Storm Surge Simulations including Wave-Current Interactions based on the 3D Nearshore Current Model

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INTRODUCTION

This paper presents the numerical simulation of storm surges including wave-current interactions based on the 3D nearshore current model. Newly developed numerical model included new terms on surface stress and wave-induced Reynolds stress. The present nearshore current model calculates nearshore current field under storm surge, the wave forcing terms should be provided by the additional computation on the waves and surface roller. For the wave-current interactions, the present model is dynamically coupled with wind wave model which is modified WAM applicable to shallow water.

We conducted storm surge simulations in Youngil-bay located in the east coast of the Republic of Korea. One of the purpose of this simulation is to estimate the influence of large breakwater constructed in the north side of bay entrance on the erosion of beaches located inside bay area during the storm.

SHORELINE CHANGES

After construction of the harbour with long detached breakwater, northern part of Youngil-dae beach underwent severe erosion. This erosion tendency was not expected in the shoreline change modeling conducted in the pre-construction study, which considered only waves without storm surge modeling.

NUMERICAL MODEL

For the computation of nearshore currents in the three dimensional space, the fully implicit method of Choi and Moin (1994) has been employed to present nearshore current model. Solving the governing equations implicitly, the model provides unconditionally stable solutions for the near shore current fields. Unlike the mode splitting method which is adopted in POM and ROMS, this numerical method does not additionally require any two dimensional nearshore current model. As the present nearshore current model dynamically coupled with the wave model, modified WAM for the accurate computation of nearshore current fields, the wave-current interaction is incorporated into the present model. The model developed has been verified such as three dimensional rip currents (Chun and Suh, 2017) and wind wave hindcasting (Chun and Ahn, 2017).

RESULTS

As are shown in Figures 1 and 2, numerical simulations with and without offshore breakwater show the reversal of longshore current velocities under storm surge on the northern part of Youngil-dae beach. After the construction of offshore breakwater, strong southward alongshore currents occur during storm condition, which might cause severe erosion during storm. Since Youngil-dae beach is located about 8.2 km away from the offshore breakwater, nearshore current due to waves alone could not produce the reversal of the alongshore current direction. Accurate 3D modeling of nearshore currents under storm surge is found to be deciding effect on the beach erosion.

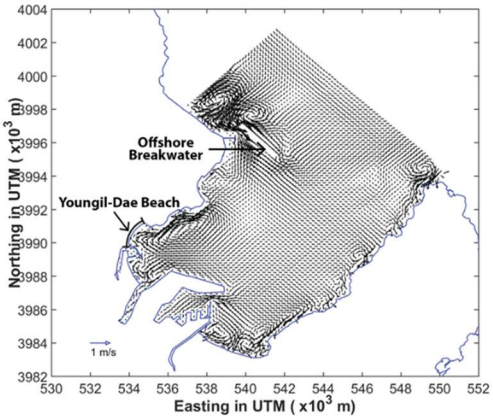

Figure 1. Nearshore current velocity field under storm surge with offshore breakwater.

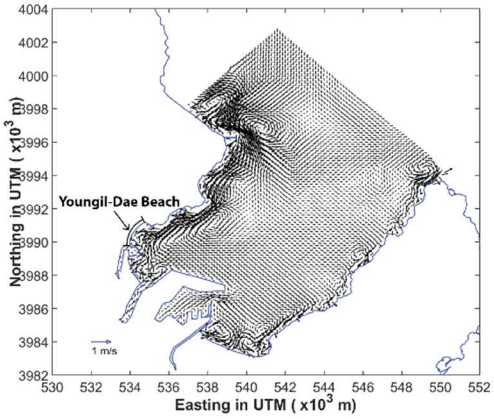

Figure 2. Nearshore current velocity field under storm surge without offshore breakwater.

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