CASE STUDY

The Pywr-WREW water resources model for England and Wales – improving drought resilience

Dr Anna Murgatroyd, Lecturer in Hydrology, School of Engineering, Newcastle University.

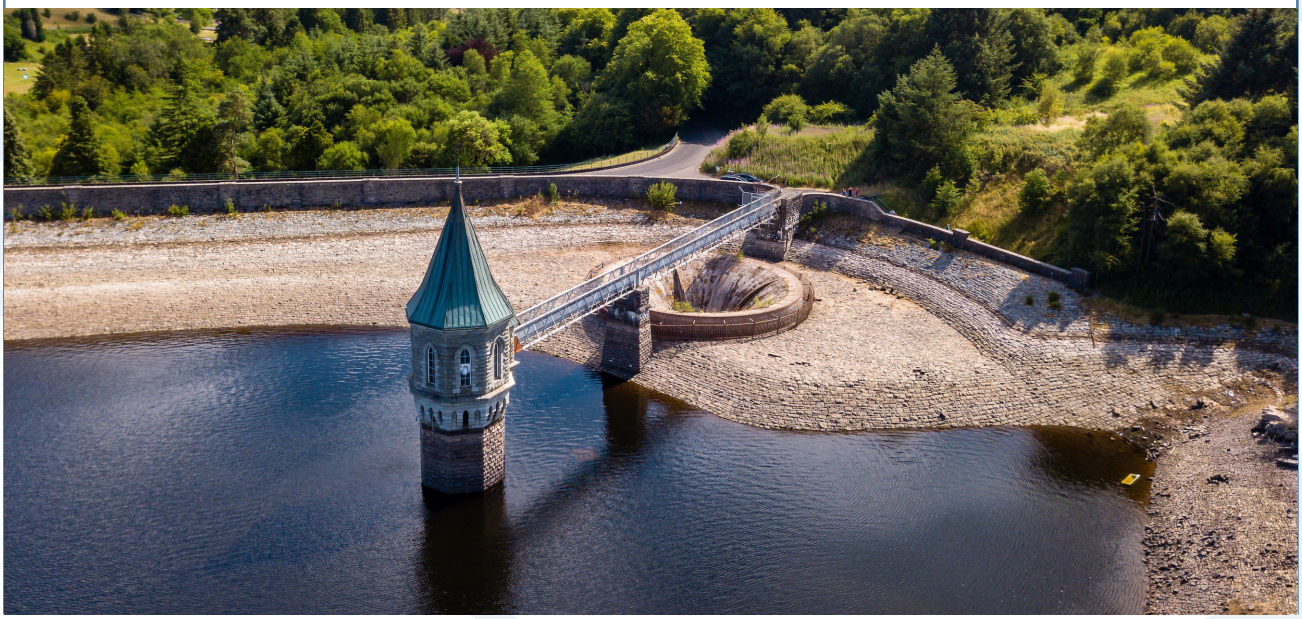
Introduction

With climate change comes longer, hotter summers and more frequent, widespread, and intense droughts[1]. In the UK, this already affects the levels of reservoirs, rivers and other water sources in multiple areas, from Northumbrian Water to South East Water. Reduced water levels have a negative effect on household water usage, farming and agricultural outputs, river life, and the wider environment.

In August 2025, the Environment Agency reported that five of its operational areas in England were experiencing drought and that a further six were experiencing a period of 'prolonged dry weather'. Ten reservoirs were less than half full by 19th August 2025[2].

To help improve countries' drought resilience, the Pywr-WREW water resource systems model for England and Wales aims to enable strategic analysis and foster improved water supply planning. It simulates water movement from source to end user, through major supply infrastructures, going beyond regional or water company scale to national scale.

[1] *https://commonslibrary.parliament.uk/droughts-in-england/*
[2] *https://www.gov.uk/government/publications/dry-weather-and-drought-in-england-summary-reports/dry-weather-and-drought-in-england-15-to-21-august-2025*



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What would you identify as the main impact of this work?

Researchers can now use regional models built using the Pywr-WREW framework with strategic assets, from boreholes to rivers, to test water systems against hundreds of different future climate scenarios.

"The models allow analysts to make better sense of what the future might look like and provides evidence for regulators and water company operators to make more informed policy and infrastructure decisions," explains Dr Anna Murgatroyd, Lecturer in Hydrology, School of Engineering, Newcastle University.

Key challenges that Pywr-WREW aims to solve

Since the privatisation of water companies, planning has focused on the individual organisation's area only, leading to lack of shared data or cohesive planning.

The Pywr-WREW model goes beyond focusing on plans for individual water companies to provide a coherent overview of the complex interconnections across and within the English and Welsh water infrastructures and even takes into account licensing and operational rules.

The analysis and outcomes from the model are essential for improving our understanding of how or what causes current water systems to be vulnerable and fail. The data and analysis gained helps to answer questions such as 'will our water system still be fit for purpose in 20- or 40-years' time, or by the end of the century?'

What was the key aim of the project?

The project took a previous model (WREW, built using proprietary water systems modelling software) and rebuilt it using the open-source, Python-based water modelling software Pywr to allow for greater collaboration with stakeholders.

Dr Anna Murgatroyd explains, ***"The main aim of the Pywr-WREW project was to create a tool that stakeholders can use in parallel with the original model (WREW model), to help them better collaborate and assess drought risk. The analysis and insights from Pywr-WREW can then be used to assess the requirement for revised strategic infrastructure and the necessity of water restriction measures to water supplies across England and Wales."***

The Pywr-WREW model is more user friendly and easier to interpret than the original WREW model, making it more accessible to a wider audience.

