Tsunamis generated by unconfined deformable granular landslides in various topographic configurations

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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, Grand Banks, Newfoundland in 1929, Lituya Bay, Alaska in 1958, Papua New Guinea in 1998, and Java in 2006.

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 width, thickness and front velocity were measured using above and underwater cameras. Landslide 3-dimensional surface reconstruction and surface velocity properties were measured 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.