Decision-Making under Uncertainty: Optimal Storm Sewer Network Design Considering Flood Risk

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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Abstract

Storm sewer systems play a very important role in urban areas. The design of a storm sewer system should be based on an appropriate level of preventing flooding. This thesis focuses on issues relevant to decision-making in storm sewer network design considering flood risk.

Uncertainty analysis is often required in an integrated approach to a comprehensive assessment of flood risk. The first part of this thesis discusses the understanding and representation of uncertainty in general setting. It also develops methods for propagating uncertainty through a model under different situations when uncertainties are represented by various mathematical languages.

The decision-making process for storm sewer network design considering flood risk is explored in this thesis. The pipe sizes and slopes of the network are determined for the design. Due to the uncertain character of the flood risk, the decision made is not unique but depends on the decision maker's attitude towards risk. A flood risk based storm sewer network design method incorporating a multiple-objective optimization and a "choice" process is developed with different design criteria.

The storm sewer network design considering flood risk can also be formed as a single-objective optimization provided that the decision criterion is given a priori. A framework for this approach with a single objective optimization is developed. The GA is adapted as the optimizer. The flood risk is evaluated with different methods either under several design storms or using sampling method.

A method for generating samples represented by correlated variables is introduced. It is adapted from a literature method providing that the marginal distributions of variables as well as the correlations between them are known. The group method is developed aiming to facilitate the generation of correlated samples of large sizes. The method is successfully applied to the generation of rainfall event samples and the samples are used for storm sewer network design where the flood risk is evaluated with rainfall event samples.

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