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Assessing the increasing flood risk in the Niger River: Climate change, land use change or increasing vulnerability?

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The Niger River in West Africa experiences a strong increase of flood risk during the past decades. The evaluation of the three most extensive databases on floods in Africa (NatCat database of Munich Re, Dartmouth Flood Observatory, International disaster database EM-DAT) shows a strong increasing trend in the annual number of people affected by floods in the Niger basin. The reason for this trend is controversial as it goes along with a decrease of mean precipitation. In the ongoing debate many studies identify land use change as cause for the increase in extreme discharges in Sahelian rivers and deny an increase of extreme rainfall. Other studies focus more on the vulnerability of an increasing population, which leads to more and more people affected.
However, quantitative approaches on the extreme discharges in the Niger basin are rare. In order to assess the floods systematically, we analyze long time series for 10 gauging stations along the Niger River with state of the art statistical methods. By means of change-point analysis coupled with trend analysis, wavelet analysis and non-stationary generalized extreme value functions (NSGEV) we are able to identify decadal changes and changing probability distributions of flood occurrence along the Niger. The results in the basins differ substantially, depending on the source region of the flood. We differentiate between the Guinean flood, originating from precipitation in the Guinean highland and the Red flood, originating from rains in the Sahelian part of the basin. We find significant changes of frequency in floods since the 80s, but only for the Red flood. The peaks of the Guinean flood recovered since the droughts of the 70s/ 80s, but do not reach the level of the 50s/ 60s. In addition, the NSGEV reveals that the probability for extreme floods has increased for the Red flood, but rather decreased for the Guinean flood in the past decade. These results indicate that the increase in vulnerability is at least not the single cause for the increase in flood risk.
On the basis of these results we use the eco-hydrological model SWIM and attempt to reproduce the observed flood trends under different conditions in terms of climate and land use change. The semi-distributed and process-based model simulates the hydrological cycle at the river-basin scale on a daily time step. Forced with WATCH-Forcing-Data-ERA-Interim reanalysis data, the model enables us to simulate the past decades without land use change under climate change conditions. First results show an increase of floods in accordance with the observations without taking land use change into account. This implies that climate change is at least partly accountable for the increase of floods.