Climate impacts tool: guidance for Environment Agency staff

Understanding the risks and impacts from a changing climate

October 2023

We are the Environment Agency. We protect and improve the environment.

We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

Published by:

Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH

www.gov.uk/environment-agency

Further copies of this report are available from our publications catalogue: www.gov.uk/government/publications or our National Customer Contact Centre: 03708 506 506

Email: enquiries@environment-agency.gov.uk

Contents

Purpose of this document

For Environment Agency staff

This document primarily provides guidance for Environment Agency staff on using the ‘Climate impacts tool’ to help understand potential opportunities, risks and impacts from a changing climate. It is a high-level risk screening and communication tool which pulls together national level information on climate change impacts, into a single source. This is to support discussions in our work, including development of strategies and guidance, staff learning and to inform local decisions and advice.

The impacts of climate change are wide and varied. For some impacts there is well developed evidence on projected future changes but for others we cannot represent them in simplified form at a national level. This tool presents both quantitative and narrative (qualitative) information, so that our decisions are informed by a range of climate change impacts information. Once the climate opportunities, risks and impacts are identified using this tool, a more in-depth assessment, often with project specific and local information, will be required to understand the level of opportunity or risk. Any in-depth assessment is outside the scope of this tool, but policy, guidance and information is signposted in the ‘more information’ section and can also be found in our ‘Climate Academy’ SharePoint pages. In some cases, low cost or low regret actions to manage climate risks can be identified and implemented without the need for detailed assessment based on the information in the climate impacts tool.

For external stakeholders

Publishing this document on GOV.UK provides the opportunity to use it to support the discussions the Environment Agency has with partners and customers, enhancing action under our climate ambition “creating a net zero nation resilient to climate change”.

This document does not replace other published Environment Agency guidance related to climate change. For example, our climate change adaptation collection.

Getting ready for a changing climate

We at the Environment Agency are continually improving the way we manage the impacts associated with a changing climate – it will significantly affect all our work, especially on flooding, water availability and freshwater habitats. We are also adapting to ensure climate change impacts are integral to our advice, guidance and regulatory decisions, with the overarching ambition of creating a net zero nation resilient to climate change.

The Defra 25 Year Environment Plan included a firm commitment to make sure that government's policies, programmes and investment decisions take into account the possible extent of climate change this century. The subsequent HM Government (HMG) Environmental Improvement Plan 2023 includes a clear policy steer that organisations must be prepared for global warming levels up to +4°C. The national Climate Change Risk Assessment sets out the overall strategic risks to the country, whilst the National Adaptation Programme (NAP) also sets out the government's adaptation priorities over a rolling 5-year period. The Third National Adaptation Programme (NAP3) includes over 40 actions that reference our work, re-affirming the extensive role we play in creating a nation resilient to climate change – for example our work with Defra on the Plan for Water.

The Environment Agency's corporate plan, EA2025, sets out our organisational commitment to building climate resilience and responding to climate impacts. Our regular adaptation report and corporate reporting (corporate scorecard and risk reporting) sets out the detailed climate risk assessments, planned adaptation actions, and progress we are making on adaptation.

We need to make sure we take account of climate change through our roles as an operator, advisor and regulator. The key to preparing for a changing climate is using the best available evidence, appropriate to the area of work, to then identify climate risks, taking a risk-based approach. 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. We do this by adopting staged and iterative processes.

Firstly, we identify (screen for) impacts associated with a +2°C rise (global mean) by mid-century and up to a +4°C rise in by the end of the century. The information in this tool supports this process. For some decisions, our strategies may require planning for even higher temperature rises by 2100 or beyond (for example, large scale investment where we have already identified impacts as relevant such as new nuclear power stations).

Once the risks are identified, it's then about being clear how we will manage those risks in our decisions, often taking a stepped and flexible adaptive approach (adaptation pathways for example). Through exploring a range of climate scenarios we can ensure our plans are sufficiently flexible to avoid lock-in (that is, ensuring decisions with long-lasting consequences do not create obstacles for future adaptation).

Overview of the climate impacts tool

We have developed the ‘Climate impacts tool’ as a screening tool to help us identify and understand climate opportunities and risks in our work. We can also use it as a communications tool to support discussions and help us and others decide where climate change impacts are relevant and thus where we would expect more detailed or location specific tools, models or information to be used.

Part 1 of the climate impacts tool provides a simplified, accessible description of present-day physical impacts (the new normal and new extremes) and potential future changes (based on +2°C and +4°C pathways).

