UK climate extremes: English weather records 2013-2022

Data from the Met Office.

Temperature

Highest daily maximum temperature record:

- 40.3°C 19 July 2022, Coningsby (Lincolnshire)

Highest daily minimum temperature record:

- 26.8°C 19 July 2022, Shirburn Model Farm (Oxfordshire)

Highest daily maximum temperature record (by month):

- February: 21.2°C 26 February 2019, Kew Gardens (London)
- July: 40.3°C 19 July 2022, Coningsby (Lincolnshire)

Highest daily minimum temperature record (by month):

- Jan: 13.2°C 1 January 2022, Chivenor (Devon)
- April: 15.9°C 19 April 2018, Kenley Airfield (Greater London)
- July: 26.8°C 19 July 2022, Shirburn Model Farm (Oxfordshire)

Lowest daily maximum temperature record:

- March: −3.7°C 1 March 2018, Little Rissington (Gloucestershire)
- March: −3.7°C 1 March 2018, Pennerley (Shropshire)

The warmest year on record for UK:

- 2022 (Met Office: Climate change drives UK's first year over 10°C)

Rainfall

The highest 24-hour total for any 24-hour period is 341.4mm from 18:00 Coordinated Universal Time (UTC) on 4 December to 18:00 UTC on 5 December 2015 at Honister Pass (Cumbria).

The highest 2-day total is 405.0mm, 4 to 5 December 2015, Thirlmere (Cumbria).

Gust speed (wind)

The highest gust speed record (low-level sites) is 106 knots (122 mph), 18 February 2022, Needles Old Battery (Isle of Wight)

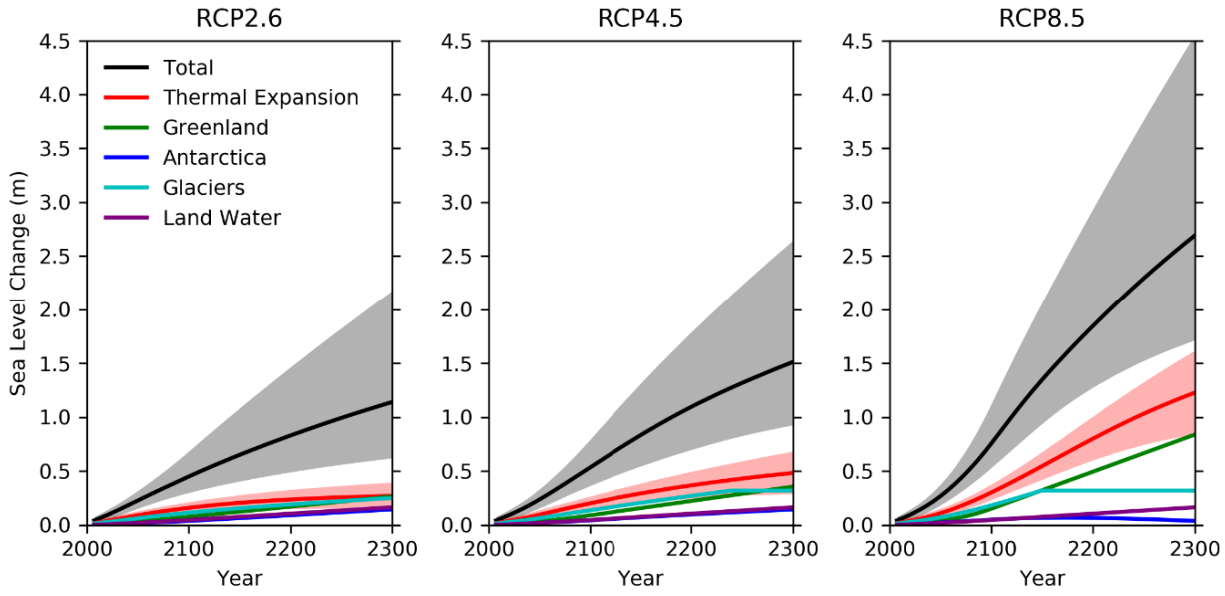
Coast and marine, including sea level rise

We have published a detailed analysis of climate impacts on coastal and marine systems in our 2023 report State of the environment: the coastal and marine environment with information on present day and future trends consistent with +2°C and +4°C scenarios. This highlights that climate change is one of the main threats to coastal and marine ecosystems. Tipping points, where irreversible environmental changes occur, are likely to be reached as the climate changes. Moreover, coastal flooding and erosion are projected to increase significantly as climate change and locked-in sea level rise continue posing a major risk to the coastal environment and communities. More detail is presented on various impacts, including warming waters, acidification, thermal stratification, changes in salinity, and sea level rise. Present day once-a-century sea level events are expected to become annual events by 2100 and sea level will continue to rise throughout the 22nd and 23rd centuries under all warming scenarios, with various different meltwater or expansion impacts contributing to the total increase.

