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Towards an in-depth understanding of thermal-hydraulic processes in sewer networks

Keywords
Sensitivity analysis, Thermal-Hydraulic Dynamics, Heat Transfer, SWMM-HEAT, UQLab

Background
A recently developed thermal-hydraulic model called SWMM-HEAT [1] allows users to predict the temperature evolution of storm- and wastewater across full urban drainage network. SWMM-HEAT is a physically based tool developed at Eawag that enhances the hydrodynamic EPA-StormWater Management Model (SWMM) with the necessary thermal components to perform such simulations. However, the application of the tool in practice may be challenging, because information on model parameters and boundary conditions, such as humidity in the sewer headspace or thermal properties of pipe material, are uncertain or difficult to obtain. Furthermore, SWMM-HEAT continues to be developed by introducing new capabilities, such as heat transfer due to the presence of sediment accumulation, which will also be taken into account in the sensitivity study. Therefore, an in-depth study of the behaviour of the model is important to identify the impact of selected parameters and boundary conditions. UQLab [2], a Matlab-based framework for uncertainty quantification developed at ETHZ, will provide the modules needed for performing the sensitivity analysis.

Goal and objectives
The goal is to quantify the model's sensitivity for most relevant parameters with a structured two-step approach. On the one hand, we would like to obtain the most important parameters that affect downstream temperatures, non-linearities between parameter changes and model outputs, and potential dependencies between individual parameters. On the other hand, engineering know-how is required to determine suitable metrics for different applications, e.g. available heat for design of heat exchangers, minimum temperatures for impact studies at the WWTP, etc. As this is an emerging field, and the model is unique, there is a high probability that the results could contribute to a peer-reviewed scientific publication.

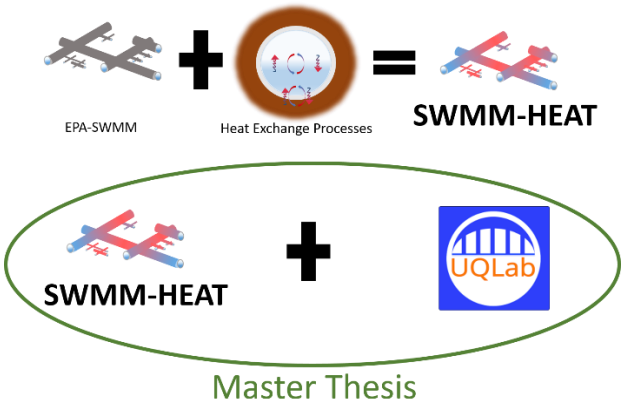

Fig. 1: EPA-SWMM is a hydraulic model for urban drainage planning and research. It is currently adapted by Eawag to include thermal-hydraulic interactions in sewers (SWMM-HEAT). UQLab provides the platform for an in-depth study of the impact of the input parameters in the model outputs.

The **suggested tasks** are as follows:

1. Review the literature and numerical implementation (Matlab's UQLab, R, Python, …) on sensititivy analysis methods, such as Morris screening or Sobol's method.
2. Study the thermal aspects of the (physically based) SWMM-HEAT model and define the range of input paramenters and estimators used to perform the sensitivity analysis.
3. Select suitable metrics for different engineering applications and identify important model parameters of SWMM-Heat.
4. Make your code and data openly available, e.g. in a host such as GitHub or open data platforms.
5. Discuss the achieved results and document your work in a written final report,

Requirements

- Interest in sensitivity analysis and physical modelling;
- Entry-level knowledge of scripting or programming languages (R, Matlab, Python);
- Good knowledge of English.

Supervision

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