

Storm surges impact in the hydrodynamics of a tidal lagoon: the case of Ria de Aveiro

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Storm surges consist in an abnormal sea level rise caused by extreme weather conditions and with a typical temporal scale of a few days. They are a hazardous phenomenon, since they may flood large coastal areas, causing socio-economical and habitation losses. Thus, the study of their characteristics and effects in coastal regions in future climate change scenarios is crucial to prevent their negative consequences.

Several climate change projections foresee the increase of storm surges frequency and intensity worldwide. However, studies for the Portuguese coast proved inconclusive in the long-term trend identification of extreme meteorological events and resulting storm surges, although most of them did not predict significant changes in the current regime.

Consequently, as this work aims to assess the storm surges impact in the hydrodynamics of a tidal lagoon located in the north-western Portuguese coast (Ria de Aveiro), future surge scenarios were determined through a statistical analysis of local tidal gauge data. The maximum annual values of the positive residual tides identified were adjusted to the generalized extreme value distribution (GEV distribution), and the storm surges amplitude for several return periods was determined. Results suggest storm surges amplitudes of 0.58 m, 0.84 m and 1.17 m for the return periods of 2, 10 and 100 years, respectively.

To assess the hydrodynamic changes in the Ria de Aveiro under storm surge conditions numerical modeling simulations were carried out, for four scenarios under mean rivers discharges: a single astronomical tidal forcing (reference) and astronomical tide plus 2, 10 and 100 years return period surges. It was used a previous calibrated numerical model (Mohid). Maximum levels and velocities for the entire lagoon and the tidal prism for the main cross-sections were determined and compared with the reference scenario, identifying the lagoon more vulnerable areas.

Generally, the model results suggest that during storm surge events the maximum levels increase in whole domain, with the largest increase found for the 100 return period storm surge scenario (1.17 m). The most significant changes occur at the main channels head for all scenarios, revealing that these regions are the most vulnerable to marginal flooding at Ria de Aveiro. Also, storm surges induce higher velocities and tidal prisms in the lagoon, increasing the marginal risk of erosion and the offshore bottom sediment exportation, as well as the salinization of the lagoon marginal lands.