Climate Change

Understanding scenarios, RCPs and ppm

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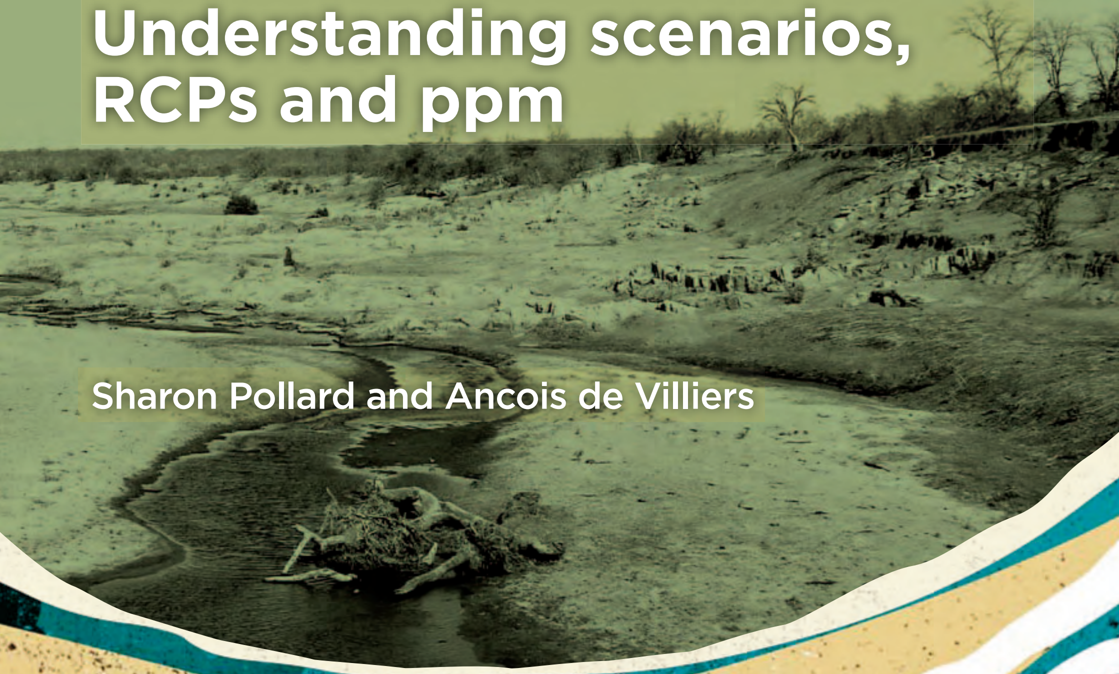

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Global warming and climate change

Global warming

refers to the **upward temperature trend** across the entire Earth since the early 20th century, and most notably since the late 1970s, due to the increase in fossil fuel emissions since the industrial revolution. Worldwide since 1880, the average surface temperature has gone up by about 0.8°C (1.4°F), relative to the mid-20th-century baseline (of 1951-1980).

(https://climate.nasa.gov/resources)

Climate change

refers to a broad range of **global phenomena** created predominantly by burning fossil fuels, which add heat-trapping gases to the Earth's atmosphere. These phenomena include the increased temperature trends described by global warming, but also encompass changes such as sea level rise; ice mass loss in Greenland, Antarctica, the Arctic and mountain glaciers worldwide; shifts in flower/plant blooming; and extreme weather events.

(https://climate.nasa.gov/resources)

Greenhouse gas (GHG) scenarios: Representative Concentration Pathways (RCPs)

The *speed* with which the climate will change and the *total amount of change* that is projected depends on

- **the amount of greenhouse gas emissions (modelled using Greenhouse Gas Scenarios) and**
- **the response of the climate to those emissions (modelled via global climate models).**

To make projections, climate scientists use greenhouse gas (GHG) scenarios – "what if" scenarios of plausible future emissions – to drive global climate model simulations of the Earth's climate. Both the scenarios and models are periodically updated as the science of climate change advances. The most recent projections for 21st century climate change are from the Intergovernmental Panel on Climate Change (IPCC, 2014; 5th Assessment Report).

Since it is impossible to predict exactly how much greenhouse gas will be emitted, scientists consider the implications of a range of different future conditions. We do not know with any certainty which scenarios are more likely but based on trends and responses, we can make choices about likely scenarios we are heading towards. It is important to consider a range of potential outcomes. Thus uncertainty is part of understanding climate change futures.

