Hydraulic modelling, a tool to identify integrated water cycle management opportunities

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Overview

While the integrated planning approaches are maturing for urban water systems, the hydrological and hydraulic modelling tools to help assess a truly integrated water system are generally lacking in terms of their ability to represent all the functions and interactions of the urban water cycle. Melbourne Water has embarked in a series of pilot studies and system wide hydraulic modelling projects aiming to fill up some of the urban water cycle knowledge gaps. Traditionally, different hydraulic models have been employed to independently assess the current and future performance of water supply, sewerage and drainage systems. Each of these independent models often have their own set of assumptions which are not transferable and are typically not aware or considerate of the assumptions relating to the other systems. To meet the challenges of ever-increasing complexity and promote transparency and consistency between models, Melbourne Water identified the need to test new planning tools which reflect the interdependencies of our urban water systems, and more explicitly assess the benefits of integrated water management projects. A pilot modelling project was undertaken to explore these benefits and identify barriers to the development of an integrated hydraulic model representing the three water networks using off-the-shelf software. Combining the water networks into one single hydraulic model would allow a clearer understanding of the interactions between the systems and better align the modelling assumptions, while reducing modelling effort. This paper will focus on the pilot modelling project while providing an update on Melbourne Water's hydraulic modelling tools set-up.

Objectives

The objective of the study was to explore the practicality of using InfoWorks ICM, software developed by Innovyze to simulate the total water cycle at an individual property scale and test this modelling concept across an established urban region in Melbourne. The pilot model included potable, sewer and stormwater networks with a rainwater tank connected to the roof of each residential allotment. The stormwater hydrology component incorporated two-dimensional (2D) surface flood modelling, linked to the one-dimensional (1D) drainage network, to enable flows to pass between the piped and surface flow systems.

Method

The pilot model was first tested on a small, local scale area with 100 residential properties in order to develop the base water cycle hierarchic rules and verify the movement of water from one system to another, at the property scale. Following the successful completion of the 100 property model testing the ability to simulate the flows and demands at that scale was confirmed, the model was then scaled up to 5,000 and 27,000 properties to test how the method applied in the 100 property model would perform under a significant increase in model extent.

Results

Several learnings were gained from this pilot modelling project that can assist urban planning in Australia. The boundaries of pressurised potable networks, gravity sewer and drainage networks are different; hence the selection of a study area that captures a reasonable boundary description for all three networks may require modelling of a larger extent than the area of interest. Replicating the operation of the potable system within a limited study area is problematic when the potable system is part of a much larger network with hydraulic controls well beyond the specific area of interest.

Conclusions

As a proof of concept, this project has demonstrated that it is possible to combine the three different piped water systems and link them to a 2D surface runoff model to provide a comprehensive, deterministic model of the total water cycle at a local, precinct or suburban scale. This is a unique approach that leverages existing modelling tools in a way that has previously not been achieved. It opens the way to define new questions and measures for water management that have up to now only been possible at a conceptual level, or on a lumped or stochastic basis.