G20 CLIMATE RISK ATLAS

Impacts, policy, economics

cmcc

UNITED KINGDOM

With the scientific contribution of Enel Foundation

How to read the Atlas: graphs, colours and scenarios.

The maps used in this Atlas are taken from **The World Bank Official Boundaries** - ***https://datacatalog.worldbank.org/search/dataset/0038272*** (accessed on May 28, 2021). For the section Energy, the maps are based on Panoply Data Viewer ***https://www.giss.nasa.gov/tools/panoply/credits.html***

Each sector of this Atlas contains data and information on various climate scenarios.

When reported in graphs, the **colour black** indicates data and information referring to the current state, the past or the baseline.

When the authors refer to **RCP (Representative Concentration Pathways)**, the 3 colours used across the factsheet refer to 3 scenarios, which are 3 different development options with different levels of greenhouse gas emissions, **respectively low emissions (green), medium emissions (orange), and high emissions (red)**. The same colour code is used when RCPs are associated with Shared Socioeconomic Pathways (SSP).

In some cases, the authors refer to global warming scenarios. In these cases, the 3 colours used refer to a temperature rise of **1.5°C (green), 2°C (dark green), and 4°C (red)**.

When the authors refer exclusively to **Shared Socioeconomic Pathways - SSPs** (Population affected by river floods in the section: "Water"), data related to **SSP3** - that encompasses, among other things, slow economic growth, material-intensive consumption, and persisting or worsening inequalities – **are reported in a lighter shade**; **SSP5** – which refers to social and economic development that is coupled with an energy-intensive lifestyle and the abundant exploitation of fossil fuel resources – is shown using a **middle shade of the colour**, whereas data related to **the present** conditions **are represented in a dark shade**.

Further details on scenarios, methodologies, and the full list of references are available at: **www.g20climaterisks.org**

Concept and graphic design by element6.eu

UNITED KINGDOM CLIMATE

OVERVIEW

The United Kingdom has an oceanic climate, featuring mild summers and cool winters, whereby high temperatures are not very common. It is often cloudy and rainy, whereas thunderstorms are quite rare as hot and cold air masses meet infrequently. The UK's climate is mainly affected by the Atlantic Ocean and latitude, as well as the path of the polar front jet stream which leads to frequent changes in pressure and unsettled weather.

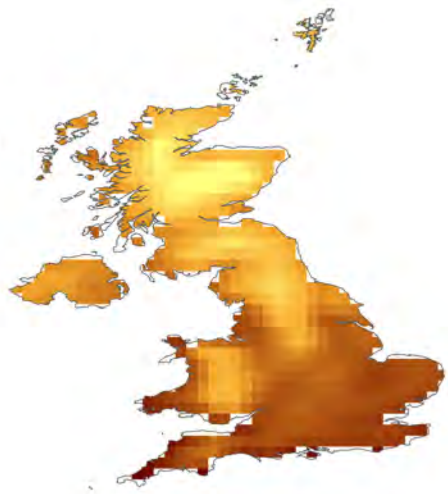
TEMPERATURE

The temperature regime in the UK is affected by the maritime polar air mass coming from the north-west. The southern part of the country, including London, generally presents higher temperatures with respect to the northern part.

MEAN TEMPERATURE

+6 12

Celsius degrees / Over 1991-2020



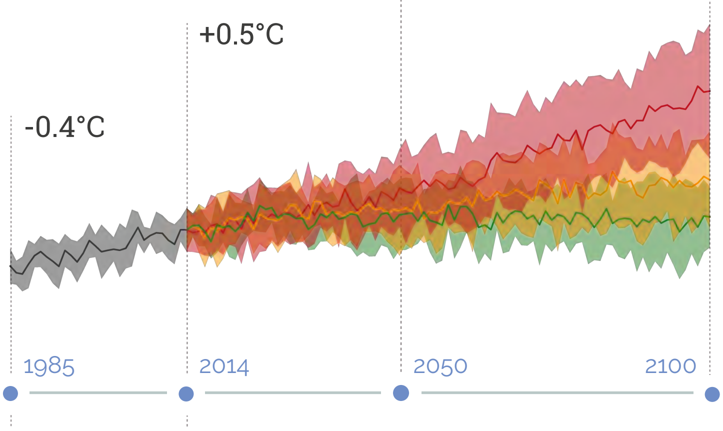
TEMPERATURE TREND

Temperature anomalies over the last 60 years with respect to the annual mean of 9°C in the United States during the 1961-1990 period

TEMPERATURE PROJECTIONS

Under a low emissions scenario projected temperature variations will remain contained under +1°C, both by 2050 and 2100.
Under a high emissions scenario, with no reduction in GHG emissions, much greater temperature anomalies are expected by both 2050 and 2100.

TEMPERATURE ANOMALY



EXPECTED VARIATION FOR TEMPERATURE AT 2050

The indicators show variations in selected temperature characteristics for a thirty-year period centred on 2050 (2036-2065) with respect to the reference period 1985-2014.

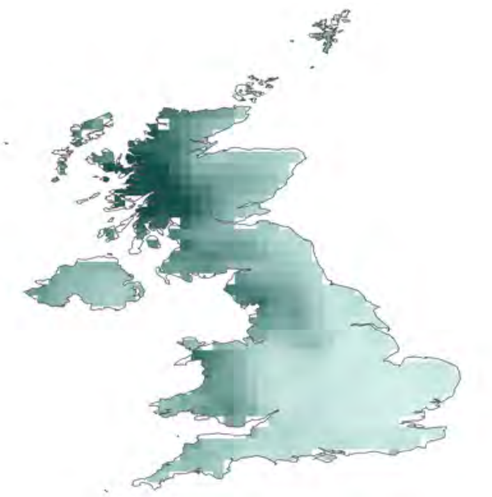
Annual Mean Temperature	Max Temperature of warmest month	Min Temperature of coldest month
+1.4°C	+2.0°C	+1.2°C
+1.0°C	+1.5°C	+0.9°C
+0.8°C	+1.3°C	+0.6°C

PRECIPITATION

The precipitation regime is mainly characterised by cloudy and rainy weather, with an average annual rainfall of about 950 millimetres per year. Scotland in particular experiences significant rainfall due to the presence of mountains. Autumn and winter are usually the wettest seasons, with the rainfall coming from the clash between warm and cold weather systems. In the summer there is still a moderate amount of rainfall, much of which comes in the form of heavy showers.
The highest frequencies and intensities of extreme rainfall occur during the summer.

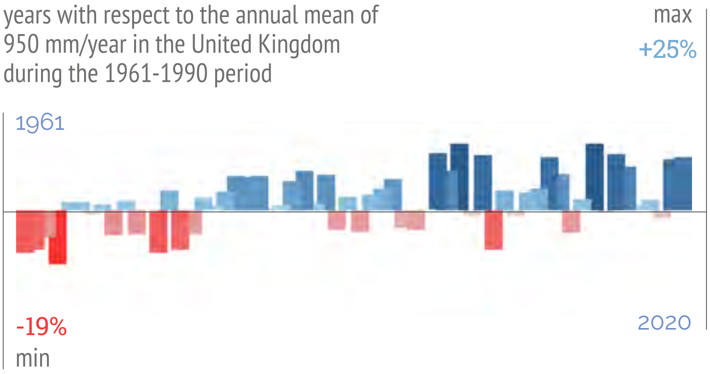
MEAN PRECIPITATION

662 — 2,582
mm/year / Over 1991-2020



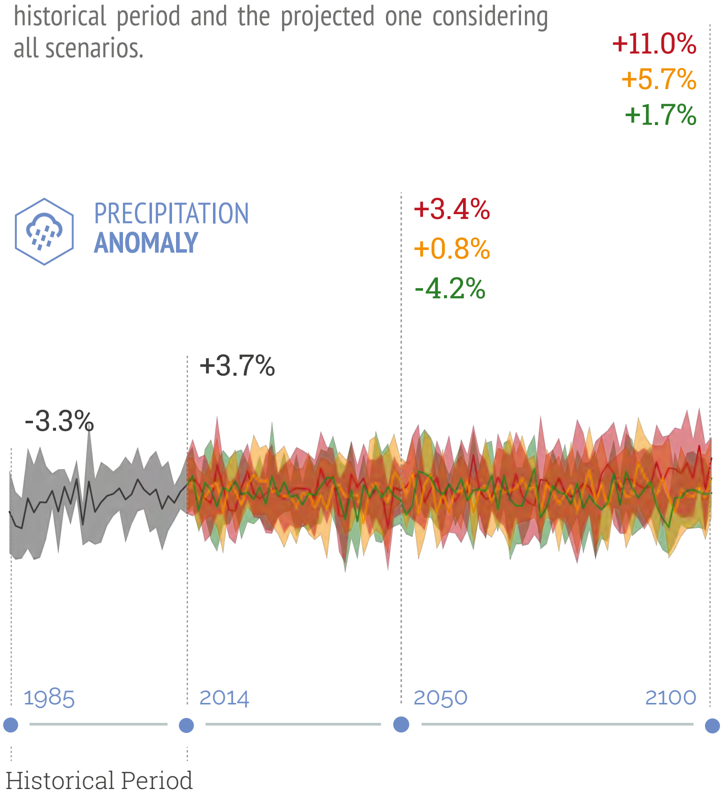
PRECIPITATION TREND

Precipiation anomalies over the last 60 years with respect to the annual mean of 950 mm/year in the United Kingdom during the 1961-1990 period



PRECIPITATION PROJECTIONS

Precipitation is projected to increase slightly in the future. The variability is quite large both for the historical period and the projected one considering all scenarios.



EXPECTED VARIATION FOR PRECIPITATION AT 2050

The indicators show variations in selected precipitation characteristics for a thirty-year period centred on 2050 (2036-2065) with respect to the reference period 1985-2014.

