OpenCLIM: Open Climate Impacts Modelling Framework

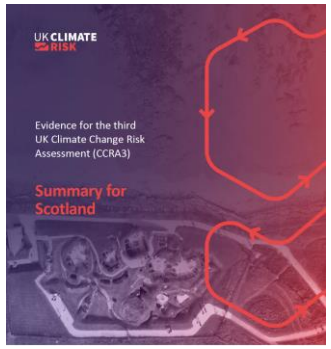
DAFNI Webinar

Robert Nicholls

Tyndall Centre for Climate Change Research, UEA

28 February 2024

Third Climate Change Risk Assessment (2021)



CCRA3 Advice Report

CCRA3 Supporting reports:

- Valuation Report
- Wildfire Report
- Projections comparison
- Opportunities
- Flood projections
- Water projections
- Behaviour
- Thresholds
- Interacting risks
- Socioeconomic dimensions
- Improving accessibility

CCRA3 National Summaries and Briefings

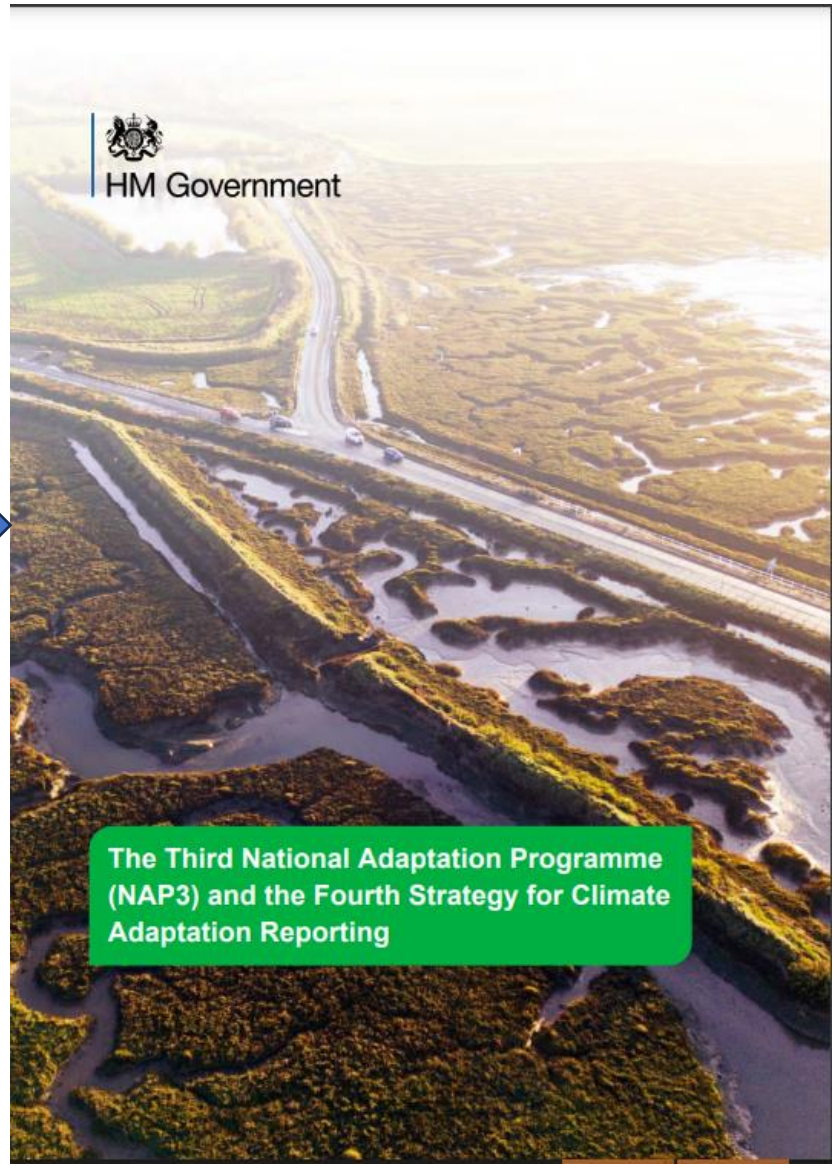
CCRA3 Technical Report

UKCP18 and other climate science

Impacts research

Adaptation research

National Adaptation Plan (2023)



Context

- The Open Climate Impacts Modelling (OpenCLIM) Framework is designed to support the UK-level Climate Change Risk Assessments and the National Adaptation Plans of the four component nations of the UK
- How can we link existing models and datasets in a consistent and repeatable manner to produce spatially explicit products (maps)
- Keywords
  - Climate risks and adaptation
  - Climate scenarios
  - Socio-economic scenarios
  - Workflows
  - Legacy of models, workflows and data
- Role of DAFNI
  - Workflow structure
  - Data repository
  - Legacy

OpenCLIM Aims

Goal

- An assessment method for CCRA4 and beyond.
- Enhance the UK's capability to assess climate change risks and adaptation choices.

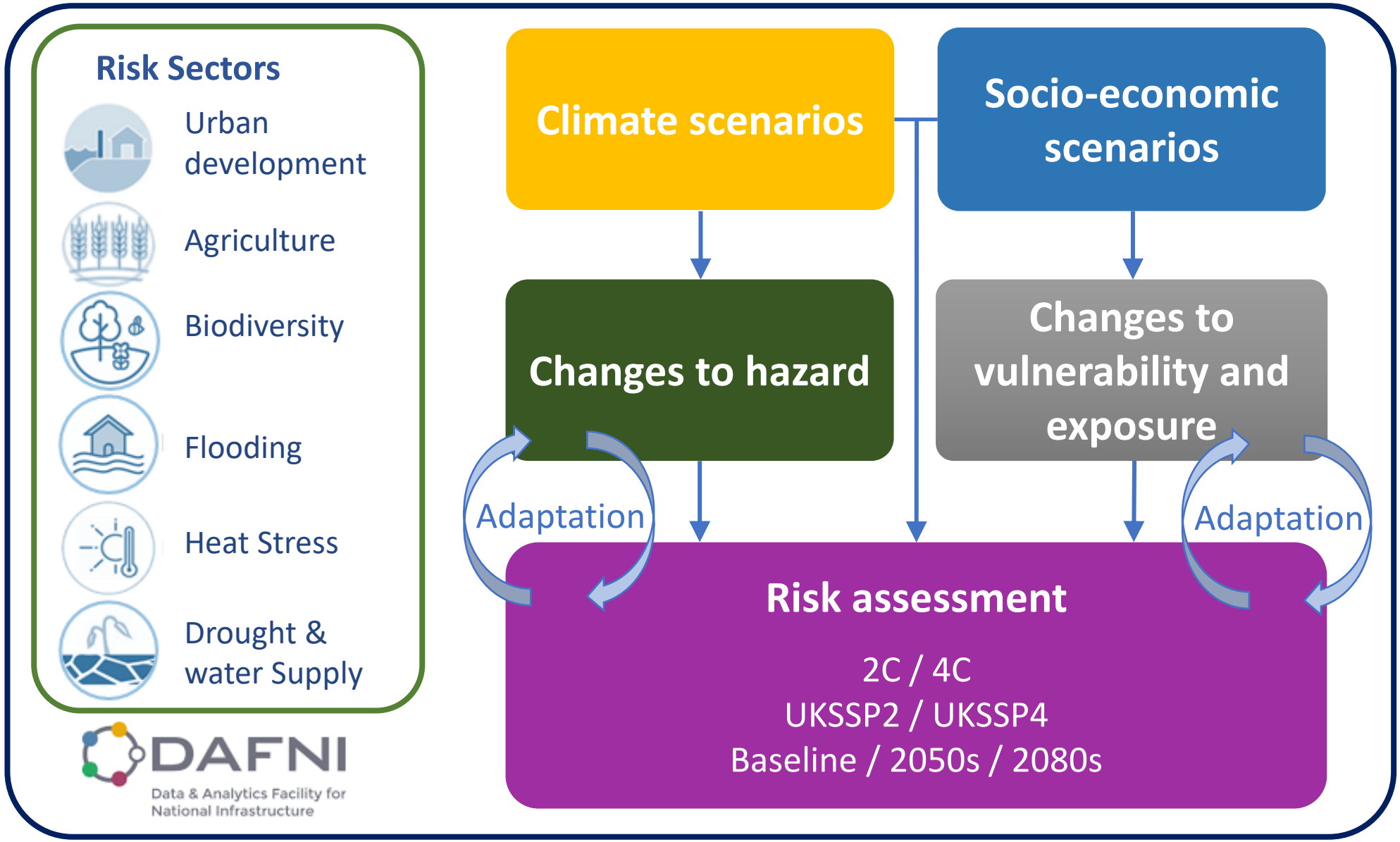
Vision

- Integrated risk and adaptation models across multiple sectors in an open framework.
- A process that integrates models to facilitate science/policy development.

