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Reconstructing historical flash flood events in South-Eastern Spain: An integrated approach with multiproxy records and hydrological modeling

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Flash floods in Mediterranean catchments are a significant threat. Over the last decades, research in this area has normally focus on recent events, largely due to the absence of long-range instrumental data. However, alternative sources like historical records and natural archives can offer valuable insights and improve our knowledge of past events. In this study, we conduct a reconstruction of major flash flood events over the past century that have impacted several catchments in the South-Eastern Spain, specifically in the Almanzora, Antas and Aguas catchments.

Our study adopts a multidisciplinary approach for the reconstruction of flash floods. We integrate a variety of instrumental gauge data, historic water level indicators on buildings and bridges, and descriptions of inundated areas and flood heights from historical documents. Additionally, we incorporate biomarkers indicative of flood levels, identified through lichenometric analysis of rock surfaces affected by water flow. This combination of diverse proxy records enables us to estimate the peak flow heights at several crucial locations within the study area. For the reconstruction of the maximum flood discharge, we perform a one-dimensional hydrological model across all study sites and in select smaller areas requiring a detailed understanding of the hydraulic behavior, we apply two-dimensional models.

The findings of this study reveal that, despite the region's characteristic low annual precipitation (less than 300 mm), it is occasionally subjected to extreme rainfall events leading to significantly high peak discharges. Typically, these meteorological episodes are associated with atmospheric circulation patterns involving blocking systems along the Mediterranean coast. Hydraulic modeling has identified peak discharges exceeding 5000 $m^3 s^{-1}$ during a major flash flood event in October 1973. This event stands as the most devastating in the past century, resulting in loss of human lives and extensive damage to numerous settlements in all the studied catchments. While other notable flash flood events occurred in 1924 and 2012, they were of lesser magnitude compared to the 1973 flood. Post the 1973 disaster, various hydraulic modifications to the river system were

implemented. These included for instance a channelization of significant portions of the Almanzora's main channel and some tributaries, as well as the construction of a large dam. These interventions have contributed to a reduced flood risk in certain areas of the catchment, particularly in the lower sections near the Mediterranean Sea outlet. Nevertheless, recent land use changes such as extensive agriculture and tourism could contribute to changes in flow regime and increased flood vulnerability.