OpenCLIM Local Climate Risk reports

User guide

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Version 01

Maximising UK Adaptation to Climate Change Hub

Contents

1. Introduction

The OPEN CLimate Impacts Modelling framework **(OpenCLIM)**[1] brought together existing state-of-the-art models to demonstrate how climate change could affect the UK over the coming century with the aim to help inform adaptation needs at national and place-based scales.

The framework is underpinned by consistent climate projections and socio-economic scenarios. This means that shared elements can be captured and modelled consistently, for example changes in temperature, population, land cover and urban development, allowing outputs from different models to be integrated and explored together. The models all provide spatial data and cover the implications of climate change on agriculture, biodiversity, heat stress, flooding and drought.

Following feedback from local stakeholders a series of local climate risk reports have been created to help users access and use OpenCLIM model outputs. The risk reports provide an initial summary of local climate risks, from which more detailed risk analysis can be planned, and additional data can be sourced. These reports aim to help local authorities, service providers, infrastructure operators, and others, who are newly thinking about climate risk, to understand how risks may change or accrue under 2°C and 4°C of warming.

The purpose of this user guide is to (i) outline the OpenCLIM data shown in the risk reports; (ii) explain how the risk reports can be accessed and interpreted to support climate change risk assessment and adaptation planning and decision-making; and (iii) to signpost to other online tools, information and datasets, that could be used alongside the OpenCLIM risk reports, to support adaptation planning and decision-making.

2. Understanding climate risk

In the context of climate change, **risk** results from the dynamic interaction between climate related **hazards** (such as floods, heatwaves, or storms); **exposure** to the hazard (such as the presence of people, assets, or nature in places and settings that could be adversely affected); and **vulnerability** (for example how likely it is that

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people will be harmed if they are exposed to a hazard). In this sense vulnerability encompasses sensitivity and capacity to cope or adapt to a given hazard. Figure 1 depicts the risk 'propellor' or 'triangle', with risk emerging from the overlap of climate hazard(s), vulnerability and exposure.

Drawing these elements together can be helpful to demonstrate that reducing climate risk isn't only about reducing the hazard(s) but also exploring where interventions can reduce exposure and vulnerability. For example, ensuring communities are well protected, have capacity to cope or recover from hazards, and issues of social equity are considered so that the most vulnerable have fair access to support and resources.

Figure 1: The components of risk as defined by the Intergovernmental Panel on Climate Change (IPCC, 2022a, Chapter 1, pp.145)

Adaptation to climate change can address one or more of the 'propellors' by ensuring hazards are less damaging (for example restoring wetlands to reduce flood intensity), exposure is reduced (for example by relocating assets or not building in flood prone zones) and vulnerability is reduced (for example through early warning systems such as heat-health alerts). Understanding risk can help adaptation planners and decision makers identify where adaptation efforts would be the most effective or should be prioritised.

3. Modelling risk in OpenCLIM

Climate change will amplify existing risks and can create new risks for natural and human systems (IPCC, 2022b). These risks will not be evenly distributed and the most disadvantaged communities and people are likely to be hit the hardest. OpenCLIM provides data to show how risks may evolve over time. This is modelled by bringing together several layers of data that contribute to climate risk in a standardised manner.

Climate data

Information on how the climate is likely to change in the future and implications for **hazards** are based on the UK Climate Projections 2018 ([UKCP18](#)) from the Met Office. The UKCP18 projections provide data on climate change projections for the UK, for different time-periods out to 2080 and 2100 depending on the dataset used (Met Office, 2021). The **projections** provide plausible representations (scenarios) of what the future climate *could* look like. They are not perfect representations or accurate **predictions** of what future climate *will* look like. This reflects the fact that outputs from climate models, which provide numerical representations of the climate system, can differ depending on assumptions of how climate change emissions and societies evolve and how atmosphere, ocean and land processes (which can often be over-simplifications) are represented in the models.

Uncertainty will be inherent in any kind of forecasting or projection. To help capture this **uncertainty** several climate models can be run to explore a range of future possibilities and provide a more robust picture of how the climate may change over time. For example, [regional projections](#) from UKCP18 reflect outputs from 12 different climate models (a 12-member ensemble). Using a set of climate models helps to capture climate model uncertainty; reflect natural variability in climate as well as human-driven climate change; and can provide decision-makers with a range of outcomes to consider. For further information see the [understanding Met Office climate data](#) pages.

Socioeconomic data

Inclusion of socioeconomic data is one way to represent features of **vulnerability** (e.g. social, economic or demographic variables) and **exposure** (e.g. population density) when considering certain risks. In OpenCLIM the [UK Shared Socio-economic Pathways](#) (SSPs) have been used. The UK-SSPs provide five imagined futures reflecting different ways in which society may change over time. Based on these narratives sets of consistent socioeconomic data are provided out to 2100 to support

climate risk assessment. One benefit of using the UK-SSPs is that they provide spatial data for a wide range of variables useful when thinking about exposure and vulnerability (e.g., demography, population, employment, social cohesion and health). Secondly, they provide projections of how these variables could change under different futures.

This is important as it is not only future changes in climate that influence risk, but also future changes in vulnerability and exposure. Additionally, there will be **uncertainty** as we do not know how socioeconomic scenarios will play out, and projected data relies on numerous assumptions. As such, when considering climate change adaptation, it is important to consider and explore how to adequately respond to a range of possible future outcomes within this space.

Risk assessment framework

Figure 2 provides an overview of the OpenCLIM modelling framework, which draws together many datasets representing hazards, exposure and vulnerability into a range of state-of-the-art climate risk models. Results from the models are presented using a consistent format to allow users to compare outputs across a range of risks and sectors.
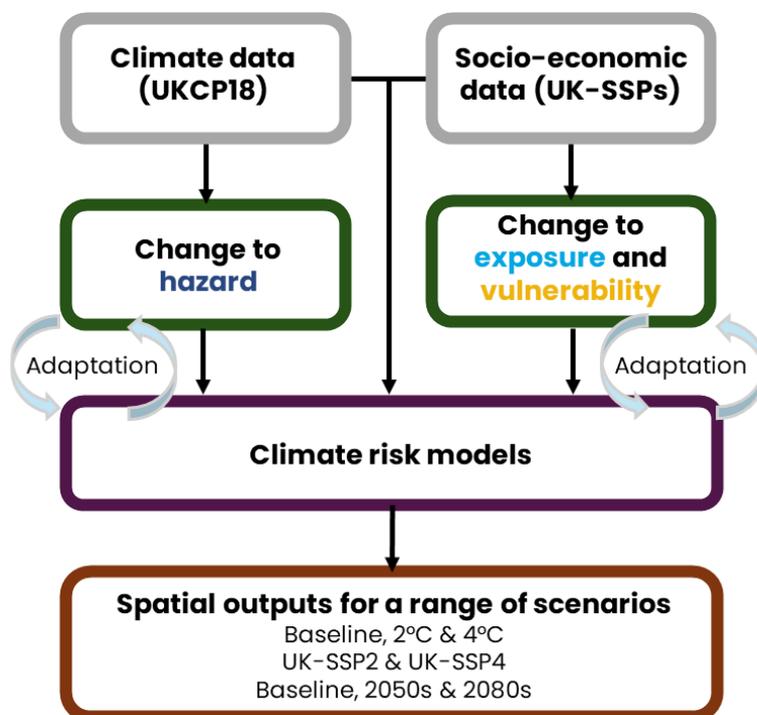

Figure 2: Flow chart illustrating the OpenCLIM modelling framework

Results are provided for a **baseline** scenario (using a time slice of data that represents the recent historic period e.g., 1981-2000) and future scenarios where a 30-year time slice of climate data is centred on a period with an increase in global mean surface temperature of **2°C** and **4°C** above the pre-industrial temperature. For context, current average global temperatures are ~1.3°C above the pre-industrial period (1850-1900) (WMO, 2025). Importantly, 2 or 4°C does not mean that the amount of warming in the UK is 2 or 4°C, but that when averaged over the whole world, the amount of average global warming is 2 or 4°C.

