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Influence of different Total Water Level components on coastal flooding simulation: a case study "real-life" assessment

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Extreme events can dramatically affect coastal areas, causing floods and shoreline erosion, consequently impacting infrastructures and, in the worst cases, resulting in life losses. These events are becoming frequent in regions along the northeastern Italian coastline, like the Emilia-Romagna region, significantly damaging the local economy. Here, regular coastal floods can impact infrastructures built on the beach or behind low-lying dunes, flooding through beach access paths. Therefore, predicting the impact of such extreme events and their appearance probability is important for coastal protection and the local economy.

Total Water Levels (TWLs) associated with extreme events can be characterised by different probability levels (i.e. different return periods), influencing the flood extension. The definition of TWL in the literature depends on the chosen variables and the methods used to estimate it. In this work, to understand the influence of the different elements on TWL extreme values, combinations of different components, such as tide, wave set-up, run-up, calculated with Stockdon et al. (2006) equation (http://dx.doi.org/10.1016/j.coastaleng.2005.12.005), between others, and two methods for Extreme Value Analysis (EVA), were used. The two methods used for the EVA were (1) the analysis of the individual time series of each component, combining each extreme value to obtain a TWL, and (2) the combination of the different elements' time series to build the TWL time series and the application of the EVA. The dataset combines modelled data for the water level (SHYFEM) and waves (WW3 model) and predicted tide levels provided by the Pytides2 library. The EVA was done by selecting return periods between 1 and 500 years with a declustering factor of 24 hours. Those were divided into three categories: high [return period: 1-20 yrs], medium [30-50 yrs] and low-frequency events [100-500 yrs]. For each method and frequency, three values of the TWL were obtained, giving 72 TWL combinations for each beach slope category (three slopes were tested for the run-up). The highest TWL values were obtained by adding the extreme values of astronomical tide, non-tidal residual, run-up and setup. Meanwhile, the lowest TWL calculated corresponds to the EVA applied to the combination of all the components' time series, which does not include the run-up.

An evaluation of flood extension with Lisflood-FP model (Bates et al., 2005; https://doi.org/10.1016/j.coastaleng.2005.06.001) based on the different TWL values was made. The coast of Lido di Volano (Ferrara, Italy) was chosen as a case study site for a real-life

assessment. For the flood model, storm events were reproduced assuming a triangular distribution for six hours, locating the starting and end points at the mean tide level. When compared with the real-life assessment, EVA method 1 demonstrated an overestimation for the same intensity of return period. EVA method 2 showed a good correlation, although an overestimation was observed when the run-up was included in the time series. Results demonstrated how the choice of EVA methods and water level contributions are crucial for predicting extreme events.