Indicator			
Annual total precipitation	+2.6%	+1.5%	+2.0%
Precipitation of wettest month	+6.3%	+3.5%	+2.6%
Precipitation of warmest quarter	-3.2%	-1.9%	-1.0%

VARIATION OF SPECIFIC CLIMATE INDICATORS

Climate indicators variation showing impacts of climate change on sectors such as agriculture, health and water. Analysis considers 3 threshold average temperature increase: **+1.5°C**, **+2°C**, **+4°C**.

Indicator	Unit			
Agricultural drought proportion of time	% of time	+35%	+19%	+14%
Hydrological drought proportion of time	% of time	+31%	+15%	+12%
Heatwave duration	% of time	+1,461%	+261%	+100%
Runoff increase	% of area	+59%	+29%	+10%
Agricultural drought frequency	% of change	+74%	+50%	+35%
Hydrological drought frequency	% of change	+17%	+12%	+14%
Heatwave frequency	% of change	+80%	+35%	+21%
Runoff decrease	% of area	+10%	+6%	+4%

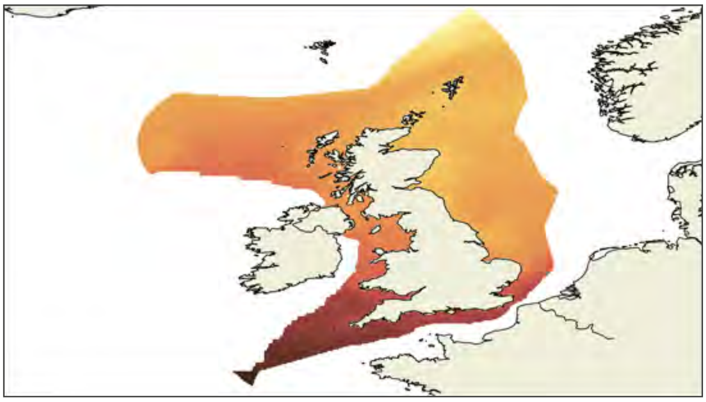
UNITED KINGDOM OCEAN

OCEAN IN UNITED KINGDOM

The UK's marine exclusive economic zone (EEZ) is mainly temperate, with warm waters in the southern basins, and it hosts a wide diversity of underwater habitats and species. The coastal systems can be divided into two main areas: the Atlantic region and the North Sea.

CURRENT CLIMATE CONDITIONS

Mean sea surface temperatures reflects the climate regime, cold and temperate, with lower values in the northern waters.



MEAN

SEA SURFACE TEMPERATURE

Celsius degrees / Over 1991-2020

TREND

Surface temperature trends indicate a general warming of 0.2°C per decade in all marine areas, with increased gains in the open waters of the North Sea.

FUTURE PROJECTIONS

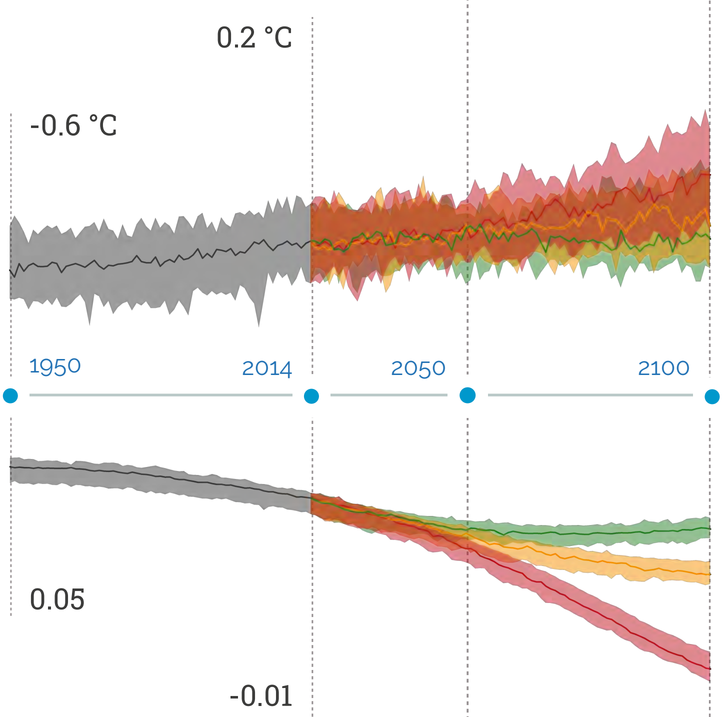
Projected annual changes within the marine EEZ for the two most significant marine indicators of climate change: sea surface water temperatures and pH.

Seawater temperature changes are in line with the definitions of each scenario, with maximum values close to +2°C under a high emissions scenario in 2100.

+2.2 °C
+1.2 °C
+0.3 °C

SEA SURFACE TEMPERATURE **ANOMALY**

+0.8 °C
+0.6 °C
+0.5 °C



SEA SURFACE pH **ANOMALY**

-0.11
-0.14
-0.18

Seawater surface pH becomes more acidic in all scenarios, closely reflecting rising atmospheric CO_2 concentrations, and only a low emissions scenario leads to a stable condition by 2100.

-0.11
-0.22
-0.45

ECOSYSTEM INDICATORS AT 2050

Regional changes in key marine ecosystem indicators under projected future scenarios by mid-century (2036-2065) with respect to present climate conditions (1985-2014).

Atlantic

North Sea

Temperature regulates the metabolism of marine organisms determining which habitats remain suitable. Excessive warming will likely push ecosystems beyond tolerance thresholds.

	Atlantic		North Sea	
Temperature	11.74°C	+0.54 °C / +0.47 °C / +0.22 °C	10.48°C	+1.38 °C / +1.11 °C / +0.83 °C

pH represents the acid/base status of marine waters, where a decreasing pH reflects the acidification of the ocean due to increased absorption of atmospheric CO_2.

	Atlantic		North Sea	
pH	8.12	-0.18 / -0.14 / -0.11	8.12	-0.19 / -0.14 / -0.11

Oxygen is fundamental to sustain marine life and its reduction can have a large impact on coastal ecosystem services including fisheries and aquaculture.

	Atlantic		North Sea	
O_2	271.82 mmol/m³	-0.49 % / -0.28 % / +0.17 %	282.85 mmol/m³	-2.61 % / -2.05 % / -1.7 %

Chlorophyll is an indicator of the biomass available at the base of the marine food web supporting all ecosystem productivity.

	Atlantic		North Sea	
Chlorophyll	0.54 mg/m³	-18.18 % / -10.39 % / -24.68 %	0.61 mg/m³	-25.49 % / -18.75 % / -26.32 %

FISH CATCH POTENTIAL

Fish catch potential is an estimate of the maximum fish catch achievable given the marine resources available over a sustained period. It is linked to the concept of maximum sustainable yield, meaning the maximum amount of fish that can be extracted from a system without causing a collapse in fish populations.

It is a characteristic of the natural system, which is substantially different from realized catch, and a direct result of the fishery policy in place.

Fish catch percentage change

2050

-21.8%

-21.3%

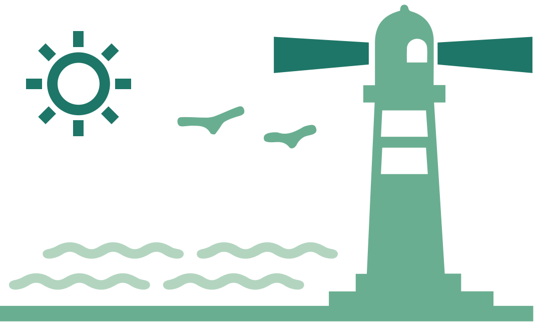
ANALYSIS DETAILS

All datasets were analysed using only data from within the marine EEZ and therefore excluding overseas territories, detached islands and any disputed or joint territories with other nations. In the assessment of current climate conditions, seawater surface tempererature data was obtained using satellite observations distributed in the framework of ESA Climate Change Initiative.

Future projections of marine indicators are represented by the combined analysis of results from 15 different Earth System models participating in the Coupled Model Intercomparison Project 6 (CMIP6). These models include new and better representations of physical and biogeochemical processes, compared to previous IPCC assessment reports.

Fish catch potential data was obtained using the FAO's technical report and refers to the best and worst case climate scenarios from the Fifth IPCC Assessment Report. These mean estimates are subject to substantial uncertainties as discussed in the original work.

UNITED KINGDOM COASTS



OVERVIEW

The British Isles, situated in the North Sea and exposed to the North Atlantic Ocean, are home to the United Kingdom, a geographically varied country with an equally diverse coastline. With a very long shoreline, characterized by flat sandy dunes, rocky cliffs, the ports and bays of England, lochs and estuaries of Scotland, and coastal mountains and peninsulas of Northern Ireland. This variety means that there are many features to consider for coastal management. Furthermore, relative to the size of the country, the shoreline is much longer than most other nations, a result of the irregular nature of the coastline, as well as the country's numerous islands, that present further natural diversity.

Shoreline Length — 19,717 km

Sandy Coast Retreat at 2050 — -27.0 m

CLIMATE CHANGE HAZARDS

Coastal hazards such as erosion, storm tide inundation and permanent flooding, can have strong adverse impacts on coastal regions, with loss of sandy shores, damage to settlements, infrastructure and ecosystems. Climate change can exacerbate these impacts due to rising sea levels and increasing impacts of waves and storms.The UK has already begun to see the effects and impacts of climate change on its shorelines, with increasing erosion on numerous beaches around the country and an increasing risk of storm surge inundation in the low lying areas of the east coast of England, including highly populated areas along the Thames Estuary and the City of London, which is currently protected by storm surge barriers.

SEA LEVEL RISE

Sea level rise in the UK, since 1904, has been around 16 centimetres (corrected for land movement). The current rate of sea level rise is approximately 1.7 millimetres per year. The latest IPCC projections indicate that, by 2050, global sea levels may rise between 0.18 metres, under a low emissions scenario, and 0.23 metres, under a high emissions scenario.

Observed and projected sea level rise at 2050

1.7 mm/year

0.23 m

0.18 m

EXTREME SEA LEVEL

On average, one in 100 extreme sea level events are expected to rise from 2.84 metres at present day to 3.03 metres by 2050 under a medium emissions scenario.

