

# IMPRES: Impacts and Risk Assessment to better inform Resilience Planning

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UK Research  
and Innovation

# Objectives = Achievements



- Produced preliminary model-based UK climate change risk assessment for drought, heat stress, water scarcity, fluvial flooding
- Identified how modelling approaches can be improved/adapted, using UKCP18 in UK as basis, in these sectors
- Application of improvements in three risk areas: heat stress, drought, biodiversity, natural capital
- New projections of future heat stress in the UK

# Outputs and stakeholder engagement

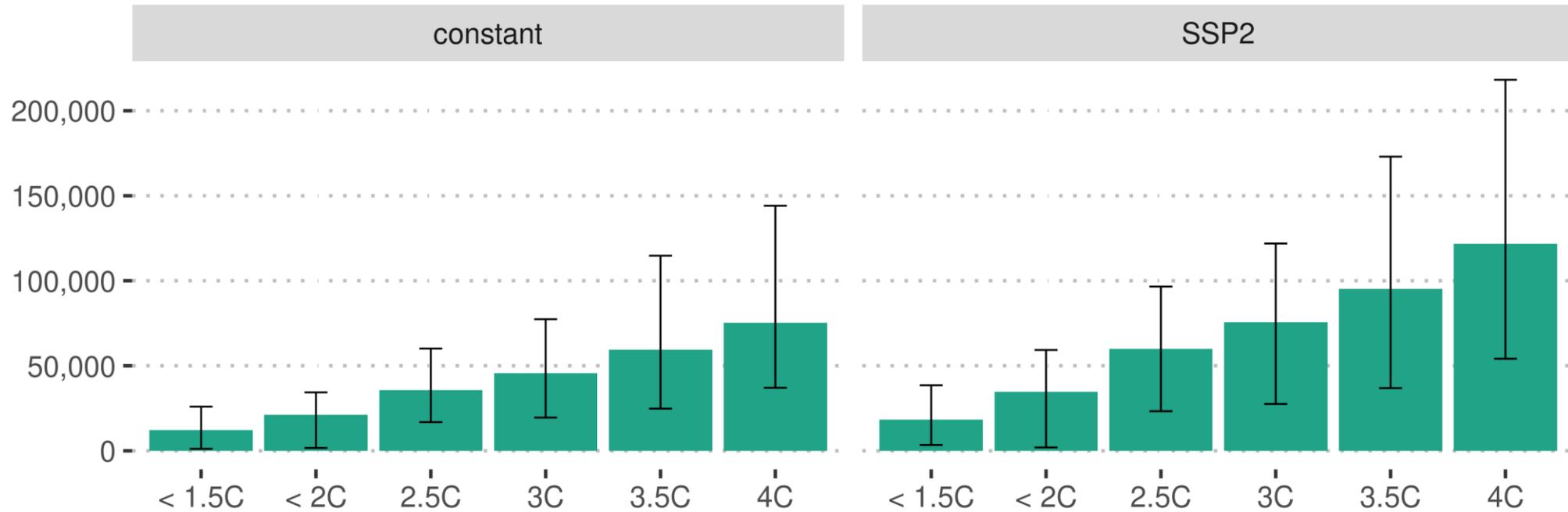


- Journal publications (heat stress, 2; others, forthcoming)
- Methodological recommendations informed development of the successful OpenCLIM bid (PI, Nicholls, Tyndall UEA)
- Synergistic relationship with sister project funded directly by BEIS on climate change risks in six countries
- Project infographic for use in future OpenCLIM workshops
- Links developed/reinforced with some key stakeholders in government, devolved administrations, and WHO, Wildlife Trusts : we hope to engage more today ....