Figure 2: Time series of global time-mean sea level change to 2300 for different Representative Concentration Pathways (RCPs) with a baseline period of 1981-2000 from 'Exploratory sea level projections for the UK to 2300'

As reported by IPCC, the likely mean global warming range for the RCPs is:

- RCP2.6: 0.3 to 1.7°C by 2100
- RCP4.5: 1.1 to 2.6°C by 2100
- RCP8.5: 2.6 to 4.8°C by 2100



Biodiversity

The UK Climate Change Risk Assessment 2022 highlighted that climate change has a wide range of effects on biodiversity, at a time when it is already degrading rapidly. The

"Risk of unsafe working conditions on site or in office environments and loss of productivity due to extreme heat or flooding.

"Increased demand on incident response services during extreme weather events resulting in reduced capacity for service delivery in other delivery areas.

"Change in species distribution and abundance on Defra group land. Loss of priority species and increase in invasive species resulting from shift in annual climate trends.

"Degradation of Defra group land quality, including designated sites, due to both extreme weather events and longer-term climate trends.

"Increased risk of watercourse and air pollution resulting from hotter, drier conditions during summer months."

More detailed discussion of risks to us can be found in our third adaptation report.

A note on 'impacts'

In the context of climate change, ISO 14090 defines 'impact' as "effect on natural and human systems". Thus, consideration of climate impacts is potentially wide ranging and thinking should not be limited to changes in weather or other physical impacts. 'Impact' is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate change or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes.

It is also important to recognise that impacts might be non-linear and may not correlate directly with increasing global temperatures. As we identify in our third adaptation report, in some cases, thresholds or tipping points may be crossed, with step changes or significant irreversible consequences for species decline and for ecosystem services and the communities and businesses that rely on them. More information on the consequences of crossing tipping points has been developed as part of the UKCRP high impacts scenarios and storylines work, and we would generally only consider these aspects for large scale or long term and higher risk sensitive decisions.

About the evidence base

The evidence base describes the data sources and methodology used to derive data in Part 1 of the climate impacts tool, along with discussion of why we have chosen the information for screening purposes.

The tool provides worst case changes for England, consistent with a +2°C rise in global mean temperature by 2050 (derived from a +4°C pathway) and a range consistent with between +2 and +4°C rise in global mean temperature by 2100.

The information in the climate impacts tool is based on UK Climate Projections 2018 (UKCP18) and impacts information derived from UKCP18. The values used are precautionary, as is appropriate for risk screening, so they will normally represent an upper estimate on possible change in a +2 to +4°C world.

To demonstrate that the climate has already changed we have included information for recent new weather records, which illustrates where our work may already be at risk from climate impacts.

For more information on the sources of information within this tool, the use of this information for various applications of risk screening or risk assessment, or to discuss potential provision of new information in the next version of this tool, please contact climatechangesupport@environment-agency.gov.uk

Part 1 climate values – summary of data selection approach

When considering possible climate impacts, it is essential to recognise that future impacts depend on the choices we make, globally, in terms of climate change mitigation. There are various scenarios (pathways) of warming depending on level of mitigation success. For the purposes of adaptation planning, we consider worst case scenarios. This does not mean that we will necessarily experience these changes or that we try any less to mitigate climate change (understanding the scale of impacts for greater levels of warming can enhance mitigation efforts) but it does mean we will be prepared for a range of possible futures.

The government's current Environmental Improvement Plan says "while we aim to limit global warming to 1.5°C, evidence shows that we must be prepared for warming up to 4°C". The Climate Change Committee advice is to plan for 2°C of global warming and assess the risks for 4°C of global warming by 2100.

