Using structural analysis derived from LIDAR to generate realistic DEM cuttings for rockfall hazard assessment

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Advances in remote sensing methods such as lidar and photogrammetry have allowed acquiring Digital Elevation Models (DEM) at centimetric to metric resolution. Such topographic detail reveals rock face geological structures to allow the semi-automatic structural analysis of mountain slope (Jaboyedoff et al., 2007; Dewez et al., 2016). It is an important step for the stability analysis of unstable rock compartments. Current techniques include the automatic detection of planar surfaces corresponding to visible discontinuities (joints, fractures, etc.), and analysis of their orientation frequency and extend.

With this realistic description of how the rock massifs are divided into blocks (with attitude and spacing), rockfall risk assessment still needs to focus on slope stability analysis.

The work presented here describes the results of the custom code TOPOCRACKS which divides a high resolution topography by sets of fractures and compute the rupture mechanisms and stability factors of resulting block. It is applied on a 1-m-resolution airborne lidar DEM of a natural hillslope in Ota, Corsica. Field structural observations on site revealed the presence of three fracture sets. So for this toy example, each of the fracture sets was deamed to be 1-m appart. Computation of blocks delimited by fracture intersections generates about 26 000 potentially unstable rock compartments in this area of ca. 600x400 m². As overhangs are very rare in this area, the method was developed in 2.5 D, and the following mechanisms of failure were considered: planar sliding, wedge sliding. The stability of each rock compartment was assessed by performing static analysis. Static analysis takes into account cohesion of joints, friction angles at discontinuities and percentage of rock bridges. Results are compared with expert methodology of rockfall risk assessment at the same study site, and show good agreement for the localization of source areas, the size of the biggest possible event, and the more probable mechanisms of rupture per source areas.

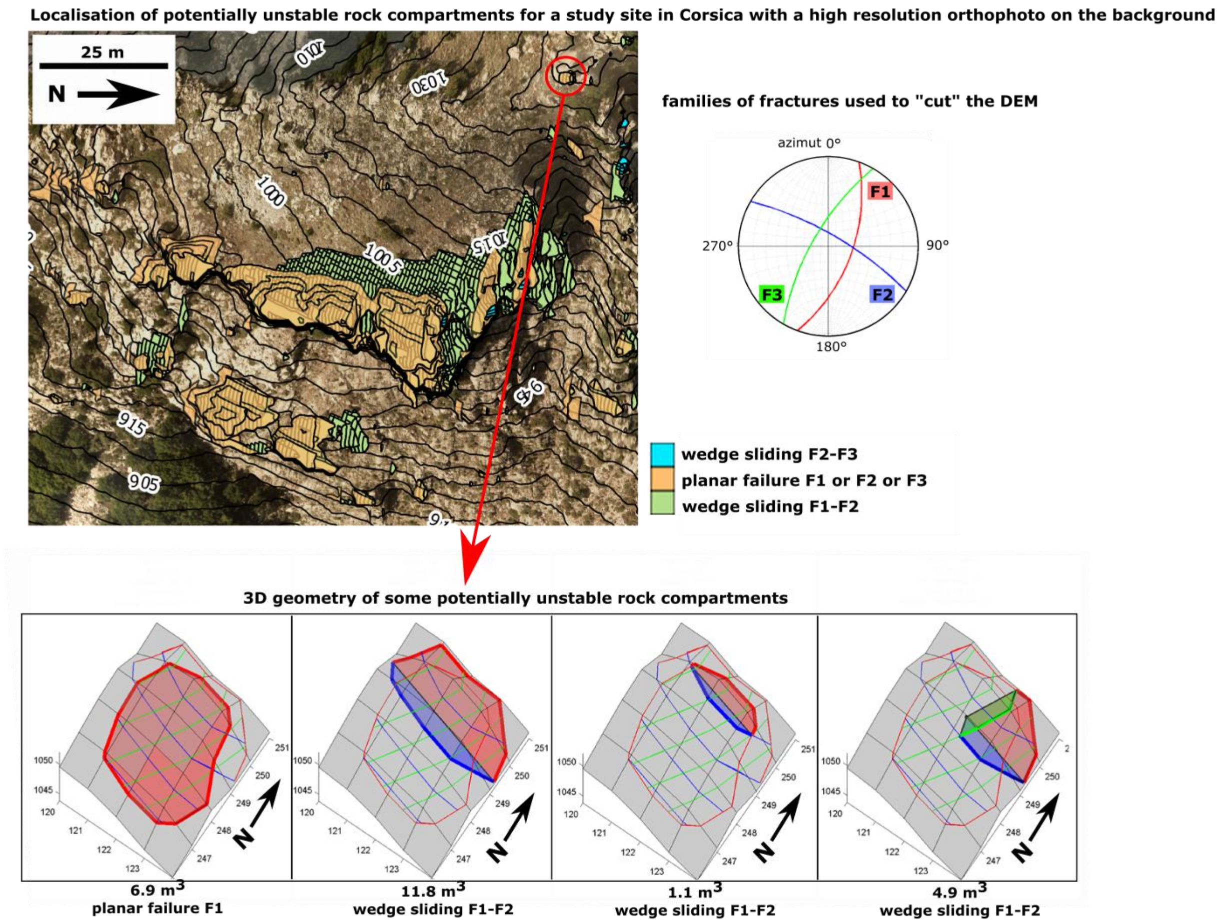

Figure 1: Result of block partitioning of a 1-m resolution DEM in Corsica based on three fracture sets recognized by field investigations. Considering that each fracture set has a 1-m-period, this figure illustrates how rock blocks could fail by planar sliding on single family fracture or by wedge rupture rooted on different pairs of fracture planes.

References:

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