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Physical Modeling of Landslide Generated Tsunamis and the 50th Anniversary of the Vajont Dam Disaster

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The Vajont river is an affluent of the Piave River located in the Dolomite Alps of the Veneto Region, about 100km north of Venice. A 265.5 m high double curved arch dam was built across a V-shaped gorge creating a reservoir with a maximum storage capacity of 0.169 km3. A maximum water depth of 250 m was reached by early September 1963 during the third filling attempt of the reservoir, but as creeping on the southern flank increased the third reservoir draw down was initiated. By October 9, 1963 the water depth was lowered to 240m as the southern flank of Vajont reservoir catastrophically collapsed on a length of more than 2km. Collapse occurred during reservoir drawdown in a final attempt to reduce flank creeping and the reservoir was only about two-thirds full. The partially submerged rockslide with a volume of 0.24 km3 penetrated into the reservoir at velocities up to 30 m/s. The wave runup in direct prolongation of slide axis reached the lowest houses of Casso 270m above reservoir level before impact corresponding to 245m above dam crest (Müller, 1964). The rockslide deposit came within 50m of the left abutment and towers up to 140m above the dam crest. The lateral spreading of the surge overtopped the dam crest by more than 100m. The thin arch dam withstood the overtopping and sustained no damage to the structural shell and the abutments. The flood wave dropped more than 500m down the Vajont gorge and into the Piave Valley causing utter destruction to the villages of Longarone, Pirago, Villanova, Rivalta and Fae. More than 2000 persons perished.

The Vajont disaster highlights an extreme landslide tsunami event in the narrowly confined water body of a reservoir. 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.