IAHS2017-225
IAHS Scientific Assembly 2017

Uncertainty Quantification of Spatio-Temporal Models with Point Estimate Methods: The case of the hydrodynamic model ANUGA

Maikel Issermann and Fi-John Chang
National Taiwan University, Department of Bioenvironmental Systems Engineering, Taipei, Taiwan (changfj@ntu.edu.tw)

Uncertainty analysis has received increasing attention from the scientific and engineering community because of the emerging realization about the uncertainty inherent to models and their inputs. In
the past such uncertainty was compensated in planning processes by Factor of Safety. However, more evidence-based methods were needed. The most prominent amongst them is the Monte Carlo method. The procedure of repeated random sampling to obtain numerical results can become computationally intensive for complex models. Although computation power increases rapidly, complexity and size of data sets, namely Big Data, increases even faster. This is especially relevant for spatial models. An alternative comes from structural engineering in form of Point Estimate Methods. In these methods a certain number, commonly two or three, of parameter values characterizing the Probability Density Function of the parameter in question are used to rerun the model simulation. The output uncertainty is estimated from the different simulation results. The Point Estimate Method applied in this research is the Hong's method. The outcome of the uncertainty analysis provides enough parameter information to estimate the Probability Density Function. In the case of spatio-temporal models the Probability Density Function of the output variable can be derived for each grid cell in each time step. For this research, the uncertainty of urban inundation projections, as being produced by the hydrodynamic model ANUGA, is assessed. The old campus of Tsinghua University in Beijing, China, serves as a case study for the inundation modelling. For that purpose, artificially generated error values in the Digital Elevation Map are introduced as the source of uncertainty in the inundation projections. Accordingly, distribution-characterizing samples from the error values are interpolated in consideration of non-stationarity to provide error fields as corrections for the Digital Elevation Map. Two implementations of the Point Estimate method are employed: batch and on-line ones. While the batch implementation runs the simulations with the different inputs separately and only combines the results at the end, the on-line implementation combines the simulation results after each time step as an input for the subsequent time step. The results obtained from the Point Estimate Method were compared with those of a Monte Carlo simulation. The comparison of the uncertainty values of inundation at selected grid cells shows that the Point Estimate Methods can be applied to spatio-temporal models with a similar accuracy as Monte Carlo. In the Point Estimate Method only three simulation runs are required, whereas a typical number of Monte Carlo simulation runs is 500. The closest resemblance to the Monte Carlo estimations is achieved by the batch implementation, whereas the on-line implementation consistently overestimates uncertainty.