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Effect of volcanic islands offshore morphology on the tsunami generation and hazard extent from coastal cliff-failures.

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Mass-wasting events on volcano islands flanks are a recognized source of tsunami. Nonetheless, little is known about the failure mechanisms, dynamics that lead to the wave formation and the tsunami extent when the displaced material plunges into the sea and moves downslope. Owing to the lack of direct and instrumental observations, the main indicator of tsunamigenesis for mass-wasting events is the volume of the failure material, often inferred from mass transport deposits offshore and/or collapse scars onshore.

This work addresses the influence of islands offshore morphology on the formation and hazard extent of tsunamis triggered by coastal cliff-failures. Particularly, we explore two common coastal morphologies of ocean volcanic islands: a volcanic island with and without insular shelves. We seek to better understand how the presence of these shallow submarine platforms constrains the dynamics of the collapses and, consequently, the tsunami generation and its hazard extent. To this end, we performed numerical simulations using different morphologic configurations and landslide volumes and allowing to simulate and analyse the formed tsunami energy (both potential and kinetic). The results show that, for the same coastal cliff-failure volume, the islands offshore morphology highly influence the tsunami generation and hazard extent. We found that tsunamis forming on islands with insular shelves have initial solitary-like waveshape with relatively short wavelength, while those on islands without shelves show N-wave shape with longer wavelength. The latter have higher energy, both potential and kinetic, allowing the tsunami to travel away from the shore and cause larger hazard extent than those occurring on islands without shelves. Our results demonstrate that offshore island morphology is a particularly determining factor in the dynamics of collapsed sectors and, therefore, on their tsunamigenesis and hazard extent.

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