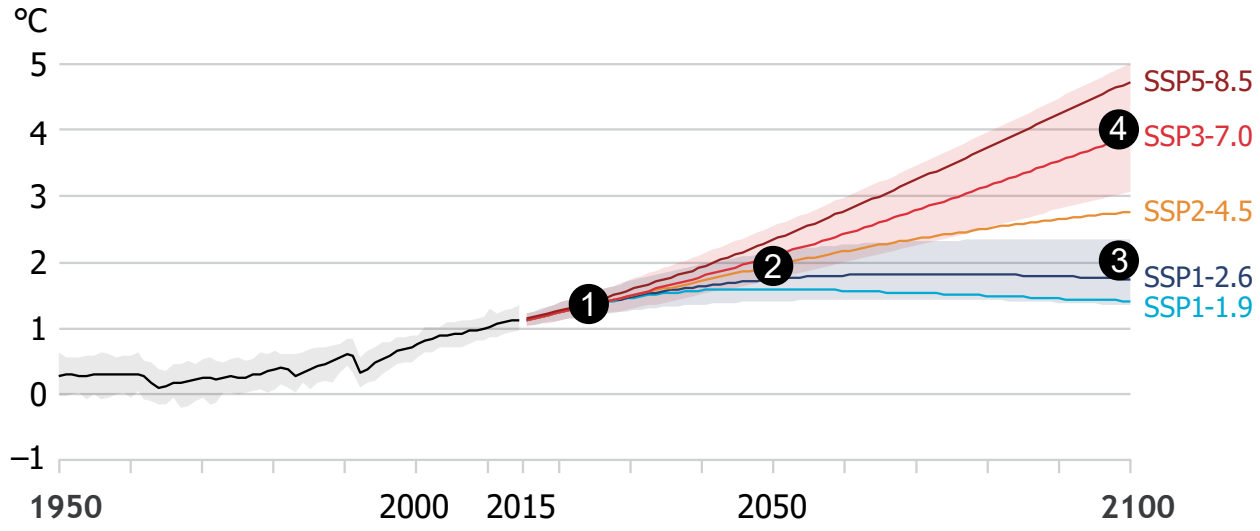
+2°C and +4°C refer to the change in global mean temperature (°C) compared to pre-industrial levels (usually related to a specific point in time – for example, by 2100).

It shows changes to some of England’s climate and environmental variables consistent with four scenarios (as illustrated in figure 1).

1. Present day (The climate has already changed).
2. Mid-century (+2°C by 2050: medium-high emissions scenario).
3. Managed transition (+2°C by 2100: low-medium emissions scenario)
4. Runaway change (+4°C by 2100: medium-high emissions scenario).

Figure 1: Global surface temperature change relative to 1850-1900, from IPCC (2021)

Coloured lines represent different potential warming pathways and are referred to as SSPx-y. ‘SSPx’ refers to the shared socio-economic pathway or ‘SSP’ describing the socio-economic trends underlying the scenario, and ‘y’ refers to the approximate level of radiative forcing (in watts per square metre, or W m–2) resulting from the scenario in the year 2100. We may see between 2°C to 4°C warming by 2100 depending on global climate change mitigation action.



A precautionary approach has been taken to select the data in this tool, so values will normally represent an upper estimate of possible changes associated with +2°C and +4°C global warming pathways. These pathways are chosen to reflect current government policy and Climate Change Committee advice on adaptation risk assessment and planning. More discussion on this is contained in the ‘Evidence base’ section.

Following the Part 1 infographic we include a selection of weather records from the past 10 years. These are included to illustrate that climate change has already occurred, and we are seeing increasing extremes of weather which may pose risk to our assets and operations today.

Part 2 of the climate impacts tool provides narrative information for a wider range of potential climate impacts where future change is credible, but evidence has not yet been established to quantify those future changes.

It is important to include all relevant climate impacts in our decisions, including those presented in Part 2, since many low cost or low regret options can be implemented now, even when uncertainty is high.

In line with best practice for climate change adaptation, the Environment Agency continually monitors new knowledge and indicators associated with climate change and it’s impacts, and we frequently publish updates to our detailed understanding of these. The ‘Climate impacts tool’ is similarly reviewed and revised periodically to keep it up to date with best scientific knowledge.