Presenting results at defined global warming levels of 2 and 4°C allows risks to be considered in a more policy-relevant manner. The warming levels align with the 3rd UK Climate Change Risk Assessment (CCRA) which considered risks at 2°C as a minimum and 4°C as an upper range that cannot be ruled out, to encourage thinking of what such a world could look like for adaptation planning (Betts and Brown, 2021).

Results are presented based on two UK-SSP scenarios. **SSP2** represents a continuation of current trends where social, economic and technological trends do not change markedly from the past. The scenario assumes continued economic growth, increased urbanisation and increasingly dense cities, and growing population. The UK population reaches 76.6 million by 2050 and 83.2 million by 2080 (this is higher than the 2020-based Office of National Statistics (ONS) principal population projection which reaches 71.4 million by 2050 and 71.6 million by 2080).

SSP4 represents a future with increased inequality across the UK in terms of investment and economic opportunity, with an increasing divide between wealthy and poorer segments of the population as well as regions of the UK. There is increased urbanisation in and around densely populated urban areas. The UK population reaches 71 million by 2050, declining to 68.8 million by 2080 (this is similar to the 2020-based ONS principal population projection until 2060, but becomes lower from 2060 onwards).

In OpenCLIM the warming levels are assumed to be independent of time, e.g., we could imagine that we reach 2°C in the 2030s, 2050s or the 2080s depending on the emission pathway we follow. Where socio-economic data is required to calculate risk metrics, we align this socioeconomic data to a time period by using data from the SSP2 and SSP4 projections for 2050s and 2080s and combining it with climate data at 2°C. We also take socioeconomic data from the SSP2 and SSP4 projections for the 2080s and join this with climate data at 4°C. In this way we can provide a picture of what climate risks may look like in the medium term (2050s) if we reach 2°C and what risks may look like in the far future (2080s) if we reach either 2°C or 4°C.

4. Outputs provided in the local climate risk reports

The OpenCLIM framework provides various outputs metrics that can be used to quantify and map climate risk in the UK. The full suite of outputs can be accessed from a technical database on the Data and Analytics Facility for National Infrastructure (DAFNI). These results are open access, although a log-in account needs to be requested.

In this user guide, we present a subset of key metrics used to describe agriculture, biodiversity, heat stress, flooding and drought risks (Table 1). A brief description of the models and the methods they use is presented below. To support the sharing and use of this data a series of county-level risk reports have been made available.

	Agriculture	Biodiversity	Heat stress	Flooding and drought
Area covered	UK	UK	UK	UK (excluding coastal)
Resolution of output data	1km	100m	12km	Catchments
Uses UK-SSPs	N/A	N/A	SSP2, SSP4	SSP2, SSP4
Baseline period in model	1980–2010	1961–1990	1981–2000	1985–2000
Output metrics provided	Potential yield for: • Wheat • Oil seed rape • Grass	Species richness to show areas of greatest value for: • Conservation • Restoration • Urban greening	Heat related mortality	Drought duration and return-period flows for: • 1-in-10-year • 1-in-100-year
Units	Tonnes per hectare (t/ha)	Relative units (%)	Number of Deaths; cumulative deaths	Drought months per 30 years; Flow metres cubed per second (m^3/s), and percent change (%)

Table 1: Key features of the OpenCLIM outputs presented in the risk reports for agriculture, biodiversity, heat stress, flooding and drought.

Agriculture: Modelling present and future risk

The CropNet model maps projected changes in the potential yield of key crops (wheat, oil seed rape, and grass) across the UK, based on projected changes in the future climate (heat and water limitation). While the model does not account for where these crops are currently grown (actual yield), it is a useful indicator for areas that may see a future increase/decrease in potential agricultural productivity. Further details are available in Hayman et al. (2024), whilst horizon scanning maps of new crops that may grow well under future climate conditions are discussed in Redhead et al. (2025) and available on DAFNI.

Biodiversity: Modelling present and future risk

The biodiversity modelling considers how climate change could have an impact on species based on their current climate envelope (the range of climatic conditions that a particular species can survive and reproduce in). Based on this climate envelope the model indicates where future projected changes in climate will affect the number of species remaining or the 'species richness' (on a scale of 0-100%), for natural and unmanaged land; agricultural and managed grassland; and urban areas. These changes are used to map the areas that would be of greatest value for conservation; restoration; and for enhanced urban green space. Further details are available in Price et al. (2024). Maps of the effects of climate change on individual species are available on DAFNI.

Heat stress: Modelling present and future risk

The Heat Adaptation Risk Model (HARM) is used to project how heat related mortality will change with climate change. The calculations are based on statistical relationships that allow the model to estimate how the daily mortality rate will change when mean temperature exceeds set thresholds. The thresholds vary dependent on the region of the UK (19.6°C in London and 16.6°C in Scotland) whilst the rate of change depends on the age group affected. HARM also uses the UK-SSPs to account for changes in the number of people (population data) exposed and the vulnerability of people exposed based on age (demographic data). The average annual number of heat-related deaths per year are mapped for each scenario. Further details are available in Jenkins et al. (2022). Additional data on changes in cold-related mortality are available on DAFNI.

Flooding and drought: Modelling present and future risk

Two hydrological models SHETRAN and HBV have been used to show how river flows will change across different catchments as e.g., precipitation, temperature and potential evapotranspiration changes with climate change. The catchment scale

river flows are used as a proxy indicator to explore how droughts and flood events may change as instances of decreased or increased river flow may correlate with the probability of flood or drought events, respectively. Maps are provided for drought duration, based on the average cumulative number of months with low flow conditions during each 30-year time slice. For flooding, maps show how likely it is that given river flow rates will be exceeded for a 1-in-10-year (low probability, low magnitude) event, and 1-in-100-year (low probability, high magnitude) event. Further details are available in Smith et al. (2024) and He at al. (2022). Additional flow rate and discharge data are available on DAFNI.

5. Interpreting the OpenCLIM local climate risk reports

The risk reports can be accessed online at the following link: OpenCLIM risk reports or via the QR code opposite. The webpage provides a list of **seventy risk reports** that have been generated for each of the UK's counties. Where counties are small, e.g. Rutland, they may have been combined with neighbouring counties. You can search the table to find the risk report for your county of interest or use the interactive map to select a region. Clicking on the county or region will open a **.pdf document** in your web browser that can be saved or printed.

Figure 3: *Scan to access risk reports*

Each report includes a title and background page, explaining the different metrics provided for agriculture, biodiversity, heat stress, flooding and drought. Pages 3-16 provide information about climate risks. As the model outputs have used consistent input data and scenarios users can view and compare maps across the pages.

