Urban Water Infrastructure Transitions : simulation and analysis of sewer networks

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Background and motivation

The problem. Urban sewer networks are ageing and increasingly under-capacity due to urban expansion. Also, most cities have combined sewers, where storm water and waste water are mixed, resulting in expensive problems such as overflows causing pollution as well as overloading waste water treatment plans (WWTPs). The **solution?** Strategies proposed include increased pipe diameters, replacement with separated systems, or Blue-Green Infrastructure to replace pipes. These solutions can be expensive and impacts on other parts of the city or infrastructure. So, analysis of the current system and designs for new solutions, under different climate, demographics and regulation must be carried out using computer models of the cities.



These high resolution results of CityCAT for Newcastle show potential flooding at building level.

The MISTRAL Urban Water Modelling

strategy We are using the **CityCAT (City Catchment**

Analysis Tool) hydrodynamic model to simulate the urban water system, as industry models cannot adequately represent the complex flows between pipes, surfaces and buildings, with a range of planned interventions. In MISTRAL we are undertaking analysis of multiple cities across the UK, to cover a range of different sizes, ages, topography and rainfall climate. This means using the Cloud for computing at high resolution for large domains, and imposing a huge burden on the need for detailed information on the sewer networks. To reduce the data requirements, we are augmenting the real pipe network data from water companies with synthetic versions of the pipe and storm drain networks which can be generated from readily available data of roads and buildings.

How does CityCAT work?





Modelling different pipe diameters

Increasing pipe diameters can improve drainage of surface water as shown in this model output. The left plot shows surcharging inlets (red points) which disappear when larger pipe sizes are used (right plot).



The importance of sewer networks

Most flood models do not include sewer networks and storm drains explicitly. These maps show the difference between a 2D and 1D/2D simulation (with the network).



CityCAT gives information on flow velocities as well as depths – the map on the left shows the effect of storm drains on flow paths and velocities for a section of the maps above.



Synthetic or new designs of networks

Using the real data is difficult and time-consuming and we can learn a lot by using synthetic (or new designs) of the sewer and drain networks.

Future work in MISTRAL

We plan to model the major cities in Britain to assess the overall capacity of the networks and flood risk associated, for the present situation and for future possible design interventions. The effects and cost of separated or super-sized pipe networks will be investigated.

This map shows a comparison of a real storm drain (gully) network and a synthetic one – water depths reflect the difference between the respective *surface water grids* generated.



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