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Return periods of extreme sea levels along the Ravenna coastline

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The low-lying coastal areas of the North-western Adriatic are exposed to a high degree of inundation risk by exceptional sea levels due to storm surges. Although the phenomenon of " extreme high water" (acqua alta) is well known and described in Venice, justifying the construction of the MOSE flood gates to protect the lagoon and the city against flooding, it remains poorly described for other Italian coastal sites.

The aim of the present investigation, conducted within the European Union funded MICORE Project (FP7 contract 202798), is the estimation of extreme water levels and their associated return periods along the vulnerable coastal areas of the Ravenna Province. A better knowledge of the phenomenon can serve as starting point for an improved Civil Protection practice, aiming at developing adequate forecasting and warning systems.

The observations available for Ravenna are measurements at 10-minute interval, recorded by the Porto Corsini tide gauge station, which is part of the National Sea Level Measurement Network. The studied time series cover a period of ten years, from 2000 to 2009. Following a preliminary quality control of the dataset, a strong correlation was found with the hourly sea level data collected by the Centro Previsioni e Segnalazioni Maree of the Venice Municipality for the tide station of Punta della Salute. It can be concluded that there is enough robustness in the Ravenna dataset to ensure the validity of further probabilistic analyses.

The methodology employed in the analysis was based on the limiting joint Gumbel distribution of the r-largest annual events. The seven largest values of sea level and surge amplitude were extracted for each year from the quality checked records of observations. Tidal residuals were computed using the program t_tide to obtain astronomic predictions and subtracting this value from the observed time series. The selection process for an event considered as independent only those separated by at least 78 hours. This is supposed to have eliminated the effect of seiche oscillations that may follow storm surges. Further validation of the representativeness of the dataset came from its cross-comparison with time series of meteorological parameters and wave measurements collected at several of the nearest stations along the Adriatic coast.

The analyses identified extreme levels of 0.85 m, 1.05 m, 1.28 m for return periods of 2, 10 and 100 years. The equivalent computed residuals were 0.61 m, 0.79 m, 1.02 m. To notice that for a landscape like the Ravenna coastal zone, where the + 1 m contour is often located 1 km inland, even an event with a moderate likelihood can produce disastrous flooding.

Future work will include the identification of representative prototype surge characteristics which will be used to assess the vulnerability of dune ridges, undertaking a detailed sensitivity analysis of the surge parameter. The identified critical thresholds will be included in an operational warning system which is being developed in the framework of the MICORE Project (www.micore.eu).