Current and projected extreme sea level at 2050

2.84 m

3.12 m

3.03 m

OBSERVED STORMS

The UK is at risk of coastal flooding and overtopping from the combined factors of large waves and high water levels. This was seen notably in the winter of 2013/14 with significant extreme coastal flooding resulting from storms that caused widespread damage. This is also of particular concern for coastal erosion, with the soft cliff faces of the south of England facing issues with weathering, and as many as 100,000 homes at risk from coastal erosion.

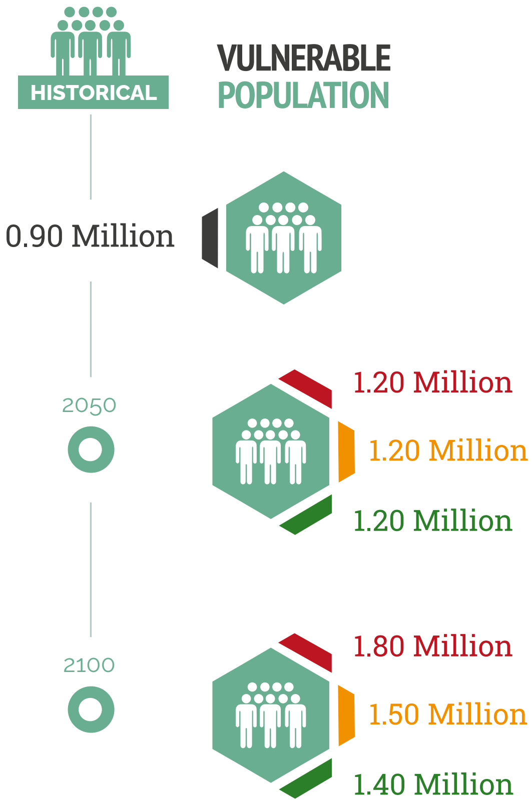
FUTURE STORMS

With rising sea levels, more areas will be at risk from extreme waves and storms in the coming years and will also lead to waves bringing greater energy to the shore, increasing the stress on coastal areas. It is estimated that in some locations in the UK the frequency of extreme sea level events, such as the one in 100 year event, will vastly increase with some areas experiencing increases by up to 100 times compared to current levels.

VULNERABILITY AND RISK

Just as the coastline and the impacts of climate change vary massively, so do the risks faced by the local population, industry, and natural environment. In terms of extreme waves and storm surges, increased wave heights can bring damage to coastal amenities, areas of natural importance and cultural heritage, as well as productive activities, roads and railways. The national supply chain depends on the correct functioning of port operations, and long duration extreme waves can have a strong negative impact on these activities.

London, as an internationally vital financial center, is substantially protected against flooding. Despite this, the city will become increasingly at risk of flooding from storm surge events, with potentially devastating consequences. Other risks come from the unpredictable coastal dynamics caused by climate change, particularly concerning coastal erosion, which is expected to increase significantly, and cause damages of over 100 million GBP per year by the end of the century, with further costs expected to arise from protecting or relocating coastal assets. Under a medium emissions scenario, the total population exposed to the annual coastal flood level is expected to increase from 900,000 to 1.2 million by 2050.



INFLUENCE OF SEA LEVEL RISE ON EXTREME SEA LEVEL

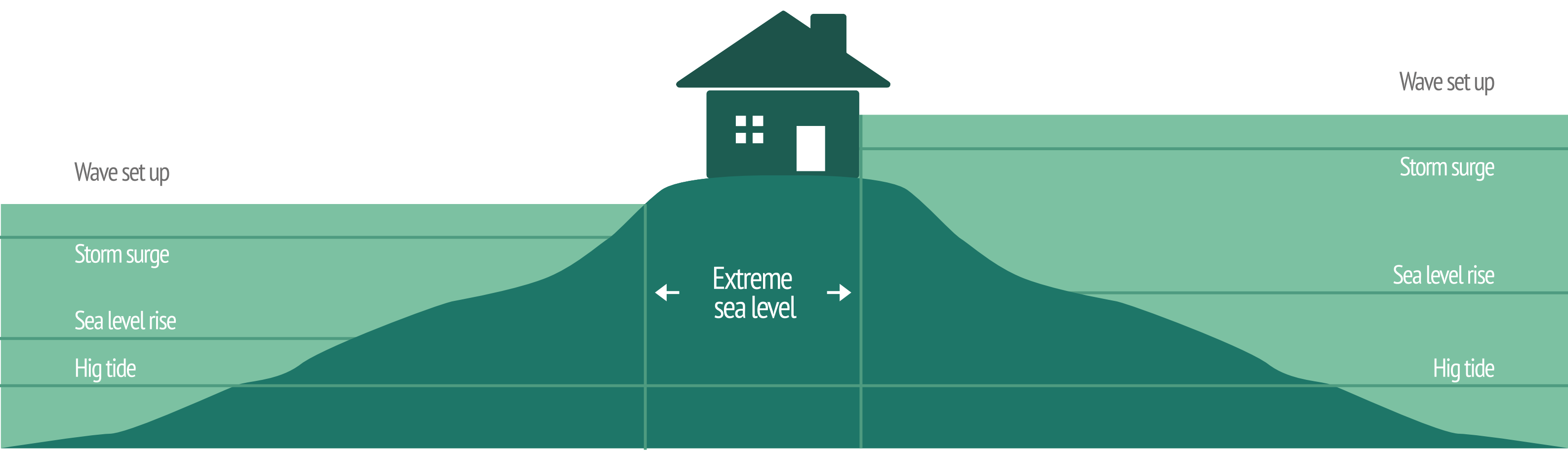
Present and future sea level rise are a consequence of carbon induced global warming causing melting ice and ocean expansion due to heat accumulation.

The extreme sea levels reported here are based on the 100-year storm surge + wave set up + sea level rise + high tide indicators. The first two parameters (storm surge + wave set up) are based on the 100-year value for the event; sea level rise is its projected value at 2050; and high tide is the absolute value of the highest tide calculated for a given locality, which won't be influenced by climate change.

+ Wave set up refers to the accumulation of water near the shore due to the presence of breaking waves.

+ Storm surge is an occasional increase in sea level driven by shoreward wind-driven water circulation and atmospheric pressure.

+ High tide is usually the highest tide reached in a given location based on tide records.



Present sea levels have risen globally by approximately 20 centimetres over the past century.

Future sea level rise is a projection based on different global warming scenarios, at approximately 100 centimetres by the end of 2100, with consequent inundation during extreme sea level events.

UNITED KINGDOM
WATER

OVERVIEW

The healthy functioning of the various water resources of the UK is vital to its population, environment, and economy.

High levels of water abstraction are leading to increased pressures on the country's water systems, and these pressures are being exacerbated by a variety of driving forces resulting from climate change, as well as the prospect of continued population growth and intensification of water usage.

A significant amount of the UK's freshwater sources are being exploited at an unsustainable rate, with much of the withdrawal being used for vital industry and electricity supply.

Renewable internal freshwater resources
145
billion m^3

Renewable internal freshwater resources per capita
2,195
m^3

Although water supply for average citizens is relatively secure, consumption rates are high and characterized by high levels of waste.

CLIMATE CHANGE HAZARDS

Climate change can affect water resources through increasing temperatures, higher rates of evapotranspiration and altered rainfall patterns. This leads to changes in the water cycle, including decrease of snow and ice coverage, alterations of surface runoff and groundwater storage, as well as drought and flood occurrence. In combination with an expected increase in water demand, the effects of climate change will also influence the UK's ability to provide sufficient clean water. The country is likely to see wetter winters, drier summers, more extreme precipitation events, and warmer average temperatures. These changes will not be seen equally, with spatial variation and unpredictable changes causing further issues for the effective management of water resources.

KEY POINT RUNOFF

It is widely expected that the UK will see increased frequency and severity of extreme rainfalls as a result of anthropogenic climate change. This will increase the pressure on already pressurised drainage systems that may be unable to cope with the effects of surface runoff and in extreme cases its associated flooding events, particularly in the face of increasing urbanisation.

At a country scale, an average increase in surface runoff by approximately 3% is expected under both low and high emissions scenarios for the 2045-2055 period compared to 2015-2025.

If temperatures rise by 1.5°C, 2°C or 4°C, 4%, 6.1% or 10% of the area of the country will likely experience an increase in runoff, while 10%, 28.6% or 59% of the surface of the country will likely experience a decrease in runoff, respectively.

2050

Changes in annual runoff
% of change

+2.5%

+2.9%

2050

Runoff increase
% of area

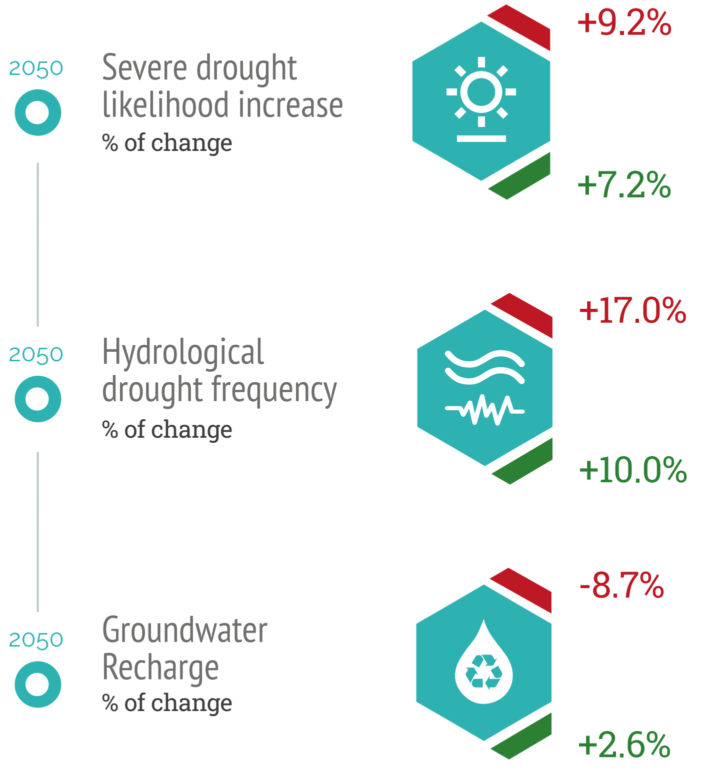
+10.0%

+4.0%

KEY POINT DROUGHTS

Severe droughts are not experienced commonly in the UK, and are even considered anomalous; however, when they do occur such as in 2018, they can be devastating due to the relative lack of preparation, particularly for vulnerable members of society and for the agricultural sector, which relies on consistent rainfall.

