UK CLIMATE RESILIENCE PROGRAMME

Insights on Hazards to Risks

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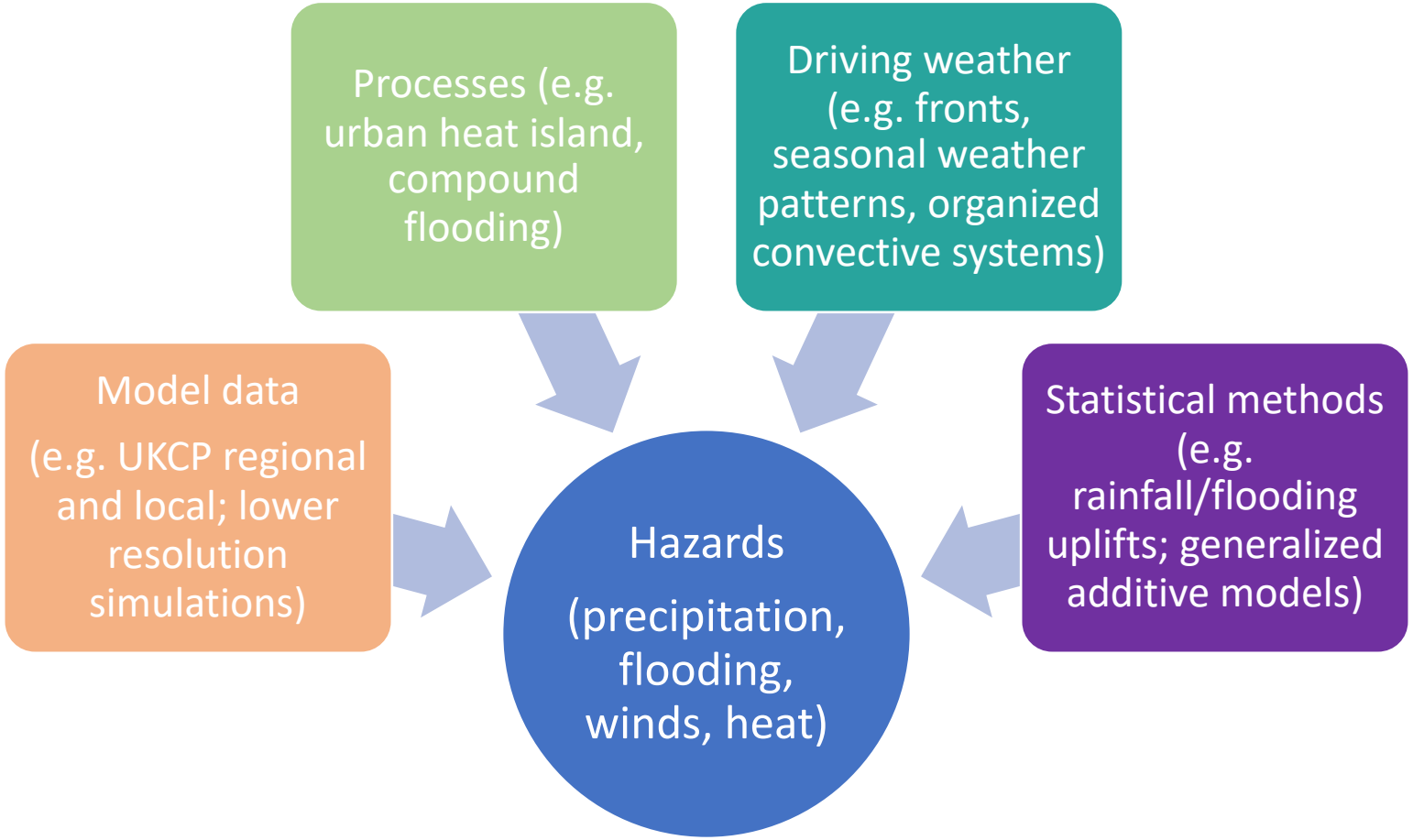
Improving the characterisation and understanding of climate hazards over the UK



Advances in Hazard data

A number of projects making use of UKCP simulations at different resolutions: the higher resolution local simulations tend to perform better for extreme precipitation, which then can feed into hydrodynamic models.

Other model simulations have been used e.g. atmosphere-only simulations to provide larger datasets of possible hazards.