When to use the climate impacts tool

We can use the climate impacts tool whenever we need to screen or discuss climate change impacts and risks associated with our work, for example:

- to support strategic discussions with stakeholders and partners
- to screen impacts for a new plan or strategy
- as part of corporate disclosure reporting, such as our adaptation reporting (Climate Change Act) or meeting TCFD requirements (Taskforce on Climate-related Financial Disclosures)
- when considering third party information in an advisory or regulatory role at a local level
- to review risks within our management systems

The climate impacts tool helps us take a consistent approach to this.

We can also use it when we need to develop staff capabilities and provide examples of the range of climate impacts that may be experienced nationally, to the end of the century.

To support local conversations on climate impacts (for example, as regulator or statutory consultee), it will be important to supplement the high-level national information in this tool with information that helps identify location-based vulnerabilities to climate impacts. There is a range of information and tools available to help identify local variability of climate impacts, including our internal Climate Change Planning Advice Note which supports the Area Sustainable Places team's strategic planning engagement work (see the 'More information' section for other examples).

This tool can be used to support consideration of whether the type of local information being used is suitable and sufficient. Also, where local climate impact information is not available, this tool can be used to start discussions on potentially relevant impacts and the information necessary to enable decisions to be made. In any external discussions it is important to recognise that it is often others (for example, applicants, contractors or partners) who are responsible for sourcing and using climate information in their climate change risk assessments, but we can use this tool as an example of how we screen impacts.

In some areas of work, we have already screened specific climate change impacts as relevant to our work and are already using more detailed tools and models. This tool does not need to be considered for those impacts where we are already assessing and managing climate change opportunities and risks to a greater depth (for example, using location specific information). For example, for Environment Agency work areas or projects that already use the catchment specific Flood risk assessments: climate change allowances or Flood and coastal risk projects, schemes and strategies: climate change allowances there is no need to use the climate impacts information in this tool. Moreover, for Flood and coastal risk management: long-term investment scenarios or higher risk decisions (for example, some sectors of regulated industry), we may consider more

precautionary climate projections (for example, RCP8.5, H++, High Impact Scenarios), to help assess the sensitivity of decisions to different climate projections or models.

How to use the climate impacts tool

There is no single way in which the tool should be used. How it is used will depend on the circumstances, whether that is at a high level to support strategic discussions or as a stepwise systematic approach to screening or reviewing impacts and risks. However, it is often beneficial to consider the various climate impacts in the context of the objectives under consideration – these range from delivery of our corporate strategy to objectives and statutory requirements associated with individual plans, projects or permit applications – and use the tool to support discussions about risks and opportunities climate change poses to these objectives and requirements.

Whilst using the climate impacts tool key questions to ask yourself include, “could our outcomes or objectives be delivered under this level of climate change?” or “knowing this impact information, would or could we do anything differently?”.

