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Reconstructing landslide dynamics and characteristics using remote sensing data (photogrammetry, LiDAR and seismic data): comparison between different techniques and complementary data analysis

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The purpose of this study is to characterize the rock planar landslide that occurred in the village of La Riba (Catalonia) on May 5th 2013, using different techniques such as photogrammetry, terrestrial LiDAR data, and seismic data. Advantages and disadvantages of these techniques were evaluated.

Back-analysis and characterization of landslides allow us to better understand their behaviour. This information could be used to protect areas affected by similar hazards. Remote techniques are an excellent tool to obtain data and to reduce the exposure of technicians in unstable (or inaccessible) areas.

After the May 5th natural landslide, a controlled blasting was carried out to stabilize the slope. Using this programmed blasting as a benchmark, two photogrammetric models and two terrestrial LiDAR data models corresponding to the pre and post blast were made to compute the rock volume involved in the blast. The blasting process was recorded with two HD video cameras and by two temporary seismic stations deployed close to the site. Both the seismic and video records enabled us to reconstruct the details of the blasted landslide. The volumes obtained from seismic data were compared with the total volumes computed by LiDAR and photogrammetry. Moreover, information about the natural landslide was obtained from the records of a permanent seismic station 10 km from the site. Data such as the estimated fallen volume, the landslide mechanism and time of occurrence are information that would otherwise not be obtained.

Six discontinuity families were detected and characterized in the rock slope using the photogrammetric and LiDAR models with a software developed by the Institut de Recerca de Geomodels of the Universitat de Barcelona. Similar results were obtained from the two models, but the higher point density of the LiDAR data enabled us to detect more discontinuity surfaces and in greater detail.

The volume involved in the blast was calculated using two methods: 1) the construction of simplified surfaces enclosing the rock mass using the software Gocad (Paradigm - www.pdgm.com) and 2) the comparison of pre and post blast models to detect the differences with the software PolyWorks (InnovMetric - www.innovmetric.com). The advantage of the simplified surfaces method is the ability to compute the volume of current stable blocks that may be part of future landslides. In contrast, the comparison method is faster and more accurate than the first method, but the need to remove the vegetation could increase the error of the computed volume in some areas.

Although the two techniques provided similar results, the differences between the data acquisition and processing are significant. Terrestrial LiDAR data are more accurate and the process to construct the model is shorter.. By contrast, photogrammetric technique is cheaper and the data acquisition in the field is faster. Another aspect that affects the two techniques is the need to have outcrops without or with sparse vegetation to obtain optimum results.