

# Climate Change

## Reviewed by

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### **What is at stake?**

Catastrophic climate change has been associated with an increase in global average temperature of >3°C. This level of global warming would probably imply a serious shift in global climate patterns, unprecedented loss of landmass creating large flows of climate refugees, significant risks to regional and global food security, a combination of high temperature and humidity jeopardising normal human activities, and massive species extinctions having adverse cascading effects on ecosystem functioning and services critical for sustaining humanity.

Catastrophic climate change would be triggered by crossing one or more tipping points of the Earth's climate system. Decision-makers have tended to assume that tipping points are of low probability and poorly understood, in spite of growing evidence that these tipping points may be more likely than previously thought, have high impacts and interact in complex and dangerous ways, threatening longterm irreversible changes. Political discussions about climate change rarely acknowledge catastrophic climate risk.

### **How much do we know?**

The Earth's climate is impacted by the concentration of certain gases in the atmosphere, known as greenhouse gases, the most important being carbon dioxide and methane. As a result of human activity since the Industrial Revolution, the atmospheric concentrations of greenhouse gases – generally expressed as the number of greenhouse gas molecules per million or ppm – have risen consistently. At the dawn of the Industrial Revolution, the global average atmospheric carbon dioxide was approximately 280 ppm; in 2020, it reached almost 413 ppm – a new record high amount. Current carbon dioxide levels are the highest in at least 800,000 years.

*“...adverse cascading effects on ecosystem functioning and services critical for sustaining humanity”*

According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), human influence has unequivocally warmed the



atmosphere, ocean and land. The climate system is undergoing unprecedented changes in human history. Every region on the planet is already being affected by more frequent and intense weather and climate extremes. Much of the damage caused by climate change (e.g., changes in the ocean, ice sheets and global sea level) is now irreversible. The global average mean surface temperature for the period 2017 to 2021 is among the warmest on record (1.06°C to 1.26°C above pre-industrial levels).

There is an estimated 50% chance that global temperature will temporarily reach the 1.5°C threshold – the aspirational temperature goal of the Paris Agreement – in the next five years. Current policies and climate targets are expected to lead to a global warming increase of approximately 2.7°C and 2.4°C, respectively, by the end of the century.

Climate change is a non-linear phenomenon where tipping points play a determining role. When warming rises above a certain level, self-reinforcing feedback loops set in, and the concentration of greenhouse gases increases rapidly. Although precise thresholds and exact scenarios remain very uncertain, we know that the level of risk increases with the rise in temperature. The latest science suggests that tipping points could be exceeded even between 1.5°C and 2°C. For example, at 2°C of warming there is a 10-35% chance that the Arctic becomes largely icefree in summer.

*“...at 2°C of warming there is a 10-35% chance that the Arctic becomes largely ice-free in summer”*

Scientists recently found that 45% of all potential ecological collapses are interrelated and could reinforce one another; in other words, ‘exceeding tipping points in one system can increase the risk of crossing them in others’.

Limiting the Earth’s temperature rise to 1.5°C is thus not only crucial for saving the majority of the world’s plant and animal species as well as safeguarding low-lying island states from sea level rise and the poorest countries from climate extremes, but also a precautionary step to prevent triggering climate tipping points.

In its 2018 special report, the IPCC estimated that the remaining carbon budget to stand a reasonable chance (66%) of limiting warming to 1.5°C would be depleted by around 2030. The panel’s conclusions were, however, criticized for being too conservative.

Considering, for example, an upper estimate of a wide range of potential Earth system feedbacks, humanity might have already exceeded the remaining budget to limit warming to 1.5°C (66% probability). Moreover, mitigation pathways compatible with 1.5°C imply the deployment of negative emissions technologies (e.g., bioenergy production with carbon capture and storage), and advances on these by science and policy are currently far from ideal.

### **Climate tipping points**

The Earth’s climate system is formed by large-scale components characterized by a threshold behaviour known as tipping elements. Put another way, climate



tipping elements are supra-regional constituents of the Earth's climate system that may pass a tipping point. The Greenland ice sheet and the Amazon rainforest are examples of tipping elements. A tipping point is 'a threshold at which small quantitative changes in the system trigger a non-linear change process that is driven by system-internal feedback mechanisms and inevitably leads to a qualitative different state of the system, which is often irreversible'.

*“The Greenland ice sheet and the Amazon rainforest are examples of tipping elements”*

What are key factors affecting risk levels?

Climate change is a highly complex phenomenon affected by many factors. We may divide them into four categories to better discern the various areas where action is possible.