Representative Concentration Pathways (RCPs) are four trajectories of **greenhouse gas (GHG)** concentration (not emissions) adopted by the IPCC in 2014. The earlier ones were called Special Report Emissions Scenarios (2000). The pathways are used for climate modeling and research. They describe four possible climate futures depending on how much GHG is emitted. **These range from an extremely low emissions scenario involving aggressive emissions reductions to a high 'business as usual' scenario with substantial continued growth in greenhouse gases.**

Table 1 *Greenhouse Gas Scenarios and descriptions (modified from Snoveretalsok 2013 in http://cses.washington.edu/db/pdf/snoveretalsok2013sec3.pdf).*

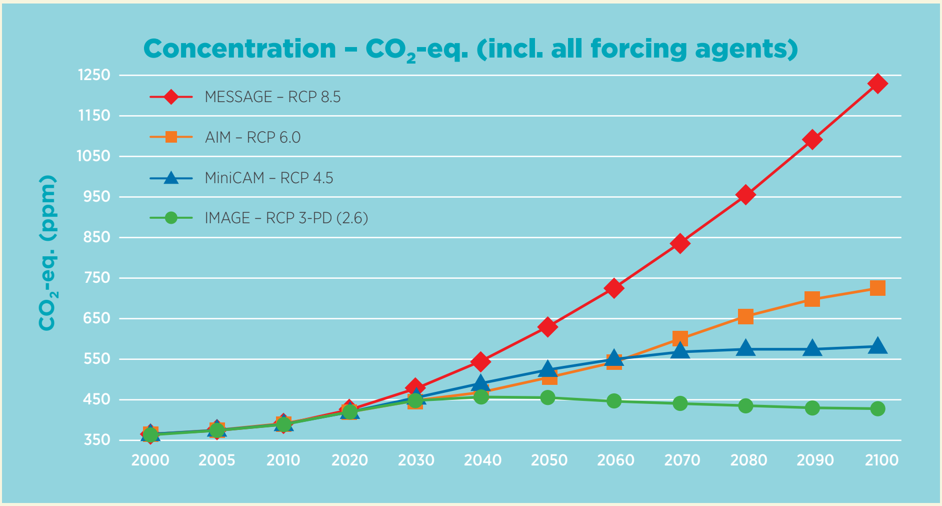
Scenarios	Scenario characteristics	Description
RCP 2.6	An extremely low scenario that reflects aggressive greenhouse gas reduction and sequestration efforts	"Very Low"
RCP 4.5	A low scenario in which greenhouse gas emissions stabilize by mid-century and fall sharply thereafter	"Low"
RCP 6.0	A medium scenario in which greenhouse gas emissions increase gradually until stabilizing in the final decades of the 21st century	"Medium"
RCP 8.5	A high scenario that assumes continued increases in greenhouse gas emissions until the end of the 21st century	"High"

TSGT Cary Humphries / Wikimedia

A molecule of carbon dioxide can persist in the atmosphere for centuries, meaning that our grandchildren will live with the legacy of the actions of their grandparents and parents.

All scenarios result in similar warming until about mid-century. Prior to mid-century, projected changes in climate are largely driven by the warming that is from historic emissions of greenhouse gases. In contrast, warming after mid-century is strongly dependent on the amount of greenhouse gases emitted in the coming decades (Snoveretalsok 2013). Globally, greenhouse gas emissions are higher and increasing more rapidly since 2000 than during the 1990s (Figure 1). We are believed to be on the RCP 8.5 trajectory (Sanford et al. 2014).

Figure 1 *CO_2 concentrations according to the Representative Concentration Pathways (RCPs) (https://en.wikipedia.org/wiki/Representative_Concentration_Pathways#/media/File:All_forcing_agents_ CO2_equivalent_concentration.png)*



What is the 400 ppm figure and why is 2°C so important?

Carbon dioxide (CO_2) is an important heat-trapping (greenhouse) gas, which is released through human activities such as deforestation and burning fossil fuels, as well as natural processes such as respiration and volcanic eruptions. This is measured in *hundred parts of carbon dioxide per million parts of air* – or parts per million (ppm). Atmospheric CO_2 concentration correlates with the Earth's surface temperature, making it a useful indicator of future global warming.

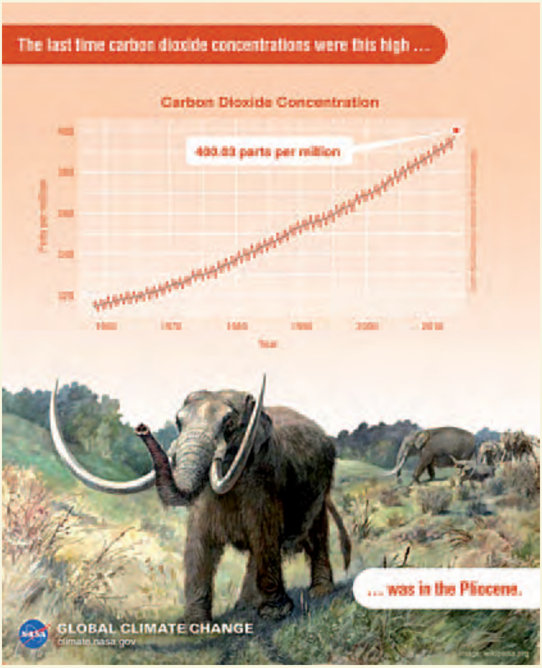


Figure 2 *Graphic showing the rise in CO_2 concentrations and the last time such concentrations were experienced. (https://climate.nasa.gov/climate_resources/7/graphic-carbon-dioxide-hits-new-high/)*

