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Response of paleofloods to climate variability in alpine catchments of different size reconstructed from floodplain sediments. Similarities or differences?

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Continuous palaeohydrological time series are generally attributed to lake sediments rather than to those of fluvial sediments. However, most of the alpine lakes analysed are fed by small catchments (few km2). Recent studies show the high potential of flood reconstruction form sedimentary floodplain proxies of mid-size catchments (hundreds of km2) when calibrated by historical sources or other markers. Despite of different catchment sizes, flood pulses achieved from lake and flood plain sediments coincides in some cases. Nevertheless, these correlations must not be taken for granted, because catchment response can be strongly influenced by local physiographic and climatic parameters such as the unequal spatial distribution of precipitation caused by summer thunderstorms and advective rainfall events. To contribute to this discussion, our study investigate new proxy data of three cores retrieved from a small basin in the Bernese Alps, fed by the alluvial fans of Eistlenbach (4 km2) and Farnigraben (2 km2) which were compared with the floodplain records from the nearby Aare (596 km2) and Lütschine (379 km2) catchments.

Following the same methodology developed previously in the other alpine basins, a 3200-yr long flood series were reconstructed from sedimentary and geochemical data applying XRF-core scan techniques, conventional XRF, LOI and grain size analysis. Flood pulses were identified by 30 flood layers, and a higher number of Zr/Ti, Sr/Ti, Ca/Ti peaks and Factor 1 scores. Modern flood signals were calibrated by historical sources, maps, aerial photographs and instrumental data. Not all events were recorded by coarse-grained beds because of the spatial variations of alluvial fan channels and their connectivity to the small distal basin. Recurrence intervals of the tipping points of the fan channel oscillation are traced by key changes of sedimentation rates and facies.

However, geochemical proxies correlate not only very close with the historical local data, but also with regional paleoflood and paleoclimate records. The aggradation of flood deposits with contribution from the highest catchment area (up to 2200 m) occurred predominantly during periods with cooler summer temperature, reduced solar irradiance and phases of drier spring-summer. This hydro-sedimentological pattern matches mostly to the variability of the flood proxies of the much larger and higher Aare catchment (4274 m) despite of the differences in catchment lithology; altitudinal vegetation belts; topography; snow and glacier cover; periglacial and slope processes; and intermediate sediment storage. Spectral analysis of the geochemical time series from different size catchments and climate proxies (TSI, 18O, tree-rings, NAO, SNAO) evidence similar periodicities during the last Millennia. Comparing the sedimentary flood proxies from the basins analysed and the Summer NAO index from 1670 to 2000, severe floods occurred mostly during positive SNAO modes. This result is supported by our findings regarding the influence of low-frequency atmospheric circulation pattern on summer floods in Switzerland (1800-2008).

Thus, the mechanisms of flood processes from the different catchments are strongly influenced by North Atlantic dynamics and solar forcing. From the data obtained we suggest that the geochemical record of the small Eistlenbach catchment provides accurate paleoclimate information at least at a decadal time resolution.