

Exploring Climate Change

Impacts

Introduction

The impacts of climate change are already being seen around the world. In Scotland and across the UK, extreme weather events have led to landslides and flooding. Climate change is having an impact on Scottish seabirds and the marine environment around our coasts.

Droughts and flooding have claimed tens of thousands of lives and put millions of lives at risk. Tropical storms are increasing in intensity. Hurricanes, cyclones and typhoons have caused billions of dollars' worth of damage.

The link between recent changes in storm patterns and climate change is one of the most complex areas.

Find out more about the UK Climate Impacts Programme: <http://www.ukcip.org.uk/>

Changing weather

More rain is falling on Scotland. Since 1961 rainfall in winter months in northern and western Scotland has increased by an average of almost 60%. In contrast, in the summer months some parts of North West Scotland have become up to 45% drier.

Climate scientists predict that Scotland's winters will continue to grow wetter, with less snow and fewer days of frost.

In August 2007 landslides caused by heavy rain brought hundreds of tonnes of mud into the small coastal village of Pennan in Aberdeenshire. Police and fire services had to help residents escape the severe mudslides. In 2007 Scotland experienced its wettest June since 1938.

Fifty-seven people had to be rescued in August 2004 when thousands of tonnes of debris and mud were brought down onto the A85 road near Lochearnhead by massive landslides. Emergency services, the RAF and the Royal Navy had to airlift stranded motorists to safety. In August 2004 parts of Scotland experienced more than three times the average expected rainfall.

In summer 2007 England was hit by intense rainfall and the worst floods for 60 years. In some places more than a month's average rain fell in just 24 hours. Tens of thousands of homes were left without power and hundreds of thousands of people had no drinking water. Bottled water and water tankers were brought in to distribute safe drinking water to people hit by the floods. The Association of British Insurers predicted that the floods caused more than £2 billion worth of damage.

In November 2009 there were major floods in Cumbria, causing extensive damage. A policeman was drowned as he directed traffic from a bridge which collapsed under the force of flood water in the River Derwent.

Climate researchers have presented evidence that greenhouse gas emissions are a cause of increased rainfall. Rainfall increased by 62 mm per century between 1925 and 1999 in the region between 40 and 70 degrees North. This region includes northern Europe, Canada, and Russia. Human activity is thought to be responsible for between 50 and 85% of this increase.

'Major floods that have only happened before say, every 100 years on average, may now start to happen every 10 or 20 years. The flood season may become longer and there will be flooding in places where there has never been any before.'

Environment Agency Sustainable Development Unit

More people are seeing and experiencing the effects of flooding. The Association of British Insurers has a Geographic Information System (GIS) map that shows flood-prone housing areas throughout the UK.

More houses are being affected by more floods. More families have to cope with losing their possessions and surviving for periods without electricity and drinking water. An increasing number of houses are being built on flat flood plains which means that more and more homes are at risk of flooding in the future. The Environment Agency estimates that 5 million people live in flood risk areas in England and Wales.

While it is not possible to link specific instances of intense rainfall to global warming, researchers have shown that climate change has increased the amount of rain that falls in Northern Europe and predict that warming will lead to more days of heavy rain in future.

By 2080 rainfall events will, on average, be unaffected in north-west Scotland, 25-75% more intense in east Scotland, up to 100% more intense in west Scotland and more than 150% more intense in parts of south-west Scotland.

Unlike changes in average temperature and rainfall, changes in rainfall intensity will be more dramatic in Scotland and England, increasing the likelihood of flash flooding of Scottish rivers.

Scotland and Northern Ireland Forum for Environmental Research (SNIFFER)

Scottish seabirds



Photo: mrpattersonsir (hi Ben!) Available for use under [Creative Commons Attribution 2.0](#) conditions

Changing marine environment

'The seas around Scotland have warmed by 1°C over the last 20 years. Warmer seas have prompted changes in composition, abundance and distribution of a number of marine species including plankton, fish, sea birds, whales, mammals, dolphins and porpoises.

