Pywr-WREW

A Water Resources model for England and Wales to enable strategic analysis of the drought resilience of water supply infrastructure

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DAFNI Data & Analytics Facility for National Infrastructure

Environment Agency

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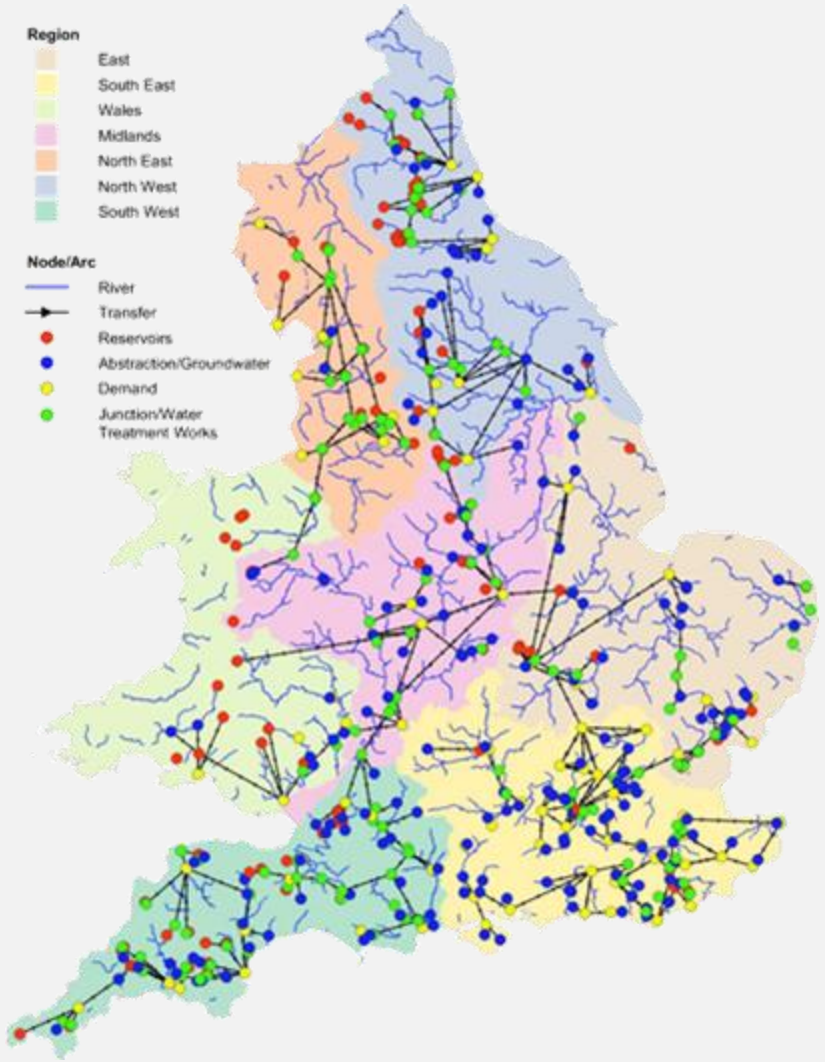
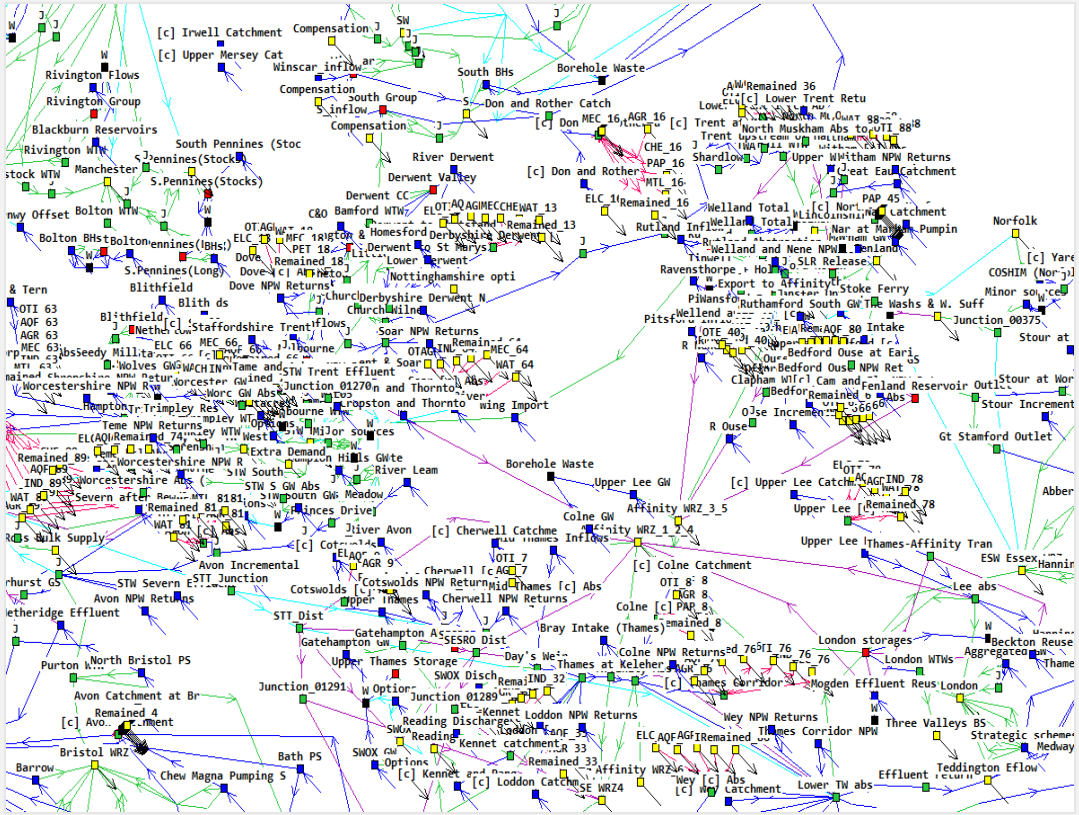
From WREW to Pywr-WREW

