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Quantification of the cumulative effects of river training works on the basin scale with 2D flood modelling

Andreas Paul Zischg, Guido Felder, and Rolf WWeingartner

University of Bern, Institute of Geography, Oeschger Centre for Climate Change Research, Mobiliar Lab for Natural Hazards, Bern, Switzerland (andreas.zischg@giub.unibe.ch)

The catchment of the river Aare upstream of Bern, Switzerland, with an area of approx. 3000 km2 is a complex network of sub-catchments with different runoff characteristics; it also includes two larger lakes. Most of the rivers were regulated in the 18th century. An important regulation, however, was realised as early as in the 17th century. For this catchment, the worst case flood event was identified and its consequences were analysed. Beside the hydro-meteorological characteristics, an important basis to model the worst case flood is to understand the non-linear effects of flood retention in the valley bottom and in the lakes. The aim of this study was to compare these effects based on both the current river network and the historic one prior to the main river training works. This allows to quantify the human impacts. Methodologically, we set up a coupled 2D flood model representing the floodplains of the river Aare as well as of the tributaries Lombach, Lütschine, Zulg, Rotache, Chise and Guerbe. The flood simulation was made in 2D with the software BASEMENT-ETH (Vetsch et al. 2014). The model was calibrated by means of reproducing the large floods in August 2005 and the bankfull discharge for all river reaches. The model computes the discharge at the outlet of the Aare catchment at Bern by routing all discharges from the sub-catchments through the river reaches and their floodplains. With this, the modulation of the input hydrographs by widespread floodings in the floodplains can be quantified. The same configuration was applied on the basis of reconstructed digital terrain models representing the landscape and the river network before the first significant river training works had been realised. This terrain model was reconstructed by georeferencing and digitalizing historic maps and cross-sections combined with the mapping of the geomorphologic evidences of former river structures in non-modified areas. The latter mapping procedure was facilitated by the newest airborne Lidar measurements of the Canton of Bern with a point density of 4 points per square meter.
The described model configuration allows routing the same worst case flood through different states of the river system and therefore to quantify the cumulative effects of all river training works.