Introduction to Climate Change

What is the Earth's atmosphere?

The atmosphere is a layer of gases around the Earth. It protects the Earth's surface from the sun's harmful rays and contains the oxygen we breathe.

The atmosphere is mostly nitrogen and oxygen, but it also contains smaller amounts of other gases, including those commonly referred to as 'greenhouse gases'. Greenhouse gases include carbon dioxide (CO_2), methane, nitrous oxide and also water vapour.

What is global warming?

The sun's rays shine on our planet and warm the surface of the Earth. Heat then radiates from the surface. Scientists have shown conclusively that greenhouse gases trap some of this heat in the atmosphere. Over the history of the Earth, this 'greenhouse effect' has helped keep the planet warm enough for life to flourish.

In recent years, the concentrations of greenhouse gases in the atmosphere have increased rapidly, particularly carbon dioxide. The increase in carbon dioxide has been caused mainly by the burning of coal, oil and natural gas – known as the 'fossil fuels'. Around the world, fossil fuels are used by people as a convenient fuel for transport and electricity generation. They also provide heat in homes when they are burned, and are used in industrial processes. The clearing of forest land around the world has also contributed to the changes in the atmosphere: trees absorb carbon dioxide when they grow and release greenhouse gases if they are cut down and are burned or left to rot.

Carbon dioxide is now at concentrations approaching one and a half times the level at the time of the industrial revolution around 200 years ago[a]. The more carbon dioxide there is in the atmosphere, the more heat is trapped, and the hotter Earth becomes. This process is known as '**global warming'** – the rising global temperatures across the Earth's lands and oceans.

How much have global temperatures increased?

The temperature of air at the planet's surface has risen rapidly, especially over the last fifty years. We know this through records from thousands of weather stations across the world, satellites, and ocean data from ships and buoys. The global average surface temperature over the decade 2006-2015 was the hottest recorded since modern records began in the second half of the 19th century (1850-1900), and is currently increasing by around 0.2°C per decade.[c]

In recent years the global average surface temperature has reached around 1°C above what it was in the second half of the 19th century (1850-1900). Warming of around 1°C over the last 150 years may sound unimportant, but it is a substantial change for the planet. Conditions on our planet are sensitive to changes of only a few degrees Celsius. For example, when ice last covered large parts of Northern Europe and North America around 22,000 years ago (during what is often referred to as the last Ice Age) the global average surface temperature was only 4–9°C colder than temperatures today.

Some areas are also getting warmer much faster than others. Land areas warm more than the oceans, and the Arctic is warming considerably faster than other parts of the planet. Large areas of the Arctic are now about 2°C warmer than they were 150 years ago.

Scientists have considered a host of factors that can affect the global temperature, including changes in the strength of the sun. They have high confidence that practically all of the global warming that we have seen recently is due to human actions, primarily those that have increased greenhouse gas concentrations in the atmosphere.[b]

Global warming is the main cause of what today we call 'climate change'.

What is climate change?

Climate change refers to a shift in average weather conditions, including measures such as temperature, humidity, rainfall, cloudiness and wind patterns – and changes in the frequency or severity of these conditions.

The Earth's climate has changed throughout its history, in cycles that occur over very long periods of time. This is a natural process.

Today we tend to use the phrase 'climate change' to refer to the very rapid changes in the climate that we have seen over the past 50 years or so. The scientific evidence is clear that these changes are not being driven by long-term natural climate cycles. Instead their main cause is global warming and the human activities that cause it.

What impacts of climate change are we already seeing?

Climate change has profound implications for people and the natural world. Impacts of climate change that we are already seeing include:

- **Changes in extreme heat**

Higher average temperatures mean heatwaves are now more frequent – and tend to be hotter when they occur. Some of the extreme heatwaves that we are now seeing would have been highly unlikely without the recent warming of the planet. The increased temperatures also make events such as the forest fires that have been happening recently in Australia more likely and more intense. Parts of the world, such as in the Mediterranean and Central and West Africa, are seeing more frequent and more extreme droughts due to climate change.

- **Increased rainfall**

Warmer air holds more water, making heavier downpours more likely as temperatures have increased. This increased heavy rainfall can lead to increased flooding, damaging property and threatening lives. In the UK, there is evidence that some specific weather events, such as the heavy rainfall in the winter of 2014/15, have been made more likely by climate change.[1] Similar impacts are occurring elsewhere in the world. The record amount of rain that fell on Houston during Hurricane Harvey in 2017 helped make it the second most costly hurricane to hit the USA since 1900. Climate change has made a damaging downpour like this around three times more likely.

