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Dynamics of design floods and their consequences - climate change

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The aim of this study is to assess whether design floods in Austria need to be adapted due to changed climate conditions. A review of the literature suggests that the future evolution of climate extremes cannot be assessed reliably on the basis of current knowledge. Credible forecasts of changes in the flood regime are hence not possible at this stage. To obtain an indication of the spectrum of potential evolutions of the flood regime, if-then scenarios were analysed. The idea is to estimate changes in the flood discharges, given plausible but hypothetical changes in the climate variables. The if-then scenarios hence need to be interpreted in the context of the assumptions on the climate variables and are no forecasts.

As the Austrian Alps are a climatic divide, two example catchments were examined, one north of the Alps (the Pielach catchment), and one south of the Alps (the Gail catchment). The following assumptions were made: higher rainfall in winter, lower rainfall in summer; higher variability of within-event precipitation due to increased convection; shift in high runoff generation conditions in the spring due to earlier snow melt and higher evaporation in summer. The assumptions differ to some degree between the two catchments in accordance with the respective flood producing processes. Simulations indicate that, in the northern catchment, the one hundred year flood does not change while, in the southern catchment, there is a 10% increase given the assumptions made on rainfall and runoff generation. The seasonal analysis gives a more complex pattern. In winter, simulated flood peaks at the northern site are +32% higher than under current conditions, at the southern site they are +14% higher. The spring floods indicate an increase of 2% at the northern site and 4% at the southern site, while the summer floods indicate a –9% decrease and a 2% increase, respectively. Simulated autumn floods indicate +8% and 14% increases at the northern and southern sites, respectively.

To put the if-then scenarios into the context of the natural variability, flood data in Austria were analysed. The focus was on understanding the information inherent in the observed flood peak time series in terms of estimating the design flood (e.g. the one hundred year flood) and the associated uncertainty. The analyses of the data indicate that the natural variability is enormous. The accuracy of the estimates strongly depends on the properties of the flood peak sample (sample size, data quality, occurrence of big floods). Specifically, there exist flood decades and decades with much smaller floods. This finding is consistent with trend analyses of flood data from the literature which suggest that there are no conclusive indications of climate induced changes. However, clustering of floods has existed throughout the centuries.

Against the backdrop of the flood data analyses, the if-then scenarios need a subtle interpretation. The combined evidence suggests that the enormous natural variability in the past will also dominate design flood estimation in the future and the potential changes of the if-then scenarios are small relative to this variability. Design flood estimation needs to account for the clustering of events and the uncertainty should be reduced by using expanded information. The focus in design flood estimation hence needs to be on maximising the data base used, as this will likely reduce the uncertainty of design flood estimates more significantly than will the use of climate related trends.