
THE 1.5°C LIMIT AND RISKS OF OVERSHOOT IN THE CONTEXT OF ADAPTATION AND LOSS AND DAMAGE FOR THE MOST VULNERABLE COUNTRIES AND REGIONS

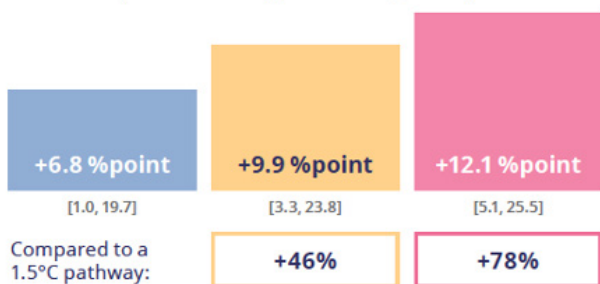
KEY MESSAGES

- With global warming continuing at an unprecedented rate, and 2023 confirmed as the hottest year on record, it is increasingly important to limit temperature rise and reduce the multidimensional and increasingly irreversible impacts of climate change. This is particularly important for the most vulnerable countries and regions such as Small Island Developing States (SIDS) and Least Developed Countries (LDCs).
- However, even if global temperature rise exceeds 1.5°C in a single year, this does not mean we have passed the Paris Agreement's warming limit, because the Paris Agreement refers to long-term (i.e., multi-decadal) global average temperature increase. Continued warming does however signal that we are heading in the wrong direction.
- Stringent mitigation in line with the Paris Agreement would require global greenhouse gas emissions to peak before 2025, and roughly halve by 2030, before reaching net zero greenhouse gas emissions in the second half of this century. Recent research confirms that this is still technically possible and that there is a good chance of 2023 having been the year when global greenhouse gas emissions peaked.
- 1.5°C-aligned action would halve the speed of global warming in the 2030s, and halt it by the middle of the century. This warming slow-down is critically important to buy time for adaptation and avoid irreversible loss and damage.
- Even if long-term temperature rise exceeds 1.5°C, ambitious mitigation can bring it back down after a temporary temperature "overshoot", limiting loss and damage in the long-term.
- However, even a temporary temperature overshoot will result in some irreversible and adverse impacts, for example on some mountain and coastal ecosystems. We will not be able to return to where we were before.
- There are already gaps between current adaptation efforts and what is needed to minimise risks and impacts. The costs of adaptation, particularly for developing countries are projected to increase, while finance flows to developing countries remain insufficient, resulting in a widening adaptation finance gap. Adaptation processes must be equitable and just, avoiding the worsening of existing vulnerabilities or giving rise to new ones. This requires new approaches for collaboration across disciplines, engaging various actors.
- SIDS and LDCs are at the forefront of climate impacts and already experience limits to adaptation across their natural and human systems, leading to loss and damage. Some adaptation limits can however be overcome by addressing a range of constraints, primarily financial, governance, institutional and policy constraints.
- Loss and damage will escalate with every increment of global warming. Seemingly small differences in warming of only fractions of a degree can have significant implications, especially in regions or countries more strongly affected or less able to respond than others, including SIDS and LDCs.

- For example, the annual expected damage from tropical cyclones in Antigua and Barbuda would increase by almost half if global warming reached 1.7°C in 2050 instead of 1.5°C, and increase by more than three quarters at 1.8°C of global warming in 2050 compared to 1.5°C.
- The number of people annually exposed to heatwaves in Senegal would meanwhile increase by almost one third under 1.7°C of global warming in 2050 compared to 1.5°C, and rise by half if warming reached 1.8°C in 2050 (see Figure).
- As damages from climate change increase, especially for the most vulnerable economies, the financial needs required to address loss and damage are growing. The dedicated loss and damage fund is expected to assist developing countries that are particularly vulnerable to the adverse effects of climate change.
- Only rapidly scaling up mitigation efforts and accelerating the implementation of available adaptation options, including adequate adaptation finance, in this critical decade, will limit the loss and damage that the fund will have to address.

