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# Climate factor based optimization of adaptive flood protection measures

Beatrice Dittes, Olga Špačková and Daniel Straub
Engineering Risk Analysis Group, Technische Universität München, Germany

**Corresponding author details:**
beatrice.dittes@tum.de, +49-89-289-25406

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**Abstract:**
Most flood protection measures are capital-intense infrastructures with a lifespan of many decades. Their design should thus not only be based on the actual situation in the protected area, but it should also take into account possible future alterations. These can be associated with the change of the damage potential due to socio-economic development or with the change of flood probability due to climate change or developments in the catchement. Additionally, the estimated probability might change with new data and improved models of the climate and the hydrological processes. These alterations are, however, associated with significant uncertainties and the future can develop according to many scenarios (Woodward et al., 2011). It has been recognized in the literature that there hence is a need for superseding the traditional approach of designing for worst case or for a "reasonable" range of cases by that of designing measures such that they are adaptable (Kwakkel et al., 2010).

We are developing a methodological framework for decision making under uncertainty that allows taking into account the adaptability of the infrastructure when optimizing the protection measures. The analysis is performed fully quantitatively, based on rigorous mathematical modeling of uncertainties and Bayesian decision analysis for assessing the optimality of risk mitigation strategies. The framework allows comparing adaptive and non-adaptive protection strategies: When adaptive strategies are used, the protection level can be changed later during the lifetime of the measure when new evidence is available or new requirements arise. If non-adaptive strategies are implemented, the initial investment is lower but the change of the protection level in the future, if needed, is costly. The proposed decision framework focuses on the uncertainty in the estimated flood probabilities that is associated with climate change. The climate change uncertainty is represented by modeling the parameters describing the non-stationarity of the extreme value model as random variables. New observations of flood events as well as the future availability of better models are new information that are considered for updating the prior assumptions and revising the decision on the flood protection strategy.

The methods developed in our research are currently being tested for implementation in the Mangfall catchment in Bavaria in close collaboration with policy makers and industry. The current policy is to protect the area for a 100-year flood. The uncertainty in the future is taken into account through a climate factor that increases the design values and that is constant for all of Bavaria and independent of the type of flood protection measure. Using our framework, we can determine this climate factor based on a quantitative analysis differently for different types of measures depending on their adaptability and costs.

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