UK Research and Innovation

Use case template for the Data Infrastructure for National Infrastructure project (DINI)

Sewer Overflow Flood Risk Analysis MOdel Dafni Enabled (SOFRAMODE)

Vassilis Glenis and Claire Walsh
School of Engineering, Newcastle University

UK Research and Innovation

Contents

UK Research and Innovation

1. Use case Report

1.1 Background and Context

The project aims to develop a modelling system on DAFNI that facilitates the understanding and simulation of urban drainage across any UK town or city for a range of storm events. A key component of this project is the creation of an optimisation tool that strategically positions Blue Green Infrastructure (BGI) features. This tool will allow 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. Furthermore, the visualisation and application of the drainage network (surface flow and pipe network) for analysing results will enhance community and stakeholder engagement as well as facilitate more effective design and risk assessments.

The main stakeholders are: City Council, Environment Agency, Water Company, Reece Foundation and community groups.

1.2 Description of Activities

Throughout the project we have undertaken a number of activities to achieve its overall aim to develop and demonstrate a state-of-the-art platform on DAFNI for understanding and simulating urban drainage for any UK city, over a wide range of current and future rainfall event magnitudes, and to provide functionality for consultants and industry, as well as researchers, to design and test a range of strategies to mitigate combined sewer overflows and surface water flooding. These activities have included 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 have been held with: City Council, Environment Agency, REECE Foundation, and community groups around Newcastle.

Practical workshops have set-up and ran models with the stakeholders to address their initial questions and needs. Workshops have taken place with: Insurance Analysts and the Water Company.

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

1.3 Benefits of Data Sharing

As with any model, the quality of the output is related to the data driving the simulations. Our aim was to demonstrate to all stakeholders who have data that could contribute to an outcome of an integrated modelling framework to understand the complex flooding system and hence improve choice, location and design of interventions to reduce flood risk.

Data sharing enables:

- An improved representation of the flooding system e.g. storm and sewer pipe networks better capture surface and subsurface interactions and combined sewer overflows;
- An enhanced modelling framework e.g. the current business model for integrated surface and sewer network flooding is for expensive and restrictive licensing of dated software which does not make full use of data available. At the heart of this framework is CityCAT which uses a unique combination of: efficient software architecture and numerics; easy use of standard, readily-available data sets; robust and accurate solutions of flow equations for fully coupled surface and pipe network flow;
- Validation of the method and results e.g. post flood event questionnaires, observed data from Newcastle City Council and crowd-sourced data from the general public to validate model outputs;
- More robust decision making e.g. awareness and awareness of new policies and plans for urban areas so that interventions complement upcoming developments.
- Detailed, efficient, economical design of mitigation interventions e.g. the project is informing Newcastle City Council's Blue-Green Initiative.

1.4 Barriers for Data Sharing

The main data sharing barriers relate to commercially sensitive data e.g. that may give one organisation/consultancy competitive advantage. Consultancies and the water company are reluctant to compare their model outputs, with that of each other's and the more sophisticated research tools used here.

The project, as a stakeholder, is impacted by a reluctance from insurers to share data related to claims which would help use validate the model and framework, and furthermore, enhance the direct damage costs in the optimisation algorithms.

Although the main barrier to data sharing is around the commercial sensitive data owned by water companies and consultants, technical barriers are also apparent. Namely, no indication of the reliability of the data, lack of interoperability and standards and usually

poor metadata for example, clear indication of when the data was collected and if any interpolation has taken place.

Our approach to overcoming barriers related to commercially sensitive data was to work towards a shared vision for the framework, where all stakeholders could identify how they could benefit from sharing their data. For example, for the water company, providing real time measurement of flow depth in the pipe network and combined sewer overflows, could inform interventions to reduce the volume of flows reaching waste water treatments plants, reducing cost, resources and pollution, reducing risk of fines and enhancing company profits and public perception.

Technical barriers were addressed by working with the water company to transfer datasets into open, accessible databases with clear metadata. This was beneficial to both the project and provide a framework for the water company to use in the future.

1.5 Sources of data – table

Data Source	Data Description	Purpose	Technical Details	Data restrictions and Licence	Barrier	Stakeholder
Storm and sewer pipe networks. Water Company	Spatial representation of the storm and sewer pipe networks which incudes pipe dimensions, invert levels and manhole locations and dimensions.	To build fully-coupled surface and sub-surface drainage networks.	Binary file from commercial software. Size: ~2 GB Limited metadata Dataset includes: vertices, edges, and initial flow conditions	Data sharing agreement just for this project.	Commercial sensitive	Policy makers Researchers
Questionnaire data. City Council	Qualitative data collected from households affected by flooding.	Validation of model results.		Data sharing agreement just for this project.	Personal sensitivity	Researchers

1.6 Results Data

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 with all project stakeholders.

1.7 Lessons Learnt and Recommendations

Lesson learnt:

- Initially data sharing is a contentious issue, with stakeholders' reluctance to provide raw data; derived data outputs are more readily shared.
- We have demonstrated the value of data sharing to all key stakeholders through the process of developing a shared vision. This has resulted in more regular conversations between the water company and the city council.
- Water Company data has been transformed from a restrictive binary format that can only be read by one commercial software package, into an accessible database supported by appropriate metadata so the data can be used by other stakeholders e.g. city council.

Recommendations:

- Priority for future funding should focus on filling other key data gaps e.g. engagement with insurance analysts to provide much needed data to validate and improve flood damage estimates.