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Self-organized criticality concepts for modeling hydromechanical triggering of rapid landslides

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Prediction of landslides in steep terrain is hampered by the wide range of hillslope responses to similar hydrologic conditions (e.g. rainfall, water content) ranging from increased runoff generation, slow creep of landmass, to rapid and hazardous mass movement. We employ concepts of Self-Organized Criticality (SOC) to explain variable hydromechanical hillslope response and to develop a model for relating frequency and magnitude of landslides for various hillslope conditions including soil types, landcover, and hydromechanical conditions. The hillslope plane is discretized into cells connected by mechanical bonds associated with cell's soil type, depth, water content (and pressure), and vegetation characteristic.The spatial distribution of these properties corresponds to field conditions. Rain water is redistributed according to storage and infiltration capacity and the excessive water flows down the slope or into underlying bedrock. Both the mechanical properties of the bonds between cells and the cell load vary with water distribution within the hillslope. Due to the significant role of plant roots in enhancing mechanical bonds, abrupt failure of root bundles may be associated with local triggering of a landslide. This feature is included by considering statistical properties and load redistribution following failure of bundles or networks of fibers (representing roots) especially close to incipient failure. The acoustic emissions associated with failure of root bundles (and land movement), potential measurement techniques, and linkage to monitoring onset of rapid landslides will be discussed.