National Water Resources Modelling on DAFNI

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Outline

- Background to national-scale water resources modelling
- Water Resources of England and Wales (WREW) model
- Ongoing WREW developments, applications and results visualisation with DAFNI

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Background

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Background

Meeting our Future Water Needs:
a National Framework for Water Resources

The National Framework explores England's long-term water needs. It sets out:

- the scale of action needed to ensure resilient water supplies are available to meet the needs of all users in the future
- a greater level of ambition for restoring, protecting and improving the environment that is the source of all our supplies

Every day:

14,000 million litres of water is provided by water companies for public water supply

1,000 million litres of water* is used by other sectors such as industry, power generation and farming – but varies across regions and seasons

*Excluding public water supplies, hydropower and aquaculture and abstraction volumes adjusted for consumptiveness

If no action is taken between 2025 and 2050 around 3,435 million extra litres of water per day will be needed for public water supply to address future pressures. This includes:

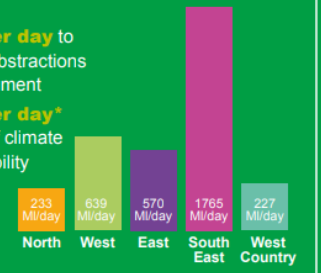
1,150 million litres per day (Ml/d) to make water supplies more resilient to drought

1,040 million litres per day to supply the growing population

720 million litres per day to replace unsustainable abstractions and improve the environment

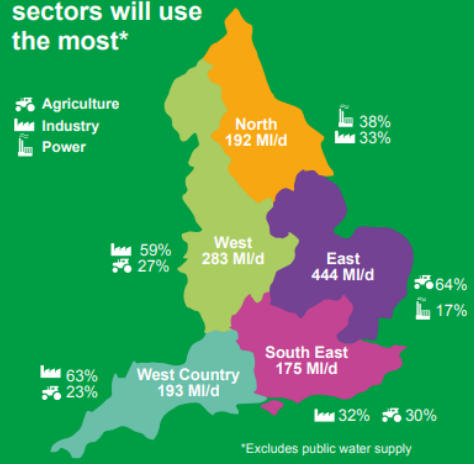
400 million litres per day* to address the impact of climate change on water availability

Around 50% of the national need is in the South East



*Water companies have included additional impacts from climate change of around 640 Ml/d in their plans up to 2025 which is before the start date for this analysis

We've estimated how much water in total other users in each region will need at 2050 and which sectors will use the most*



*Excludes public water supply

https://www.gov.uk/government/publications/meeting-our-future-water-needs-a-national-framework-for-water-resources