- What we've done
  - Developed and used WREW in the proprietary Wathnet framework (Kuczera 1992).
  - Assessed future drought risk and evaluated possible strategic infrastructure options, with England's Environment Agency, OFWAT and water utilities.
- What's needed
  - Continual improvements in communication and understanding of the national model in comparison with regional water company models, by regulators and companies.
- What's next
  - Rebuild the WREW model formulation on the open-source Python framework, Pywr (Tomlinson, Arnott and Harou 2020).

Water Resources model for England and Wales

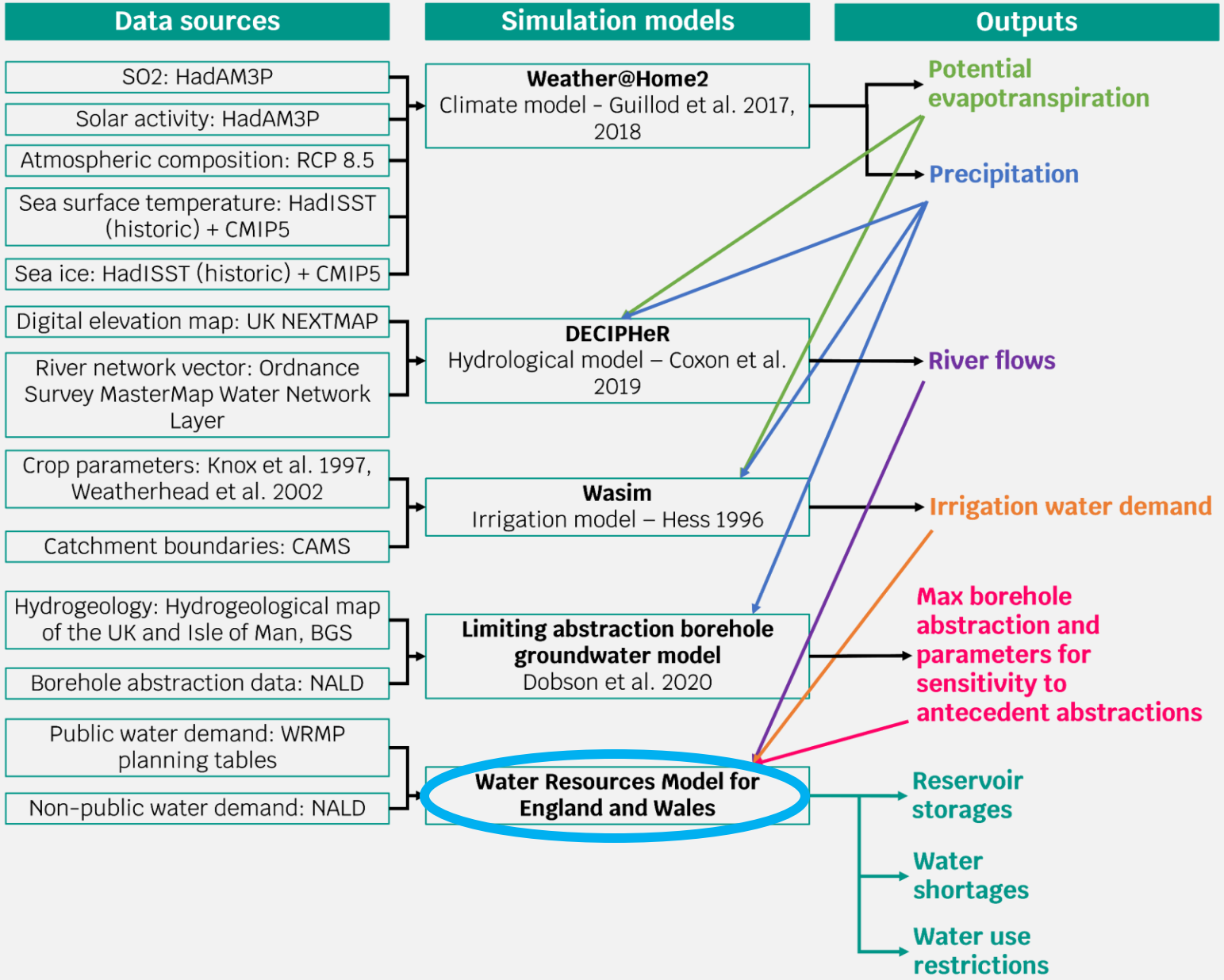




Model represents:

