

### Briefing 3

#### What are the impacts of climate change?

Across the world, there is evidence of climate change starting to affect people's lives. Figure 1 shows Peru's Quelccaya ice cap, the largest glacier in the Tropics. In places it is shrinking by nearly 200m a year; by 2050 it may have completely disappeared. Thousands of people rely on its water for drinking and generating electricity. As far as the impacts of climate change are concerned, this is just the tip of the iceberg!

Figure 1

Peru's Quelccaya ice cap



<https://earthsky.org/earth/future-disappearance-quelccaya-melting-ice-cap-glacier-andes>

*Read more about the demise of the Quelccaya ice cap at:*

<https://earthsky.org/earth/future-disappearance-quelccaya-melting-ice-cap-glacier-andes>

Climate change is, and will continue to have significant impacts on people and human activities.

- **Social** – these are the impacts on our lives and our lifestyles
- **Economic** – these impacts are to do with money and the increasing costs of coping with climate change
- **Environmental** – these impacts involve changes to natural ecosystems

It seems almost certain that the global climate is changing and that we are experiencing a rapid increase in average global temperatures. Associated with this is an increase in sea level. Many scientists believe that recent extreme weather events may be triggered by global warming too.

The Intergovernmental Panel on Climate Change (IPCC) has reported that it is “virtually certain that humans are responsible for global warming”.

- Average temperatures have risen by about 1°C (range 0.8°C – 1.2°C) since pre-industrial levels

- At the current rate of increase, average temperatures are likely to reach 1.5°C between 2030 and 2052
- Temperature increases are variable across the world; they are rising by up to x3 in the Arctic. Temperatures are rising faster on land than over oceans.
- Trends in intensity and frequency of some climate and weather extremes have been detected
- Impacts on natural and human systems have already been observed
- Global sea level has risen by about 20cm since 1900
- By 2100 global sea level is likely to rise by another 26-82cm

*The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess climate change based on the latest science.*

<https://www.ipcc.ch/>

*The IPCC produced a special report in October 2018 to consider the likely impacts of a 1.5°C increase in global temperatures above pre-industrial levels:*

<https://www.ipcc.ch/sr15/>

## Sea level rise

An average rise in sea level of 20cm since 1900 may not sound very much but it has already had a significant impact on natural and human systems. In the future, sea level may rise by up to one metre by the end of the century.

Global sea levels are rising for two reasons:

1. Melting freshwater ice from ice sheets (Greenland and Antarctica) and glaciers adds water to the oceans
2. Warmer water expands – this is called thermal expansion – causing sea levels to rise

Rising sea levels threaten low lying coastal areas with flooding and more frequent damage from storms and tropical cyclones. Figure 2 lists some social, economic and environmental effects of sea level rise.

Figure 2

Social, economic and environmental impacts of sea level rise

Social	Economic	Environmental
600 million people live in coastal areas that are less than 10m above sea level.	Many important world cities including New York, Venice and London could be affected by flooding	Pollution of freshwater sources such as wells by salty seawater – this is called salinization
People living in vulnerable areas may have to move home or even move to different countries. Some small island states such as Tuvalu and Vanuatu are particularly at risk.	Valuable agricultural land, (e.g. in Bangladesh, Vietnam, India and China) may be lost to the sea or polluted by seawater	Damage to coastal ecosystems such as mangrove swamps, which form natural barriers to storms.
People may suffer increased frequency of flooding and storm damage.	Transport systems, such as railways, roads and airports may be damaged or destroyed	Damage to coral reefs by storms and powerful waves will affect fish breeding grounds and ecosystems.
People living in vulnerable areas will suffer from anxiety and depression	Harbours and ports may be affected which will have an impact on fishing and trade	Increased rates of coastal erosion will affect ecosystems and habits.
People may lose their jobs, for example, in fishing or tourism, and have to learn new skills.	Valuable land and property will need expensive measures of coastal defence	The IPPC estimates that up to 33% of coastal land and wetlands could be lost in the next 100 years.
The numbers of environmental refugees – people who have lost their homes due to flooding – will increase	Many countries depend on coastal tourism as their main source of income. Beaches may be eroded or flooded forcing hotels to close. People may decide not to visit.	Harbours may become blocked by sediment due to increased rates of coastal erosion

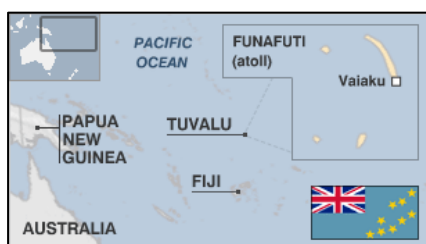
### Case Study: Tuvalu

Where is Tuvalu?

Tuvalu is a group of nine tiny islands in the South Pacific (Figure 3). Most of the islands are low-lying - the highest point on the islands is at 4.5m above sea level (Figure 4). Some 11,000 people live on Tuvalu and the economy is based on the export of copra (dried coconut kernel used to extract coconut oil), the sale of fishing licences for tuna and the sale of its colourful postage stamps!