Antigua and Barbuda

Annual expected damage from tropical cyclones



Senegal

Number of people annually exposed to heatwaves

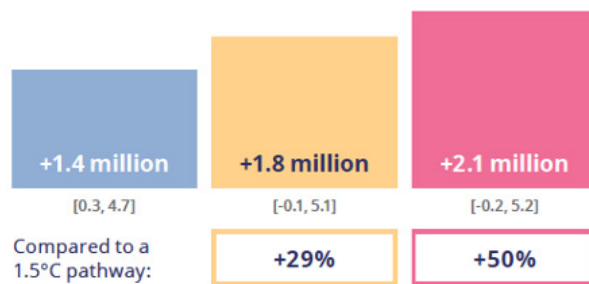


Figure: Left panel: Annual expected damage from tropical cyclones in 2050 in Antigua and Barbuda; Right panel: Number of people annually exposed to heatwaves in 2050 in Senegal; as a result of three different global warming levels in 2050 (blue: 1.5°C; orange: 1.7°C; magenta: 1.8°C).

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INTRODUCTION

Enabling adaptation and limiting loss and damage as the raison-d'être for the Paris Agreement 1.5°C warming limit.

Limiting warming reduces the consequences of climate change. As global temperatures rise at an increasing rate, even more urgent action is needed to avoid every additional fraction of a degree of warming and limit warming to 1.5°C. This will minimise the impacts, risks and costs of climate change for everyone, everywhere, but particularly for the most vulnerable people and communities on the frontlines of the climate crisis.

This briefing note considers where we are now in terms of the Paris Agreement's long-term temperature limit, and what future mitigation action could mean for adaptation and loss and damage (commonly understood as "the adverse effects of climate change

that are not or cannot be avoided by mitigation and adaptation efforts"¹), particularly for Small Island Developing States (SIDS) and Least Developed Countries (LDCs). It highlights progress and challenges, including financial, and the need for equitable and just action.

In doing so, it is important to note that both SIDS and LDCs have made negligible contributions to global warming². SIDS and LDCs have much lower per capita emissions than the global average, together contributing less than 1% of historical cumulative CO₂ emissions (1850- 2019) from fossil-fuel combustion and industrial processes. At the same time, the most vulnerable people and systems are observed to be disproportionately affected by adverse impacts and loss and damage.

1.5°C: UNDERSTANDING THE LONG-TERM TEMPERATURE LIMIT

What is the current level of global warming, where are we heading and what role does natural variability in the climate system play?

In 2021, the Intergovernmental Panel on Climate Change (IPCC) assessed that **global average temperatures** (2011-2020) were around 1.1°C higher than in the pre-industrial era (1850-1900)³. Subsequent updates⁴ put the current change in global temperatures at 1.15°C on average over the last decade.

Although these changes may seem small, 2023 has been confirmed as the **hottest year on record**. This was largely driven by a strong **El Niño** event, a natural fluctuation in the climate system that typically lasts for a few years. The current El Niño, which is expected to continue into early 2024 at least, comes on top of the long-term trend in human-driven global warming⁵.

We are already seeing devastating climate impacts at current warming levels, underscoring the importance of pursuing every effort to limit the long-term temperature increase to 1.5°C.

Yet, as of now, the world is on a path to warming of far more than 1.5°C: If current policies were followed, global warming this century would be around 3°C; this could be brought down to 2.5°C if all unconditional and conditional NDCs were implemented, and to 2°C if all net zero pledges were implemented.⁶

¹ UNEP, 2023: **Adaptation Gap Report 2023**

² IPCC, 2022: **Mitigation of Climate Change**

³ IPCC, 2021: **The Physical Science Basis**

⁴ Forster et al., 2023: **Indicators of Global Climate Change 2022**

⁵ WMO, 2024: **WMO confirms that 2023 smashes global temperature record**

⁶ UNEP, 2023: **Emissions Gap Report 2023**

What does the Paris Agreement's long-term temperature goal mean?

The 2015 Paris Agreement seeks to strengthen the global response to climate change, with a goal of “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognising that this would significantly reduce the risks and impacts of climate change”.

The Agreement reflects **global, human-made long-term temperature change** and excludes short-term natural variability in the climate system such as the current El Niño (this type of natural variability is generally the dominant cause of year-to-year changes on timescales up to a decade).

The human-made change is estimated by averaging global mean temperature change over several decades (20 to 30 years)⁷. As above, natural variability comes on top of this long-term trend (the internal variability in any single year is estimated to be $\pm 0.25^\circ\text{C}$).