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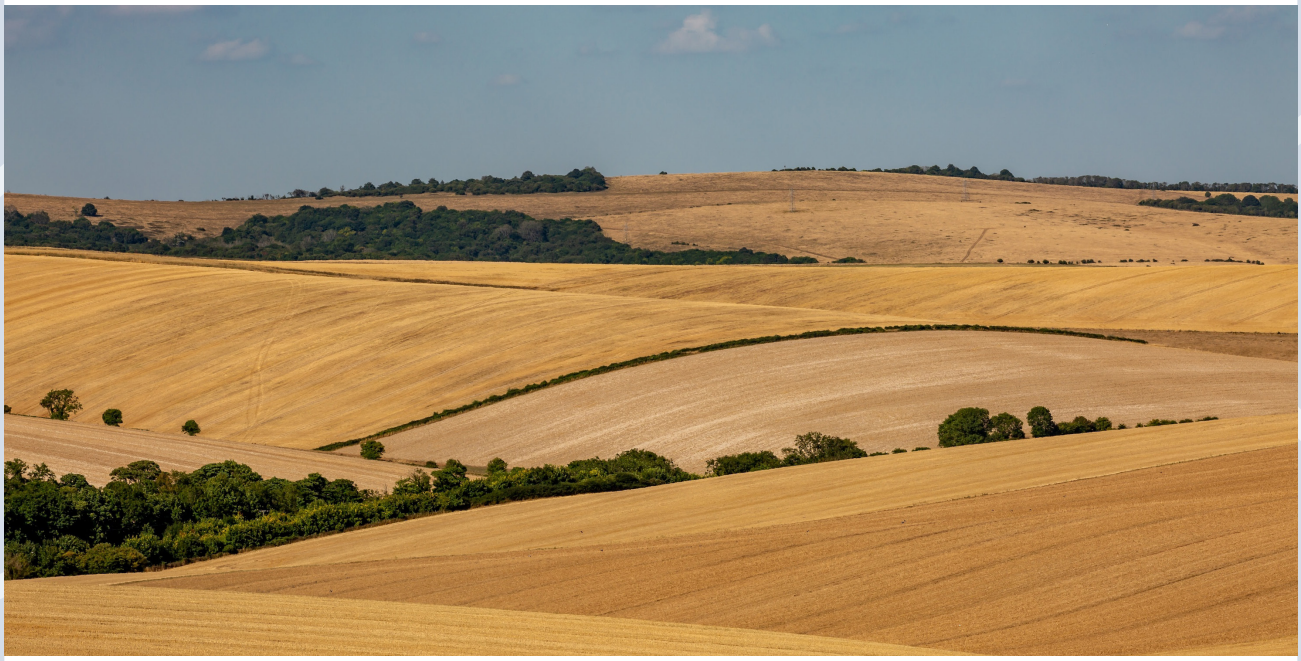
What did DAFNI allow you to do that you could not have achieved otherwise?

Prior to completing the Pywr-WREW project, it was a laborious process for Anna to share information with the Environment Agency (EA) and water companies. She had to build a model, refine it, book run time on the university super computers, extract the results, process them, and finally, share the highlights with colleagues in the EA.

Thanks to Pywr-WREW and DAFNI, the group can work more collaboratively and see all the results online.



"DAFNI has provided a much more dynamic space which is invaluable, especially when working with big teams. Also, the ease of accessing different files and datasets has really helped the project to progress," Dr Anna Murgatroyd adds.

"The DAFNI team were invaluable in providing advice and guidance on how best to create a workflow that anyone within the Pywr-WREW User Group could run and interpret. They also provided expertise in using DAFNI, creating a model workflow from start to finish, Dockerising and putting the model onto the DAFNI platform," she says.

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The main outputs from the Pywr-WREW project available on DAFNI are:

- New water systems models (Pywr-WREW)
- Accompanying datasets produced and shared with model users at the Environment Agency
- JSON model files

How could this work benefit society as a whole?

The Pywr-WREW model makes it much easier to analyse and make decisions around difficult environmental questions and challenges on a national scale for England and Wales. It allows researchers to gain a better understanding of water systems, and to make preparations and mitigations for conditions that will cause harm to society.

It contributes to larger scale systems-thinking, to move beyond planning of small areas in isolation.

How do you anticipate other researchers, policymakers and stakeholders using this work?

The Pywr python product is already being used across the world. Professor Julien Harou and his group at the University of Manchester are using it to study infrastructure resilience along the Blue Nile, which flows from Ethiopia through to Sudan and Egypt. More recently, a researcher in India reached out to Anna's team and is planning to use Pywr to build their own model for their city.

The Pywr-WREW work has also been incorporated into teaching at Newcastle University, introducing water resource systems modelling to engineers. In addition, Masters students and undergraduates there are using Pywr-WREW to develop their own models -- future generations being trained for future decades!

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The future

Ultimately the team would like to extend the model to cover the whole of Great Britain.

Looking ahead, the team is hoping to collaborate with other regions across the country and the Environment Agency's regional water resources team, as well as with other universities. Dr Murgatroyd is interested in looking at how efforts to achieve Net Zero will impact water supplies and how shortages may impact these efforts.

The Pywr-WREW team is collaborating with another DAFNI project: USARIS (Uncertainty quantification and Sensitivity Analysis for Resilient Infrastructure Systems), led by Dr Francesca Pianosi at the University of Bristol. Together they now have a working example of the USARIS framework to use in a safe toolbox with the Pywr-WREW model on DAFNI.

Who's involved?

The Pywr-WREW project is led by Principal Investigator, **Dr Anna Murgatroyd**, Lecturer in Hydrology, School of Engineering, Newcastle University, (formerly at University of Oxford), with Co-Investigator, **Professor Jim Hall**, University of Oxford, and **Tom Russell**, University of Oxford.

When did the project start and finish?

The project ran from 1st of October 2023 to 31st of March 2025.

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