- 90% of England and Wales's population and public water use:
- 80 catchments; 70 WRZs; 16 water utility companies;
- All resources > 2Ml/day, and key transfers and assets;
- Some smaller sources & demand zones amalgamated or removed

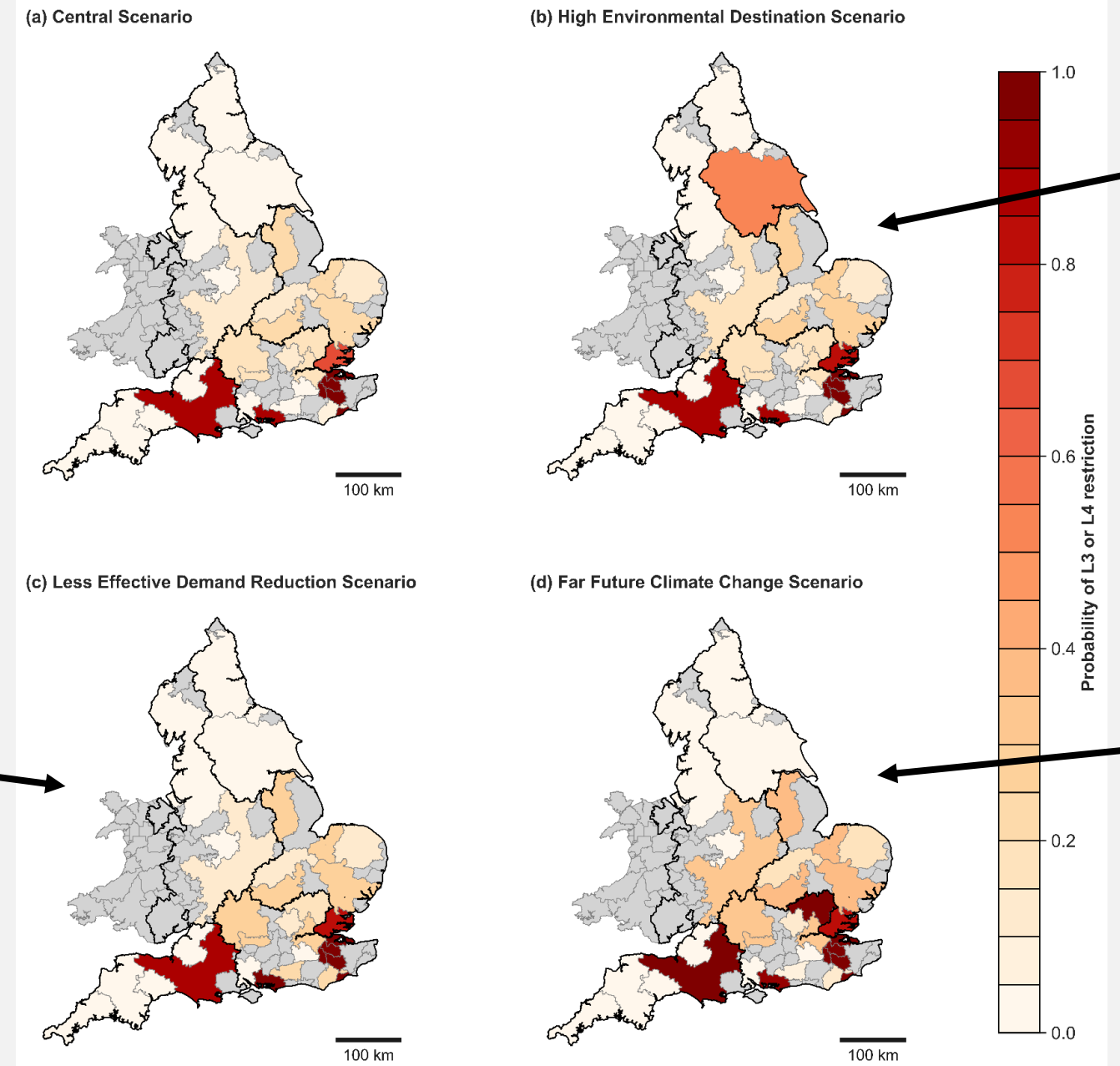
Fig. Overview of workflow, showing the main data sources, models and outputs.



Coupled modelling system developed to analyse strategic water resources in the context of large scale drivers of change, including:

- Climate
- Abstraction reform
- Changing demand

Fig. Probability of severe restrictions on water use for four different climate and demand scenarios.



