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Sea level rise in the Venetian lagoon inferred from the 150-year-long tidal record

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The city of Venice (Northern Italy), together with its lagoon, is a historic, cultural and artistic heritage of inestimable value. One of its peculiarities consists in the recurrent storm surge phenomena, referred to as *acqua alta*. Sea level rise and local subsidence made their frequency to increase dramatically with respect to the past, causing severe damages to the lagoon and in particular to the city centre, as during the exceptional high tide verified on November 12, 2019.
Here we show the analysis of the historical time series of tidal maxima and minima recorded in the Venetian lagoon, covering the period 1872-2018. It is the longest and most complete historical series of the Venetian area and one of the longest records of the entire Mediterranean region. During this period, the relative sea level height has increased of about 30 cm with respect to the reference level, while the average number of *acqua alta* events – evaluated over a 40-year time interval - has passed from about 4 to 70 per year. These events usually occur during the fall season (from October to December), even if a not negligible number has been also recorded during winter. Therefore, we analyse the October-March average annual time series with advanced spectral analysis methods, like Monte Carlo Singular Spectrum Analysis (MC-SSA), to extract and reconstruct the significant variability modes characterizing the record. They are the increasing long-term trend and components with multidecadal, decadal and interannual periods. The trend results from the superposition on the global eustacy of the local subsidence affecting the Venetian lagoon, which is due to both natural causes and human activities. We also discuss the possible linkage of the other significant spectral components to large scale climatic patterns. In particular, the decadal-scale oscillation is one of the most important variability modes affecting Northern Italian hydrology.
Finally, we apply simple statistical methods (autoregressive models and feed-forward neural networks) to forecast the long-term evolution of sea level over the next ten years. In this contribution, we illustrate results from this state of the art two-fold statistical prediction system that provides robust predictions of sea level in the Venetian lagoon for the next decade and discuss them in the light of current longer-term projections of future sea level rise. Finally, we will test the predictive skill of the applied methods using tidal measurements recorded during 2019, to verify if our predictions are able to describe tidal variability characterizing the current year.

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