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Augmenting a Sociohydrological Flood Risk Model for Companies with Process-oriented Loss Estimation

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Sociohydrological models are increasingly used in flood risk analysis to reveal and understand the temporal dynamics in coupled human-flood systems. While most sociohydrological flood risk models are stylized and describe hypothetical human-flood systems, very few recent case studies employ empirical data to investigate real world systems. The mathematical representation of flooding processes in these models is often simplistic and does not reflect the current state of knowledge. This is due to the intricacy of human-flood interactions and the lack of sufficient and suitable historical data.

We augment an existing, parsimonious sociohydrological flood risk model with a process-oriented flood loss model to integrate better understanding of flood damage processes into a sociohydrological modeling framework. Using Bayesian inference, we simulate the co-evolution of the flood risk system for companies located at the river Elbe in Dresden, Germany, over the course of 120 years. We compare model versions with differently complex process description on the basis of their loss prediction accuracy and uncertainty. This allows for exploring the added value of (i) resolving the inundation and damage process with more detail and (ii) accounting for heterogeneity across economic sectors. Apart from historical sociohydrological data, the proposed, augmented model versions are informed by object-level loss data, inundation maps, and spatial data, enhancing the pool of information available to the model. A leave-one-out cross-validation experiment shows that the augmented model versions increase the precision and reduce the uncertainty of company flood loss predictions in Dresden. In addition, the augmented models provide reliable loss predictions even in the absence of extensive historical flood loss data.

The demonstrated model augmentation concept is not limited to the flood damage process but could be transferred to other processes within the human-flood system. For instance, by incorporating a dedicated model from protection motivation theory that describes how flood awareness and preparedness change after the occurrence of a damaging flood event.