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Rock fall source areas detection and volume estimation by using terrestrial laser scanner data

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A structural geological assessment is a preliminary and necessary step in rock fall hazard analysis. Classical methods for structural assessment are expensive, time-consuming and require access to remote and dangerous areas. Actually, Terrestrial Laser Scanner (TLS) data acquisition resolves these handicaps and provides information for detailed structural analysis. The emphasis of this research is on identifying potential source areas and quantifying the volume involved in the movement by analyzing 3D discontinuity sets identified from TLS data.
The high density of information (point clouds) obtained with TLS requires automatic processing methodologies. The GEOMODELS Research Institute has developed an algorithm to characterize discontinuity sets from TLS point clouds. This methodology is divided into 4 basic steps: (a) the first steps consist in a distribution of the points into groups in order to speed up the computing time; (b) the second step perform a planar regression to find continuous surfaces. This step allows finding two parameters (coplanarity and coliniarity) which represent the plane adjustment at the terrain surface; (c) the third step consists in the filtering of those surfaces which have not geologic interest (vegetation, random points, etc). Finally, the last step (d) provides a tool to cut off discontinuity sets based on their dip and dip direction. Field measurements and observations are used to validate the discontinuity sets determined from TLS data, since TLS point cloud is normally affected by occlusion and certain biases.
After the application of this algorithm, a 3D discontinuity model is obtained taking into account the discontinuity sets orientation and their spatial distribution. This model is used to develop a geometric analysis in a GIS. Potential rock fall source areas are detected considering the spatial distribution and orientation of discontinuities and the slope aspect and slope inclination. Also, the geometric relationships between discontinuity sets and slope surface allow estimating the volume of the unstable masses. The results obtained are of paramount importance for rock fall susceptibility and hazard assessments and for the application of rock fall simulation models.