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SINMAP Modeling of an active landslide area in the Swabian Alb

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Landslides are a common hazard in German low mountain areas such as the Swabian Alb. As areas of former landslides are highly prone to secondary movements, this study aims to assess the susceptibility for landslide hazard around Mössingen-Öschingen, a region consistently affected by landslides during the last decades. Based on the history and development of mass movements and a detailed geomorphological map, slope stability was calculated using SINMAP (Stability Index Mapping).

SINMAP (Pack et al., 1998; Tarboton, 1997) is based on the "infinite slope stability model" by Hammond et al. (1992) and Montgomery and Dietrich (1994) describing the ratio of slope stabilizing factors (e.g. cohesion) and slope destabilizing factors (e.g. gravitation) on a slip surface parallel to the slope. Most input parameters are determined by the relief and therefore, can be calculated from a digital terrain model (DTM, resolution 5 m). Based on the local morphology and geology, a total of 10 'calibration regions', each with similar hydrogeological characteristics, were defined. Further input parameters were: Shear strength via friction angle (Phi), cohesion (C) and hydraulic conductivity (T/R). The data was obtained from soil mechanical assessments and field/laboratory analyses. As a result, a specific stability index is calculated, describing the susceptibility of a slope movement.
In a first step, the 'topographic wetness index' (derived from catchment area, slope gradient and hydraulic conductivity) was calculated. Results show several preferred (natural) drainage channels with generally higher water saturations in morphological depressions. Several of them can be linked to the location of damaged houses in the settlement area on the lower slope. The SINMAP calculation clearly revealed the impermeable Callovian clay layers as most prone to slope movements.
A comparison of the susceptibility map with slide masses which were mapped during a field survey showed generally good agreements. This was in particular true for the slopes of the "Landhaussiedlung", a small settlement area east of Mössingen-Öschingen. In the uphill areas, a large landslide was triggered on June 3rd, 2013, mainly caused by heavy rainfalls during the days before. The scarp/slip surface was situated in the Callovian clay layers and in an area which was shown as susceptible for slope movements by the SINMAP model earlier Terhorst and Kreja (2009). The movement processes reactivated an old slide mass, which reached the outermost parts of the settlement area and damaged the densely built-up underground of the Landhaussiedlung. Although no house was destroyed completely by the slide mass, the induced pressure caused severe damages, rendering the buildings uninhabitable and leading to the evacuation of the Landhaussiedlung. The results show, that the modeling provided a solid identification of the vulnerable slope areas. The recent landslide area is almost completely situated in a region modeled as vulnerable for slope movements. Therefore, the landslide event of 2013 practically validated the susceptibility map. On the base of solid data and under consideration of detailed and differentiated information, SINMAP is a powerful tool for the assessment of susceptibilities for translational slides.

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