The IPCC is clear: temperatures in any single year, month or location can vary above or below the long-term human-caused trend, due to substantial natural variability. As a result, the occurrence of individual years with global surface temperature change above 1.5°C (relative to 1850–1900) does not mean that 1.5°C of global warming has been reached.

This would occur only if average temperatures were at or above 1.5°C for several decades.

The dominance of natural variability on short time scales has another important implication: determining when human-made warming has reached or exceeded 1.5°C will only be possible when we can look back over temperature records for the past 20–30 years.

Which pathways can limit warming to 1.5°C (with no or limited overshoot)?

The IPCC's Working Group III report⁸ assessed more than a thousand greenhouse gas emissions pathways and what they mean for future temperature rise. These pathways have certain characteristics, for example, how likely they are to hold temperatures to certain limits, and when greenhouse gas emissions are likely to peak and reach net zero.

They also consider the extent and duration of overshooting 1.5°C. According to the IPCC, limited overshoot refers to exceeding 1.5°C by up to about 0.1°C for up to several decades, and high overshoot refers to exceeding 1.5°C by 0.1°C–0.3°C for up to several decades.

The majority of very low emissions pathways assessed by the IPCC are projected to temporarily exceed 1.5°C in their median temperature outcome – if “only” by up to 0.1°C and for a few decades – before returning back below that limit. Only a few pathways have a good chance of never exceeding 1.5°C.

There are however still pathways that limit warming and achieve net zero greenhouse gas emissions in the second half of the 21st century in line with the Paris Agreement.

In terms of greenhouse gas reductions, these pathways involve:

- Peak greenhouse gas emissions “between 2020 and at the latest before 2025”
- By 2030, almost halving greenhouse gas emissions compared to 2019 levels
- By 2035, reducing greenhouse gas emission by 60% compared to 2019 levels
- Net zero CO₂ emissions by mid-century
- Net zero greenhouse gas emissions in the early 2070s

This would limit temperature increase as follows:

- Peak temperature (maximum temperature during the 21st century): 1.6°C (range of uncertainty: 1.4–1.6°C)
- Limited overshoot of no more than 0.1°C and average overshoot duration of 27 years (range of uncertainty: 0–56 years)
- Temperature increase at the end of the 21st century of 1.2°C (range of uncertainty: 1.1–1.4°C)

Only following these emissions pathways would succeed in limiting warming in line with the Paris Agreement.⁹

⁷ The COP27 Decision of the Second periodic review of the long-term global goal reiterates that the long-term global goal is assessed over a period of decades

⁸ IPCC, 2022: **Mitigation of Climate Change**

⁹ Carbon Brief and CONSTRAIN, 2023: **Interactive: The pathways to meeting the Paris Agreement's 1.5C limit**

What would temporarily overshooting 1.5°C mean for mitigation ambition, adaptation, and loss and damage?

“Temperature overshoot” is where global average temperature rise exceeds a specific limit, such as 1.5°C, before it is brought back down below that limit. To meet the Paris Agreement goal, any potential overshoot above 1.5°C must still remain “well below 2°C”.

However, even a temporary temperature overshoot would have implications for international efforts on mitigation, adaptation, and loss and damage¹⁰.

Continuing delays to stringent climate **mitigation** is increasing the possibility of at least a temporary overshoot of 1.5°C. In comparison, ambitious action in the short-term to peak greenhouse gas emissions before 2025 would strongly limit the risk of overshooting 1.5°C.

Recent research indicates that there is a good chance that greenhouse gas emissions peaked in 2023 and that 2024 will be the first year that we see globally declining greenhouse gas emissions, if recent rollout rates of renewable energy and electric vehicles are maintained and efforts are made to cut methane and other non-CO₂ gases¹¹.

After emissions peak, they need to halve by 2030, before reaching and sustaining net-zero – in line with the Paris Agreement's mitigation ambition (Article 4 of the Paris Agreement). This would then lead to a decline in long-term temperatures. If temperatures do overshoot 1.5°C, reaching net zero greenhouse gas emissions would mean that temperatures would eventually be brought back down below 1.5°C.

Non-CO₂ greenhouse gases like methane will meanwhile play a crucial role in determining the warming trend into the 2030s: strong emissions cuts would limit warming in the near-term, and reduce the risk of overshooting 1.5°C (or both limit and delay it).