Figure 3

Location of Tuvalu



<http://www.bbc.co.uk/news/world-asia-pacific-16340072>

Figure 4

Tuvalu – most of the islands are very low-lying



<https://coolheadsforahotplanet.files.wordpress.com/2012/04/tuvalu.jpg>

*What are the issues facing Tuvalu?*

Along with Vanuatu and the Maldives, Tuvalu is threatened by sea level rise which could swamp the entire islands.

- Increased level of salinization (pollution by saltwater) is affecting the soils, which is having an impact on agricultural productivity.
- There are no rivers on Tuvalu, as rainwater soaks into the coral rock. Water comes from wells but these are increasingly becoming polluted by seawater. At times, seawater actually bubbles up to the surface through the porous coral.
- Water supply is a key issue, with droughts becoming more common due to climate change
- Coastal erosion has affected some of the islands, eroding away productive land
- During King Tides (highest tides of the year) the islands are battered by powerful waves, threatening homes and flooding roads (Figure 5)
- The main runway is under threat from flooding

Figure 5

The impacts of a King Tide in Tuvalu



[http://www.worldviewofglobalwarming.org/pages/Tuvalu2011\\_4.php](http://www.worldviewofglobalwarming.org/pages/Tuvalu2011_4.php)

*How are the people in Tuvalu responding?*

- The Tuvalu government has been campaigning for the international community to tackle global warming by reducing carbon emissions.
- Already some people have decided to leave the islands for nearby New Zealand fearing that their homes will become uninhabitable. They are a new wave of 'environmental refugees'.

- Some low seawalls have been constructed but they themselves are now suffering from erosion. Seawalls are not the long term solution.
- Japan is supporting a coral reef restoration programme to reintroduce species to damaged reefs. This could provide some protection from storms as sea levels continue to rise.

In 2017, the Tuvalu Coastal Adaptation Project was established. The 7-year project, funded jointly by the Green Climate Fund and the Tuvalu Government, seeks to strengthen resilience to climate change and sea level rise. The project has three key components:

- Strengthen institutions, human resources, awareness & knowledge for resilient coastal management
- Reduce vulnerability of key coastal infrastructure, including homes, schools, hospitals – to wave-induced damages through the construction of coastal protection
- Establish a sustainable financing mechanism for long-term adaptation efforts

(see <https://tcap.tv/about-tcap> for further details about the project)

*Further information about Tuvalu:*

<http://www.tuvaluislands.com/>

<http://unfccc.int/resource/docs/napa/tuv01.pdf>

<https://tcap.tv/>

## **Extreme weather events**

*Can extreme weather events be linked to climate change?*

A single extreme weather event, such as a thunderstorm or a heavy snowfall cannot be linked to long-term changes in the climate. Extreme weather events such as these have always occurred from time to time.

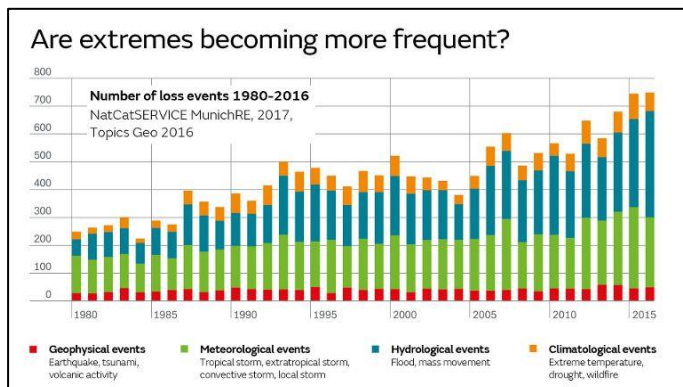
However, scientists have noticed that there have been an exceptional number of these extreme events in recent decades. In recent reports, the IPCC has observed a clear increase in the number, frequency and intensity of heatwaves and heavy rainfall events. If this trend continues, then the link with long-term climate change may become stronger.

In a warming world, there is more energy in the atmosphere. Greater rates of evaporation from the world's oceans result in more water vapour that can in turn lead to more rainfall or snow. Climate patterns may shift, so that some areas become much drier and others much wetter.

The atmosphere is extremely complex and it is impossible to make accurate predictions into the future. But it does seem that we are now living in a world with more extreme weather events (Figure 6).

Figure 6

Trends in the numbers of insurance loss events (1980-2016)



<https://www.metoffice.gov.uk/weather/learn-about/climate-and-climate-change/climate/what-affects-climate/extreme-weather>

Explore CarbonBrief's interactive extreme weather map at:

<https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world>

Explore the Center for Climate and Energy Solutions interactive map of US extreme weather events at:

<https://www.c2es.org/content/extreme-weather-and-climate-change/>

Explore the Guardian's month-by-month guide to extreme weather events for 2018 at:

<https://www.theguardian.com/environment/ng-interactive/2018/dec/21/deadly->

### **Case Study: Brazilian drought 2014**

In 2014 Brazil faced a record-breaking dry season resulting in drought conditions across parts of the country. As water levels fell in reservoirs some of Brazil's major cities including Sao Paulo faced water shortages. Many people had to collect water from water bowsers or had to endure water rationing in their homes.