Many parts of the country are likely to see an increase in the occurrence of droughts through longer dry periods and reduced river flow, particularly in the southeast, and the impacts will be made more severe through higher evaporation rates driven by global warming, which could also lead to heatwaves, wildfires, and drying of the land.



KEY POINT GROUNDWATER

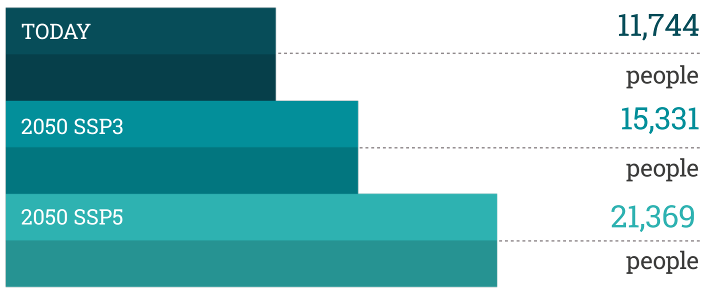
Groundwater plays an important role in the water security of the country, providing nearly a third of the UK's drinking water, and the quality of this water depends largely on the recharge from surface water and minimal runoff. Given the driving factors of groundwater quality and availability, climate change is likely to have significant impacts, both in terms of precipitation and temperature levels, as well as in seasonality.

Excess abstraction from groundwater bodies also poses a significant threat at current unsustainable levels, with 15% of these bodies at risk of future deterioration. At the country level, a +2.6%, -4.4% and -8.7% change of the annual groundwater recharge for the period 2045-2055 compared to the timeframe 2015-2025 is expected respectively under low, medium and high emissions scenarios.

KEY POINT FLOODS

The UK is prone to flooding events, a consequence of precipitation levels in combination with the urbanization and also the physical characteristics of the river catchments. These events are the costliest of all-natural disasters that the UK faces and present high risk to many areas of the country. In 2007, for instance, because of one of the wettest months on record in Britain, severe summer floods caused widespread damage and multiple deaths, and in comparison to many similar events worldwide, were driven largely by surface water flooding. Climate-driven meteorological changes will increase the risk of flooding across the country and in turn exacerbate issues of water security, although these changes will not be evenly distributed, but instead increasing the susceptibility in the northwest of the UK in particular. Changes in the population exposed to floods are expected, with an increase from about 11,000 in the present day to about 15,000 under SSP3 and 21,000 under SSP5 by 2050. As such, potential impacts related to river floods might increase.

POPULATION AFFECTED BY RIVER FLOODS

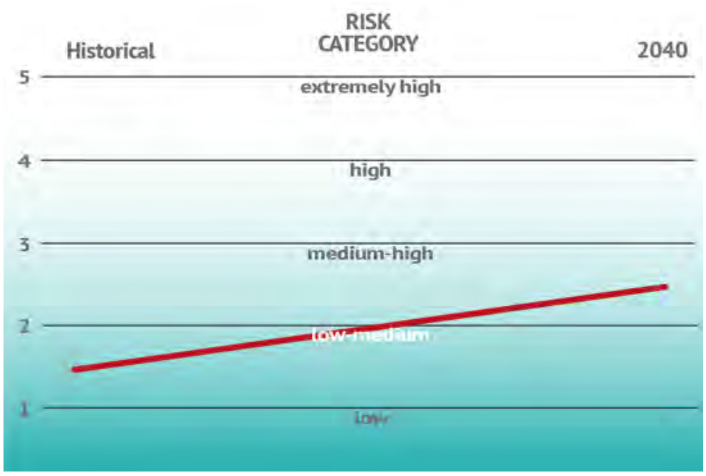


RISK INDICATORS

The water stress index summarises current and future water related vulnerabilities and risks at the global level. Scores are based on the ratio of total water withdrawals, including agriculture, industrial and human consumption, to available renewable surface and groundwater supplies.

WATER STRESS

The UK water stress level is considered low-medium for the recent past (1960-2014 average), and it is expected to increase in the near future (2030-2050) based on climate change projections.



UNITED KINGDOM AGRICULTURE

OVERVIEW

Agricultural area in the United Kingdom accounts for 71% of land use, employing close to half a million people and providing 50% of domestic consumption.

Agriculture in the UK has changed substantially over the last half century, due to technological and socio-economic factors. Cereal crops (mainly wheat and barley) cover 50% of the arable area. Other important productions are oilseed, sugar beet, potatoes, and horticultural crops (fruits and vegetables).

Most of the cultivated areas are located in the lowlands of southeast Great Britain, which have relatively warmer temperatures and lower rainfall. Water abstracted for agriculture in 2017 was less than 1% of the total water abstracted. This value is highly variable from year to year and greatly influenced by rainfall amounts.

13.6 Mt
Wheat

2 Mt
Rapeseed

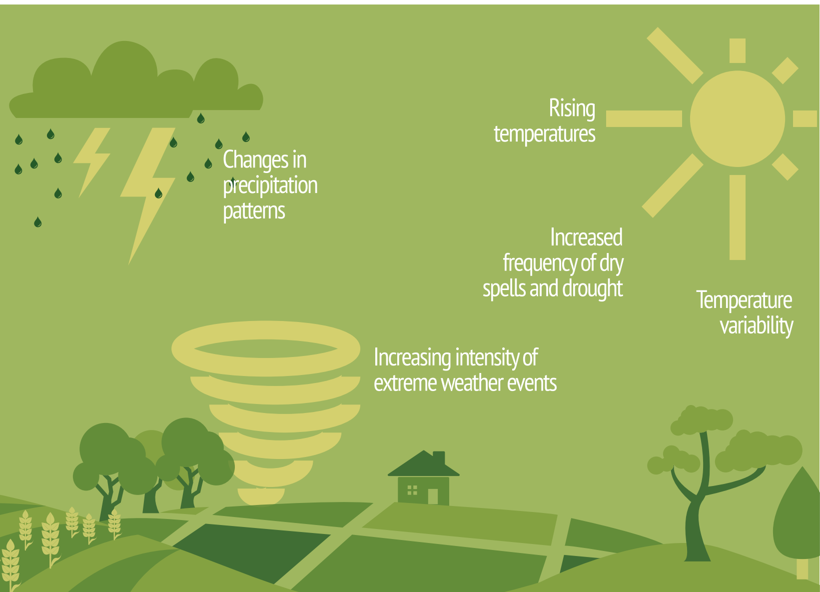
0.5 Mt
Apples

7.6 Mt
Sugarbeet

	Added Value of Agriculture, Forestry and Fishing	Share of Agriculture Value added in Total GDP	Agricultural land	Area Equipped for Irrigation
2000	15,673 USD Million	0.7 %	5,928 Thousand HA	243 Thousand HA
2018	17,413 USD Million	0.6 %	6,084 Thousand HA	208 Thousand HA

EXPECTED IMPACTS ON AGRICULTURE PRODUCTIVITY

Rising temperatures, reduction in average annual precipitation, and intensification of extreme events such as heat waves and drought, affect production variability with a tendency towards yield reduction for many cultivated species, accompanied by a probable decrease in food quality. Crops respond to increases in temperatures with changes in duration of the growing season, early appearance of phenological phases and potential shifts of cultivation areas toward higher latitudes and altitudes for better growing conditions. However, impacts vary significantly depending on the geographical area and specific crops in question.



CROP PRODUCTIVITY

Crop productivity refers to the harvested yield of a crop per unit of land area. It is strongly influenced by climate and other environmental and management factors.

Climate change is expected to have an impact on the productivity of several major crops, although this may in part be offset by the fertilizing effect of higher CO_2.

Impacts are estimated using a range of model projections based on low to high emission scenarios and reported as percentage changes between the 30-year average around the historical period and the 30-year average around 2050.

8.3
5.3 (-1.8)%
9.2 (2.8)%
Wheat
tons / ha

67.8
-5.1 (-13.2)%
0.8 (na)%
Sugarbeet
tons / ha

3.4
2.4 (-2.8)%
7.2 (na)%
Rapeseed
tons / ha

tons / ha

2050

Productivity change with (without) the CO_2 fertilization effect. Estimates assume sufficient water and nutrient supplies, and do not include impacts of pests, diseases, or extreme events.

CHANGE IN WHEAT

− = +

CHANGE IN SUGARBEET

− = +

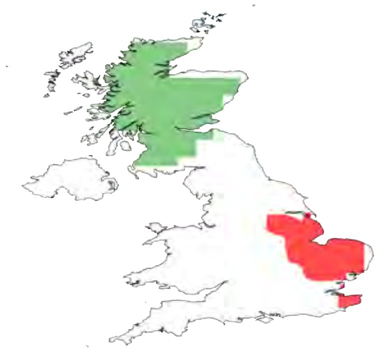
Warmer temperatures will lead to a longer growing season and possible higher yields for some cereal and horticultural crops. Wheat productivity is expected to increase in areas such as the Midlands, and South East England. Projections show an average increase of up to 9% for wheat, and up to 7% for rapeseed. Water scarcity represents one of the main limiting factors for rainfed cereals, oilseed rape and sugar beet in the southern and eastern areas. Sugarbeet productivity is expected to decline by an average of up to 5%, with strongest decline projected for the southern areas, whereas some midland and west areas may benefit from climate change. Potato yields, without restrictions in water or fertilizer, are projected to increase by about 15%, mainly due to increasing temperatures, radiation and CO_2 fertilisation effects. Increases in temperature may lead to a northward shift of suitable areas for many annual and perennial crops (e.g. maize, grapevines, apricots, potatoes).

