

Global warming impacts: an update

By Mark Nowell

In 2015, world leaders from over 150 countries met in Paris to discuss how best to manage climate change. By the end of their meeting it was agreed that average global temperatures should be limited to no more than 1.5°C above pre-industrial levels. A rise of 2°C would be catastrophic.

One year earlier, the fifth report of the Intergovernmental Panel on Climate Change (IPCC) was published. It included predictions of how the climate might change in the future. The worst-case scenario suggested an increase in the average global temperature of 4.8°C by 2100 – more than double the target set in Paris.

Scientists have been making predictions about climate change since the early 1970s. So far, their projections have been reasonably accurate.

This unit focuses on recent changes in temperature and precipitation, and the impact of those changes on selected regions.

Key terms

Greenhouse gases: gases that absorb energy from the sun, such as carbon dioxide, methane and nitrous oxide.

Global warming: the process of change in the Earth's atmosphere leading to higher temperatures as the sun's energy is absorbed by greenhouse gases. These gases have increased as a result of human activities.

Fossil fuel: any non-renewable source of energy which, when used, releases carbon, e.g. oil, coal, gas.

Drought: a long period of very low rainfall leading to a shortage of water.

Learning outcome

After working through this unit, you will:

- learn how the global climate is changing
- understand the reasons for these changes
- learn how temperature and precipitation are changing across the world
- understand the impact of climate change on some countries and regions.

Relevance to GCSE specifications

AQA	3.1, Section A The challenge of natural hazards, 3.1.1.3, page 10 Click here
Edexcel A	Component 1, Topic 2 Weather hazards and climate change, 2.1–2.4, page 12 Click here
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OCR A	2c, 2.3 Environmental threats to our planet, 2.3.1–2.3.6, page 12 Click here
OCR B	Topic 2 Changing climate, 2.1, page 8 Click here
Eduqas A	Component 2, Key idea 8.1 Consumerism and its impact on the environment, page 20 Click here
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Cambridge IGCSE	Theme 3, 3.7 Environmental risks of economic development, page 14 Click here
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Global warming impacts: an update

What is climate change?

The UK Meteorological Office describes climate change as ‘a large-scale, long-term shift in the planet’s weather patterns and average temperatures’.

The Earth is surrounded by layers of gases that make up the atmosphere. Some of these gases are described as **greenhouse gases** because they act like the glass of a greenhouse. Certain gases in the atmosphere – carbon dioxide, methane and nitrous oxide – allow shortwave radiation from the sun to pass through and be absorbed by the surface of the Earth. The Earth re-radiates longwave radiation, either back into space or to be absorbed by greenhouse gases in the atmosphere. More greenhouse gases in the atmosphere leads to higher average global temperatures, or **global warming**.

Humans can be described as ‘ecosystem engineers’ – we change our environment to our own use. Human activities such as deforestation, agriculture and the burning of **fossil fuels** (oil, gas and coal) have been changing the Earth’s landscapes, oceans and atmosphere for thousands of years. Actions that probably contribute most to climate change are:

- **Deforestation and changes to land use:** trees are often cut down to make

space for human settlement or farmland. Forests store carbon from the atmosphere during photosynthesis. If trees are cut down, the Earth is less able to remove greenhouse gases from the atmosphere.

- **Burning fossil fuels:** the large-scale burning of fossil fuels, particularly coal, began at the start of the Industrial Revolution around 1750. Since then the concentration of greenhouse gases in the atmosphere has increased dramatically (Figure 1).

How have global temperatures changed?

Across the world in 2017:

- land surface temperature was 1.31°C above the 20th-century average
- ocean temperatures were at their third highest since global records began in 1880, at 0.67°C above the 20th-century average.

During the last 50 years, global temperature has risen at an average rate of about 0.13°C per decade – almost

twice as fast as the 0.07°C per decade increase observed over the previous 50 years. The hottest years on record are 2015 and 2016. Each of these years experienced a strong El Niño episode (see *GeoActive* 595 ‘El Niño, La Niña and extreme weather events’ for an explanation of how the El Niño Southern Oscillation (ENSO) results in hotter and colder periods).

Regional temperature summaries for 2017

- **Europe** had its fifth warmest year on record.
- **North America** experienced the sixth highest average annual temperature on record.
- **South America** had its second warmest year on record (highest was 2015, by 0.16°C).
- **Africa** had its fourth highest continental temperature on record (higher in 2010, 2015 and 2016).
- **Asia**’s regional temperature was the third highest on record (highest in 2015, second highest in 2007).
- **Oceania** had its sixth warmest year ever.