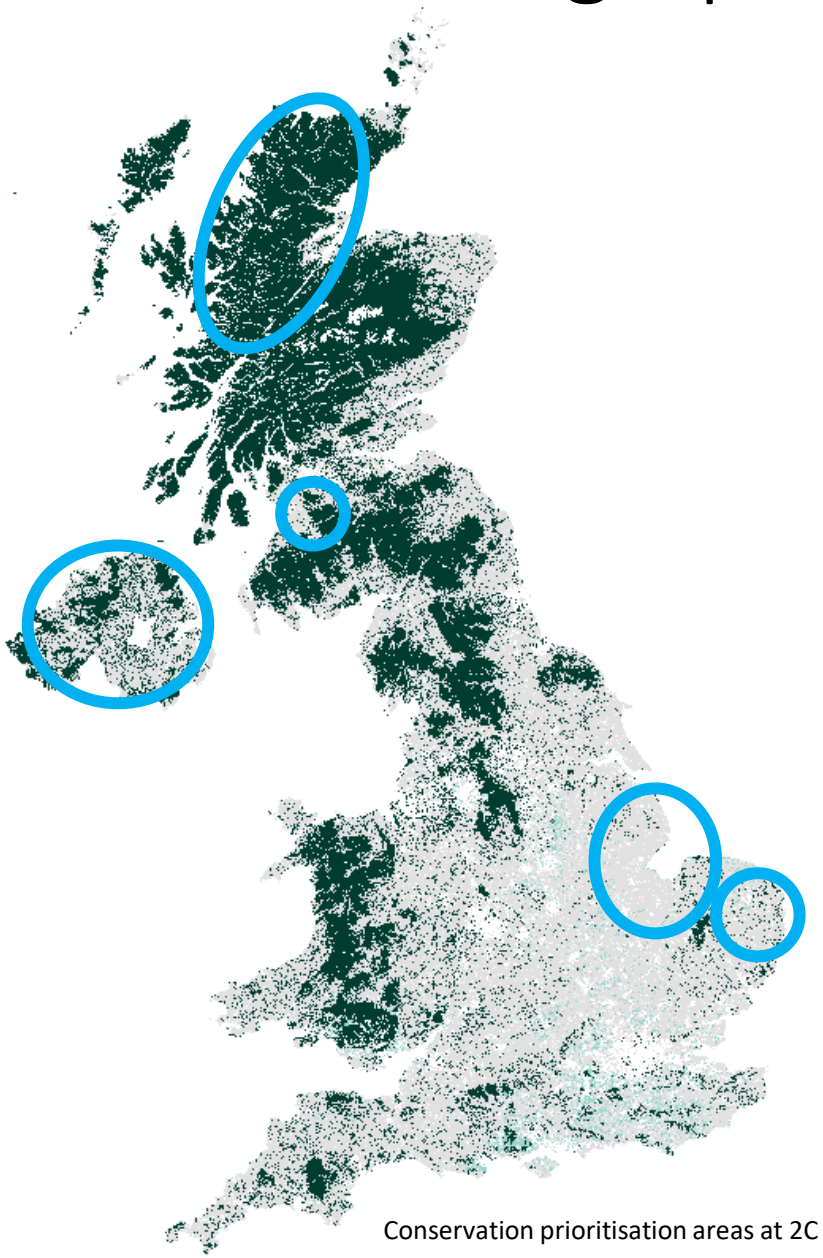
Innovation

- Consistent and spatially explicit results.
- Identify risk hotspots, including compound risks (detailed maps).
- Assess adaptation.

OpenCLIM Framework



Geographic coverage

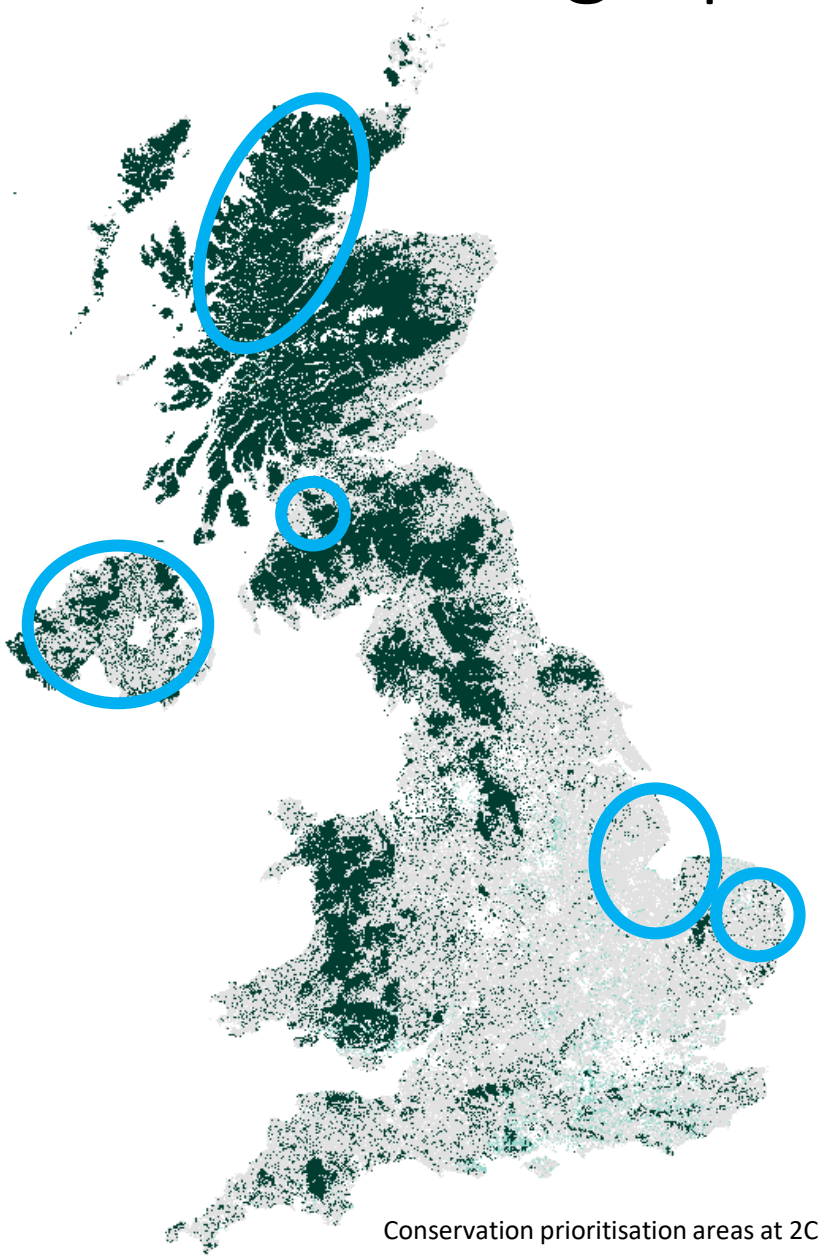


Conservation prioritisation areas at 2C

Results Available

- Nationally – United Kingdom
- Devolved Administrations
- Sub-National, examples include:
  - Clyde
  - Norfolk
  - Highland Council
  - Northern Ireland
  - Fens

Geographic coverage



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Outputs

OPEN CLIMATE IMPACTS MODELLING FRAMEWORK

Modelling workflow	Resolution	Coverage	Warming scenario	Socioeconomic scenario§	Time-step*
Urban development	100m	GB	N/A	SSP1-5	2035, 2050, 2055, 2065, 2080, 2085, 2100
Agriculture	1km	UK	2C and 4C	N/A	2050 & 2080
Biodiversity	20m	UK	1.5, 2, 3, 4C	N/A	2050 & 2080
Heat	12km	UK	1.5, 2, 3, 4C	SSP2, SSP4 & SSP5	2050 & 2080
Water supply	Water resource zone	England & Wales	2C and 4C	ONS high pop	2050 & 2080
River flooding	Catchments, 1km	UK	2C and 4C	SSP2 & SSP4	2050 & 2080
Urban rainfall flooding	2m	GB cities	Flood event-based	SSP2 & SSP4	2050 & 2080
Natural flood management	Catchments, 1km	UK	2C and 4C	SSP2 & SSP4	2035, 2050, 2055, 2065, 2080, 2085, 2100

§ UKSSPs projected for GB only due to data access restriction in NI for UDM workflow.
* Time step can be a single year or 30 year average, depending on model or input data.

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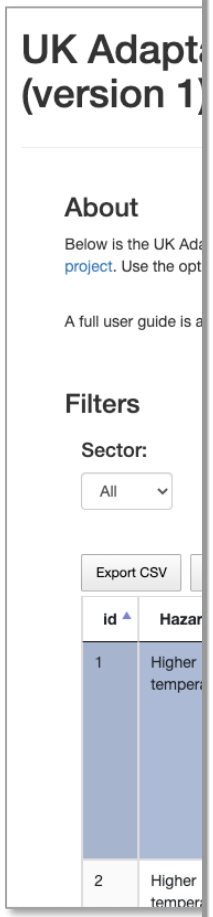
Adaptation inv

- Online database of UK adaptation on the ground
- Systematic review of
  - peer-reviewed journal articles
  - 2nd round adaptation power reports
- ~360 examples

Database:
nismod.ac.uk/openclim/adaptation_inventory
Journal paper: Jenkins et al. (2022)
https://doi.org/10.1016/j.crm.2022.100430



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Identifying adaptation 'on the ground': Development of a UK adaptation Inventory

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Implementation
Stocktake

ABSTRACT

Adaptation plays a crucial role in managing the unavoidable risks from climate change. The UK is considered to be at the forefront of national adaptation planning. However, the extent to which plans and programmes translate into tangible risk reducing action on the ground, as opposed to adaptive capacity building, remains less clear. Given that there is no formal database of adaptation action for the UK, despite the various needs of government to identify, assess and report on adaptation progress, including the UK national stocktake on adaptation under the UNFCCC Paris Agreement, this study outlines the development of an up-to-date and forward-looking UK Adaptation Inventory. The Inventory documents adaptation on the ground, based on national reporting to government by public and private sector organisations and a systematic review of peer-reviewed literature. The framework is centred on identifying and documenting current and planned adaptation; how it is being implemented in terms of the types of adaptation actions; and the sectors where adaptation is occurring and where gaps may remain. For the sub-set of sectors captured there is clear evidence of a wide range of cross-sectoral and sector-specific adaptation being implemented. In total, 360 examples were identified, over 80% of which have already been implemented. This comprises 134 different types of adaptation action, largely aimed at reducing vulnerability using engineered, built environment or technological mechanisms. Compared to the situation a decade earlier, this suggests that significant progress has occurred in the UK in terms of reporting and implementing adaptation, including adaptation by the private sector in climate sensitive sectors. At the broader level, the Inventory is a first step in providing a baseline assessment for the UK stocktake on adaptation; can help inform other organisations about adaptation options that are available; and provide case studies of actions in practice to help support decision-making.

