# From seismic waves to landslide and tsunami processes


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As they flow down the slope or travel in the ocean, landslides and tsunamis generate seismic waves that propagate for 100's of km from the source. In effect, the potential energy of a landslide is dissipated across a granular medium at intermediate scales down to the grain scale, giving rise to waves that span a broad range of frequencies. These waves, recorded by dense seismic arrays, carry crucial details on the source processes such as bulk landslide accelerations and decelerations at low frequencies (0.01-0.2 Hz) or variations in grain-scale forces at high frequencies (1-50 Hz). Therefore, beyond mere detection and locating of landslides, full deciphering of this huge amount of high-accuracy wave data should provide invaluable clues to the complex characteristics and dynamics of landslides and related hazards.

Advanced numerical models of the source coupled with wave propagation codes provide unique tools for extracting information about source processes from the recorded seismic waves. Indeed, by comparing simulated and recorded signal characteristics, it is possible to discriminate the signature of the different processes on the seismic signal (mass, topography, friction, presence of fluid, etc.). I will show here how seismic inversion of low-frequency waves associated with landslide simulations can be used to recover key landslide characteristics such as its volume, friction coefficient, or erosion/deposition processes. I will also present very recent results where landslide-tsunami models were shown to be necessary to explain the origin of a 9-day monochromatic seismic signal recorded all over the world. Finally, I will highlight the challenges of extracting information from the high-frequency seismic waves and show how laboratory-scale experiments of granular flows and generated acoustic waves can provide unique insights into the grain-scale mechanisms at the origin of this signal.