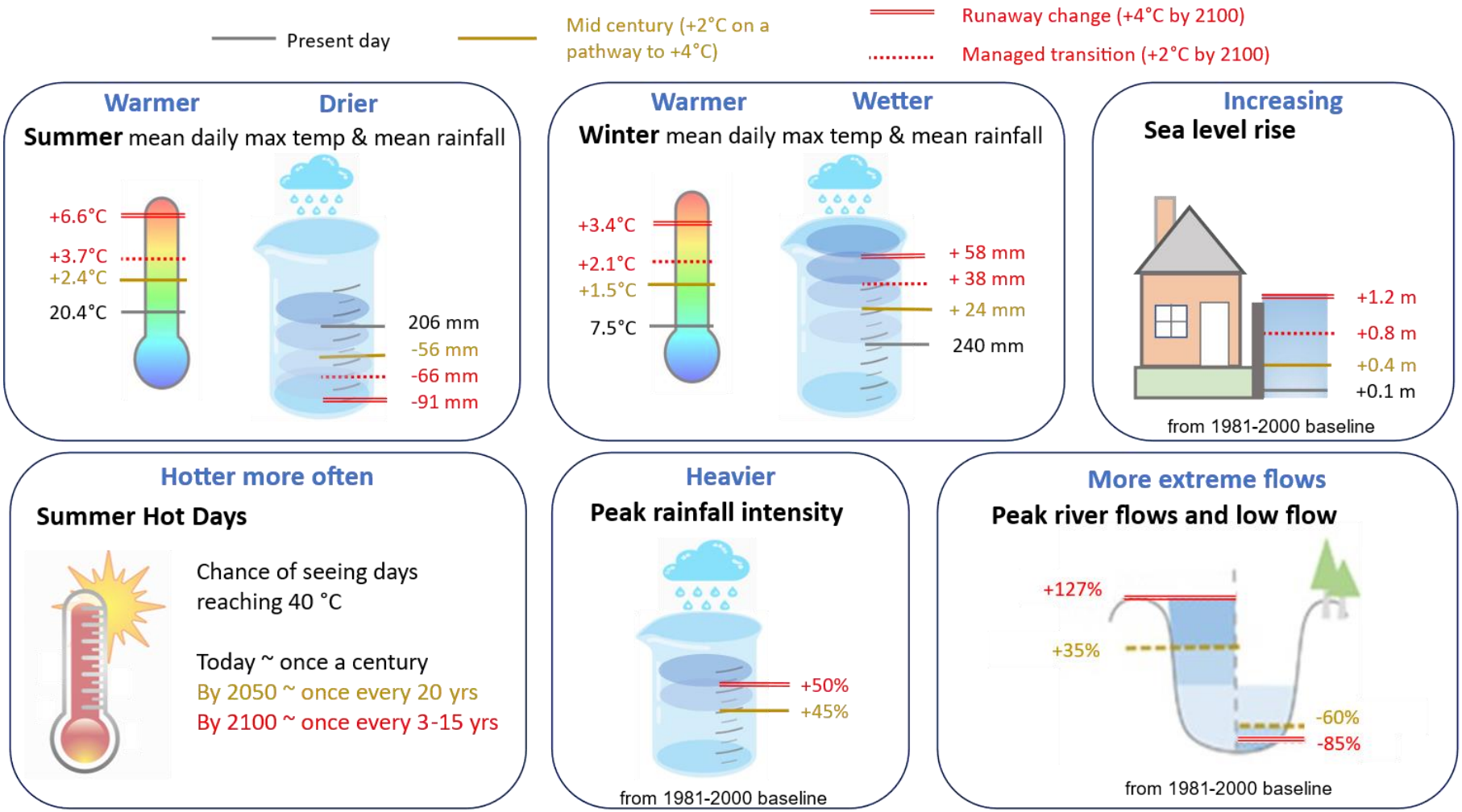
If our objectives or outcomes are identified as at risk, according to the tool, we should:

- show how the climate risks could be addressed either now or in the future – depending on how long-term the risks are
- seek more advice from technical specialists (functional climate change adaptation leads or climatechangesupport@environment-agency.gov.uk)
- undertake a more detailed assessment – this work would be beyond the scope of this tool

In some cases, we will be considering climate change impacts associated with a plan, project or application external to the Environment Agency (for example when we are being consulted on external strategies or plans or are inspecting an installation with an environmental permit). In these cases, you can ask yourself, ‘has the plan owner, duty holder or applicant adequately considered the future climate impacts in the context of the outcomes being sought?’ Often this involves focusing on protection of people and the environment, and consideration of how climate change impacts might pose a risk over the lifetime of the plan or project we are considering. If we have concerns that climate change impacts have not been considered, we can discuss these and in specific cases (for example under environmental permitting and COMAH regulations) we can require others to improve the way they consider climate change.

We are aware that there is, and always will be, a certain amount of uncertainty associated with future climate change projections. Yet, our corporate commitments for quality and sustainability are clear, including the need to 'think big, act early, and be visible'. We as an organisation need to make sure we get ready for a changing climate, and we need to influence businesses, citizens and communities to increase their resilience by helping them to adapt to future climate risks.

Climate impacts tool – Part 1: Physical impacts



Temperature, rainfall, and hot day data are national 'England' values, whilst sea level and river flow data are for the most extreme catchment or location in England. The symbol '~' means approximately. More details of how the values are derived and a table of these values can be found in the 'Evidence base' section. This tool is for advice only and does not replace other published Environment Agency guidance in relation to climate change.

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)

Climate impacts tool – Part 2: Wider physical and systemic impacts

"Storms and floods impact emergency responder access and resources"

"Intense rainfall impacts staff safety, especially when working outside or travelling"

"Sea level rise and increasing storminess threaten coastal communities"

"High temperatures and drought increase wildfires risk or fire risk at regulated sites"

"Air quality changes could impact people and the environment, for better or worse"

"We could still see extreme winter cold – we need to remain prepared!"

"Heat and drought impact industrial cooling systems and agriculture – adding to longer term impacts of warming on land, soil and water"

"Prolonged dry weather impacts water quality, resources and ecosystems"

"A warming climate impacts biodiversity, its vulnerability and the threat of invasive species"

"Storms, erosion and subsidence impact infrastructure (our assets and those of others) causing cascading impacts that could affect our work"

"Climate impacts are increasing, becoming more frequent and more severe – we need to act now to manage the risks!"