Within this screening tool we consider how various climate parameters may change from present, through mid-century (by 2050) to the end of the century (by 2100). The choice of scenarios has been guided by current government policy – we need to be prepare for

4°C – and analysis of the rate of global warming under different pathways. Most pathways indicate we will see between +1.5 to +2°C by mid-century (with the upper end looking increasingly likely) so we have chosen a single data point consistent with +2°C by 2050 for mid-century change. Subsequently, depending on global mitigation success and policy commitments, the end of the century could see between +2°C to +4°C rise, so aligned to the advice of the Climate Change Committee we include both these scenarios.

We have been precautionary in our approach to selecting data, choosing higher potential changes for screening purposes. Where available we have selected data based on the 90th percentile of a 4°C pathway (or 10th percentile for decreases). In addition, for 2100, we provide 90th percentile data for a 2°C pathway in order to illustrate the possible range of change by 2100 (+2°C to 4°C). In some cases, data is not available specifically for +2°C or +4°C pathways, so we have used RCP8.5 data, which is consistent with reaching +4°C globally by 2100.

Climate data is based on averages over decades, so discrete values for 2050 and 2100 are not projected. The information is selected to be consistent with the changes we may see by 2050 or by 2100. Where we provide values for today's climate, we have adjusted the level of future change expected to reflect the changes we have already seen since climate models were created (recalibrating data for a change in baseline from 1981-2010 to 1991-2020 by deducting the change seen in the first decade of the projection).

The data sources and derived values are explained in the following sections. Many are obtained from the [UK Climate Risk Indicators (CRI) website](#).

Figure 3. A screenshot from the CRI website

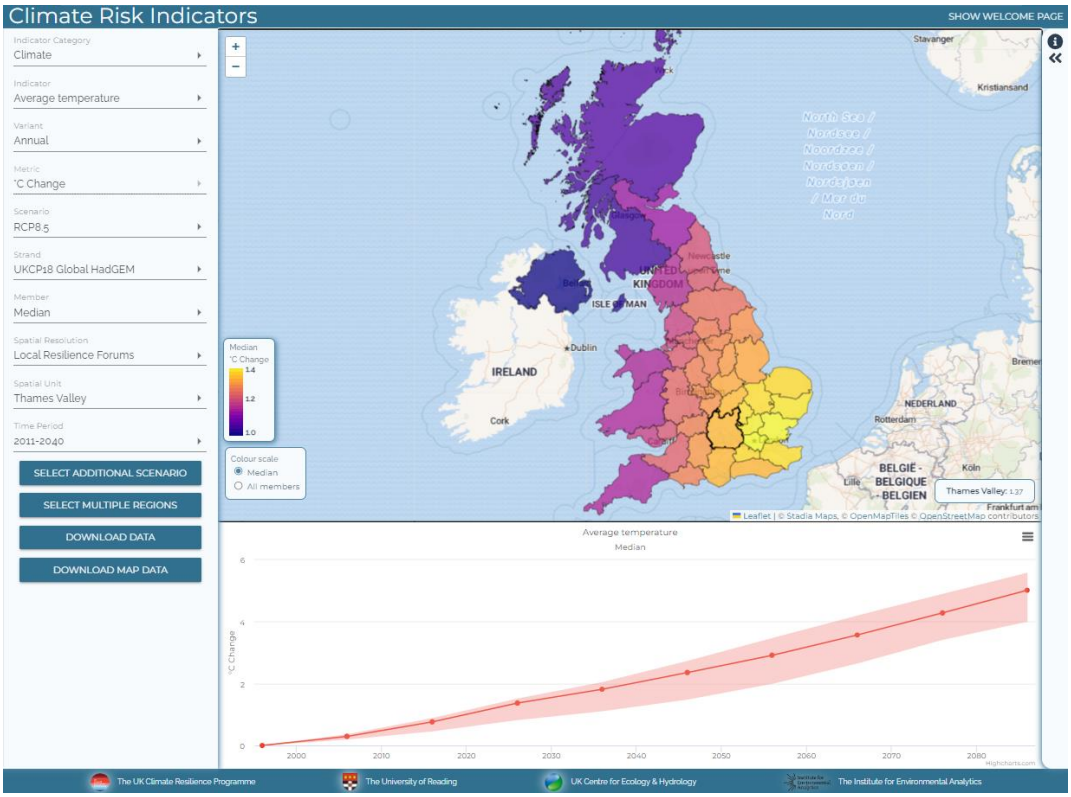


Table of Part 1 information (national England data)

For detail and information sources, see the paragraphs following this table and the data references. Blank cells indicate data has not been included in this tool.

