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Trees as hillslope debris flow brakers

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Worldwide, landslides and hillslope debris flow cause major infrastructure damage and fatalities. It is widely recognized that forests can prevent the release of a landslide by reinforcing the soil with the roots and positively influence the water balance. However, the question remains whether and how trees affect the runout of hillslope debris flows. The objective of this study was to quantify the potential braking effect of trees and the influence of different forest structures in the runout zone of hillslope debris flows. We therefore combined an analysis of historical hillslope debris flow events in the forest and on open land with laboratory tests.

The analysis of the historical events showed a general tendency that forest has a positive effect on the runout, in particular for smaller events (release area < 300 m²). The runout length significantly decreased with an increasing tree density. In addition, significantly more material was deposited behind thicker trees. This suggests that a well-structured stand with a high stem number, but also occasional large diameters, offers ideal protection against hillslope debris flows in the runout zone. The results of the laboratory tests indicate that the braking effect of different forest structures (dense, open, with gaps) is always given in comparison to a situation without forest, and this at lower (16%) and higher (20%) water contents. Generally, the effect of the trees was more pronounced for soils with a lower water content. Although the influence of the forest was always highlighted in comparison to the situation without forest, no significant influence was showed between the three forest structures.