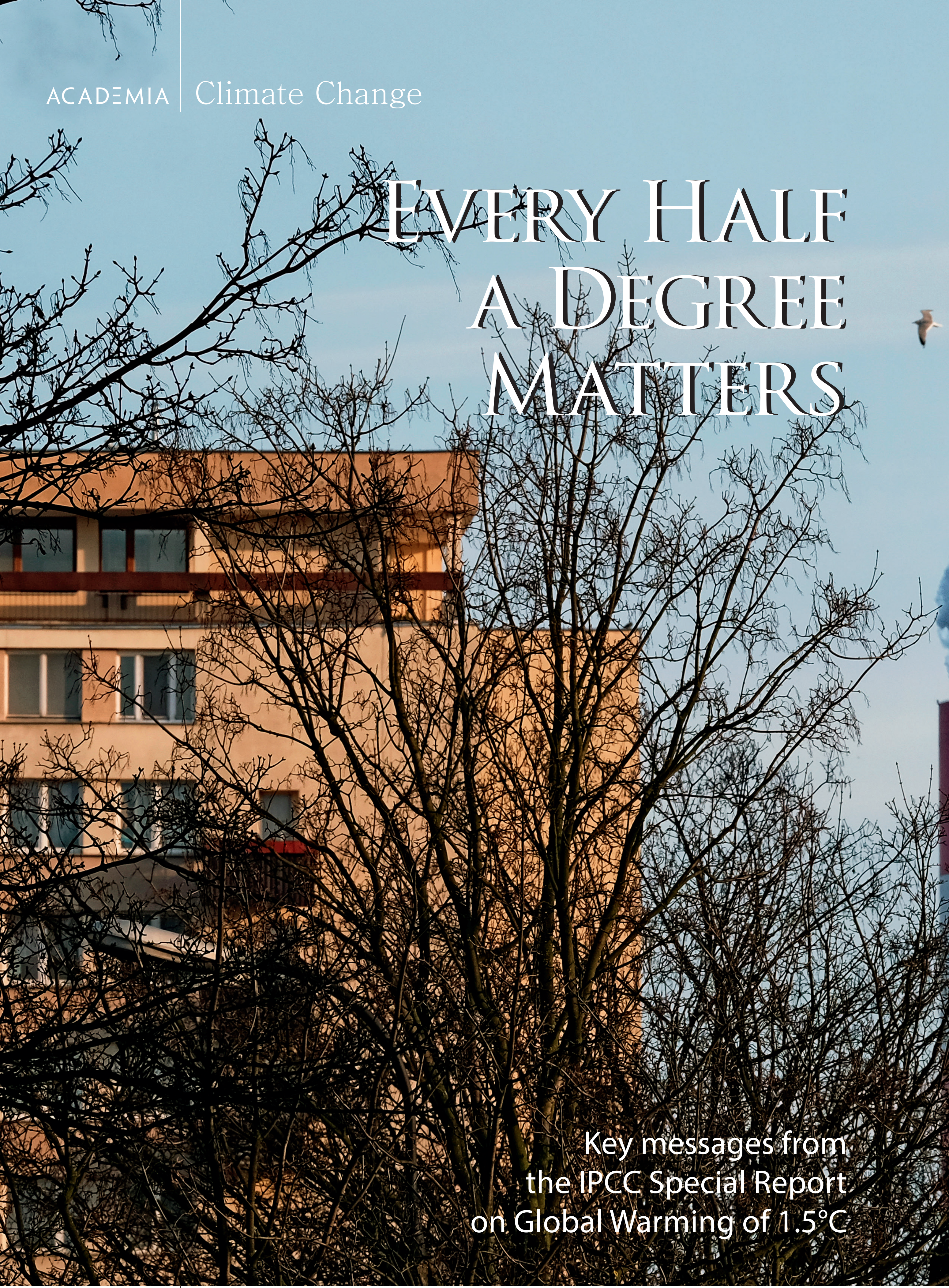

Every Half a Degree Matters

Key messages from the IPCC Special Report on Global Warming of 1.5°C

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- Climate change is already affecting people, ecosystems and livelihoods all around the world.
- In terms of climate-related risks, there are clear benefits to keeping warming to 1.5°C compared to 2°C, or higher. Every half a degree matters.
- Limiting warming to 1.5°C is not impossible but would require unprecedented transitions in all aspects of society. Every year matters.
- Limiting warming to 1.5°C can go hand-in-hand with achieving other world goals, such as achieving sustainable developments and eradicating poverty. Every choice matters.

