The evolution of the cross-shore beach profile is tightly related to the evolution of the coastline in both small and large time scales. Bathymetry changes in extreme maritime events can also have important effects on coastal infrastructures such as geotechnical failures of foundations or the modification of the incident wave conditions towards a more unfavourable situation.

The available strategies to study the evolution of beach profiles can be classified in analytical, physical and numerical modelling. Analytical solutions are fast, but too simplistic for many applications. Physical modelling provides trustworthy results and can be applied to a wide variety of configurations, however, they are costly and time-consuming compared to analytical strategies. Finally, numerical approaches offer different balances between cost and precision depending on the particular model.

Some numerical models provide greater precision in the beach profile evolution, but incurring in a prohibitive computational cost for many applications. In contrast, the less expensive ones assume simplifications which do not allow to correctly reproduce significant phenomena of the near-shore hydrodynamics such as wave breaking or undertow currents, neither to predict important features of the beach profile like breaker bars.

In this work, a new numerical model is developed to reproduce the main features of the beach profile and hydrodynamics while maintaining an affordable computational cost. In addition, it is intended to reduce to the minimum the number of coefficients that the user has to provide to make the model more predictive.

The model consists of two main modules. Firstly, the already existing 2D RANS numerical model IH2VOF is used to compute the hydrodynamics. Secondly, the sediment transport model modifies the bathymetry according to the obtained hydrodynamics. The new bathymetry is then considered in the hydrodynamic model to account for it in the next time step.

The sediment transport module considers bedload and suspended transports separately. The former is obtained with empirical formulae. In the later, the distribution of sediment concentration in the domain is obtained by solving an advective-diffusive transport equation. Then, the sedimentation and erosion rates are obtained along the seabed. Once these contributions are calculated, a sediment balance is performed in every seabed segment to determine the variation in its level.
With the previously described strategy, the resulting model is able to predict not only the seabed changes due to different wave conditions, but also the influence of this new bathymetry in the hydrodynamics, capturing features such as the generation of a breaker bar, displacement of the breaking point or variation of the run-up over the beach profile. To validate the model, the numerical results are compared to experimental data.

An important novelty of the present model is the computational effort required to perform the simulations, which is significantly smaller than the one associated to existing models able to reproduce the same phenomena.