Narrative information for a range of potential climate impacts (further physical and systemic impacts)

Storms

Within its discussion of the effects of climate change, the Met Office highlights it is possible that climate change will cause an increase in both the frequency and severity of storms in the UK. More detailed Met Office discussion of wind storms highlights that modelling the factors which influence storms is complex – there is not yet scientific consensus on future trends, though UKCP18 projected a modest increase in near surface wind speeds over the UK for the second half of the 21st century, occurring in the winter season when more significant impacts of wind are experienced. However, whilst there remain uncertainties and research needs, the Climate Change Committee has recently highlighted, when discussing climate risks to infrastructure, that the possibility of changes in the strength and frequency of storms makes prudent planning today vital. Indeed, in 2022 UK saw 3 named storms in one week for the first time and one of these set the highest gust speed ever recorded at a low-level site in England. Storms can bring multiple simultaneous threats (intense rainfall, strong winds and lightning) in combination, and often with cascading impacts, which can affect natural and human systems.

Heatwaves and increasing seasonal temperatures

As our climate changes, hot spells are expected to become more frequent, more intense and with longer duration. Part 1 of this tool includes projections indicating that summers could become over 6°C warmer and winters over 3°C warmer by 2100. Also, as explained by the Met Office. extreme heatwaves could become almost 100 times more likely by the end of the century than at present. Hot weather can impact our buildings, assets and people's health – we need to consider both the health of our staff and those affected by the decisions we make. Heat can affect anyone, but some people run a greater risk of serious harm.

Increased air temperatures also transfer heat to freshwaters and to the marine environment, affecting biochemistry, habitats, behaviour and reproductive success, especially affecting amphibians. This could also affect cooling systems, sewage and water works, and other processes, including through higher evaporation rates. Waterbodies may be more vulnerable to heat-tolerant invasive species

Temperatures in the UK soared to the highest the country has ever seen during the July 2022 heatwave, exceeding 40°C over a wide area. Examples of impacts included increased wildfires and amplification of the impacts from the ongoing drought, power outages, significant disruption to transport and technology sectors, restrictions on school hours and significant pressures on emergency services, with several Fire and Rescue Services declaring major incidents. Industrial impacts that occurred affected multiple businesses with fires and other infrastructure or equipment failures.

Extreme cold

As illustrated in Part 1 of this tool**,** average winter temperatures are increasing. However, recent weather records illustrate that it is still possible that we will see extreme cold events in the future, such as the 'Beast from the East' that occurred in 2018, with a range of potential direct and cascading impacts on our work and on wider society. (Examples include – 'meals on wheels' services may be unable to deliver hot food to vulnerable people, social care visits can be interrupted, public transport can be cancelled so people are unable to go to work in hospitals, schools and so on.) It should also be considered that any gradual reduction in cold weather events could impact on our ability to respond when severe cold weather does occur, due to an erosion of staff capabilities regarding cold weather response (though this could be mitigated by appropriate exercising).

Wildfires

With the increasing frequency and severity of heatwaves and summer drought, UK wildfire risk is also projected to increase, with increasing risks to people, businesses and ecosystems due to both the direct impacts of fire or subsequent systemic impacts (UK Climate Change Risk Assessment 2022). For example, upland fires can destroy peat bogs, releasing large quantities of carbon to the atmosphere (a feedback loop), damaging habitats and recreational areas, whilst potentially causing water pollution, and increasing flooding and erosion as the thick 'sponge' sitting on impermeable rock is destroyed. Wildfires can also add to air quality problems where a plume affects residential areas. The Met Office's Fire Severity Index (FSI), is an assessment of how severe a fire could become if one were to start, and its uses include as a trigger for fire prevention restrictions on access land mapped under the Countryside and Rights of Way Act (2000).

Air quality

Whilst there have been some improvements in air quality in recent years, temperature increases resulting from climate change are likely to compound pressures on air quality, with complex implications for human health and the natural environment (OEP report 'Progress in improving the natural environment in England, 2021/2022'). This includes increasing ground level ozone (UK Climate Change Risk Assessment 2022). Overall we could see a higher frequency of summer pollution episodes (photochemical smogs) and a reduction in winter smogs (Air Quality Expert Group report 'Air Quality and Climate Change: A UK Perspective'). Climate change is further contributing to air pollution by increasing the risk of wildfires, and driving increasing emissions of ammonia from agriculture and natural sources (Environment Agency third adaptation report). Encouragingly, for virtually all of the changes proposed for Net Zero pathways, positive, improved and better air quality outcomes can be envisaged (Air Quality Expert Group report 'Impacts of Net Zero pathways on future air quality in the UK').

