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The Tambora effect on the hydrology of Switzerland in 1816/1817

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The eruption of the volcano Tambora in 1815 caused what is literally called “the year without summer” in 1816 in Switzerland, resulting among others in extensive harvest losses. Furthermore, it has been reported that the snow was significantly present throughout the year. Hence, in the following winter fresh snow piled on top what was left from the last year, and an unusually snowy spring 1817 further increased snow heights. It has been argued that the spring floods at the Lake Constance (highest reported lake level) and at Basel are a result from the assumed massive snow melt.

We here present an approach and first results of a study that tries to reconstruct this extraordinary event. Based on historical meteorological measurements at three locations, an analogue method was applied that reconstructs daily precipitation and temperature for the years 1816 and 1817 for the Rhine river basin up to Basel. Analogues were sampled from observation based gridded datasets of precipitation and temperature from last 50 years in Switzerland. As the Rhine catchment to Basel covers also parts of Germany and Austria, the Swiss gridded dataset was extended via analogues date from the E-OBS dataset.

This meteorological input drove the hydrological model WaSiM-ETH, both for the reference period 1981-2009 and the Tambora scenario period 1816/1817. First, the hydrological model was calibrated (1991-1999) and validated (1981-2009) against discharge from the river Rhine at Basel, CH, using the same gridded data sets for temperature and precipitation. For the sake of simplicity in first place, land use and river regulations are kept as they are today.

We found that the general river regime is reproducible in 1816 and 1817. So is the reported snow development. Hence, we argue that the general set up is feasible and the effect of the Tambora eruption on the average hydrological conditions can be estimated. However, the flood peaks during the years 1816 and 1817 are underestimated if present at all as comparisons with early recordings of flood peaks in Basel show.