More water retained for the environment (lower withdrawals from river)

Water companies fail to meet Per Capita Consumption targets (less effective demand and leakage management)

Climate ensemble for 2070-2099 used in simulations

Fig. Strategic Resource Options (SROs) modelled in WREW and key water company locations.

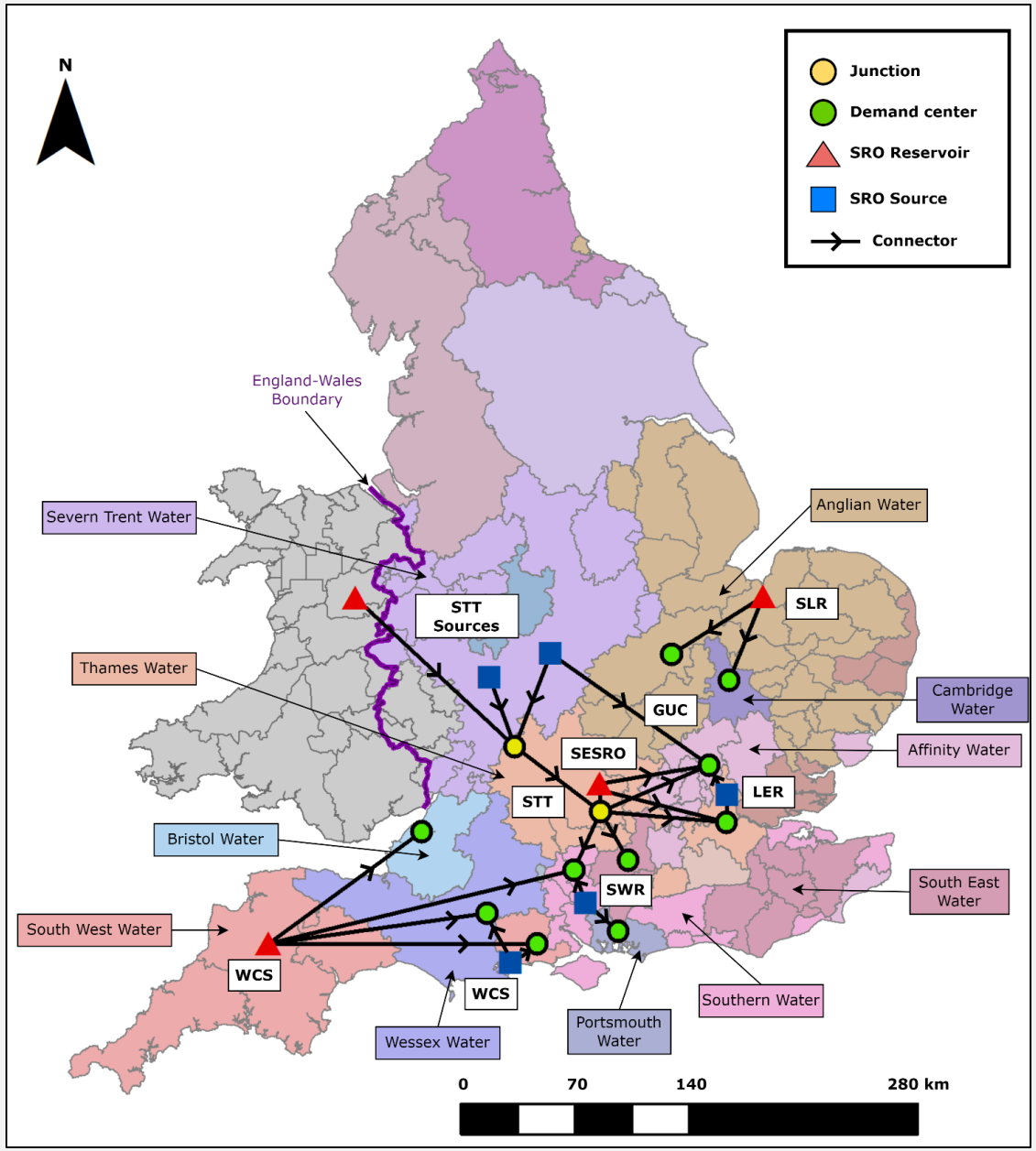
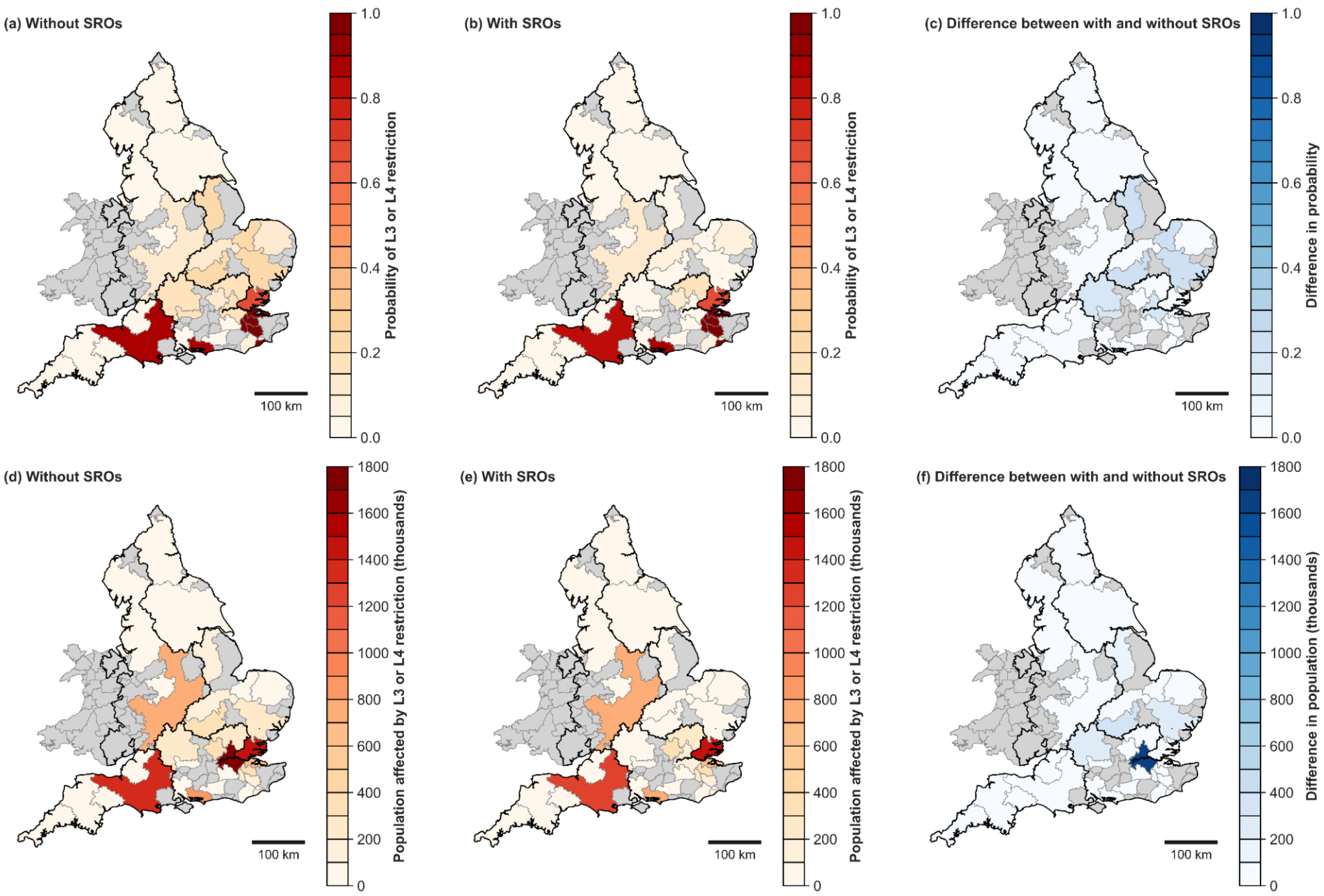


