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High-resolution seismic monitoring of geomorphic activity in a catchment

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Continuous survey of the surface activity in a river catchment is essential for the understanding of the landscape dynamics. In steep mountain catchments, a detailed spatial and temporal monitoring of geomorphic processes is generally impossible. The classic techniques (imagery and *in situ* channel approaches) are not adapted to the extreme conditions that occur during strong rainstorms. There is a real need to develop a method and to define the procedures that will allow the study of surface processes without any environmental dependency. Nowadays, more and more studies explore the use of the seismic instruments to survey the catchment activity. Seismometers can be deployed in sheltered area, which allow us to record in continuous the ground vibrations induced by surface processes, like the sediment transport and mass movements. To continue the exploration of this potential, we deployed a dense array of 10 seismometers in the Illgraben, a 10-km^2 catchment in the Swiss Alps, during the summer 2011. This catchment is highly prone to hillslope and debris flow activity, so almost every summer convective storms trigger geomorphic events. The network was designed to monitor the spatial and temporal features of every type of surface activity. Thus during rainstorms, the stations located along the main stream well record the channel activity like the passage of sediment flows, while the instruments installed around the catchment reveal the occurrences of many rockfalls. These latter events show a spectral seismic signature at high frequencies (> 1 Hz), whereas the channel activity is dominant between 10 and 30 Hz. For the largest debris flow of the summer, we are able to identify the location of its initiation from the hillslope. Then, we can map the secondary events, which were triggered by the propagation of the debris flow. With these preliminary results, we demonstrate that the use of a dense seismic array is relevant to map in real time the landscape dynamics at the scale of catchment and at the time resolution of a single rainstorm. We also show that the seismic recordings allow us to monitor the coupling and feedbacks between slope and channel processes. In the future, longer experiments will help to understand the conditions necessary for a hillslope event to trigger a channel debris flow, and when this latter is relevant to control the slope activity.