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The simulation of Typhoon-induced coastal inundation in Busan, South Korea applying the downscaling technique

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Due to typhoons, the south coastal cities including Busan in South Korea coastal are very vulnerable to a surge, wave and corresponding coastal inundation, and are affected every year. In 2016, South Korea suffered tremendous damage by typhoon ‘Chaba’, which was developed near east-north of Guam on Sep. 28 and had maximum 10-minute sustained wind speed of about 50 m/s, 1-minute sustained wind speed of 75 m/s and a minimum central pressure of 905 hpa. As ‘Chaba’, which is the strongest since typhoon ‘Maemi’ in 2003, hit South Korea on Oct. 5, it caused a massive economic and casualty damage to Ulsan, Gyeongju and Busan in South Korea. In particular, the damage of typhoon-induced coastal inundation in Busan, where many high-rise buildings and residential areas are concentrated near coast, was serious. The coastal inundation could be more affected by strong wind-induced wave than surge. In fact, it was observed that the surge height was about 1 m averagely and a significant wave height was about 8 m at coastal sea nearby Busan on Oct. 5 due to ‘Chaba’. Even though the typhoon-induced surge elevated the sea level, the typhoon-induced long period wave with wave period of more than 15s could play more important role in the inundation.

The present work simulated the coastal inundation induced by ‘Chaba’ in Busan, South Korea considering the effects of typhoon-induced surge and wave. For ‘Chaba’ hindcast, high resolution Weather Research and Forecasting model (WRF) was applied using a reanalysis data produced by NCEP (FNL 0.25 degree) on the boundary and initial conditions, and was validated by the observation of wind speed, direction and pressure. The typhoon-induced coastal inundation was simulated by an unstructured gird model, Finite Volume Community Ocean Model (FVCOM), which is fully current-wave coupled model. To simulate the wave-induced inundation, 1-way downscaling technique of multi domain was applied. Firstly, a mother’s domain including Korean peninsula was simulated using wind and pressure produced by WRF to produce surge and wave. And then, the wave-induced inundation was simulated applying the surge height and wave height simulated by mother’s model to the open boundary and initial condition of child’s model which was ranged near Busan. Our simulated surge height is generally underestimated about 15 % due to the underestimation of surface pressure on WRF. However, since the effect of wave on inundation could be more significant than surge-induced forcing in this real system, our research could predict the typhoon-induced inundation by combining the surge and wave forcing in nested domain.