Séchilienne rockslide

The Séchilienne network is located in the French Alps near Grenoble, in the Isère department. It is made of incoherent joint and fault fractures in the Eocene limestone. Some of the stations are located on the hilts of the Isère River, at elevations between 700 m and 950 m, and involve a rock volume estimated to about 30 km$^3$.

Geodetic network and measured displacements

This area has been extensively monitored since May 2007 by the CETS Lyon, with extraneous stations, so as to monitor rockslides and seismic waves, for the purpose of assessing the impact of human activities on the structure and the activity of this very active zone. The network includes stations located on the margins of the landslide, in the area of the landslide, and on the opposite side of the Isère River. The stations are equipped with 3-components 2 Hz accelerometers located on top of rock surfaces.

Seismic Network

Two stations (Thév and Thé) have been installed in May 2007 for passive monitoring of Séchilienne landslides. Each station is connected to a vertical 5 Hz sensor and a 2-component 2 Hz seismometer. Station Thév is placed just above the active area, where the landslide has been monitored for more than 10 years. The signal is drift between sensors is about 0.1 Hz. This was monitored during April 2008 and recorded 31 Hz and 2 vertical geophones (3 vertical sensors), and one 2-axis seismometer has been installed in April 2008 in the 240 m long survey gallery close to the landslide zone. The stations were generally recording in triggered mode at 250 Hz, but for some periods the sampling rate was higher (100 Hz). The stations were recording continuously.

Seismic activity: characteristics and temporal variations

This figure shows the characteristic features of seismicity: the massive swell of seismic events, from the seismic network. The signal is recorded by station Thév from May to October 2007, from April to August 2008. The seismic activity is very variable, with a few events per day to more than 100 events per day during seismic events. Most events are associated with precipitation, with a time delay smaller than 1 day between rain and triggered seismic events. Sensing in also possible with accelerometers of the network.

Rockfall propagation

The rockfall propagation model is based on the analysis of the seismic data recorded by the network. The model uses a finite element method to simulate the propagation of the rockfall. The model is validated by comparison with the observed seismic data.

Events location

Event location is difficult because most signals recorded look impulsive waves, so that we can not paint the time of the first arrivals. Instead, we use cross correlation of seismic signals off of interest to estimate the time delays between sensors. We then look for the source position and seismic wave velocity that best explains the observed time delays.

We have not yet located all events recorded by all stations. We have first located at each station independently and then processed. We have also used correlation of seismic data recorded by the same network (for nearby events) and Thé (400 events) from 10/4/2008 to 7/8/2008.

The stations located that most events originate from the top of the landslide are shown in red.

Comparison of seismic activity, rain, and displacement (per target rocks located in the most active zone). (left) Station Thév from Mai to October 2007, (right) station Thé from April to August 2008. The seismic activity is very variable, with a few events per day to more than 100 events per day during seismic events. Most events are associated with precipitation, with a time delay smaller than 1 day between rain and triggered seismic events. Sensing in also possible with accelerometers of the network.

Perspectives

- Installation of a camera and video to observe rockslides, and to evaluate the volume of material
- Sensitivity will be improved and instrumented with accelerometers, inclination meters, and parameters to measure fluid pressure. Seismogrames or depth studies help us to better understand the depth of seismic events
- More than 100 events have been performed in June 2008, and will allow us to use 3-P wave and surface wave tomography. Using a seismic metric wave velocity model should also improve the location of seismic events.

Sequels

Sequels from vertical channels of all 3 stations, zoom of the largest event, and spectrograms. The amplitude is not correlated so the signal is not well correlated with seismic waves. The signal is not well correlated with seismic waves. The signal is not well correlated with seismic waves.