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Inundation area by the 2011 Tohoku earthquake tsunami in Sendai plain: comparison to the 869 Jogan earthquake tsunami

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The 2011 off the Pacific coast of Tohoku Earthquake and following tsunami, occurred on 11 th March, affected widely to east Japan. The tsunami caused serious damages in particular to Iwate, Miyagi and Fukushima prefectures. According to the analysis by USGS, the moment magnitude is estimated at 9.0, which is the largest value among the observed earthquakes in Japan and 4 th largest event in the world. In Sanriku coasts, maximum run-up heights reached up to 40 meters (JSCE). Tsunami heights on the coasts in Sendai and other flat coastal plains are estimated around or more than 10 m. In addition, tsunami inundation in the coastal lowlands extended around several kilometers from the coast due to the large-scale tsunami and coseismic subsidence (GSJ).

In Sendai City, tsunami height of around 10 m near the coast was measured at Arahama, Wakabayashi Ward (JSCE). Post-tsunami survey by Research group of Tohoku University clarified that inundation depths reached around 2.8 meters in the areas 2 km from the coast. Although slopes of Sendai East Expressway prevented the tsunami inundation in the inland area, the tsunami run-up passed through underpath and elevated bridges of the expressway. Post-tsunami survey by Tohoku University clarified that traces of tsunami inundation exist at Kasuminome, Wakabayashi Ward, which is located landward of the elevated bridges and apart more than 5 km from the coast. The result is roughly consistent with the estimated inundation area from the satellite images and aerial photographs (GSJ). Therefore, inundation area could have reached around 5 km from the coastline through entire Sendai plain, if the expressway did not exist.

Like the 2011 event, the 869 Jogan earthquake has been known as one of the major historical earthquake that caused a large-scale tsunami in Tohoku region like the 2011 event (Watanabe, 2001). Deposits by the Jogan tsunami are distributed in the coastal plains of Ishinomaki, northern coast of Sendai Bay, Sendai and neighboring areas (Minoura & Nakaya, 1991; Sugawara et al., 2001; Sawai et al., 2007; Shishikura et al., 2007). In Sendai Plain, the Jogan tsunami deposit extends up to 3 km from the paleo-coastline, which is located around 1 km inland of the present beach (Sugawara et al. 2011). They estimated the hydraulic character of the Jogan tsunami based on the distribution and sedimentological feature of the deposit and reconstructed numerically the inundation area of the tsunami. Inundation area by an earthquake with a magnitude of 8.35 (fault length = 200 km, width = 85 km, displacement = 6.1 m) reaches around 3.5 km from the paleo-coastline. This is consistent with the distribution and character of the deposit. According to the calculation, tsunami height is estimated around 7 m near the coast and 2.5 m in lowlands around 2 km from the coast.

Based on the results from Sendai Plain, the inundation area (inundation distance) by the 2011 event is 2 km greater than that by the Jogan event. Tsunami height is around 3 m higher near the coast and several tens of centimeters higher in the inland area.

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