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC, 2018; 2014) estimate that human activities have already caused approximately 1 °C of global warming above pre-industrial levels. It is not only the human influence on the climate system that is clear, but also evidence of widespread impacts on human and natural systems, which will increase in severity in a warmer world (IPCC, 2018; 2014). The global community is demonstrating significant cooperation in terms of mitigation under the UNFCCC Paris Agreement,

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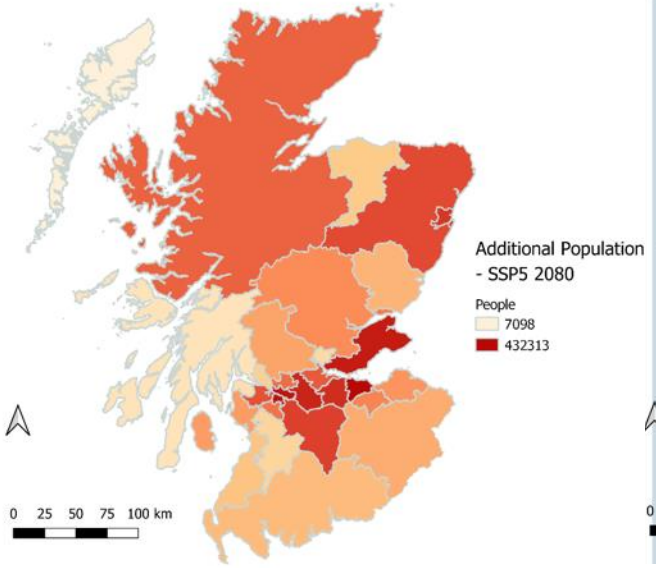
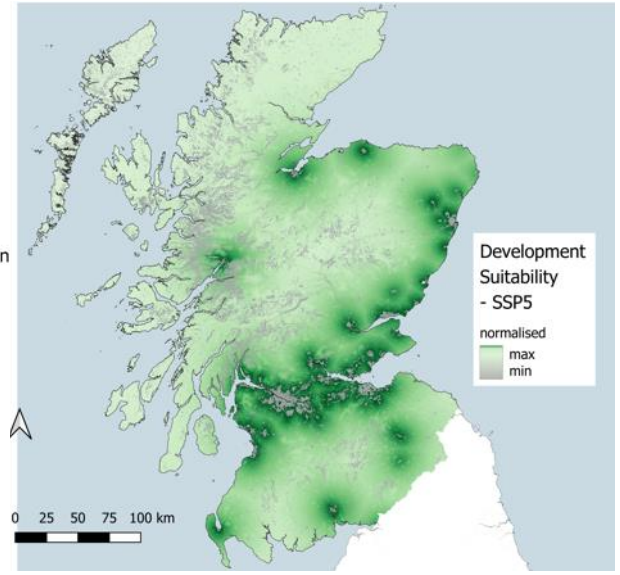
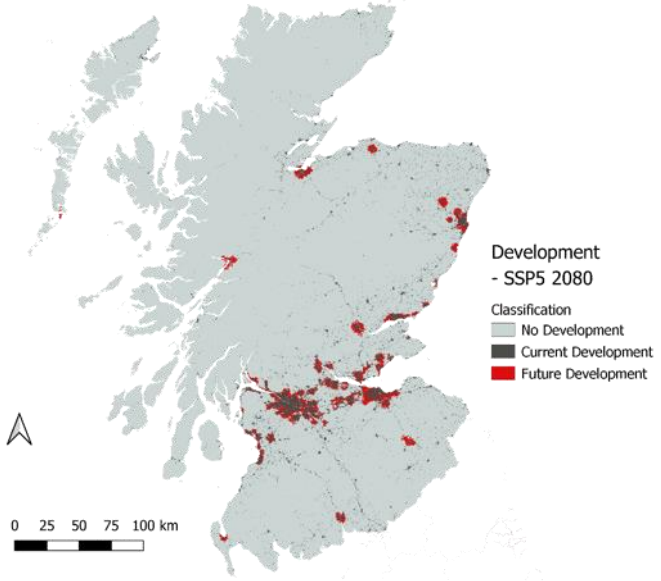
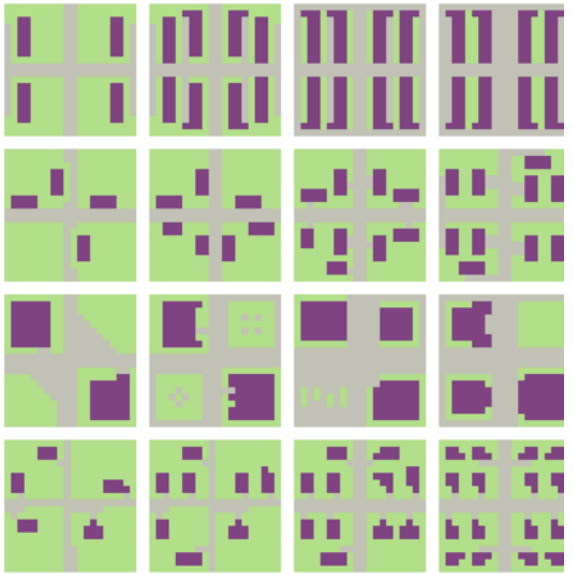
Vulnerability - Urban Development









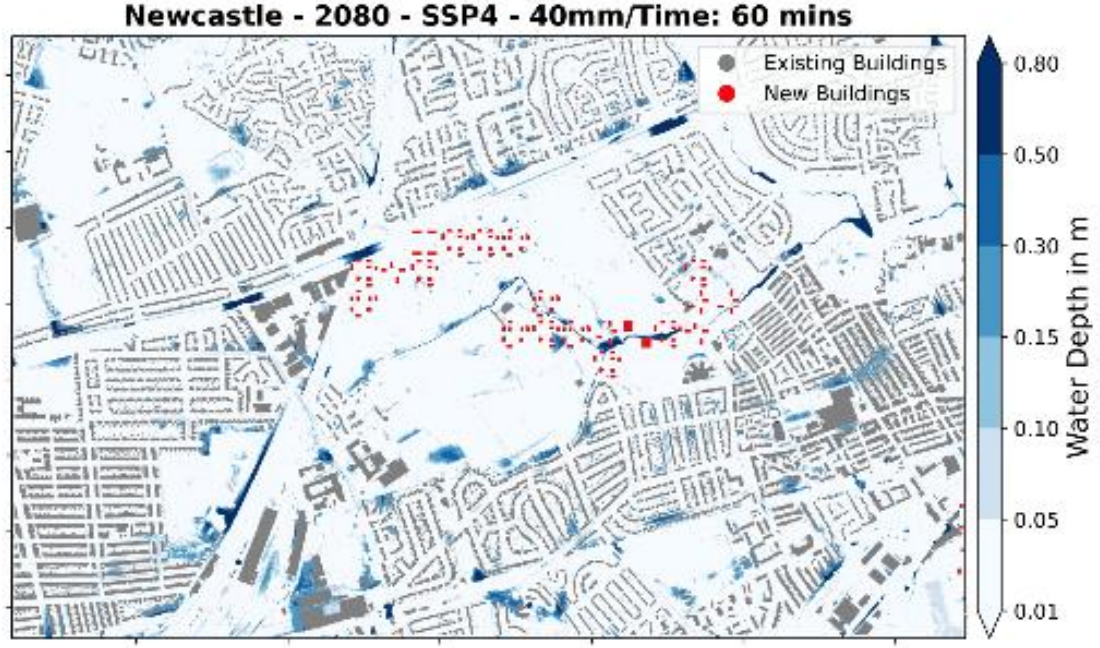
1. Population
Changes to population mapped from SSPs at LAD scale.

