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High resolution modelling of extreme precipitation events in urban areas

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The present day society needs to adjust to the effects of climate change. More extreme weather conditions are expected, which can lead to longer periods of drought, but also to more extreme precipitation events. Urban water systems are not designed for such extreme events. Most sewer systems are not able to drain the excessive storm water, causing urban flooding. This leads to high economic damage. In order to take appropriate measures against extreme urban storms, detailed knowledge about the behaviour of the urban water system above and below the streets is required. To investigate the behaviour of urban water systems during extreme precipitation events new assessment tools are necessary. These tools should provide a detailed and integral description of the flow in the full domain of overland runoff, sewer flow, surface water flow and groundwater flow.

We developed a new assessment tool, called 3Di, which provides detailed insight in the urban water system. This tool is based on a new numerical methodology that can accurately deal with the interaction between overland runoff, sewer flow and surface water flow. A one-dimensional model for the sewer system and open channel flow is fully coupled to a two-dimensional depth-averaged model that simulates the overland flow. The tool uses a subgrid-based approach in order to take high resolution information of the sewer system and of the terrain into account [1, 2]. The combination of using the high resolution information and the subgrid based approach results in an accurate and efficient modelling tool. It is now possible to simulate entire urban water systems using extreme high resolution (0.5m x 0.5m) terrain data in combination with a detailed sewer and surface water network representation. The new tool has been tested in several Dutch cities, such as Rotterdam, Amsterdam and The Hague.

We will present the results of an extreme precipitation event in the city of Schiedam (The Netherlands). This city deals with significant soil consolidation and the low-lying areas are prone to urban flooding. The simulation results are compared with measurements in the sewer network.

References
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[2] Vincenzo Cassuli and Guus S. Stelling, 2013. A semi-implicit numerical model for urban drainage systems. International Journal for Numerical Methods in Fluids. Vol. 73:600-614. DOI: 10.1002/fld.3817