Climate impact	Guidewords	Present day	By 2050 (+2°C) scenario	By 2100 (+2°C) scenario	By 2100 (+4°C) scenario
Summer mean daily max temp	Warmer	20.4°C	+2.4°C	+3.7°C	+6.6°C
Summer mean rainfall	Drier	206 mm	−56 mm	−66 mm	−91 mm
Winter mean daily max temp	Warmer	7.5°C	1.5°C	2.1°C	3.4°C
Winter mean rainfall	Wetter	240 mm	+24 mm	+38 mm	+58 mm
Sea level rise (1981-2000 baseline)	Higher	+0.1 m	+0.4 m	+0.8 m	+1.2m
Hot days – chance of reaching 40°C	Hotter more often	Once a century	Once every 20 years	Once every 3-15 years	Once every 3-15 years
Peak rainfall intensity (1981-2000 baseline)	Heavier		+45%		+50%
Peak river flow (1981-2000 baseline)	More extreme		+35%		+127%
Low river flow (1981-2000 baseline)	More extreme		−60%		−85%

Summer mean daily maximum temperature

Our current summer mean daily maximum temperature baseline in England is 20.4°C. By 2050 it could increase to approximately 22.8°C. By 2100 summer mean daily maximum temperatures could increase to between 24.1°C and 27°C.

Observed mean daily maximum temperature for summer

20.4°C

Mean value for England calculated from summer (June to August) maximum daily temperatures over a 1991-2020 baseline (Met Office temperature data). (This value has increased by approximately 0.3°C from the previous 1981-2010 baseline.)

Increase in summer mean daily maximum temperature

By 2050: +2.4°C to 22.8°C (for a 4°C global warming pathway)

By 2100: +3.7°C to 24.1°C (for a 2°C global warming pathway)

By 2100: +6.6°C to 27°C (for a 4°C global warming pathway)

Values taken from the UK CRI website: change in summer mean daily maximum temperature, at 90th percentile. Increase by 2050 taken as value for 2031-2060 and increase by 2100 taken as value for 2071-2100. Increases adjusted to deduct the initial projected decade of change since we use a more recent observed baseline – we have already experienced approximately 0.3°C increase as the observed data has advanced from a 1981-2010 baseline to a 1991-2020 baseline.

See the UK CRI website for more explanation of this information and the ability to explore local or regional impacts (for example, by county or Local Resilience Forum), and model uncertainty associated with differing warming scenarios.

Summer mean rainfall

Our current summer mean rainfall baseline in England is 206mm. By 2050 it could decrease by approximately 27%. By 2100 average summer rainfall could decrease by between 32% to 44%.

Observed long term mean summer rainfall

206mm

Mean value for England calculated from summer (June to August) rainfall in England based on 1991-2020 baseline (Met Office rainfall data).

Decrease in summer mean rainfall

By 2050: −27% or −56mm to 150mm (for a 4°C global warming pathway)

By 2100: −32% or −66mm to 140mm (for a 2°C global warming pathway)

By 2100: −44% or −91mm to 115mm (for a 4°C global warming pathway)

Values taken from the UK CRI website: change in summer rainfall (%), at 10th percentile. Decrease by 2050 taken as value for 2031-2060 and decrease by 2100 taken as value for 2071-2100. Decreases adjusted to deduct the initial projected decade of change since we use a more recent observed baseline.

See the UK CRI website for more explanation of this information and the ability to explore local or regional impacts (for example, by county or Local Resilience Forum), and model uncertainty associated with differing warming scenarios.

Winter mean daily maximum temperature

Our current winter mean daily maximum temperature baseline in England is 7.5°C. By 2050 it could increase to approximately 11°C. By 2100 winter daily average temperatures could increase to 13.2°C.

Observed mean daily maximum temperature for winter

7.5°C

Mean value for England calculated from winter (December to February) daily maximum temperature over a 1991 to 2020 baseline (Met Office temperature data). (Note, this value has increased by approximately 0.3°C from the previous 1981-2010 baseline.)

Increase in winter mean daily maximum temperature

By 2050: +1.5°C to 7.5°C (for a 4°C global warming pathway)

By 2100: +2.1°C to 9.6°C (for a 2°C global warming pathway)

By 2100: +3.4°C to 10.9°C (for a 4°C global warming pathway)

Values taken from the UK CRI website: change in winter mean daily maximum temperature, at 90th percentile. Increase by 2050 taken as value for 2031-2060 and increase by 2100 taken as value for 2071-2100. Increases adjusted to deduct the initial projected decade of change since we use a more recent observed baseline – we have already experienced approximately 0.3°C increase as the observed data has advanced from a 1981-2010 baseline to a 1991-2020 baseline.

