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Extreme rainfall over West Africa: Current state and projected impacts of climate change

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West Africa is increasingly experiencing socio-economic distress caused by floods due to extreme precipitation events, the frequency of which is projected to increase in light of climate change. Working towards adaptation strategies generally require reliable and ideally long-term observational datasets in order to increase the knowledge about the spatiotemporal nature of extreme rainfall in the region. Thus, leveraging the capabilities of the high-resolution, satellite-based Global Precipitation Measurement (GPM) dataset Integrated Multi-satellite Retrievals for GPM (IMERG), this study evaluates the present-day as well as future statistics of daily precipitation extremes over West Africa by utilizing an extreme value analysis approach. Extreme precipitation values in IMERG for the period 2001-2022 are modelled with the generalized extreme value (GEV) distribution through yearly-based block maxima sampling of daily rainfall. A decrease of spatial uncertainty is further accomplished by using the Regional Frequency Analysis (RFA)"based on the so-called "Index-flood method".

Results show that high return values, up to around 300 mm at a 50-year return period, are largely found over the coastal areas of West Africa, highlighting, among other things, the influence of the coastal shape on the formation of intense land-sea breeze convection, and orographic enhancement of rainfall along the Guinea Highlands. Thus, while extreme precipitation is prevalent along the highly urbanized coast, return values decrease with (a) distance from the coastline, and (b) towards the climatologically drier Sahelian region. Overall, the spatial pattern of return values for a given return period are strongly correlated with the pattern of mean daily rainfall, which suggests that the magnitude of mean daily rainfall is widely driven by precipitation extremes.

In a further step, the projection of future precipitation extremes is compiled using the statistically downscaled dataset of CMIP6 models "NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6)" . By determining the difference in the GEV parameters between future scenarios and the historical runs, an adjustment of the IMERG-based GEV parameters is accomplished to mimic a potential future state of the rainfall distribution ("Delta method"). Here, the most extreme scenario SSP5-8.5 projected onto the long-term period 2081-2100 suggest an increase of the return value magnitude by over 100% in the populous coastal region of West Africa. Together with growing urbanization and the rise of sea levels, West Africa is facing dire socioeconomic stress without dedicated action plans against flood risk, especially in the densely populated Guinea Coast region.

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