2. Suitability
Areas of land for new urban development mapped for each SSP.

3. Future urban development
Simulated at 1ha grid scale based on population and suitability.

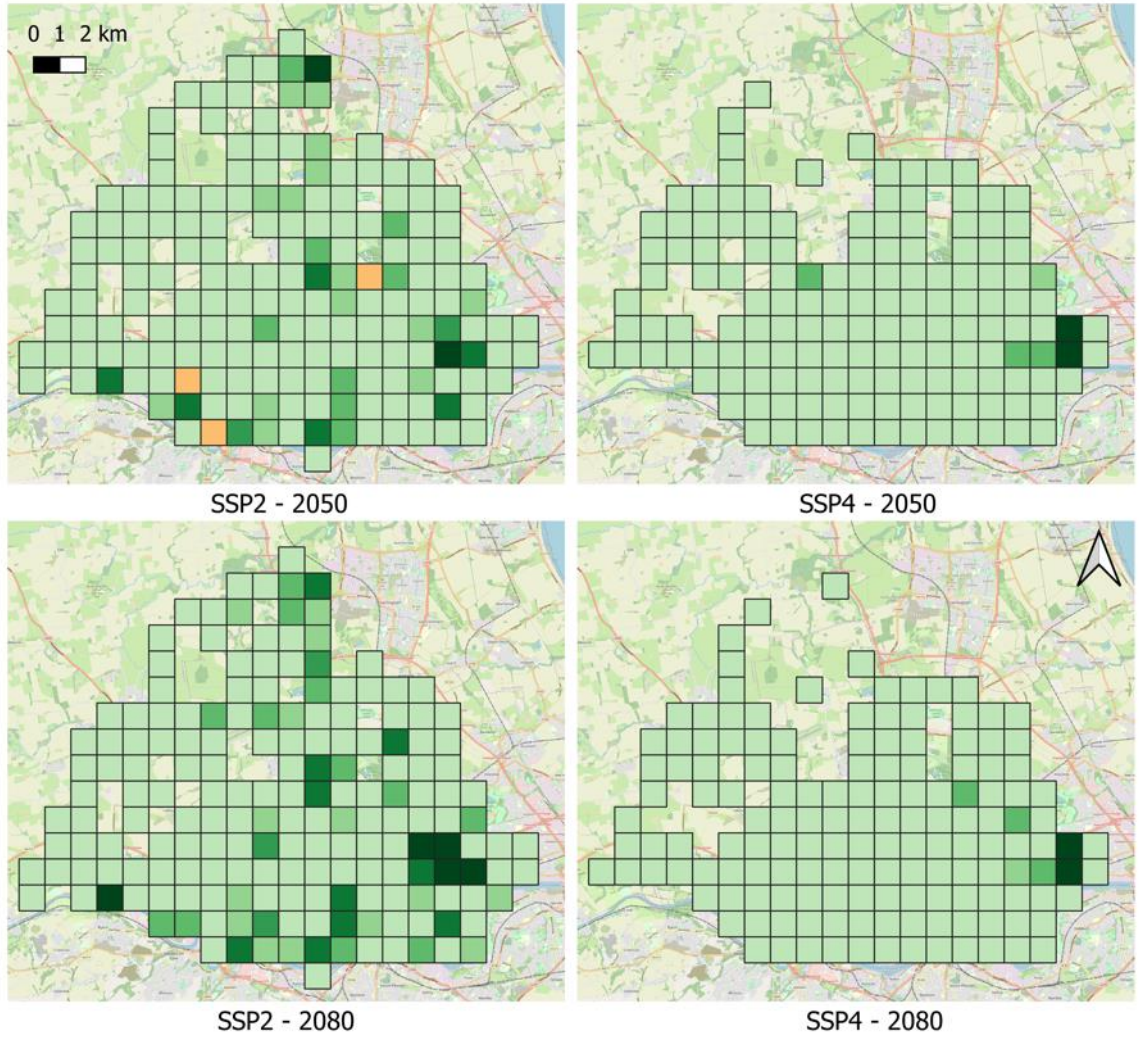
4. Building density
Each 1ha grid square assigned an urban fabric tile corresponding to the density of development.

Urban Rainfall Flood Analysis



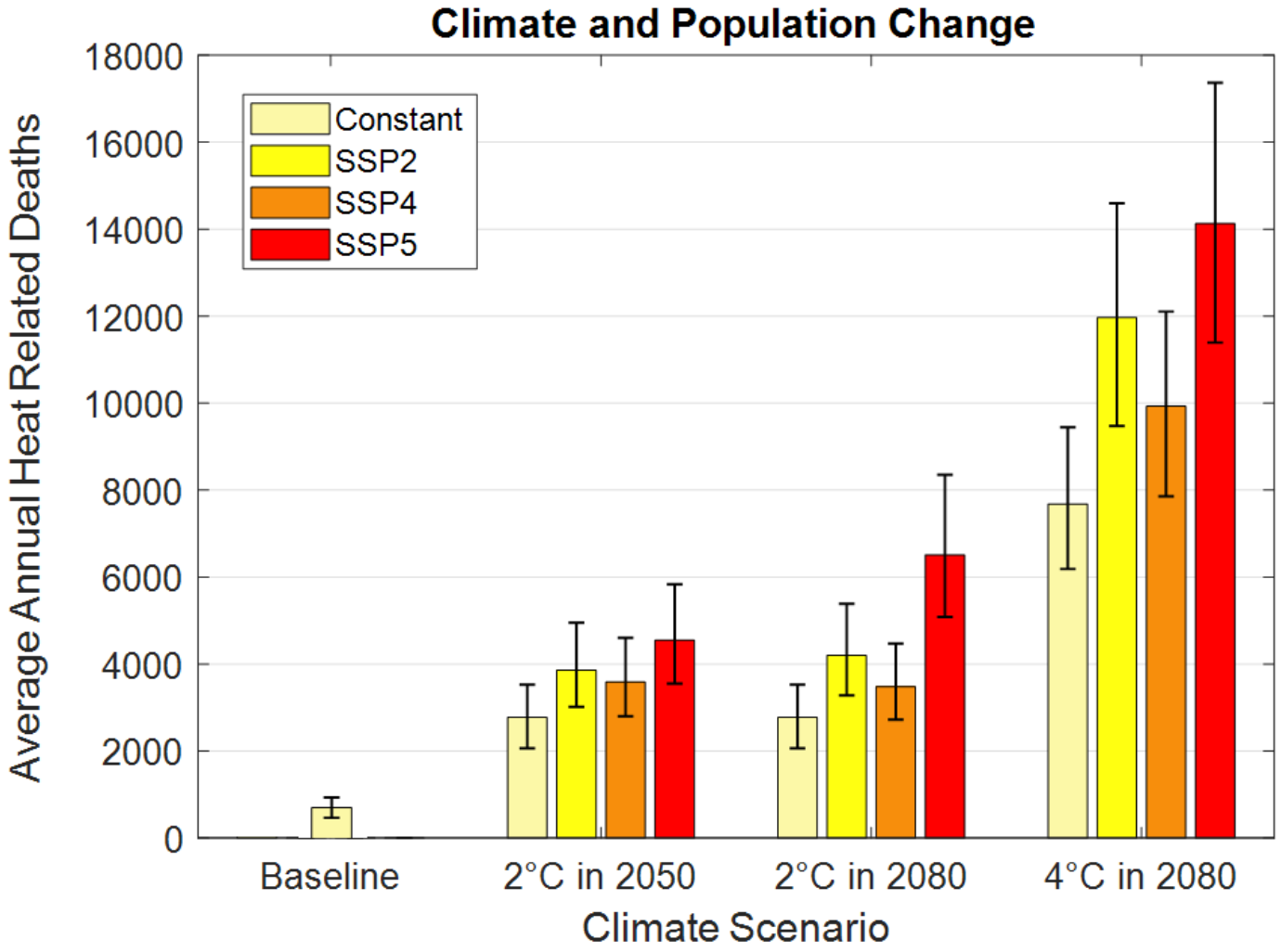
	Indicative Damages	
baseline	£141M	
SSP2 2050	£146M	↑4%
SSP2 2080	£149M	↑6%
SSP4 2050	£142M	↑1%
SSP4 2080	£142M	↑1%

Increase in total damages (£1000s) due to new development with a 35mm/hr storm event



UK heat related mortality

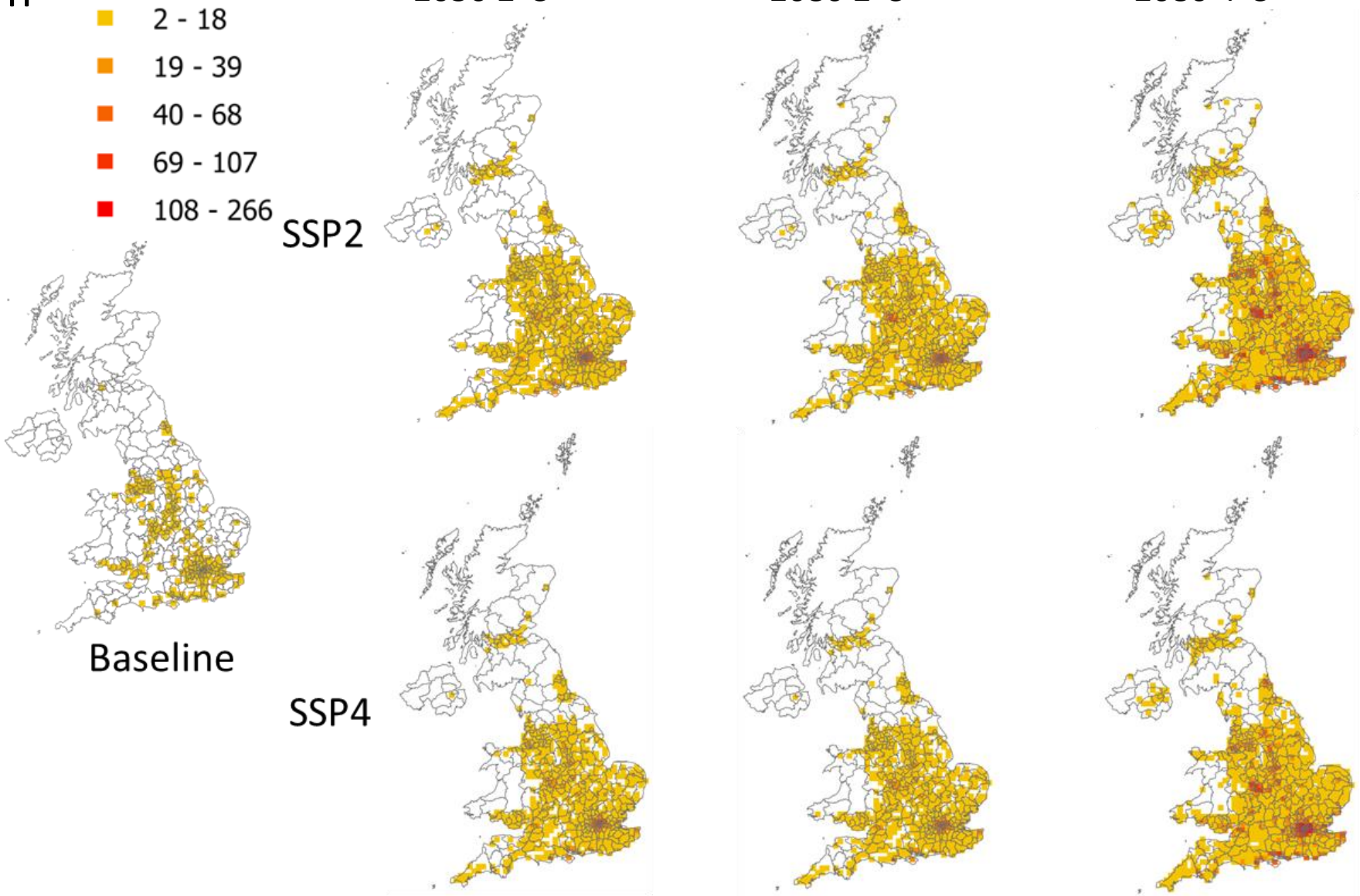
- Heat related mortality is projected to increase with climate change.
- Assumptions about future population very important, particularly in the 2080s
- Over 85s particularly at risk