Agriculture: Potential yield for oil seed rape, grass and wheat (pages 3, 5, 7 of each risk report). Based on these maps you can locate the areas which are likely to be the most productive places to farm these crops in the future.

Highlights the theme, county and metric presented

Maps show results for the baseline (1980-2010) and with 2°C and 4°C of warming

| Agriculture | Biodiversity | Heat | Hydrology |

Berkshire | Potential Yield | Oil Seed Rape

Baseline | **2°C** | **4°C**

Potential Yield (t/ha)
13.3
5.9
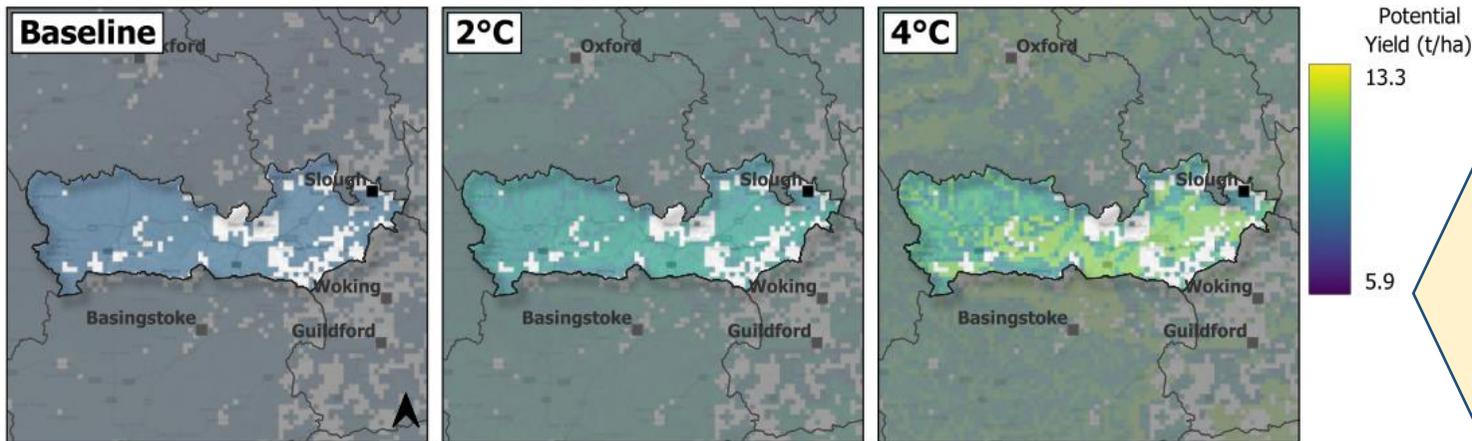
The legend shows the potential yield (tonnes per hectare).

Maps show the spatial pattern of potential yield (1km resolution). Change in colour indicates areas where a crop is likely to increase/decrease in yield due to climate-forced changes in temperature and water availability.

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

Key Points

Potential yield (tonnes per hectare) shows change in potential oil seed rape yield at 1km resolution, due to heat limitation and water limitation under baseline, 2°C, and 4°C warming scenarios.

Scenarios shown include the CO2 fertilisation effect (enhanced plant productivity).

A modest increase in potential yield is projected at 2°C and 4°C for most of the Berkshire area.

Local Summary

Minimum, mean and maximum potential yield (t/ha) for the Berkshire region at baseline, 2°C and 4°C warming scenarios.

County	Mean			Minimum			Maximum		
	Baseline	2°C	4°C	Baseline	2°C	4°C	Baseline	2°C	4°C
Berkshire	8.3	9.6	10.6	7.8	8.2	8	8.5	10.2	9.7

The table provides a summary of results for the whole County or region

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The mean shows the average value from the ensemble.

The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., how closely the climate models agree and the range in outputs.

The OpenCLIM project was funded by the UK Climate Resilience Program. For details visit openclim.science

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Agriculture: Potential yield (difference) for oil seed rape, grass and wheat (pages 4, 6, 8)

Difference shows how the potential yield is likely to change from the baseline.

The potential yield (tonnes per hectare) is shown for the baseline.

The difference in yield is shown if we reach 2 or 4°C. Red/orange areas are those where yield will likely fall relative to current potential rates.

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

The table provides a summary of results for the whole County or region

The difference shows the change in yield from the baseline under a 2 and 4°C future.

Agriculture | Biodiversity | Heat | Hydrology

Berkshire | Potential Yield - difference | Oil Seed Rape

Baseline | 2°C | 4°C

Potential Yield (t/ha) Baseline
13.3
5.9

Difference (t/ha)
15
-15

Key Points

Potential yield (tonnes per hectare) shows change in potential oil seed rape yield at 1km resolution, due to heat limitation and water limitation under baseline scenarios with the difference from baseline at 2°C and 4°C warming level scenarios.

Scenarios shown include the CO2 fertilisation effect (enhanced plant productivity).

A modest increase in potential yield is projected at 2°C and 4°C for most of the Berkshire area.

Local Summary

Minimum, mean and maximum potential yield (t/ha) for the Berkshire region at baseline, 2°C and 4°C warming scenarios, with the difference from the baseline mean for 2°C and 4°C warming scenarios.

County	Mean			Minimum			Maximum			Difference	
	Baseline	2°C	4°C	Baseline	2°C	4°C	Baseline	2°C	4°C	2°C	4°C
Berkshire	8.3	9.6	10.6	7.8	8.2	8	8.5	10.2	9.7	1.3	2.3

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The mean shows the average value from the ensemble.

The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., how closely the climate models agree and the range in outputs.
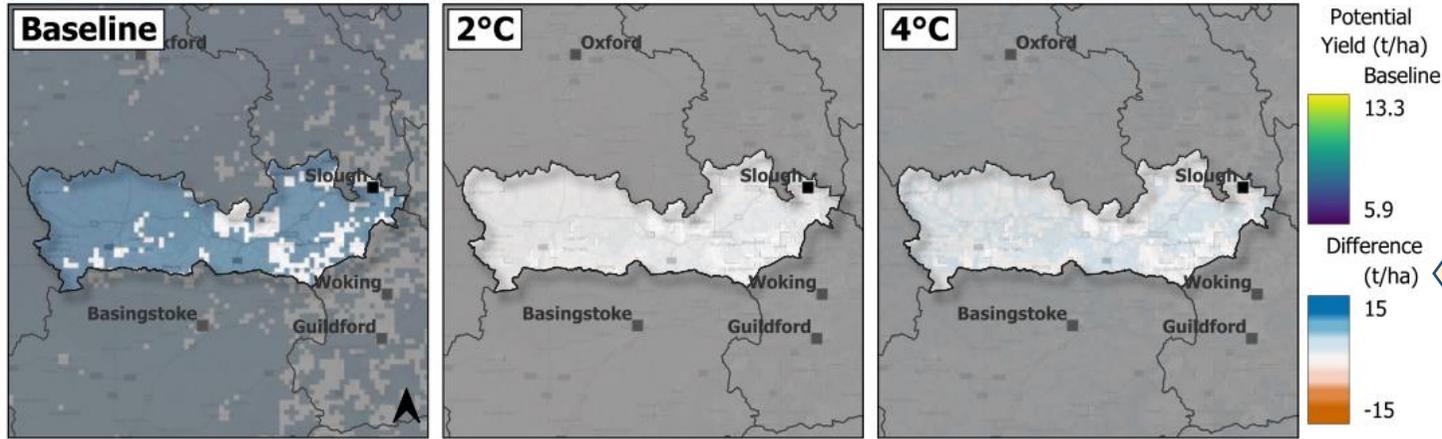
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Maps highlight an areas potential for conservation.

