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An analysis of flood regimes in Austria on the basis of the dependence between peaks and volumes of maximum annual floods

Ladislav Gaál (1,2), Jan Szolgay (2), Silvia Kohnová (2), Kamila Hlavčová (2), Juraj Parajka (1), Alberto Viglione (1), and Blöschl Günter (1)

(1) Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology, Vienna, Austria (gaal@hydro.tuwien.ac.at), (2) Department of Land and Water Resources Management, Faculty of Civil Engineering, Slovak University of Technology, Bratislava, Slovakia

We present an analysis of the dependence between flood peaks and the corresponding flood volumes in a regional context, with the aim to understand the causal factors controlling this dependence. While Gaál et al. (2012, WRR) analyzed the average dependence between peaks and volumes on the basis of flood time scales, the current work is concerned with the degree of consistency between peaks and volumes (quantified by the Spearman's rank correlation coefficient) and their controls. The analysis is performed for annual maximum floods, using Austria as a case study area, with 330 catchments, ranging from 6 to 500 km^2 in size.

Our hypothesis is that the strength of the dependence between flood peaks and volumes is related to proportions of various flood types in the dataset of annual maximum floods. For instance, if only a single flood type or a dominance of a particular flood type occur in the given catchment, the flood peak-volume relationship is expected to be highly consistent. Nevertheless, annual flood maxima are usually generated by a mixture of different flood processes. In such cases, a lower degree of consistency between flood peaks and volumes, i.e. a lower value of correlation is observed. To sum it up, the particular mix of processes in the dataset of annual maximum floods should demonstrate itself in the type and strength of the relationship between the two variables.

The results indicate that climate related factors are more important than catchment related factors in controlling the consistency. Spearman's rank correlation coefficients typically range from about 0.2 in the high alpine catchments to about 0.8 in the lowlands. The weak dependence in the high alpine catchments is due to the mix of flood types, including long duration snowmelt, synoptic floods and flash floods. In the lowlands, the flood durations vary less in a given catchment which is related to different factors: i) long duration snowmelt floods are absent, ii) the catchment filters the distribution of all storms to produce the distribution of flood-producing storms, and iii) the co-evolution of climate, landform, soils and vegetation contributes to a more consistent flood response between events.

It is concluded that a mix of different flood types reduces the consistency between flood peaks and volumes. However, this particularly applies to catchments where long duration snowmelt floods are involved. To fully capture the effect on the dependence between peaks and volumes the nature of snow related floods (long duration snowmelt floods in mountains vs. shorter snow related floods in lowlands) needs to be ascertained.