UK heat related mortality

- Greatest risk in southern and central England
- Expansion of heat-related mortality risk.
- Increases in average annual heat-related deaths relative to the baseline:
  - England (+11,235)
  - Wales (+479)
  - Scotland (+289)
  - Northern Ireland (+75)

*4°C SSP2 2080 scenario



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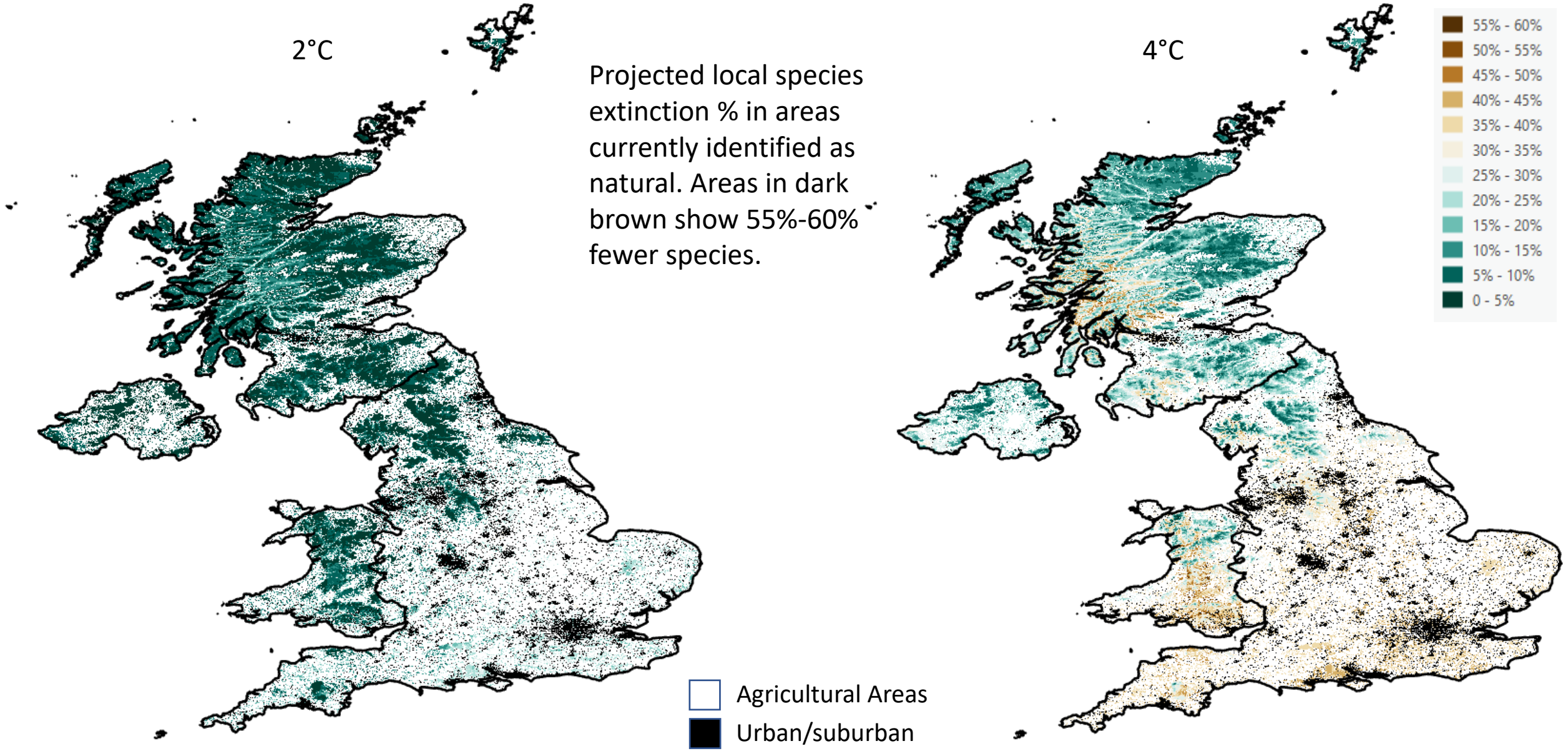
Loss of Biodiversity

OPEN CLIMATE IMPACTS MODELLING FRAMEWORK

2°C

4°C

Projected local species extinction % in areas currently identified as natural. Areas in dark brown show 55%-60% fewer species.



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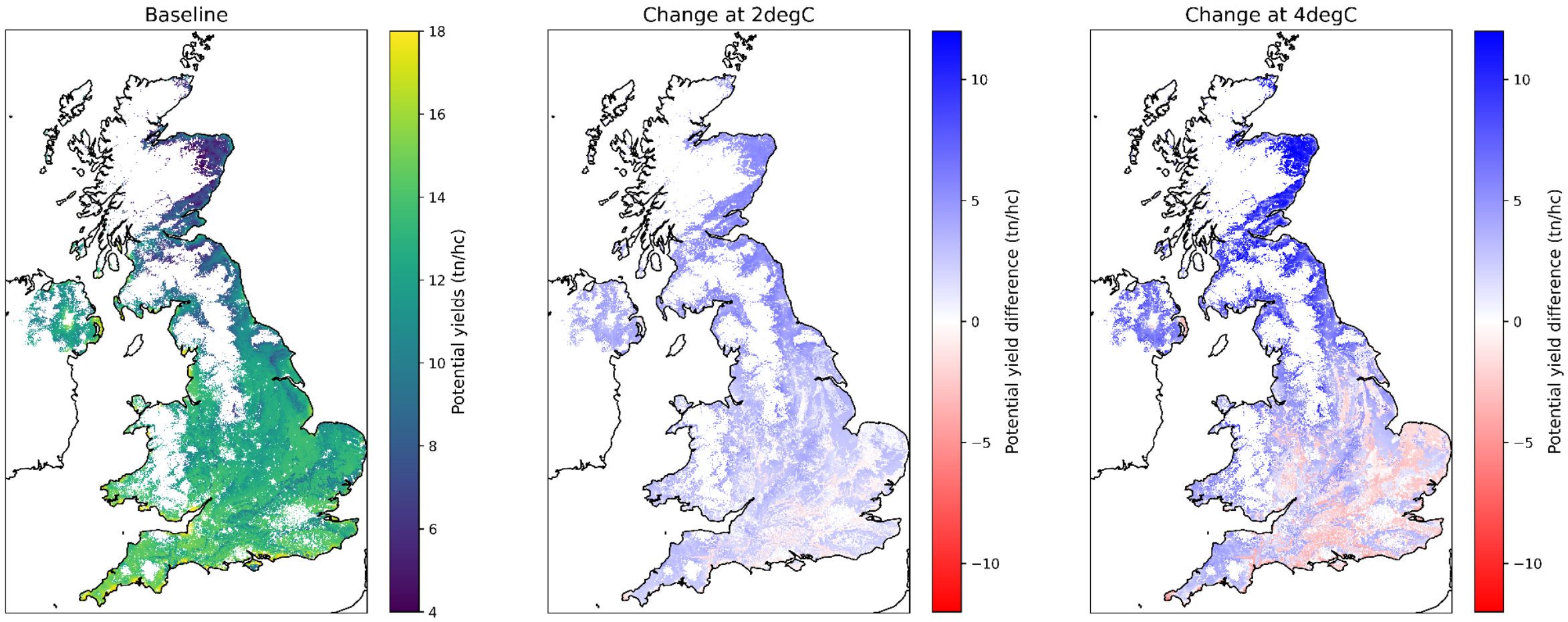
Potential wheat yields

