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Hydrology of landslide triggering

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Triggering of landslides occurs frequently during heavy rainfall events when saturation of the ground causes an increase of weight and a decrease of frictional resistance. When defining rainfall thresholds that are critical for slope instabilities, a common premise is that soil saturation is uniform and static. However, soil saturation shows highly dynamic and non-linear behaviour. Quick drainage or limited infiltration capability may prevent complete saturation of the ground, and thus may prevent instability.

Hydrological data from sprinkling experiments and natural rainfall events on 24 hillslopes in Switzerland confirmed, for different soils, how saturation depends on precipitation intensity and volumes, and illustrated how drainage occurs through many forms of preferential flow paths. Application of a dye tracer during sprinkling experiments allowed infiltration processes and preferential flow paths to be visualised.

The results provide insight into the development of saturation and groundwater levels in natural hillslopes. Depending on the efficiency of preferential flow and on how this flow is initiated, soils saturate differently. Saturation may start at the topsoil and spread downwards as a wetting front. However, preferential flow can bypass the soil profile and start saturation from below, above soil layers with reduced permeability or impermeable bedrock. Complete saturation of the soil profile may be prevented by: (1) a perched saturation within the topsoil and subsequent overland flow during short, high-intensity precipitation events, or (2) continuous lateral drainage through subsurface stormflow during long-duration events with lower intensity. The results help to evaluate critical combinations of soil structure, slope and precipitation characteristics that may lead to slope failure.