**Flooding in Venice: investigating extreme water level and its components**

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**Abstract**

The city of Venice is known worldwide for its picturesque canals, but also for its *acqua alta*. Nowadays, the combined effect of land subsidence and mean sea level rise have increased the severity and occurrence of flooding events threatening the future of the city and its cultural heritage. As an example, the flooding event in November 2019 caused damages of around $1 billion. Efforts to protect the city have been progressively implemented, such as the recently completed MoSE barrier. However, the unique character of Venice requires ad hoc adaptation strategies that build upon a thorough understanding of the water level, its components, i.e., mean sea level, storm surge, astronomical tide, and their relationship. Particularly, in region of shallow water, i.e., near shore, surges occurring at high tide tends to be damped while surges occurring at rising tide are amplified, even though this behavior can be influenced by other factors such as wind, atmospheric pressure, and local morphology.

Hence, in this preliminary study we will analyze water level observations in Venice from 1924 to 2020 considering two tidal gauges: the gauge *Punta della Salute* - located inside the Venetian Lagoon - and the gauge *Piattaforma Acqua Alta* – located outside the Venetian Lagoon. We will first evaluate the statistics of water level extremes and its components accounting for the detected signal of mean sea level rise via nonstationary extreme value analysis. We will then characterize the dependence between water level components, i.e., astronomical tide and storm surge, via a copula-based framework. Afterwards, we will investigate the influence that the dynamics of the lagoon might have on this dependence, if observed, via comparison between gauges. Finally, we will discuss how assumptions regarding the selection of extremes, the assumption of nonstationarity, and dependence model between water level components influence flood hazards in complex systems such the Venice case.