Context

This IPCC Special Report has been prepared in response to an invitation by governments, through the Decision of COP21 of the United Nation Framework Convention on Climate Change in December 2015. This request arose out of the concerns of about 100 countries that the long-term goal of the Paris Agreement, keeping global warming to well below 2°C above pre-industrial levels, may not be sufficient to prevent dangerous climate change, and from the lack of scientific knowledge on differences in impacts for 1.5°C and 2°C of global warming, and differences in compatible greenhouse gas emission pathways.

The invitation was accepted by the Panel during its spring 2016 Plenary, where government delegates defined the full mandate of this report to be "An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty." The IPCC decision to strongly link the assessment not just to climate change but also to the multiple aspects of sustainability has guided the design of the structure of the report, and shaped novel aspects of the assessment of the state of knowledge, for instance the systematic exploration of synergies and trade-offs between mitigation and adaptation response options, and sustainable development goals.

The enthusiastic response of the international research community to produce and publish timely new knowledge has been instrumental in the new information provided in the report. There has also been extraordinary motivation shown by scientists worldwide to participate in the scoping, preparation and review of the report.

The report has been prepared by 91 authors from 40 countries, with support from 133 contributing authors. They have performed an assessment of about 6,000 scientific, technical and socio-economic publications, 75% of them published in the last 3 years. The IPCC strives to perform assessments of the state of knowledge that are rigorous, exhaustive, transparent and objective. More than 42,000 review comments received by 1,131 reviewers in the three-step review process fully contributed to the quality of the final report.

Where are we?

Since pre-industrial times, approximated in this report as 1850–1900, human activities have caused approximately 1.0°C of global warming, with a *likely* range of 0.8°C to 1.2°C.

We are already seeing the consequences of 1°C of global warming through more extreme weather such as heat waves and heavy rainfall events, rising sea levels and diminishing Arctic sea ice extent, among other changes.

If the world continues to warm at its current rate, at 0.2°C per decade, global mean surface temperature is *likely* to reach 1.5°C between 2030 and 2050.

Although past emissions from pre-industrial times to the present will continue to cause further changes in the climate system and committed future sea level rise, these past emissions alone are *unlikely* to cause global warming of 1.5°C.

There is still a window of opportunity to stabilise global warming to 1.5°C, depending on the pathway of global greenhouse gas emissions and primarily emissions of CO_2 due to the combustion of fossil fuels in the next decade.

Reducing emissions of CO_2 to net zero is key for climate stabilisation, due to the relationship between the level of global warming and cumulative CO_2 emissions. Faster immediate CO_2 emission reductions limit cumulative emissions. The future peak level of warming is determined by cumulative net CO_2 emissions, and by net non-CO_2 radiative forcing (impact on the

Where is the full report?

The full report is available here : www.ipcc.ch/report/sr15. It includes a Summary for Policy Makers, 10 Frequently Asked Questions, a Glossary and 5 chapters.

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Earth's radiative budget) due to methane, nitrous oxide, aerosols and other anthropogenic forcing agents. Reducing the net climate effect of non-CO_2 emissions is also crucial for climate stabilisation.

Where do we want to go?

Global climate models project robust differences in climate between present-day and global warming of 1.5°C, and between 1.5°C and 2°C. In all cases, the intensity of warming is larger over land than oceans, and amplified in the Arctic region.

Changes in precipitation are spatially heterogeneous. Climate models project an increase in annual mean precipitation in cold regions, where a warmer atmosphere can hold more moisture, and a decrease in precipitation in areas with a Mediterranean climate today, due to changes in large-scale atmospheric circulation. The projections of reduced annual precipitation amounts for each additional 0.5°C of warming are particularly clear around the Mediterranean Sea, in South Europe, the Middle East, and North Africa.

