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Influence of forest input data on rockfall simulations at the stand level

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The protective effect of trees against rockfall hazards has been known for a long time and numerical models are now able to simulate the trajectory of falling rocks and the possibility of impacts with trees. Using such models in real case-study requires high resolution input data regarding topography and forest cover, such as provided by airborne laser scanning (ALS) remote sensing. However, the errors in forest predictions might result in erroneous forest protection quantification. The objective here is to compare the results of rockfall simulations within a forest stand whose characteristics are derived from two types of data: field inventory or ALS remote sensing.

The software RockyFor3D is used to simulate the propagation of 2 m^3 blocks on a 35° slope. Blocks accelerate across an unforested area of 50 m and then enter a forest stand where impacts on trees might slow or stop them. The kinetic energy of passing blocks is recorded at the contour line immediately below the forest patch.
Two forest stands are used to produce the input data for the forest patch : a high forest (80x120m^2) and a coppice forest (50x50m^2). For each stand, five scenarios for forest data inputs are compared.
- "real": the tree positions and diameters inventoried on the field are used.
- "inventory": stand-level parameters derived from the "real" inventory are supplied to the software which will then simulates the positions.
- "stand estimation": stand-level parameters derived from the ALS data are supplied.
- "tree detection": tree positions and diameters are estimated from the ALS data.

For the coppice stand, the "real" and "inventory" scenarios yield similar results: approx. 82% of passing blocks with a mean energy of 360 kJ. The small difference may come from the models used to generate trees positions and diameters from the stand-level data. In the "stand estimation" scenario almost all blocks pass through the forest (98%) and they have higher energies (390 kJ). The forest protection effect is under-estimated, probably because the ALS prediction models under-estimate the mean diameter, while the number of stem is correctly predicted.
For the high stand, the mean energy of passing blocks is similar between the "real" and "inventory" scenarios but their proportion is different (resp. 53 and 63%). This might be explained by the random affectation of coniferous/broadleaved nature by the software in the "inventory" scenario. In the "stand estimation" scenario, the over-estimation of the protection effect is probably due to the higher stem density predicted by the ALS model. On the contrary, the "tree detection" scenario under-estimates the protection effect. Indeed dominant trees are correctly detected but smaller trees are not.

Errors in forest inputs thus have a major influence on rockfall simulation results at the stand level. Besides some improvements are possible regarding the way tree positions, diameter and coniferous are simulated from stand-level parameters, within the simulation software.