CLIMATE ANALYTICS

1.5°C to survive

Evidence from the IPCC Special Reports

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1.5°C to survive

Evidence from the IPCC Special Reports

This briefing summarises the impacts of global warming at and above 1.5°C relative to pre-industrial levels. Key information is extracted from the Special Reports of the Intergovernmental Panel on Climate Change (IPCC) of its sixth assessment report cycle (AR6). These Special Reports are:

- *The Special Report on the Impacts of Global Warming of 1.5°C* (SR1.5) from 2018, and

- *The Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (SRLand) from 2019.

- *Special Report on the Ocean and Cryosphere in a Changing Climate* (SROCC) from 2019.

These Special Reports represent an invaluable resource to understand the impacts of exceeding 1.5°C and new science published after their compilation has only contributed to an ever clearer picture of the grave consequences of exceeding that limit. In addition to the overview on climate impacts based on the Special Reports, latest information on global mitigation efforts and requirements to meet the 1.5°C limit are also included.

Summary

The 1.5°C limit means we can avoid the worst of the climate crisis

The IPCC Special Reports SR.15 and SRLand are clear: limiting warming to 1.5°C can avoid the worst impacts of climate change. Compared to 2°C of warming, 1.5°C would see much less severe extreme events, for example mid-latitude heat waves would be 1°C colder on average. There would also be fewer disruptions to human and ecological systems – crop yield change would affect 158 million fewer people. Limiting warming to 1.5°C means substantially fewer people would be impacted by water scarcity, lack of food security and extreme poverty.

The 1.5°C warming limit is still within reach

Limiting warming to below 1.5°C is still possible but requires very urgent and rapid action now. Stringent emission reductions need to take place in the very near-term to halve current projections for 2030 CO_2 emissions. 1.5C pathways require CO_2 emissions to peak now and reach net zero by mid-century, with total greenhouse gases quickly following suit in the second half of this century.

Are we on track for 1.5°C?

The world is not on track for 1.5°C and most countries still lack sufficient climate targets. Recent updates to national climate targets presented at the US Climate Leaders' Summit are a step forward to limiting warming to 1.5°C. The Climate Action Tracker calculates that the impacts of these updates reduce estimated end of century warming to 2.4°C, meaning we are closer to the 1.5°C temperature goal than ever before. These recent updates to national targets have reduced the emissions gap (the gap between current policy projections' 2030 emissions and a 1.5°C trajectory) - by 11-14% (2.6-3.9 $GtCO_2e$). However, a large gap of 20-23 $GtCO_2e$ remains.

Overview of 1.5°C projected impacts

The two Special Reports looked at for this brief highlight a number of climate change impacts and irreversible losses that could be avoided by limiting global warming to 1.5°C compared to higher degrees of warming.

The IPCC Special Reports reveal the benefits of ambitious mitigation and effective adaptation for sustainable development and the escalating costs and risks of delayed action. More and more limits to adaptation are reached and exceeded if warming exceeds 1.5°C. See our table comparing specific climate impacts of 1.5°C versus 2°C of warming.

Increasing intensity and frequency of extreme events

The frequency, intensity and duration of many extreme events have already increased in many parts of the world, especially heatwaves, droughts and heavy precipitation events.

Temperature extremes are projected to increase by several degrees for 1.5°C of global warming and ocean marine heatwaves are 20 times more frequent by 2081-2100 relative to 1850-1900. Substantial changes in precipitation patterns such as droughts and heavy rainfall events increase in frequency and intensity with global warming and degrade terrestrial ecosystems, leading to desertification and increased food insecurity. A large number of people living in drylands are projected to be vulnerable to water stress, drought intensity and habitat degradation by 2050.

Sea-level rise and ocean acidification will affect large areas of human and ecological systems

Sea level is projected to rise by 0.26 to 0.77 m by 2100 at 1.5°C (relative to 1986-2005). However, there is *high confidence* that sea level will continue to rise well beyond 2100 and reach higher levels by 2300 for 1.5°C.

Human and ecological systems, including health, heritage, freshwater availability, biodiversity, agriculture, fisheries and other services, are projected to be affected by this sea level rise. Concerning ocean acidification, it is *virtually certain* that continued carbon uptake by the ocean is projected to increase ocean surface layer acidity (decrease pH) until at least mid-century for 1.5°C of warming scenarios, adversely affecting a broad range of marine species.

Climate change as a poverty multiplier

Human societies are impacted particularly through water scarcity, lack of food security, and health. Poorer populations are especially vulnerable to these impacts. Climate change is expected to force several millions of people into extreme poverty. The number of people both exposed to climate-related risks and susceptible to poverty would be substantially lower under 1.5°C than higher degrees of warming.

