AN APPROACH FOR PROBABILISTIC TSUNAMI HAZARD ASSESSMENT AND APPLICATION TO SOUTHERN COASTAL AREAS OF CHINA

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BACKGROUND

Seismic tsunami poses risks to many coast areas. Strong earthquakes in the area of Manila Trench may produce large-scale seismic tsunamis in South China Sea. This study aims to conduct PTHA (Probabilistic Tsunami Hazard Assessment) for the southern coastal areas of China. Several methods have already been developed to carry out PTHA, e.g. Geist & Parsons, (2006). However, there are multiple seismic parameters that affect the scale of seismic tsunamis, and those parameters are with strong uncertainties. For accurately assessing the tsunami hazard, a large number of scenarios are inevitably required to do the probabilistic statistical analysis. Therefore, existing methods do make some limits on seismic parameters to ensure the efficiency. In order to balance the accuracy and feasibility in PTHA, this study proposes a new approach.

METHOD

Based on the linear assumption of tsunami waves in deep water, the computation of tsunami wave propagation is given by the linear superposition of waves caused by unit sources of water level disturbance, which transforms a large number of seismic tsunami scenarios simulations into a limited number of simulations on wave propagating from each unit source. In this study, we place 5438 unit sources with the interval of 0.1° around Manila Trench. The initial water level disturbance is assumed as a Gaussian function, and the wave propagation of each source is computed by FVCOM. The results of unit source cases form a database for further estimating the tsunami wave propagation caused by an earthquake with any combination of seismic parameters. By approximating the initial water level disturbance caused by an earthquake by linear superposition of unit sources, the evolution of tsunami waves in the entire South China Sea caused by an earthquake can be obtained by linear superposition of the wave fields in the database.

By analyzing historical earthquake records, we build a set with 1,380,000 scenarios obtained from the combination of magnitude, epicenter and focal depth. The water level fluctuation process of each target point along the 100m isobaths in every scenarios is calculated to estimate whether the maximum wave height of the leading wave exceed a specific critical value. The target points are shown in Figure1. Combining the probability density of each seismic parameter, the exceedance probability of the specific wave height at a target point is given. In the meantime, sensitivity analyses of four variables have been conducted, including the smoothness of the probability distribution of epicenters, the annual occurrence rate of different magnitudes, the fitting coefficient of the relationship between magnitude and frequency, and the lower limit of magnitude in the probability distribution function. Then, one appropriate combination of these variables is selected to calculate the exceedance probability caused by seismic earthquakes from Hainan to Fujian.

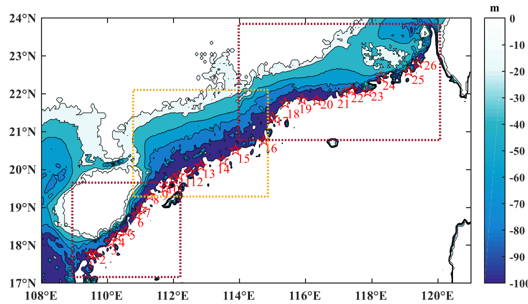

Figure 1 - Target points along the southern coast of China

RESULTS

The recurrence period of 0.5m wave height at water depth of 100m is about 500 years in the south of Hainan Island, more than 200 years at the west side of the Pearl River estuary, and around 100 years at the east side of the Pearl River estuary. The recurrence period of 0.1m wave height is about 100 years in the south of Hainan Island, about 50 years at the west side of the Pearl River estuary, and around 30 years at the east side of the Pearl River estuary. Some results are shown in Figure 2.

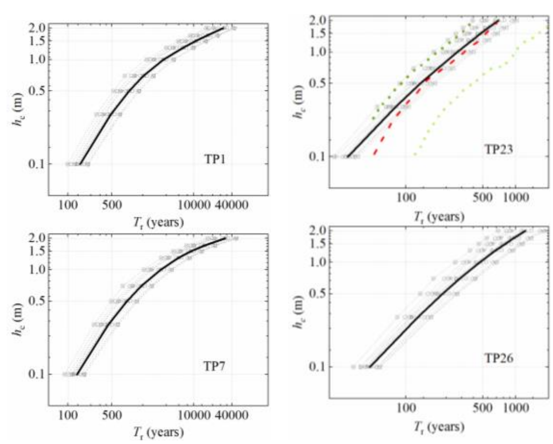

Figure 2 - Hazard curves of target points showing specific critical wave height as a function of return period

REFERENCES

Geist, Parsons (2006). Probabilistic analysis of tsunami hazards. Natural Hazards, vol. 37, pp. 277-314.