

## Climate change

**The climate has changed and is continuing to change. Positive action now will help ensure the well-being of the country in the future.**



### Summary

This is an overview of the main issues surrounding climate change. More specific details can be found in other topics.

Over the past 50 years it has become increasingly apparent that the world's climate is changing at an unprecedented rate, and science suggests that our use of fossil fuels is one of the main causes of this change.

Scotland has already seen changes to its weather patterns over the last century. The impact of these changes will be considerable and could affect everyone in Scotland. We not only need to reduce emissions, but also adapt to climate change.

### Introduction

Over the past 50 years it has become increasingly apparent that the world's climate is changing at an unprecedented rate. Evidence of an increase in average global temperatures (Figure 1), along with an increase in greenhouse gases in the atmosphere (Figure 2), has led to the conclusion that it is our use of carbon-based fuels (e.g. oil and gas) that is the main reason for this change. There has been a rapid increase in the amount of carbon dioxide (CO<sub>2</sub>) in the atmosphere compared with the period before the Industrial Revolution (Figure 2).

The Intergovernmental Panel on Climate Change (IPCC) has identified six main greenhouse gases, all of which contribute to rising global temperatures to varying degrees:

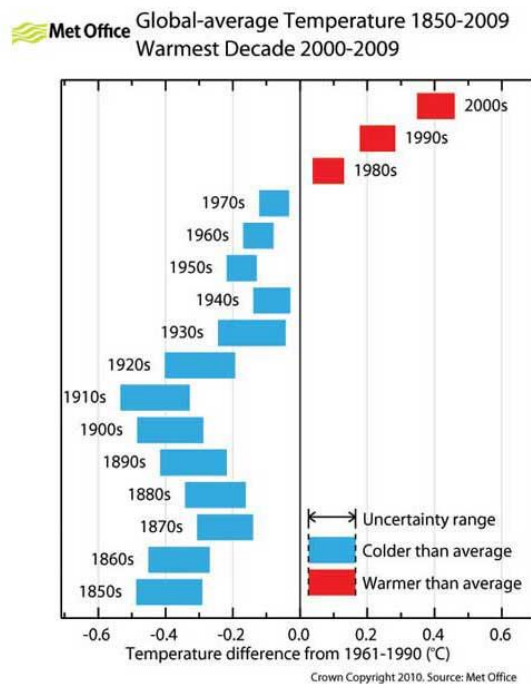
- CO<sub>2</sub>;
- Methane;
- Nitrous oxide;
- Hydrofluorocarbons;
- Perfluorocarbons;
- Sulphur hexafluoride.

A detailed description of these gases can be found on the [IPCC](#) website.

As CO<sub>2</sub> is produced in greater amounts than the other five gases, this is the greenhouse gas with which we are most concerned. CO<sub>2</sub> is mainly produced by burning coal, oil and gas in power stations, businesses, homes, cars and aircraft.

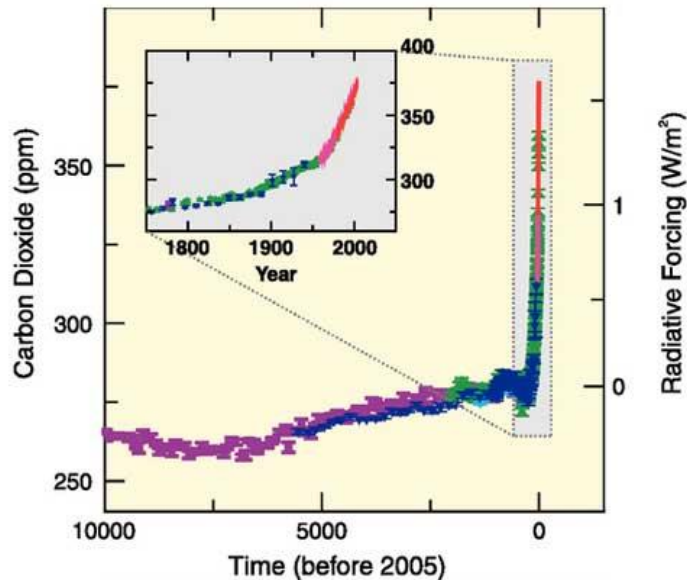
It is important to recognise the difference between weather and the climate, not just of Scotland, but of the whole world. Weather is the temperature, precipitation (rain, hail, sleet and snow) and wind we experience, which changes hour-by-hour, day-by-day. Climate is the average weather expected over a long period of time. So, whereas the weather brings different temperatures all over the world on a daily basis, over a year we would expect the global climate to produce an average temperature of about 14°C. More information on this can be found on the [Met Office](#) website.

