TYPHOON JEBI-INDUCED FLOOD MODELING DUE TO WAVE OVERTOPPING/RUNUP AND REVERSE FLOW AT KANSAI AIRPORT

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INTRODUCTION

Typhoon-induced high waves and precipitations cause severe flood damage in low-lying coastal areas. Typhoon Jebi (2018) induced a compound flood at Kansai Airport by stormy waves, and seawater reversed flow through sewer systems. However, the cause of damage at Kansai Airport has been presented incompletely in various studies that analyzed individual flood factors and simply summed each result. A valid method for simulating the compound flood has not yet been established due to insufficient discussions. It means that we might encounter serious difficulties in adequately addressing the potential compound flood risk in the future. Therefore, this study validates the applicability of the compound flood simulation model by reproducing the flooding process of Kansai Airport.

METHOD

A series of numerical experiments were conducted to reproduce Jebi-induced inland flood at Kansai Airport by using a coupled coastal flood model of the storm surge, high wave, wave overtopping/runup, precipitation, and sewer backflow (Jo et al., 2021). The model was developed based on a coupled model of Surge, Wave, and Tide (SuWAT, Kim et al., 2008). In the innermost domain, the integrated formula of wave overtopping and runup (Yuhi et al., 2021) and one-dimensional shallow water equations are embedded for calculating wave-induced inundation and reverse flow-induced flood, respectively. The bathymetry and coastal geometry data are configured in seven domains using DEM data by the Geospatial Information Authority of Japan (GSI). The innermost domain (D07) has a 10 m grid size to analyze the inland flood in detail. The heights of breakwaters at the Kansai Airport are 5.7 m along the southwest (SW) side and 5.5 m along the southeast (SE) side. This study was designed to verify the applicability of the coupled coastal flood model on the flood risk assessment by simulating both individual floods and compound floods.

RESULTS AND CONCLUSIONS

The generation time and the amount of overflow by wave-induced inundation at Kansai Airport vary with nearshore flow properties (i.e., storm surge height (SSH), significant wave height (Hs), wave period (Ts), and wave direction). Points 1 and 2 in Fig. 1(b) were selected to compare the flow properties on the SW and SE sides of breakwaters where the wave-induced inundation occurs. The results show that the SSH is similar at both points, with up to 2 m. As a result, surge-induced overflows were not generated. On the contrary, higher Hs and longer Ts were simulated, especially on the SE side. It causes a large amount of wave overtopping over breakwaters.

The amount of flood discharge from each experimental condition is shown in Fig 2. The wave overtopping at the non-coupled model is calculated based on the wave information calculated by the fixed breaking point. This model cannot consider the variation of the breaking point location and the overflow seawater at the nearshore in the simulation process. It might overestimate the amount of wave overtopping when the sea surface level increases. On the other hand, flood rates due to the wave overtopping with varying breaking points are smaller than those at fixed breaking points. Moreover, a flood distribution due to each component at 15:10 4th September 2018 (JST) is shown in Fig 3. The inundation caused by individual components is reproduced in Fig. 3(a) and (b), respectively. A large amount of inundation was calculated in Fig. 3(c), which is caused by compound components (i.e., wave overtopping and reverse flow), compared to a single flood component. The present results demonstrate the applicability of the coupled coastal flood model for the compound flood simulation in low-lying coastal areas. This model can be used as a practical tool for coastal flood risk assessments.

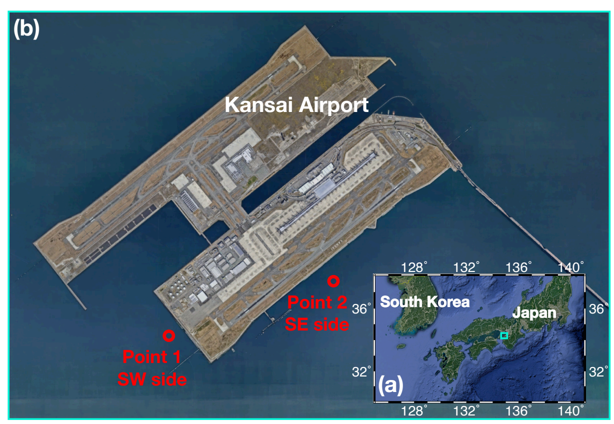

Figure 1 - General layout of Kansai Airport with locations for a comparison of storm surges and waves; Point 1: SW side and Point 2: SE side, 150 m from the breakwaters. (a) a location of Kansai Airport, (b) Kansai Airport

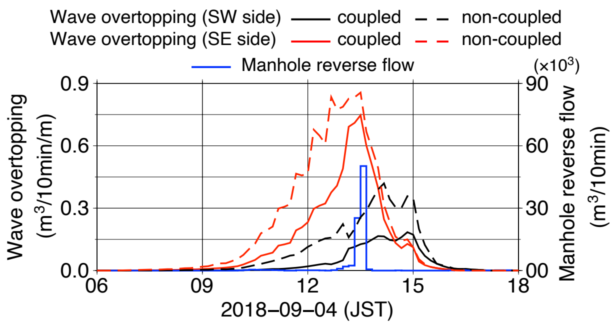

Figure 2 - The amount of flood discharge due to the each component in the coupled and non-coupled simulations

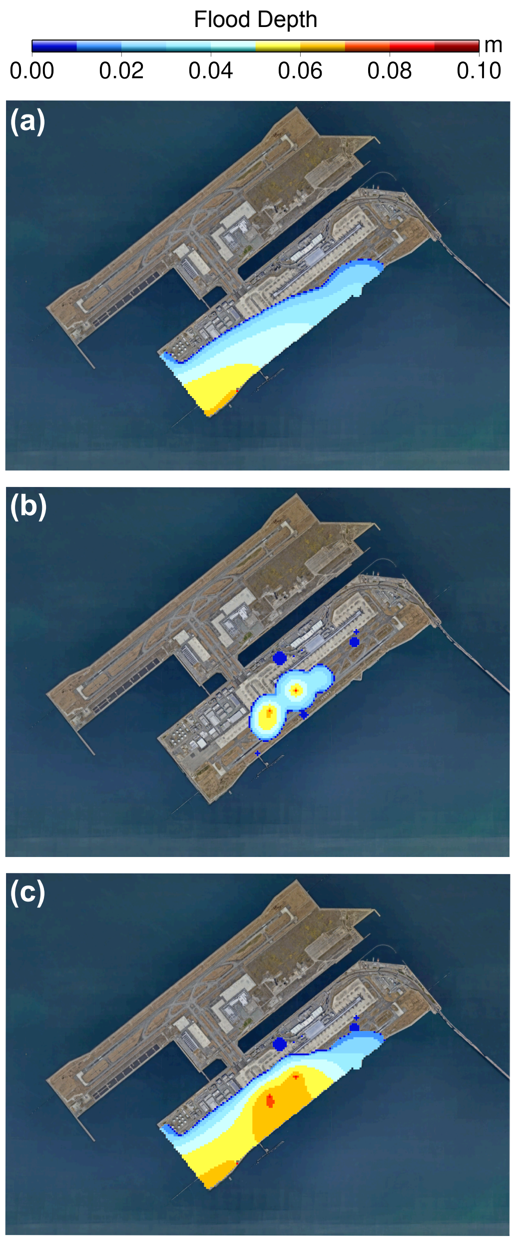

Figure 3 - A flood distribution at 15:10 4th September 2018 (JST) due to each flood component: (a) wave overtopping, (b) reverse flow, and (c) compound components

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