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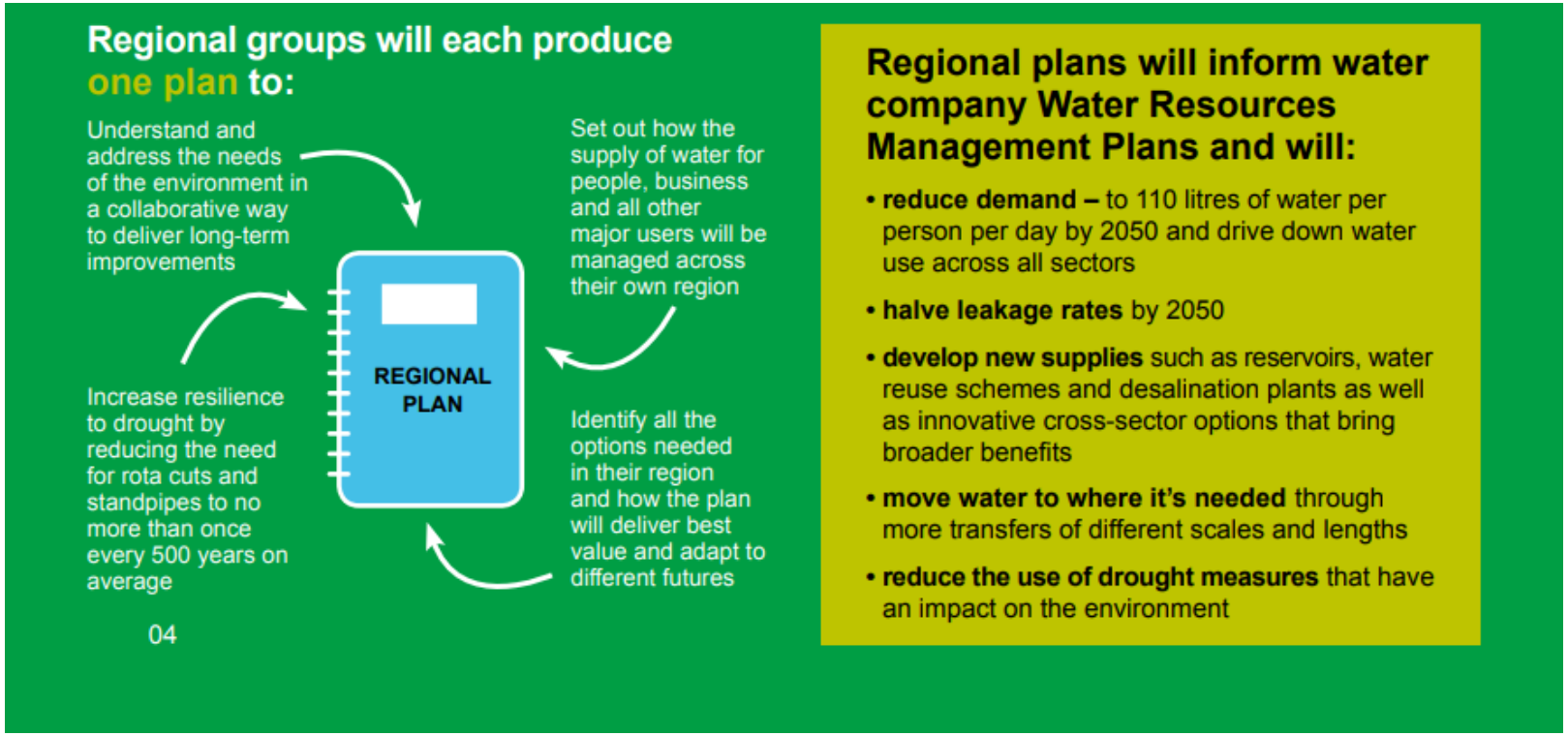