**Figure 1:** Global changes in air temperatures, per decade, since 1850



Source: [Met Office](#)

**Figure 2:** Variations in CO<sub>2</sub> concentration in the atmosphere over the last 450,000 years



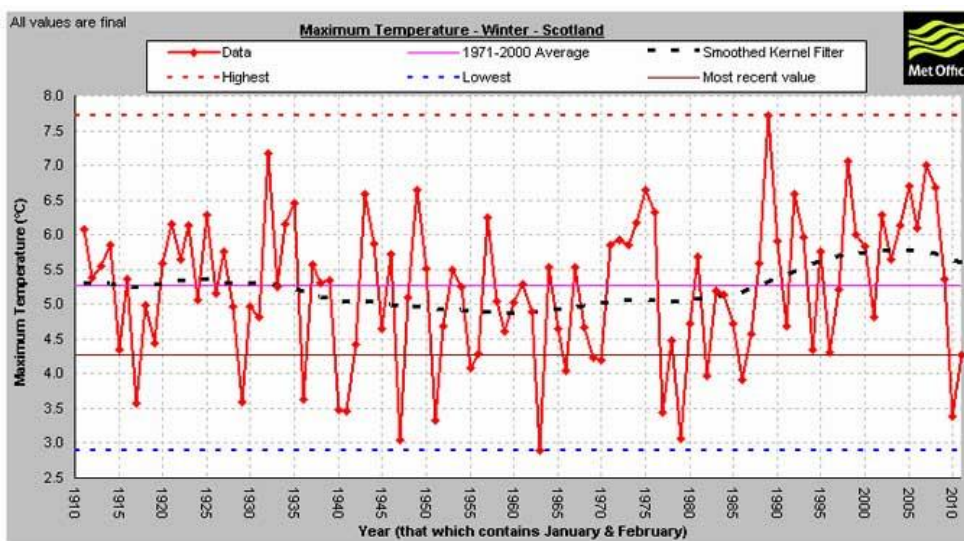
Source: [IPCC Fourth Assessment Report: Climate Change 2007](#)

On an international scale, the impact of the changes in atmospheric greenhouse gas concentrations are likely to be complex and far-reaching. It is inevitable that these changes will also impact on Scotland, as both a trading nation and as one dependent on other countries for the lifestyle we enjoy today. As a result, we not only need to control our own emissions as part of a global effort, but also plan for a future climate different to that of today.

## Description of climate change

Scotland's annual and seasonal climate varies dramatically from year-to-year and it is often difficult to find patterns over the long term when these large swings are taking place. Figure 3 shows the variability of annual winter temperatures in Scotland since 1910 compared to the 30-year average value (1971–2000).

**Figure 3:** Winter temperature in Scotland since 1910



Source: [Met Office](http://www.metoffice.gov.uk)

[A handbook of climate trends across Scotland](#) describes, in some detail, the changes in our weather patterns already experienced in Scotland. Table 1 summarises these recent climate trends. This handbook is expected to be updated in 2014.

**Table 1:** Observed changes in Scotland's climate between 1961 and 2004

Parameter	Observed change in Scotland's climate between 1961 and 2004 <sup>1</sup>
Temperature	Recent temperatures for Scotland are the highest in the records, with average annual temperature increasing 1°C between 1961 and 2004. This applies across all seasons.
Rainfall	Annual precipitation in Scotland increased by 21% between 1961 and 2004, with an almost 70% increase in winter precipitation for northern Scotland. Heavy rainfall events have increased significantly in winter, particularly in northern and western regions.
Snow cover	There has been a 25% reduction in winter days with snow cover, with even larger percentage decreases in spring and autumn. The snow season has shortened, starting later and finishing earlier in the year.
Days of frost	Since 1961 there has been a more than 25% reduction in the number of

	frost days across Scotland, with a downward trend since the 1980s.
Growing season	The growing season is now nearly five weeks longer in Scotland (comparing 1961 to 2004), with the greatest change occurring at the beginning of the season.
Sea level <sup>2</sup>	Sea level at all of Scotland's ports has been rising over the last century, with the rate accelerating over the last two decades (now exceeding 3–4 mm/year in nine out of ten ports).

<sup>1</sup>. The source *A Handbook of Climate Trends Across Scotland* (SNIFFER, 2006) compiles and analyses observed climate data across Scotland over the last century (1914-2004), providing a benchmark of observed climate trends for Scotland.

