A simulation study of typhoon surge inundation using open data at Su-ao Harbour, Taiwan

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Introduction

Storm surge is an abnormal rising of water level primarily generated by the strong wind of storms or hurricanes over the predicted astronomical tide. The low pressure of the storm has minimal contribution. This is a major risk along the coastal area in the world. Thus, previous studies have been carried out the numerical predictions of the inundation by storm surges. Shim, J.S. et al. (2013) using the computational fluid dynamics with a high-resolution topographic map to simulate the inundation of Masan Bay. Li L. et al. (2014) using D-Flow flexible mesh model to evaluate the inundation area and quantities the economic loss in Pearl River Delta. In 2010, Typhoon Fanapi caused storm surge inundation in Kaohsiung, Taiwan. This kind of events happens yearly in Taiwan.

In this paper, the coastal inundation generated by one of the largest recorded storm surges around Su-ao harbor is simulated using 3D Computational fluid dynamics (CFD) model. The purpose of this study is to reproduce the storm surge inundation caused by the Typhoon Soudelor over Su-ao harbor area, including the extreme height and overflow into coastal land areas.

Database

The bathymetric and wave data are applied to the storm surge and coastal flooding model. These two datasets were managed to retrieve from open data in the present study. The bathymetric data were downloaded from the open government website (data.gov.tw) and wave data were provided by CWB via TORI Open Data platform.

Open data is available and accessible public data to use. The data have to be licensed in a way that allows for their reuse. TORI Open Data platform is developed from mid-2015. There are two goals in this project. One is to develop a platform that regularly collects and store oceanographic data to our database from the government in Taiwan; the other is the value-added service of the Open Data. TORI Open Data platform can provide an efficient mean to offer our researchers to obtain more resources used in their studies.

To date, we have developed the interface of the Central Weather Bureau (CWB) open data from mid-2015 and Water Resources Agency (WRA) open data from 2017. There are various data types to be collected in our open data database including the ocean buoy, tide gauge, weather station and current data.

Super Typhoon Soudelor (August 2015) was used as a case study to simulate the Typhoon tide level and flooding situation. Also, the observed wave data of Su-ao Buoy (46706A) are obtained from the interface of the CWB via TORI Open Data database.

Conclusion

To simulate the 3D wave field in the vicinity of inundation for the Su-ao harbor area with high accuracy, the Reynolds-Averaged Navier-Stokes equations solved by the FLOW-3D code (Hirt and Nichols, 1981; Flow Science, 2002) are used. FLOW-3D utilizes a true volume of fluid (VOF) method to compute free surface motion and the fractional area/volume obstacle representation (FAVOR) technique to model complex geometric regions. A finite difference approximation is used for discretization of each equation (Shim, J.S. et al., 2013).

In this study, we performed one case study. A digital terrain model (DTM) was employed to the topographic input data. The wave height and wave period observed from Su-ao buoy were input into the model. Numerical simulation shows that both the overflow and inundation of the storm surge occurs over the low-lying area, included the river rim of Xincheng, Beijing Ao, Doufujia and so on. But in the result of 3D numerical simulation, the shoaling effect is yet to show in the inundation process. Thus, to improve the accuracy of inundation prediction, the simulation should use the digital surface model (DSM) data. The DSM represents the earth's surface including all objects such as terrain features, buildings, vegetation, power lines amongst others. The 3D numerical models with the detailed DSM data will be able to well reproduce the characteristics of surge inundation in the coastal area. Figure 1 show the storm surge overflowed the seawall and propagated inland.

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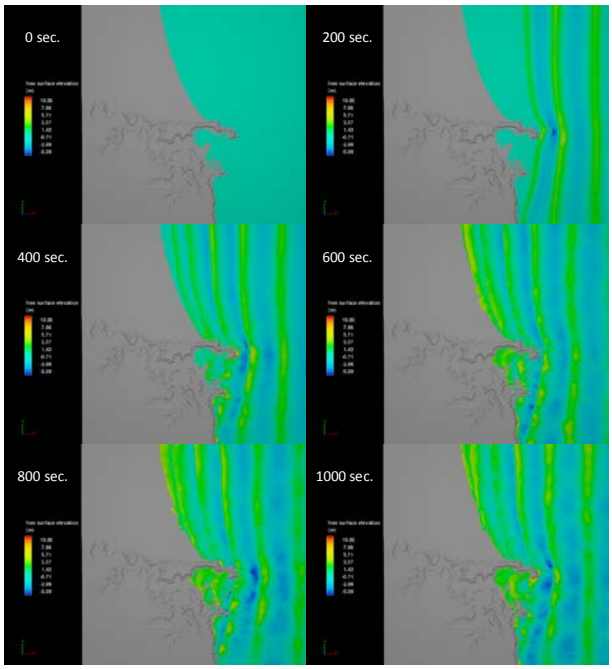

Fig. 1. The simulation result of water level changes around Su-ao harbor area.

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