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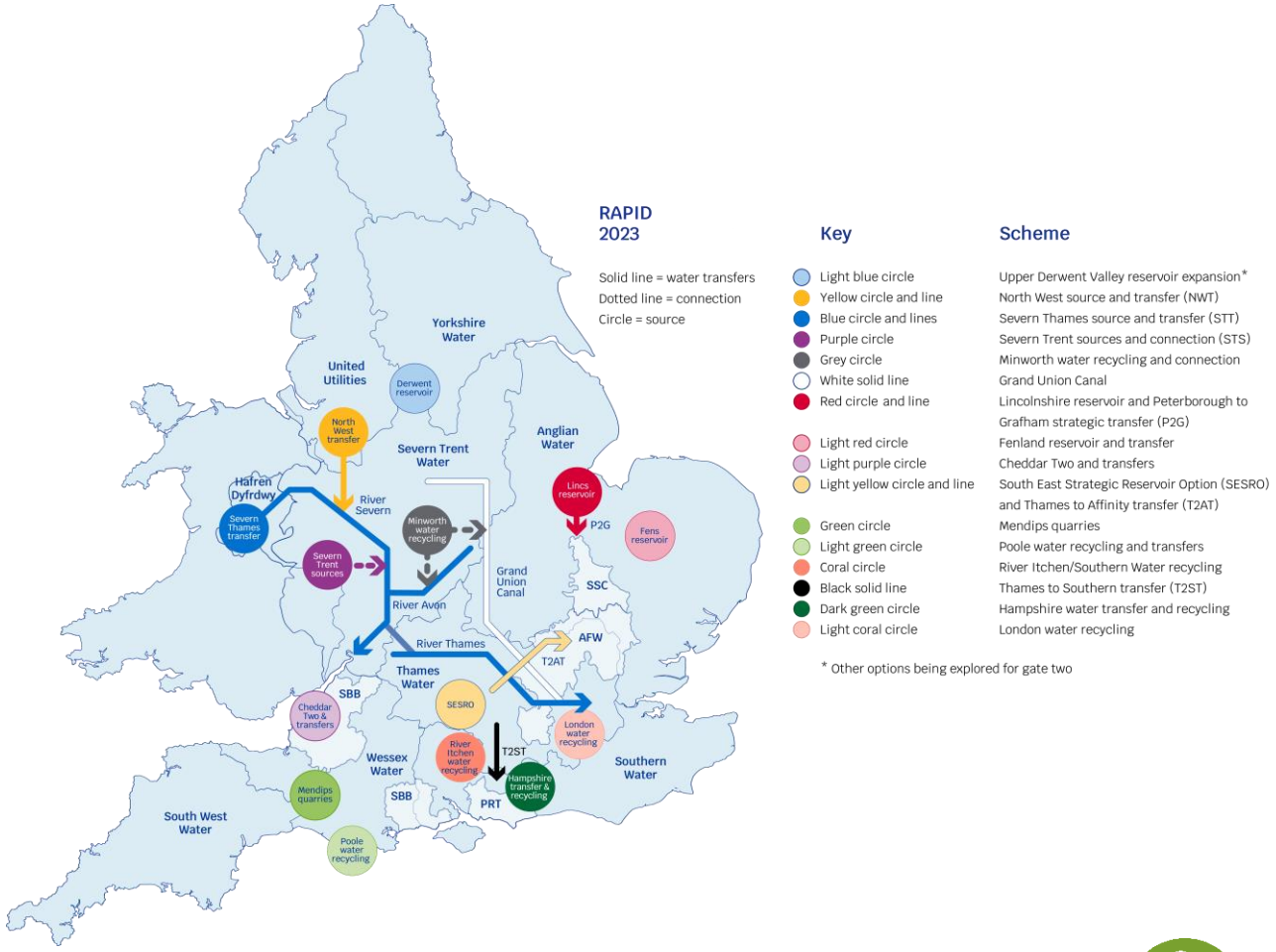
- Several major water supply schemes are being explored through the RAPID* programme



*Regulators' Alliance for Progressing Infrastructure Development
https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/

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Background

- Why are we interested in national-scale water resources modelling?

1. To evaluate the national-scale coherence of plans
2. To improve our understanding of system resilience, trade-offs, dependencies and sensitivities
3. To provide an independent view on water company and regional group modelling

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WREW Model

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WREW

- Water Resources of England and Wales (WREW) model
- Collaboration now undertaken in National System Simulation Project (NSSM)

And more…!

Model Types

- Three types of national water resources modelling undertaken in our team (National Appraisal Unit) at the EA

1. Aggregate supply-demand balance calculations
2. High-level evaluations of potential supply options
3. Detailed system modelling – WREW / NSSM project

WREW = Water Resources of England and Wales model
NSSM = National System Simulation Modelling project