First, the risk is directly related to the release of greenhouse gases in the atmosphere through human activity. Carbon dioxide mainly results from the burning of fossil fuels for energy and transport. In turn, this is a factor of population growth and unsustainable production and consumption models. As to methane emissions, they largely relate to large-scale animal farming, driven by demand for meat, dairy and wool.

Second, some ecosystems store large amounts of carbon, particularly forests and coastal marine ecosystems, and their destruction could result in the large-scale release of greenhouse gases into the atmosphere.

The third factor is our capacity for global coordination to reduce emissions. This may be positively impacted by a better understanding of tail-end climate risk and climate tipping points, increasing the sense of urgency and prompting faster action.

Finally, the risk of catastrophic climate change is increased by insufficient knowledge and understanding of impacts and vulnerability, in turn affecting our ability to build resilience. The complex and interrelated nature of global catastrophic risk suggests an integrated research agenda to address related challenges and dilemmas – such as the use of solar radiation management techniques (namely, stratospheric aerosol injection) to reduce the risk of catastrophic climate change, which might harm in other ways<sup>28</sup> – and ensure human development and the protection of the non-human living beings that enable life on the planet to thrive.

*“In 2021... global emissions rebounded to their highest level in history”*



### **CO2 emissions on the rise**

According to a 2021 report by the International Energy Agency, in 2020 primary energy demand dropped by approximately 4% and global energy-related CO2 emissions fell by 5.8%. The unprecedented reduction in oil demand during 2020 (8.6%) – mostly associated with the drop in road transport and aviation activity – accounted for over half of the reduction in global emissions. In turn, low-carbon fuels and technologies accelerated their expansion; rising from 27% in 2019 to 29% in 2020, the share of renewables in the global energy mix reached the highest annual increase ever recorded. The COVID-19 pandemic resulted in a decline in emissions of nearly 2,000 million tonnes of CO2 – in absolute terms, the largest-ever decline in global emissions.

However, as the pandemic is brought under control and the global economy stirs to life, emissions are on the rise again. In 2021, and despite an unprecedented growth in renewable power generation, global emissions rebounded to their highest level in history. The recovery of energy demand was compounded by the rise in natural gas prices, which resulted in more coal being burned. It is clear that the world is not growing back greener. Although green spending is rising, it is not enough for a sustainable recovery.

According to the Organisation for Economic Co-operation and Development (OECD), the budget allocated to environmentally positive measures has recently reached USD 1090 billion. Yet ‘potentially environmentally harmful government support amounts to more than USD 680 billion annually around the world, including subsidies to fossil fuel production and consumption, and environmentally harmful agricultural support’, meaning that ‘after only two years, these subsidies already cancel out the USD 1090 billion of green spending to be spent over multiple years’.

“...global warming makes conditions more favourable to the spread of some infectious diseases and air pollution makes people more vulnerable to infection.”

### **Climate change, biodiversity loss and human health**

The COVID-19 global health crisis urges us to rethink our relationship to nature and the non-human species with which we share the planet.

The coronavirus has been attributed to anthropogenic interferences on the natural world such as deforestation, which is a major contributor to climate change; encroachment on animal habitats; and biodiversity loss, which is driven, among other factors, by climate change. The crisis is a reminder of our enmeshment in a more-than-human world. It also calls our attention to the critical links between climate change and biodiversity loss, and their impacts on human health.

By eroding wild spaces, largely for agriculture and mostly for raising cattle or growing crops to feed them, changing the climate – thus forcing animals to find food and shelter close to people or migrate to the poles to escape heat, which



creates new opportunities for pathogens to get into new hosts – and by trading and consuming wild animals, we increase the likelihood that zoonotic viruses will jump to humans. Moreover, we know that global warming makes conditions more favourable to the spread of some infectious diseases, while air pollution makes people more vulnerable to infection.

*“...climate change might become the main anthropogenic driver of virus transmission across species by 2070”*

We also know that when biodiversity declines, the species that thrive are the ones that are best at transmitting diseases (e.g., bats and rats); as current species extinction rates have no parallel in human history, there are strong reasons for concern.

A recent study suggested that species migrating due to climate change are potentially already propagating their viruses further. It also concluded that climate change might become the main anthropogenic driver of virus transmission across species by 2070, and that ‘holding warming under 2 °C within the century will not reduce future viral sharing’. The most affected areas are predicted to be biodiversity hotspots and densely populated areas in Asia and Africa.

Current and future policies must thus integrate climate, biodiversity and health considerations as well as the needs and rights of the nonhuman living beings with which we share the Earth.