Tools

Project	Product
STORMY-WEATHER	Front identification code
FUTURE-DRAINAGE	RED-UP Rainfall Perturbation Tool
Met Office WP2	HOTdays tool
Stochastic Simulation	Stochastic weather generator

Datasets

Project	Product
SEARCH	Risk of compound flooding map
EuroCORDEX-UK	Data explorer webpage
Multiple Hazards	Case studies of agricultural compound hazards
STORMY-WEATHER	Storm type dataset
FUTURE-DRAINAGE	Design rainfall flood uplifts
Met Office WP2	Return levels at high resolution
ExSamples	Extreme winter scenarios

Characterising and Projecting Future Hazards

Future hazards

- Changes to the seasonal distribution of extreme precipitation, with more in the autumn.
- Organized convective systems projected to double their precipitation.
- Future increases in the frequency of extreme windstorms over the UK; one in 20-year storms in the 1990s could occur once every 10 years by the 2070s under a high emissions scenario, posing risks to electricity distribution networks.
- 10-fold increase in the number of days of dairy cattle heat stress in the next 50 years in the South West of England calculated using the multi-variate analysis.

Improving the characterisation and understanding of climate hazards over the UK

Summary

- Uncertainties between the UKCP Regional and Local simulations suggest that it is essential to have a physical understanding of the hazards when interpreting model output.
- New physical (eg flooding) and statistical (eg heatwave) models have contributed to projections of worst-case scenarios for the hazards in question.
- There has been a focus on the physical causes of hazards; for example, precipitation extremes have been considered in terms of slow-moving storms, weather system types and seasonal weather patterns.

Future Directions

- Need a better understanding of the uncertainties between models and developing constraints for the projections based on global warming levels.
- Multi-model ensembles of Cloud Permitting Models.
- Essential to understand how new datasets (e.g. precipitation uplifts) are being used.
- Data from CPM (and other) models needs to be fed into hydrological (and other) models on a national scale, requiring a much better understanding of vulnerability and exposure, and improved collaboration between different disciplines.
- Converting new hazard information to estimates of risk by considering the risk budget of hazard, vulnerability and exposure.

Future changes in indicators of climate hazard and resource in the UK

How are indicators of hazard and resource changing across the UK?

Climate Risk Indicators
IMPRES
FUTURE-DRAINAGE
CREWS-UK
CROP-NET
Met Office programme
...others...

- Calculate various metrics from UKCP18 climate projections
- Multiple sectors

Health

Extreme weather

Transport

Agriculture

Energy

Wildfire

Natural environment and assets	Infrastructure	Health, communities and the built environment
The crop growing season starts earlier and lasts longer	Road accident risk due to ice decreases	Heatwaves and heat-health alerts become much more frequent, particularly in the south and east
Growing degree days increase	High temperature extremes affecting rail infrastructure increase	High temperature extremes become much more frequent, particularly in the south and east
Frost days decrease	Adverse rail operating days increase in England, but decrease in Scotland	Heat-related mortality increases
Growing seasons for viticulture warm and lengthen	Short-duration rainfalls become more frequent	Cold weather extremes reduce but remain common
Soil moisture deficits increase in summer	River flows decrease in summer and – in the north and west – increase in winter	Cold-related mortality decreases
Agricultural drought risk increases	River floods become larger and more frequent in the north and west	Heating degree days reduce
Warm and dry summers become more common	Low river flows decrease and become more frequent across Britain	Cooling degree days increase
Potato blight becomes more frequent	River drought frequency increases across Britain	
Thermal heat stress to dairy cattle increases	Dissolved organic matter increases in upland drinking water sources	
Wildfire danger increases across the UK		

Reflections

- Changing climate hazards and resources across the UK have been quantified, using consistent climate scenarios and indicators relevant to resilience policy

- Most consequences are adverse, and increasingly so with higher emissions in the future

- Most evidence is based on UKCP18 very high emissions scenarios, and some is expressed in terms of level of warming