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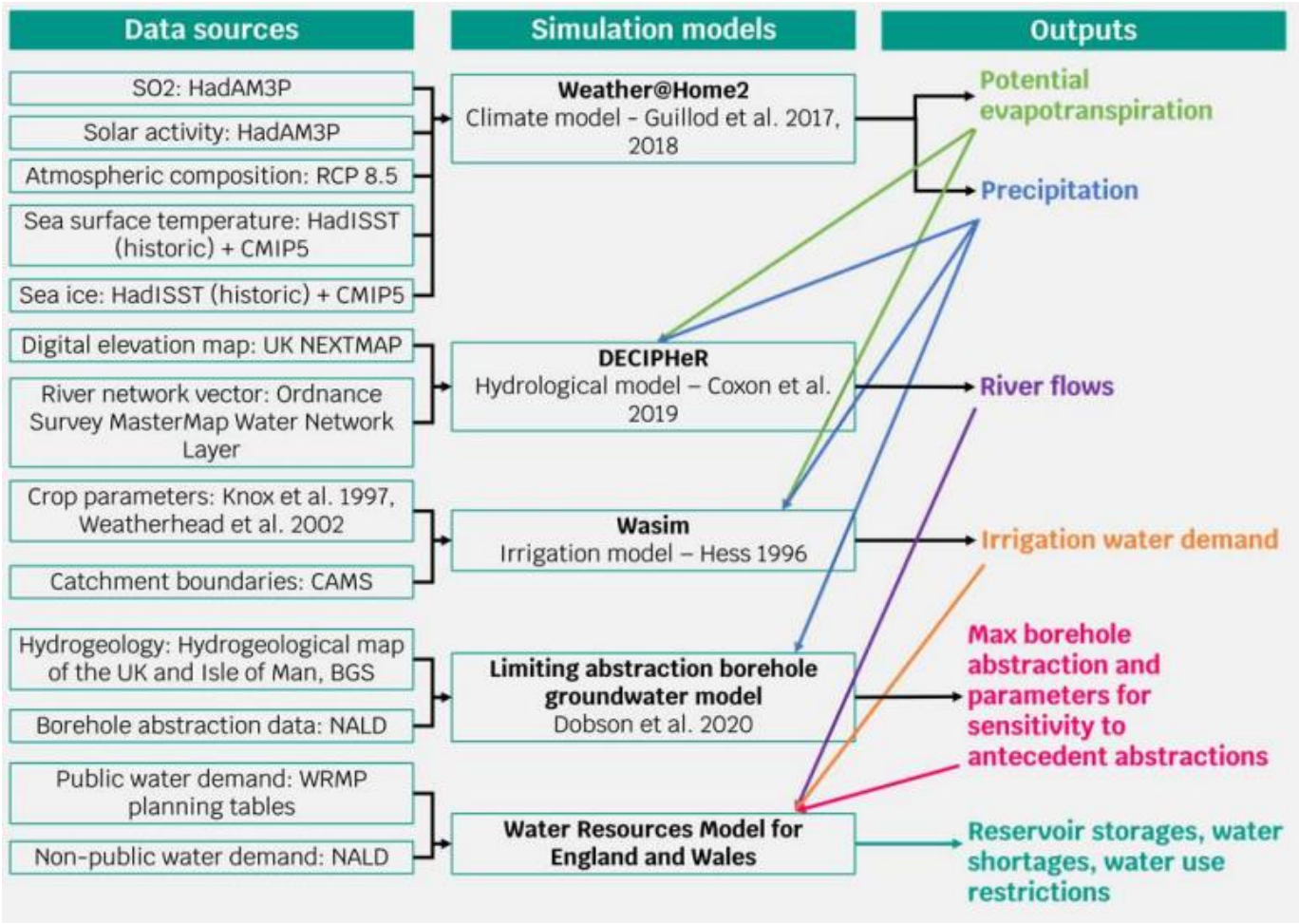
Modelling Chain



Murgatroyd et al. (2023): Impacts of Climate Model Uncertainty on Future Water Restrictions across England and Wales (AGU presentation).

