CROSS-SHORE BEACH PROFILE SIMULATION IN THE SWASH ZONE OF NARRABEEN-COLLAROY BEACH

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INTRODUCTION

Sediment transport and, consequently, the beach profile changes in the swash zone are important to the overall sediment budget and beach profile evolution because the hydrodynamic condition in this zone is complex. One of the swash zone morphodynamic difficulties is estimating the beach profile accretion and erosion above the mean water level. Although there have been considerable studies and investigations into the swash zone morphodynamic, numerical models for predicting sediment transport rate and beach profile changes are limited. Therefore, this study examined a morphodynamic numerical model to predict beach profile evolution in the swash zone using a nearshore beach profile dataset measured at the Narrabeen-Collaroy beach, Australia.

STUDY AREA

In this study, open access wave and cross-shore beach profile datasets measured at Narrabeen-Collaroy beach (hereafter referred to as Narrabeen) were employed. Narrabeen is located on the southeast coastline of Australia. A long-term cross-shore beach profile measurement program has been conducted since 1976, which is one of the limited ongoing beach profile measurements all around the world.

Narrabeen is a 3.6 km long curve-shaped sandy beach composed of quartz sand with a median grain size of 0.3 mm. Five cross-shore beach profiles with monthly intervals have been measured regularly. In this study, the cross-shore beach profile located in the center of the coastline has been selected to reduce the effect of longshore sediment transport.

BEACH PROFILE SIMULATION

Various uncertainties are noticeable in the swash zone sediment transport mechanisms. The division between sediment moving as bedload or suspended load is one of them. Furthermore, sophisticated hydrodynamic conditions affecting the bed shear stresses might be challenging to calculate. A numerical model similar to the previous research represented by Tabasi et al. (2020) was evaluated. The model comprises hydrodynamic, sediment transport, and beach profile update modules. The sediment transport module is the main part of the model, estimating the sediment transport rate based on separated erosion and accretion modes proposed by Suzuki and Kuriyama (2008).

RESULTS AND DISCUSSION

The sediment transport equations used for the calculations were originally derived for the estimation of sediment transport at the Hasaki coastline in Japan. However, the sediment properties such as the median grain size are different from this case study. Therefore, constant numerical parameters of the sediment transport equations were modified to obtain reasonable results. Figures 1 show the measured and simulated cross-shore beach profiles as well as wave conditions. Figure 1b indicates that the erosion was dominant from April 4th to June 12th, 2012. Very close to the final measurement, a strong storm with a maximum wave height of 4.5 m happened for about a week. It seems that this storm had a significant effect on this erosional profile. Red lines and circle marks in figures 1a, and c indicate storm events.

Nevertheless, the wave condition from September 12th to October 26th, 2011, is milder (figure 1c). A few days after the initial cross-shore beach profile measurement, waves had the stronger condition, and a maximum wave height of 2.7 m was recorded. However, waves were milder after this storm event, and accretion was the dominant sediment transport mechanism. The model's performance was assessed using the Brier Skill Score (BSS). The BSS values reveal that this model can achieve good results for berm erosion and formation.

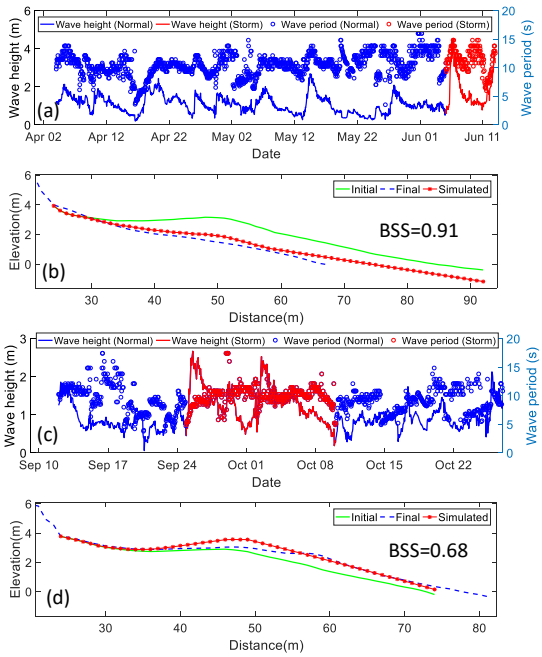

Figure 1 - (a) and (c): Wave conditions during simulation periods. (b) and (d): Comparison between simulated and measured cross-shore beach profiles.

REFERENCES

Suzuki, Kuriyama (2008): Simple model of cross-shore sediment transport rate for berm formation and erosion, ICCE. 1762-1773.
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