CASE STUDY

RIWS: Resilience in integrated water systems

Dr Ana Mijic, Professor in Water Systems Integration, Imperial College London

Introduction

The RIWS project (Resilience for Integrated Water Systems) developed the WSIMOD (Water Systems Integration Model) and successfully implemented it onto the DAFNI platform, making it available to a wider research community.

WSIMOD simulates the entire water cycle, allowing for comparison of resilience across different water system components, including supply, wastewater, flooding and water timely.

The release of WSIMOD onto DAFNI is timely as, in 2025, the government asked for one of the most comprehensive ever reviews of the UK water system, in the Cunliffe review, which culminated with the Independent Water Commission report published in June 2025.

Key recommendations include the need for water planning to have a coordinated approach based on integrated water systems and that "the UK and Welsh governments should each bring forward a new, long-term, cross-sectoral, and systems-focused National Water Strategy for England and Wales". Quantitative evidence for coordinated and integrated water planning can be supplied from WSIMOD.

The recommendation that **"a comprehensive systems planning framework should be introduced for England and Wales with responsibility for integrated and holistic water system planning"** was also highlighted.

RIWS: Resilience in integrated water systems

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

The RIWS project has produced WSIMOD, a powerful integrated water systems modelling tool that simulates key processes across the entire terrestrial water cycle, allowing water companies, local governments and researchers to explore complex water system interactions and develop better-informed strategies.

WSIMOD provides evidence that natural water systems are suffering due to infrastructure development and system spills and leakages.

This is the first time that a resilience model has been developed at a water systems level. WSIMOD demonstrates its application and validation for adaptive planning approaches.

As the recent Greater London Authority Infrastructure Team's 2024 paper comments, **"Integrated modelling, using WSIMOD in this case, provides the basis for improvements in policy, planning and decision making through the production of numerical system evidence"**.

Key challenges that RIWS aims to solve

The team sought to create an integrated water systems model and add to DAFNI in order to create new possibilities for researchers.

An engagement workshop with stakeholders helped to finalise the definition of the resilience framework before it was applied to the adaptive planning. Input from Thames Water, Mott McDonald, United Utilities and more was key in helping to identify issues.

What were the key aims of the project?

The main aims were to:

- Add technical integrated modelling to the DAFNI platform
- Extend knowledge in the context of resilience by developing integrated resilience assessment for both supply and wastewater and bringing them together in a united way.

Included in the project was development of an assessment framework which can be used to inform the future planning of water systems and create a new way of developing adapted planning, using resilience as an indicator.

CASE STUDY

RIWS: Resilience in integrated water systems

What did DAFNI allow you to do that you couldn't have achieved otherwise?

Results using analysis from WSIMOD demonstrate the resilience of different parts of the water system, now allowing researchers to directly compare both the supply and wastewater side.

The modelling also provides data on resilience of the water system to flooding as regards river pollution, an area not normally considered in resilience. WSIMOD allows researchers to quantify the resilience of infrastructure systems by measuring nitrate and phosphate levels. In England, this is a significant issue.

"DAFNI is a huge repository of tools, data and models, and having the WSIMOD tool on the platform will allow a much wider community of researchers to access it in an easier way. Researchers can use WSIMOD itself in a standardised implementation on DAFNI, not just a demonstrator," Dr Ana Mijic, Professor in Water Systems Integration, Imperial College London

Having the model on the DAFNI platform provides standardised access to the model, making it more universally accessible for set-up, outputs and downloads than via GitHub.

RIWS: Resilience in integrated water systems

The main outputs from DAFNI available on RIWS are:

The Water Systems Integration Modelling framework (WSIMOD) is now publicly available and free to use on the DAFNI platform. WSIMOD is a powerful integrated water systems modelling tool that simulates key processes across the entire terrestrial water cycle, including:

- Water supply & demand
- Drainage, wastewater & surface runoff
- Groundwater dynamics
- River flow & water quality

To help users get started, an example model of the Luton catchment is available, showcasing how WSIMOD can support resilience planning and decision-making under uncertainty.

Visualisation of the results can also be achieved through DAFNI, thanks to a script on the platform.

How could this work benefit society as a whole?

WSIMOD provides the opportunity for researchers to explore complex water system interactions and develop better-informed strategies, leading to more available and cheaper drinking water, reduced flooding and overflows, as well as cleaner rivers and lakes.

The model simulates the whole water system and is already being used by city authorities such as the Greater London Authority, Greater Manchester and the Environment Agency. WSIMOD provides evidence of performance at system level that allows users to see the interactions with stakeholders including local authorities and NGOs, leading to more collaborative decisions.

A key finding is that infrastructure systems have relatively high resilience whilst water quality parameters, especially nutrients, show very low resilience. WSIMOD will allow decision makers to start from the river and work backwards to ensure that the infrastructure is sound and avoids spills and pollution.

RIWS: Resilience in integrated water systems

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

Researchers and policymakers will be able to use WSIMOD on DAFNI in combination with other models to analyse interactions and make benchmarking easier.

The model is open source, allowing researchers to further develop it to suit their specific needs.

DAFNI is a collaborative platform, allowing researchers who are geographically disparate to work together more easily online.

Papers published to date are:

1. RIWS: Mijic, Ana, Barnaby Dobson, and Leyang Liu. (2024) "Towards adaptive resilience for the future of integrated water systems planning." *Cambridge Prisms: Water 2* (2024): e11. DOI: https://doi.org/10.1017/wat.2024.9
2. RIWS: Liu, L., & Mijic, A. (2025). Performance-based resilience assessment in integrated water systems: challenges and opportunities. *Journal of Hydrology*, 134042. https://doi.org/10.1016/j.jhydrol.2025.134042
3. RIWS: Liu, Leyang, Pianosi, Francesca, and Mijic, Ana. (2026). A benchmarking framework for refining decision-making under deep uncertainty approaches to improve planning cost-efficiency. Water Research, Under Review. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2026.147850

RIWS: Resilience in integrated water systems

The future

Future explorations will look at the concept of resilience in multiple geographical or water company areas and further develop benchmarking for comparative research.

"The regular meetings and showcase events that DAFNI arranged with researchers across the BSRW and UKRI-funded projects on the platform allowed us to collaborate with researchers in other areas, such as USARIS," Dr Ana Mijic, Professor in Water Systems Integration, Imperial College London

Additional work is in the pipeline on sensitivity analysis and adaptive planning with Dr Francesca Pianosi and the USARIS (Uncertainty quantification and Sensitivity Analysis for Resilient Infrastructure Systems) model. It will focus on decision-making and uncertainty with historical benchmarks used to test and refine scenarios with real options for adaptive planning, in order to align the results more closely with the way that the system has behaved in the past.

The foundation WSIMOD model on DAFNI includes all the elements of the water cycle and can be altered to provide different levels of complexity, from a conceptual model to detailed modelling. The team are investigating whether AI can be used in places to allow for quicker model runs.

Who's involved

Principal Investigator: Professor Ana Mijic, Professor Water Systems Integration, Imperial College London.

Leyang Liu and Barnaby Dobson, both Research Associates at the Department of Civil and Environmental Engineering, Imperial College London.

When did the project start and finish?

The project ran from October 2023 to March 2025

AUTHOR: CATHERINE DHANJAL