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Simple explanations for shallow landslides!?

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In order to find easily recordable and practicable parameters for estimating the resistance of steep slopes against superficial soil failure, 218 comprehensively documented shallow landslides triggered in forested area have been analysed.

The parameters investigated are divided into three principal subject areas: soil mechanics, vegetation, and topography.

From the soil mechanical perspective, the shear parameters angle of internal friction Φ' and cohesion c' were pivotal. Information on them derived from field classification, laboratory analyses of grain size distribution (USCS) as well as from direct shear and triaxial compression tests with corresponding soil material.

In respect of vegetation, forest aspects were of particular interest e.g. tree species composition, degree of coverage, layering, development stage, health, and gap size.

Topographically, the focus was on terrain morphology, inclination, exposition, and altitude.

It turned out that applying a three-step filter based on the aforementioned parameter categories yielded a retrospectively explanation power of 97% (n=212). The respective main criteria that were serially applied are:

- soil mechanics: slope inclination α is less than 5° steeper than the angle of internal friction Φ' of the corresponding soil material
- vegetation: forests are in a multi-layered or well structured pole or tree wood stage with a tree coverage degree of $> 40\%$
- topography: the line of slope – transverse profile of the area of shallow landslide is NOT concave-flat, flat-concave, or convex-concave

The application of the first step, the "5°-criterion", revealed that about 50% (n=107) of the slopes with the superficial soil failures were more than 5° steeper than the angle of internal friction Φ' of the soil material.

In the second step, the vegetation-criteria explained another 40% (n=90) insofar that the corresponding requirements were not met.

The topography step, finally, showed that additional 15 shallow landslides (7%) were triggered in types of terrain morphology highly susceptible to superficial soil failure.

This "retrospective explanation scheme" is suggested an additional way to produce new or adapt existing hazard maps for shallow landslide susceptibility. Furthermore, it offers a promising possibility for refining risk assessment, i.e. for estimating the probability of shallow landslides, given certain boundary conditions of soil mechanics, vegetation structure, and terrain morphology.