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Landslide precursor events derived from concepts of Self-Organized Criticality

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Landslides triggered by heavy rainfall events present a threat to life and infrastructure and are notoriously difficult to predict due to the manifold of topographical, hydrological and soil factors. Even for landslides triggered by intense rainfall within a small catchment a wide range of released mass per landslide is observed. The relationship between frequency and magnitude of landslides often follows a power-law indicating the critical nature of the process with no unique spatial scale. The evolution of a system towards a critical state can be reproduced based on principles of self-organized criticality (SOC). Criticality emerges from the interaction among a large number of elements where an 'activated' element interacts with its neighbors and may initiate a chain-reaction. We expect similar mechanisms for landslide triggering when a local perturbation may propagate through the system. As soon as a slope attains such a critical state, events of all sizes including the release of hazardous landslides can occur. In this study we analyze precursor events to determine the proximity of a system to its critical state. In a first step we determine precursor events in model concepts related to SOC (sand-pile, forest-fire, fiber bundles) and present properties that indicate the change of a system towards the critical state. In a second step, we analyze precursor events in a landslide model that describes the propagation of local failure according to rules of SOC. The ultimate goal of this work is the development of a warning system based on the monitoring of hillslope properties that can be used as indicators for the evolution towards the critical state.