- **Changes in the availability of food and freshwater**

Changing weather patterns have affected crop yields – the quantity of crops like wheat and maize that can be produced from an area of land. In some areas of the world climate change has helped yields go up, but overall yields have not risen as fast as they would without the effects of climate change. The

[1] Schaller, N. et al. (2016) Human influence on climate in the 2014 southern England winter floods and their impacts. *Nature Climate Change*, 6, 627–634.

availability of freshwater for drinking and agriculture in some places has also been affected, particularly downstream from melting glaciers, in areas like the European Alps. Glaciers are an important source of drinking water for almost one-third of the global population.

- **Rising sea levels**

Higher air temperatures are causing the increased melting of huge 'ice sheets' on land in Antarctica and Greenland, which run off into the oceans. The warming planet is also causing an expansion of sea water, increasing its volume - similar to how the liquid inside a thermometer expands when it is heated. Both of these factors are driving an increase in global sea-levels. The global sea-level has risen by around 20 cm since the start of the 20th century. This has made storm surges – the rise in sea level that occurs during intense storms – more likely to exceed existing sea defences and cause flooding. As many densely-packed cities are in low-lying coastal regions around the world, this hazard can affect large numbers of people. This is particularly true in developing countries such as Bangladesh, but cities like Venice and Miami are also low lying and will be affected too. In the UK, rising sea levels have contributed to recent decisions to abandon areas of coastline, such as the village of Fairbourne on the Welsh coast.

- **Loss of biodiversity and nature**

In the ocean, the increase in water temperature is putting pressure on ocean life. The Great Barrier Reef, where the coral population is in shallow water, has recently declined by up to 50%.[1] The ocean heat that caused large damage to the Great Barrier Reef in 2016 would have been highly unlikely before the time of the industrial revolution around 200 years ago, but is now likely to happen around 1 in every 3 years on average in today's climate.[2] Current ocean conditions haven't existed in at least the last 65 million years. There is also evidence of climate change affecting nature on land, with many species of plants and animals shifting to new areas due to warming.

What about future impacts of climate change?

Much of the carbon dioxide we have already emitted will remain in the atmosphere for centuries – some even for thousands of years. As we continue to add to it, the concentration of carbon dioxide and other greenhouse gases will increase and the planet will become even hotter.

As the world warms, the impacts of climate change are becoming stronger and clearer: more frequent heatwaves, the declining availability of water in regions that are already dry today, substantial risks to the diversity of animals and plants around the world today.

The consequences of these impacts, and the possibility of higher migration of people around the world to escape them, have led to efforts to slow and eventually halt global warming by tackling its causes.

What is 'net-zero'?

The planet will only stop warming when we reach 'net-zero' carbon dioxide emissions.

Achieving net-zero means reducing global greenhouse gas emissions to a much lower level than today – and balancing the remaining emissions by reabsorbing the same amount from the atmosphere.

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[1] Hughes, T. P. et al. (2017) Global warming and recurrent mass bleaching of corals. *Nature*, 543 (7645), 373–377.

[2] King, A. D. et al. (2017) Australian climate extremes at 1.5 and 2 degrees of global warming. *Nature Climate Change,* 7, 412–416.

Greenhouse gases can be absorbed by growing trees and plants, as well as through technological processes that can remove carbon dioxide from the air, but have not yet been used at large-scale.

Reducing global greenhouse gas emissions rapidly and emitting as little as possible on the way to net-zero will also help minimise further changes in the climate.

What is Climate Assembly UK going to consider?

The scale of climate change risks has led to an international agreement to reduce global greenhouse gas emissions. This is called The Paris Agreement. It aims to keep global warming to beneath 2°C above temperatures before the industrial revolution, around 200 years ago – and to pursue efforts to keep it below 1.5°C.

At the moment, every country in the world has signed the Paris Agreement. However the United States, under the direction of President Donald Trump, has signalled that it intends to leave The Paris Agreement later this year.

Several countries around the world – including the UK – have also signed up to a national goal of net-zero greenhouse gas emissions as part of our contribution to this global effort. In June 2019, the UK's Government and Parliament agreed a law committing the UK to reaching net-zero greenhouse gas emissions by 2050. **The topic you are going to discuss at Climate Assembly UK is what the UK should do to achieve this goal, and how it should do it.**

Optional further reading

You do not have to read any more information to take part in Climate Assembly UK. However if you are interested in reading more, good sources of information include:

- These frequently asked questions on climate change: https://www.imperial.ac.uk/grantham/publications/climate-change-faqs/
- This briefing on climate science: https://bit.ly/2QDAFon
- These resources for understanding why scientists have concluded that global warming needs to stay below 1.5°C: https://www.ipcc.ch/site/assets/uploads/sites/2/2018/12/ST1.5_OCE_LR.pdf