

Climate

Scotland generally has cool summers, mild winters and rain falls throughout the year. Over the last century it has become warmer, with drier summers, wetter winters and more frequent heavy rainfall.

Summary

Key messages

- Scotland has a variable climate. We have cool summers, mild winters and rainfall spread throughout the year.
- Within the country, there are regional differences in climate as well as differences between seasons.
- Over the last century, our climate has become warmer, while altered precipitation patterns have led to drier summers, wetter winters and more frequent heavy rainfall.
- The world's climate is changing at an unprecedented rate. Since the late 1800s, the atmosphere and ocean have warmed, amounts of snow and ice have diminished, the sea level has risen, and concentrations of greenhouse gases in the atmosphere have increased.
- People are causing this rapid change in climate mainly due to greenhouse gas emissions.
- We need to reduce our greenhouse gas emissions to prevent further climate change.
- We also need to prepare for the climate change that we cannot avoid due to our previous emissions.
- The [Climate Change \(Scotland\) Act 2009](#) makes a commitment to cut greenhouse gas emissions in Scotland by 80% of 1990 levels by 2050. The Act sets a framework for action in Scotland to reduce emissions as well as adapt to a changing climate.

State and trend

Scotland's climate is currently in a good state for people to live in; however, it is changing rapidly. Over the last 100 years it has become warmer, while altered precipitation patterns have led to drier summers, wetter winters and more frequent heavy rainfall. Changes in our climate over the next few decades are unavoidable because of the greenhouse gases already in the atmosphere. When viewed over long-term averages, we expect the UK to experience [more milder wetter winters and more hotter drier summers](#) in the future. These changes in climate and their effect on our weather will have major implications for our way of life.

Overview

Weather is the temperature, precipitation (rain, hail, sleet and snow) and wind we experience. It is short term and changes from hour to hour, and it can be localised in small areas. Climate is the average weather taken over a long period of time – typically 30 years. It is what we expect rather than what we actually get. So, while the weather brings different temperatures across the country every day, the [long-term average](#) maximum air temperature for Scotland between 1981 and 2010 was 10.7 °C, while the average minimum air temperature was 4.2 °C.

Scotland's climate

Scotland has a [temperate maritime climate](#) (temperate because it has moderate temperatures and maritime because of the influence of the sea). We generally have cool summers, mild winters and rainfall spread throughout the year. However, even within a small country there are regional differences as well as differences between seasons. These are caused by a [range of factors](#), including latitude, distance from the sea, prevailing winds, ocean currents and altitude.

A changing climate

We have been collecting weather data in Scotland since the 19th century; the first network was set up in 1855. Data show that Scotland's climate has changed rapidly during this time – it has got warmer (Figure 1), while altered precipitation patterns have led to drier summers, wetter winters and more frequent heavy rain.

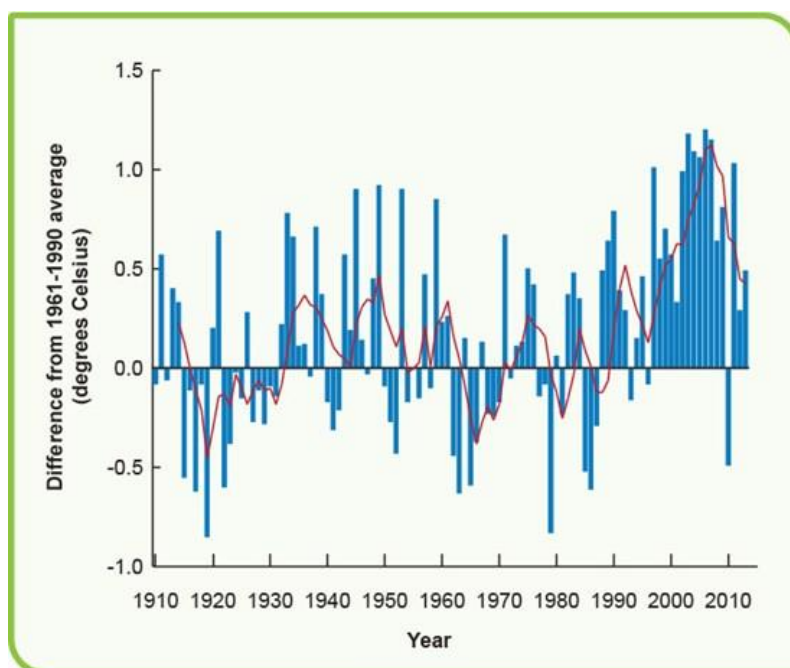


Figure 1: Average annual surface temperature in Scotland compared to the 1961–1990 average