Greenhouse gas	Atmospheric concentration (parts per million)		Atmospheric lifespan (years)
	Pre-Industrial Revolution	2015	
Carbon dioxide (CO ₂)	280	401	20–200
Methane (CH ₄)	0.7	1.8	12
Nitrous oxide (N ₂)	0.270	0.328	114

Figure 1 Selected greenhouse gases and their atmospheric lifespan
Sources: United States Environmental Protection Agency (US EPA); Intergovernmental Panel on Climate Change (IPCC)

Changes in precipitation

Worldwide levels of precipitation (rainfall, snow, sleet and hail) have increased because there is more heat energy in the Earth's system. This encourages more evaporation, cloud formation and precipitation. However, some places receive lower than average levels of precipitation.

Global sea-level rise

Sea-level rise is caused by two things related to global warming:

- 1 the added water from melting glaciers and icecaps
- 2 the expansion of seawater as it warms.

Records dating back to 1870 show that by 2013, sea level had risen by approximately 230 mm. Between 1993 and 2018, it rose by approximately 86 mm.

These changes, along with other events associated with climate change, are already contributing to an increase in migration around the world. Nobody really knows how many climate refugees will be

created in the coming years. Different estimates of the number of people who will be forced to migrate from low-lying areas by 2050 range from 200 million to 1 billion. The IPCC has found that people who live in developing countries are those least able to cope with the risks associated with climate change.

Effects of climate change on people

Migration from the Pacific islands

People in the small Pacific island nations of Kiribati, Nauru and Tuvalu, close to Australia, are facing a range of threats from climate change.

- Many of the coral islands that make up Kiribati lie no higher than 1.83 m above sea level. This makes them very vulnerable to any rise in sea level.
- Flooding by the sea contaminates the fresh groundwater and the soil. It also increases coastal erosion (Figure 2).
- Nauru has very little fresh water and is vulnerable to **drought** conditions.

About 10 000 people in the three nations tried to emigrate between 2005 and 2015 but they were not able to do so, because they could



Figure 2 Coastal flooding on low-lying Kiribati in the Pacific Ocean
Source: Jeremy Sutton-Hibbert / Alamy.com

not afford to. Figure 3 shows where people from Kiribati migrated to in 2013.

A survey of nearly 7000 islanders found that most had been affected by climate change. In Kiribati, 70% of people said they hoped to migrate if the impact got any worse.

It is recognised that many of the islanders will be forced to

migrate. However, their ability to migrate is restricted by a lack of money, international visa restrictions and practical arrangements.

Impacts and adaptation in Bangladesh

For a flat, low-lying nation like Bangladesh, climate change could be devastating

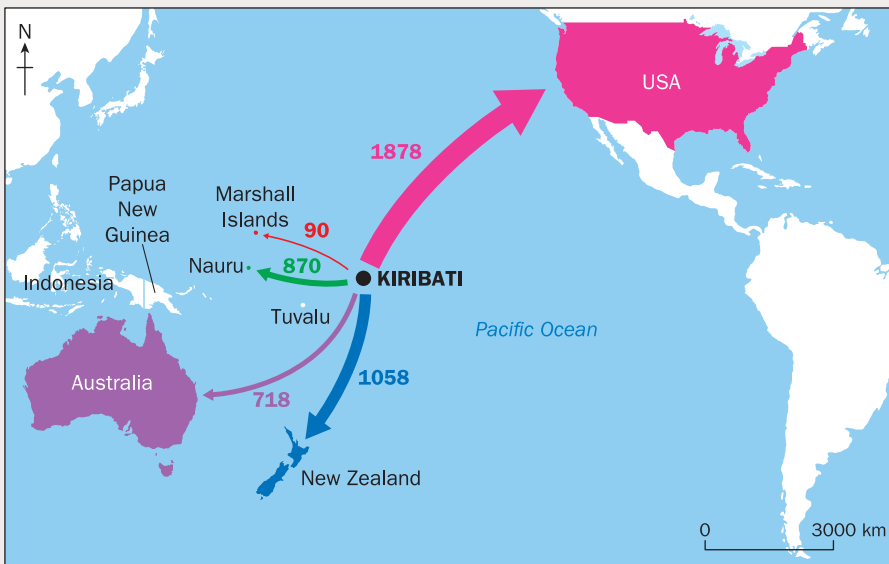


Figure 3 Migration from Kiribati, 2013
 Source: From UNICEF data; total number of people

(Figure 4). Already roughly 35% of the country is submerged during extreme floods and it is believed that around 50% of the country would be under water if sea level rose by 5 metres. This would mean that millions of people (Bangladesh has a population of 167 million) would have to find somewhere else to live. It would also damage large areas of farmland, because that land was either under water or had become too salty. Today 40% of Bangladeshis are employed in farming. Any sea-level rise is likely to make farming very difficult. This is especially worrying in a country where millions already suffer through poverty and hunger.