Fig.
Probability of severe restrictions on water use.

Expected population affected by severe water restrictions.

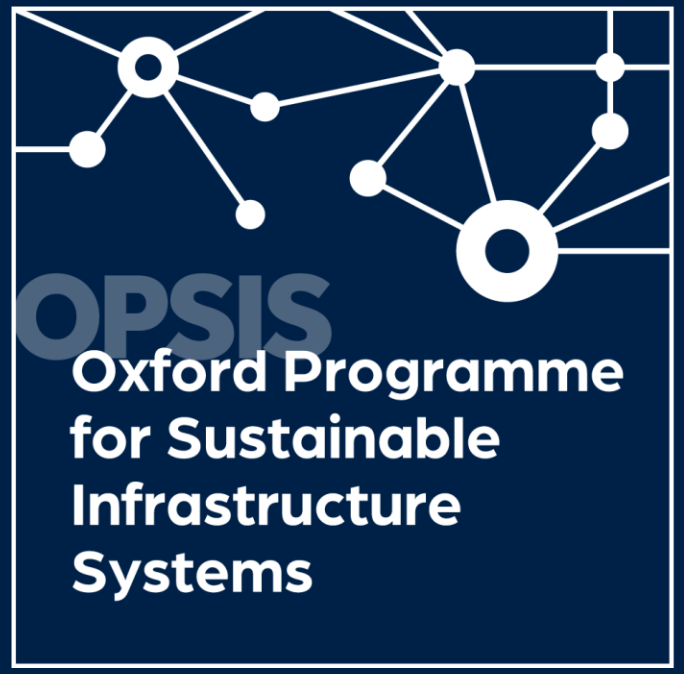


Pywr-WREW

- Re-build the national Water Resources model for England and Wales using the open-source generic dynamic python library for network-based resource allocation models, Pywr.
- Advantages of Pywr:
  1) **Open-source:** Pywr's source code is available on Github. Given that the framework is devised entirely in the widely-used Python programming language, users can easily detect and fix bugs, as well as implement new features.
  2) **Free to use:** Pywr has been designed to be free end-to-end. This means that models can be formulated and solved using open-source optimisation solvers (e.g., GLPK), avoiding expensive license fees.
  3) **Strong support base:** Pywr's userbase spans the globe, which provides a strong support base for users. Since Pywr is currently the only open-source water resources modelling framework, its documentation and features are continuously growing.