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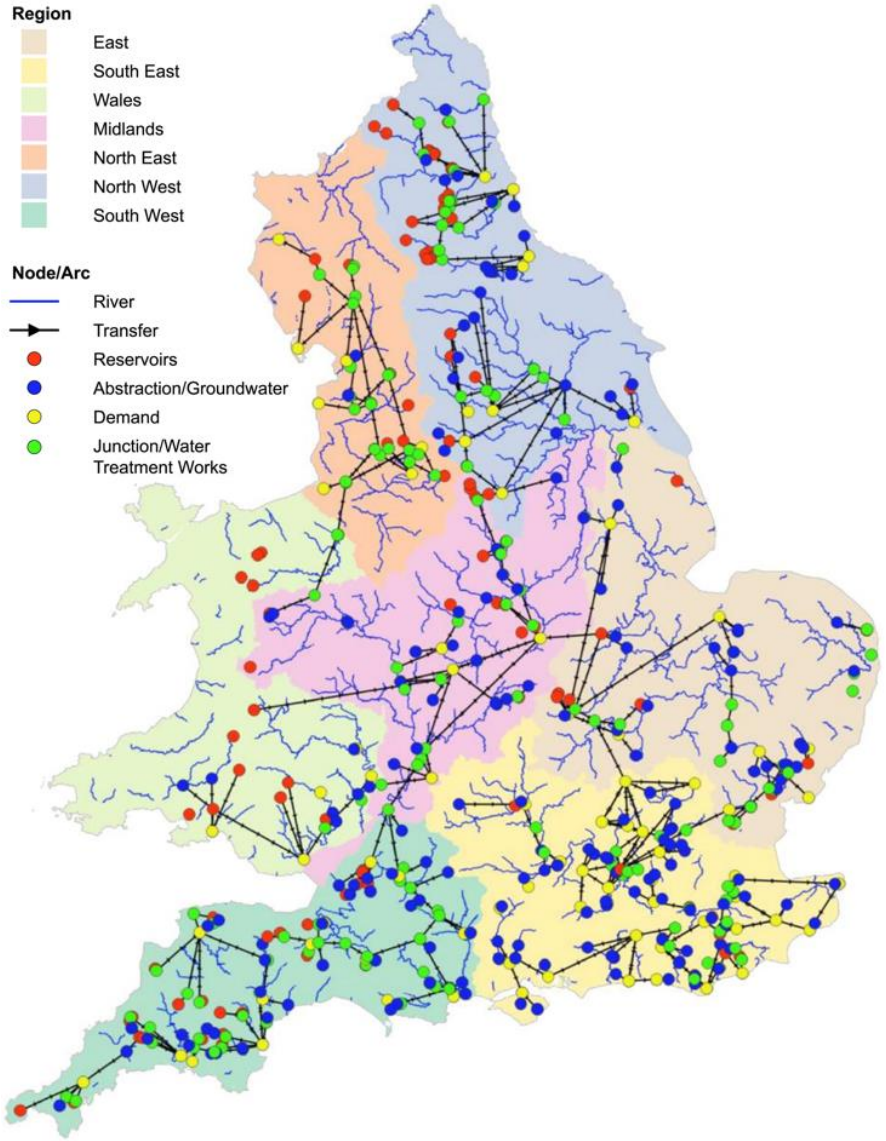
Overview Schematic



Dobson et al. (2020): https://doi.org/10.1029/2020WR027187

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System Model

- WREW is built in the WATHNET network flow software
- Allocates available river flow, groundwater and reservoir storage to try to meet demands and environmental needs optimally each day
- Encodes rules, constraints and preferences that govern water infrastructure operation
- We can vary inputs (e.g. climate projections, demands, …) or system configuration (e.g. new reservoirs, transfers, …)

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NSSM Phases

- Over the past few years WREW advances have been undertaken in three phases in the NSSM project

1. Proof-of-concept for testing individual SROs*
2. Testing robustness of SROs together under selected climate, demand and sustainability scenarios
3. Investigating full WRMP24** planning scenarios

*SRO = Strategic Resource Option (within RAPID programme)
**WRMP24 = Water Resources Management Plan 2024 (planning round)
NSSM = National System Simulation Modelling project