ADAPTATION IN AGRICULTURE AND WATER RESOURCES

Traditionally, most crops are grown on natural rainfall with limited irrigation requirements. However rainfall may vary significantly across the country and between years. Recent droughts, like the heatwave in 2018, highlight the importance of irrigation in agriculture to cope with significant climate risks. Climate risks will present hotter and drier summers, increasing irrigation demand due to higher plant evapotranspiration and a possible decline in water supplies. Irrigation demand will likely expand in the future especially within catchments where precipitation is projected to decline creating considerable levels of water stress.

CHANGE IN WATER DEMAND

− = +



Agriculture Water Demand
% of change

+50.7%
+35.5%

2050

Action priorities include integration of technologies to implement precision irrigation, smart sensor networks, irrigation scheduling with weather forecasting, and catchment-based approaches to improve water allocation.

UNITED KINGDOM FORESTS

FORESTS IN UNITED KINGDOM

With a very suitable climate for plant growth, UK forests are characterized by two main types: broadleaved forests, which are largely present throughout the country; and mature conifers which make up 60% of tree types in the north. The majority of woodland cover is made up of planted forests, except for a few hectares in the south. The current distribution is a direct result of the important reforestation policies that took place following the two world wars.

1990

3 Mln ha
Million hectares
Forested area

311 Tons/ha
Tons of Carbon per hectare
Carbon stock

2020

3 Mln ha
Million hectares
Forested area

344 Tons/ha
Tons of Carbon per hectare
Carbon stock

FORESTED AREA AND CARBON STORAGE

In recent decades UK woodland cover has increased to approximately 13%. This increase was more pronounced in Scotland where the cover rate has risen to approximately 17%. According to Forest Research (FR) the forest carbon stock (including soil carbon) is almost 3,8 gigatonnes and forests remove about 20 million tons of carbon dioxide from atmosphere yearly. UK forests are a net carbon sink and vital to the republic's emission reduction policies.

FOREST PRODUCTIVITY

Forest productivity or Net Primary Production is the net carbon captured by plants. It is the difference between the carbon gained by Gross Primary Production - net photosynthesis measured at the ecosystem scale - and carbon released by plants' respiration. It is expressed per unit land area.

2050

Productivity anomaly
Tons of Carbon per hectare per year

+0.84

+0.40

Increase in northern and southern UK and part of Northern Ireland, more pronounced under a medium emissions policy. Very high uncertainty in model projections

+ Fertilizing effect of increasing atmospheric CO_2, nitrogen deposition, rising temperatures, and increasing length of growing period promote productivity

No areas with an expected decrease in forest primary production

KEY SPECIES UNDER CLIMATE CHANGE

INCREASE
CONIFERS
Increases in primary production in upland conifer forests of the north and west of England may result.

VULNERABILITY
OAKS
High vulnerability for native oaks (pedunculate and sessile) in particular in the southern range

PATHOGENS
ALL SPECIES
Increased incidence of pathogens for all species

LOW VULNERABILITY
MIXED
Mixed stands show less vulnerability

FIRES IN UNITED KINGDOM

Fire is a structural ecological process that provides several types of ecosystem services and impacts on socio-ecological systems, including human health, carbon budgets, and climate change. Changes in global fire activity are influenced by multiple factors such as land-cover change, policies, and climatic conditions. Fire also releases large quantities of greenhouse gases into the atmosphere, contributing to a vicious cycle.

During the last two decades, the total land area affected by fire was approximately 89,000 hectares.

BURNING
89 THOUSAND HECTARES

EMITTING
0.06 TERAGRAMMES OF CARBON PER YEAR

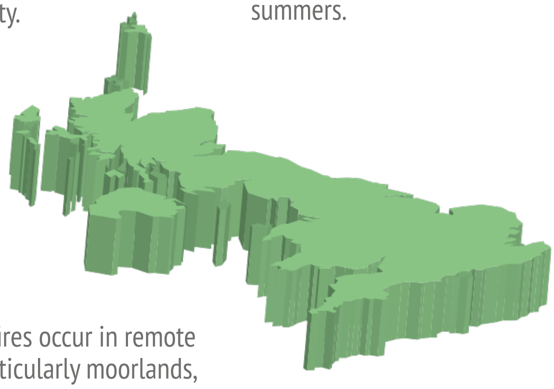
FOREST FIRE EMISSIONS CONTRIBUTED TO 8.2% OF TOTAL FIRE RELATED CARBON EMISSIONS

COSTING
UP TO 1.4 MILLION USD IN A LARGE PEAT MOORLAND FIRE

WHERE DO FIRES OCCUR?

Most wildfires occur where rural and urban areas meet or on arable land, particularly with regards to fires caused by human activity.

Wildfires occur prevalently in spring because of the availability of dead and dry fine vegetation as fuel, but could also occur during hot and dry summers.



Many large fires occur in remote areas, particularly moorlands, forests and peatland bogs.

FUTURE BURNED AREA

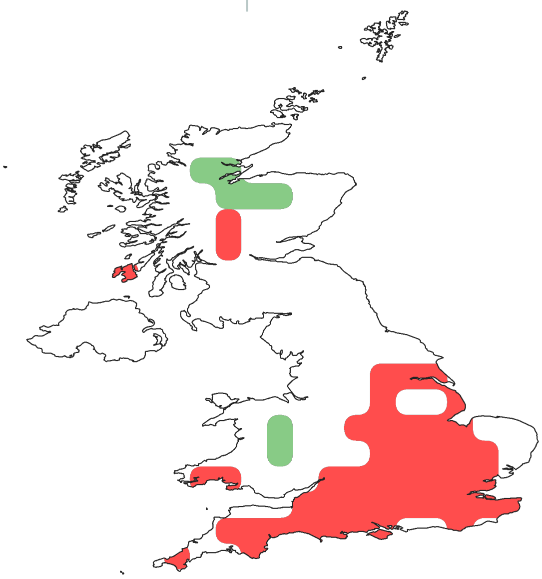
Under low a emissions scenario, burned areas are expected to increase primarily in southern England and predominantly affecting lowland beech forests. This spatial pattern might be less marked under a medium emissions scenario.

Burned Area
km² per year

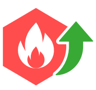
2050

+9.8

+26.2



Decrease in burned areas for a low emissions scenario



Increase in burned areas for a low emissions scenario

+ Increase in the number of fires and area affected due to drier summers

+ Increase in vegetation growth due to warmer, wetter winters which will add to the fuel load

VARIATION OF SPECIFIC FIRE INDICATORS

% of change
Average danger over fire season

2041-2070

+0.4%

+0.1%

% of change
High fire danger days per year

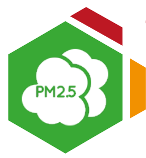
2041-2070

+0.2%

0%

% of change
PM2.5 emissions

2010-2050



+22%

+20%

FUTURE FIRE EMISSIONS

Fire emissions follow a similar spatial pattern to burned areas, with projected changes across both low and medium emissions scenarios

Fire Carbon emission
Teragrams of Carbon per year

2050

+0.31

+0.15

UNITED KINGDOM URBAN

OVERVIEW

The total population is projected to grow by 8% and become more than 90% urbanized by 2050.

Nearly half the urban population lives in cities with fewer than 300,000 residents. London is the largest city, with 16% of the urban population, and is projected to pass 10 million residents by 2035. The remainder of the urban population will live in cities with up to 5 million people, with 45% still living in cities with fewer than 300,000 people.

Built up areas cover 5.78% of the UK (14,060.43 square kilometers).

OVERVIEW OF KEY CLIMATE IMPACTS IN URBAN AREAS

The increasingly apparent impacts of climate change include higher than average temperatures, increased flooding and more extreme weather. There is an increased chance of warmer, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of extremes.

HEATWAVES AND HEAT STRESS

Cities experience higher temperatures than surrounding rural areas because of the Urban Heat Island (UHI) effect, whereby built up areas absorb solar radiation during the day and release heat at night, warming the surrounding air. UHI is caused by factors such as less natural landscapes, the materials used for buildings, urban layouts and waste heat.

The UK's top 10 warmest years on record have all been since 2002 and the average number of hot days per year has been increasing since the 1960s. The average hottest day of the year, in the 10 year period between 2008 and 2017, was on average 0.1°C warmer than the 1981 to 2010 average and 0.8°C warmer than the 1961 to 1990.

Future scenarios of 1.5°C, 2°C and 4°C mean temperature increases indicate that heatwaves will last longer throughout the entire country. This will lead to an increase in the number of cooling degree days.

2020

2050

Population in Urban Areas

56,495,180

68,007,652

Graphs refer to data provided by United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization

2020

2050

Urbanization Rate

83.9%

90.2%

2050

Cooling Degree Days
% of change

+236.9%

+78.3%

+47.1%

2050

Heatwave frequency
% of change

+80.1%

+35.1%

+21.4%

2050

Heatwave duration
% of time

+1,461%

+261%

+100%

HEAT, HEALTH AND AIR POLLUTION

2,000 people die prematurely every year in the UK from heat-related conditions. Heat related health impacts from increasing air temperatures in urban areas are accentuated by air pollution. PM2.5 is an urban air pollutant that has negative health effects, with emissions in cities primarily coming from power generation, domestic heating and vehicles.

In the UK, PM2.5 levels tend to be highest in urban areas in the southern and eastern parts of the UK, also due to greater exposure to pollution from mainland Europe. In 2017, nearly 66.5% of the UK population was exposed to levels exceeding WHO guideline values for PM2.5.

