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Sensitivity analysis of urban flood flows to hydraulic controls

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Flooding represents one of the most significant natural hazards on each continent and particularly in highly populated areas. Improving the accuracy and robustness of prediction systems has become a priority. However, in situ measurements of floods remain difficult while a better understanding of flood flow spatiotemporal dynamics along with dataset for model validations appear essential. The present contribution is based on a unique experimental device at the scale 1/200, able to produce urban flooding with flood flows corresponding to frequent to rare return periods. The influence of 1D Saint Venant and 2D Shallow water model input parameters on simulated flows is assessed using global sensitivity analysis (GSA). The tested parameters are: global and local boundary conditions (water heights and discharge), spatially uniform or distributed friction coefficient and or porosity respectively tested in various ranges centered around their nominal values - calibrated thanks to accurate experimental data and related uncertainties. For various experimental configurations a variance decomposition method (ANOVA) is used to calculate spatially distributed Sobol' sensitivity indices (Si's). The sensitivity of water depth to input parameters on two main streets of the experimental device is presented here. Results show that the closer from the downstream boundary condition on water height, the higher the Sobol' index as predicted by hydraulic theory for subcritical flow, while interestingly the sensitivity to friction decreases. The sensitivity indices of all lateral inflows, representing crossroads in 1D, are also quantified in this study along with their asymptotic trends along flow distance. The relationship between lateral discharge magnitude and resulting sensitivity index of water depth is investigated. Concerning simulations with distributed friction coefficients, crossroad friction is shown to have much higher influence on upstream water depth profile than street friction coefficients. This methodology could be applied to any urban flood configuration in order to better understand flow dynamics and repartition but also guide model calibration in the light of flow controls.