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The role of local damage accumulation and mechanical healing on rainfall-induced landslide triggering

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The abrupt release of shallow landslides is often preceded by progressive internal damage (local cracks and small failures) that may suddenly coalescence and form a slip plane. Such local failure events may involve breakage of cementing agents or roots, deformation and friction, and formation of small fractures. Such internal damage may accumulate even during innocuous rainfall events (no catastrophic mass release) and depending on rainfall sequence and other factors, local failures may 'heal' or remain as potential weak spots for future hydrological perturbation. The mechanical state of a hillslope including damage accumulation and potential healing were modeled using the fiber bundle framework. By adapting strength distribution of fibers and load redistribution mode after failing of weak elements, a wide range of mechanical properties can be simulated. We incorporated time-delayed recovery of broken fibers (e.g., root regrowth) and implemented the modified model at a hillslope scale consisting of soil columns connected to bedrock and adjacent columns by fiber bundles. The critical rainfall amounts needed to trigger landslides and frequency/magnitude distributions of resulting (simulated) landslides were determined for different rainfall sequences and patterns and for a range of healing rates of broken fibers.