Our vision

- Create an open-source version of WREW, hosted by DAFNI.
- Pywr-WREW will offer a more transparent tool than the Wathnet-based WREW, making stakeholder engagement, model evaluations and result disseminations easier for all.
- Pywr-WREW will be ‘outcome-based’, helping decision makers better manage future climate risks to the national water supply network.
- The flexible nature of the Pywr platform will allow other important variables, such as cost and water quality, to be included in WREW in the future.
- A multi-objective national water resources model such as Pywr-WREW will play a critical role in identifying optimum and robust solutions, and will aid joint agreement and decision making across regulators.



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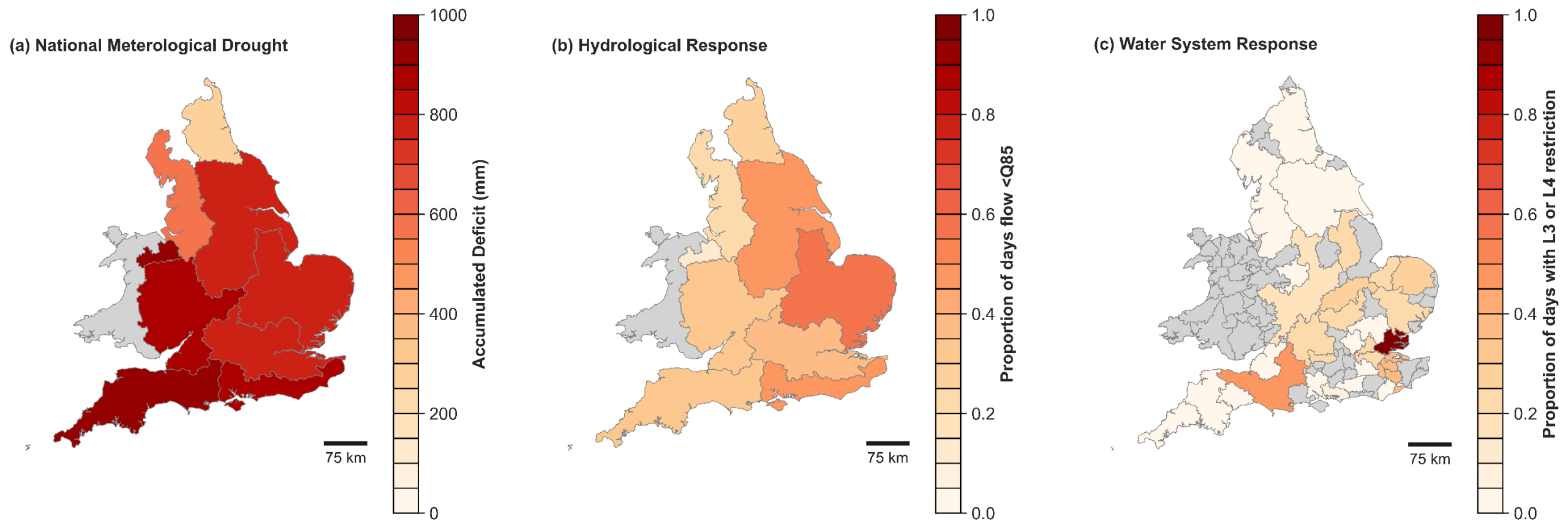
Extra slides

Fig. 24-month national meteorological drought and associated hydrological and water system response.