# Projected UK Exposure to Fluvial Flooding > Q100-20C



## Additional UK population exposed annually, 2086-2115



**Expected population shifts appear to have negligible influence in the UK  
Climate change seems to dominate impacts on Fluvial Flooding.**

He et al in review,  
confidential,  
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# Methodological improvements identified for Water Scarcity and Fluvial Flooding

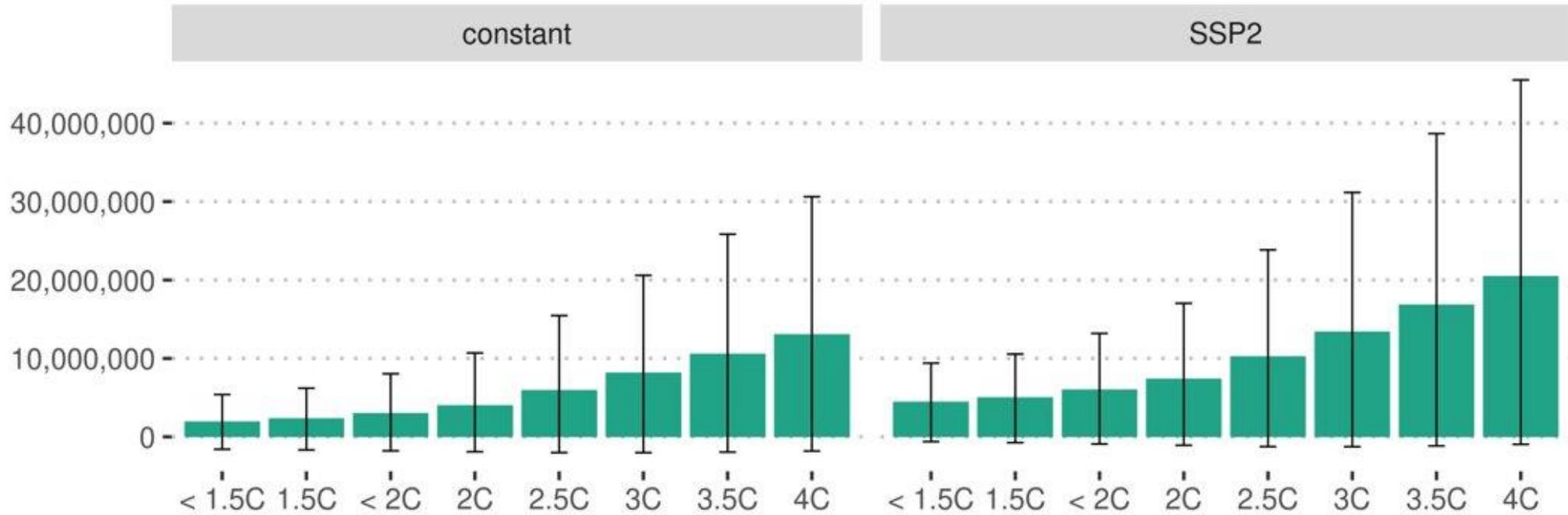


- The model used in IMPRES is based on CMIP5 projection coupled with a rainfall-runoff model and a hydrodynamic model. This is more advanced than the previous UK wide projections.
- Spatial resolution to increase from 50km (CMIP5 in IMPRES) to 12km or 2.2/5km (UKCP18) in OpenCLIM.
- IMPRES has produced flood inundation simulations for the UK 15 major basins.
- 15 major basins (where at least 1 cell is represented in the climate data) in the UK were simulated. Most of the smaller basins can be included when the resolution increases in OpenCLIM.

# Drought Risk: SPEI<sub>12</sub> < -1.5



## Additional UK population exposed annually, 2086-2115



**Both climate change and population changes affect level of risk**

Price et al forthcoming,  
confidential,  
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# Methodological improvements for Drought and Extension to Natural Capital



- .
- Analysis of various drought metrics in different land cover classes in UK
- Implications for Biodiversity and Natural Capital, with focus on pollination
- Adaptation applications, in terms of identifying natural areas to protect or restore

# Methodological improvements for Heat Stress



## Research objectives:

- Evaluate UKCP18 climate products at different spatial scales to assess suitability for understanding future UK summer temperature and heat stress extremes
- Assess which heat stress metrics and thresholds are most appropriate for the UK
- Explore future extremes of summer temperatures and heat stress in UKCP18

# Heat stress & temperature extremes: data



Four subsets of UKCP18 simulations used<sup>1,2</sup>:

'Global' GCM	(60 km)	Ensembles carried out by UK Met Office
'Regional' RCM	(12 km)	
'Local' CPM	(2.2 km)	
'IPCC-class' CMIP <sub>5</sub>	(60 km)	Carried out by other international modelling groups

HadUK-Grid<sup>3</sup> (observational) and ERA5<sup>4</sup> (reanalysis) data is used for model evaluation

1. Murphy et al. 2019. UKCP18 land projections: Science report. *Met Office*: <https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Land-report.pdf>.
2. Kendon et al. 2019. UKCP Convection-permitting model projections: Science report. *Met Office*: <https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP-Convection-permitting-model-projections-report.pdf>.
3. Hollis et al. 2019. HadUK-Grid—A new UK dataset of gridded climate observations. *Geoscience Data Journal*, 6, 151-159.
4. C3S 2017. ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. Copernicus Climate Change Service Climate Data Store (CDS).

# Heat stress & temperature extremes: metrics



Heat stress is a 'feels like' measure of temperature, often including a humidity component

Three heat stress metrics assessed<sup>1</sup>, all expressed as daily maximum:

Apparent Temperature	↓ Increasing vapour pressure component
Humidex	
Simplified Wet Bulb Globe Temperature	

Summers are taken as 1 June – 15 September, in line with Heatwave Plan for England<sup>2</sup>

1. Zhao et al. 2015. Estimating heat stress from climate-based indicators: present-day biases and future spreads in the CMIP5 global climate model ensemble. *Environmental Research Letters*, 10, 084013.
2. Public Health England 2019. Heatwave plan for England. PHE Publications.



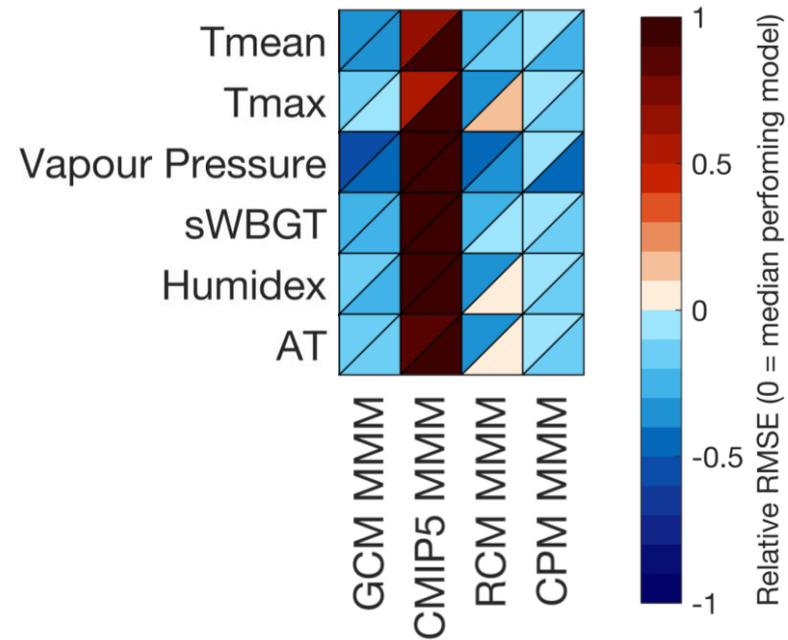
# UKCP18 evaluation

Kennedy-Asser et al, in review, confidential, not for distribution

Performance vs. HadUK-Grid (observations)



Performance vs. ERA5 (reanalysis)



Evaluation of heat stress related variables shows UKCP18 simulations perform better than CMIP5 models in general

UKCP18 resolution makes a small difference

Heat stress metrics generally have lower absolute and relative errors than temperature

