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Integral assessment of floodplains as a basis for spatially-explicit flood loss forecasts

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A key aspect of disaster prevention is flood discharge forecasting which is used for early warning and therefore as a decision support for intervention forces. Hereby, the phase between the issued forecast and the time when the expected flood occurs is crucial for an optimal planning of the intervention. Typically, river discharge forecasts cover the regional level only, i.e. larger catchments. However, it is important to note that these forecasts are not useable directly for specific target groups on local level because these forecasts say nothing about the consequences of the predicted flood in terms of affected areas, number of exposed residents and houses. For this, on one hand simulations of the flooding processes and on the other hand data of vulnerable objects are needed. Furthermore, flood modelling in a high spatial and temporal resolution is required for robust flood loss estimation. This is a resource-intensive task from a computing time point of view. Therefore, in real-time applications flood modelling in 2D is not suited. Thus, forecasting flood losses in the short-term (6h-24h in advance) requires a different approach.

Here, we propose a method to downscale the river discharge forecast to a spatially-explicit flood loss forecast. The principal procedure is to generate as many flood scenarios as needed in advance to represent the flooded areas for all possible flood hydrographs, e.g. very high peak discharges of short duration vs. high peak discharges with high volumes. For this, synthetic flood hydrographs were derived from the hydrologic time series. Then, the flooded areas of each scenario were modelled with a 2D flood simulation model. All scenarios were intersected with the dataset of vulnerable objects, in our case residential, agricultural and industrial buildings with information about the number of residents, the object-specific vulnerability, and the monetary value of the objects. This dataset was prepared by a data-mining approach. For each flood scenario, the resulting number of affected residents, houses and therefore the losses are computed. This integral assessment leads to a hydro-economical characterisation of each floodplain. Based on that, a transfer function between discharge forecast and damages can be elaborated. This transfer function describes the relationship between predicted peak discharge, flood volume and the number of exposed houses, residents and the related losses. It also can be used to downscale the regional discharge forecast to a local level loss forecast. In addition, a dynamic map delimiting the probable flooded areas on the basis of the forecasted discharge can be prepared. The predicted losses and the delimited flooded areas provide a complementary information for assessing the need of preventive measures on one hand on the long-term timescale and on the other hand 6h-24h in advance of a predicted flood.

To conclude, we can state that the transfer function offers the possibility for an integral assessment of floodplains as a basis for spatially-explicit flood loss forecasts. The procedure has been developed and tested in the alpine and pre-alpine environment of the Aare river catchment upstream of Bern, Switzerland.