<sup>2</sup>. Recent analysis of sea level trends by Rennie and Hansom (2010). Source: [SCCIP adapting to climate change](#)

On a global scale, nine of the warmest ten years since records began over 100 years ago have been in the last decade and global temperatures are now 0.75°C warmer than they were 100 years ago. Since the mid-1970s, average global temperatures have increased at a rate of more than 0.15°C per decade.

Sea-surface temperatures around the UK coast have risen over the past three decades by about 0.7°C, whereas overall sea level has risen by about 1 mm/year in the 20<sup>th</sup> century. The rate for the 1990s and 2000s has been greater than this.

Future greenhouse gas emissions (and thus future climate) will depend on complex interactions between population change, economic development and technological advances. The IPCC has considered a series of possible emission scenarios and modelled the potential effects on the global climate. They estimate that global average surface warming is likely to be between 1.1°C and 6.4°C by [2100](#). To put it in perspective, if we had completely stopped emitting greenhouse gas in 2000, we would still expect to see an increase in temperature of between 0.3°C and 0.9°C by 2100 because of the amount of CO<sub>2</sub> already in the atmosphere.

The UK Climate Change Projections ([UKCP09](#)) provide the latest indications of the likely trends for Scotland's climate throughout the rest of the 21<sup>st</sup> century (Figure 4). It is based on scientists' best current understanding of how the climate system operates and how it may change in the future.

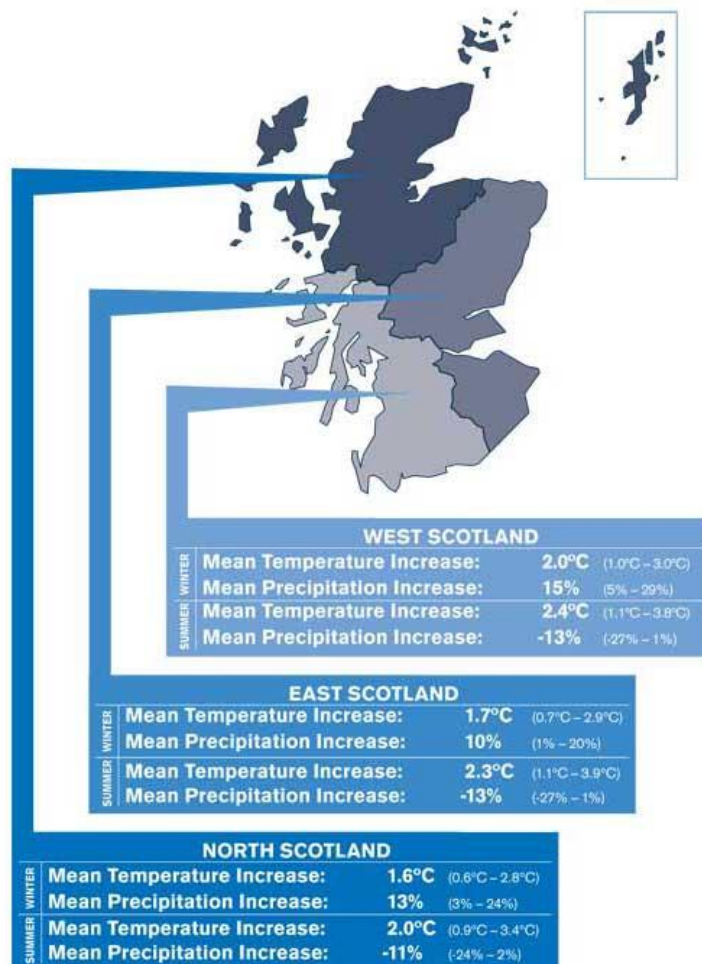
The key climate change trends expected for Scotland are:

- hotter, drier summers;
- milder, wetter autumns and winters.

We can also expect to see:

- an increase in summer heat waves, extreme temperatures and drought;
- increased frequency and intensity of extreme precipitation events;
- reduced occurrence of frost and snowfall;
- sea level rise.

**Figure 4:** UKCP09 projections for mean temperature and precipitation for winter and summer in the 2050s under a medium emissions scenario for different regions of Scotland<sup>3</sup>



<sup>3</sup> UKCP09 projections provide a range of possible climate outcomes. In Figure 4 the main numbers given in bold are the middle of this probability range, while it is very unlikely that temperature and precipitation will be outside the range given in brackets Source: [SCCIP adapting to climate change](#)

## Pressures affecting climate change

### Greenhouse gas emissions



Everyday activities such as our travel choices, heating our homes and emptying our bins all lead to greenhouse gases being produced.