Source: [Scottish Government: High level summary of statistics trends - annual mean temperature](#)

Global climate change

On a global scale, it has become more and more apparent that the world's climate is changing faster than ever before. The Intergovernmental Panel on Climate Change (IPCC) report [Climate Change 2013: The Physical Science Basis](#) confirms that since the late 19th century the atmosphere and ocean have warmed, amounts of snow and ice have diminished, the sea level has risen, and concentrations of greenhouse gases in the atmosphere have increased.

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 (Figure 2). Scientific evidence suggests that in the northern hemisphere, there is a likelihood of between 66 and 100% that [1983-2012 was the warmest 30-year period in the last 1,400 years](#).

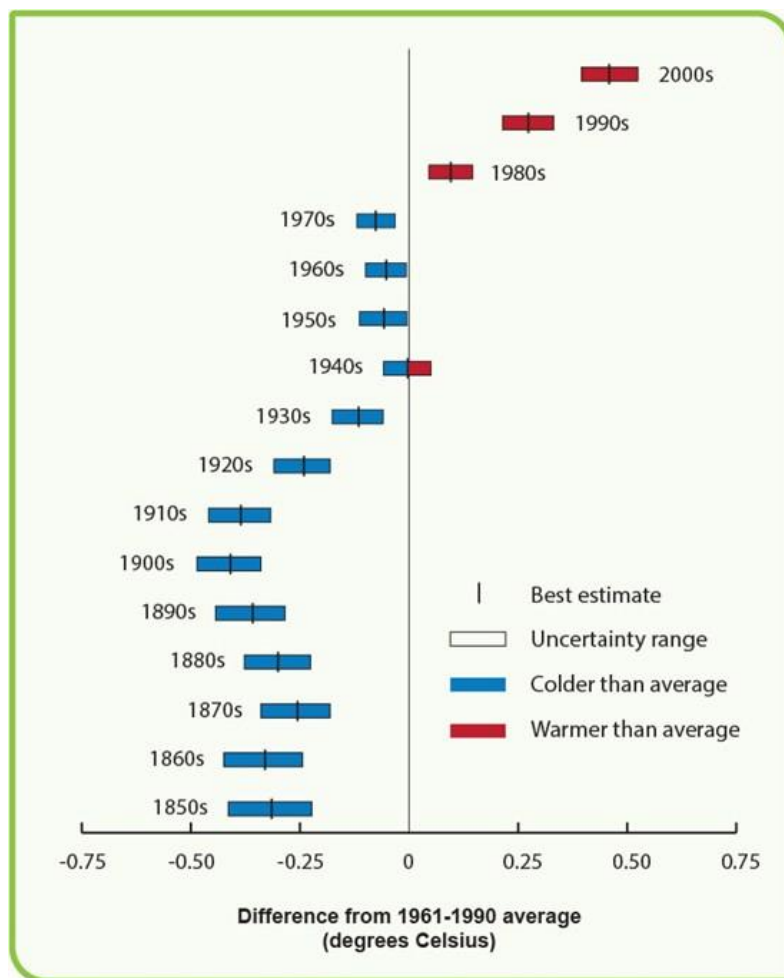


Figure 2: The difference between the average decadal temperature in Scotland and the average 1961-1990 temperature. British Crown Copyright 2014

Source: Met Office

On a global scale, [13 of the 14 warmest years](#) since modern records began in 1850 occurred in the 21st century.

Causes of climate change

The [main cause of climate change](#) is [increasing greenhouse gas concentrations in the atmosphere](#).

