

## **The effect of forests on rockfall occurrence frequency**

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Many forests in mountain regions protect people, settlements and infrastructure from rockfall and play an important role in risk prevention. Despite recent advances regarding forest-rockfall interactions, open questions still remain, namely on how the mitigating effect of forests can be quantitatively integrated into rockfall risk analyses. The quantification of the influence of forests on rockfall occurrence frequency is particularly demanding, even more so when related to elements at risk.

The goal of this study is to quantify the effect of forests on the occurrence frequency based on rockfall simulations with the three-dimensional, process-based model Rockyfor3D. We define a constant rockfall release probability based on a power-law magnitude-frequency distribution, which is used to simulate rockfall events over a period of 1000 yrs on a virtually constructed slope. The simulations are conducted for different forest and non-forest scenarios under varying terrain conditions. These simulations firstly provide input data for the determination of rockfall occurrence frequencies at five different evaluation zones situated at 0, 150, 300, 450, and 500 m from the release area. Secondly, based on multivariate statistical models, we try to find out how specific forest and terrain characteristics control the rockfall occurrence frequency along a slope.

The results for a 0.5 m<sup>3</sup> block show, for example, that at a distance of 500 m from the release area, the occurrence frequency (expressed as a return period in years) changes from 30 yrs on a non-forested to more than 1000 yrs on a forested slope. The difference in the frequency increases with increasing distance from the release area and is less pronounced for larger block volumes (> ~1.2 m<sup>3</sup>). The results of the statistical analyses allow to quantify the effect of specific forest and terrain characteristics on the reduction of the occurrence frequency. For example, a forested slope length of 100 m with a dense forest (basal area = 45 m<sup>2</sup>/ha) is required to reduce the occurrence frequency of blocks < 1.0 m<sup>3</sup> with 70 %. Based on these results, conclusions can be drawn for real rockfall slopes. They further provide a quantitative basis for determining the effect of forests on rockfall risks.