Some of the main sources of greenhouse gases in Scotland are: electricity generation in power stations (36%), domestic transport (21%), agriculture and related land use (21%) and the gas, coal and oil used for heating homes (14%). More detail on the different levels of emissions produced in sectors of the economy can be found [here](#).

Scotland has large stores of carbon, largely as a result of natural processes. Carbon has built up in both the soils and the plants of Scotland, to the extent that we have reserves of carbon that are far greater than our annual emissions. Much of the store is held within peatlands, where the slow but steady accumulation of carbon has been taking place over thousands of years. In the last century, large areas of Scotland were also planted with forest. As trees grow they absorb carbon from the atmosphere (as CO<sub>2</sub>) and store it, reducing our total emissions by around 20% as a result.

Net Scottish greenhouse gas emissions have fallen overall by 28.9% since 1990. The decline and closure of heavy industries like steel making and coal mining in Scotland have led to some of the largest decreases. In some areas, like landfill sites, we are now more careful than in the past in how we handle and dispose of our waste – this has helped reduce greenhouse gas emissions. However, there has also been growth in other areas, which has led to increased emissions. For example, greenhouse gas emissions from domestic transport have increased by 2% and from international aviation and shipping by 12% since 1990, as our use of cars, trains, aircraft and ships has continued to grow.

Scotland currently produces a small proportion – about one seven-hundredth (1/700) – of global greenhouse gas emissions. However, we import products from abroad, so our influence on greenhouse gas emissions is felt worldwide. Greenhouse gas concentrations in the atmosphere are a global problem and the pressures on Scotland's environment from climate change result from activities on a global scale.



## Consequences of climate change



The consequences of climate change are well documented.

For example, we are already feeling the effects with rising temperatures and more frequent winter storms impacting on our lives, our environment and the economy

[Climate projections](#) show that we can expect milder, wetter winters and hotter, drier summers. Extreme weather is likely to become more variable and more frequent, leading to a greater risk of both droughts and floods. This could affect the length of our growing season and the types of crops we may be able to grow in future. The impacts of climate change in Scotland are discussed within each section of this website where relevant links are provided in Table 2.

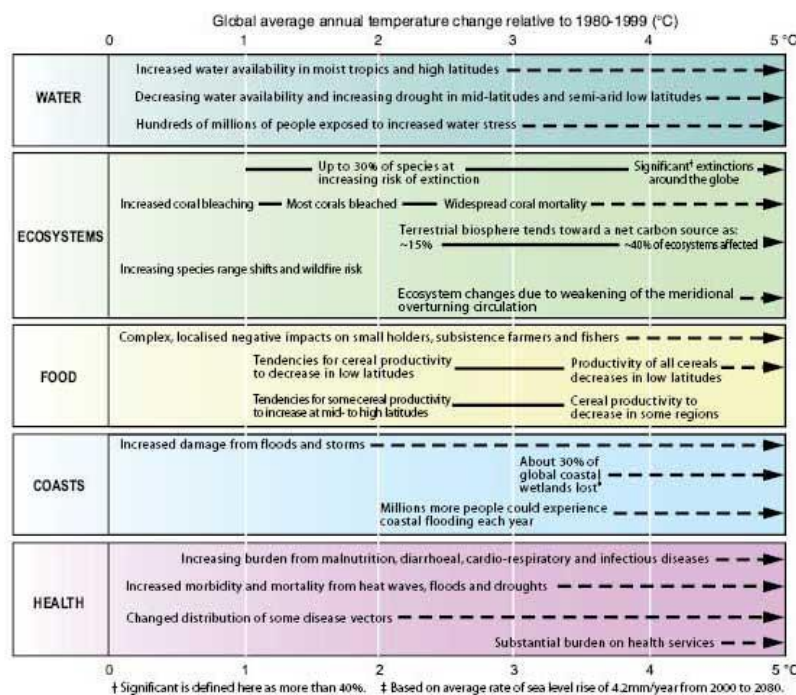
**Table 2:** Consequences of climate change in Scotland

Climate change will impact:
<a href="#">Agriculture</a>
<a href="#">Biodiversity and ecosystem resilience</a>
<a href="#">Built environment</a>
<a href="#">Business and industry</a>
<a href="#">Emergency and rescue services</a>
<a href="#">Energy</a>
<a href="#">Forests and forestry</a>
<a href="#">Health and well-being</a>
<a href="#">Marine and fisheries</a>
<a href="#">Spatial planning and land use</a>
<a href="#">Transport</a>
<a href="#">Water resource management</a>

[Foresight](#) teams are looking at many broader issues throughout the world, e.g. the impact of climate change on issues such as global food production and migration patterns. All of these will have potential consequences for the way we live (Figure 5).