The Earth receives heat from the sun. About half of this energy is absorbed by the Earth's surface, some is absorbed by the atmosphere and some is reflected back into space. As the surface of the planet heats up, some of the heat is emitted back into the atmosphere and absorbed by greenhouse gases, which trap the heat and keep the Earth warm. This is a natural process and known as the greenhouse effect (Figure 3).

However, if concentrations of greenhouse gases in the atmosphere increase, more heat is trapped and the Earth becomes even warmer. This is known as the enhanced greenhouse effect.

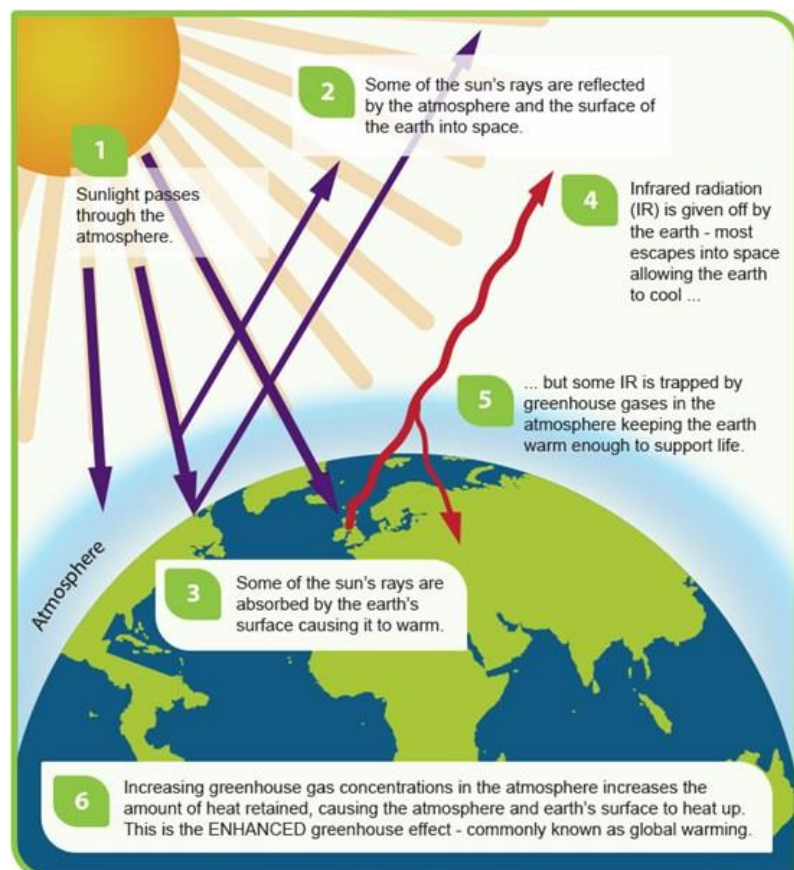


Figure 3: The greenhouse effect

The main greenhouse gases are: water vapour (H₂O); carbon dioxide (CO₂); nitrous oxide (N₂O); methane (CH₄) and ozone (O₃). These are formed as a result of natural and human activities. There are also a number of entirely human-made greenhouse gases in the atmosphere, such as sulphur hexafluoride (SF₆), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

These gases accumulate in the atmosphere. Significant increases in concentrations of CO₂, CH₄ and N₂O occurred in the industrial era (Figure 4). All of these increases have been caused by human activities. The global increases in CO₂ concentration are due primarily to using fossil fuels and changes in land use, while those of CH₄ and N₂O are mainly due to agriculture.