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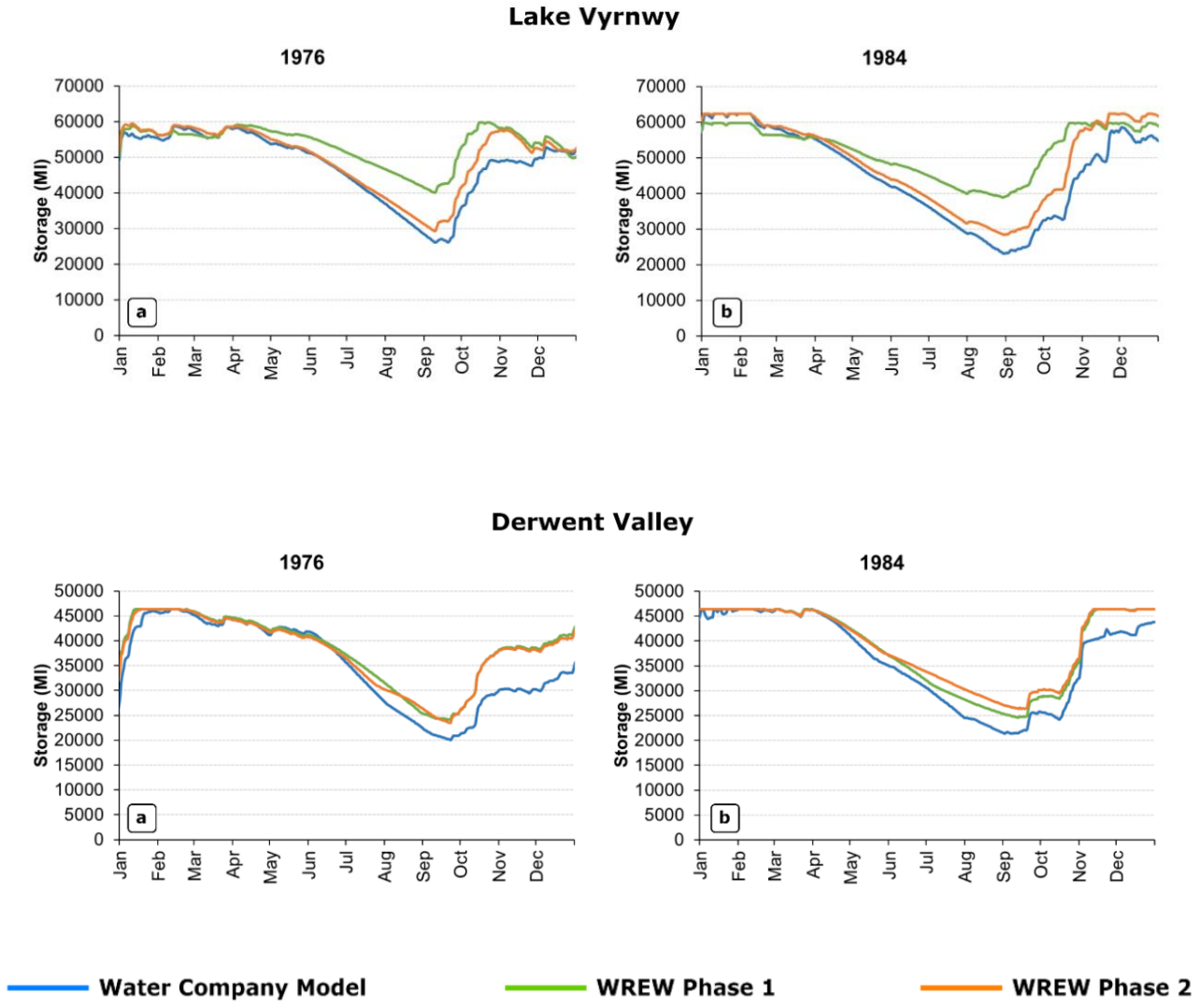
Model Performance



https://www.ofwat.gov.uk/publication/the-national-system-simulation-modelling-nssm-project-phase-1-report/

