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Assessing the Potential of Soil Wetness Information for Regional Landslide Early Warning

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Rainfall-triggered shallow landslides pose a serious risk in mountainous regions around the world. Recent studies have shown that existing rainfall-based landslide early warning systems (LEWS) could be improved by explicitly including antecedent wetness information in their prediction models. At the same time, soil wetness measurements have become increasingly available, making this a potential source of information for future LEWS.

The goal of this thesis was to assess the specific information content of in-situ soil moisture measurements for regional landslide activity. For the first time, all available soil moisture measurements in Switzerland were gathered and homogenized. A statistical framework was developed to analyse the temporal soil moisture variation and to compare statistical properties with the regional occurrence of landslides taken from a national inventory. Second, the soil moisture variation was simulated at the same and at additional sites in Switzerland using a physically-based soil water transfer model. The same statistical framework was applied to test the information content of simulated soil moisture in comparison to using measurements. Finally, in a field experiment in the Napf region (Switzerland), different soil wetness monitoring set-ups were compared to assess their ability to detect critically saturated conditions. Specifically, different sites were compared (flat vs. sloped location) and various soil wetness monitoring techniques were tested (soil moisture sensors, tensiometers, electrical resistivity tomography ERT).

It was shown that in-situ soil moisture measurements bear specific information content for regional landslide occurrence and that it decreases with increasing distance between monitoring site and landslide. Differences between sites become small if relative soil wetness variation is considered. Simulated soil moisture can be used to complement a monitoring network, but the ability to predict shallow landslides depends strongly on the ability to reproduce the seasonal water balance. Finally, the potential of ERT for monitoring critically saturated conditions was demonstrated.

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