

A Numerical Model to Simulate Cross-Shore Beach Profile Evolution

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INTRODUCTION

Beach profile response due to cross-shore (CS) sediment transport has aroused widespread concern. The capability to quantify storm impact on the CS beach profile is becoming increasingly significant both for coastal engineers and managers. Previous studies of beach morphology mainly focused on the certain part of the beach, such as nearshore bar evolution (Armaroli and Ciavola, 2011), berm formation and dune erosion (Larson, Erikson, and Hanson, 2004; Dissanayake et al., 2015). Less focus on the evolution of the entire beach (Roelvink et al., 2009) since the connection between subaerial part and subaqueous part is complex and tricky. This paper presents a physical-based model to simulate the change of the entire CS beach profile that is based on the work by Zhang and Larson (2022). The model can be employed in practical projects.

MODEL STRUCTURE

As shown in Figure 1, the model consists of various governing processes for describing the beach and dune evolution which can be divided into hydrodynamic and morphodynamic processes. The hydrodynamic processes include wave transformation, mean water elevation, and mean CS currents. The morphodynamic processes calculate the bed load transport, suspended load transport, swash-zone sediment transport, and dune-zone sediment transport (the overwash routine has not been included).

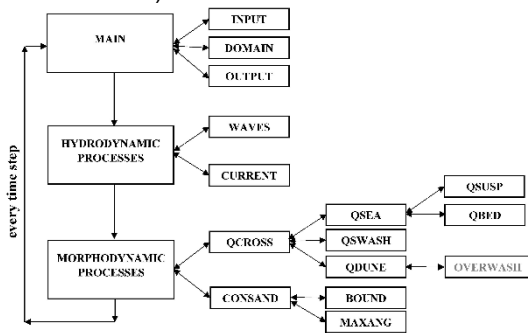


Figure 1- Schematic of the interconnected calculation modules in the numerical model of beach profile evolution (Zhang and Larson (2022)).

SELECTED RESULTS

In order to validate the model, a number of simulation tests were carried out employing both laboratory data from the SUPERTANK data collection project and field data from Ocean city and Myrtle Beach. Here, results from simulations for laboratory Case ST_50 and field Case HAL45, Ocean City, Maryland are presented in Figures 2-3, respectively.

As shown in Figure 2, the calculated profiles match well the measured data in both the dune and beach regions. It is clearly seen that the dune face keeps retreating shoreward with time. Figure 3 shows the calculations and measurement results for case HAL45 under the

Halloween storm. It can be seen that the evolution of dune region fits rather well. Overall, the model can reliably capture the general morphological behavior, which has great potential in practical engineering projects.

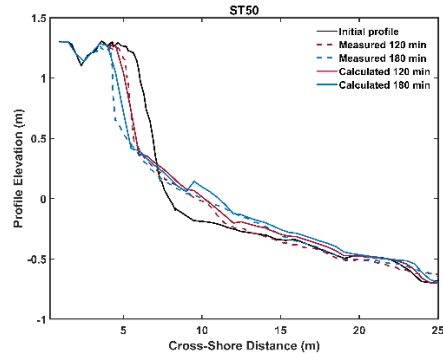


Figure 2- Calculated and measured beach profiles for Case ST_50 after 120 min and 180 min of wave action (Zhang and Larson (2022)).

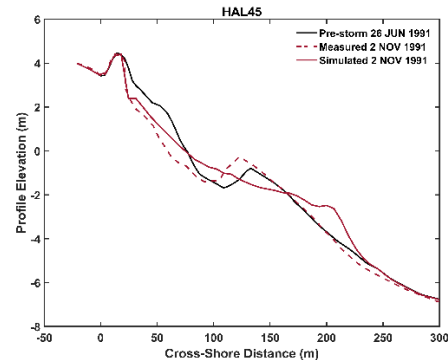


Figure 3- Calculated and measured beach profiles for case HAL45, Ocean City, Maryland (Zhang and Larson (2022)).

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