Bringing temperatures back down after a potential overshoot will also require the deployment of carbon dioxide removal (CDR) options, but this comes with feasibility and sustainability constraints as acknowledged in the IPCC Working Group III report¹². Stringent mitigation, starting now, will reduce the need to rely on CDR in future.

As well as limiting overshoot, stringent mitigation could slow down the pace of warming as early as the 2030s, thus buying time for **adaptation** efforts. This would reduce the risk of human and natural systems reaching their adaptation limits.

Mitigation efforts that focus on limiting temperature rise to 1.5°C in the long run, or lowering temperatures again after an initial overshoot, would also reduce risks from climate change and lead to less **loss and damage** in the long-term, but would do little to minimise loss and damage in the next 30 years.

Also, some consequences of overshoot will be irreversible for certain polar, mountain, and coastal ecosystems, for example due to ice sheet and glacier melt and sea level rise. Processes such as the thawing of permafrost will also exacerbate impacts through the release of additional greenhouse gases. In other words, we will not be able to return to where we were before.

In summary, near-term action that limits global warming to 1.5°C would reduce future loss and damage (but cannot eliminate it), whereas exceeding 1.5°C of warming could result in irreversible losses, including species extinctions and the loss of ecosystems and the services that they provide, or reaching some “tipping points” in the climate system.

¹⁰ CONSTRAIN, PROVIDE, ESM2025, 2023: **The risks of temperature overshoot. Submission to the first Global Stocktake**

¹¹ Climate Analytics, 2023: **When will global emissions peak?**

¹² IPCC, 2022: **Mitigation of Climate Change**

ADAPTATION IN SMALL ISLAND DEVELOPING STATES (SIDS) AND LEAST DEVELOPED COUNTRIES (LDCs)

Adaptation progress and challenges

The IPCC Working Group II report¹³ warns that as global warming intensifies, the risks posed by climate change will become more complex and harder to manage. The interplay between multiple climatic and non-climatic risk factors will exacerbate overall risks, leading to cascading impacts across various sectors and regions.

The IPCC Synthesis Report also identifies persistent challenges, noting that many adaptation efforts remain fragmented, incremental, and focused on specific sectors, with an uneven distribution across various regions.

This highlights a widening gap between current adaptation activities and what is necessary to effectively respond to climate challenges.

The IPCC report also draws attention to the phenomenon of "**maladaptation**," which disproportionately impacts marginalised and vulnerable groups such as SIDS and LDCs. Maladaptation occurs when adaptation actions, designed with a narrow focus and a short-term perspective, inadvertently entrench vulnerabilities, exposures, and risks, creating difficulties that are hard to reverse.

In addition, the IPCC expresses concern that the efficacy of adaptation strategies is likely to diminish as global warming escalates. This makes it even more crucial to prioritise closing adaptation gaps and circumventing maladaptation.

Nonetheless, these efforts are impeded by several barriers, including limited resources, insufficient private sector and citizen engagement, inadequate financial mobilisation, low levels of climate literacy, lacklustre political commitment, constrained research capacity, and a slow and limited adoption of adaptation science.

Equitable and just adaptation

The IPCC Working Group II report emphasised the need for an adaptation process that is equitable and just, supported by strong multi-level governance and decision-making that encourages widespread participation and incorporates diverse knowledge systems, particularly including Indigenous and local knowledge.

The report underscores the critical need to avoid interventions that might worsen existing vulnerabilities or give rise to new ones, and to be wary of maladaptive responses that could heighten inequity and sideline vulnerable groups. It further recognizes the perpetuation

of existing or historical power dynamics, like colonial legacies, as significant obstacles to achieving climate-resilient development.

To confront these challenges, alongside new climate science, innovative, dynamic and integrated ways of working together across disciplines are needed, engaging various actors to create a shared understanding of a common desired future. Such inclusive approaches are not yet sufficiently widespread, or adopted at the scale necessary, to meet the urgency of the challenge.

In line with this, IPCC Working Group II stresses the fundamental need to develop new methods of transdisciplinary collaboration. These methods should promote meaningful participation and tailor climate science to meet the specific needs of decision-makers. Such approaches must also weave together social, cultural, and governance considerations, as well as Indigenous, local, and scientific knowledge, to fully grasp dwindling opportunities to foster climate-resilient development.