OPEN CLIMATE IMPACTS MODELLING FRAMEWORK

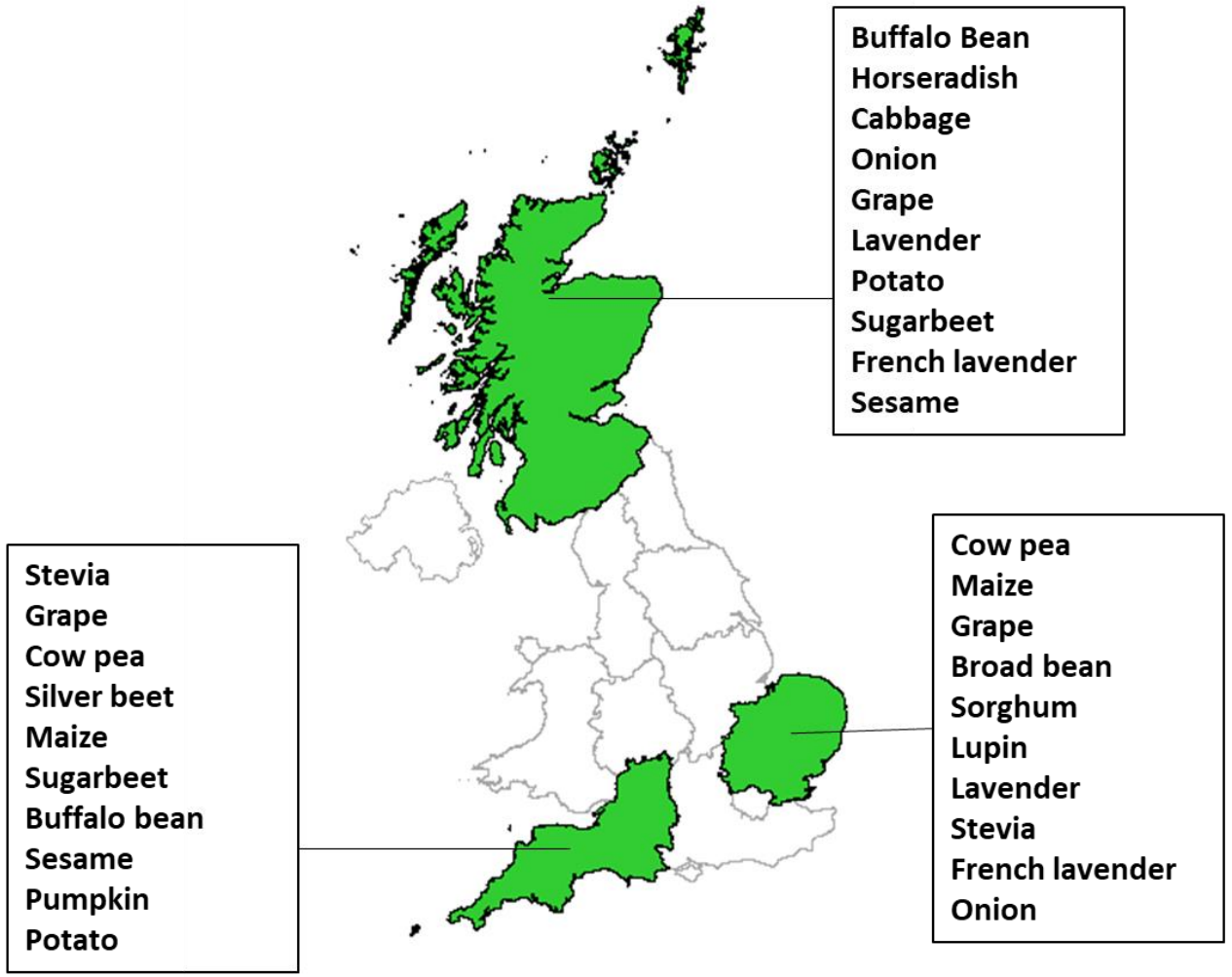


Agricultural horizon scanning

Ten field crops showing greatest increases in suitability for contrasting regions of the UK, +2°C

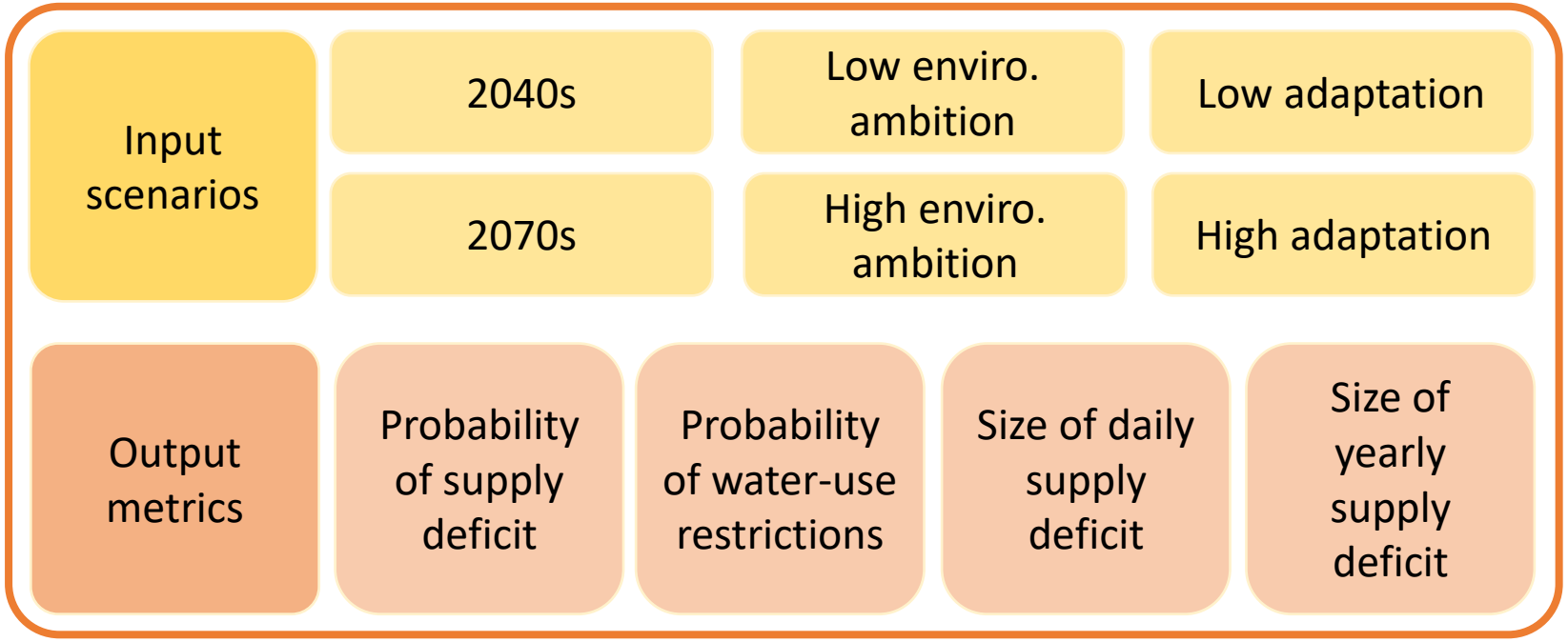
Current crops showing local declines in suitability

- Kale
- Brussels sprouts
- Chicory
- Strawberry
- Rhubarb



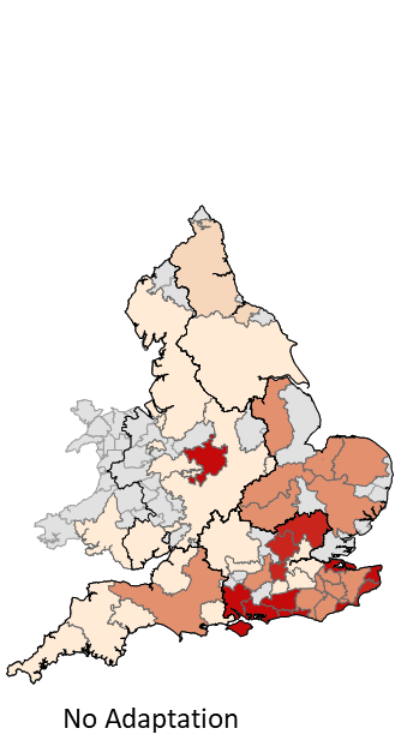
Water Supply

- Analysing scenarios from the Environment Agency's Water Resources England & Wales (WREW) model

