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Contextualizing recent extreme floods in the Western Mediterranean region: insights from historical records and paleoflood hydrology

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The Mediterranean region is expected to experience more extreme rainfall events due to climate change. These extreme weather events, together with the ever-increasing human occupation, could lead to an increase in the risk of flash floods. This situation could be worrying, as wildfires may occur during hotter and drier summers, which might increase the hydrological response. Adaptation and mitigation strategies need to be put in place at the level of water and civil protection authorities. However, this is challenging due to the widely recognised lack of data, the high variability of the Mediterranean hydroclimate, and previous shortcomings in the performance of climate-based models for the region. Here, we combine historical, geological and tree-ring data to provide a compressive multi-century reconstruction of flood frequency and magnitude for the Clariano River, a medium-sized (265 km^2) Mediterranean catchment in the Province of Alicante (Spain). A historical flood database was collected from published compilations, documentary sources, photographic archives and newspapers. The Municipal Archive at Ontinyent provided flood evidence since CE 1320 with a continuous flood record since 1500. Slackwater flood deposits were studied in ten stratigraphic profiles on three river reaches, and flood units were dated by radiocarbon and optically stimulated luminescence. Finally, thirty-five scarred trees growing on floodplains in three different river reaches were sampled to record the occurrence of recent floods. In three river reaches, 1D and 2D hydraulic models were implemented on high-resolution topographies to convert palaeostages and historical levels into flood discharge. The multi-source data compilation provides evidence of at least 47 major floods since the 13th Century. Apart from the flood caused by the dam break in 1689, the magnitude of the most recent floods caused by mesoscale convective cells in 2016 and 2019 were similar to or slightly below in magnitude to those experienced during the rich flood period (1850-1895) following the end of the Little Ice Age. This implies that the information on past extreme floods could be used as a scenario-based approach to quantify expectations of recent extreme floods under climate change scenarios.

Furthermore, our records have allowed a more accurate estimation of flood frequency in Ontinyent city, which could be used to provide a more robust flood hazard zonation. Throughout this comprehensive study, we show that quantitative historical and palaeoflood hydrology allows the determination of past and recent flood magnitude response to climate variability, reducing the uncertainties in flood hazard and risk assessment in the Mediterranean region.