See the UK CRI website for more explanation of this information and the ability to explore local or regional impacts (for example, by county or Local Resilience Forum), and model uncertainty associated with differing warming scenarios.

Winter mean rainfall

Our current winter mean rainfall baseline in England is 240mm. By 2050 it could increase by approximately 10%. By 2100 average winter rainfall could increase by between 16% to 24%.

Observed long term average winter rainfall

240mm

Values taken from average winter (December to February) rainfall in England based on 1981-2010 baseline (Met Office rainfall data).

Increase in winter mean rainfall

By 2050: +10% or +24mm to 264mm (for a 4°C global warming pathway)

By 2100: +16% or +38mm to 278mm (for a 2°C global warming pathway)

By 2100: +24% or +58mm to 298mm (for a 4°C global warming pathway)

Values taken from the UK CRI website: change in winter rainfall (%), at 90th percentile. Increase by 2050 taken as value for 2031-2060 and increase by 2100 taken as value for 2071-2100. Increases adjusted to deduct the initial projected decade of change since we use a more recent observed baseline.

See the UK CRI website for more explanation of this information and the ability to explore local or regional impacts (for example, by county or Local Resilience Forum), and model uncertainty associated with differing warming scenarios.

Sea level rise

Sea levels in England have already risen and could increase by up to 0.4 metres by 2050, and up to between 0.8 and 1.2 metres by 2100.

Increase in sea level (from 1981 to 2000 baseline)

Present day: +0.1m

By 2050: +0.4m (London RCP8.5 top of range)

By 2100: +0.8m (London RCP4.5 top of range)

By 2100: +1.2m (London RCP8.5 top of range)

Sea level rise differs by geographical location and in general, greater sea level rise is projected for the south of the UK, where values are similar to the global mean projections. This tool uses values for London taken from the UKCP18 marine report, Table 3.1.2: Projected ranges of sea level rise at UK capital cities under RCP2.6, RCP4.5 and RCP8.5 relative to a baseline period of 1981-2000. The value for 2050 is interpolated from 2040 and 2060 data (see also graph 3.1.4).

Assessments that are sensitive to sea level rise should refer to the latest location specific sea level projections – for example, from the UKCP18 marine report.

Hot days

Climate change is increasing the chance of seeing 40°C temperatures in the UK.

Increase in chance of seeing 40°C

Today: approximately once a century

By 2050: approximately once every 20 years

By 2100: approximately once every 3 to 15 years (range for high to medium emission scenarios)

Information taken from Met Office heatwaves extreme event summary, from the graph of 'Chances of seeing 40°C temperatures in the UK under a high emission scenario'. (Whilst present day chance of seeing 40°C in any one year is low, the record breaking summer of 2022 demonstrated that even low probability events can still happen now.)

Peak rainfall intensity

Our daily extreme rainfall intensity in England could increase by up to 45% by 2050 and by up to 50% above current baseline by year 2100.

Increase in daily extreme rainfall intensity

By 2050: up to +45%

By 2100: up to +50%

Values taken from peak rainfall climate change allowances by management catchment – information generated by Met Office Hadley Centre (2019): UKCP Local Projections on a

5km grid over the UK for 1980-2080 (Peak rainfall climate change allowances by management catchment). The values are the upper end allowances for the catchments where the maximum change is predicted for an event with a 100-year return period. ‘By 2050’ uses the '2050s' epoch (2022-2060) and ‘By 2100’ uses the '2070s' epoch (2061-2125).

Peak river flows and low flows

Peak river flow could increase by up to 35% by the 2050s and by up to 127% above current baseline by year 2100. Low flows could decrease by up to 60% by the 2050s and by up to 85% below baseline by year 2100.

Increase in peak river flows

By 2050: up to +35%

By 2100: up to +127%

Values taken from peak river flow climate change allowances by river basin district. Data for maximum change anticipated in most extreme catchment. ‘By 2050’ uses 2050s upper end and ‘By 2100’ uses 2080s upper end, based on 1981-2000 baseline (Peak river flow climate change allowances by management catchment).

