Effects of spatial resolution in run-up tsunami simulation on probabilistic tsunami inundation hazard assessment

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Our study is primarily motivated by a need to understand that information of probabilistic tsunami inundation hazard on a tsunami run-up area in a city contributes to the utility of disaster prevention plans and risk assessment. The probabilistic tsunami inundation hazard assessment for Japan can be quantified using much inundation information of area and depth in coastal regions, resulted from tsunami run-up simulations with many tsunami sources. One of efforts to obtain reliable and detailed information depends on computing cost such as spatio-temporal resolution of tsunami run-up simulations.

In this study, to investigate effects of spatial resolution in run-up tsunami simulation on probabilistic tsunami inundation hazard assessment, we applied two types of bathymetry grids with coarse (50 m) and fine (10 m) spatial resolutions for tsunami run-up simulations. The value of coarse spatial resolution is to reduce computing cost constrained by a tsunami run-up simulation. In our case, it is implemented as a surface model at 50 m grid size of minimum along coastal regions, however, which is not enough resolution to form an inhomogeneity of terrain topography and built structures which include disaster prevention facilities, levees and seawalls in finer resolution than 50 m, and to evaluate tsunami inundation depth. On the other hand, a detailed inundation hazard assessment is expected as a result of implementing 10 m grid size. Also, a comparison of structure conditions among inundation hazard (A) prevented by top-end structures, (B) depending on only mesh division and (C) following elevation without any structures is discussed.

Here our study provides quantification of probabilistic tsunami inundation hazard for a city, Wakayama one of example, using maximum inundation depth obtained from tsunami run-up simulation run at the spatial resolution 50 m and 10 m with the many tsunami sources used in the previous study that characterized earthquake fault models (CEFMs) along the Nankai Trough has been constructed to obtain 3945 Earthquake scenarios for the probabilistic tsunami hazard (Touyama et al., 2014, JpGU). We also implement the structure conditions to the tsunami run-up simulations. A basic methodology of the tsunami run-up and propagation simulation follows the previous study (Takayama et al., 2016, JpGU).

We compare the simulation-derived inundation depth of 10 m with 50 m. The inundation area and depth in the structure condition (B) of 50 m grid size is larger than 10 m. This result compatible with the previous result that the tendency that inundation area of run-up tsunami simulation decreases as mesh size decrease was theoretically confirmed (Murashima et al., 2006; 2008, CEJ). We also newly find that the tsunami run-up simulations using the many types of the Earthquake scenarios capture a trend and a correlation between the inundation depths of 10 m and 50 m grid size depending on tsunami heights and the structure conditions. The larger the tsunami heights are, the broader the difference between inundation areas of both the resolutions become. The trend agreements in inundation area from the structure condition (B) and (C) are best, showing except full protection like the structure (A). Similar results are obtained for a horizontal distribution of the probabilistic tsunami inundation hazard for a city that is described by the hazard curves at every grid points on run-up area.

In the next work, we will study a regional dependency that is needed for an adaptation of this results to the other sites as this results may do not cover the whole coastal regions and not available for all the various types of a land use because the correlation is attributed to regional uncertainties in a real surface topography and an actual structure conditions.
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Keywords: the Nankai Trough, Run-up tsunami simulation, Tsunami inundation, Probabilistic tsunami hazard assessment (PTHA)

