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The influence of slope profile extraction techniques and DEM resolution on 2D rockfall simulation

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The development of advanced 3D rockfall modelling algorithms and tools during the last decade has allowed to gain insights in the topographic controls on the quality and reliability of rockfall simulation results. These controls include DEM resolution and roughness, and depend on the adopted rockfall simulation approach and DEM generation techniques. Despite the development of 3D simulations, the 2D modelling approach still remains suitable and convenient in some cases. Therefore, the accuracy of high-quality 3D descriptions of topography must be preserved when extracting slope profiles for 2D simulations. In this perspective, this study compares and evaluates three different techniques commonly used to extract slope profiles from DEM, in order to assess their suitability and effects on rockfall simulation results. These methods include: (A) an "interpolated shape" method (ESRI 3D Analyst), (B) a raw raster sampling method (EZ Profiler), and (C) a vector TIN sampling method (ESRI 3D Analyst). The raster DEMs used in the study were all derived from the same TIN DEM used for method C.

For raster DEM, the "interpolated shape" method (A) extracts the profile by bi-linear interpolating the elevation among the four neighbouring cells at each sampling location along the profile trace. The EZ Profiler extension (B) extracts the profile by sampling elevation values directly from the DEM raster grid at each sampling location. These methods have been compared to the extraction of profiles from TIN DEM (C), where slope profile elevations are directly obtained by sampling the TIN triangular facets. 2D rockfall simulations performed using a widely used commercial software (RocfallTM) with the different profiles show that: (1) method A and C provide similar results; (2) runout simulated using profiles obtained by method A is usually shorter than method C; (3) method B presents abrupt horizontal steps in the profiles, resulting in unrealistic runout.

To study the influence of DEM resolution on rockfall simulation, profiles have been extracted from 1m, 5m, 10m and 15m gridded DEMs. The 2D rockfall simulations with the different resolution show that: (1) the effect of different resolution depends on topographic characteristics of the slope (e.g., steep or flat); (2) for steep slopes the rockfall motion is dominated by bouncing, and the coarser DEMs result in lower bouncing and lower kinematic energies and velocities; (3) for flat slopes, the motion is dominated by rolling and sliding, and the effect is the opposite: the coarser the DEM, the longer the runout.