

Modeling the submarine landslides and tsunamis triggered by the Tagoro eruption

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ABSTRACT

The 2011-2012 eruption of Tagoro, a submarine volcano located 1.8 km south of the island of El Hierro in the Canary Islands, provided a unique opportunity to study the interplay between volcanic activity, submarine landslides, and tsunami generation. During this period, the Spanish Institute of Oceanography (IEO) conducted periodic bathymetric surveys, revealing the growth of the volcanic cone from a depth of 300 m to just 88 m below the sea surface, as well as multiple episodes of collapse and flank instability. These collapses triggered landslides along the preexisting submarine gully, causing significant material transport downslope and reshaping the seafloor (Vázquez et al., 2013).

Submarine landslides, such as those observed at Tagoro, are key triggers of tsunamis through the rapid displacement of water volumes. However, the complex interactions between deformable landslides, water dynamics, and tsunami generation pose significant challenges for numerical modeling (Yavari-Ramshe and Ataie-Ashtiani, 2016).

To address these challenges, we developed a numerical approach using a 3D Navier–Stokes (3D-NS)

solver implemented in OpenFOAM. This model captures the dynamics of granular flows with a non-Newtonian rheology. Using this setup, we simulated the successive collapses during the Tagoro eruption and the subsequent wave generation.

Our results highlight the potential of 3D-NS models to capture the coupled processes of granular collapse and tsunami generation, suggesting that 3D-NS models are a promising tool for assessing risks associated with landslides in volcanic islands.

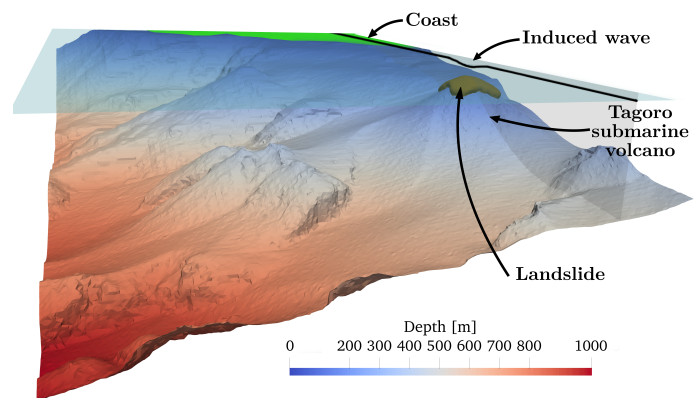


Figure 1: Simulation of a granular collapse during a landslide and subsequent tsunami wave generation.

References

Vázquez, J. T., et al. Geomorphology of Tagoro volcano along eruptive and post eruptive phases. El Hierro Island. Cham: Springer International Publishing, 2023.

Yavari-Ramshe, S., and Ataie-Ashtiani, B.. Numerical modeling of subaerial and submarine landslide-generated tsunami waves—recent advances and future challenges. Landslides, 13, 2016..