Water quality and water resources

In our third adaptation report we outline the complex and seasonal interactions between water quality, water resources and the climate change impacts on these (and on interacting ecosystems). Climate change driven processes will accelerate the loss of special habitats, such as wetlands, or of key species, while contributing to an increase in non-native invasive species and the spread of plant and animal diseases. Research by the Climate Change Committee found that 35% of 402 terrestrial species in England are at risk of range loss and 42% may expand their range in future. Overall, climate change is driving a 'new ecology' for which today's water quality standards could become redundant, protected area objectives inappropriate and species re-introductions unsuitable. In some cases, thresholds or tipping points may be crossed, with significant irreversible consequences for species decline and for ecosystem services and the communities and industries that rely on them. For example, recent research has explored how rising temperatures, droughts and floods, combined with wider system pressures, are changing chalk stream ecosystems and putting chalk stream species at risk of population declines and local extinction (Chalk streams of the future).

The UK Climate Change Risk Assessment 2022 also highlights that:

> "Higher temperatures can … increase the possibility of water quality problems through increasing the rates of biological and chemical processes, especially algal growth rates and nutrient cycling … impacting on the provision of clean water for consumption and associated water treatment costs, and the recreational potential of fresh waters."

Land and soil

In our third adaptation report we outline that geomorphological processes will change, resulting in impacts such as soil erosion, sedimentation, waterlogging and capping of soils. This can subsequently cause danger to people or infrastructure from landslides, loss of nutrient uptake and land contamination as heavy rainfall mobilises contaminants. Impacts on land can also affect the water environment, such as, through reduced land infiltration due to dry periods increasing surface runoff during a subsequent rainfall event, with associated flooding, erosion and loss of nutrients.

Climate change presents challenges to land management, including for agriculture and carbon sequestration. New or traditional crops that are unsuited to the climate could have negative consequences for soil and water as well as for food security and nutrition. The decline of insect pollinators is exacerbated by climate change and presents a risk to crops. Wetter winters and more extreme rainfall events will make it more difficult to manage risks from agricultural wastes that are normally spread on land.

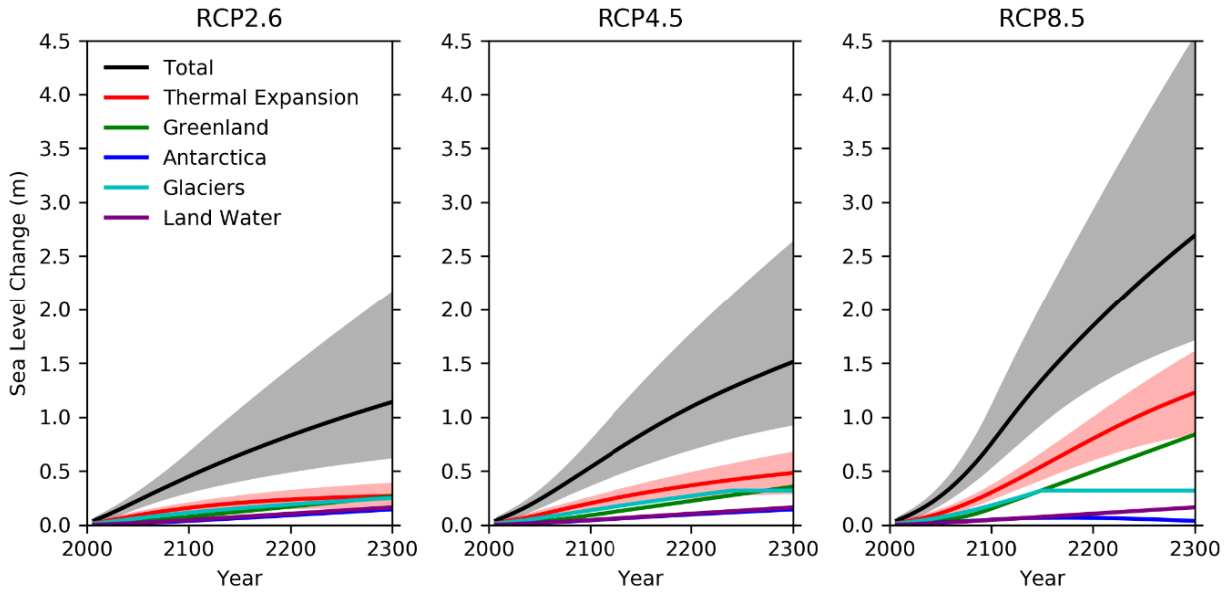
Coast and marine, including sea level rise