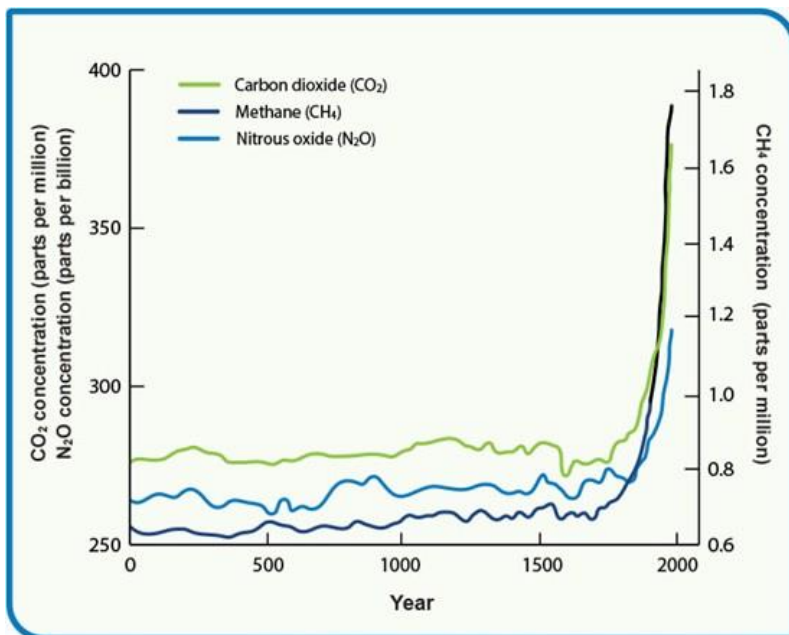


Figure 4: Atmospheric concentrations of important greenhouse gases over the last 2,000 years. Increases since about 1750 are due to human activities in the industrial era

Source: [IPCC](#)

The [IPCC reports](#) that scientific evidence now shows with at least 95% certainty that human activity is the main cause of global warming since the mid-20th century.

While the recent rapid change in climate can be attributed to human activities, the climate has also [changed throughout geological time](#), well before people were around. This is known as natural climate variability and is due to a number of factors, including:

- [changes in solar activity](#);
- changes in the Earth's orbit;
- [volcanic eruptions](#);

- [aerosols](#);
- [El Niño and La Niña](#).

The [difference between weather and climate, what drives our climate and how our climate is changing](#) is summarised on the Met Office website.

Environmental state and trends

State

Scotland generally has cool summers, mild winters and rainfall spread throughout the year. However, there are [regional differences](#) as well as differences between seasons.

- The south is generally warmer than the north in summer, mainly due to the influence of latitude.
- The west is generally milder, cloudier and wetter than the east due to the prevailing winds from the south-west and the influence of the North Atlantic Drift. The east is also sheltered by the mountain ranges in the west, which create a rain-shadow effect.
- The west also has a lower range of temperatures than the east because of the moderating influence of the Atlantic Ocean.
- The north and west Highlands usually have lower temperatures throughout the year than the low-lying areas in the south and east because of the influence of altitude.
- The west has more rain in winter, when Atlantic depressions are more frequent.

Scotland can be separated into three climatic zones – north, east and west. Regional climate summaries for [northern](#), [eastern](#) and [western](#) Scotland are available on the [Met Office](#) website. More detail on [regional climate statistics](#) can also be found on the Met Office website.

Trends

Scotland's [Climate Trends Handbook](#) is published on this website. The handbook describes the changes in weather patterns experienced in Scotland over the last century. The following text summarises the recent climate trends over the period 1961-2011 (unless stated otherwise).

Temperature

Across Scotland the [mean annual temperature](#) has increased by 1.3 °C, with the biggest seasonal change found in spring which has warmed by 1.5 °C on average. The mean temperature has also increased for all seasons in all regions by at least 1 °C.

The [maximum temperature](#) has increased for all seasons in all regions. The increases have been slightly greater than those observed in mean annual temperatures.

The [minimum temperature](#) has also increased for all seasons in all regions. The increases have been slightly less than those observed in mean annual temperature, with the [length of cold spells](#) reduced by almost eight days across Scotland (from 1961-2003). However, two exceptionally cold winters (2009/2010 and 2010/2011) have occurred in recent years – the winter of 2010/2011 was the second coldest since that of 1985/1986.

Frost

All regions have seen a decline in the number of days a year on which there is [air or ground frost](#), with a reduction of 21 days of [air frost](#) and 29 days of [ground frost](#) for Scotland. However, in 2010 the UK experienced the coldest December for over 100 years. Although changes in the total number of air frost days are largest in winter, it is spring and autumn that have seen the largest changes as a percentage and that show a significant downward trend.

Sunshine

Since 1961 there has been a clear increase in [sunshine hours](#) for all regions of Scotland in the spring. There has also been an increase in sunshine hours in autumn, but summer and winter have seen little change.

