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Detecting debris- and mud-flow propagation at a distance with a microseismic monitoring network

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Debris-flow (mixtures of water and sediment of diverse shapes and sizes, commonly ranging from clay particles to great boulders) and mud-flow (mixtures mostly composed of grains smaller than sand) are among the most dangerous natural phenomena that may occur in mountainous torrents. They can cause severe damages to human settlements and infrastructures that are built too close to the torrent channel or on the alluvial fan.

Monitoring these phenomena in instrumented catchments allows the collection of field data that can provide an important comparison with the geomorphological and topographical surveys of erosion, sediment supply and channel evolution. Monitoring data and the inferred quantification of the transported sediment are also of crucial importance for hazard assessment, land-use planning and design of torrent control structures, including warning systems. The reduced boulder content of mud-flows may have an important influence on the results of the monitoring, which might be significantly different than those of debris-flows. This is particularly true if seismic devices were employed as detecting tools, since the lack of huge boulders and large particles might impede the generation of strong ground vibrations. The ground vibration signals produced by mud-flows might also have different frequency ranges and different peak frequencies. These different behaviors should be investigated, not only for scientific purposes but also because they might lead to the choice of different parameters and algorithms in case seismic sensors are used for warning purposes.

For these reasons the CNR IRPI has undertaken an experimental investigation and equipped the left Cenischia valley (NW Italian Alps), an alpine catchment prone to debris- and mud-flows previously instrumented only with a rainfall monitoring network. Actually, the monitoring station consisting of four 10 Hz vertical geophones placed on the ground, an ultrasonic sensor and 3 videocameras, is installed along the right bank of the Marderello torrent, a left tributary of the Cenischia river. This equipment has been installed in the Spring 2013 and in July an event occurred in two different sub-basins of the Cenischia valley. In particular, the Marderello torrent produced a mud-flow while in the Malo torrent, another left tributary of the Cenischia valley located 2 km North from the monitoring station, a debris-flow was observed. Both phenomena were detected by the geophone network.

In this work, the first data recorded by the monitoring system and the documentation gathered by the authors after the event are presented together with a characterization of the whole catchment and an outline of future investigation plans.