EGU23-1621, updated on 09 Dec 2023
https://doi.org/10.5194/egusphere-egu23-1621
EGU General Assembly 2023

Robustness experiments on simulated extreme floods over Switzerland

Eleni Kritidou[1], Martina Kauzlaric[2], Marc Vis[1], Maria Staudinger[1], Jan Seibert[1], and Daniel Viviroli[1]
[1]Department of Geography, University of Zurich, Switzerland (eleni.kritidou@uzh.ch)
[2]Institute of Geography and Oeschger Centre for Climate Change Research, University of Bern, Switzerland

Globally, floods are the most frequent natural hazard. Reliable estimates of flood characteristics are key in measures that reduce or even prevent damage. Traditionally, floods and their impacts have been studied through statistical techniques based on historical observations. Due to the relatively short available streamflow records, extrapolation techniques based on the observed hydrographs are usually implemented. Furthermore, assumptions about antecedent conditions of an event (e.g., soil moisture, snowpack, storage levels of lakes and reservoirs) and their spatiotemporal variability are made. However, these methods incorporate several limitations related to the estimation of floods, especially when the focus is on very rare flood events.

Here, we explore the robustness of an elaborate framework based on continuous simulations with a hydrometeorological modeling chain (Viviroli et al., 2022). The modeling chain starts with a multi-site stochastic weather generator, focusing on the generation of extremely high precipitation events. Then, the bucket-type hydrological model HBV (Hydrologiska Byråns Vattenbalansavdelning) is used to simulate discharge time series. Finally, the RS Minerve model is employed to implement simplified representations of river channel hydraulics, floodplain inundations and lake dynamics. To explore the robustness of simulation results and derived flood estimates, we selected the potentially most sensitive elements of the weather generator and the hydrological model and varied them across a palusible range. For the weather generator, the chosen elements include different precipitation lapse rates between 0-10%, a parameterization dependent on 4 different weather types, and 10 different parameterizations of the Extended Generalized Pareto Distribution, describing the precipitation intensities. For the hydrological model, firstly, another model structure will be tested. Then, the model's precipitation lapse rates, distributing the mean catchment precipitation input from the weather generator to the different elevation zones, will be varied within 0–10%. Considering a set of small (a few 10 km²) to large (a few 1'000 km²) study catchments in Switzerland, we evaluate the impact of each of these changes on the simulated extreme floods and thus assess the robustness of the approach.

The robustness experiments will shed light on the applicability and feasibility of the hydrometeorological modeling chain for estimating very rare floods and help point out this approach's benefits and limitations. These findings are also expected to identify sensitive modeling decisions that should be treated carefully or for which further research would be highly

beneficial. They should also provide a clearer picture of uncertainties important for hazard assessment, safety analyses and hydraulic engineering projects.

References

Viviroli D, Sikorska-Senoner AE, Evin G, Staudinger M, Kauzlaric M, Chardon J, Favre AC, Hingray B, Nicolet G, Raynaud D, Seibert J, Weingartner R, Whealton C, 2022. Comprehensive space-time hydrometeorological simulations for estimating very rare floods at multiple sites in a large river basin. Natural Hazards and Earth System Sciences, 22(9), 2891–2920, doi:10.5194/nhess-22-2891-2022