

ASSESSING COMPOUND FLOODING HAZARD IN ESTUARIES BY INTEGRATING A CLIMATE EMULATOR AND A HYBRID METAMODEL

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MOTIVATION

Many coastal settlements are located in estuaries where flooding can result from oceanographic sources (e.g. tides, storm surges and waves), but also from river discharge (fluvial) and direct surface runoff (pluvial). These drivers are typically causally linked through associated storms, and may therefore occur simultaneously or in close succession, exacerbating the impact of flooding. Historical observations of these multivariate drivers causing compound flooding represent only a small fraction of the possible range of conditions capable of causing adverse flooding consequences. Therefore, a joint probability method is needed to generate many synthetic extreme multivariate events (tides, storm surge, precipitation and river discharge) capable of producing new combinations of oceanographic and fluvial forcing conditions. On the other hand, a numerical model is required to simulate the compounding effects of spatially distributed interactions between river discharge and downstream sea level in tidal channels and estuaries. However, these models are typically too computationally expensive to dynamically simulate the new full parameter space of oceanographic and pluvial/fluvial conditions that can cause compound flooding.

METHODOLOGICAL FRAMEWORK

In this study, a hybrid statistical-dynamical framework is proposed to efficiently predict spatially varying estuarine water levels and inundation areas for assessing compound flooding hazard (Figure 1). A new version of the climate-based emulator TESLA (Cagigal et al., 2020) is used to generate new compound flooding events by identifying their relationship with a set of weather types representing different large-scale atmospheric pressure patterns. This climate emulator is coupled to a metamodel, similarly to Anderson et al., (2021), based on Delft3D simulations, in this case, to emulate water levels and flood inundation under any combination of tidal, storm surge and river discharge conditions. This fast and efficient method to predict estuarine hydrodynamics is based on selection, and interpolation techniques (Camus et al., 2011) reducing the computationally intensive cost of classical dynamical modeling.

STUDY SITE

The Santoña Marshes, or estuary of the river Asón, forms a wide bay at the mouth of the aforementioned river, located in the northern Spain. The estuary is characterised by its

large area (about 18.7 km²), its complex bay-like morphology, the presence of large areas of relatively well-preserved tidal flats and mudflats (although with a high degree of anthropisation), and the presence of residual rocky reliefs rising above the bay. It is a shallow estuary dominated by tidal dynamics, with large intertidal areas of muddy flats crossed by sinuous fluvial-tidal channels. The most important fluvial-tidal channels are Rada and Limpias which join to form a single channel, the Treto river.

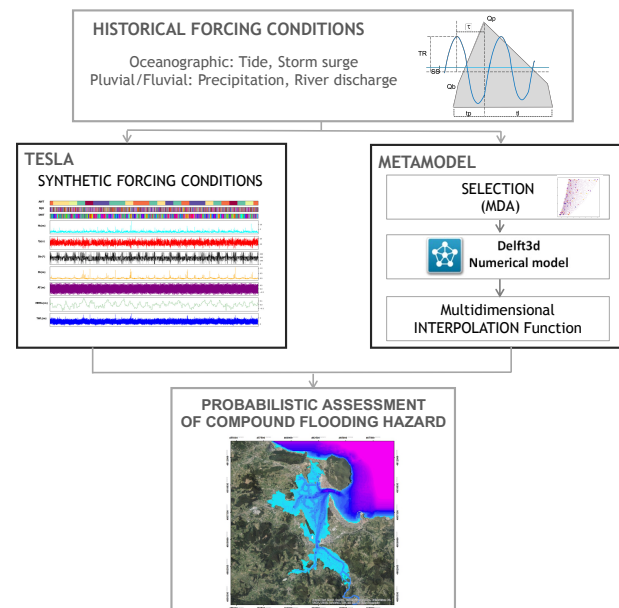


Figure 1 - Methodological framework for assessing compound flooding hazard in estuaries.

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