COASTAL FLOODING

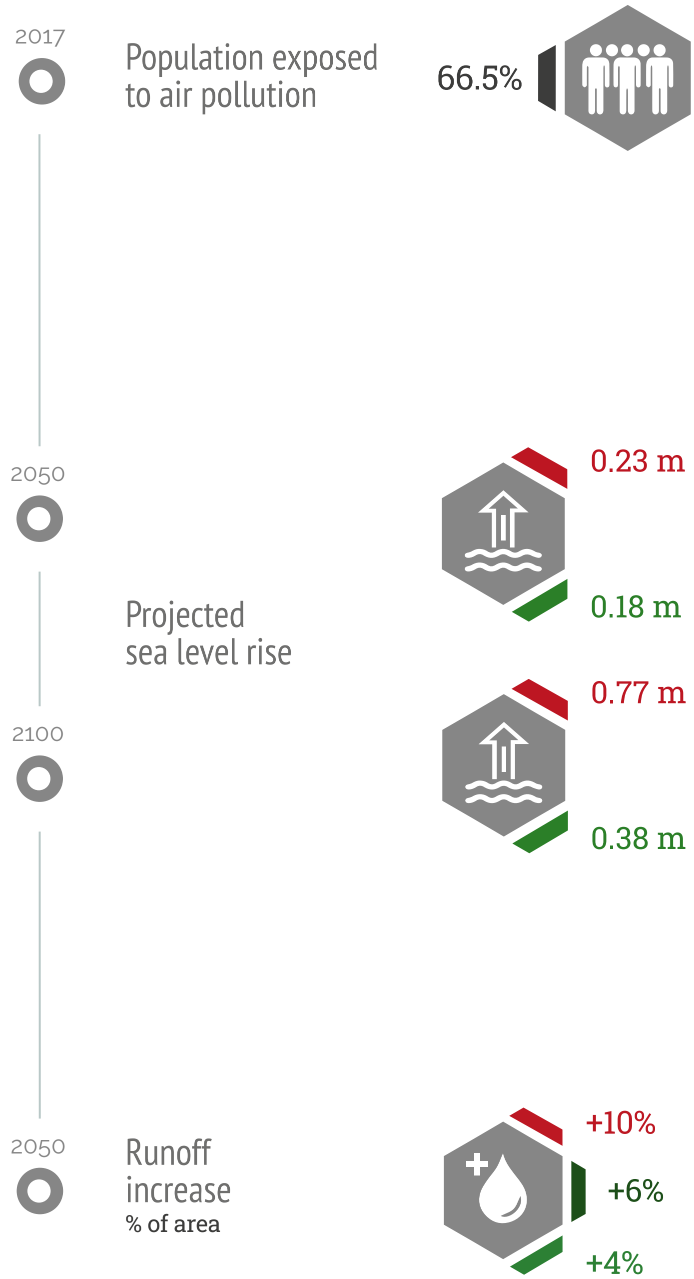
The impacts of flooding and coastal change, which pose risks to communities, businesses and infrastructure in the UK, are already significant and expected to increase as a result of climate change. Average UK sea levels have risen at a rate close to the global average rate of change.

Relative sea level rise is also influenced by vertical movements in the land mass due to isostatic rebound, with a general pattern of sinking in the south and lifting in the north. When corrected for land movement, mean sea level around the UK has risen by about 17 centimetres since the start of the 20th century.

EXTREME PRECIPITATION

There have been upward trends in rainfall across the UK, with more winter rainfall in heavy rainfall events. Total rainfall from extremely wet days (exceeding the 99th percentile of 1961-1990 rainfall) increased by around 17% during 2008-2017.

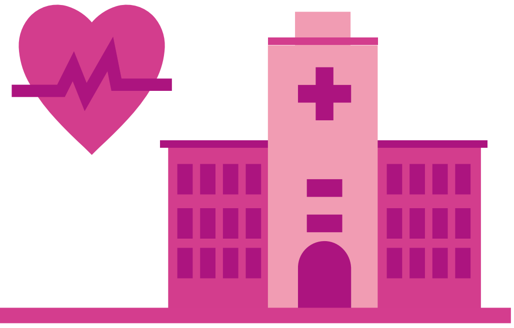
More and heavier rainfall are projected for the UK. Despite overall summer drying trends, increases in the intensity of heavy summer rainfall events are projected. Increases in heavy hourly rainfall intensity, particularly in autumn, are expected due to change in the seasonality of extremes.



SURFACE SEALING AND FLOODS

Heavy precipitation in cities is problematic due to the high level of sealed surfaces. Soil sealing increases run off and reduces the amount of water absorbed by soil. Where there are large amounts of impervious ground cover, short duration extreme rainfall events can lead to increased flooding, even resulting in flash floods.

UNITED KINGDOM HEALTH



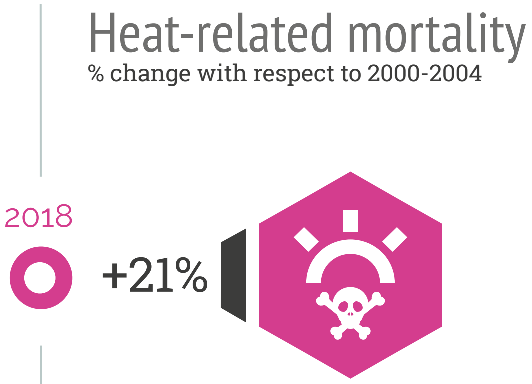
OVERVIEW

Extreme events such as heatwaves and floods have increased significantly in the UK. In addition to increased frequency and severity of such events, climate change will likely have further health impacts: excess mortality and morbidity from heat; respiratory diseases related to ground-level ozone; vector-, water- and food-borne diseases and increases in the prevalence of skin cancer related to UV exposure. The UK experiences a substantial annual heat- and cold-related health burden associated with exposure to current weather patterns. The fraction of deaths attributable to cold weather is currently much larger than that due to hot weather. Future changes in climate are likely to lead to an increase in heat-related deaths in the UK and a proportionally smaller decrease in cold-related impacts. The incidence of existing infectious agents, such as Lyme disease transmitted by ticks, is likely to increase.

HEAT RELATED MORTALITY

Heat-related mortality is projected to increase under future warming scenarios. One positive impact of climate change could be a decrease in winter mortality. However, under a high emissions scenario, heatwave-related excess deaths will increase by 49%.

In 2018, there was a 21% increase in heat-related deaths in the UK compared to the 2000 to 2004 baseline. 35.1% of heat-related mortality in the UK during 1991 to 2016 can be attributed to human-induced climate change.

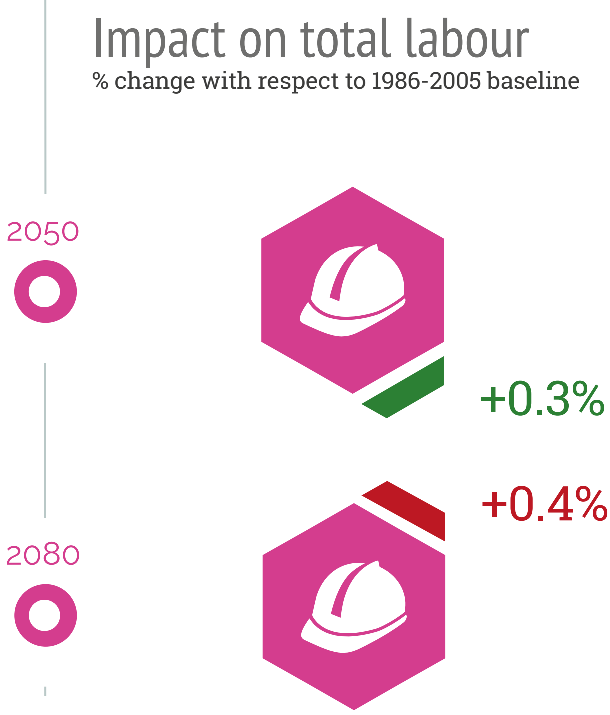


IMPACTS ON LABOUR

Labour is directly affected by changes in environmental conditions. Warming affects both the number of hours worked (labour supply) and on the productivity of workers during their working hours (labour productivity). Both labour supply and productivity are projected to decrease under future climate change in most parts of the world, and particularly in tropical regions.

Parts of sub-Saharan Africa, south Asia, and southeast Asia are at highest risk under future warming scenarios. Future climate change will reduce global total labour in the low-exposure sectors by 18 percentage points and by24.8 percentage points in the high-exposure sectors under a 3.0°C warming scenario

Total labour in the UK is expected to increase by 0.3% under a low emissions scenario and 0.4% under a medium emissions scenario.



CLIMATE CHANGE AND DENGUE

Dengue has spread throughout the tropical world over the past 60 years and now affects over half the world's population. Globally, vectorial capacity for both dengue vectors (A. aegypti and A. albopictus) has been rising steadily since the 1980s, with nine of the ten highest years occurring since 2000.

Climatic stressors are one important driver of the current distribution and incidence of dengue. Climate change is likely to expand the geographical distribution and suitability of several vector-borne human infectious diseases including dengue. The risk of dengue transmission is increased by warming climates, as the growth and development of mosquitoes are significantly influenced by temperature, precipitation, and humidity.

CLIMATE CHANGE AND ZIKA

Zika virus has spread to at least 49 countries and territories since 2013. Climate change impacts on transmission suitability risk have increased over the years and future warming over 1.3 billion additional people could face suitable transmission temperatures for Zika by 2050.

CLIMATE CHANGE AND MALARIA

Warmer springs associated with climate change and land-use change can lead to rising numbers of ticks. Climate models predict further proliferation this species across Europe, including the UK. Future warming may increase the suitability of the UK's climate for vectors that spread malaria and dengue.

POLLUTION AND PREMATURE MORTALITY

The annual mortality from human-made air pollution in the UK is roughly equivalent to between 28,000 and 36,000 deaths every year. In 2019, the fraction of mortality attributable to long-term exposure to anthropogenic particulate air pollution was estimated at 5.1% in England.

UNITED KINGDOM ENERGY

ENERGY SYSTEM IN A NUTSHELL

With plans for a “Green Industrial Revolution” and net zero emissions by 2050, the UK is a global leader in decarbonization.

Domestic energy production has declined dramatically by almost 60% since its peak in 1999, leaving the UK increasingly dependent on energy imports. At the same time, renewable energy production has seen significant growth.

