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Tsunamis generated by 3D granular landslides in various scenarios

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Tsunamis generated by landslides and volcanic island collapses account for some of the most catastrophic events. Major tsunamis caused by landslides or volcanic island collapse were recorded at Krakatoa in 1883, Lituya Bay, Alaska in 1958, Yanahuin Lake, Peru in 1971, Papua New Guinea in 1998, Java in 2006 and Haiti in 2010. Landslide tsunami hazards exist even in areas not exposed to tectonic tsunamis. Source and runup scenarios based on real world events are physically modeled in the three dimensional NEES tsunami wave basin (TWB) at Oregon State University (OSU). A novel pneumatic landslide tsunami generator (LTG) was deployed to simulate landslides with varying geometry and kinematics. The LTG consists of a sliding box filled with up to 1,350 kg of naturally rounded river gravel which is accelerated by means of four pneumatic pistons down the 2H: 1V slope, launching the granular landslide towards the water at velocities of up to 5 m/s. Topographical and bathymetric features can greatly affect wave characteristics and runup heights. Landslide tsunamis are studied in different topographic and bathymetric configurations: far field propagation and runup, a narrow fjord and curved headland configurations, and a conical island setting representing landslides off an island or a volcanic flank collapse. Water surface elevations were measured using an array of resistance wave gauges. The granulate landslide shape and front velocity were measured using above and underwater cameras. Three-dimensional landslide surfaces with surface velocities were reconstruction using a stereo particle image velocimetry (PIV) setup. The speckled pattern on the surface of the granular landslide allows for cross-correlation based PIV analysis. Wave runup was measured with resistance wave gauges along the slope and verified with video image processing. The measured landslide and tsunami data serve to validate and advance 3-dimensional numerical landslide tsunami and prediction models, which is critically important for the preservation of world heritage cites.