Projected impacts on the cryosphere

The likelihood of an Arctic ocean that is free of sea ice in summer would be once per century for 1.5°C of warming, compared to at least once per decade under 2°C warming. The risks for permafrost degradation are already *high* at 1.5°C and assessed *very high* if warming exceeds 2°C, indicating great risks of irreversible losses.

Increasing damage to ecosystems and loss of biodiversity

Species loss and extinctions are projected to increase with further warming. At 1.5°C of warming, ecosystems will be experiencing increasing amounts of damage and many marine species are expected to shift to higher latitudes.

Coral reefs would decline by 70-90%, whereas virtually all (>99%) would be lost under 2°C. High-latitude tundra and boreal forests are particularly at risk of climate change-induced degradation and loss. There is *high confidence* that desertification will reduce the provision of dryland ecosystem services and ecosystem health, including losses in biodiversity.

Food security at increasing risk

Climate change is projected to cause global reductions in crop and livestock productivity, with risks to food systems becoming increasingly severe with increasing temperatures. Food systems, and therefore food security, will be increasingly affected by projected future climate change. There is *high confidence* that low-income consumers are particularly at risk.

How can we limit warming to 1.5°C?

The IPCC *Special Report on the Impacts of Global Warming of 1.5°C* is clear that limiting warming to 1.5°C above pre-industrial is still possible even when accounting for uncertainties and feedbacks in the climate system, for example from the carbon cycle and aerosol forcing.

With stringent emission reductions in the very near-term, it is still possible to limit warming to below 1.5°C. If we fail to get the world on a 1.5°C track, 1.5°C would be reached between 2030 and 2050 following current warming rates. Stringent emission reductions in line with 1.5°C would also have significant near-term benefits, potentially halving the warming rate already over the next two decades.

Emission reductions in the next decade are critical to limiting warming to 1.5°C

Near-term emission reductions are crucial to limit warming to 1.5°C. To avoid overshooting the limit we must reduce greenhouse gas emissions to 25-30 $GtCO_2e$ per year by 2030.

Net zero CO_2 emissions by mid-century

Limiting warming to 1.5°C implies reaching net zero CO_2 emissions globally around mid-century alongside deep reductions in emissions of non-CO_2 forcers, particularly methane. Fossil fuel (coal, oil, gas) phase out is a must to limit warming to 1.5°C.

Do we need CDR?

Carbon Dioxide Removal (CDR) describes technologies that deliberately remove atmospheric CO_2 and store it in land, ocean or geological reservoirs. The IPCC links large amounts of CDR to 1.5°C pathways (up to unsustainable amounts of several $GtCO_2$ per year).

However, **new science** demonstrates that the scale of CDR in IPCC pathways is much less dependent on our chances to limit warming to 1.5°C, than on model specific and long-term assumptions in emission scenarios towards 2100.

What is a 1.5°C pathway?

The IPCC has defined 1.5°C pathways to *as likely as not* limit warming to 1.5°C, which means there is a good chance of meeting this target if emissions follow these pathways.

1.5°C pathways are also referred to as 'no or low overshoot' pathways in the reports, classifying by how much peak warming could overshoot the actual warming limit.

The IPCC SR1.5 has not identified any pathways that provide a *likely* (>66%) chance to limit warming to 1.5°C throughout the 21st century.

