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Calculation of the rockfall scar volume distribution using a Terrestrial Laser Scanner in the Montsec Area (Eastern Pyrenees, Spain)

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Magnitude-frequency relations are a key issue when evaluating the rockfall hazard. It is a common practice to calculate them using databases of past events. However, in some cases, they are not available or complete. Alternatively, the analysis of the scar volume distribution on the wall face provides useful information on the slope's rockfall activity.
The Montsec range, located in the Eastern Pyrenees, Spain, is a limestone cliff from upper cretaceous. In some parts, clear evidences of rockfall activities are present: Large recent rockfall scars are distinguished by their orange colour in comparison with grey non active surfaces on the slope face. To identify the scars and analyse their volume distribution, a methodology has been carried out (Santana et al. 2011) which is based on the elaboration of data from a high resolution Digital Elevation Model (DEM) obtained with Terrestrial Laser Scanner (TLS).
This methodology requires a point cloud of the slope and it includes the following steps: a) identification of discontinuity sets b) generation of discontinuity surfaces c) calculation of areas of the exposed discontinuity surfaces and rockfall scar heights, and d) calculation of the rockfall scar volume distribution.
Three discontinuity sets were identified on the point cloud. To generate the discontinuity surfaces, SEFL software was used. The input data for accepting that two neighbouring points of the point cloud belong to the same surface, was a minimum spacing of 0.4m. The resulting planes were visually checked. Assuming that the discontinuities of set 1 preserve the basal shape of the rockfall scars and the altitude is parallel to the discontinuities of set 2, the volume can be calculated as the product of the area of surfaces of set 1 with the length of the surfaces of set 2 using the afore mentioned SEFL software. Areas were found to follow a Lognormal distribution and lengths a Pearson6 one. The volume calculation was then made probabilistically by means of a Monte Carlo simulation.
The volume distribution was found to be well fitted by a power law with exponent -1.7. Maximum volumes reach some thousands of cubic meters. This work forms part of an on going investigation on the assessment of the temporal frequency-magnitude relation of rockfalls.

References

Santana, D., Corominas, J., Mavrouli, O., Garcia-Sellés, D. 2011. Magnitude-frequency relation for rockfall scars using a Terrestrial Laser Scanner. Engineering Geology 145-146, 50-64