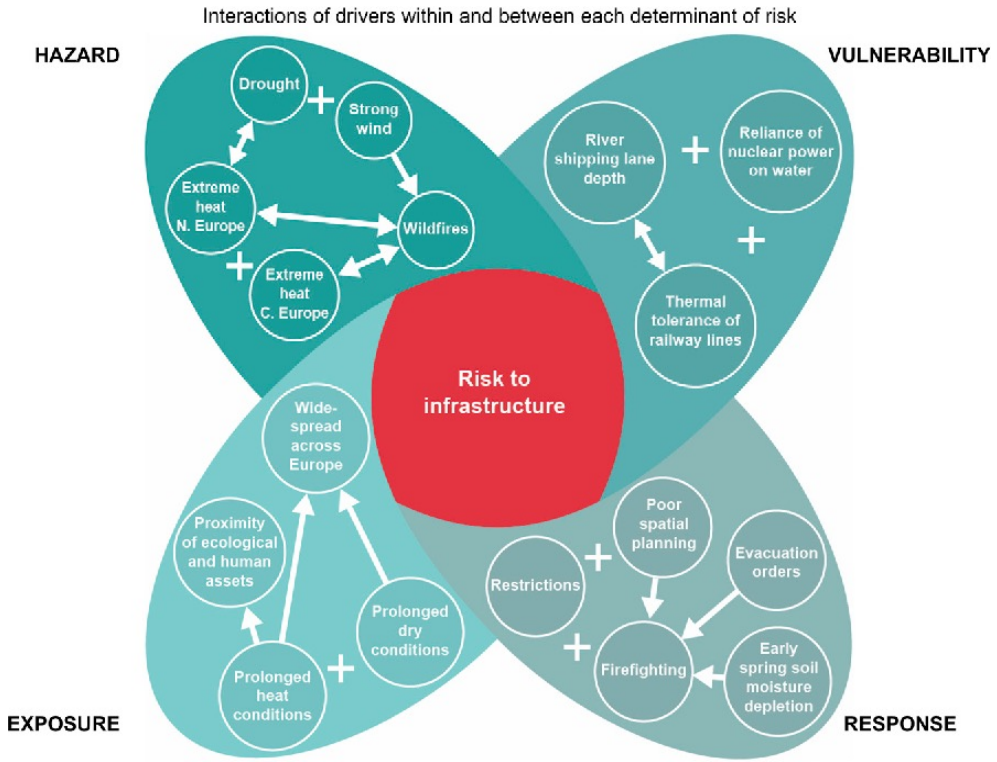
- Some gaps remain
  - Indicators of ecosystems and the services they provide
  - Relatively little on changing risks from compound hazards

What has been learned about converting climate hazard data to climate risks information?

Understanding climate risks requires consideration of the hazard, vulnerability and exposure.

Different approaches and methodologies to convert climate hazard data to climate risk information have been pursued and applied through the UK Climate Resilience Programme (UKCR). For example,

- Qualitative mapping
- Threshold-based methodologies
- Simulation models
- Catastrophe (CAT) modelling frameworks
- Systems-based approaches



An example of risk to infrastructure as a function of hazard, exposure, vulnerability and response

10.1016/j.oneear.2021.03.005

What has been learned about converting climate hazard data to climate risks information?

Examples of Key Developments

- Local, regional and global data from the latest UK Climate Projections can now be linked to UK Shared Socioeconomic Pathways.
- Substantial progress in projections of future exposure and vulnerabilities, and methodologies to combine these with climate projections to quantify future climate risk.
- Several developments have allowed the production and sharing of datasets to better inform assessment of changing climate risk (Table 1).
- Advances in spatially coherent event set generation are important. For example, applied to extreme events.
- Advances in uncertainty calculations. Different climate products have been used extensively to account for uncertainty.

Class	Project	Dataset
Hazard	AquaCAT	AquaCAT flooding event sets.
Hazard	Climate Risk Indicators	Risk-informed indicators of climate-related hazards for different UK sectors.
Exposure & vulnerability	UK-SSPs	UK-specific socioeconomic pathways (SSPs), down-scaled from the Global/European SSPs.
Risk	Meeting Urban User Needs	Heat Vulnerability Index to assess heat risk within the city of Belfast.
Risk	OpenCLIM	Risk-related metrics covering heat stress; inland flooding; risks to water supply; drought; biodiversity and agriculture under different socioeconomic and climate futures.

Table 1: A small selection of the new datasets for hazard, vulnerability, exposure and risk developed through the UKCR programme.

What has been learned about converting climate hazard data to climate risks information?

Summary

- Understanding and quantification of climate vulnerabilities is central to developing valuable assessments of future risks.
- There is an ongoing need for multiple risk frameworks and tools for informing different climate resilience and adaptation decisions.
- Benefits of working with stakeholders to maximise utility and uptake have been highlighted across projects. Closer communication between climate research and impact sectors would continue to support insightful application of climate data to resilience issues and ultimately enable more valuable advice and services.

Knowledge gaps

- Access to existing exposure and vulnerability data is highly fragmented; a centralised authoritative repository, where such data could be combined with climate data, would widen access and facilitate research.
- The analysis of compound, cascading and systemic risks would benefit from more focus in the context of national scale risk assessments.