See more on the Paris Agreement and the feasibility of 1.5°C here

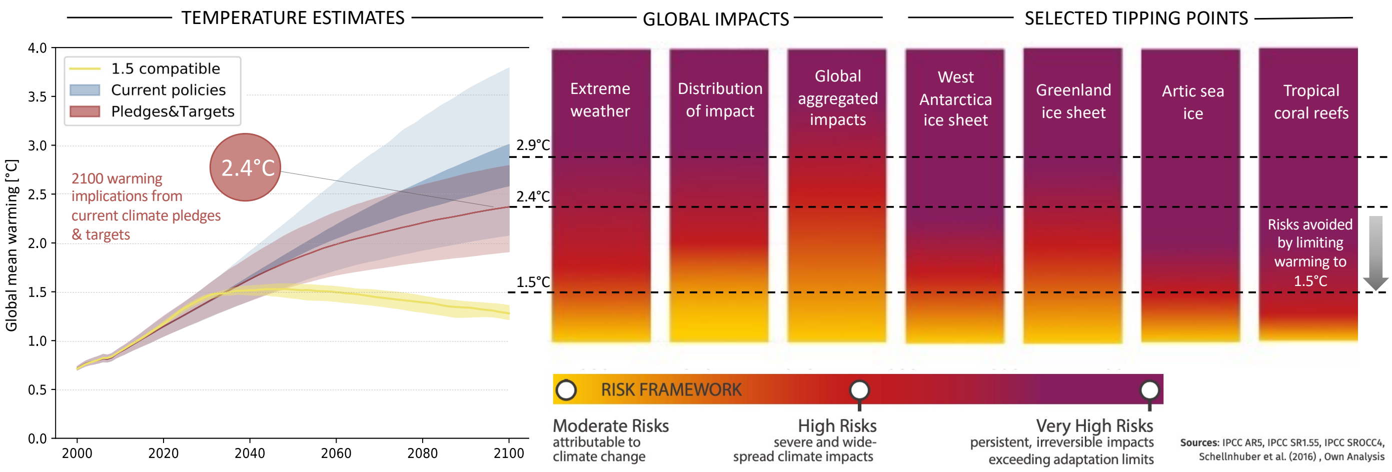
Are we on track for 1.5°C?

Current climate pledges and targets imply an estimated end of century warming of 2.4°C – a long way from 1.5°C.

Recent updates at the US Climate Leaders' Summit in April 2021 and announcements from other countries since September 2020 have narrowed the gap in emissions between what climate targets promise to deliver by 2030 and what they would need to be to limit warming to 1.5°C by around 11-14% (2.6-3.9 $GtCO_2e$), according to the [Climate Action Tracker](). This has lowered projected warming from pledges from 2.6°C to 2.4°C, an improvement of 0.2°C. This is a step forward, but not enough.

The end of century warming estimate from current policies is 2.9°C, nearly twice what it should be. A number of countries including Australia, Brazil, Mexico, India and Turkey are still lacking sufficient climate targets. While the 2030 emissions gap has significantly narrowed, around 20-23 $GtCO_2e$ remain.

The Figure below shows the difference in risk from current climate targets versus warming of 1.5°C.



Projected impacts and risks of 1.5°C versus 2°C of global warming in 2100

Projected impacts and risks	1.5°C	2°C
Temperature extremes	Increases of up to 3°C in the mid-latitude warm season and up to 4.5°C in the high-latitude cold season.	Increases of up to 4°C in the mid-latitude warm season and up to 6°C in the high-latitude cold season.
Frequency of sea ice free Arctic summers	One sea ice-free Arctic summer per century	One sea ice-free Arctic summer per decade
Global changes in urban population exposure to severe drought	350.2 ± 158.8 million	410.7 ± 213.5 million
Increase in the population affected by river flooding compared to 1976-2005	100% increase	170% increase
Species loss	6% insects, 4% vertebrates, 8% plants	18% insects, 16% vertebrates, 8% plants
Arctic permafrost thaw	21-37%	35-47%
Coral reef loss	70-90%	>99%
Decrease in global annual catch for marine fisheries	1.5 million tonnes	> 3 million tonnes
Coastal area exposed to flooding (assuming no defences)	562–575 thousand km^2	590–613 thousand km^2
Coastal population exposed (assuming no defences)	128–143 million	141–151 million
Number of people both exposed to climate-related risks and susceptible to poverty	Reduced by 62 to 457 million for 1.5°C compared to 2°C	

Projected impacts and risks of 1.5°C versus 2°C of global warming in 2100 cont.

Projected impacts and risks	1.5°C	2°C
People exposed and vulnerable to crop yield change under the 'Regional Rivalry Scenario' (SSP3)	20 million	178 million
World population exposed to new or aggravated water scarcity	Additional 4% from 2000 levels	Additional 8% from 2000 levels
Dryland population exposed and vulnerable to water stress under the 'Sustainability Scenario' (SSP1), in 2050	2 %	3 %
Dryland population exposed and vulnerable to water stress under the 'Regional Rivalry Scenario' (SSP3), in 2050	20 %	22 %
People exposed to habitat degradation in non-dryland regions under the 'Sustainability Scenario' (SSP1)	Less than 100 million	257 million
People exposed to habitat degradation in non-dryland regions under the 'Regional Rivalry Scenario' (SSP3)	107 million	1 156 million
Dryland population vulnerable to water stress, drought intensity and habitat degradation in 2050 under the 'Middle of the Road Scenario' (SSP2)	178 million	220 million
Global mean sea level rise in 2100 compared to 1986-2005	0.26 to 0.77m higher	0.04 to 0.16m higher

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