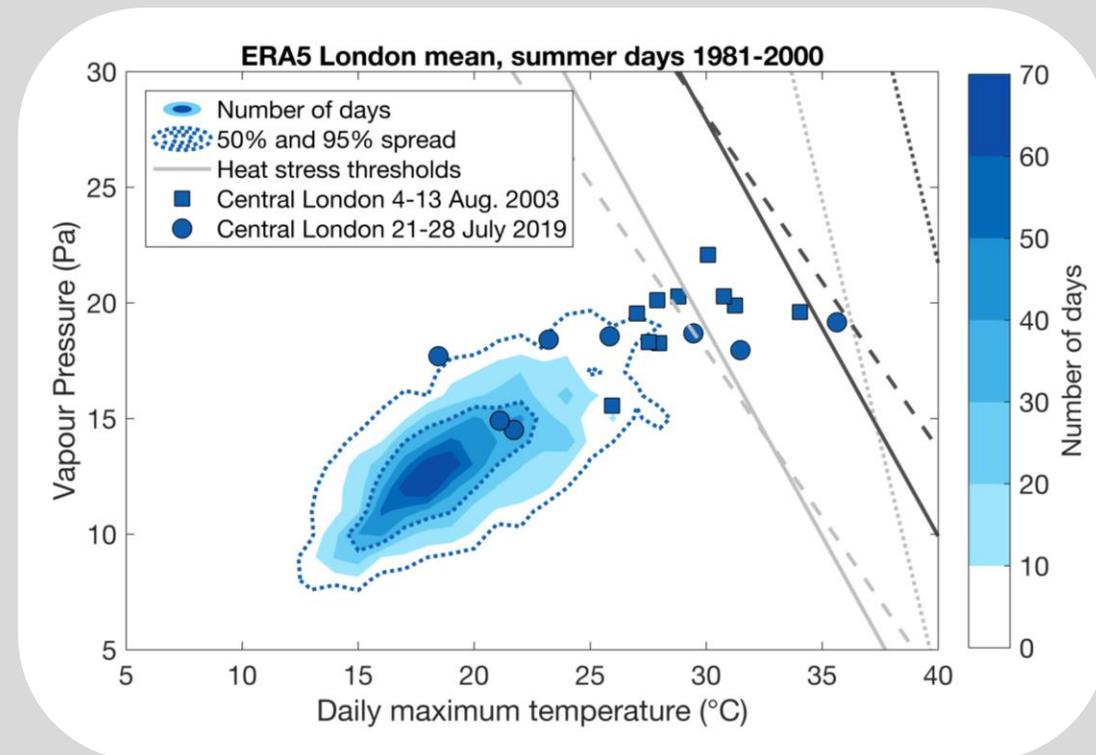
# Heat stress metrics & thresholds



Global heat stress thresholds less applicable to UK:  
Thresholds used by Zhao et al. 2015 (grey lines) are rarely broken in the UK, even during the most extreme events to date

Thresholds are also likely time-variable:  
Static absolute values are less appropriate as they do not account for any adaptation or acclimatisation

Suggest the use of percentile-based definitions of extremes  
**These considerations will feed into OpenCLIM**



