

TSUNAMI HAZARD DATASET IN THE SOUTH CHINA SEA

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OBJECTIVE

The South China Sea and surrounding coastal regions are at risk of earthquakes and tsunamis from the Manila Trench, which is the junction of the Philippine Sea plate and the Sunda plate. In order to reduce the impact of tsunami hazard in the South China Sea, tsunami hazard assessment is necessary, with the probabilistic tsunami hazard assessment (PTHA) being the main focus in recent years. In the entire process of probabilistic tsunami hazard assessment, there are varying degrees of uncertainty. The largest source of uncertainty is the seismic activity including the maximum possible magnitude and rupture characteristics. With the rapid development of Global Navigation Satellite System (GNSS), the method of using surface GPS horizontal velocity field data to invert fault coupling and slip deficit has been widely used. The distribution of coupling and slip deficit can be used to estimate the seismic potential and describe the characteristics of slip distribution in an earthquake. The study aims to clarify the spatial distribution of tsunami hazard in the South China Sea through the PTHA considering geodetic coupling. The effects of different heterogeneous slip distributions on PTHA results are investigated.

SEISMIC POTENTIAL ASSESSMENT

Fault coupling is related to seismic potential in subduction zone. Generally, in higher coupling patches, faults accumulate slip deficit at a faster rate, thereby accumulating more stress, and are more likely to become the start of rupture or generate greater slip in the next earthquake event. Fault coupling and slip deficit are obtained from inversion of GPS velocities by using the inversion program TDEFNODE. The observed GPS velocities distributed on the Philippine Sea Plate, the Sunda Plate and surrounding areas are used. Two widely-used coupling distributions are considered in the inversion including the Gamma distribution and Gaussian distribution, which were both used to describe fault coupling in relevant research.

The Manila subduction zone is divided into two segments with a boundary at 14.5°N. The north segment is 14.5 to 22°N and the south segment is 13 to 14.5°N. The static cumulative seismic moment estimated by the coupling can only be released by about 40-50%, which is caused by the non-uniformity of faults. Therefore, the release rate of 40% of static cumulative seismic moment is considered when evaluating the seismic potential. Finally, the seismic moment accumulation rate in the north segment of Gaussian and Gamma model is 1.52×10^{20} N·m/a and 1.22×10^{20} N·m/a. The maximum magnitude for 500 years is 8.9 in two models, which is assumed to be the maximum possible magnitude for the north segment. And the maximum possible magnitude for the south segment is 8.5 in Gaussian model and 7.9 in Gamma model.

SPATIAL DISTRIBUTION OF TSUNAMI HAZARD

Tsunamis generated by possible earthquake scenarios have been obtained by numerical model to show the spatial distribution of tsunami hazard. Considering the uncertainty of earthquake magnitude and epicenter, possible combinations of magnitude and epicenter were adopted, when the maximum magnitude of the Manila subduction zone had been evaluated as 8.9. A total of 6,082,119 tsunami scenarios were simulated using the unit source method (Zhang & Niu, 2020). The observation points in the South China Sea were selected at an interval of 0.1°, with a total of 23,754 observation points. The tsunami wave height of each observation point with a return period of 1000 years can be obtained through the PTHA method, as shown in Figure 1.

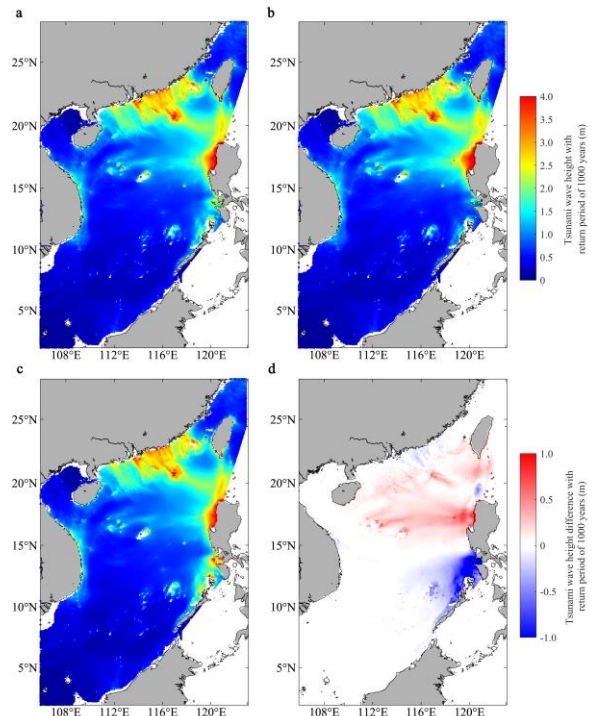


Figure 1 - Spatial distribution of tsunami hazard with a return period of 1000 years in the South China Sea. (a) Mean tsunami wave height with a return period of 1000 years. (b) Tsunami wave height with a return period of 1000 years in Gamma model. (c) Tsunami wave height with a return period of 1000 years in Gaussian model. (d) The difference of tsunami wave height with a return period of 1000 years between Gamma model and Gaussian model.

The main high tsunami risk regions in the South China Sea include the southeast coast of China and the southern part of Taiwan Island, the western coast of Luzon Island in the Philippines, and some islands and

reefs in the South China Sea include the Xisha Islands and the Dongsha Islands. The tsunami wave heights in these regions are generally greater than 4 m with a return period of 1000 years. Luzon Island faces a high tsunami risk due to its proximity to the source area. As the continental shelf outside the southeast coast of China becomes shallower, the tsunami waves gradually increase. The tsunami wave height on the east side of the southeast coast is significantly higher than that on the west side. The steep terrain of Taiwan Island and Xisha Islands also makes these areas face high tsunami risk. However, these islands only have a high tsunami risk on the side facing the source area.

Compared with previous study on the spatial distribution of tsunami hazard in the South China Sea (Ma et al., 2022), the spatial distribution pattern of tsunami hazard is similar, and the location of high-risk areas is the same. The spatial distribution map has important reference

significance for hazard prevention and mitigation, as well as the design and construction of offshore engineering in the South China Sea. The tsunami wave height with a return period of 1000 years in the South China Sea obtained in this study is slightly smaller, and possible reasons include the selection of upper magnitude limit and fault segmentation.

REFERENCES

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