

SOFRAMODE: Data sharing to enhance flood modelling with DAFNI-DINI

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Introduction

The SOFRAMODE project (Sewer Overflow Flood Risk Analysis MOdel Dafni Enabled) took the existing CityCat hydrodynamic model and developed it. The enhanced model facilitates better understanding of surface water flooding and high-profile storm overflow events, allowing town planners, academics and policymakers to plan detailed mitigation measures related to any town or city, in the UK or overseas.

A key component of the project is the creation of an optimisation tool that strategically positions Blue Green Infrastructure (BGI) features. This allows users, including communities and local authorities, to assess flood and combined sewer overflow (CSO) risks and explore cost-effective management options for a range of scenarios.

The visualisation and application of the drainage network (surface flow and pipe network) for analysing results can enhance community and stakeholder engagement as well as facilitate more effective design and risk assessments.



The quality of the data coming into the model directly affects the quality of the outputs. To discuss challenges around data sharing, the SOFRAMODE team held several one-to-one meetings and practical workshops with stakeholders.

This DAFNI-DINI (Data Infrastructure for National Infrastructure) project focused on the benefits and barriers to data sharing, discussed sources of data, and captured lessons learnt and subsequent recommendations.



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

The team worked with Northumbrian Water in the North East of England to build a model to transform datasets from a restrictive binary format that can only be read by one commercial software package, into datasets packaged in open, accessible databases with clear metadata. This means that any dataset can be transformed and used by other stakeholders, such as the city council, and provides a framework for the water company to use in the future.

Demonstrating the value of data sharing to all key stakeholders through the process of developing a shared vision has resulted in more regular conversations between the water company and the city council.

Key challenges to data sharing

The interviews and workshops demonstrated that the main barriers to data sharing are around commercially sensitive data that may give one organisation or a consultancy competitive advantage. For that reason, consultancies and the water companies are typically reluctant to compare their model outputs with each other, or with the more sophisticated research tools used in the SOFRAMODE CityCat project.

The findings also discovered reluctance from insurers to share data related to claims. However, such data would help to validate the model and framework, and could be used to enhance the direct damage costs in the optimisation algorithms.

A number of technical barriers also became apparent. These included:

- Lack of indication of the reliability of the data
- Issues with interoperability and standards
- Metadata was often lacking, leading to data without a clear indication of when the data was collected, and whether any interpolation had taken place.



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What was the key aim of the project?

SOFRAMODE-DINI's approach to overcoming barriers, related to commercially sensitive data, was to work towards a shared vision for the framework through a series of meetings and workshops, where stakeholders could identify how they could benefit from sharing their data.

Providing real-time measurement of flow depth in the pipe network and combined sewer overflows, for example, could provide a host of benefits to the water company, including:

- Inform interventions to reduce the volume of flows reaching wastewater treatment plants
- Reducing costs
- Reducing resources required
- Reducing risk of fines from spills
- Ultimately the benefits of insights into real time combined data could reduce pollution whilst enhancing company profits and public perception.



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

DAFNI funding allowed the SOFRAMODE DINI team to hold one-to-one discussions and workshops with stakeholders to define their specification of capabilities and scope for the platform and to understand known barriers to data and information sharing.

One-to-one discussions were held with: Newcastle City Council, the Environment Agency, the REECE Foundation (a charity that promoted engineering and manufacturing in North East England), and community groups around Newcastle.

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The practical workshops set-up and ran models with insurance analysts and Northumbrian Water to address their initial questions and needs.

During a 'sprint' at Northumbrian Water's Innovation Festival in July 2024, the project was able to provide near real time results and outputs to scenarios to inform investment priorities for the water company. The enhanced CityCAT modelling framework was demonstrated, and subsequent scenarios co-developed with stakeholders.

The method and results were validated through post flood event questionnaires, observed data from Newcastle City Council and crowdsourced data from the public to validate model outputs.

The main outputs from SOFRAMODE available on DAFNI are:

The data is stored in a spatially enabled database on Newcastle University data mirrored servers. Raw data is currently not shared.

Model outputs are stored as raster or relational tables in a database on the DAFNI platform. Size varies from a few megabytes to gigabytes depending on the domain and user-defined resolution. Outputs are shared and available to all project stakeholders.

DAFNI platform users can also access the CityCAT optimisation tool to identify where best to place blue green infrastructure.

How could this work benefit society as a whole?

The work enables more robust decision making. Blue green infrastructure interventions can complement upcoming developments and help tailor policies and plans for urban areas appropriately.

CityCAT can be used for detailed, efficient, economical design of mitigation interventions and is already benefitting the population of Newcastle through its use in Newcastle City Council's Blue-Green Initiative.



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

The DAFNI-DINI SOFRAMODE project demonstrates that workshops and one-to-one conversations around a shared goal can break down defensiveness around data sharing. Commercial and security concerns remain real and there are contentious issues around raw data but, with a clear shared goal, derived data outputs are more readily shared.

The process of developing a shared vision for data sharing can also result in stakeholders having more regular conversations and more open lines of communication.

The CityCAT model is available for use, offering a unique combination of:

- Efficient software architecture and numerics
- Easy use of standard, readily-available datasets
- Robust and accurate solutions of flow equations for fully coupled surface and pipe network flow.

The future

The work carried out on data sharing demonstrated that future research should prioritise how to fill other key data gaps. These include engagement with insurance analysts to provide much-needed data to validate and improve flood damage estimates.

Dr James McKenna, Research Associate on the project, has been awarded a DAFNI Fellowship, so from April 2026 is taking SOFRAMODE's work forwards within his Fellowship to focus on scaling the CityCAT and SOFRAMODE work nationally, strengthening collaborations across academia, industry and government. The aim is to help the hydrodynamic optimisation tool developed within SOFRAMODE to become a reusable, high-value asset supporting long-term infrastructure resilience.



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Who's involved?

Dr Vassilis Glenis, Senior Lecturer in Hydroinformatics in the School of Engineering at Newcastle University, with Co-Investigator **Dr Claire Walsh**, Professor of Water Security at Newcastle University, plus researcher **Dr James McKenna**, Research Associate in Hydrodynamic Modelling at Newcastle University.

When did the project start and finish?

The project started in January 2024 and run until March 2025.