Rainfall

Although there has been an overall increase in [rainfall](#) (27%), it varies among seasons and regions. These variations are more marked in winter, with a 24% increase in total rainfall in the east and an increase of 45% and 51% in the west and north respectively. In the west and north, the [number of days of heavy rain](#) in a year has increased by 12 and seven days respectively, while an increase of five days is found in the east.

Snow cover

All regions have seen a decline in [snow cover](#) from 1971-2011, however autumn is the only season for which there is a clear trend. In recent winters there has been an increase in the number of days of snow cover, following a period of winters with relatively little snow.

Wind

There has been a decreasing trend in average wind speed for all regions of Scotland, with the largest decreases found in the north and west. However, we have low confidence in these results because of uncertainties relating to their measurement.

The future – climate change projections

Our future climate depends on many factors, mainly the concentration of greenhouse gases in the atmosphere.

Future greenhouse gas emissions (and, thus, the future climate) will depend on complex interactions between population change, economic development and technological advances as well as the willingness of countries to reduce their greenhouse gas emissions.

The IPCC has considered a series of possible future emissions and modelled the potential effects on the global climate. They estimate that global average surface warming is [likely to be between 0.3 °C and 4.8 °C by the year 2100](#). Even if we had stopped emitting greenhouse gases completely in 2000, we would still expect to see an increase in temperature by 2100 because of the amount of CO₂ 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 21st century (Figure 5). It is based on scientists' best current understanding of how the climate system works 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 heatwaves, extreme temperatures and drought;
- increased frequency and intensity of extreme rainfall;
- reduced frost and snowfall;

- rising sea levels.

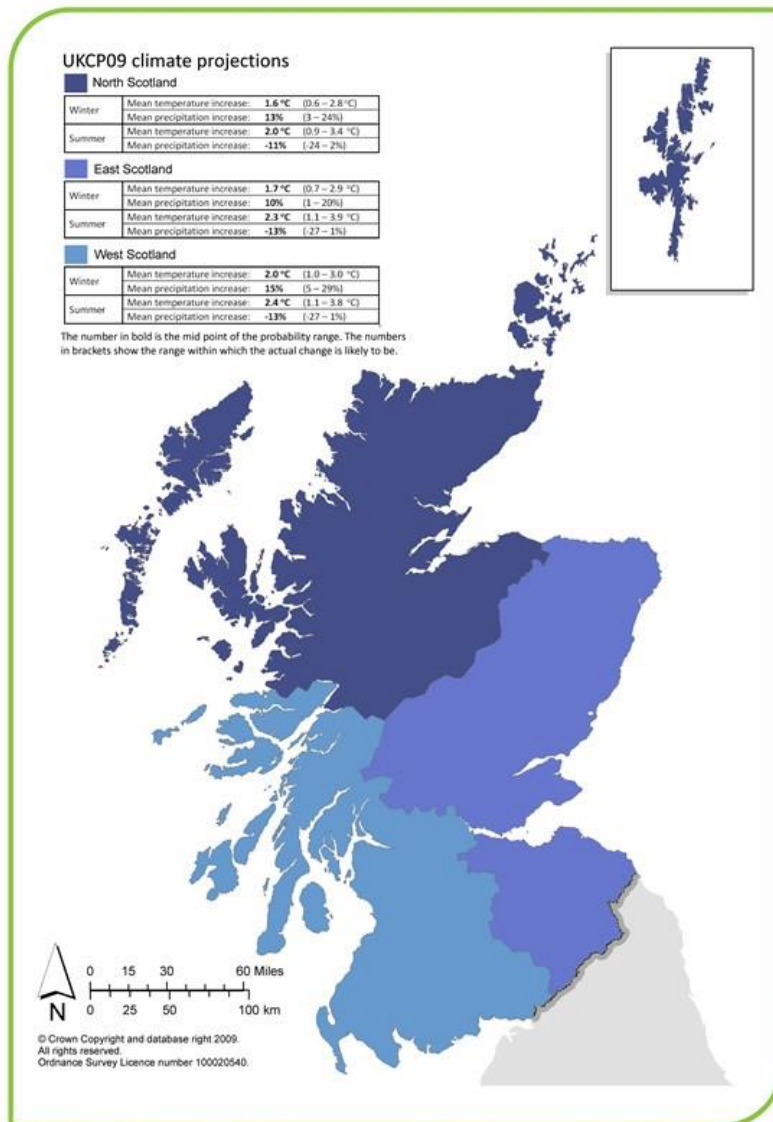


Figure 5: UKCP09 projections for mean temperature and precipitation for winter and summer for different regions of Scotland in the 2050s based on a medium amount of emissions