The potential global impacts of a change in temperature of between 0 and 5°C (i.e. as predicted by IPCC modelling) on water, ecosystems, food, coasts and health are shown in Figure 5.

**Figure 5:** Global impacts of climate change.



Source: [IPCC Fourth Assessment Report: Climate Change 2007](#)

This figure shows that a global surface warming of 4°C would mean that hundreds of millions of people would be exposed to increased water stress, cereal productivity would decrease in some regions, millions more people could experience coastal flooding and more people would die from heat waves, floods and droughts.

An interactive Met Office map of climate change impacts across the world for warming of 4°C can be found on the [National Archives](#) website.

The [stern review](#) estimates that if we do not take action globally, the overall costs and risks of climate change will be equivalent to losing at least 5% of global gross domestic product (GDP) each year, now, and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more. However, the costs of reducing greenhouse gas emissions to avoid the worst impacts of climate change, can be limited to around 1% of GDP every year.

## Response by society



Once greenhouse gases enter the atmosphere, their effect will be felt over decades to come. It is important for us to both reduce our greenhouse gas emissions in line with global ambitions and adapt to changes in the climate that are already being seen. So, as well as trying to reduce emissions (mitigation), we also need to prepare for the climate change that we cannot avoid (adaptation) because our emissions have already set us on course for a changing climate.

The Climate Change (Scotland) Act 2009 made a commitment that greenhouse gas emissions in Scotland will be cut by 80% of 1990 levels by 2050. The Act sets a framework for action in Scotland on both mitigation of emissions, as well as adaptation to a changing climate.

### Mitigation

Reducing our emissions by 80% by 2050 will require changes for everyone – our industries, our homes and ourselves. Some of those changes will need to be big, for example changing the way our electricity is generated, whereas others will be small, but important changes, such as being more careful in using energy in our homes.

Meeting the challenge of climate change presents us not only with risks, but also opportunities. Scotland, with extensive wind and wave resources, is well placed to help meet the increasing demand for renewable energy. Investment in renewable energy helps create jobs, and taking steps to improve domestic energy efficiency will enhance the homes in which we live.

We need a plan to meet such a complex challenge. The Scottish Government has published the [report on proposals and policies](#), which outlines the actions needed through to 2022, setting a course towards the 2050 target of an 80% reduction in emissions.

In order for some of these proposals to work, new technologies will need to be developed, particularly in relation to carbon capture and storage, which is intended to trap CO<sub>2</sub> emissions from large power stations. However, it will also require a wider response from society. For example, individuals, companies and public bodies can all help reduce our levels of energy usage. Although major companies and employers are involved in a range of schemes intended to reduce emissions, such as the [EU emissions trading system](#) and the [CRC energy efficiency scheme](#), it is important that the general public are engaged with the climate change agenda.

To help with public engagement, the Climate Change (Scotland) Act 2009 includes a requirement for a [public engagement strategy](#). Ensuring that the public sector – where many critical decisions that can influence emissions are made – also takes account of, and addresses the issue of, climate change through the establishment of a [public bodies duty](#), is also important.

The Scottish Government has also published a [land use strategy](#). This strategy sets objectives for this important sector that contribute to greenhouse gas emission reduction targets, to climate change adaptation and to sustainable development. It also sets out policies and proposals for meeting those objectives and the timescales over which these are expected to take effect.

## Adaptation

Although we can start to tackle emissions, their effects will continue to change Scotland's climate for many decades to come, and we need to adapt the way we live to a changing world.

We need to plan for both the negative impacts to come, as well as the new opportunities change may bring. To do this, [Scotland's climate change adaptation framework](#) was published in 2009, and a series of [sector action plans](#) have been developed as many adaptation decisions are taken at a local level by individual organisations.

[Adaptation Scotland](#) is an initiative helping organisations and communities in Scotland adapt to the unavoidable impacts of climate change. The Adaptation Scotland website offers free access to the best-quality data on climate trends and their impacts in Scotland, as well as access to tools, guidance and advice on adapting to the impacts.

In the future, the [UK climate change risk assessment](#) (UKCCRA), due for publication in January 2012, will play a key role in helping us to focus action on the impacts that are most important and urgent for Scotland. It will draw together evidence and analysis that will improve our understanding of the threats and opportunities presented by the changing climate. In response to the UKCCRA, the Scottish Government will produce an Adaptation Programme, which is planned to be delivered in March 2013.

When the UKCCRA is published, we will have a more comprehensive analysis of the potential impacts of climate change in Scotland. In the meantime, the [sector action plans](#) are a good source of information about our current understanding of the risks.