Dyfed | Conservation | Warming Levels

Baseline **2°C** **4°C**

Conservation
100
0

A high percentage of conservation suitability is given to areas that are projected to support high species richness if conserved effectively.

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

Key Points

A relative scoring is shown for an area's suitability for Conservation, based on a metric of species richness remaining.

Under 2°C and 4°C warming scenarios, a decline in suitability is projected, with mean values shown in the Table (right).

Under 4°C of warming, only one area is projected to retain a maximum suitability of 100 (range = 60 to 100), while the mean rarely exceeds 50, showing the importance of limiting warming to 2°C or less.

Local Summary

Minimum, mean and maximum conservation potential (%) for Dyfed at baseline, 2°C and 4°C warming scenarios.

County	Mean			Minimum			Maximum		
	Baseline	2°C	4°C	Baseline	2°C	4°C	Baseline	2°C	4°C
Dyfed	34.7	31.1	22.5	0	0	0	100	100	88

The table provides a summary of results for the whole County or region

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The mean shows the average value from the ensemble.
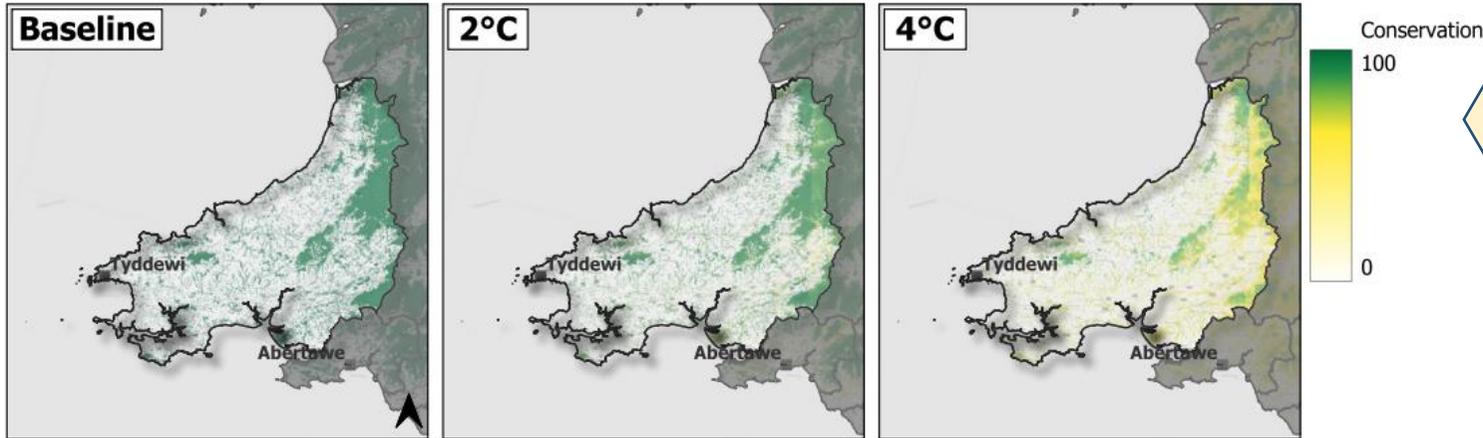
The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., how closely the climate models agree and the range in outputs.

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Biodiversity: Restoration (page 10)

Maps highlight the potential suitability of land for restoration for areas where nature is restored effectively from current agricultural or non-natural land use.

A high percentage of restoration suitability is given to areas that are projected to support a high species richness if restored effectively.

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

The table provides a summary of results for the whole County or region

Agriculture | **Biodiversity** | Heat | Hydrology

Dyfed | Restoration | Warming Levels

Baseline | **2°C** | **4°C**

Restoration
100
0

Key Points

A relative scoring is shown for an area's suitability for Restoration, based on a metric of species richness remaining.

Under 2°C and 4°C warming scenarios, a decline in suitability is projected, with mean values shown in the Table (right).

Under 4°C of warming no areas remain with a projected maximum suitability of 100 (range = 60 to 95), showing the importance of limiting warming to 2°C or less.

Local Summary

Minimum, mean and maximum restoration potential (%) for Dyfed at baseline, 2°C and 4°C warming scenarios.

County	Mean			Minimum			Maximum		
	Baseline	2°C	4°C	Baseline	2°C	4°C	Baseline	2°C	4°C
Dyfed	65.3		42.7	0	0	0	100	99	83

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The mean shows the average value from the ensemble.
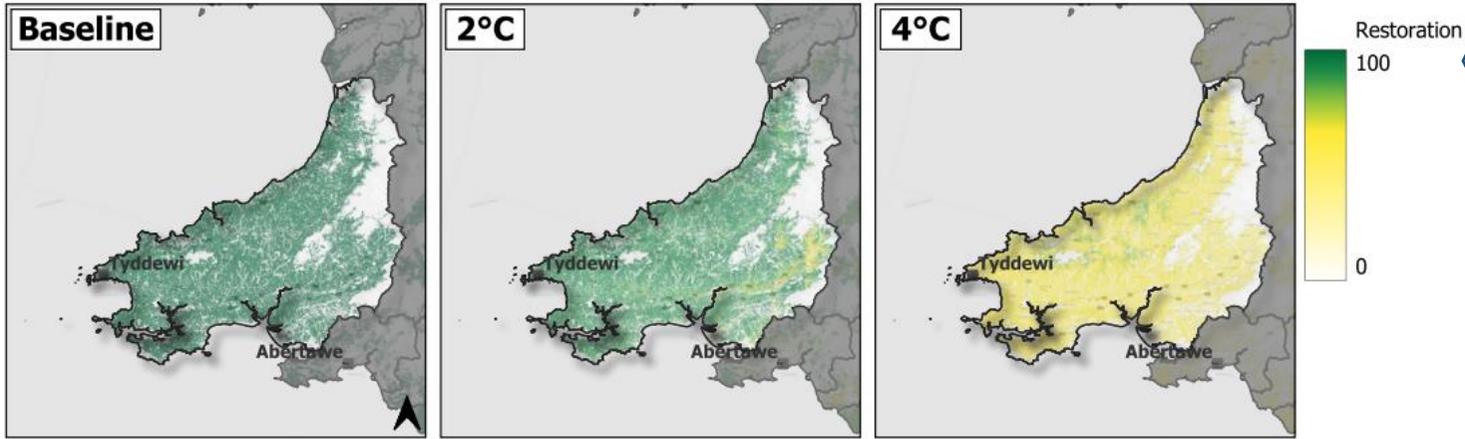
The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., how closely the climate models agree and the range in outputs.

