Geophysical Research Abstracts
Vol. 14, EGU2012-4688, 2012
EGU General Assembly 2012

Influence of model reduction on uncertainty of flood inundation predictions

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Derivation of flood risk maps requires an estimation of the maximum inundation extent for a flood with an assumed probability of exceedence, e.g. a 100 or 500 year flood. The results of numerical simulations of flood wave propagation are used to overcome the lack of relevant observations. In practice, deterministic 1-D models are used for flow routing, giving a simplified image of a flood wave propagation process. The solution of a 1-D model depends on the simplifications to the model structure, the initial and boundary conditions and the estimates of model parameters which are usually identified using the inverse problem based on the available noisy observations. Therefore, there is a large uncertainty involved in the derivation of flood risk maps. In this study we examine the influence of model structure simplifications on estimates of flood extent for the urban river reach. As the study area we chose the Warsaw reach of the River Vistula, where nine bridges and several dikes are located. The aim of the study is to examine the influence of water structures on the derived model roughness parameters, with all the bridges and dikes taken into account, with a reduced number and without any water infrastructure. The results indicate that roughness parameter values of a 1-D HEC-RAS model can be adjusted for the reduction in model structure. However, the price we pay is the model robustness.

Apart from a relatively simple question regarding reducing model structure, we also try to answer more fundamental questions regarding the relative importance of input, model structure simplification, parametric and rating curve uncertainty to the uncertainty of flood extent estimates. We apply pseudo-Bayesian methods of uncertainty estimation and Global Sensitivity Analysis as the main methodological tools. The results indicate that the uncertainties have a substantial influence on flood risk assessment. In the paper we present a simplified methodology allowing the influence of that uncertainty to be assessed. This work was supported by National Science Centre of Poland (grant 2011/01/B/ST10/06866).