Ref: HESS_2022_109_review (submitted on 25 April 2022) Title: The role of catchment characteristics, sewer network, SWMM model parameters in urban catchment management based on stormwater flooding: modelling, sensitivity analysis, risk assessment

Dear Reviewer, Thank you for your attention. Indeed, aspects of uncertainty analysis (its effect on simulation results of specific flood volume and manhole overflow) and the use of a logistic regression model were addressed in the publications mentioned above. However, the data and context of their use was different than in the manuscript submitted for review. In connection with this, let us clarify it. Namely, in the manuscript: "Influence of urban catchment characteristics and rainfall origins on the phenomenon of stormwater flooding: A case study" (Environmental Modelling and Software) developed a logit model based on rainfall data and catchment characteristics on identifying only the phenomenon of stormwater flooding in the catchment. These analyses were performed for sub-catchments A, B, C, D (Fig. 1), which was justified by their location and the possibility of conducting a field survey simultaneously in two catchments during a single rainfall event.

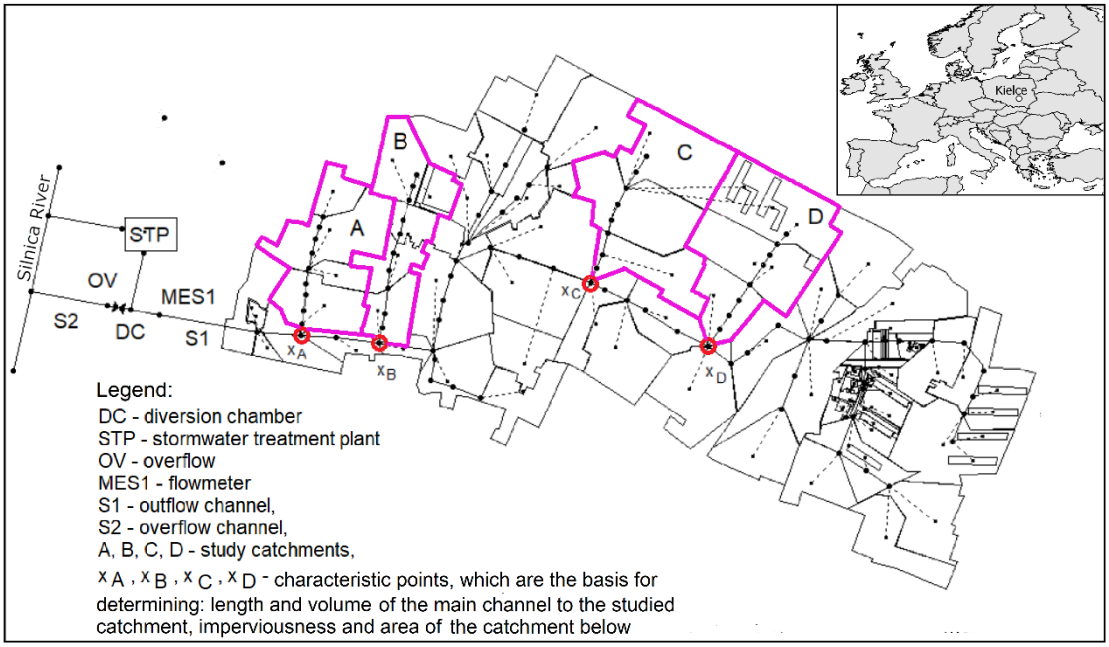

Fig. 1. Study catchments for the determination of a logit model for stormwwater flooding identification (Szeląg et al. 2022)

The 159 rainfall events observed during the period 2008 - 2019 were used for this purpose. Although the feasibility of using the developed model to identify stormwater flooding in a catchment during a single rainfall - runoff event was demonstrated, because the field study covered only 4 catchments, the resulting relationships in the manuscript by Szeląg et al. (2022) did not fully reflect the phenomenon of stormwater flooding occurrence and did not take into account the volume of stormwater flooding. The limitations of the developed model are highlighted in this work. In the context of literature data (Jato - Espino et al. 2018, Li and Willems 2020), improved predictive capability was possible by using a hydrodynamic model which enables to perform simulations. Nevertheless, the authors focused on developing simulators to identify flooding from a single manhole based on simulation results with a calibrated hydrodynamic model. However, in the context of uncertainty analysis, it is known that there is an interaction between the calibrated parameters, resulting in many possible combinations of SWMM parameters for which identical matches between computational results and measurements are obtained. In this context, it is difficult to unambiguously consider as correct the results of a simulation of a well stormwater flooding, for example, ignoring the uncertainty of the calibrated parameters.