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



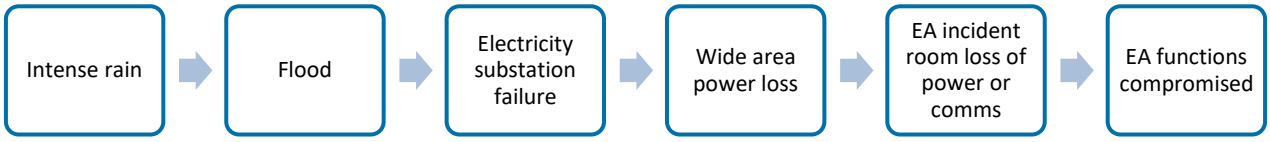
Biodiversity

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

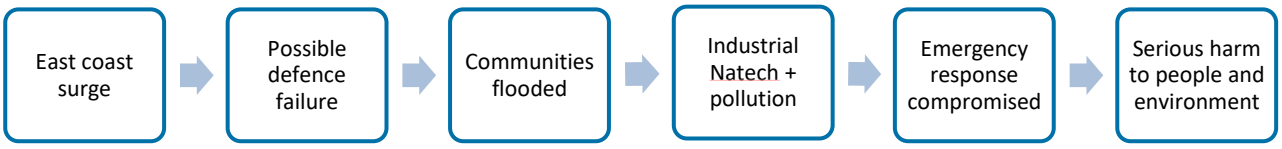
abundance and distribution of UK terrestrial and freshwater species has declined by 13% since 1970. Increased temperatures and extreme events such as drought and wildfire pose the biggest threats while upland areas face particularly acute risks. 75% of present-day upland species face a potential decline in climate suitability by 2100 under a medium level of warming. Moreover, impacts to biodiversity can affect agriculture and thus cascade to impact food supply chains, at local, regional and international levels.

Cascading and supply chain impacts (business continuity)

Extreme weather and other climate impacts can create cascading risks that spread across sectors. The third national adaptation programme discusses that it is important to understand and manage systemic and cascading risks. For example, intense rain can cause flooding which might damage an electricity substation, which has a knock-on effect on transport or on power supplies**.** This could impact our activity as a category 1 responder and advisor during an incident, for example due to loss of power or communications to an Area Incident Room (AIR).



A specific subset of cascading impacts is known as 'NaTechs' (Natural Hazard Triggered Technological Accident) where natural causes initiate or exacerbate accidents at industrial facilities, which can increase the overall scale of impact, for example through causing additional pollution, danger to people or pressures on emergency responders.



In practice, cascading risks may not be linear, but can spread simultaneously throughout many aspects of a system, further amplifying the impacts. The potential for cascading impacts and risks is growing through a more interconnected world, where risks can spread across sectors and in doing so lead to system-wide consequences (UK Climate Change Risk Assessment 2022). Thus, climate impacts do not need to affect us directly, we could be affected by cascading impacts increasing risks to our supply chains, business continuity and incident management functions, if our approaches are not sufficiently resilient.

Geological impacts

The evolution of climate and weather patterns over longer periods of time can have cascading and feedback impacts which include geological ones. Sea level rise, subsidence, dissolution, river and coastal erosion, and landslips are all examples of geohazards that can impact on our work and will be affected by our changing climate. The susceptibility of different regions to geohazards is likely to change as we experience changes in climatic phenomena, including temperature and precipitation changes. In their policy statement on geohazards and climate change the British Geological Survey highlight that increasing extreme events, including droughts and flooding, also have the potential to increase the frequency and magnitude of a specific geohazard event's occurrence.

