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Monitoring of debris flows and landslides by wired and wireless systems. Experiences from the Catalan Pyrenees.

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Sophisticated monitoring of landslides for research purpose has started in the 1990thies in the Catalan Pyrenees. Since then several types of mass movements (large landslides, debris flows, shallow landslides and rock falls) and multiples techniques have been applied.
In this contribution, special attention will be given to the debris-flow monitoring system installed since summer 2009 in the Rebaixader catchment, Central Pyrenees. The monitoring system has continuously been improved during the last years and nowadays includes devices studying the three major aspects: 1) initiation, 2) flow dynamics, and 3) accumulation. While some parts of the monitoring network include a traditional wired system, the newer parts were installed using low-power wireless devices.
Two major aspects will be discussed. First, results of the Rebaixader monitoring site will be presented. Second, experience regarding the monitoring will be evaluated focussing on technical aspects and the comparison between wired and wireless techniques.
In the Rebaixader catchment, 6 debris flows and 11 debris floods were observed between August 2009 and October 2012. Surprisingly, also 4 major rock falls were recorded. The rainfall analysis shows that the debris flows were triggered by short, high-intensity rainstorms with a preliminary threshold of about 15 mm during 1 hour. In addition, there was observed a positive trend between event volume and rainfall amount or intensity. The analysis of the ground vibration signals shows significant differences between the time series recorded at the different geophones. These differences are associated with the geophone location in the channel (distance and material), the mounting or the data acquisition system. For instance, the most downstream geophone, installed in bedrock, shows the clearest debris-flows vibration time series, while the uppermost is the most reliable regarding the detection of rockfalls.
An evaluation of wired versus wireless monitoring systems shows that wireless techniques have several advantages. They are generally smaller and due to the wireless condition the selection of the sensor location is not restricted like in the standard wired systems. Additionally, they are simple to install and consume much less power. Importantly, they are also more competitive in terms of pricing versus traditional wired solutions. Nevertheless, the adoption of this new technology has not been straightforward due to the harsh conditions where sensors are usually deployed. The later delayed and complicated the installation of some sensors in the Rebaixader site but allowed us to improve the monitoring solution.
Finally, some very recent experiences on the wireless sensor network installed in a shallow landslide in the Pre-Pyrenees confirmed that this technique is a perfect solution not only for monitoring, but also for warning systems.