Simulation of Tsunami Inundation in City Scale Model

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Objectives: The 2011 Tohoku Earthquake Tsunami showed complex behaviour of tsunami inundation over the land, especially in city areas, along the Japanese coast. The tsunami behaviour in these city urban areas was different from rural areas and indicated importance of physical roughness (e.g. buildings, houses and streets) on inundation characteristics and hydrodynamic force estimations. The purpose of this study is to understand and validate of two numerical models of tsunami inundation in the city area.

Methods: This study used quasi-three-dimensional (Q3D) model and two-dimensional (2D) nonlinear shallow water model for numerical simulation. Both models are hydrostatic model, Q3D is based on Regional Oceanic Modeling System (ROMS; Shchepetkin and McWilliams, 2005) but vertical discretization are different each other. The two different numerical models are compared to the physical experiments of Seaside, Oregon, by Park et al. (2013), which examined tsunami inundation in an idealized urban shoreline at 1/50 scale.

Results: Both 2D and Q3D model agreed well with the experimental results on the strait street from shorelines. However, the numerical models were differed from the experiment at the points behind large scale buildings. The inundation depth and velocity of the 2D simulation tended to be smaller than those of the Q3D model especially further inland. This is because the 2D model allows for larger wave energy dissipation due to a fixed vertical velocity profile and excluded turbulence and vorticity modelling.

Conclusions: The 2D and Q3D model are available to estimate the damage of the tsunami in city scale but the accuracy of inundation depends on the local reflection and diffraction due to large scale buildings. According to the comparison of Q3D model and 2D model, it is likely that the 2D model underestimates the inundation extent and local hydrodynamic forces during the tsunami inundation process.

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