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Biodiversity: Urban green (page 11)

Maps highlight the potential suitability of land for enhanced urban greening.

| Agriculture | **Biodiversity** | Heat | Hydrology |

Dyfed | Urban Green | Warming Levels

Baseline

2°C

4°C

Urban Green
100

0
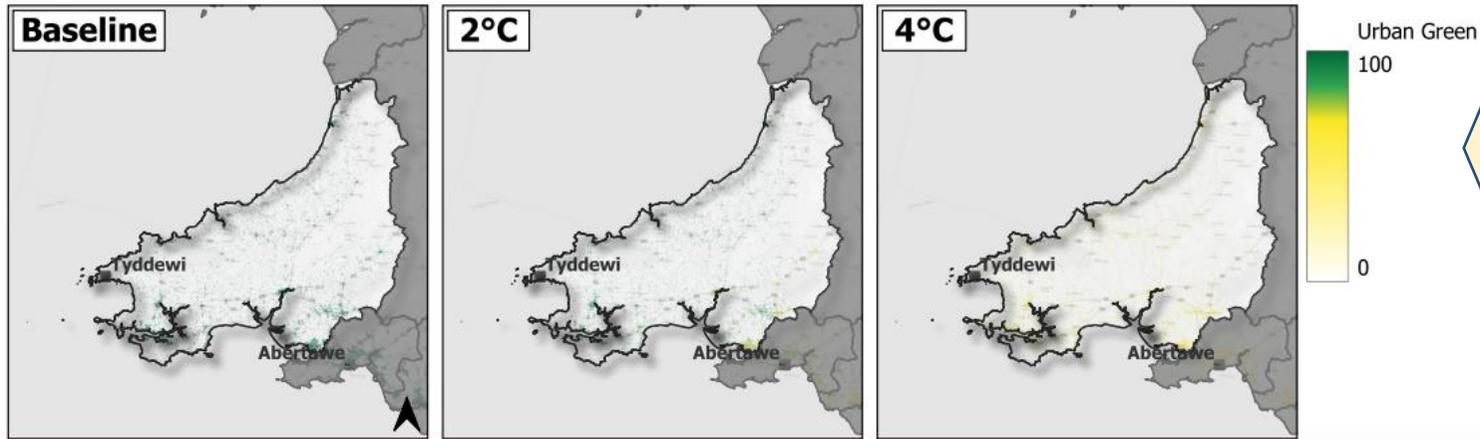
A high percentage of urban green (shown as greener areas on the map) is given to areas that would be of greatest value for enhanced urban green space, based on species richness.

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

Key Points

A relative scoring is shown for an area's suitability for Urban Green Space, based on a metric of species richness remaining.

Under 2°C and 4°C warming scenarios, a decline in suitability is projected, with mean values shown in the Table (right).

Under 4°C of warming there are no areas remaining with a maximum suitability of 100 (range = 60 to 95), showing the importance of limiting warming to 2°C or less.

Local Summary

Minimum, mean and maximum urban greenspace potential (%) for Dyfed at baseline, 2°C and 4°C warming scenarios.

County	Mean			Minimum			Maximum		
	Baseline	2°C	4°C	Baseline	2°C	4°C	Baseline	2°C	4°C
Dyfed	5.6	4.6	3.4	0	0	0	100	98	80

The table provides a summary of results for the whole County or region

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The mean shows the average value from the ensemble.

The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., how closely the climate models agree and the range in outputs.

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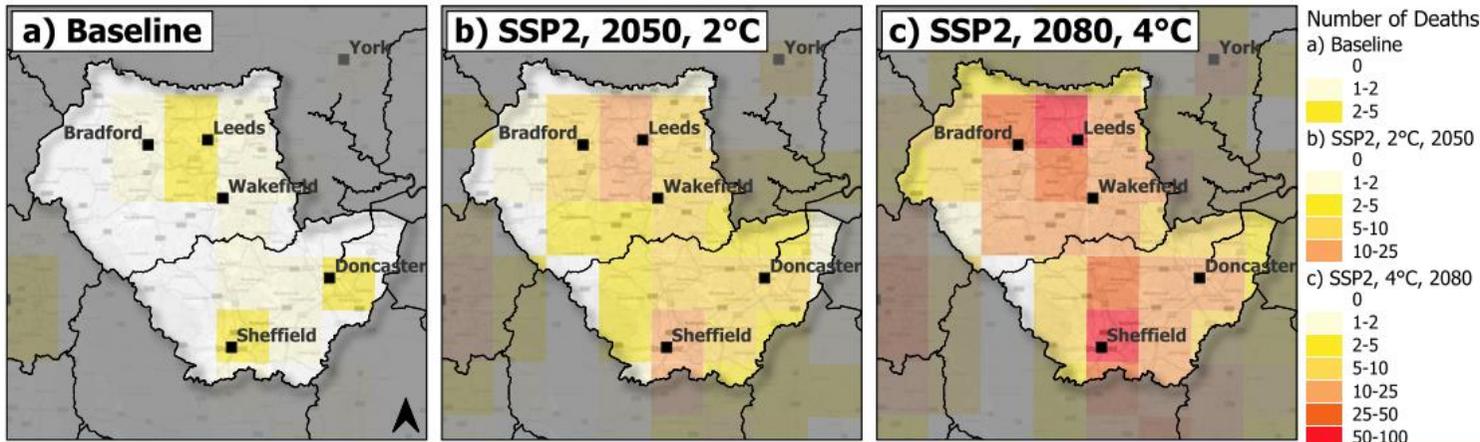**Maximising UK Adaptation to Climate Change Hub**

Heat Stress: Heat mortality using shared socio-economic pathways SSP2 and SSP4 (pages 12, 13)

Maps show the number of heat-related deaths in each modelled grid cell.

Headers highlight the climate and population scenario used and the time-period population is taken for.

Agriculture | Biodiversity | Heat | Hydrology

South-West Yorkshire | Heat Mortality | Combined Future Scenarios

a) Baseline — York, Bradford, Leeds, Wakefield, Doncaster, Sheffield

b) SSP2, 2050, 2°C — York, Bradford, Leeds, Wakefield, Doncaster, Sheffield

c) SSP2, 2080, 4°C — York, Bradford, Leeds, Wakefield, Doncaster, Sheffield

Number of Deaths
a) Baseline
0
1-2
2-5
b) SSP2, 2°C, 2050
0
1-2
2-5
5-10
10-25
c) SSP2, 4°C, 2080
0
1-2
2-5
5-10
10-25
25-50
50-100

The average number of heat-related deaths per year is shown. Higher deaths are shown by orange and red shading.

Key Points

Heat mortality shows average deaths per year at 12km resolution, under future scenarios combining warming (2°C, 4°C), socioeconomics (SSP2, SSP4), and population (2050, 2080).

An increase in heat mortality is projected under 2°C and 4°C scenarios under SSP2. Additional population in 2050 and 2080 also increase mortality.

The climate model ensemble shows a range of outcomes, summarised by the 10th to 90th percentile range (bottom Table, right).

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

Local Summary

Mean deaths per year and cumulative deaths in South-West Yorkshire for baseline and future scenarios.

County	Baseline Mean	Baseline Cumulatiave	SSP2 2050 2°C Mean	SSP2 2050 2°C Cumulatiave	SSP2 2050 2°C Difference	SSP2 2080 4°C Mean	SSP2 2080 4°C Cumulatiave	SSP2 2080 4°C Difference
South Yorkshire	1	19.6	4.6	91.9	3.6	15.1	246.2	14.2
West Yorkshire	0.8	20.2	3.8	98.3	3	13.4	278.2	12.6

Mean deaths (death/yr) for each future scenario and the climate model ensemble range between 10th and 90th percentile.

County	Baseline Mean	10th - 90th percentile	SSP2 2050 2°C Mean	10th - 90th percentile	SSP2 2080 4°C Mean	10th - 90th percentile
South Yorkshire	1	0 - 5	5	0 - 26.9	15.1	0.1 - 78.6
West Yorkshire	0.8	0 - 4.4	4.2	0.2 - 21.3	13.4	0.6 - 62.2

Cumulative values are the sum of all heat-related deaths across the County or region.

