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Attribution of flood changes in mountainous catchments with flood-type decision trees

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Changes in land-use and climate conditions are expected to affect the likelihoods for hydrological floods. While trend analysis is an useful approach to quantify theses change impacts, one issue is that usually the varying flood generating mechanisms are no explicitly considered. This is limiting as the changes may also result a change in the flood generation processes such as shifting from snow dominated into rainfall dominated floods. Although, an exact effect of such climate change on the catchment functionality is difficult to evaluate, it is relatively easy to extract a categorized information from past flood episodes. These floods can be grouped into distinctive classes of similar patterns such as driven by heavy rainfalls or intense snowmelts. Such flood classes (flood-types) are useful for improving our understanding of flood processes and their changes at the catchment scale and for making estimates of current or future floods. A long-term analysis of identified flood types allows thus for detecting whether the frequencies and magnitudes of different flood types changed over time. This might provide guidance on further changes that can be expected.

In this work, we present a categorized approach for analysing flood trends in observed time series of discharge and precipitation by means of decision trees. Thus, observed time series are split into single flood events and each flood event is assigned a single (or multiple) flood-type(s) using catchment and event characteristics. We next attribute the change in the contribution of flood-types in the catchment to changes observed in the mean catchment temperature and precipitation totals. For this purpose, two decision trees were used, a crisp tree (resulting in single food types) and a fuzzy tree (allowing for mixed flood types) and their estimates were confronted with each other. Our study catchment sample consisted of 27 mountainous catchments in Switzerland with 30 years of continuous observations of precipitation and discharge. Results from these catchments demonstrated that, independently from the tree being used for classification, snow-related floods decreased and rainfall-driven events increased in high altitude catchments. Number of flash-floods increased in small catchments towards the end of the observation period. The exact change in the contribution of different flood-types depended however on the applied tree (crisp or fuzzy) and was better identifiable (with uncertainty consideration) with the fuzzy approach. As opposed to the flood specific analysis, no clear signal in the change of the flood magnitudes could be detected when all floods were pooled into one group. Hence, our study highlights the importance of analysing flood trends in the context of flood processes and considering the differences in flood types when analysing trends.