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Abstract: 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 flows corresponding to frequent to rare return periods. The influence of 1D Saint Venant and 2D Shallow water model (Telemac2D) 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) and spatially uniform or distributed friction coefficient tested around their calibrated values thanks to accurate experimental data and related uncertainties, where the outputs of interest are spatially distributed water height and outlet discharge. For various experimental configurations a variance decomposition method (ANOVA) is used spatially to calculate distributed Sobol' sensitivity indices (Si's). The sensitivity of water depth and discharge to input parameters on the whole 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. The spatially distributed Sobol' index in 2D configuration show similar trends as in 1D with except for a sub-critical flow zone where coupling effects between the tested parameters is highlighted. The role of street width and obstruction on discharge distributions is also analyzed using GSA. This methodology could be applied to any urban flood configuration in order to better understand flow dynamics and distribution but also guide model calibration in the light of flow controls.