Maximum reductions in river flows

By 2050s: as much as −60%

By 2080s: as much as −85%

Values for England taken from the UK CRI website: water, low river flows, RCP8.5, minimum value. Decrease by 2050 taken as value for 2031-2060 and decrease by 2100 taken as value for 2071-2100.

See the UK CRI website for more explanation of this information and the ability to explore local or regional impacts (for example, by county or Local Resilience Forum), and model uncertainty associated with differing warming scenarios.

Part 1 data references

Met Office temperature data

Met Office heatwaves data

Met Office rainfall data

Met Office marine data

UK Climate Risk Indicators, Research undertaken as part of the UK Climate Resilience Programme funded by UK Research and Innovation and the Met Office

Environment Agency (2022a), Peak rainfall climate change allowances by management catchment

Environment Agency (2022b), Peak river flow climate change allowances by management catchment

More information

This guidance does not replace other published Environment Agency guidance in relation to climate change, in particular any functional guidance and information which enables more detailed location specific assessment of impacts and risks.

Information is linked throughout this document, but specific key sources are listed below. 'The Climate Academy' on our SharePoint provides an evolving wealth of information and tools geared to identification of climate impacts and risks and subsequent adaptation action.

A range of adaptation reports are available, describing climate impacts and measures to manage them – see GOV.UK for third round reports.

Detailed guidance on best practice for how to identify, assess and manage climate change impacts and risks can be found in: ISO 14090 (adaptation to climate change), ISO 14091 (assessing climate risks), BS 8631 (adaptation pathways). The standards are available to download from Barbour (through Athens).

The Met Office maintains information showing how the UK climate may change in the future. Summaries, headline data, and links to more detail are supplemented by a more extensive range of products via the UKCP18 user interface. In 2023 Met Office launched a new GIS based Climate Data Portal.

For general news on climate impacts a good start point is the BBC climate pages, which in addition to frequent posts on global events include other introductory and summary information, such as What is Climate Change? A really simple guide and Sweltering and Sheltering: Summer 2023 in six extreme weather events

For flood risks see Advice on how to take account of and address the risks associated with flooding and coastal change in the planning process. Guidance such as the Flood risk assessments: climate change allowances and Flood and coastal risk projects, schemes and strategies: climate change allowances, should be used to support more detailed assessments.

Allowances for drainage design are included in Flood risk assessments: climate change allowances. These allowances are derived from the Future Drainage project. These allowances should provide sufficient information to inform drainage design, however, more detailed rainfall projections are provided through the Future Drainage project page.

Our internal Climate Change Planning Advice Note supports Area Sustainable Places team's strategic planning engagement work. It contains a new checklist of key climate change considerations for assessing draft development plans.

Other relevant information and guidance can be found on the Environment Agency climate change adaptation pages of GOV.UK. For example, climate change impacts and

adaptation and guidance relevant to water resources planning and environmental permitting. We have also recently published River Water Temperature Projections for English Chalk Streams and research on the effects of climate change on these iconic river systems.

Graphical information on future changes to climate risk indicators across the UK and by various geographical areas is provided by the UK Climate Resilience Programme, alongside a range of other useful resources.

For Health impacts, the Local Climate Adaptation Tool is a highly accessible source of local climate information, designed with and for local decision makers, providing information on both impacts and potential adaptation measures. The Local Partnerships Climate Adaptation Toolkit outlines a 5-step process to help councils prepare for current and future climate impacts

City Packs are available, providing high-level, non-technical local summaries of many city's future climates, as part of an extensive range of more detailed information based on the UK Climate Projections.

Further details on climate and environmental impacts is presented in the RIDE climate change impact report cards for the water, biodiversity and infrastructure sectors. Report cards are also available for agriculture and forestry and health.

For further detail on estuarine and marine related climate impacts and management options see the Marine Climate Change Impacts Partnership (MCCIP) Impacts Hub including in particular the Marine Climate Change Impacts Report Card 2020.

Forest Research publish a range of information on impacts and adaptation in England's woodlands, and progress on adaptation is also summarised in the Forestry Commission's third adaptation report in 2022. Natural England's third adaptation report was published in 2022 and examines risks, opportunities and adaptation plans associated with the state of the natural environment.

Climate impacts on business and industry and how to manage them are outlined in various publications, including from Environment Agency (2023), IEMA (2022), CIA (2021), OECD (2022), JRC (2022).

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