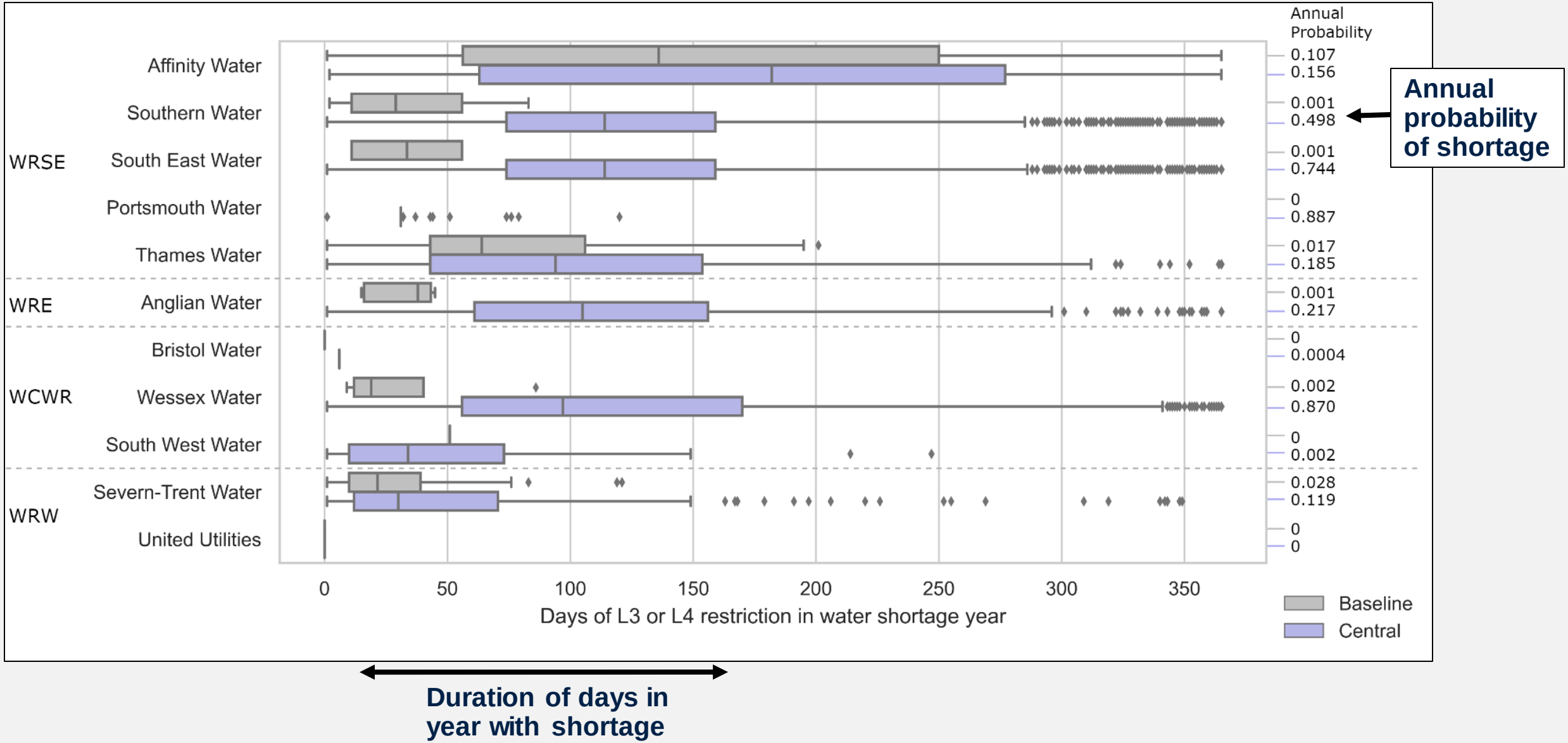


Accumulated deficit of drought events below Q50 threshold for effective precipitation

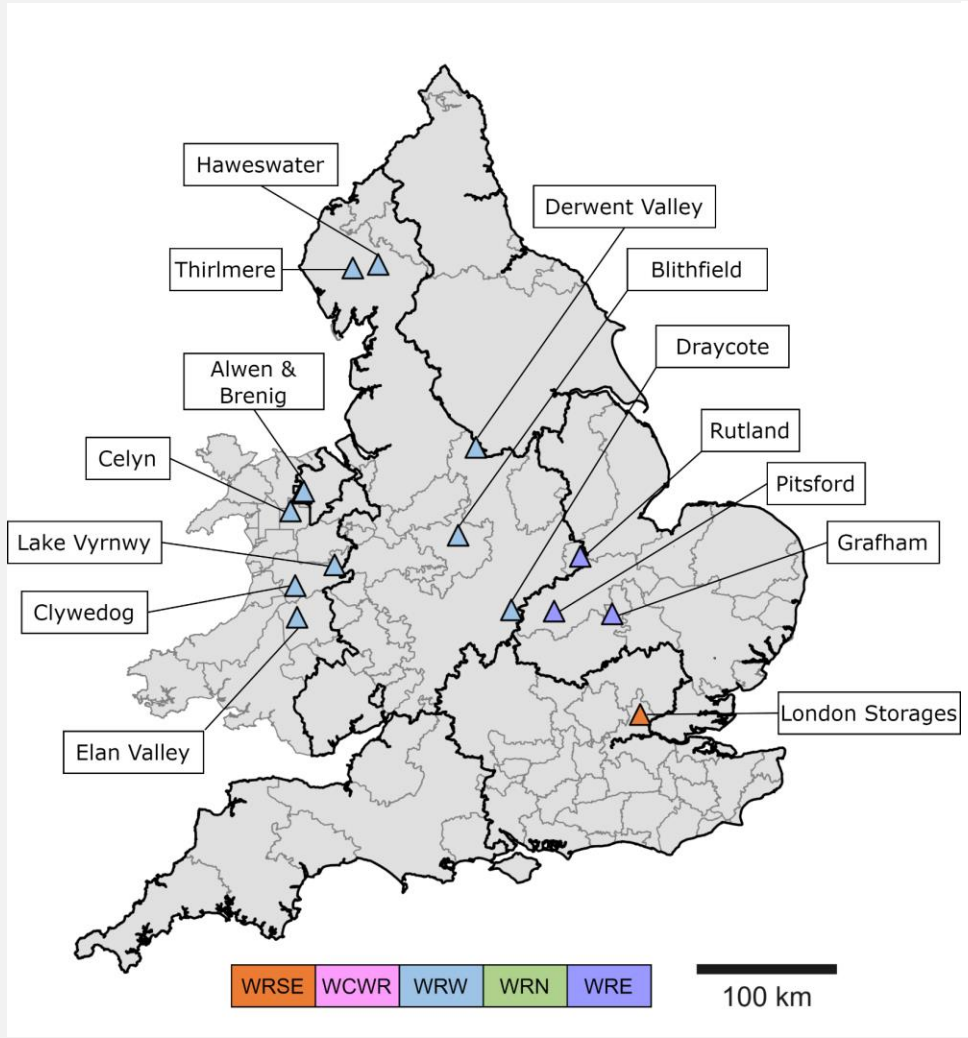
Proportion of days below Q85 threshold in key rivers (per basin)