Adaptation finance for SIDS and LDCs

According to the IPCC Working Group II report, adaptation finance to date has come predominantly from public sources. Public adaptation finance flows to developing countries were estimated at US\$21 billion in 2021 by the UNEP 2023 Adaptation Gap Report¹⁴, but have however declined since 2020, and disbursement of international public adaptation finance is lower (66%) than the disbursement of overall development finance (98%).

Adverse climate impacts can meanwhile reduce the availability of financial resources by incurring loss and damage and impeding national economic growth. This would further increase financial constraints for adaptation, particularly for developing and least developed countries.

According to the Adaptation Gap Report, the cost of adaptation is estimated to be between US\$215-387 billion/year for developing countries this decade, equivalent to 0.6-1.0% of all developing countries' gross domestic product (GDP) combined. These adaptation costs are projected to rise significantly by 2050 because of growing climate risks.

The costs/needs of adaptation relative to these public finance flows are called the **adaptation finance gap**. This gap is currently 10–18 times as much as international public adaptation finance flows. A widening gap indicates a deepening climate crisis, and will mean increased loss and damage.

¹³ IPCC, 2022: **Impacts, Adaptation, and Vulnerability**

¹⁴ UNEP, 2023: **Adaptation Gap Report 2023**

LOSS AND DAMAGE IN SMALL ISLAND DEVELOPING STATES (SIDS) AND LEAST DEVELOPED COUNTRIES (LDCs)

The concept of loss and damage

The UNEP 2023 Adaptation Gap report states that, in practice, loss and damage is most commonly understood as “the adverse effects of climate change that are not or cannot be avoided by mitigation and adaptation efforts”.

IPCC Working Group II assesses this broadly as harm from (observed) impacts and (projected) risks, which can be economic or non-economic.

- *Economic* loss and damage includes impacts that can be assigned a monetary value, such as damage to infrastructure or loss of earnings or productivity.
- *Non-economic* loss and damage covers a range of outcomes that are not easily assigned a monetary value and are not subject to market transactions. These include: loss of life, health, rights, territory, cultural heritage, indigenous knowledge, biodiversity loss and loss of ecosystem services.

A justice lens underscores that loss and damage is not the product of climate hazards alone but is influenced by differential vulnerabilities to climate change. These in turn are often driven by a range of sociopolitical processes, including racism and histories of colonialism and exploitation.

The IPCC stresses that human-induced climate change has already caused “losses and damages to nature and people”. It further states that “losses and damages are unequally distributed across systems, regions and sectors and are not comprehensively addressed by current financial, governance and institutional arrangements, particularly in vulnerable developing countries”^{13,14}.

Loss and damage finance

The UNEP 2023 Adaptation Gap report estimates that, over the past 2 decades, damages in the 55 most vulnerable economies exceeded US\$500 billion. The costs are expected to rise in the future, particularly in the absence of strong mitigation and adaptation.

Since the financial needs for addressing loss and damage are likely to grow significantly in the future, applying and scaling up existing sources of finance (such as grants, insurance and concessional loans) and exploring innovative sources of finance (such as marine shipping levies, aviation levies, taxation, debt relief, debt swaps and special drawing rights) will be essential.

¹³ IPCC, 2022: *Impacts, Adaptation, and Vulnerability*

¹⁴ UNEP, 2023: *Adaptation Gap Report 2023*

THE 1.5°C LIMIT IN THE CONTEXT OF NEAR-TERM MITIGATION, ADAPTATION AND LOSS AND DAMAGE

What difference can strong mitigation make in the near-term?

The IPCC Working Group III report demonstrates how different societal choices translate into emissions and temperature change, showcasing alternative futures.

There are still pathways compatible with limiting warming to 1.5°C (see section “Which pathways can limit warming to 1.5°C (with no or limited overshoot?)”). These reflect worlds in which there is a heavy reliance on renewable energy, low energy demand, and a broader shift towards sustainable development. **These pathways all include a phase-out of fossil fuels.** Energy supply is primarily met with renewables, as well as biomass (non-traditional), with very little or next-to-no nuclear energy.