A figure that became important in the late 1980s was **350 ppm**. The 350 limit came from peer-reviewed research by NASA scientist Dr. James Hansen, who defined 350 ppm as the upper limit "to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted." Now we use 400 ppm as a symbolic threshold to highlight change. It represents a point of "no return" since we are now almost certain that atmospheric CO_2 concentrations will never go below 400 ppm even in our great-grandchildren's lifetime.

In May 2012, atmospheric CO_2 crossed 400 ppm in the Northern Hemisphere's Arctic region for the first time and this was also eventually observed at the South Pole in June 2016.

400 may not sound worrying, but the last time the Earth experienced CO_2 concentrations at this level was between 2.2 and 4 million years ago, long before modern humans appeared just 200 000 years ago.

At 405 ppm (the upper limit which 195 countries committed to stay below as part of the UN Climate Agreement) a warming of 2°C is anticipated above pre-industrial temperatures. The most recent measurement is 408 ppm (Figure 3).

In 2016 atmospheric concentrations of CO_2 passed 400 parts per million.

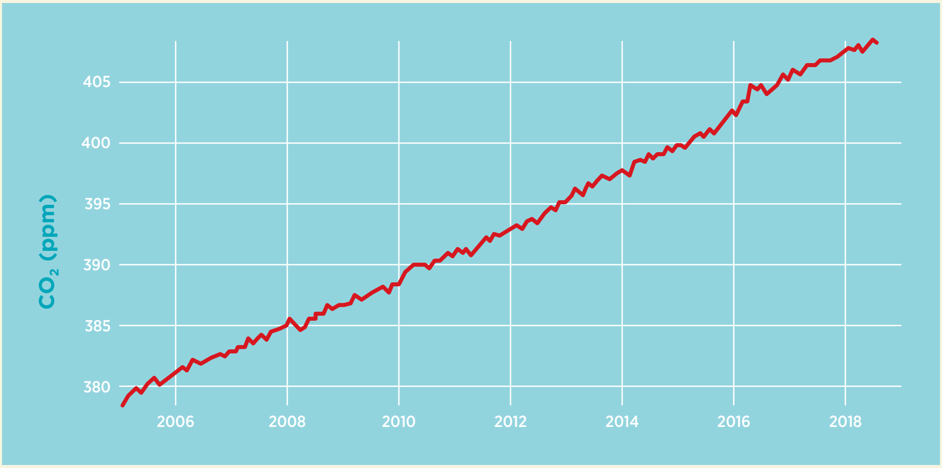


Figure 3 *CO_2 concentrations in the last 12 years (Source: NASA)*

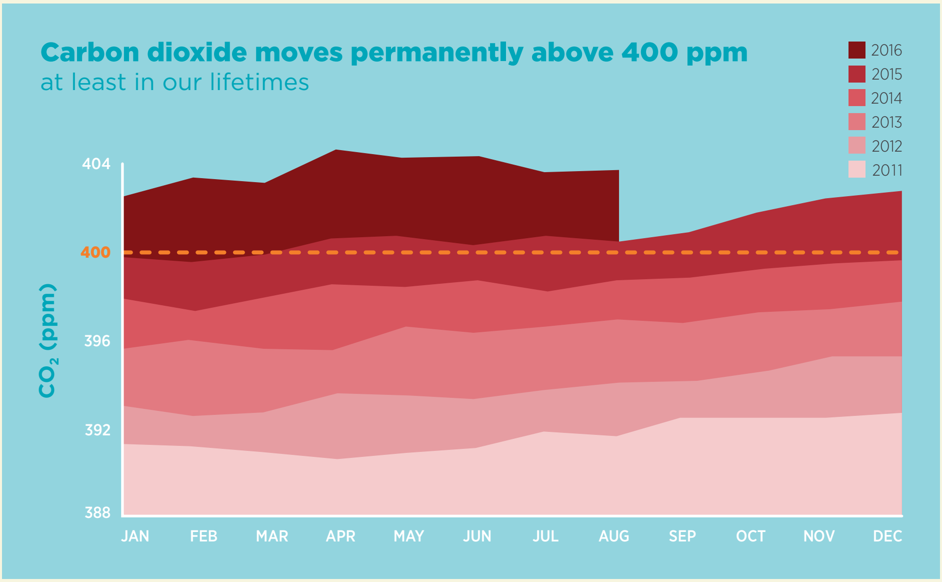
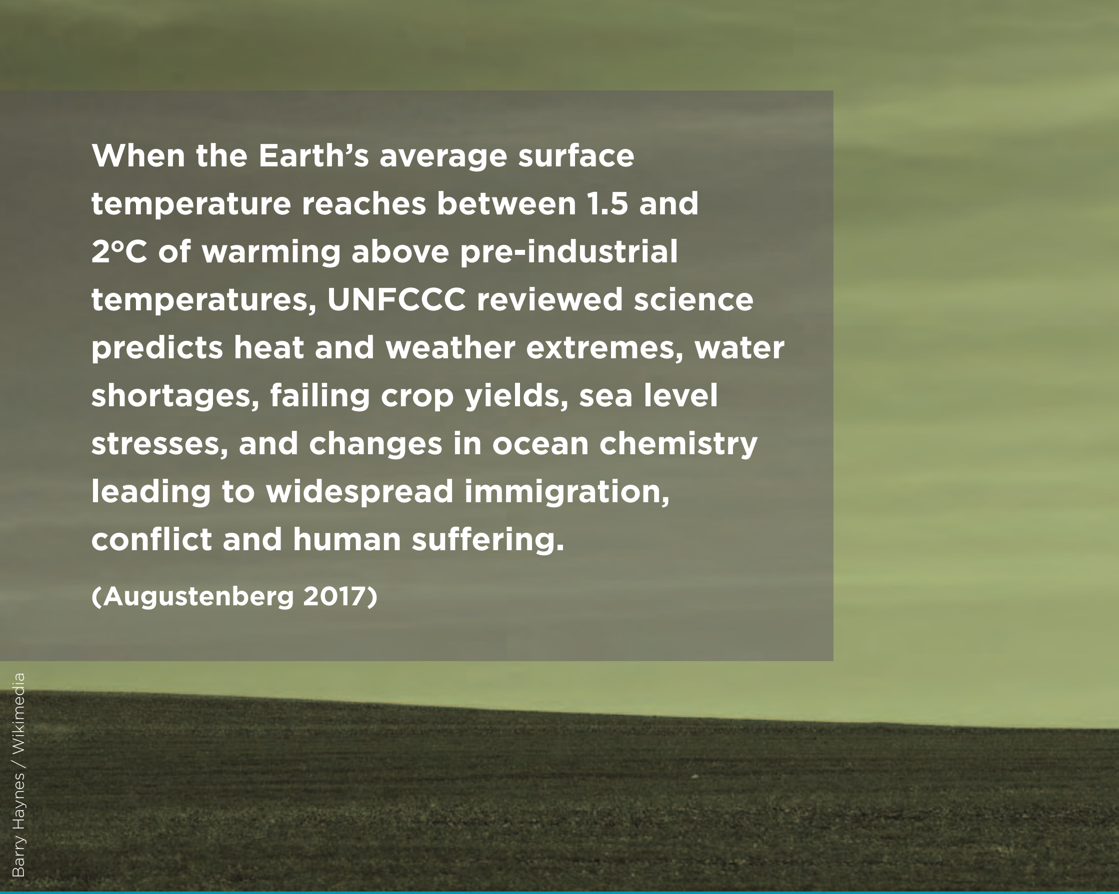


Figure 4 *CO_2 levels between 2011 and 2016 (Source: http://www.climatecentral.org/news/world-passes-400-ppm-threshold-permanently-20738)*

When the Earth’s average surface temperature reaches between 1.5 and 2°C of warming above pre-industrial temperatures, UNFCCC reviewed science predicts heat and weather extremes, water shortages, failing crop yields, sea level stresses, and changes in ocean chemistry leading to widespread immigration, conflict and human suffering.

(Augustenberg 2017)



Barry Haynes / Wikimedia

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The Association for Water and Rural Development

AWARD is a non-profit organisation specialising in participatory, research-based project implementation. Their work addresses issues of sustainability, inequity and poverty by building natural-resource management competence and supporting sustainable livelihoods. One of their current projects, supported by USAID, focuses on the Olifants River and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems to sustain livelihoods and resilient economic development in the catchment.

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About USAID: RESILIM-O

USAID: RESILIM-O focuses on the Olifants River Basin and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems that support livelihoods and resilient economic development in the catchment. The 5-year programme, involving the South African and Mozambican portions of the Olifants catchment, is being implemented by the Association for Water and Rural Development (AWARD) and is funded by USAID Southern Africa.

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