Global Sensitivity Analysis and Multi-Objective Optimisation for Estimation of Combined Sewer Overflows – Case Study Linz

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EXTENDED ABSTRACT

The modelling of rainfall-runoff-transport processes in urban drainage systems is well established and extensively applied and described in the literature (Rauch *et al.*, 2002). The importance of a proper model assessment and a thorough calibration has been highlighted in many scientific studies and is promoted in several publications on good modelling practice. While numerous methods for model analysis and calibration exist, their application in general practice is still limited.

In scope of the 7th EU framework programme project SUDPLAN (www.sudplan.eu) possible impacts of climate change on urban infrastructure are assessed. For the urban drainage pilot of Linz, Austria the performance of a combined sewer system is evaluated according to the current Austrian 'ÖWAV Regelblatt 19' guideline on CSO design (OEWAV, 2007) by aid of an aggregated SWMM5 sewer model.

This paper discusses the application of a global sensitivity analysis method – the screening method of Morris (Morris, 1991) – and multi-objective optimisation based on evolutionary algorithms (Muschalla, 2008) for model calibration on the practical example of Linz, Austria in order to

- identify and rank the important model parameters in order to (i) evaluate which parameter could profit of a better prior evaluation and (ii) derive the important model parameters for model calibration,
- calibrate the model based on available measurement data using a state-of-the-art multi-objective optimisation method to eventually
- provide a sound model basis for the Linz pilot in the SUDPLAN project.

Methods

The Linz urban catchment is located at the Danube River in Austria and covers approximately 900 km², including the highly urbanised area of downtown Linz and 39 neighbour communes that are drained to a central wastewater treatment plant.

Global sensitivity analysis (GSA) allows a thorough prior analysis of the model behaviour and permits deriving influential parameters e.g. for model calibration. In this study the Morris screening was chosen as it allows parameter ranking and identification of non-linear behaviour and/or interactions and works at low computational costs compared to other methods (Saltelli *et al.*, 2004). Several screening runs were performed with different parameter ranges to identify parameter sensitivities with respect to CSO efficiency according to the Austrian RB19 guideline.

Concerning model calibration the Nash-Sutcliffe efficiency was optimised using data from three in-sewer water level measurements for five independent storm events. A synthetic parameter set was then determined from weighting the 5 obtained parameter sets. The algorithm was chosen as it has already been successfully applied in urban drainage studies (Muschalla (2008) and Gamerith *et al.* (2011)) and can be linked directly to SWMM.

Results and Discussion

It was shown that the GSA allowed identifying the important model parameters influencing the CSO efficiency. Especially the imperviousness of the neighbour communes was highlighted as influential. Concerning the CSO efficiency for particulate pollutants the assumed sedimentation efficiency of the storage tanks showed to be highly influential. A better assessment could significantly increase model quality and reduce the uncertainties. On the other hand one subcatchment where considerable effort was made to assess its structure in the model set up was shown not to influence the results significantly.

Model calibration yielded different quality for the five selected events. For two of the events the use of one single rain gauge proved insufficient for the large catchment. Overall it was demonstrated how the chosen methods can be applied to a real world application. Satisfying results were obtained as basis for the SUPLAN project.

References

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