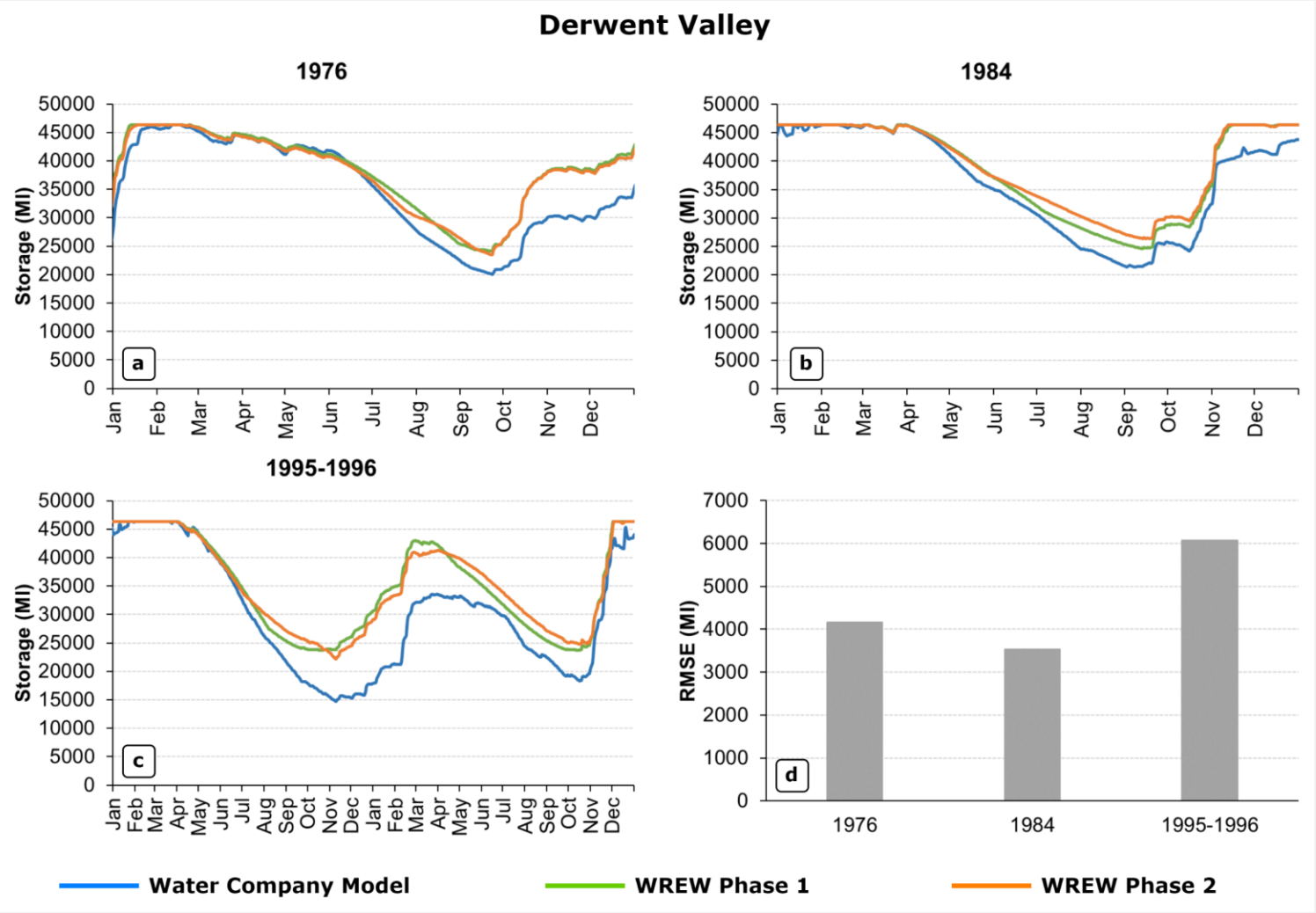
Proportion of days with severe water use restriction

Fig. Water shortage event probabilities and durations for different demand scenarios.



Reservoir validation





Reservoir validation