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Physically based landslide warning at regional scale

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Albeit advancements in the past within the field of geotechnical engineering have led to an increasing in situ damage control in many parts of the world, heavy rainstorms still cause severe damage by triggering landslides. Landslides are usually restricted to the local scale when taking into consideration single events, however, they often tend to occur spatially abundant which makes them a regional phenomenon. This makes the necessity of regional-scale early warning systems (EWS) indispensable. When dealing with landslide EWS, it is impossible to cover all potential early warning situations. Although the calculation of rainfall thresholds is the most common approach for assessing regional landslide early warning, they only represent a simplification of the physical processes involved. In most cases, indeed, there is more than just this one causative factor involved.

Here, we present an early prototype for a regional, physically based landslide EWS driven by real-time spatio-temporal rainfall data. Instead of assuming uniform rainfall over a certain area, an automated geostatistical approach is suggested which allows approximating real-time spatially distributed, hourly rainfall predictions based on gauged rainfall data available on the internet. The methodology presented in this study is especially suitable for the implementation in warning systems that contain predefined thresholds and for landslides related to a progressive increase of soil saturation and/or a rising groundwater table. The transient rainfall infiltration and grid-based slope stability (TRIGRS) model is used in a modified way to compute transient pore-pressure changes and associated changes in the factor of safety due to rainfall infiltration. The geotechnical properties involved are probabilistically integrated within certain predefined ranges to account for the inherent spatial uncertainties. The result is an automatically generated probability of failure raster map that is updated hourly based on the most recent spatial pattern of rainfall.