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Seismic monitoring of the Séchilienne Rockslide (French Alps): analysis of seismic signals and their correlation with rainfalls

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In the French Alps, Séchilienne rockslide is one of the natural phenomena presenting the highest risk in terms of socio-economical outcomes. This rock slide has been officially recognized as active for a few decades, and has been instrumented since 1985 for surveillance purposes. The current very active volume of this rockslide is roughly estimated to be up to 3 millions m3, located on the border of a slowly moving mass reaching 50 to 100 millions m3. The velocity of the most active zone has reached 1.4 m/yr in 2008, about twice the value of 2000. To assess the potential of seismology to supplement the current monitoring system, presently based on displacements measurements, a seismic network was installed in May 2007. It consists in three seismological stations deployed as antennas together with 37 velocimeters. It was installed thanks to the OMIV French national Observatory on landslides. Besides its main role in the monitoring of the seismic activity within the landslide, such network also aims to assess potential seismic site effects in case of earthquakes. Finally, it could also be useful to detect and characterize possible seismic velocity changes over time, by using noise correlation methods which require large observation periods.

The seismological network has now recorded several thousands events, mostly due to rockfalls, but also hundreds of local (within the landslide) and regional earthquakes. We show here that most part of the recorded events can be distinguished and classified using their signal characteristics (frequency, duration). Some of the events, which were generated by rock falls, were also recorded by a camera facing the landslide for large volume studies. Unfortunately the acquired images are presently unable to provide the crucial information on fallen volumes, what prevents any calibration attempt between seismic energy and rock fall volume. We also found that rock falls and micro-seismicity, which occur in burst of activity, were weakly - but significantly - correlated with rainfall, which is monitored by various meteorological stations around the landslide. If rock fall occurrence increases linearly with precipitations, it however presents strong fluctuations of the numbers of rock falls per day for the same rainfall intensity. No threshold was found for rain fall triggering, even one mm of rain being enough to trigger rockfalls. Rock fall activity starts immediately during a rainfall episode, and lasts for several days after the rainfall. Together with rainfall, the correlation between seismic activity and displacements will be analyzed.

Besides all the mentioned applications, the seismological network will also be used for localization purposes, particularly for rock fall and micro-seismicity events. This approach is not straightforward in such heterogeneous landslide and needs the knowledge of a precise 3D seismic velocity model. It could however permit to locate the presence of active seismic zones within the landslide and also to detect active rock fall zones and to characterize their propagation properties (velocity, trajectory).