Climate models also project a marked increase in the number of hot days, especially in tropical areas, an increase in the temperature of hottest days, especially over land areas, and in the temperature of coldest nights, especially in north Europe and around the Arctic region. In several regions, climate models project an increase in the severity of heavy rainfall events, and an increase in the probability of drought.

Regional climate change hotspots have been identified, and they are projected to intensify with the level of global warming. These regions include the Arctic sea-ice and land areas, with losses of habitats for specific species and biome shifts; Alpine regions, with biome shifts; the Mediterranean area, with increased risks of extreme drought, runoff decrease and water deficit; the tropics, with increases in heat waves and risks for livestock heat stress and human health, key crop yields, and loss of biomass in some rainforests; South East Asia, with increased risk of flooding due to sea level rise and intensification of heavy precipitation, as well as projected crop yield reductions; West Africa and the Sahel, with increased risks associated with heatwaves as well as projected reductions in areas suitable for maize and sorghum production, implying increased under-nutrition risks; Southern Africa, with projected reductions in water availability, heat stress, increased mortality from heat waves, and high risk of under-nutrition for population depending on dryland agriculture and livestock. Small islands are exposed to compound risks of land exposed to inundation, enhanced coastal flooding, freshwater stress, increased number of warm days and persistent heat stress for cattle; and severe degradation of coral reefs and loss of their ecosystem services.

Based on new evidence, the report has revised upwards climate-related risks for warm water corals, mangroves, small scale low latitude fisheries, terrestrial ecosystems, coastal flooding, fluvial flooding, reduced crop yields, tourism (including snow tourism), and heat related morbidity and mortality for a global warming between 1°C, 1.5°C and 2°C. By 2100, global mean sea level rise would be around 10 cm lower with global warming of 1.5°C compared to 2°C. This would mean up to 10 million fewer people exposed the risk of rising seas, but still around 100 million people facing related adaptation needs.

The pledges that governments have made over the last three years about their mitigation ambitions are not enough to keep warming below 1.5°C.

Loss of biodiversity and species extinction are projected to be lower with global warming of 1.5°C compared to 2°C. Limiting warming to 1.5°C compared with 2°C would mean smaller reductions in yields of maize, rice, wheat, and potentially other cereal crops, particularly in sub Saharan Africa, Southeast Asia, and Central and South America. The proportion of the world population exposed to climate-change induced water shortages would be up to 50% less with global warming of 1.5°C compared to 2°C.

Importantly, this special report highlights how all of these things affect people's lives and livelihoods around the world. For example, the impacts of climate change in the ocean are increasing risks to fisheries and livelihoods that depend on them. Limiting global warming to 1.5°C compared to 2°C could reduce the number of people exposed to climate-related risks and susceptible to poverty by up to several hundred million by 2050. It would imply lower risks for health, livelihoods, food security, water supply, human security and economic growth, especially in tropical regions. At 1.5°C of global warming, disproportionately high risk is identified for Arctic, dryland regions, small-island developing states and the least developed countries.

To limit global warming to 1.5°C, global emissions of carbon dioxide would need to reach "net zero" around 2050. This means that any remaining emissions would need to be balanced by removing carbon dioxide from the air.

A wide range of adaptation options can reduce climate risks, if implemented. Adaptation needs are less at 1.5°C compared to 2°C. There is a lack of scientific knowledge about the costs of adaptation, and about the costs of losses and damage when adaptation limits are exceeded.

A summary for urban policy makers (adaptation of SR1.5°C):
https://www.globalcovenantofmayors.org/wp-content/uploads/2018/12/Summary-for-Policy-Makers_Final_Online.pdf

A summary for teachers (prepared by the Office for Climate Education, supported by the French Academy of Sciences):
http://www.oce.global/resources/

How to get there?

The trajectories of greenhouse gases compatible with limiting warming at 1.5°C and 2°C are diagnosed from a database of published emission pathways, in open access for transparency and traceability (https://data.ene.iiasa.ac.at/iamc-1.5c-explorer).

