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Modelling vegetation landslides

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Shallow translational landslides are believed to represent a major ecosystem disturbance in the Andean rain forests of South Ecuador. Aiming at a better understanding of gap dynamics in this mega-diverse ecosystem, we investigated several landslides in an area of undisturbed tropical montane rain forest and found that in some cases almost no inorganic material was involved. Current physically-based landslide models cannot reproduce this type of process, since they focus on soil physical properties. Even though vegetation is incorporated in these models by its weight and by the contribution of roots to soil cohesion and hence to shear resistance, we think that the role of vegetation has to be viewed differently within this ecosystem: Roots do mainly grow in a thick organic layer above the mineral soil and do not penetrate sufficiently deep into the mineral soil to contribute to slope stability according to common models.

To accommodate such circumstances, we formulated an extension to the widely used infinite slope model for assessing slope stability, and applied it to our research site. Biomass, root layer and soil properties before sliding events were reconstructed on and close to landslides that occurred within the preceding years. By introduction of an additional factor of safety for the organic layer, we are able to mathematically describe classical shallow translational landslides as well as vegetation slides.

A high spatial and temporal variability of vegetation, root layer and soil physical properties within the research area complicate model applications. Thus we assumed spatial gradients for ranges of model parameters and stochastic parameter variations within these ranges according to our field measurements and published data. Finally we outline the model validation by comparison to historical landslide inventories. Possible applications of the model are located within undisturbed tropical montane rain forests and contribute to the fields of automated landslide classification as well as spatiotemporal modelling of landslides and forest gap dynamics.