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Potential of alpine retention measures to reduce floods at the Inn river in Tyrol

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The study region is the Austrian part of the Inn catchment, Tyrol. The source of the Inn is in the Swiss Alps in the Engadine region. It runs north-eastwards through Switzerland and Tyrol before entering Germany, discharging a total area of about 9800 km^2. At the Austrian-German border, the average runoff is 305 m^3/s, and the highest observed runoff is 2340 m^3/s (2005).
Tyrol is a mountainous country with elevations from 480 m a.s.l. to 3768 m a.s.l. (mean 1890 m a.s.l.) and hence land for building is scarce due to topography. In the Inn valley there are areas which would be suitable for building, however, these areas are in flood prone areas or in areas which are designated as retention areas. Alternatively, retention measures could be built in alpine areas.
On behalf of the Tyrolean state government we evaluated the potential of alpine retention measures. We assumed 130 potential sites for retention measures, each with a dam height of 10 m, combining to a total volume of 21 Mio. m^3, spread over the catchment. The main question of this study was to quantify the potential reduction of floods in the Inn that could be obtained with these alpine retention measures.
To evaluate the effect of the potential retention measures, we developed a stochastic precipitation model to generate a dataset of 10.000 years of hourly precipitation data. The precipitation model was calibrated on a set of precipitation stations and is able to reproduce the statistical properties of the observed precipitation. The generated precipitation is then used as driver for a distributed hydrological model (spatial scale 1x1 km, temporal scale 1 hour), calibrated on 35 years of observed runoff data.
There are two Monte Carlo simulation runs: the first one is taking into account the current situation, and the second one is taking into account the potential retention measures. The results show that the effect of the alpine retention measures on the Inn floods is only marginal with a flood peak reduction in the order of 3-4%. Results also show that the effect of the retention measures differs strongly with the spatial extent of the precipitation.

Keywords: floods, retention, precipitation model, hydrological model, Monte Carlo