These 1.5°C-compatible pathways slow down the rate of global warming between now and 2050 (Figure 1). In fact, **the current warming rate of around 0.2°C per decade could well be halved in the 2030s**, and warming could be halted or even begin to reverse by the middle of the century. In contrast, delaying strong action to mid-century would also mean a delay in slowing down warming, while following current climate pledges would mean warming essentially continuing at its current and very high rate.

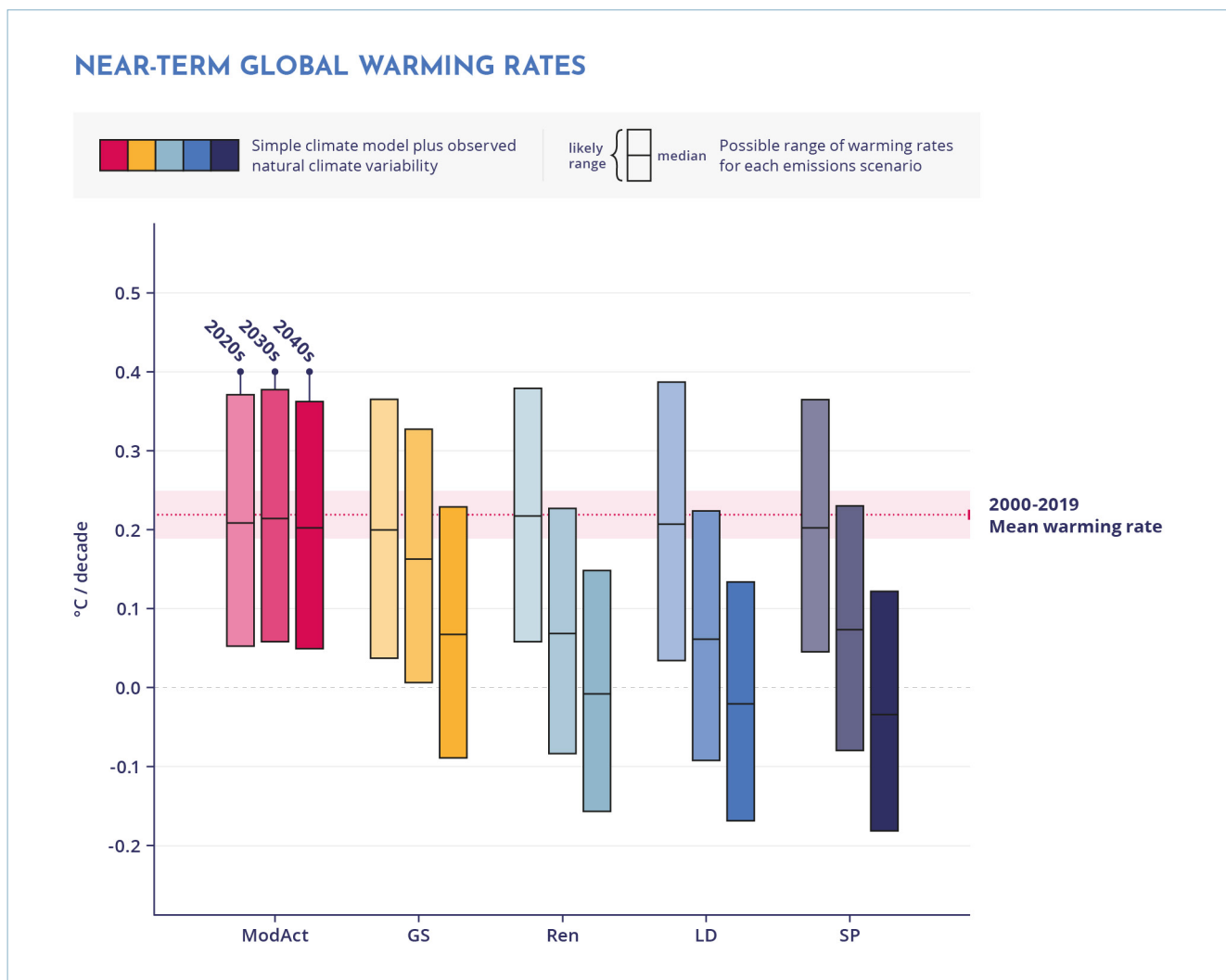


Figure 1: Warming per decade up to 2050 of selected illustrative pathways (sustainable development – SP; low energy demand – LD; renewable energy – Ren; gradual strengthening of current policies – GS; and the reference pathway for moderate action – ModAct). From¹⁵.