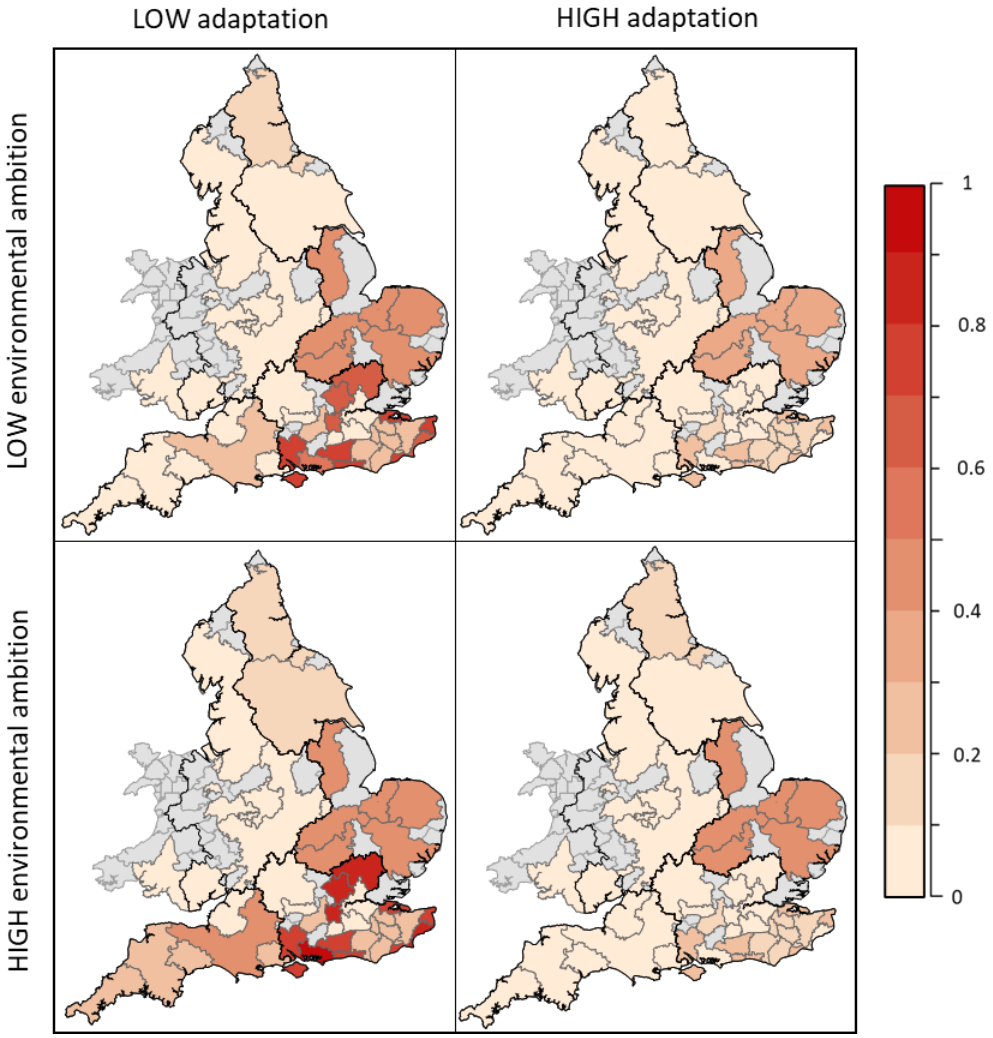


Water Supply

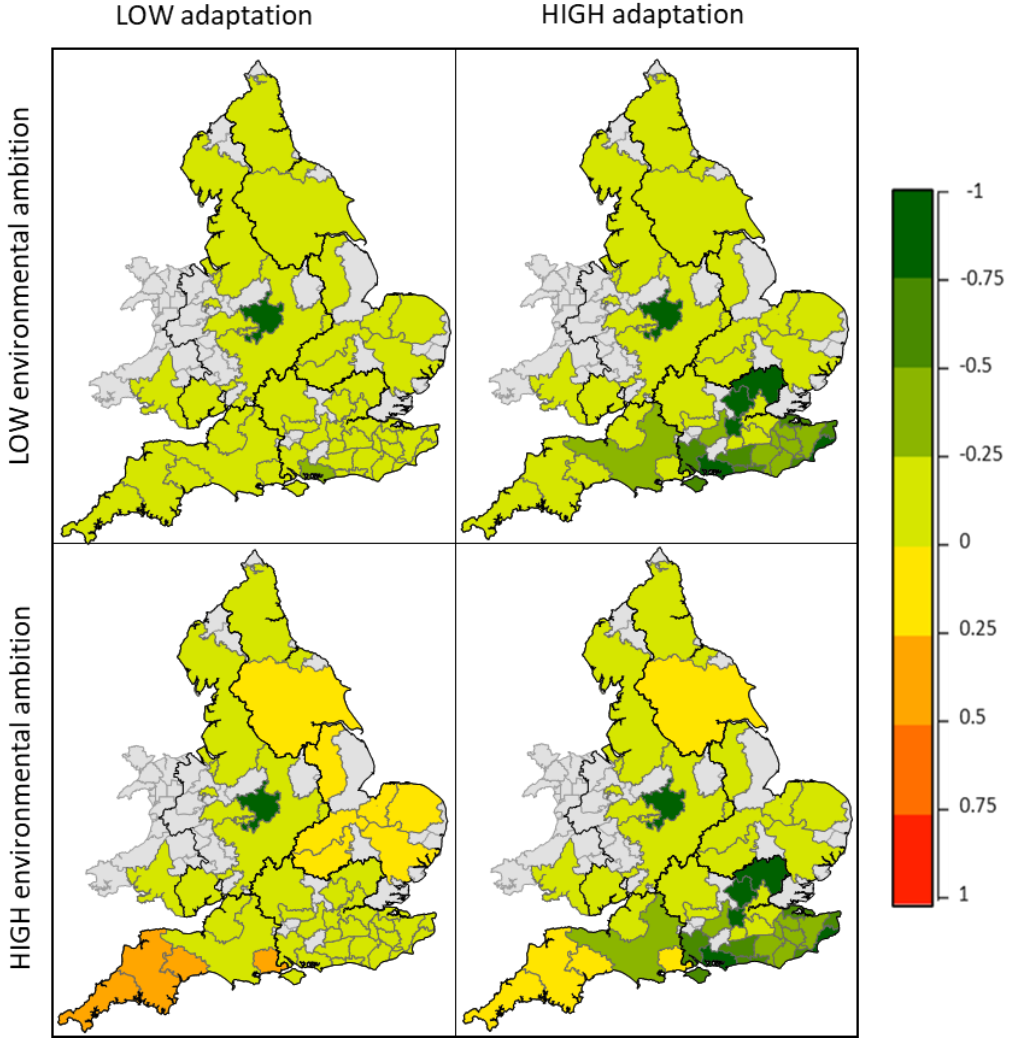
Near Future: Average annual probability of a yearly shortfall in water for different Water Resource Zones



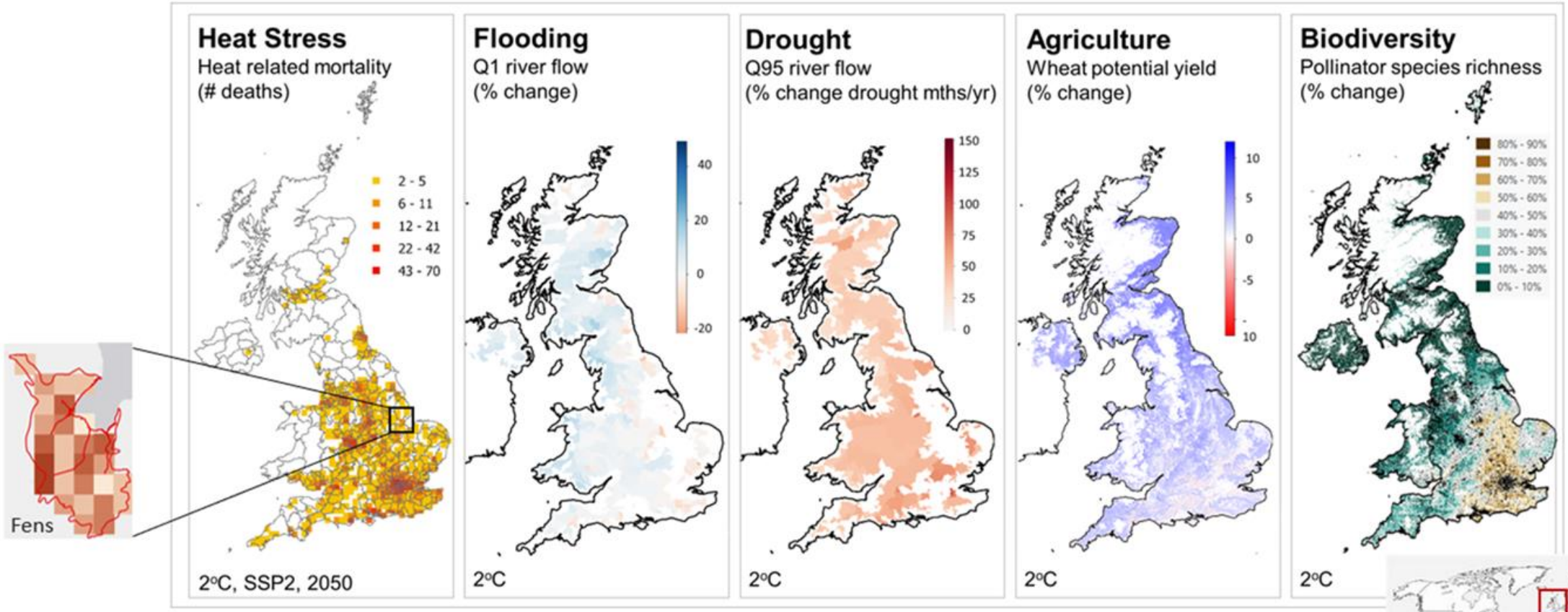
No Adaptation



Near Future: Difference from no adaptation baseline (green = reduction in shortfalls)



A common view for 2°C



OpenCLIM Themes:

Urban development

Drought and water supply

Agriculture

Heat stress

Biodiversity

Flooding

Conclusions across sectors

Heat stress

- Heat-related mortality increases in most areas, particularly in south-eastern England.

Drought and water supply

- Future warming increases the number & duration of low flow (droughts) everywhere, particularly in the east.

Agriculture

- Agricultural winners and losers are indicated, with most areas of reduced wheat yield in England and potential gains in Scotland.

Biodiversity

- Biodiversity is impacted by each additional increment of warming, with the most resilient refugia in Scotland & Northern England.

Flooding

- Modest increases in north & west, modest decreases in the east. Large interannual variability means extreme events may increase in frequency. Natural Flood Management has been quantified and can help manage flood risk.