Shortages of water have affected industrial production, such as aluminium and farming, due to the shortage of water for irrigation. The exceptionally dry weather has affected the coffee industry in Brazil as beans shrivelled on the bushes in January and February due to lack of rainfall (Figure 7). Coffee production dropped significantly due to the drought.

Figure 7

Coffee beans shrivelling due to the intense heat and drought



<http://www.wallstreetdaily.com/2014/10/21/coffee-prices-brazil-drought/>

The drought has also led to a reduction in the production of HEP, due to falling water levels in reservoirs. In parts of the southeast, HEP reservoirs were operating at 30% of their capacity. Alternative forms of energy such as liquefied natural gas (LNG) had to be used to maintain Brazil's energy supply.

As reservoir levels have dropped to 10% of their capacity and rivers have dried up, levels of pollution have increased damaging natural ecosystems and killing fish.

***Case study: climate change in the UK***

Climate change is already happening in the UK. Since 1970 temperatures in the UK have increased by about 1 C. By 2080 they could rise by up to 3.5 C. Summer temperatures are higher and there has been an increase in high intensity rainfall events, for example in Yorkshire and Derbyshire, 2019 (Figure 8). These changes in our climate could have huge impacts on the natural world and on our daily lives.

Figure 8

Flooding at Fishlake, Doncaster, North Yorkshire (2019)



<https://www.telegraph.co.uk/news/2019/11/11/uk-weather-residents-flooded-village-complain-werent-warned/>

The Met Office publishes excellent reports on extreme weather events in the UK:

<https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-extreme-events-heavy-rainfall-and-floods>




<https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/other-content/other-resources/extreme-weather>

<https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather-events>

Figure 9 identifies a range of threats and opportunities associated with climate change in the UK.

Figure 9

Threats and opportunities of climate change in the UK

Climate change	Threats	Opportunities
<p><b>Higher temperatures – warmer summers, heatwaves, droughts</b></p> <p>Will wildfires become more common?</p>  <p><a href="http://www.dailymail.co.uk/news/article-2360273/UK-weather-Met-Office-alert-scorching-weekend-wildfires-sparked-temperatures-climb-30C.html">http://www.dailymail.co.uk/news/article-2360273/UK-weather-Met-Office-alert-scorching-weekend-wildfires-sparked-temperatures-climb-30C.html</a></p>	<ul style="list-style-type: none"> <li>• Heatwaves will lead to deaths amongst the elderly</li> <li>• Droughts will affect crop production and natural ecosystems</li> <li>• Wildfires will become more common threatening settlements and destroying habitats</li> <li>• Roads and railways will need more maintenance as tarmac melts and rails buckle</li> <li>• Millions of people could suffer from water shortages by 2050s</li> </ul>	<ul style="list-style-type: none"> <li>• Tourism industry in the UK will probably increase boosting the economy and creating jobs</li> <li>• Heating costs will fall</li> <li>• Industrial innovation will be encouraged to design new products to cope with the conditions</li> <li>• Agricultural productivity may increase under warmer conditions</li> <li>• Outdoor events such as festivals will become more common</li> </ul>
<p><b>Higher rainfall – more frequent and severe storms</b></p> <p>Flooding at Upton-on-Severn, July 2007</p>  <p><a href="http://www.bbc.co.uk/news/uk-england-18783297">http://www.bbc.co.uk/news/uk-england-18783297</a></p>	<ul style="list-style-type: none"> <li>• Floods will become more common, threatening buildings, infrastructure and farmland</li> <li>• By 2080s over one million properties could be at risk from flooding</li> <li>• Insurance costs will increase. Annual damages could reach £12 billion by 2080s</li> </ul>	<ul style="list-style-type: none"> <li>• Manufacturing industry will be boosted by the need for flood defence construction and new building design features</li> <li>• Managed rivers may be encouraged to revert back to their natural form and new wetlands may be created boosting wildlife</li> </ul>
<p><b>Sea level rise resulting from global warming</b></p> <p>Salt marsh under threat?</p>  <p><a href="http://www.geograph.org.uk/photo/1368924">http://www.geograph.org.uk/photo/1368924</a></p>	<ul style="list-style-type: none"> <li>• Sea defences including the Thames Barrier will need to be upgraded or replaced which will be very expensive</li> <li>• Cliff collapse may increase putting properties at risk</li> <li>• Some salt marshes may become flooded and eroded</li> <li>• Agricultural land may be lost due to managed retreat</li> <li>• Beaches may be eroded affecting the tourist industry</li> </ul>	<ul style="list-style-type: none"> <li>• Managed retreat will create new salt marsh habitats</li> <li>• Construction industry will be boosted by the need to build sea defences</li> </ul>