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Experimental tsunami wave generation by gravity driven granular collapse

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Various reported geological events have shown that landslides involving volumes from a few thousand of cubic meters to several cubic kilometers can happen near coastlines. These events may lead to tsunami waves with significant amplitude with potential important damages to infrastructure and populations located on or near the coast. Despite this important hazard, these events remain poorly understood and difficult to model, leading to a very approximated estimate of the associated hazards. One key problem is the deep understanding of the tsunami wave generation by the granular nature of landslides. We look here at the water wave generation by the collapse of an initial vertical granular column in a small scale laboratory experiment.

The setup consists of a tank of 2 m long and 0.15 m wide with a column of dry granular material (typically glass beads of few mm in diameter) at one end maintained initially by a vertical sliding gate above of a quiescent water layer of a few cm deep. Upon quickly opening the gate, the subaerial grains collapse by gravity and impact the water free surface generating an impulse wave. With a camera, we record and track both the time evolution of the granular collapse and of the generated wave. In this small scale experiment, we can vary easily the different control input parameters of both the falling granular mass (height, volume, aspect ratio, grain size and density) and water layer (height or slope), and measure in particular the height and width of the generated leading wave. This allows us to look at the energy transfer between falling grains and water. Our experimental results show that the volume of the generated leading wave is about proportional to the volume of grains impacting the water surface, and that the wave energy is only a few percent of the grains energy, with thus a large dissipation both in the granular flow itself and in the grain/fluid interactions.