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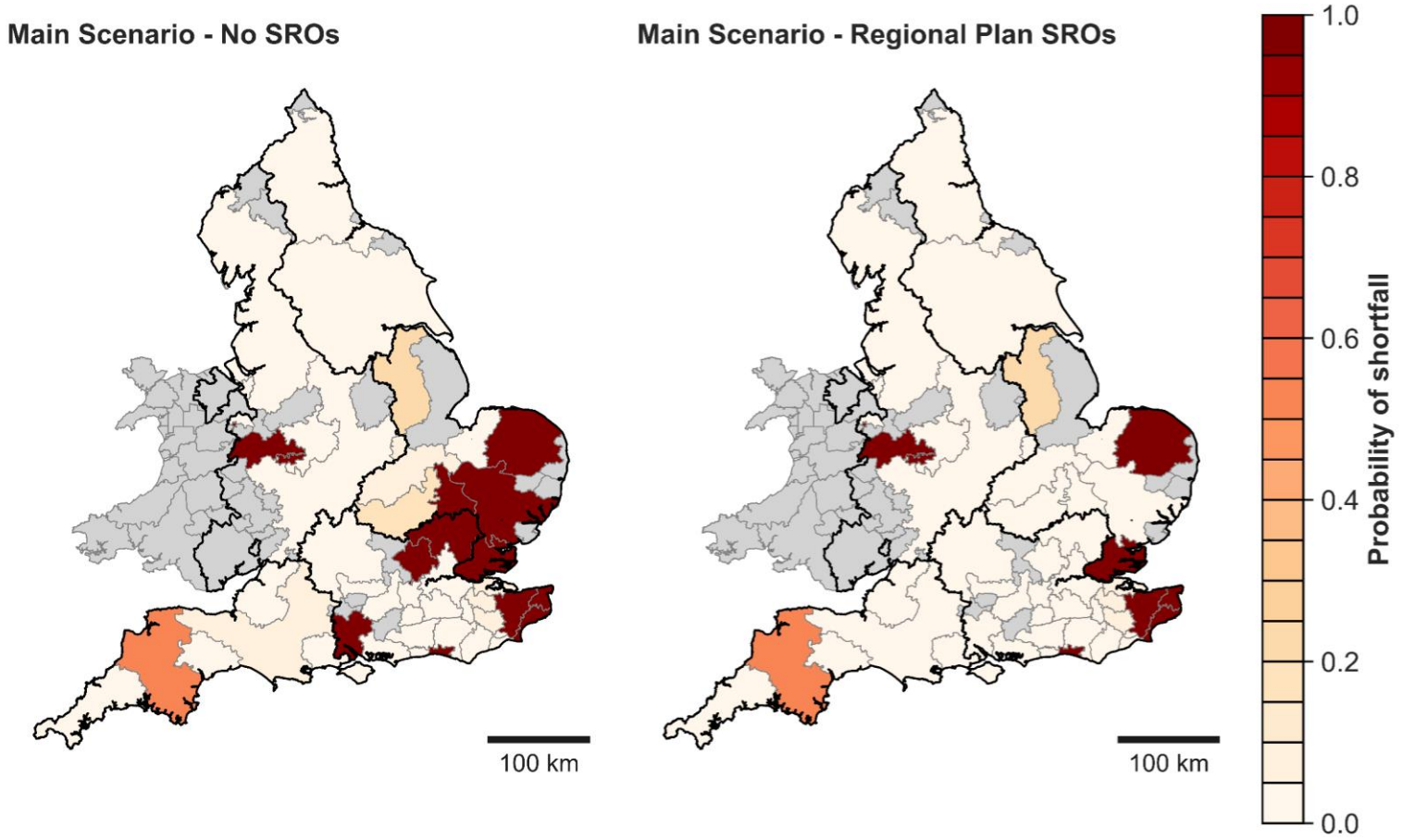
Phase 2 Example Results



SRO = Strategic Resource Option (within RAPID programme)
https://www.ofwat.gov.uk/publication/the-national-system-simulation-modelling-nssm-project-phase-2-report/

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Ongoing WREW Work on DAFNI

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WREW on DAFNI

- DAFNI facilitates parallelised large-scale national simulations based on 100-member(+) climate projection ensembles
- Easier collaboration with partners and stakeholders for sharing data, results, workflows, visualisations, …
- User-friendly versioning, parameter sets and interfaces speed up learning and using WREW

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Phase 3 Workstreams

- Alongside investigating WRMP24 planning scenarios, there are several technical workstreams in NSSM Phase 3

1. Relating drought characteristics and supply vulnerability
2. Assessing different climate datasets, e.g. UKCP18 RCM*
3. Updated statistical groundwater modelling
4. Hydrological modelling refinements and comparisons
5. Improving supply system representation in key areas

*UKCP18 RCM = Met Office UK regional climate projections (2018 project)
WRMP24 = Water Resources Management Plan 2024 (planning round)
NSSM = National System Simulation Modelling project