Warm water fish such as red mullet, sardines and anchovies have been caught off

Scotland's coast since 1995. Some plankton species, which form the basis of the marine food web, have migrated north by up to 10 degrees latitude (about 700 miles). Changes in plankton distribution and abundance have serious consequences not only for the marine ecosystem but for the ability of the oceans to absorb carbon dioxide and ultimately regulate the Earth's climate.'

SEPA state of the Environment report 2006

Seabirds like puffins, guillemots and kittiwakes nest in huge numbers round the coast of Scotland. In recent years there has been a run of very poor breeding seasons, especially in 2004 and 2005.

In these years seabird colonies produced very few young. Some species didn't lay eggs while in others the young died before they could leave the colony. The most important cause was lack of food for both adults and young, especially the usually common sand eel, which is the preferred food for many of these species.

Both seabirds and sand eels populations have been studied for about 40 years in the North Sea, because of concerns that industrial fishing of sand eels, for agricultural fertiliser and as a fuel for power stations, would damage sea bird populations and commercial fisheries. While the fishing had affected seabird populations in the past, the 2004 and 2005 problems could not be caused by fishing as the fishing is now strictly controlled.

A complex story unfolded. The shallow North Sea is heating up quickly, by between 1°C to 2°C in 30 years. Slower warming is occurring in deeper Atlantic water to the west of Scotland. This warming is changing the timing and distribution of the tiny plants (the phytoplankton) and the small animals that feed on them (the zooplankton) that form the base of the North Sea food-web.

This leads to changes in size and distribution in sand eels. If there are not enough sand eels in the waters near the sea bird colonies, then they will have a poor breeding season, or even disastrous ones like 2004 and 2005.

Since 2005 Scotland's seabirds have had some better breeding years but the changes in fish distribution, caused by warming seas, have led to poor breeding success in most. Declines in breeding numbers of most species since 2000 have occurred in most seabird species, especially on the east coast, with 55% fewer kittiwakes and 25% reduction in Arctic terns. These declines are especially worrying as seabirds are long lived and it takes years of poor breeding success to affect the numbers of breeding adults.

Droughts and flooding



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In Europe, in 2003, record heat waves caused at least 35,000 deaths. More than 14,000 people died in France alone and over 2,000 in the UK.

'Though heat waves rarely are given adequate attention, they claim more lives each year than floods, tornadoes, and hurricanes combined... Heat waves are a silent killer, mostly affecting the elderly, the very young, or the chronically ill.'

Earth Policy Institute (EPI)

The Hadley Centre for Climate Prediction and Research¹ estimates in its report 'Uncertainty, Risk And Dangerous Climate Change' that man-made climate change has doubled the risk of heat waves. It predicts that by the middle of the 21st century summers in Europe may be dangerously hot.

In Australia, 2005 was officially the hottest year on record, with an average temperature of 22.89°C. While the average global temperature has risen over the last 25 years by 0.6°C, Australia's average temperature for 2005 was 1.09°C higher than the 1961-90 global average.

In recent years bushfires have burned thousands of hectares of bushland and farmland across Australia. Raging bushfires have threatened the suburbs of Sydney; destroying homes and sending thick smoke billowing across the city. In the last few years Australia has also been suffering from its worst drought on record, devastating farmland and leading to ongoing water restrictions in its cities.

African countries have been experiencing more frequent and longer droughts, and unpredictable rainfalls.

'There used to be a major drought every 15-20 years. Now it's every two or three years. Our climate is worsening every year.'

Philip Emanman, social development officer, Kenyan Arid Lands Management Programme

In 2005-06 the Horn of Africa and East Africa were hit by a severe drought that devastated crops. The drought led to widespread food shortages and famine that threatened millions of lives. More than 70 million people in the Horn of Africa live in poverty and face food shortages. Between 2001 and 2007 the region was hit by four major droughts.

In June 2007 six African governments and the United Nations agreed a road map to tackle the root causes of hunger across the Horn of Africa.

'The Horn is hit by some of the world's most severe food crises and they are coming faster and more furious because of climate change, environmental degradation, political and armed conflicts and a host of other factors... We all now need to show the commitment to end this cycle of despair and disaster.'

Kjell Magne Bondevik, UN Special Humanitarian Envoy to the Horn of Africa

Christian Aid has estimated that 182 million people in sub-Saharan Africa could die of disease directly attributable to climate change by the end of the 21st century. Millions more could become climate change refugees.

