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High frequency seismic signal generated by landslides on complex topographies: from numerical simulation to field observation at Dolomieu crater, La Réunion

Julian Kuehnert (1), Anne Mangeney (1,2), Yann Capdeville (3), Virginie Durand (1), El Hadji Koné (1), and Éléonore Stutzmann (1)

(1) Institut de Physique du Globe de Paris, Sismologie, USPC, CNRS, Paris, France, (2) Universite Paris-Diderot, Paris, France, (3) Laboratoire de Planetologie et Geodynamique de Nantes, CNRS, Universite de Nantes, Nantes, France

During their flow along the topography, landslides generate seismic waves in a wide frequency range. The recorded signals, so called landquakes, are used to deduce landslide properties and dynamics. For example, the landslide's volume can be calculated from the recorded high frequency seismic energy (Hilbert et al., 2011; typical dominant frequency range for Dolomieu crater rockfalls: ∼1-20 Hz). In order to get reliable results, the energy is calculated by averaging the signals recorded at different seismic stations. The signal amplitude plays a crucial role in this process and its origin is generally poorly understood. Indeed, topography and other site effects may significantly change the seismic wave amplitude at the different stations, especially at high frequencies. We address this issue here by simulating seismic wave propagation including a detailed description of the (distributed) landslide seismic source and the complex natural topography. The time dependent spatial distribution of the forces applied to the ground by the landslide are obtained using granular flow numerical modeling on 3D topography. The generated seismic waves are simulated using the spectral element method. Finally, the simulated seismic signals are compared to observed seismic data from rockfalls at the Dolomieu Crater of Piton de la Fournaise, La Réunion. We show that topography effects can explain the observed strong differences between wave amplitude at different stations, suggesting to use the stations separately to calculate the rockfall volume from the recorded seismic signal.

Hibert et al. (2011). Slope instabilities in Dolomieu crater, Réunion Island: From seismic signals to rockfall characteristics. Journal of Geophysical Research: Earth Surface, 116(4):1–18.