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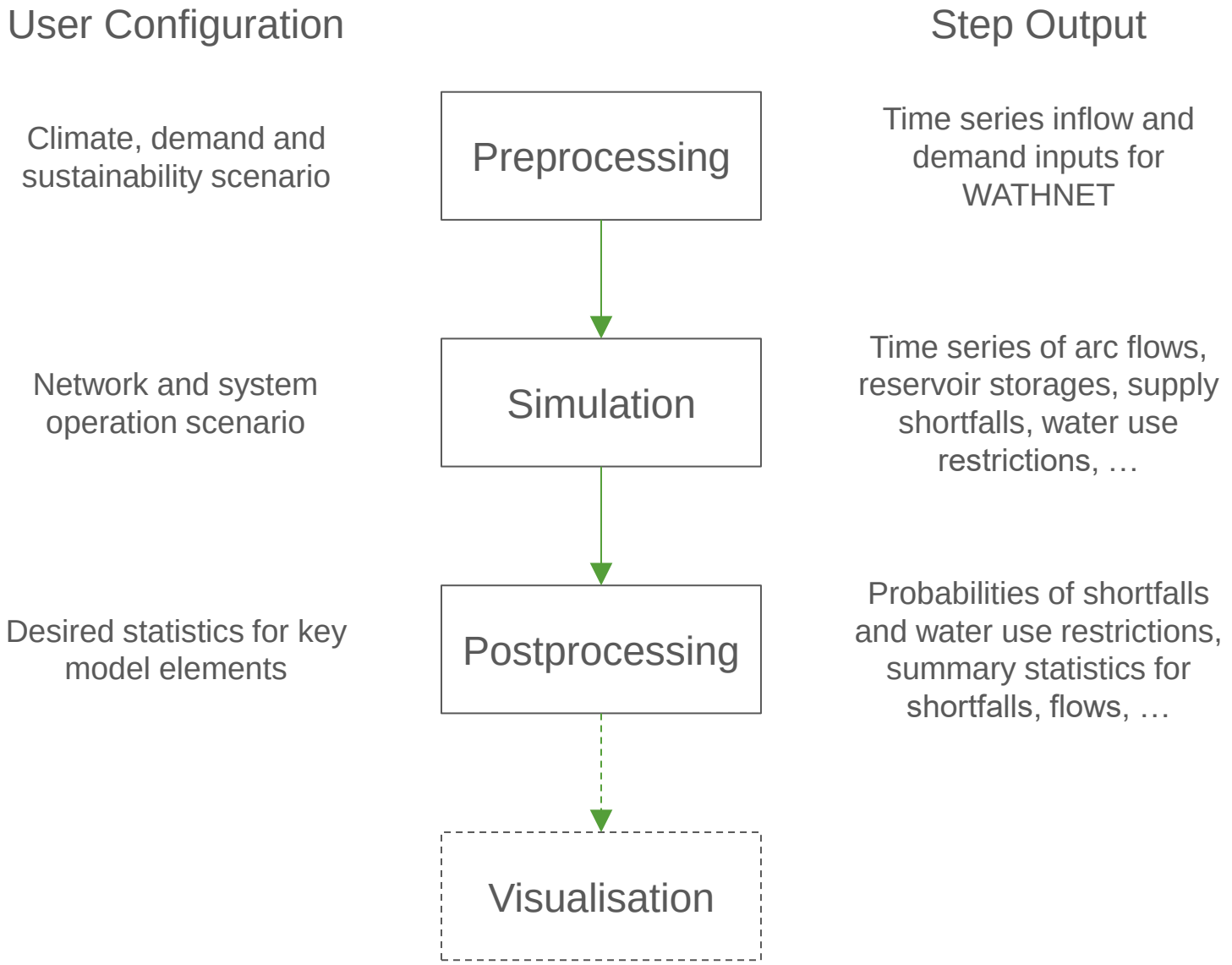
Typical Workflow



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Visualisation

- Visualisation for a range of stakeholders and partners required in the NSSM project
- Includes academics, researchers, water companies and regulators (internal and external), with a mixture of specialist and non-specialist backgrounds
- Show here some examples from using both “traditional” figures and interactive plotting tools
  - Work is still in progress, so results should be considered indicative rather than definitive

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Interactive Tool

- Developing interactive results and model behaviour exploration tool(s) that span high-level to detail-focused visualisations
- Written in Python, particularly using HoloViz packages (especially Panel) and bokeh
- Still being worked on, but deployment on DAFNI is in progress (thanks DAFNI team!)

https://holoviz.org/
https://bokeh.org/

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Summary

- A national-scale water resources system model (WREW) has been developed through cross-sector collaboration
- The model can be used to help take a strategic view on water supply infrastructure requirements and proposals
- DAFNI has facilitated ongoing development and application of WREW, including improved options for visualisation

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Thank you

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