

Propagation and inundation process of the 2024 Noto Peninsula earthquake tsunami inferred from numerical modeling

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A tsunami was observed throughout the Japan Sea following the Noto Peninsula earthquake (Mw 7.5) on January 1, 2024. Based on the geodetic and seismological observations, the source fault was interpreted as a series of submarine active faults that were previously recognized in the tsunami hazard assessment. This study aimed to obtain implications for tsunami source and propagation and inundation processes through numerical simulations. Fault models used in this study were hypothetical fault models F42 and F43 proposed by MLIT (2014) and an event-specific model of the 2024 Noto earthquake by GSI (2024). The simulation results were examined by the observations of tsunami waveform at tide stations (Toyama, Kashiwazaki, and Sado) and the inundation on the Iida Bay coast, Suzu City, Ishikawa Prefecture. A composite fault model of F43 and the western half of F42 best explained the tsunami arrival time, wave height, and inundation distance. Although the quantitative comparison is insufficient this model is also consistent with locally high tsunami heights at Joetsu coast and southern Sado, Niigata Prefecture. This fault model suggests that large sea-surface displacements occurred above the eastern edge of the tsunami source fault.

Tsunami travel time was highly affected by the heterogeneous bathymetry around the tsunami source (e.g., Toyama Trough and Iida Spur). Extensive inundation on the Iida Bay coast was estimated to be caused by the second wave ~30 min after the earthquake. In particular, the tsunami height near the Ukai Port might be amplified due to the superposition of two waves propagated along the north and south shores.

Any fault model could not reproduce the tsunami arrival time at Toyama tide station (~3 min after the earthquake). Large submarine mass failures (SMFs) in Toyama Bay were identified through bathymetric surveys by the Japan Coast Guard and might have contributed as an additional tsunami source. We examined the tsunami excitation potential of the SMFs by numerical simulations with the formula proposed by Watts et al. (2015) to estimate SMF-induced tsunami initial waveform. As a result, the tsunami arrival time at the Toyama station was well reproduced by considering SMF's characteristic time and delay of peak ground motion. However, the tsunami period and amplitude were not consistent with the observation and may suggest the occurrence of other SMFs.

Keywords: Eastern margin of the Japan Sea, Submarine active fault, Submarine landslide