The difference shows the change in mean deaths from the baseline under a 2 and 4°C future.

The tables provide a summary of results for the whole County or region

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The mean shows the average value across the ensemble.

The 10th– 90th percentile indicates the upper and lower range of outputs from the ensemble, i.e., how closely the climate models agree and the spread in outputs.

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Hydrology: Drought duration (page 14)

Staffordshire | Drought Duration | Warming Levels

Headers highlight the metric shown and climate scenario used

Maps show areas most at risk from hydrological drought

a) Baseline

b) 2°C

c) 4°C

Months / 30yrs
a) Baseline
- <3
- 3-5

b) 2°C
- <3
- 3-5
- 5-10

c) 4°C
- <3
- 3-5
- 5-10
- 20-200
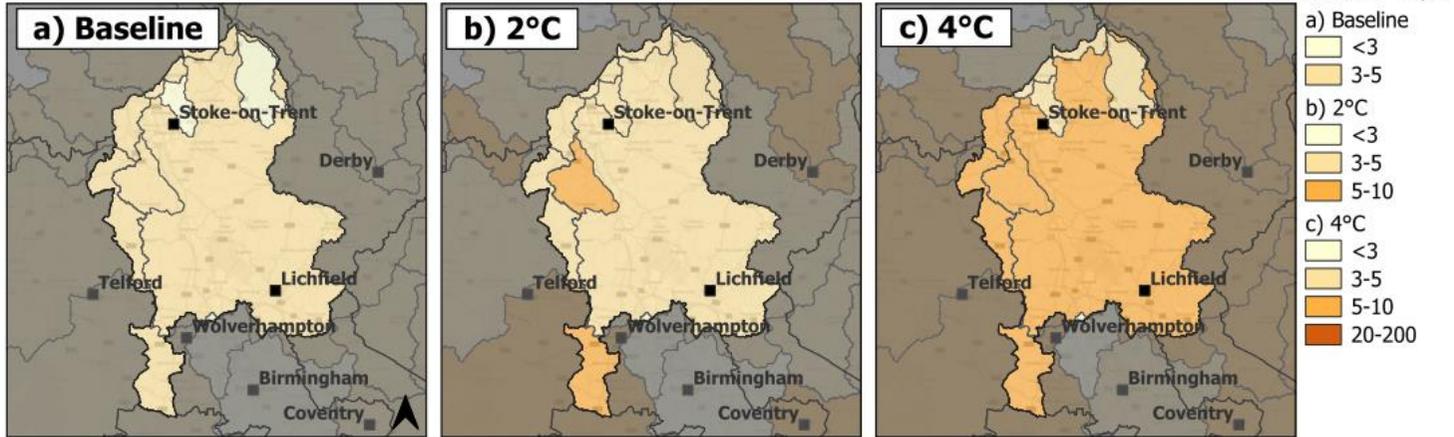
Drought duration is measured as the number of drought months that occur during a 30-year period. For each catchment boundary within the County / region. Longer duration is shown in orange and dark orange.

Any catchments that are coastal or tidally influenced are not modelled and shown in white on maps.

Key Points

Drought duration is a low-flow metric representing the average cumulative duration of drought projected within a future 30-year period. Gridded 1km results are modelled at catchment scale. Coastal or tidally influenced catchments are not modelled.

Nationally for 2°C and 4°C warming scenarios, most catchments are projected to experience an increase in drought duration, particularly in southern and eastern areas.

The climate model ensemble shows a range of possible future outcomes, summarised by the 10th to 90th percentile range (bottom table).

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

Local Summary

Median, minimum, and maximum drought duration (months/30-yr) for baseline scenario in Staffordshire, and the percentage change from baseline for a 2°C and 4°C warming scenario.

County	Median			Minimum			Maximum		
	Baseline	2°C	4°C	Baseline	2°C	4°C	Baseline	2°C	4°C
Staffordshire	3.3	4.3	5.8	2.3	2.5	2.9	4.4	10	24.8

Median drought duration (months/30-yr) for baseline scenario in Staffordshire, the climate model ensemble range between 10th and 90th percentile, and the percentage change from baseline for a 2°C and 4°C warming scenario.

County	Baseline Median	10th - 90th percentile	2°C Median	10th - 90th percentile	4°C Median	10th - 90th percentile
Staffordshire	3.3	1.9 - 7.2	4.3	2.2 - 18.6	5.8	2.5 - 54.3

The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., the range in outputs.

The tables provide a summary of results for the whole County or region

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The median shows the central value across the ensemble.

The 10th- 90th percentile indicates the upper and lower range of outputs from the ensemble, i.e., how closely the climate models agree and the spread in outputs.

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Hydrology: Flooding: 10-year return period flow (page 15)

Aberdeenshire | 10 year Return Period Flow | Warming Levels

a) Baseline

b) 2°C

c) 4°C

Flow Rate
a) Baseline (m³/s)
- <20
- 20-50
- 50-100
- 100-300
- 300-1000

b) 2°C % change
- -5 to +5
- 5 to 30

c) 4°C % change
- -5 to +5
- 5 to 30
- 30 to 60

Aberdeen

Key Points

The 1-in-10-year return period flow is a high-flow rate metric with a 10% annual probability of occurring. It is a proxy for a low probability, low magnitude flood event.

Nationally for 2°C of warming, most catchments are projected to experience 5% to 30% increase in flows, with little additional increase for most catchments at 4°C. Flow is projected to decrease for some central & eastern catchments.

The climate model ensemble shows a range of outcomes which is summarised by the 10th to 90th percentile range (bottom table).

Local Summary

Median, minimum, and maximum flow rate (m³/s) for baseline scenario in Aberdeenshire, and the percentage change from baseline for a 2°C and 4°C warming scenario.

| County | Median | | | Minimum | | | Maximum | | |
	Baseline	2°C	4°C	Baseline	2°C	4°C	Baseline	2°C	4°C
		% change							
Aberdeen City	142.9	18.4	32.3	142.9	18.4	32.3	142.9	18.4	32.3
Aberdeenshire	66.4	15.9	15.2	14.9	1.2	1.1	909.7	28.7	46.4

Median flow rate (m3/s) for baseline scenario in Aberdeenshire, the climate model ensemble range between 10th and 90th percentile, and the percentage change from baseline for a 2°C and 4°C warming scenario.