What difference do incremental temperature changes make to climate impacts?

With global warming continuing at an unprecedented rate¹⁶, it is increasingly important to evidence how limiting temperature rise can reduce the multidimensional impacts of climate change for the most vulnerable countries and regions.

The IPCC's Working Group II report reiterates this, stating with very high confidence (at least a 9 out of 10 chance) that: "[...] projected adverse impacts and related losses and damages escalate with every increment of global warming."¹⁷

The relatively small differences in warming rates over the coming decades set out above, and in absolute warming by 2050, can have significant implications for climate impacts (Figure 2).

In other words, every fraction of avoided warming matters. This is especially true for regions or countries that are more strongly affected or less able to respond than others, with the most vulnerable people and systems disproportionately affected by adverse impacts and loss and damage.¹⁸

¹⁶ Forster et al., 2023: *Indicators of Global Climate Change 2022*

¹⁷ IPCC, 2022: *Impacts, Adaptation and Vulnerability*

¹⁸ IPCC, 2022: *Impacts, Adaptation and Vulnerability*

ILLUSTRATIVE 2050 CLIMATE IMPACTS

■ 1.5°C of 2050 global warming | ■ 1.7°C of 2050 global warming | ■ 1.8°C of 2050 global warming

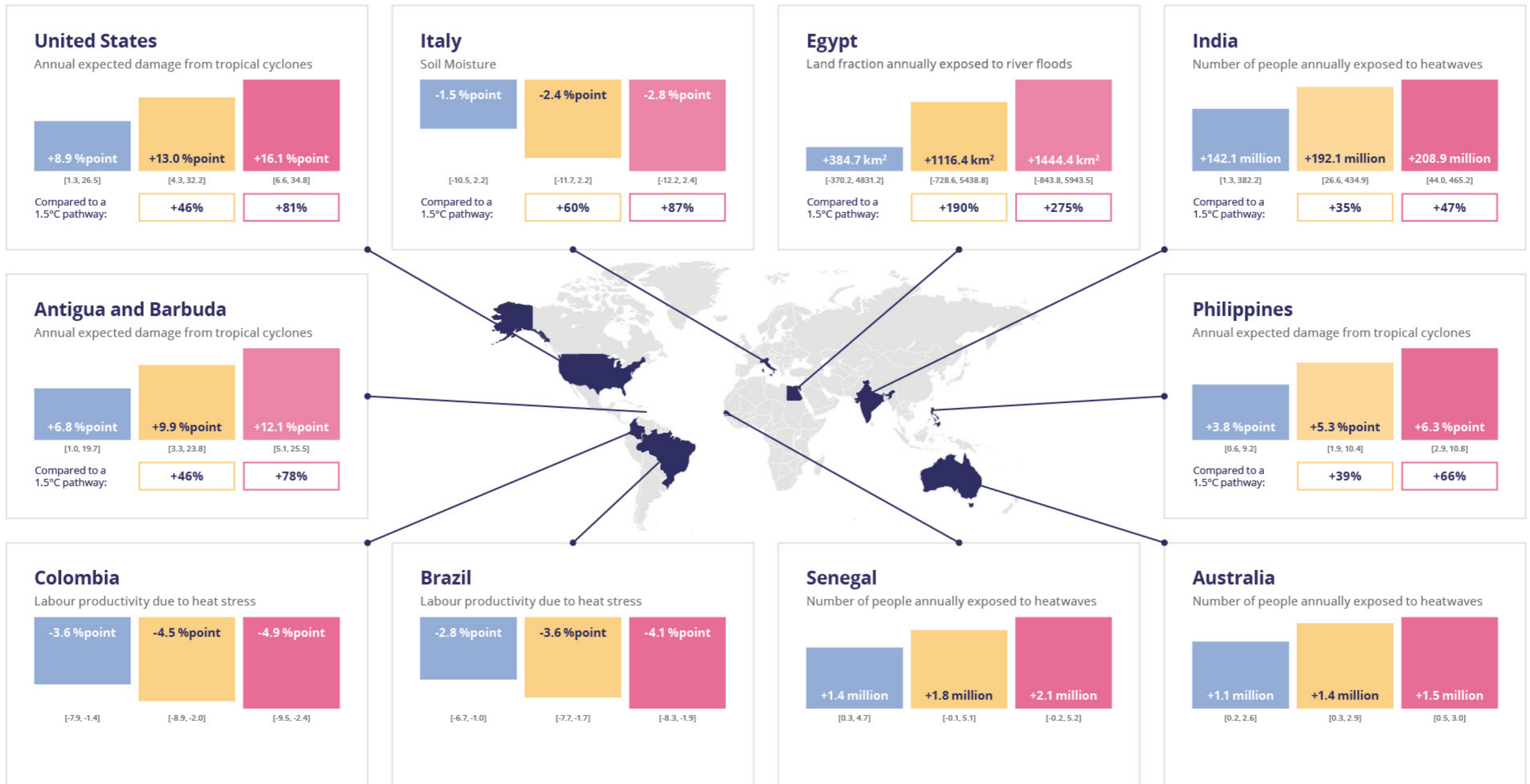


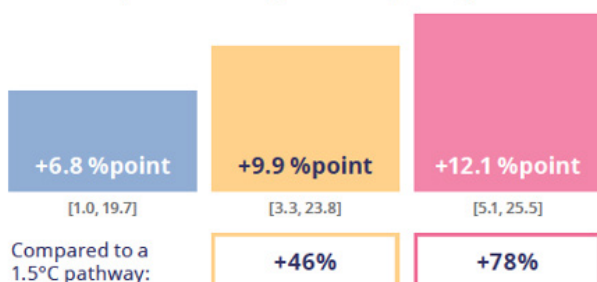
Figure 2: Examples of climate impacts in 2050 as a result of three different global warming levels in 2050 (blue: 1.5°C; orange: 1.7°C; magenta: 1.8°C) in different countries. Results are presented in either absolute terms or changes in percentage points relative to the 1986-2005 reference period (median; 90% uncertainty range in square brackets). Relative differences in 2050 impacts compared to the 1.5°C pathway are based on data from the Climate Impact Explorer¹⁹. From²⁰.

