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Short term predictions of coastal flooded areas using a machine-learning approach

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Coastal flooding is one of the most important natural hazards worldwide, increasingly growing in a changing climate. Various problems concerning the current and potential future risk of coastal areas, highlighting the needs for reliable forecast of storm conditions that can reach the coasts and of consequent estimated of the probability of flooding of urbanized areas.

The study presented here aims to develop a method to predict flooding in coastal areas through Artificial Neural Networks (ANNs). The method was applied to the village of Granelli, in the South-Eastern part of Sicily (Italy). The present work was organized into two-phase: the first was dedicated to create the database of the flooded areas, through a physically-based modelling of wave propagation from offshore to the coast; the second was dedicated to study how to use the relate through machine learning approach onshore flooding results to offshore wave characteristics.

As regards the first phase, the wave data used in the present study were obtained using two nested numerical models: SWAN and Xbeach. For an accurate simulation of wave propagation both in the nearshore zone and on the beach, a bathymetric survey of the submerged foreshore and a morphological survey of the emerged beach were carried out. The first one was surveyed through a Multibeam eco-sounder up to a depth of -12 m. The survey of the emerged beach was carried out using a Trimble TX8 Laser Scanner. As regards the boundary conditions, more than 1600 scenarios were simulated by changing both the offshore wave characteristics and the water elevation.

During the second phase, the offshore wave characteristics and the resulting flooded areas were used to train several configurations of an ANN. After a calibration process of the ANN configuration, the best one was identified through comparison with the results of Xbeach.

The proposed approach allows both to significantly reduce the time required for the estimation of flooding areas (8-9 hours required by Xbeach for each sea state against a few seconds required by ANN for the entire storm) and to obtain extremely reliable results with an accuracy of 0.05 m^2 in terms of root mean square error.

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