Limiting global warming to 1.5° implies reducing emissions of carbon dioxide by about 50% by 2030, compared to 2010 levels. For comparison, in most pathways that limit global warming to below 2°C, carbon dioxide emissions decline by about 25% by 2030

To limit global warming to 1.5°C, global emissions of carbon dioxide would need to reach "net zero" around 2050. This means that any remaining emissions would need to be balanced by removing carbon dioxide from the air. For comparison, pathways that limit global warming to 2°C reach net zero around 2070.

As part of limiting warming to 1.5°C, reducing emissions of substances other than carbon dioxide such as methane and black carbon would improve air quality and have direct and immediate health benefits. Pathways compatible with climate stabilisation to 1.5°C without any overshoot have CO_2 emissions decrease in the next decade. Pathways with delayed reduction in CO2 emissions, starting at the end of this decade, imply the large-scale deployment of negative CO_2 emissions in the second part of this century.

Limiting warming to 1.5°C implies rapid, far-reaching and unprecedented changes in all systems (energy; land, including agriculture, forestry and food systems; urban, including changes in urban planning practices; industrial; and infrastructure). It means deep emission reductions in all sectors, the use of a wide range of technologies, behavioural changes, and a 5- to 6-fold increase in investment in low carbon options by 2050. The use of coal declines steeply in all pathways. Rapid progress is already being made in some areas, notably renewable energy. This progress would need to be picked up in other sectors such as transport and land management.

There are many different 1.5°C-consistent pathways, with different near-term patterns in the reduction of emissions of CO_2 from fossil fuels and industry (with small residual emissions after around 2050), major shifts from agriculture, forestry and land use carbon fluxes (reaching either neutrality or net negative emissions after around 2050), and various scales of deployment of bioenergy with carbon capture and storage.

To limit warming to 1.5°C, we would need to start taking carbon dioxide out of the atmosphere during the 21st century. Methods for doing this include: planting trees; bioenergy combined with carbon dioxide capture and storage; rehabilitation of degraded ecosystems; changed land management as well as some other approaches that are at very early stages of development. Carbon dioxide removal on a large scale based on biomass energy would have implications for food security, ecosystems and biodiversity.

The pledges that governments have made over the last three years about their mitigation ambitions are not enough to keep warming below 1.5°C, even with ambitious and very challenging efforts after 2030. They place us on a trajectory of global warming of 3°C or more by 2100.

Carbon dioxide emissions would need to decline substantially before 2030 to avoid warming of more than 1.5°C in the middle of the 21st century, with the associated overshoot climate-related risks, followed by large scale carbon dioxide removal, and implications. Climate change risks and how we respond to them are closely linked to sustainable development and the UN sustainable development goals. These goals balance social well-being, economic prosperity and environmental protection.

As part of limiting global warming to 1.5°C, a mix of measures to adapt to climate change and options to reduce emissions will, if carefully selected, have benefits for meeting the sustainable development goals. In each context, ethical, fair and just transitions can be designed, by placing attention upfront to protect those most vulnerable to the impacts of climate change, and to climate policies. This is most effective when local and regional governments and decision makers are supported by national governments, and when participatory mechanisms are put in place. Strengthening the capacities of national and sub-national authorities, civil society, the private sector, indigenous peoples and local communities can support the ambitious actions that would be required to limiting global warming to 1.5°C.

What is next for the IPCC?

In 2019, the IPCC will release an update of the methodological report on guidelines for emission inventories (May 2019); a Special Report on Climate Change and Land (August 2019); and a Special Report on the Oceans and the Cryosphere in a Changing Climate (September 2019). The main Working Group reports are scheduled for 2021 (WGI, the Physical Science Basis; WG2, Impacts, adaptation and vulnerability; WGIII, mitigation of climate change). They will contribute to the Synthesis report, scheduled for April 2022.
Scientists can contribute to the assessment of the state of knowledge by participating to the expert review of the main Working Group reports, which will start in spring 2019 for Working Group 1. Information on timelines is available from the IPCC web site and on social media.

International cooperation and mobilisation of finance is critical for this to be achieved in all countries and for all people, especially for developing countries and vulnerable regions. The feasibility of ambitious climate response is also strongly linked to education and innovation, with a strong role for the academic role to support societal transformation and transitions.

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