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Framework for probabilistic flood risk assessment in an Alpine region

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Flooding is among the natural hazards that regularly cause significant losses to property and human lives. The assessment of flood risk delivers crucial information for all participants involved in flood risk management and especially for local authorities and insurance companies in order to estimate the possible flood losses. Therefore a framework for assessing flood risk has been developed and is introduced with the presented contribution. Flood risk is thereby defined as combination of the probability of flood events and of potential flood damages. The probability of occurrence is described through the spatial and temporal characterisation of flood. The potential flood damages are determined in the course of vulnerability assessment, whereas, the exposure and the vulnerability of the elements at risks are considered. Direct costs caused by flooding with the focus on residential building are analysed.

The innovative part of this contribution lies on the development of a framework which takes the probability of flood events and their spatio-temporal characteristic into account. Usually the probability of flooding will be determined by means of recurrence intervals for an entire catchment without any spatial variation. This may lead to a misinterpretation of the flood risk. Within the presented framework the probabilistic flood risk assessment is based on analysis of a large number of spatial correlated flood events. Since the number of historic flood events is relatively small additional events have to be generated synthetically. This temporal extrapolation is realised by means of the method proposed by Heffernan and Tawn (2004). It is used to generate a large number of possible spatial correlated flood events within a larger catchment. The approach is based on the modelling of multivariate extremes considering the spatial dependence structure of flood events. The input for this approach are time series derived from river gauging stations. In a next step the historic and synthetic flood events have to be spatially interpolated from point scale (i.e. river gauges) to the river network. Therefore, topological kriging (Top-kriging) proposed by Skøien et al. (2006) is applied. Top-kriging considers the nested structure of river networks and is therefore suitable to regionalise flood characteristics. Thus, the characteristics of a large number of possible flood events can be transferred to arbitrary locations (e.g. community level) at the river network within a study region.

This framework has been used to generate a set of spatial correlated river flood events in the Austrian Federal Province of Vorarlberg. In addition, loss-probability-curves for each community has been calculated based on official inundation maps of public authorities, elements at risks and their vulnerability. One location along the river network within each community refers as interface between the set of flood events and the individual loss-probability relationships for the individual communities. Consequently, every flood event from the historic and synthetic generated dataset can be monetary evaluated. Thus, a time series comprising a large number of flood events and their corresponding monetary losses serves as basis for a probabilistic flood risk assessment. This includes expected annual losses and estimates of extreme event losses, which occur over the course of a certain time period. The gained results are essential decision-support for primary insurers, reinsurance companies and public authorities in order to setup a scale adequate risk management.