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Approaching a more Complete Picture of Rockfall Activity: Seismic and LiDAR Detection, Loaction and Volume Estimates

Michael Dietze (1), Solmaz Mohadjer (2), Jens Turowski (1), Todd Ehlers (2), and Niels Hovius ()

(1) GFZ German Research Centre for Geosciences, Section 5.1 Geomorphology, Potsdam, Germany (mdietze@gfz-potsdam.de), (2) Department of Geosciences, University of Tübingen, Tübingen, Germany

Rockfall activity in steep alpine landscapes is often difficult to survey due to its infrequent nature. Classic approaches are limited by temporal and spatial resolution. In contrast, seismic monitoring provides access to catchment-wide analysis of activity patterns in rockfall-dominated environments. The deglaciated U-shaped Lauterbrunnen Valley in the Bernese Oberland, Switzerland, is a perfect example of such landscapes. It was instrumented with up to six broadband seismometers and repeatedly surveyed by terrestrial LiDAR to provide independent validation data. During August-October 2014 and April-June 2015 more than 23 (LiDAR) to hundred (seismic) events were detected. Their volumes range from < 0.01 to 5.80 cubic metres as detected by LiDAR. The evolution of individual events (i.e. precursor activity, detachment, falling phase, impact, talus cone activity) can be quantified in terms of location and duration. For events that consist of single detachments rather than a series of releases, volume scaling relationships are possible. Seismic monitoring approaches are well-suited for studying not only the rockfall process but also for understanding the geomorphic framework and boundary conditions that control such processes in a comprehensive way. Taken together, the combined LiDAR and seismic monitoring approach provides high fidelity spatial and temporal resolution of individual events.