The country only contributes 0.4% of the total global greenhouse emissions each year despite having 2% of the world's population. It is unlikely that Bangladesh,

acting alone, will be able to dramatically slow the rate of global warming. However, the government is advising people how to adapt to climate change. Some of these strategies are shown in Figure 5.

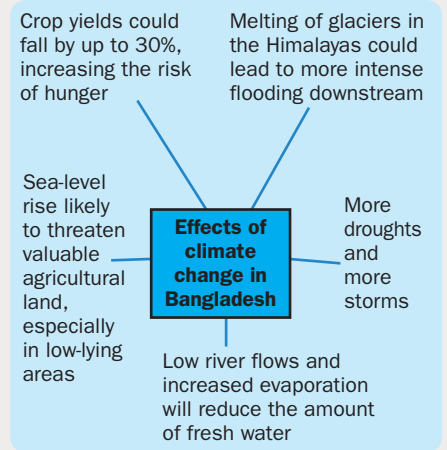


Figure 4 Potential impacts of climate change in Bangladesh

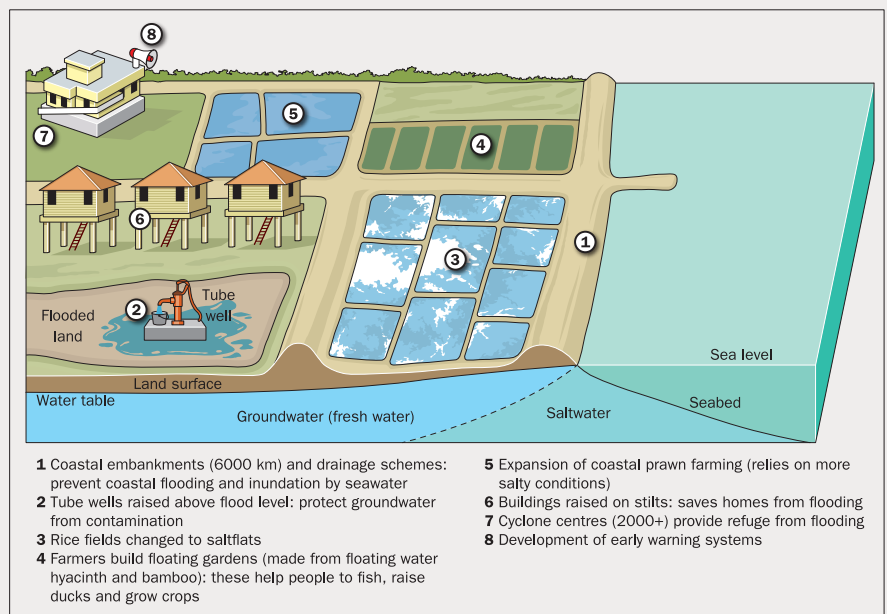


Figure 5 Adaptation to climate change in Bangladesh
 Source: Adapted from *Aquaculture Reports*, November 2015

A warming Arctic

One of the most noticeable indicators of rising global temperatures has been the rapid decline in Arctic sea ice. Winter temperatures in the region have been up to 8°C above average – the winter of

2017/18 was the warmest on record and it was also the year that Arctic sea ice hit a record low. This has implications for the region and for the planet:

- Loss of ice means more heat is absorbed: snow and ice are

light in colour and reflect energy from the sun back into space. But as the Earth heats up the ice and snow has been melting, revealing darker surfaces such as open ocean water, soil and rock. These darker surfaces absorb more heat, leading to higher

global temperatures – and so the cycle continues.

- Melting of the Greenland ice sheet raises sea level.
- Thawing (melting) once-frozen ground, known as ‘permafrost’, may release locked-in greenhouse gases.
- Ocean circulations could change, affecting weather patterns across the globe.

In the winter of 2017/18, Arctic sea ice hit a record low for the time of year.

Ocean warming and acidification

Since around 1850, the oceans have absorbed between a third and a half of the carbon dioxide released to the atmosphere. This has made the oceans 26% more acidic, which makes it difficult for shellfish to form their shells. The number of fish and shellfish being caught is falling in many parts

of the world. This could result in hunger for the 1–3 billion people worldwide who rely on seafood as their main source of protein.

