A Probabilistic Tsunami Hazard Model for South China Sea

Aykut Ayca, FM Global, aykut.ayca@fmglobal.com
Yufang Rong, FM Global, yufang.rong@fmglobal.com
Harold Magistrale, FM Global, harold.magistrale@fmglobal.com
Elliot Klein, FM Global, elliot.klein@fmglobal.com

INTRODUCTION AND METHODS

In this study, we have developed probabilistic tsunami hazard maps for the Philippines, Taiwan, Southeast China, and Vietnam. These regions face the potential threat of large, destructive tsunamis due to subduction zone earthquakes along the Manila Trench, located off the western coast of the Philippines.

To construct these hazard maps, we gathered earthquake scenarios from the Global Earthquake Model (GEM) seismicity model specific to the Philippines (Penarubia et al., 2020). This model provided us with a stochastic event set consisting of earthquakes with a range of magnitudes, corresponding return periods, and rupture scenarios. Initially, we generated a 1,000,000-year time-independent, stochastic earthquake catalog. We then conducted an optimization process, beginning with a random and shorter i.e., 10,000-year for southern segment, 12,000-year for central segment, and 25,000-year for northern segment subset and continually generating new random samples until the difference between the sample and model magnitude-rate curves was minimized for the first 10,000, 12,000 and 25,000-year period for each segment. Overall, the final, optimized catalog contained ~1,000 Mw > 7 subduction zone interface earthquakes, each featuring a unique non-uniform slip distribution. A k^{-2} finite fault model was used to generate these non-uniform slip fields. We numerically simulated these events to estimate maximum inundation depths and flow velocities along the entire coastlines of the four countries.

Hydrodynamic tsunami simulations were carried out with the COMCOT model, a linear and nonlinear shallow water wave solver. We simulated all the events in the stochastic catalog using computational grids that have 90-meter horizontal resolution, which were put together from various open-source datasets. This relatively high-resolution modeling is essential to quantify the on-shore and on-land tsunami hazards accurately.

RESULTS

This probabilistic tsunami hazard assessment (PTHA) yielded estimates of the spatial distribution of 500, 1,000, 2,500, and 10,000-year maximum tsunami amplitudes in the study region. In our presentation we will discuss these in detail. Here we provide examples of two maps for return periods of 500 and 2,500 years, which approximately correspond to the 10% and 2% annual exceedance probabilities over 50 years (Figures 1 and 2), aligned with the design levels recommended by ASCE7-22 for disaster resiliency.

Our comprehensive study offers insights into the risk of tsunami in this region and provides a scientific basis for informed decisions to prepare these communities for the potential devastation of tsunamis.

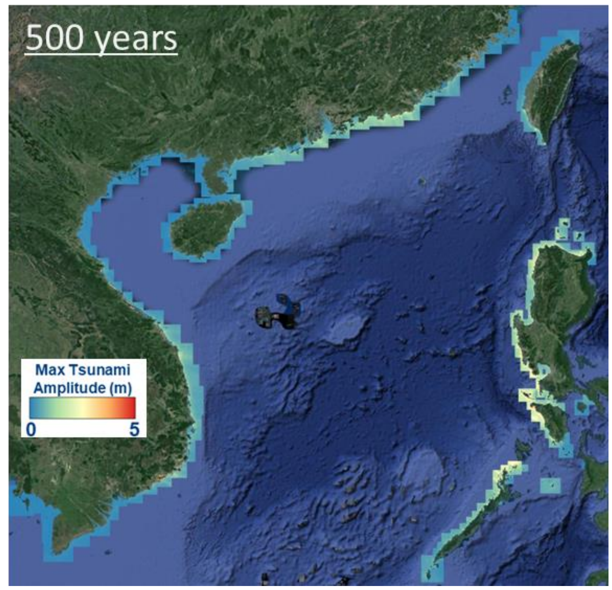

Figure 1. 500-year nearshore wave heights.

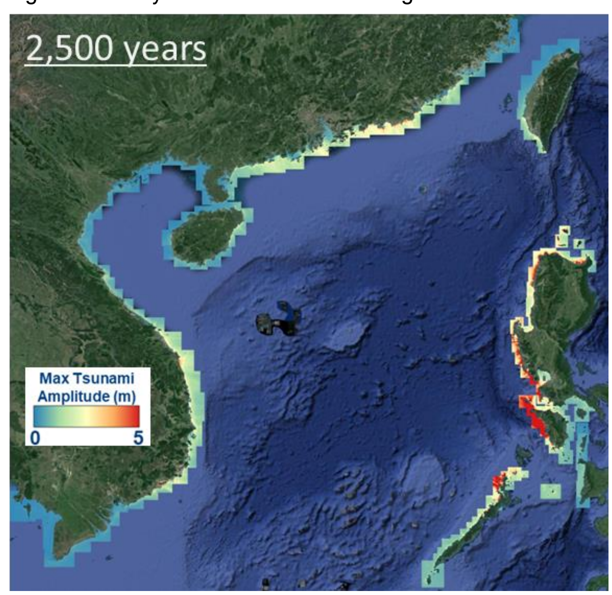

Figure 2. 2,500-year nearshore wave heights.

REFERENCES

Peñarubia, Johnson, Styron, et al. Probabilistic seismic hazard analysis model for the Philippines. Earthquake Spectra. 2020;36(1_suppl):44-68.