County	Baseline Median	10th - 90th percentile	2°C change	4°C % change
Aberdeen City	142.9	119.9 - 179.4	18.4	32.3
Aberdeenshire	66.4	12.8 - 1115.9	15.9	15.2

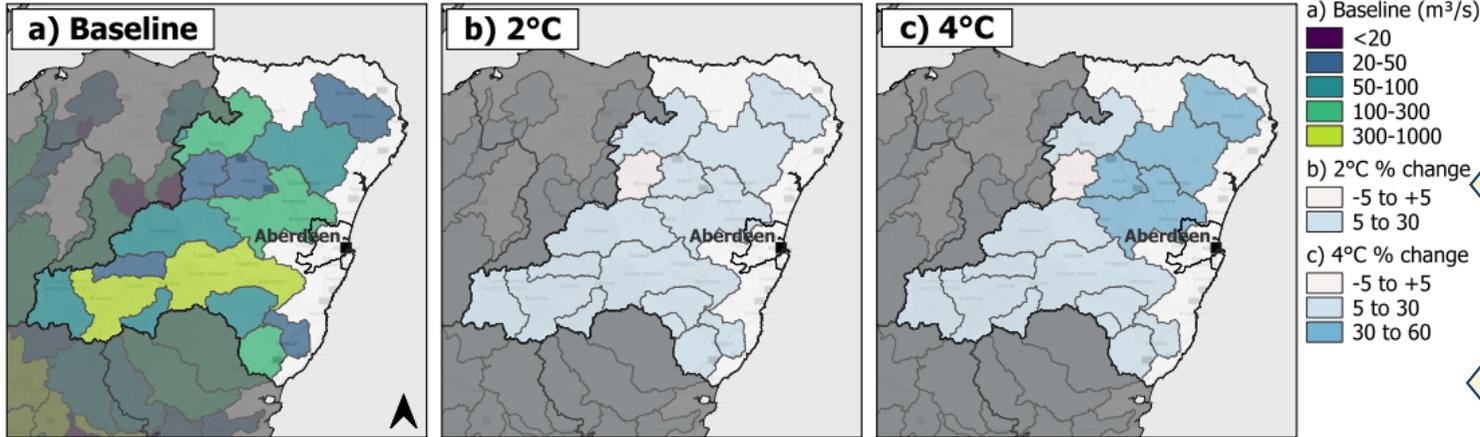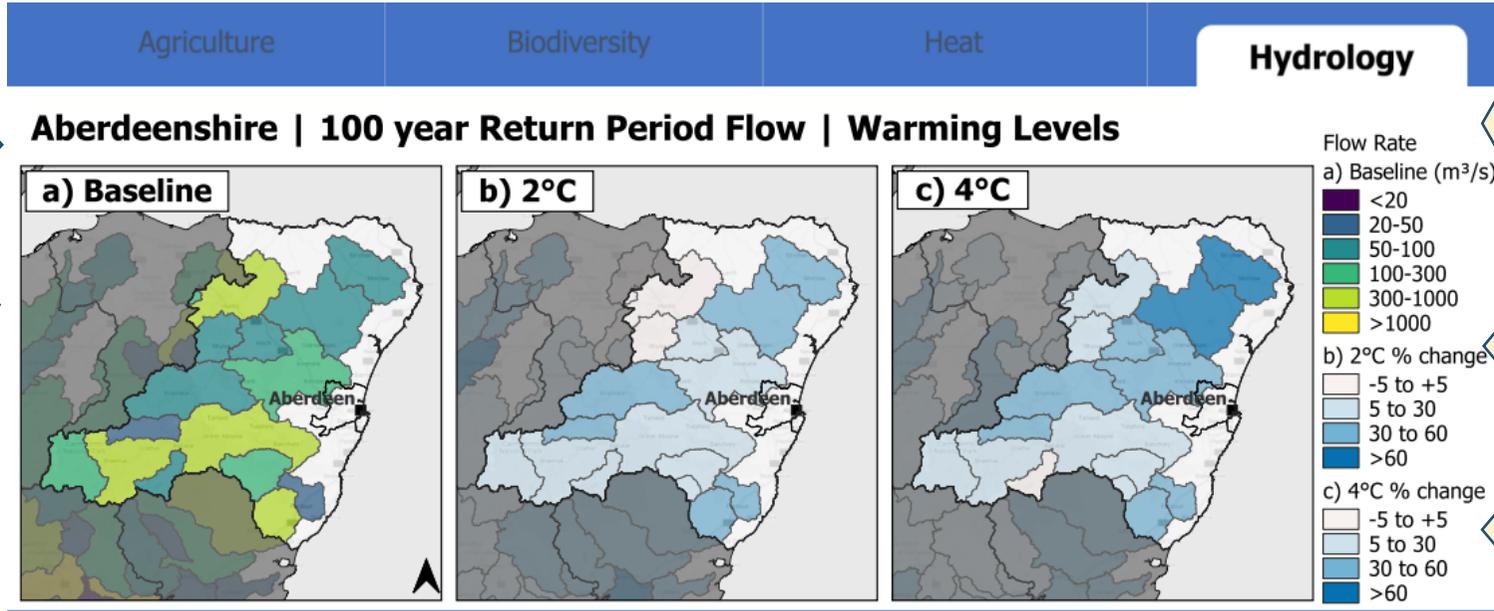**Annotation callouts:**

Headers highlight the metric shown and climate scenario used

Maps show areas most at risk from low magnitude flood events

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

The baseline map shows the catchment scale river flow (in metres cubed per second) that has an annual probability of being exceeded of 10% (1-in-10-year return period)

Maps for 2 and 4°C show the percent change in the flow rate from the baseline. Darker blue indicates a greater increase.

Any catchments that are coastal or tidally influenced are not modelled and shown in white on maps.

The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., the range in outputs.

The tables provide a summary of results for the whole County or region

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The median shows the central value across the ensemble.

The 10th-90th percentile indicates the upper and lower range of outputs from the ensemble, i.e., how closely the climate models agree and the spread in outputs.

Maximising UK Adaptation to Climate Change Hub

Hydrology: Flooding: 100-year return period flow (page 16)

Aberdeenshire | 100 year Return Period Flow | Warming Levels

a) Baseline

b) 2°C

c) 4°C

Flow Rate

a) Baseline (m³/s)
- <20
- 20-50
- 50-100
- 100-300
- 300-1000
- >1000

b) 2°C % change
- -5 to +5
- 5 to 30
- 30 to 60
- >60

c) 4°C % change
- -5 to +5
- 5 to 30
- 30 to 60
- >60

Key Points

The 1-in-100-year return period flow is a high-flow rate metric with a 1% annual probability of occurring. It is a proxy for a low probability, high magnitude flood event.

Nationally for 2°C warming, most catchments are projected to experience 5% to 30% increase in flows, while at 4°C more catchments are projected to increase flow >60%. Flow is projected to decrease for some catchments in the East.

The climate model ensemble shows a range of outcomes which is summarised by the 10th to 90th percentile range (bottom table).

Local Summary

Median, minimum, and maximum flow rate (m³/s) for baseline scenario in Aberdeenshire, and the percentage change from baseline for a 2°C and 4°C warming scenario.

County	Median Baseline	% change 2°C	% change 4°C	Minimum Baseline	Minimum 2°C	Minimum 4°C	Maximum Baseline	Maximum 2°C	Maximum 4°C
Aberdeen City	287.1	23.3	47.4	354	23.3	47.4	354	23.3	47.4
Aberdeenshire	105.3	20.4	28.5	28	-2.9	1.5	1388	59.5	105.9

Median flow rate (m3/s) for baseline scenario in Aberdeenshire, the climate model ensemble range between 10th and 90th percentile, and the percentage change from baseline for a 2°C and 4°C warming scenario.

County	Baseline Median	10th - 90th percentile	2°C % change	4°C % change
Aberdeen City	287.1	149.8 - 446.4	23.3	47.4
Aberdeenshire	105.3	15.2 - 1767.8	20.4	28.5

Maximising UK Adaptation to Climate Change Hub

Annotations:

Headers highlight the metric shown and climate scenario used

Maps show areas most at risk from low magnitude flood events

This box provides a summary of the metric, further information on what is/is not included in the model, and key results/trends seen.