¹⁹ Climate Analytics: Climate impact explorer

²⁰ CONSTRAIN, 2022: ZERO IN ON The Critical Decade

Antigua and Barbuda

Annual expected damage from tropical cyclones



Senegal

Number of people annually exposed to heatwaves

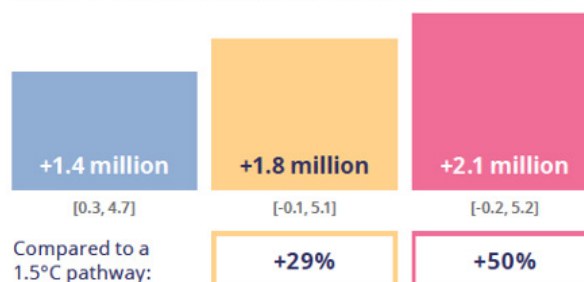


Figure 3: Excerpt of Figure 2 for Antigua and Barbuda, Senegal.

Differences in impacts at even incrementally different levels of global warming are evident in SIDS and LDCs (Figure 3). For example, the annual expected damage from tropical cyclones in Antigua and Barbuda would increase by almost half if global warming reached 1.7°C in 2050 instead of 1.5°C, and increase by more than three quarters at 1.8°C of global warming in 2050 compared to 1.5°C.

For Senegal, the number of people annually exposed to heatwaves would increase by almost one third under 1.7°C of global warming in 2050 compared to 1.5°C, and increase by half with 1.8°C instead of 1.5°C.

In addition, the IPCC highlights that limits to adaptation are already being experienced at current levels of global warming and that additional limits will be reached at

global average temperatures above 1.5°C.

Recent research²¹ also highlights the unavoidable impacts of sea level rise for SIDS even under 1.5°C warming, but also underscores how negative impacts can still be avoided with urgent climate action.

Such information can therefore be used to highlight the avoidable climate risks that regions and countries could face in the coming decades, and provide strong science-based arguments for keeping the Paris Agreement's 1.5°C warming limit, and 1.5°C-compatible emissions pathways, on the table.

²¹ Martyr-Koller and Schleussner, 2023: Coastal loss and damage for small islands