Geophysical Research Abstracts
Vol. 20, EGU2018-4761, 2018
EGU General Assembly 2018

The consideration of uncertainties in meso-scale flood damage modeling

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Modeling the damage that is caused by floods is prone to uncertainties, which are usually not considered in flood risk management. However, quantitative uncertainty information leads to better informed and more effective decisions. Therefore, this study aims to develop a flood damage model framework which incorporates different kinds of uncertainty in a consistent manner.
Recently, multi-variable flood loss models like e.g. tree-based models have become more and more popular as they promise many advantages compared to single-variable models as e.g. stage-damage-functions. We apply a Random Forests approach to model the flood damage that is caused to companies. Yet, the uncertainty framework can easily be adapted to other assets and model types.
Instead of providing a single point estimate for a damaged object (as e.g. the expected damage), in this uncertainty framework we rather provide a probability distribution over each damage value. To determine the probability distribution - and consequently the uncertainty that is related to the damage prediction - we make use of the ensemble of regression trees that form the Random Forest and derive a conditional distribution for the response variable by considering the realizations in the corresponding leaf nodes of each tree.
A second kind of uncertainty incorporated in the framework is related to the input variables, especially if multi-variable models are applied. The input variables can be prone to uncertainty (for example, the value of a damaged building is usually not exactly known) or missing (for example, the precaution measures undertaken by a company are generally unknown). Especially for the damage prediction of potential future events there is a large uncertainty on what kind of companies will be affected and to which extent. Hence, the input variables are a major source of uncertainty, which has to be represented in the model results. Therefore, the proposed framework enables the estimation of the unknown input variables under the consideration of the uncertainty by means of a sampling scheme based on official statistics and observations on previous flood events.
Consequently, the presented model framework captures two main sources of uncertainty and incorporates them within the model results in the shape of flood damage distributions. These distributions of flood damage can facilitate a more informed decision making with regard to flood risk management under uncertainty.