0.06
ktoe/US$
Energy intensity

0.0%
AC Share in electricity consumption

37%
Import dependence ratio

ENERGY SUPPLY

The UK's energy mix is dominated by fossil fuels, which accounted for 78% of total primary energy supply in 2019. Natural gas and oil accounted for 40% and 35% respectively, whereas use of coal and nuclear are minimal (3% and 9% respectively). The share of fossil fuels in the energy mix has declined over the last 10 years, with coal usage dropping by more than half. The share of renewables has been growing, from just 2% in 2007 to 13.4% in 2019.

ENERGY DEMAND

Energy demand in the UK is dominated by use in transport (32% in 2018, vast majority on road), residential (29%), industry (17%) and tertiary (13%) sectors. In the agriculture, forestry and fishing sectors consumption is minimal. Demand for air conditioning use is almost non-existent.

CLIMATE CHANGE TODAY

WIND

Strong winds are one of the main causes of damage and disruption to all infrastructure, including energy.

HYDROPOWER

Hydroelectric power generation is dependent on sufficient water availability and power generation was reduced by 7% in 2018 as a result of lower rainfall.

STORMS AND FLOODS

Storms and lightning strikes have caused widespread power outages in Edinburgh (2021), England, Wales (2019) and Northern Ireland (2020). Hundreds of power stations and substations are at significant risk from flooding across the UK.

FUTURE ENERGY DEMAND

In the UK, changes in seasonal demand are expected. Winter heating needs are expected to decrease, while at the same time demand for summer cooling will increase. Overall, energy demand is projected to decrease, as the decrease in heating needs outweighs any increases in summer cooling needs. Energy demand is expected to fall by 984 Pj (274 billion Kwh) by 2050 under a medium emissions scenario.

Net change in energy demand due to changes in HDD/CDD
Billion KWh

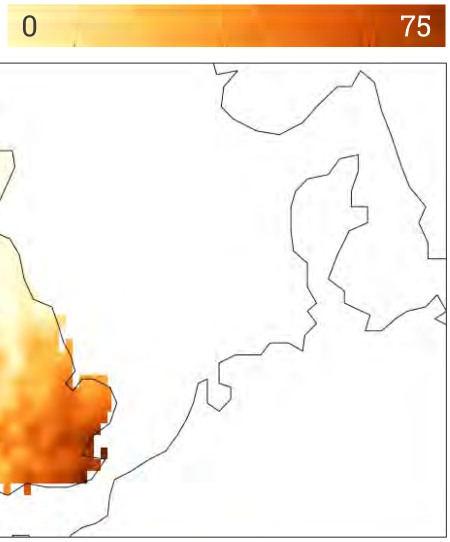
2050

- 273.52

COOLING NEEDS

Negligible increases are expected in Scotland, Northern Ireland, Wales and northern England; some moderate increases in the south, particularly along the British Channel coast. Summer cooling needs could increase energy demand by up to 200% in mid-summer in London.

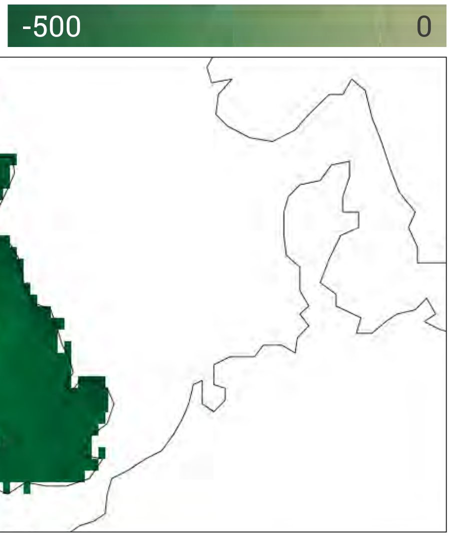
COOLING DEGREE DAYS



HEATING NEEDS

A marked drop in heating needs is expected all over the country, with no major difference between north, south or high and low elevations.

HEATING DEGREE DAYS



FUTURE ENERGY SUPPLY

The future configuration of the UK energy mix is likely to be determined by the evolution of climate mitigation policies and hence is outside the scope of this report. The UK target of net zero emissions by 2050 will likely result in a marginal relevance of fossil fuels and their vulnerabilities to climate change, while carbon free sources and their vulnerabilities will prevail.

Change in Hydropower generation
% of change

2050

-3.21%

-2.86%

EXPECTED IMPACTS OF CLIMATE CHANGE

Strong winds may threat overhead electricity lines as falling trees and branches damage infrastructure. Energy infrastructure located near rivers will be vulnerable to high flows and those near coasts to sea level rise. Increasing frequency and severity of storms may damage energy infrastructure. Hydro power generation is projected to decline.

Fossil fuel power plants may lose efficiency as a result of higher temperatures and reduced water availability needed for cooling. More frequent extreme events and higher temperatures could reduce the capacity of the electricity distribution network.

UNITED KINGDOM ECONOMY

OVERVIEW

The UK has one of the wealthiest economies among G20 countries. It has been hit severely by the COVID crisis, recording a decline in real GDP growth rate of 9.9% in 2020. However it recovered in 2021with a real GDP growth rate of 5.3%.

IMPACTS ON GDP

Climate change will have an effect on the growth rate and overall economic performance of the country. Although estimates vary, some projections show that in the short run the overall economic impacts of climate change might even be positive.

By mid-century, the effects of climate change could result in gains of between 11.2 and 13.5 billion EUR under a low and high emissions scenario, respectively.

By the end of the century, however, the estimated costs are projected to become severe, peaking at 89.1 billion EUR (or almost 4% of GDP) under a high emissions scenario and 36.6 billion EUR (or 1.6% of GDP) under a low emissions scenario.

GDP Change

% change w.r.t baseline

2050

0.6/-1.5%

0.5/-1.28%

2100

-2.52/-3.97%

0.11/-1.63%

SECTORAL ECONOMIC IMPACTS

IMPACTS ON INDUSTRY AND INFRASTRUCTURE

Sea-level rise represents a major risk in the UK. Without any adaptation, the cost of sea-level rise will lead to a 10% loss of GDP in 2050 under a high emissions scenario. This estimate includes floods, retreat, wetland losses and inundation costs.

SEA LEVEL RISE DAMAGES

Under the current level of coastal protection, the projected costs of coastal flooding are substantial. By the middle of the century, sea-level rise and coastal flooding may cost the country 17.5 to 37 billion EUR in terms of expected damages to assets in low and high emissions scenarios, respectively.

By the end of the century, expected losses may increase to 48.2 billion EUR in a low emissions scenario and could reach 170.8 billion EUR under a high emissions scenario.

Sea Level Rise

Expected annual damages
Billion Euro

2050

37

17.5

2100

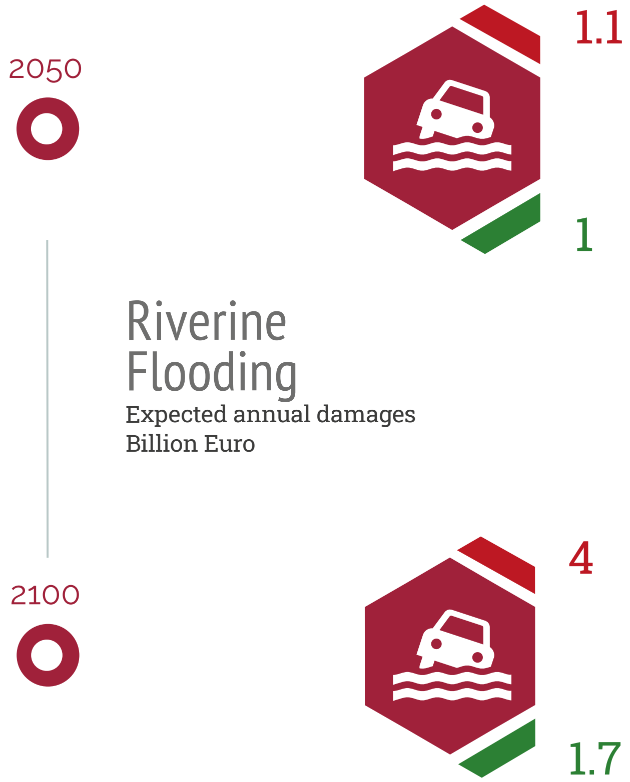
170.8

48.2

RIVER FLOODING DAMAGES

River flooding is also expected to cause damage and economic losses, though less severe than those from sea-level rise. By the mid century total asset losses are projected to be 1 to 1.1 billion EUR under a low and high emissions scenario, respectively.

By the end of the century these costs are projected to rise to 1.7 billion EUR under a low emissions scenario, and could reach 4 billion EUR under a higher emissions scenario.



IMPACTS ON AGRICULTURE

Agriculture uses 71% of UK land and contributes about 0.53% of total GDP. Gross Value Added is estimated to reach £10.4 billion in 2019.

More frequent extreme temperatures and changes to rainfall patterns will lead to overall negative impacts on agricultural production in the UK, even if improved growing conditions for some crops are expected in northern areas where climate will be warmer.

In a medium emissions scenario changes in crop yields are estimated around -5% (range -12% to +3%) in 2050, and -6% by 2080 (range -18% to +2%). Increased flooding, including that caused by sea-level rise, may lead to substantial losses in crop production in low-lying agricultural areas and may contribute to waterlogging and erosion of soil. Estimated productivity loss in 2020 due to soil erosion is 5.314 million EUR, resulting in 2.614 million EUR losses in UK GDP.

IMPACTS ON ENERGY

As with all other economic sectors, energy supply and energy networks in the UK will undergo more intense stress from extreme weather events.

Economic impacts of shifts in household and firm energy demand (see chapter on energy) are difficult to predict and will mostly lead to redistribution effects. In the case of the UK an overall decrease in energy bills is expected due to the heavily reduced heating needs, whereas the increase in cooling need is expected to be negligible.

Expected annual damage to energy infrastructure is projected to show a 13-fold increase compared to present by mid century under a high emissions scenario.