The baseline map shows the catchment scale river flow (in metres cubed per second) that has an annual probability of being exceeded of 1% (1-in-100-year return period)

Maps for 2 and 4°C show the percent change in the flow rate from the baseline. Darker blue indicates a greater increase.

Any catchments that are coastal or tidally influenced are not modelled and shown in white on maps.

The minimum and maximum values show high- and low-end outputs from the ensemble, i.e., the range in outputs.

The tables provide a summary of results for the whole County or region

Running multiple climate models with slightly different set-ups results in a range (ensemble) of outputs. The median shows the central value across the ensemble.

The 10th-90th percentile indicates the upper and lower range of outputs from the ensemble, i.e., how closely the climate models agree and the spread in outputs.

6. Links to other online resources, data and toolkits

The OpenCLIM risk reports provide users with information and data for a subset or climate-related hazards and risks. However, users should be aware that this is just one resource and there are multiple other sources of relevant information, tools, and dashboards that are available to support climate change risks assessment and adaptation planning and decision-making. The following section outlines some of these other resources and particularly indicates which are most compatible and can be used alongside the OpenCLIM outputs (Table 2).

For example, the Met Office Local Authority Climate Service (LACS) is a complementary tool for characterising projected changes in future climate, with a focus on meteorological variables, such as average temperature, precipitation rate, and sea-level rise for coastal areas. These variables are presented at Local Authority scale with graphs of average values projected at different warming levels. A PDF report can be downloaded for each Local Authority which provides tables of results and guidance on how to interpret and use reports, as well as links to additional resources. A key difference from OpenCLIM is that spatial maps are not provided. The outputs are focused on changes in average climate (e.g. temperature and precipitation) and climate indicators. The climate indicators are useful when considering impacts of changes in e.g. temperature, such as how often you would need to use heating or cooling. Overall, the reports are useful to assess some of the hazards that may be faced in a Local Authority area. When combined with the OpenCLIM risk reports they can help provide a thorough and informative summary of future climate hazard and risks.

The OpenCLIM project excluded risks associated with coastal change, such as sea-level rise and erosion. The river catchments modelled (shown in the flood and drought maps excluded any catchments that are tidally influenced, meaning some coastal areas do not have drought or flood results. Consequently, in addition to the risk reports presented users may be interested in exploring the Environment Agency's National Flood Risk Assessment (NaFRA) and National Coastal Erosion Risk Map (NCERM)(NaFRA2 and NCERM). These maps better account for factors that can reduce or increase the risk of flood, such as managed defences, and show a detailed assessment of flood likelihood and potential depth at high resolution. They show current risk and a future high emission climate scenario for the 2050s in England. Equivalent maps are available for devolved nations as highlighted in table 2.

Name	Theme	Number of metrics	Warming levels	Hazard or risk*	Socio-economic/ vulnerability metrics	Coverage	Data available for local areas	Data Format	Click arrow for link
OpenCLIM	Agriculture, biodiversity, heat, hydrology, water resources		2 & 4ºC	Hazard and risk	yes	national	yes	Shapefile, raster, csv	➤
LACS (Local Authority Climate Service)	Heat, precipitation, sea level	5	1.5, 2, 4ºC	hazard	no	national	yes	from separate site	➤ ➤ (data download)
CRI (Climate Risk Indicators)	Heat, precipitation, transport, agriculture, hydrology, fire	40	1.5 –4ºC	Hazard	no	national	yes	shapefile, .csv	➤
ClimateJust[1]	Flood, heat	40	no	Risk	yes	England/Wales	Yes (lsoa)	shapefiles	➤
Coastal Res[2]	hydrology	4	no	Hazard & risk	yes	Coastal England	Yes (lsoa)	images	➤

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NaFR2 (National Flood Risk Assessment 2)	hydrology	10	no	Risk	No	Coastal/fluvial England	yes	Shapefile, .csv	➤ ➤ (Climate change version)
SEPA Flood Map	hydrology	5	no	Hazard	no	Coastal/fluvial Scotland	yes	Non-downloadable	➤
NRW Flood Map	hydrology	5	no	hazard	no	Coastal/fluvial Wales	yes	images	➤
Flood Map NI	hydrology	5	no	hazard	no	Coastal/fluvial Northern Ireland	yes	pdfs	➤

Table 2: *A summary of, and links to, other climate hazard and risk data resources (*IPCC definition. ¹ Uses a Socio-Spatial Vulnerability Index based on various metrics, each metric can be viewed alone or as part of the combined index. ² Coastal resilience mapping tool enables the user to set their own weightings for the different performance measures (response/recovery time, habitat loss, natural system disruption, risk exposure: avoidance; protection; residual) so that different futures can be explored.)*

[The Met Office climate data portal](#)

User guides - tools

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Decision-making frameworks to support adaptation

Alongside hazard and risk metrics there are also useful online resources and toolkits developed to help support the process of adaptation planning and decision-making. The list below is not exhaustive but provides an outline of some of the resources abvailable.

The Local Climate Adaptation Tool (LCAT) is an online climate service that comprehensively documents changes to future climate risk, compiling information about hazard, exposure, and vulnerability, at county and unitary authority-scale. In addition, this service documents a wide range of adaptation options that have been implemented elsewhere and may help to increase resilience to the projected future changes.

Climate risks have also been explored alongside current or recent vulnerability and exposure indices in the London Climate Risk Maps. It should be noted, however, that OpenCLIM includes data on vulnerability and exposure via the SSPs which account for future changes. Online resources such the London Climate Risk Maps often use data for the present day. As such the increase in risk will only reflect changes in the climate and not changes in the vulnerability of exposure of future populations, environments or assets.

The UKCIP Adaptation Wizard created by The Environmental Change Institute at the University of Oxford is a step-by-step guide for organisations to use to help them create a climate adaptation plan. This tool requires organisations to provide their own data to, for example, assess your organisations past responses to extreme weather events to see how to improve responses to future extreme weather events. In addition, it provides resources to aid the organisation in creating the plan including case studies and a list of adaptation strategies.

Through Verture and the Scottish Government, Adaptation Scotland provide several tools to support those thinking about and planning adaptation. Their Climate-Ready Places page documents adaptation strategies while the Climate Adaptation Capability Framework provides a handbook for adaptation in the public sector. In addition, the Community Climate Adaptation Routemap shows communities how climate change adaptation can be tackled in tandem with other community issues e.g. housing and employment. These tools are all well designed and very user

friendly. Additionally, they split their guidance by level of experience of climate adaptation.

TalX2, a collaboration between Climate Ireland and Climate Northern Ireland, provides a framework for adaptation partnerships to follow by splitting the process into four sections: Leadership, Evidence, Partnership, and Resource. Through these it provides practical actions for climate adaptation partnerships to undertake to help set up, or strengthen, existing adaptation techniques.

Other resources that provide information on adaptation options and actions include weADAPT which is a collaborative platform facilitated by the Stockholm Environment Institute. This includes a Map of case studies and successful adaptation stories to support sharing of best practice as well as other online resources and networking functions.

Disclaimer

Please [click here](#) to read our full disclaimer and intended use policy. OpenCLIM results have been produced for a specific purpose, which may affect the type and completeness of the data and interpretation. You must verify the suitability of the material for your intended usage.

For further information on OpenCLIM please see: https://tyndall.ac.uk/projects/openclim/.

For further information on the MACC Hub please see: https://macchub.co.uk/.

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