While some parts of the world experience droughts, other areas experience floods.

The Pacific islands are especially vulnerable to rising sea levels. Coastal areas, where the majority of people live and most agricultural land can be found, are increasingly at risk of

¹ <http://www.metoffice.gov.uk/climate-guide/science/science-behind-climate-change/hadley>

flooding. Some Pacific islands have already been evacuated as a consequence of climate change. As sea levels rise, low-lying islands are now vanishing beneath the waves.

'On the island where I live, it is possible to throw a stone from one side to the other. Our fears about sea level rise are very real. Our Cabinet has been exploring the possibility of buying land in a nearby country in case we become refugees of climate change.'

Teleke Lauti, Minister for the Environment, Tuvalu

In 2004, Bangladesh was ravaged by its worst floods in six years. Hundreds of people died and at least 30 million people were made homeless. Disease followed the flooding as a lack of clean drinking water led to the spread of diarrhoea and dysentery. More than three quarters of crops were destroyed.

Most of Bangladesh is precariously perched just above sea level. This country regularly faces flooding but if, as predicted, the severity and frequency of the floods increases then millions of people will be displaced - losing their homes and livelihoods.

Developing nations will be hit hardest by climate change and are the least able to deal with its consequences. In the UK and other developed nations we have the money and resources to help deal with the consequences of climate change. We spend millions of pounds on flood defence measures to protect our flood-prone cities and coast. Floating homes are now being built in Holland as people adapt to our changing climate.

Around the world people are already suffering and dying from the impacts of climate change. The World Health Organisation² estimated that climate change was responsible for 150,000 deaths in 2000. It is the developing countries of the world that suffer most while they contributed least to the problem. The average person in the UK produces 48 times more CO₂ than the average person living in Bangladesh.

'Climate change is a significant and emerging threat to public health, and changes the way we must look at protecting vulnerable populations... Climate variability and change cause death and disease through natural disasters, such as heatwaves, floods and droughts.'

In addition, many important diseases are highly sensitive to changing temperatures and precipitation... diseases such as malaria and dengue; as well as other major killers such as malnutrition and diarrhoea. Climate change already contributes to the global burden of disease, and this contribution is expected to grow in the future.'

World Health Organisation, Climate Change and Human Health

² <http://www.who.int/en/>

Tropical storms



Photo: NASA/Jeff Schmaltz, MODIS Land Rapid Response Team

Tropical storms have the potential to do great damage, especially on islands and coastal continental areas. Their names reflect where they form, hurricanes in the North Atlantic and Caribbean, typhoons in the Pacific, and tropical cyclones over Australia.

Tropical storms frequently hit the headlines, never more so than when Hurricane Katrina devastated New Orleans in 2005. The hurricane killed at least 1,800 people and caused an estimated \$81 billion worth of damage, making Katrina the costliest natural disaster in history.

One of the results of Hurricane Katrina was to focus the world's attention on the role of climate change in the intensity and frequency of hurricanes and other tropical storms. The debate became polarised, with the US Government denying climate change played any role and some extreme views claiming the storm and its intensity were a direct result of higher temperatures. The reality is somewhere in between and is much more complex than either extreme would like it to be.

The scientific consensus is that warming of ocean surface waters is likely to lead to an increase in the intensity of tropical storms, with higher peak wind speeds and heavier rainfall. This means that hurricanes will be more damaging.

Scientists from the National Center for Atmospheric Research (NCAR)³ and Institute of Technology have concluded that warmer sea surface temperatures and altered wind patterns associated with global warming are responsible for increases in the number of hurricanes. On average twice as many hurricanes form in the Atlantic each year than a century ago.

'These numbers are a strong indication that climate change is a major factor in the increasing number of Atlantic hurricanes.'

Greg Holland, National Center for Atmospheric Research (NCAR)

There has been a marked increase in the number of tropical storms from the 1970s. This increase is greater than predicted based on the records we have of past storm cycles. One possible effect for Scotland is that hurricanes are likely to become more common in areas outside the tropics, increasing the chance of severe winds and extreme weather events here.

³ <http://ncar.ucar.edu/>