IMPACTS ON TOURISM

Tourism is a key sector in the United Kingdom, expected to expand by 3.8% annually. By 2025 the UK tourism industry will be worth over 257 billion GBP, around 10% of the UK's GDP. Climate change may contribute to an increase in tourism.

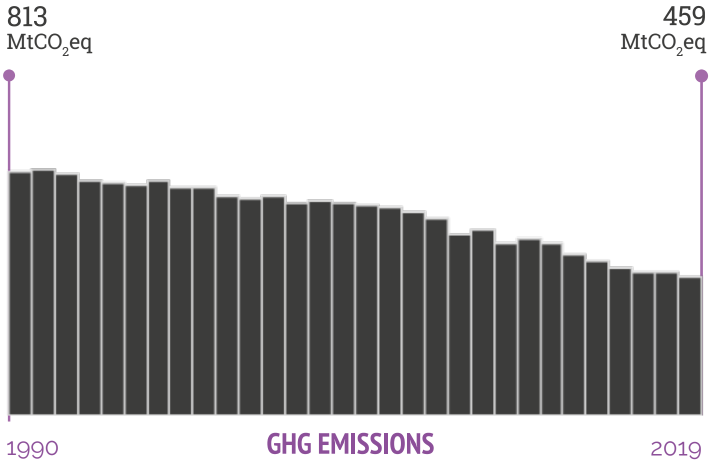
Following the international pattern, tourism shifts north. Especially in the northern regions of the UK the temperate climate may attract European tourists escaping from hot continental summers.

Although economic projections are not available, estimates of the impact of the hot weather of summer 2003 on domestic tourism in the UK found a positive impact on revenues ranging between 17 million and 36 million EUR.

UNITED KINGDOM
POLICY

OVERVIEW

The UK is responsible for 1% of global GHG emissions and has a 20% higher than world average rate of CO_2 emissions per capita. Emissions have been declining since 1991, and a net zero emissions by 2050 target has been set.



GHG EMISSIONS

INTERNATIONAL COMMITMENTS

The UK adopted a 2050 net zero emissions reduction target, strengthening its previous 2050 goal of at least an 80% GHG emissions reduction below 1990 levels by 2050. The new plan aims for at least a 68% reduction in greenhouse gas emissions by 2030, compared to 1990 levels.

CLIMATE POLICY COMMITMENTS CHRONOLOGY

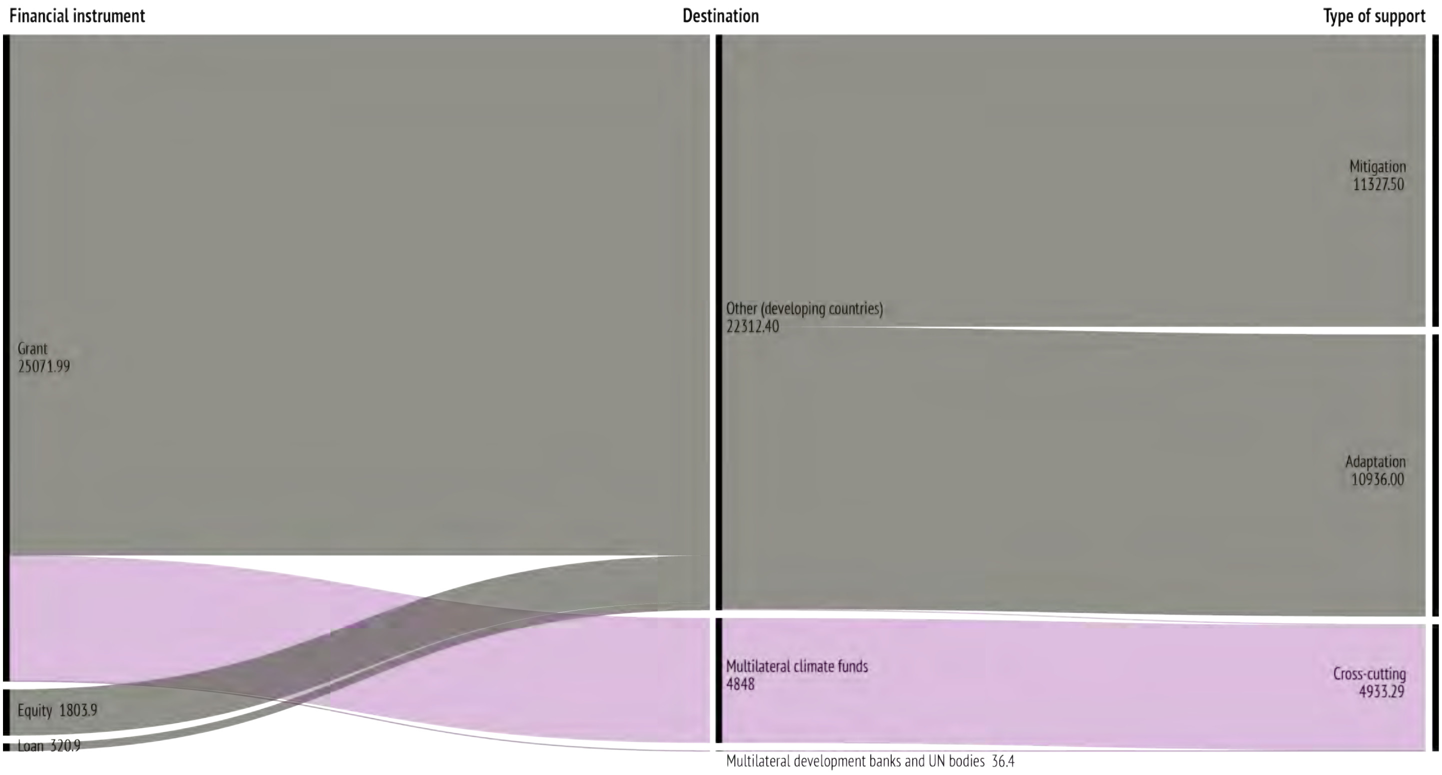
2002 — **Kyoto Protocol - 1st period**
12.5% yearly average reduction in GHG over the four year period 2008-2012, with reference to 1990 levels

2016 — **Paris Agreement - 1st NDC**
40% GHG reduction by 2030, with reference to 1990 levels

2020 — **Paris Agreement - NDC update**
60% GHG reduction by 2030, with reference to 1990 levels

INTERNATIONAL CLIMATE FINANCE ASSISTANCE

The 4th Biennial Report shows that the UK committed 27.1 billion USD for climate-specific development finance in 2017-2018 . The majority was provided through bilateral channels and evenly distributed between adaptation and mitigation projects.



SUSTAINABLE RECOVERY POLICY

According to the Global Recovery Observatory, in 2020 the proportion of green spending out of total recovery spending was 20%, 30% of which was allocated to green market creation.

Total Spending	Recovery Spending	Green Spending
1,296.49 billion $	391.31 billion $	79.22 billion $

DOMESTIC ADAPTATION POLICY

Every 5 years, the National Adaptation Programme (NAP) addresses the risks identified by the UK Climate Change Risk Assessment. The second NAP period runs from 2018 to 2023, and covers the natural environment, infrastructure, people and the built environment, business and industry, and local government sectors.

- ○ Domestic Adaptation Policy
  - ○ Inclusion of Adaptation in NDCs
  - ● Integrated Adaptation & Mitigation Policy
  - ● Dedicated Adaptation Strategy
  - ● Dedicated Adaptation Plan
- ● Subordinate Adaptation Policies
  - ● Sectoral Adaptation Plans
  - ● Subnational Adaptation Plans

○ Policy not in place ● Active policy

ADAPTATION POLICY HIGHLIGHTS

TRANSNATIONAL INITIATIVES

North Sea Region 2020 Strategy

The strategy recognizes climate change risks for the regions, such as sea-level rise, increased coastal flooding, increase of the burden on the marine ecosystem through water warming, acidification and the influx of new species. The strategy calls for a collaborative transnational approach to address climate change across the North Sea

NATIONAL INITIATIVES

Flood and coastal resilience innovation programme

The programme funds 25 areas to provide innovative practical actions that improve resilience to flooding and coastal change, including the ability to adapt to future climate change.

UK Climate Resilience

This programme draws together fragmented climate research and expertise to deliver robust, multi-disciplinary climate risk and solutions research ensuring the UK is resilient to climate variability and change.

SUBNATIONAL INITIATIVES

Manchester Climate Change Framework 2020-25

The high-level strategy sets out how Manchester aims to limit the impacts of climate change and create a healthy, green, socially just city where everyone can thrive.

One City Climate Strategy: A strategy for a carbon neutral, climate resilient Bristol by 2030

The strategy outlines some of the necessary actions to reduce emissions as well as actions to adapt to extreme weather events as a result of climate change, which are expected to increase in the future.

ENERGY TRANSITION

The UK shows an Energy Transition index about 5 points above the G20 average, thanks in particular to outstanding performances in the Efficiency domain, a sector in which the UK is ranked among the top countries of the group. Also in Emissions and Electrification, the UK is positioned in the medium to high part of the ranking, outperforming in both cases the G20 average.
Surprisingly, despite having relevant oil and gas reserves, the UK has a positive performance also in the Fossil Fuels domain, with a score higher that the groups average. However, this positive result on fossil fuels is not accompanied by remarkable performances in Renewables, which is the only indicator where the UK does worse than the G20 average.
In this respect, nuclear generation capacity and reliance on biomass have a negative influence on the poor penetration of renewables even if the progressive ageing of the nuclear park will reverse the trend in the coming years.

	G20 AVERAGE	COUNTRY
Energy Transition	58.7	63.4
Fossil Fuels	45.3	51.8
Renewables	19.7	17.0
Efficiency	84.9	92.6
Electrification	70.8	74.8
Emissions	72.9	80.9

Only actively pursuing an energy transition based on decarbonization and electrification – from policy and regulation, to health and education – will enable countries to benefit the most from future opportunities and fight climate change whilst ensuring an equitable distribution of wealth.

The Energy Transition indicators were developed by Enel Foundation in cooperation with SACE, and provide a retrospective analysis based on historical data.