Geophysical Research Abstracts,
Vol. 11, EGU2009-8627, 2009
EGU General Assembly 2009

Quantification of uncertainty sources in a 2D hydraulic model for the river Rhine using expert opinions

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Hydrodynamic river models are applied to design and evaluate measures for purposes such as safety against flooding. These numerical models are all based on a deterministic approach. However, the modeling of river processes involves numerous uncertainties, resulting in uncertain model results. Uncertainty is defined as any deviation from the unachievable ideal of complete determinism. Uncertainty in models comprises (1) the difference between a model outcome and a measurement and (2) the possible variation around the computed value or measurements. Knowledge of the type and magnitude of these uncertainties is crucial for a meaningful interpretation of the model results. The aim of this study is to identify the sources of uncertainty that induce the largest uncertainties in the model outcomes and quantify this uncertainty using expert opinions. In this study, the two-dimensional WAQUA model for the Dutch river Rhine is used as an example for the quantification of uncertainty sources.

Sixteen experts have been selected based on a Pedigree matrix with 4 criteria: 1) experience with code development, 2) experience with WAQUA projects, 3) experience in years, and 4) number and type of publications about WAQUA. The 16 experts with the highest Pedigree scores have been invited for an interview. Interviews are held with 11 of these experts. During the interviews, the experts are asked to list the most important uncertainty sources for the following two situations: (1) the computation of design water levels (DWL), based on a design discharge wave and (2) the computation of the effect of a measure in the river bed, which is done using a constant discharge as input. To compare the different experts, the experts are asked to quantify the uncertainty sources on the same level of detail. Finally, the experts are asked to quantify the effect of the uncertainty sources on the computed water levels.

The experts stated that the sources of uncertainty are different for the computation of the DWL and effect studies. In case of effect studies, the experts agreed that the sources of uncertainty that do not change between the computation with and without a measure have little influence on the uncertainty in the computed effect. In case of DWL computations, the uncertainties are dominated by the sources that do not change between the calibration and the prediction. The experts agreed that the imposed stage-discharge relation and the roughness predictor for the main channel have a relatively large uncertainty. Also the data used for calibration are mentioned as an important source of uncertainty. Next to the large values given for the order of magnitude of the uncertainty, also a large scatter is shown in the experts' opinions. Finally, the effect of the uncertainty sources on the model outcomes showed that the uncertainty sources have a significant effect on the predicted water levels under design discharge conditions.