Staff health, safety, and wellbeing

Climate change could affect our health, safety and wellbeing through a range of impacts. Extreme weather, such as storms, heatwaves or extreme cold can create direct hazards to staff and as discussed previously these extremes are predicted to become more frequent and more severe. The Local Climate Adaptation Tool is being developed as a source of health impact information, including measures that can be taken to control risks. We have also seen that during periods of extreme weather (for example, flood or prolonged dry weather) there is an increase in the scale, duration and number of incidents we respond to and thus increasing weather extremes could further impact the resilience of our incident response. We may also face new hazards in the field from invasive species or an increase in risk of diseases more commonly found in warmer climates. Moreover, 'climate anxiety' has become recognised as the issue of climate change and its effect on our mental health – a sense of fear, worry or tension linked to climate change.

Impacts, risks and opportunities

The impacts outlined in this tool can create risks to and opportunities for our work. It is often helpful to understand the risk created when making decisions about how much information is required to qualify or quantify a climate impact.

Every extreme weather event or update of climate science and information provides us with an opportunity to discuss climate impacts and the need to adapt at pace to become a nation resilient to climate change.

The Defra group sustainability strategy 2023 to 2033 outlines the headline climate change risks for Defra group operations:

> "Damage to Defra group assets and infrastructure resulting from extreme heat, drought and flood events. Risk to staff safety and impact on incident response capacity.

"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

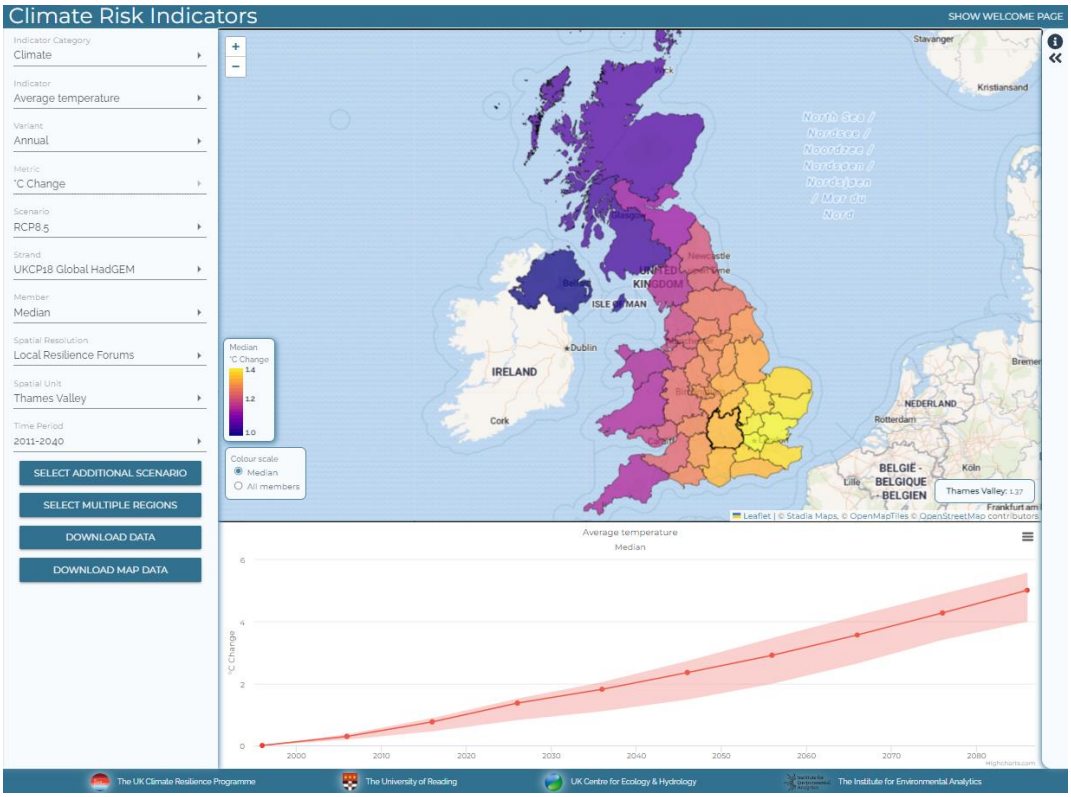


Table of Part 1 information (national England data)

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).

Would you like to find out more about us or your environment?

Then call us on

03708 506 506 (Monday to Friday, 8am to 6pm)

Email: enquiries@environment-agency.gov.uk

Or visit our website

www.gov.uk/environment-agency

incident hotline

0800 807060 **(24 hours)**

floodline

0345 988 1188 **(24 hours)**

Find out about call charges (https://www.gov.uk/call-charges)

Environment first

Are you viewing this onscreen? Please consider the environment and only print if absolutely necessary. If you are reading a paper copy, please don’t forget to reuse and recycle.