For example:

- A 2014 study found that rock oysters, commonly found in Australia, are shrinking in size and their population is falling.
- The shells of mussels in Loch Fyne, Scotland have become weaker.
- Catches of coldwater fish are in decline where ocean temperatures are increasing. Warming means fewer fish reach maturity. Young cod are moving out of their typical shallow habitat into deeper, cooler waters but are then eaten by predators.

Storms and hurricanes

Climate change is causing more storms, and stronger

storms, which produce more rainfall.

- Warmer environments, particularly warmer sea-surface temperatures, lead to more evaporation and precipitation.
- This means that hurricanes are stronger, form more quickly and with faster wind speeds. More rapidly intensifying storms leave people with less time to prepare and to evacuate, which can result in injury and loss of life.
- There is evidence that extra water vapour in the atmosphere is making storms wetter. During the past 25 years, satellites have measured a 4% increase in water vapour in the air. Much heavier downpours are happening more often.

Hurricane Harvey, 2017

In August 2017, Hurricane Harvey dropped more than 102 trillion litres of water over Texas, USA, making it the wettest Atlantic hurricane ever measured. Some parts of Houston, the state capital, received more than 1250mm of rainfall. This was so much that the National Weather Service had to update the

colours on its weather charts! With one-third of Houston completely flooded, the weight of the water temporarily sank the city by 2cm.

Emergency services handled as many as 10 000 rescue missions around Houston, and at least 30 000 people were evacuated to temporary shelters. There were 107 confirmed deaths. An estimated 13 million people

were affected, with nearly 135 000 homes damaged or destroyed and up to 1 million cars wrecked. Flood-damaged household material added up to an estimated 6 million m³ of waste in Houston alone.

Hurricane Harvey ranks as the second most costly hurricane to hit the US mainland since 1900. Damage is estimated to have cost \$125 billion.

Conclusion

Events such as flooding, drought, storms and wildfires are likely to become more common as global warming

continues. People in developing countries will be less able to adapt to changes in the environment. Water scarcity is already a serious problem in some regions,

particularly in parts of the Middle East and North Africa. Climate change will have to be managed in the future both by individual countries and by international organisations.

Activities

1 Using the data in Figure 1, note the increase in the concentration of the following greenhouse gases between pre-industrial times and 2015:

- carbon dioxide
- methane
- nitrous oxide.

2 Make a copy of the following paragraph and fill in the gaps.

Global warming is thought to be linked to human activity. Humans burn _____ fuels such as coal, oil and gas to power transportation, heating, electricity generation and industrial processes. These activities emit _____ gases into the atmosphere. Humans cut down trees in a process known as _____. Trees and other plants trap carbon dioxide during the process of _____.

3 a Using the data in Figure 6 and an outline map of the Pacific region, draw different-sized arrows to show key

Region or country destination	Country of origin		
	Kiribati	Nauru	Tuvalu
Australia	654	728	190
New Zealand	1533	0	1474
Fiji	775	0	411
Solomon Islands	265	0	0
Kiribati	0	1590	316
Marshall Islands	275	0	0
Nauru	865	0	229

Figure 6 Key migrant destinations for Kiribati, Nauru and Tuvalu in 2015

Source: www.un.org

migrant routes from *either Kiribati or Tuvalu or Nauru*. Use a scale of 1 mm = 100 people for the arrows.

- b** Give three reasons why people living in these islands are worried about climate change.
- 4 a** Describe three ways in which climate change will have an impact on people in Bangladesh.
- b** Referring to Figure 5, explain how people in Bangladesh are adapting to:
- saltier soils
 - sea-level rise
 - storms.
- 5** Give two examples of the impacts of global warming and acidification.
- 6** Draw a table with three headings: Social, Environmental and Economic. List the impacts of Hurricane Harvey under these headings.

Learning checkpoint

- Average global temperatures are about 1°C higher than pre-industrial levels. If temperatures rise by 2°C above pre-industrial levels, the consequences could be catastrophic.
- The atmosphere now contains more water vapour, bringing more rainfall and wetter storms.
- Some areas are experiencing less rainfall, increased evaporation, drier soils and long droughts.
- The world's oceans are warming and becoming more acidic.
- People are having to adapt to the impacts of climate change.

Glossary task

Write glossary definitions for these terms:

drought

global warming

fossil fuel

greenhouse gases

Remember this unit

To help you remember this unit, make notes using the following headings:

What is climate change?

How has the climate changed in recent years?

What are the key impacts of climate change?

Why are people in developing countries particularly vulnerable to the impacts of climate change?

How can people adapt to the challenges of climate change?

Try to make your notes fit a single sheet of A4.