Kennedy-Asser et al, in review, confidential, not for distribu

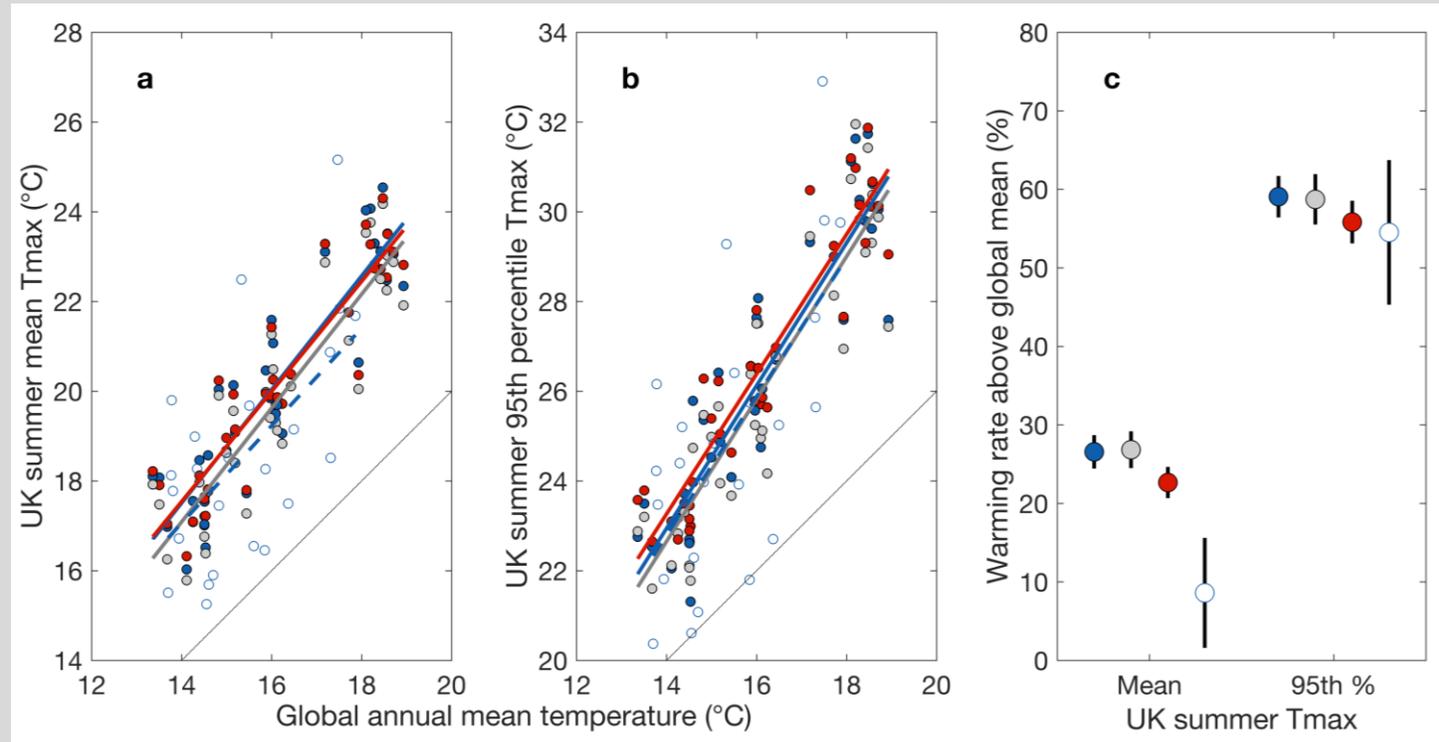
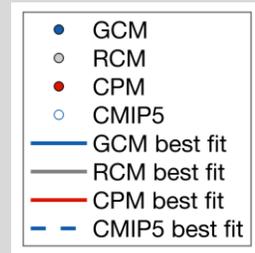
# Future extremes



UK summer temperatures warm more than global mean

UK summer extremes warm even more rapidly

e.g. For 0.5 °C global warming:  
UK summer mean temperatures increase up to ~0.65 °C, while UK summer extreme temperatures increase up to ~0.8 °C