Source: [Adaptation Scotland, Adapting to Climate Change](http://www.adaptation-scotland.gov.uk)

Pressures

Our climate is affected by a range of global pressures. Some of these pressures are natural, such as the emission of particles and gases from volcanoes or related to the amount of energy coming from the sun or the orbit of the Earth. However, the overriding pressure on our climate is global warming caused by the increase in greenhouse gas concentrations in the atmosphere.

Greenhouse gas emissions

Everyday activities such as our travel choices, heating our homes and how we dispose of our rubbish all lead to greenhouse gases being produced.

In 2012 net emissions of the [six main greenhouse gases](#) created by human activities in Scotland were estimated to be 52.9 million tonnes of carbon dioxide equivalent (million tonnes CO₂ eq). The sources and amounts of greenhouse gases emitted in 2012 are shown in Table 1. You can find more information in the [Scottish Greenhouse Gas Emissions 2012](#) report.

Table 1: Scottish greenhouse gas emissions, 2012

Source of greenhouse gas emissions	Greenhouse gas emissions in 2012 (million tonnes CO ₂ eq)	Share of 2012 emissions (%)
Energy supply	17.13	32
Domestic transport	10.54	20
International aviation and shipping	2.36	5
Business and industrial process	8.53	16
Residential	7.28	14
Public sector	1.37	3
Waste management	2.77	5
Development	1.68	3
Agriculture and related land use	11.17	21
Forestry	-9.92	-19
Total	52.9	100

[Net Scottish greenhouse gas emissions have fallen by 29.9% since 1990, although there was a 0.8% increase in net emissions between 2011 and 2012.](#) The decline and closure of heavy industries like steel-making in Scotland have led to some of the largest decreases. More efficient energy generation, storing more carbon in soils and trees, and a decline in methane emissions from landfill sites have also contributed to the reduction in emissions.

Scotland's soils contain large amounts of organic matter. Approximately [3,200 million tonnes of carbon](#) is stored within the organic matter in soils. This is equivalent to nearly 230 times our annual greenhouse gas emissions. To put it into perspective, if we lost 0.5% of the carbon contained in Scotland's soil in a year, it would be enough to double our annual greenhouse gas emissions. Therefore, it is vitally important to manage soils carefully to ensure the carbon stays in the soils and does not escape into the atmosphere as greenhouse gases.

Scotland currently produces a small proportion – about one-thousandth – of global greenhouse gas emissions. However, on average, each person in Scotland emits around 10 tonnes CO₂ eq each year, which is around one-third more than the average for each person on the planet. So we are responsible for more than our fair share of global emissions. We also import products from abroad, so our influence on greenhouse gas emissions is greater than just those emitted in Scotland. Greenhouse gas concentrations in the atmosphere are a global problem, and the pressures caused by climate change result from activities on a global scale.

Impacts of climate change

Scotland's climate is changing, and the effects are already being felt by people and the environment. Our climate will continue to change in years to come and the effects are likely to become more obvious and widespread. The potential impacts of climate change are outlined in [A climate change risk assessment for Scotland](#).

Impacts on people

The most obvious impacts on people are likely to be caused by more flooding and landslides caused by more frequent extreme weather events and rising sea levels. These will disrupt road and rail links and damage buildings. However, there may be less disruption to transport links due to a reduced occurrence of snow and ice.

Rising sea levels are likely to change the geography of the coast and increase the risk of flooding for low-lying properties. Many sites of historical importance are located on or near the coast, and these will also be in danger of flooding. There is a significant risk of an increase in mental health problems as a result of more flooding.