Wider lessons

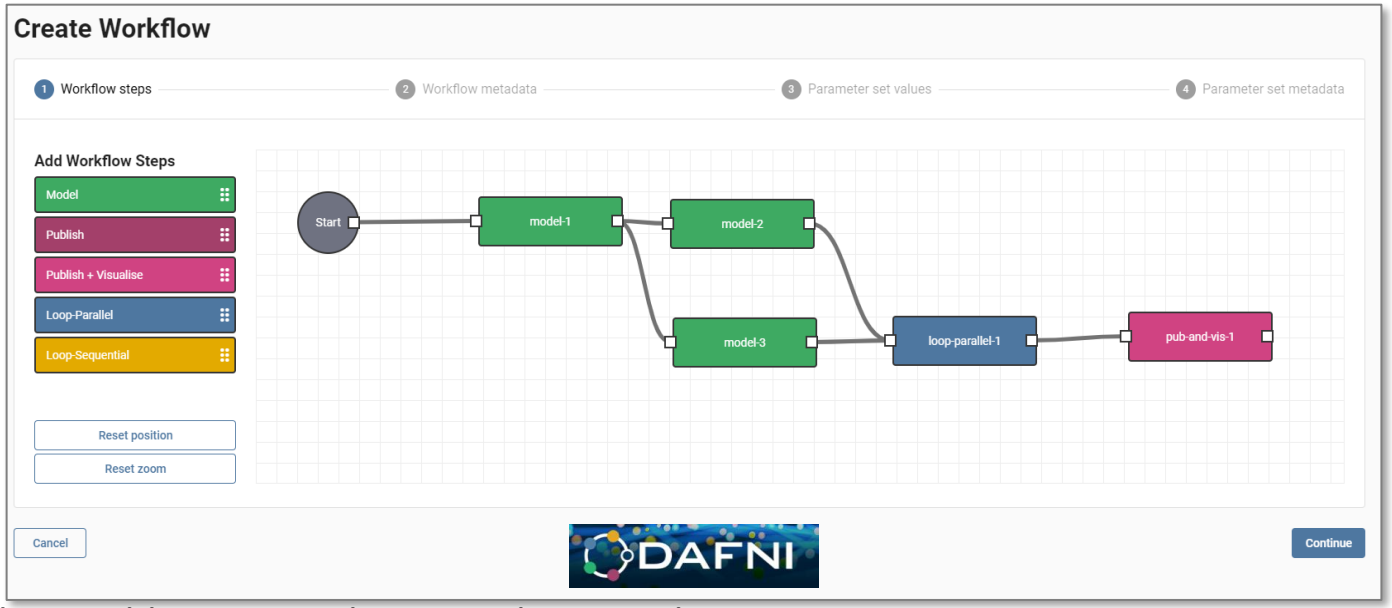
- Developing a consistent framework for the analysis is a substantial effort, but only by working together in a sustained manner can the difficult questions of consistency be addressed.
- Socio-economic scenarios are as important as climate scenarios – the UK SSPs provide explicit and common realisations of the futures (e.g., urban development and more widely land use and links to biodiversity) and promote consistency.
- SSPs work well with national stakeholders – less well with local stakeholders.
- Spatially explicit results (detailed maps) are powerful tools to show patterns of change and engage diverse stakeholders.
- Subnational application of the results adds value and allows consistent views between studies – Highland Region vs. Northern Ireland vs. Norwich/Norfolk.
- Using DAFNI facilitates the OpenCLIM legacy – there are workflows and output datasets for consistent scenarios available on DAFNI.

Ongoing activity

- Data-visualisation tool has been developed and is progressing slowly.
- Developing a set of papers on the integrated method and the integrated results, including sub-national applications (e.g., Highlands), as well as the details for each sector, hydrological model intercomparisons, nature-based solutions, etc.
- Finalising an assessment of Nature-Based Catchment Adaptation.
- Developing with EA and the WREW (Water Resources England and Wales) model a capacity to use OpenCLIM to explore CCRA-type questions.
- Reflecting on the lessons learnt, such as climate scenario needs for CCRA4 (with others such as the Met Office).
- Continuing to develop regional applications, such as in Norfolk and the Fens, which has significant potential beyond national assessment.

Data access

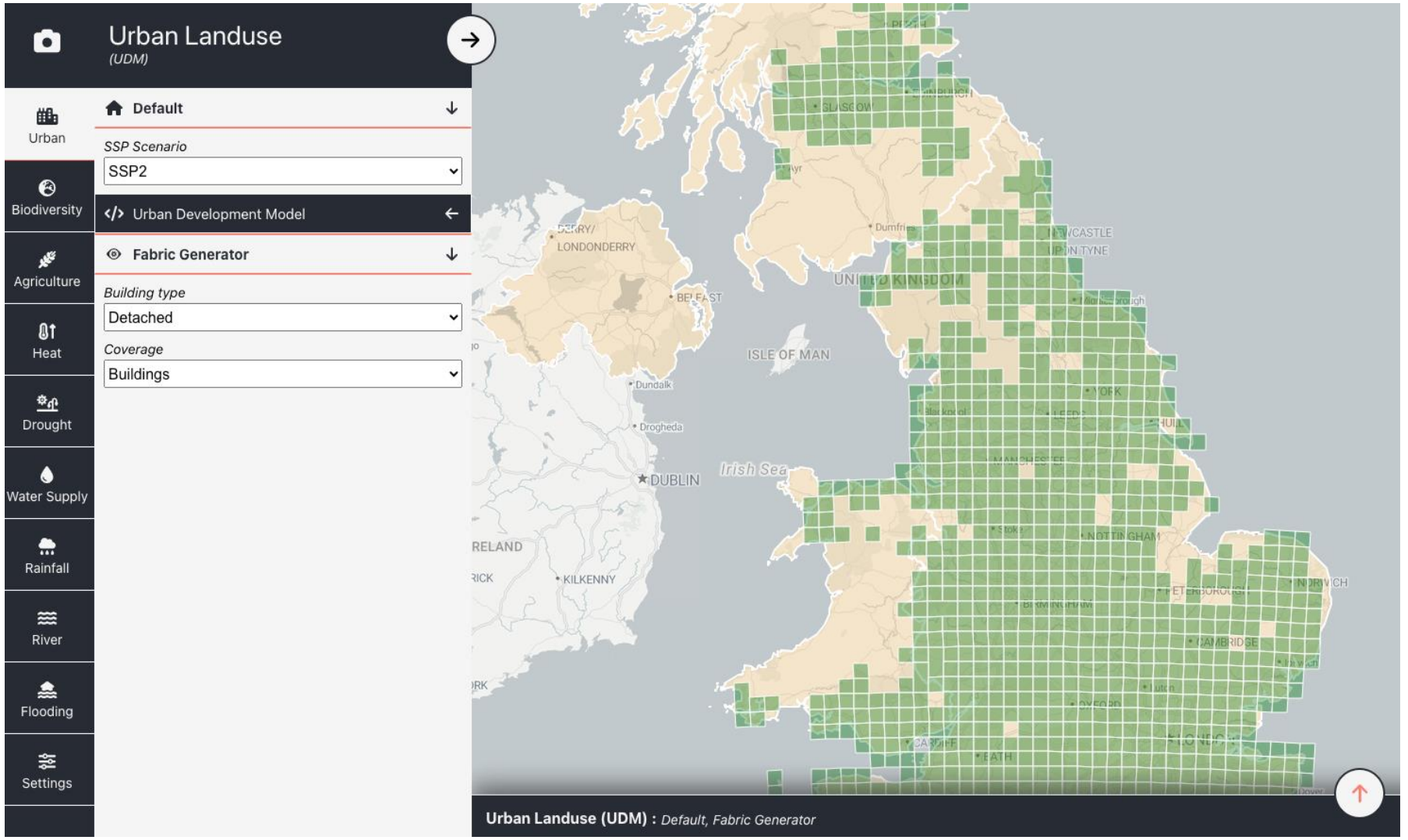
- More than 600 model results (e.g. maps, tables) available through DAFNI
- JASMIN data being migrated to CEDA shortly
- Data visualisation tool is progressing.
- Workflows are available on DAFNI to enable community model development*.



* Commercial work only possible via consultancy with researchers.

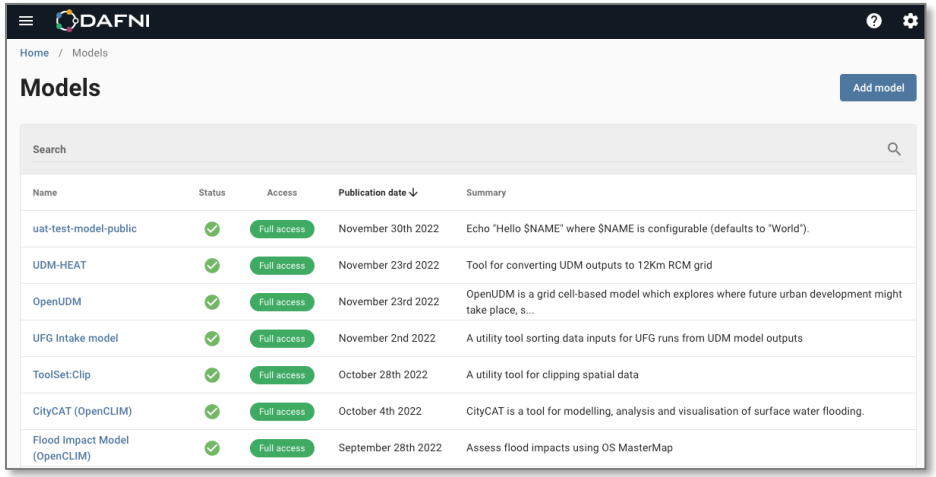
Visualisation tool

(under development)



Key lessons for DAFNI

- OpenCLIM has been critical in driving the direction of the DAFNI platform.
- OpenCLIM is a heavyweight user of DAFNI workflows and changes have focussed on the progressive improvement of the experience of OpenCLIM users.
- Improvements have included
  - Loops in workflows
  - More intuitive interface
  - More clarity around permission inheritance.
- These developments are ongoing.



Thank you

Any questions?

OpenCLIM team
Rachel Warren, Richard Dawson, Alistair Ford, Craig Robson, Katie Jenkins, Jeff Price, Asher Minns., Oliver Andrews, Alan Kennedy-Asser, James Virgo, Olivia Butters, Liz Lewis, Helen He, Ben Smith, Stephen Birkinshaw, Brian Matthews, Bethan Perkins, Rose Dickinson, Sudipta Goswami, Vassilis Glenis, Paul Sayers, Sam Carr, Richard Pywell, Matt Brown, John Redhead, April Dyer, Adam Smith.