Kennedy-Asser, et al. forthcoming. Confidential, not for distribution

# Heat stress conclusions



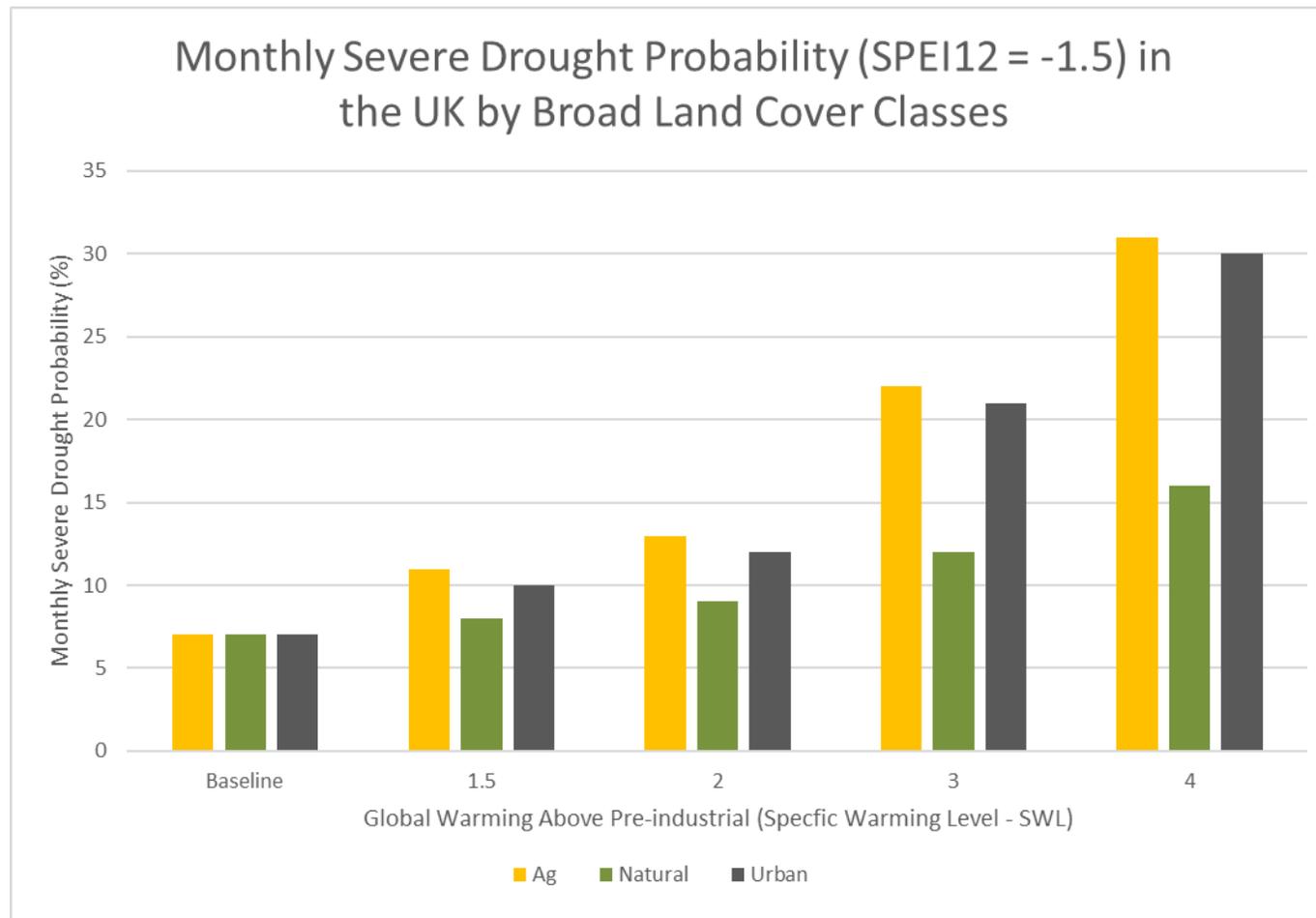
- UKCP18 simulates UK summer heat stress variables (temperature, vapour pressure) well compared to CMIP5 models, with minor improvements in model skill due to increasing resolution
- Global heat stress thresholds are not suitable for the UK – they underestimate the risk
- UK summer temperature extremes are projected to warm faster than the global mean
- There are regional differences in projected increases in temperature and vapour pressure extremes

Contact: [alan.kennedy@bristol.ac.uk](mailto:alan.kennedy@bristol.ac.uk). Presented results currently in review (Kennedy-Asser et al.)



# Severe Drought Probability by Land Cover Type

Price, et al. In review.  
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Probability that a given month in a given 30-year period will be in severe drought (SPEI12 of -1.5) in different broad land cover categories

# IMPRES Conclusions



- Our projections of increased drought, heat stress, flood risk and biodiversity loss are consistent with earlier studies
- Our focused study of heat stress is guiding our development of the heat extremes toolkit in OpenCLIM including appropriate use of UKCP18 data
- The development of novel techniques to assess risks to biodiversity, ecosystem services and natural capital is being taken forward in OpenCLIM
- It has enhanced our engagement with some key stakeholders
- All of our work is improving quantification future climate change risk in the UK including the analysis of uncertainties