Probabilistic tsunami hazard assessment for the Japan Sea region

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While our attention is drawn to the east coast of Japan due to the occurrence of mega tsunamis in the subduction zones, such as the Japan Trench and Nankai Trough, its counterpart in the west coast possesses non-negligible tsunami hazards. The west coast of Japan is situated in the eastern margin of the Japan Sea, which is known to host large tsunami events generated by earthquakes (M>7) on several active fault systems in the region: The 1993 South-west Hokkaido (M 7.8), 1983 Japan Sea (M 7.7), 1964 Niigata (M 7.5), 1940 Shakotan-oki (M7.5), and 1833 Shonai-oki (M 7.5). Each earthquake causes considerable coastal tsunami impacts, with the highest observed tsunami of approximately 30 m at Okushiri Island associated with the 1993 event. These historical records highlight the necessity to assess the tsunami hazard levels along the west coast of Japan as part of mitigation efforts, particularly in relation with the coastal development strategy.

To that end, we conducted a probabilistic tsunami hazard assessment (PTHA) study around the Japan Sea in accordance with 60 submarine active faults identified by the Ministry of Land, Infrastructure, Transport and Tourism of Japan (MLIT, 2014). The faults correspond to estimated moment magnitudes ranging from 6.8 to 7.9. We generated multiple stochastic non-uniform slip models on each fault system to develop a regional synthetic earthquake catalog, while the earthquake recurrence rate was determined using real data from the Japan Meteorological Agency earthquake catalog within a period of 1997-2017. The PTHA was derived based on a Green’ s function approach, in which maximum coastal tsunami heights were resulted from a superposition of precalculated tsunami scenarios weighted by slips. In this study, we considered 156 coastal points in the analysis representing municipalities along the west coast of Japan.

In general, the hazard level increases from southwest to northeast. This is consistent with the limited number of identified faults in the southwestern part, as well as the types of fault that are mainly characterized by strike-slip faults. However, the southwestern part could also be subjected to significant tsunamis, especially at locations situated very close to the fault system. Deaggregation analysis further confirmed the profound effect of local faults to the coastal tsunami heights indicating the main characteristic of tsunamis in the Japan Sea.

Such near-field events are very difficult to deal with as they can produce a very large tsunami with an extremely short lead time. Our study shows the potential of near-field tsunamis that may cause severe damage in the Japan Sea region. Thus, specific precautionary measures for near-field events should be implemented to protect coastal areas at risk.

Keywords: Japan Sea, Probabilistic tsunami hazard assessment, Earthquake

