Geophysical Research Abstracts
Vol. 20, EGU2018-9288-1, 2018
EGU General Assembly 2018

Seismic signals of torrent related processes at Illgraben, Switzerland

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Mass wasting, such as rockfalls, landslides and debris flows in steep mountain torrents are important erosion mechanisms and can have a high destruction potential. As an alternative to conventional approaches, seismology allows monitoring of such mass movements at safe distances and to efficiently detect and locate events.

Here, we make use of the continuous seismic event catalog from the Illgraben catchment in Switzerland to better understand the formation of debris flows. Located in Switzerland‘s Canton Valais, the Illgraben catchment has an area of about 4.6 km^2 and is dominated by steep slopes (average gradient of 40º) with a high fraction of exposed bedrock and loose sediment cover (44%) [1]. Yearly precipitation is controlled by summer rainstorms with high rainfall intensity. During this period active mass wasting with several rock-slope failure events and debris flows can be observed which make the Illgraben an excellent study sight for seismic signatures of mass movements. In 2017, eight seismic stations were deployed to record seismic signals related to the debris flow formation.

Here we present a seismic study of mass wasting processes recorded by the seismic network in 2017. The highly active catchment generates a variety of seismic signals almost every day. During the deployment period, three major debris flows were observed as well as various high frequency (>10 Hz) rockfall events and several other signals related to the debris flow formation. Our study shows that recorded signals can be assigned to different event classes, depending on their duration and frequency content. These events range from low-frequency events with a dominant frequency of about 1 Hz to events whose dominant frequencies exceed 10 Hz. Besides typical mass movement seismicity, signal move-out of several seconds suggest an atmospheric source and resulting pressure waves for some events. A simultaneous installation of an infrasound array further constrains source mechanisms and contributes to the understanding of seismogenic processes related to hillslope activity.

[1] Schlunegger, F., Badoux, A., McArdell, B.W., Gwerder, C., Schnydrig, D., Rieke-Zapp, D. and Molnar, P., 2009. Limits of sediment transfer in an alpine debris-flow catchment, Illgraben, Switzerland. Quaternary Science Reviews, 28(11), pp.1097-1105.