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Effect of DEM resolution and roughness in rockfall model restitution and friction coefficients

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Energy loss by rebound and rolling in rockfall simulation is usually modelled through "contact functions" relating the block kinematics (in terms of velocity) or its dynamics (in terms of energy) before and after the impact. Such functions are expressed as restitution and friction coefficients.
Values for these coefficients have been derived through experimental/empirical observations of scale or in situ rock fall tests. These values are different since the coefficients include the effects of different characteristics of both the slope and the block (e.g., type of substrate and surface material, block mass, block shape, block material, geometry of the block to surface contact).
In this work, we investigate the influence of DEM resolution and surface roughness on model rockfall restitution and friction coefficients. This is of interest since, recently, LIDAR and terrestrial laser scanning (TLS) DEMs have been made available, allowing for a very accurate surface description resulting in a generally rougher surface with respect to other techniques adopted for DEM generation.
We performed a series of back analyses of real events with different DEMs (Lidar DEM, Topogrid DEM and TIN DEM) at different resolution (from 1x1 m to 20x20 m). Analyses have been performed in the areas of Lecco (Lombardia, Central Italian Alps) and Venzone (Friuli, Eastern Italian Alps) in order to stress the effect of different geomorphologic settings (i.e. convergent or divergent slopes).
In order to obtain by back analysis a consistent pattern of impact marks, runout, 3D dispersion pattern (e.g. different curvature of trajectory), and type of motion (e.g. bouncing, rolling) it is necessary to adopt a different set of input values. The comparison of the different models allows to recognize variations of restitution and friction coefficients up to 100%. This variation depends on the DEM resolution but also on the technique used for DEM generation (i.e. for the same cell size, the sets of calibrated parameters are different for DEM generated with different techniques).
To investigate the dependence of coefficients on surface roughness, we computed a vector ruggedness measure for each DEM (Sappingthon et al, 2007), and we investigated the relationship among surface roughness and percent variation of restitution and friction coefficients. As a result, we defined different functions that can be applied to different geomorphic settings to scale the coefficients according to DEM roughness.

Sappington, J.M., Longshore, K.M., Thompson, D.B. (2007): Quantifying Landscape Ruggedness for Animal Habitat Analysis: A Case Study Using Bighorn Sheep in the Mojave Desert. Journal of Wildlife Management 71(5):1419–1426.