Once we identified this problem, we concluded that it was necessary to determine the effect of uncertainty in the calibrated SWMM model parameters on the results of the parameter calculations that form the basis for evaluating the performance of the drainage network. A literature study (Siekman and Pinekamp 2011) indicated that the appropriate parameters for evaluating the performance of a drainage system are specific flood volume and manhole overflow (degree of flooding). These calculations were made for the entire urban catchment, without sub-catchment division in the paper: "Relationship between rainfall duration and sewer system performance measures within the context of uncertainty" (Water Resources Management). However, is the value of specific flood volume determined for the whole catchment an adequate measure of stormwater system performance evaluation and should it serve as a basis for decision making? Of course not, because it is important to answer the question which part of the drainage system needs to be upgraded. To meet this objective, there would be a need to separate sub-catchments in the model where specific flood volume would be determined. In the manuscript: "Relationship between rainfall duration and sewer system performance measures within the context of uncertainty" such analyses were not performed. Indeed, in the manuscript by Szeląg et al. (2021) the influence of SWMM model parameters on specific flood volume was analyzed, but the data were presented for a single rainfall only, and thus the obtained relationships were of a preliminary nature and only illustrated certain trends, but not strict relationships that can be practically used. To determine the relationship between specific flood volume and SWMM model parameters in the work of Szeląg et al. (2021), the results of sewer operation simulations were used in which 5000 simulations were performed (considering the combination of SWMM parameters) for each independent rainfall event. The obtained preliminary results turned out to be interesting and bearing in mind that so far no simulator of specific flood volume has been developed that would simultaneously take into account the characteristics of the catchment, the stormwater network and the parameters of the SWMM model, an attempt was made to build one. For this purpose, sub-basins were separated in the model using the developed hydrodynamic model, which is a common practice. In this approach, the authors were guided by the limitations of the obtained logit model obtained in the paper: "Influence of urban catchment characteristics and rainfall origins on the phenomenon of stormwater flooding: A case study". The aim was not to simulate similar processes, because the probability of a specific flood volume and the probability of a stormwater flooding are quite different independent parameters. The use of measured data of stormwater flooding in the catchment (Szeląg 2022), as well as the adopted calculation methodology clearly confirmed the lack in the developed model.

The number and diversity of catchment characteristics used to build the model were insufficient from a simulation point of view. It is the number of data for model building that determines the results of calculations and the relationships obtained. In this context and bearing in mind that the aim of the analyses is an attempt to develop a universal tool for the use of hydrodynamic modeling, increasing the number of sub-basins for the planned experiment made it possible to increase the data for model building. We wanted to mention that the division of catchments and separation of sub-catchments was supported by the analyses of Walek (2019), who separated sub-catchments of side channels as part of his PhD dissertation and spatial data analyses for the whole of Kielce. The number of sub-catchments, their arrangement, was conditioned by the variation within them of the characteristics of the catchment, stormwater network, which is important from the point of view of the scope of applicability of the simulation model built. Taking into account the limitations of the models developed so far and the simulation results in the works of Szeląg et al. (2021, 2022), Jato - Espino et al. (2018), Li and Willems (2020), a simulation experiment was planned involving the separation in the analyzed catchment, sub-catchments for which simulations of specific flood volume were performed for the separated rainfall events in the observational series of measurements (2008 - 2018). Thus, the methodology proposed in this paper is a compilation of experiments, but not of computational results obtained in the works: ,,Influence of urban catchment characteristics and rainfall origins on the phenomenon of stormwater flooding: Case study", "Relationship between rainfall duration and sewer system performance measures within the context of uncertainty". Efforts were made to develop a model that would reflect the operating conditions of the stormwater system (in the

context of hydrology), but also to increase the amount of data to build the model, which is an indirect method to increase its accuracy (if the results of calculations with the logit model proved to be unsatisfactory, more advanced methods of machine learning would be applied). Using such a modified methodological approach to preparing data for model building, a logit model was developed that has nothing in common with the model obtained in the work of Szeląg et al. (2022).

Dear Reviewer, The objective of the present analyses was primarily to develop a tool to determine the influence and interaction between the calibrated parameters of the SWMM model and the specific flood volume taking into account both catchment characteristics, stormwater network and rainfall data. Based on the developed model, it was determined that at the stage of sensitivity analysis, boundary conditions are important. The values of catchment characteristics determine the influence of SWMM model parameters on stormwater flooding, which is very important from the point of view of model calibration, selection of techniques for identifying catchment and stormwater network characteristics before attempts are made to create a hydrodynamic model. The methodology obtained in this study actually answers a number of questions that can be initially answered before the construction of the hydrodynamic model is started. This is extremely important as it allows for optimization of the model calibration methodology. The obtained results and the model can be used as a tool for preliminary identification of requirements that must be fulfilled for the model to provide high agreement between the calculation results and measurements.

The manuscripts of Szeląg et al. (2021, 2022) only attempted a step-by-step methodology to identify the problem due to the enormous computational effort involved. As mentioned above 108 precipitation events were used to build the logit model (Szeląg et al. 2021), 90,000 simulations (16 rainfall events and 5000 simulations) were performed to determine the effect of uncertainty in the calibrated SWMM parameters, in the present problem the number of simulations is many times larger. Undertaking such a complex problem indeed required preliminary analyses, which were necessary because in undertaking subsequent simulation problems we were unable to answer the question of whether it is possible to develop such a simulator.

In this manuscript, we tried to highlight the influence of catchment characteristics on the results of sensitivity coefficient calculations, which is important from the point of view of selecting SWMM model parameters for calibration, but also may be relevant at the stage of planning the location of measuring devices. In addition, efforts were made to focus on reflecting stormwater flooding conditions in catchments given the varying catchment characteristics. From this point of view, it would indeed be reasonable to attempt to compare the results obtained with the studies of other authors and to perform a preliminary verification of the model developed. It seems advisable to compare the results of the sensitivity analysis obtained by other authors. First of all, it is advisable to highlight the influence and interaction between catchment characteristics and SWMM parameters in the context of literature data and to demonstrate the usefulness of the developed model.

We would also like to mention that the results of calculations, which were obtained in the previous works: ,,Influence of urban catchment characteristics and rainfall origins on the phenomenon of stormwater flooding: Case study", "Relationship between rainfall duration and sewer system performance measures within the context of uncertainty" were not used for model building in this manuscript. Data for building the logit model (in this manuscript) were obtained by performing independent computer simulations over a period of 4 months.

Literature

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We are also grateful for your specific remarks. We would like to address them in the author response letter.