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Expanding information for flood frequency analysis using a weather generator and distributed hydrological modelling in a Spanish Mediterranean catchment

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Flood risk management requires the knowledge of flood quantiles associated with high return periods. To date and due to the short temporal length of the maximum available flow records, these present very high uncertainties. This scarcity makes unfeasible the use of classical statistical methods, becoming necessary to advance in a methodological approach of flood frequency analysis based on the understanding of the main hydrological processes and taking advantage of the better information on extreme rainfall at regional scale. In this article, a storm modeling approach with a weather generator (WG) and distributed hydrological modeling including sediments (TETIS model) are proposed to support the frequency analysis, being implemented in a case study: the Segura river basin (Murcia, Spain) with 14,000 km^2. Specifically, the methodology consists of the following steps:

- Perform a regional study of annual maximum daily precipitation.
- Calibration of a WG on a daily scale and generation of a long daily precipitation series (5,000 years)
- Extreme storm selection (698) and temporal disaggregation into sub-daily scale (hourly)
- Implementation of TETIS at hourly resolution and hydrological simulation of selected storms
- Final peak flow frequency analysis and validation of the methodology

A validation of the methodology has been carried out with historical flood data considering six catastrophic flood events since 1825. According to the results obtained, a significant reduction in the uncertainty associated with both rainfall and flow quantiles has been achieved. For the last major flood in September 2019, the results have shown that, in the Abanilla tributary (one of the main flow contributors to the flood zone), the recorded peak flow is highly likely to correspond with an event with a medium probability of flooding (around a 100-year return period), although it corresponds with a rainfall event with a return period between 10 and 1000-year, depending on the location of the rain gauge within the Abanilla subcatchment.

Finally, it is possible to advance in an analysis of risk management measures to evaluate their effectiveness and viability, comparing present conditions and future scenarios and considering different strategies (structural and non-structural measures or nature-based solutions).