Milder, wetter winters may result in houses becoming damper, increasing the growth of algae and fungi, with knock-on effects for health. There is likely to be less demand for energy in winter for heating and more demand in summer for cooling.

Impacts on the environment

Changing temperature and rainfall patterns are likely to result in changes in river flows and soil moisture as well as an increase in wildfires.

These can all result in loss of habitats and the wildlife they support. This may mean the loss of some rare native species, such as capercaillie, as their habitat disappears. However, new habitats may form and new species may become established as the Scottish climate becomes more favourable for them.

Some pests and diseases may become more prevalent as they survive through warmer winters. New pests and diseases may also emerge. Higher temperatures and more droughts may mean that some of Scotland's blanket bogs may begin to dry out, resulting not only in a loss of internationally rare habitat and species, but also a loss of carbon stored in the peat, which may contribute to further climate change.

Rising sea levels and increased coastal erosion and flooding may damage rare Scottish coastal habitats, such as machair.

Warmer temperatures may lead to a longer growing season for some crops and trees, but higher rainfall may make it more difficult to cultivate the land. Some crops and trees will grow better, whereas others will fail. It may be possible to grow different crops. However, this may be tempered by a reduction in water supply in summer.

You can find more details on the impacts of climate change on the environment in the relevant topics on [Scotland's Environment](#) website.

What is being done

Once greenhouse gases enter the atmosphere, their effect will be felt over decades to come. Therefore, we need to reduce (mitigate) our greenhouse gas emissions to prevent additional climate change. We also need to prepare for the climate change that we cannot avoid (adapt) because our emissions have already set us on course for a changing climate.

Climate change is a global issue and greenhouse gas emissions affect the whole planet, regardless of where they come from. Tackling climate change requires co-ordinated action by nations around the world. The [United Nations Framework Convention on Climate Change](#) (UNFCCC) came into effect in 1994 with the aim of stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent "dangerous" human interference with the climate system. Today the Convention has been ratified by 195 countries.

The [Kyoto Protocol](#) was adopted in 1997 and came into effect in 2005. It commits industrialised countries to stabilise greenhouse gas emissions based on the principles of the Convention.

As a contribution to global efforts to stabilise greenhouse gas concentrations in the atmosphere, the [Climate Change \(Scotland\) Act 2009](#) has made a commitment that greenhouse gas emissions in Scotland will be cut by 80% of 1990 levels by 2050, with an interim target of a 42% cut by 2020.

The Act sets a framework for action in Scotland to mitigate emissions and adapt to a changing climate.

Mitigation

Reducing our emissions by 80% by 2050 will require changes for everyone – our industries as well as ourselves. Some of those changes will need to be big; for example, changing the way our electricity is generated, whereas others will be small, such as being more careful in using energy in our homes or the decisions we make about transport. The [Committee on Climate Change](#) published their third report on [Scotland's progress towards meeting emission reduction targets](#) in March 2014.

The Scottish Government has published its [second report on proposals and policies](#). This outlines how Scotland can meet its greenhouse gas emission reduction targets for the period 2013–2027. These include:

- expanding our renewable energy production;
- improving energy and resource efficiency in households and industry;
- reducing carbon emissions from transport;
- expanding renewable sources of heat;
- sustainable land use.

Adaptation

Although we can start to reduce emissions, their effects will continue to change Scotland's climate for many decades to come, so we need to adapt the way we live.

We need to plan for the negative consequences 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](#) were developed, as many adaptation decisions are taken at a local level by individual organisations.

[Adaptation Scotland](#) is an information and advice service, funded by the Scottish Government, to raise awareness of changes in climate. It helps organisations and communities in Scotland prepare for, and increase their resilience to, the impacts of climate change.

The [UK Climate Change Risk Assessment](#) (CCRA), published in 2012, was the first assessment of current and predicted impacts of climate change for the UK. The CCRA consists of a number of reports, including a [Climate Change Risk Assessment for Scotland](#). A [summary](#) of the assessment for Scotland is also available. These bring together evidence and analysis to help improve our understanding of the threats and opportunities of a changing climate.

A new Scottish Climate Change Adaptation Programme is being developed, which will address the risks identified for Scotland in the CCRA.