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Spatiotemporal reconstruction of a landslide in the Swabian Alb (Southwest Germany) - A dendrogeomorphological approach

R. Holland (1), B. Neuwirth (1), R. Bell (2) and T. Glade (2)

(1) Department of Geography, University of Bonn, Germany, (2) Department of Geography and Regional Research, University of Vienna , Austria (Herr-Holland@gmx.de, b.neuwirth@geographie.uni-bonn.de, rainer.bell@univie.ac.at)

Landslides in the Swabian Alb cause significantly economic damage. To assess respective hazards and risks, detailed information on landslide activity is crucial. Thus, this study presents the potential of a dendrogeomorphological approach in assessing landslide activity for local study sites.

To generate a time series of the active phases of a landslide in the Swabian Alb (Southwest Germany), tree-ring growth curves from tilted beeches (Fagus sylvatica L.) and Scotch Pines (Pinus sylvestris) were analysed. The investigated slope (ca. 1 ha) is highly active and part of a larger complex landslide (ca. 50 ha). The study area is located at the Jurassic escarpment and consists of impermeable clays and marls underlying limestone.

Eccentricity as the most important growth anomaly and abrupt growth changes were used to date the slope's instable phases. In addition to the visual analysis, statistical techniques was applied in the verification of both approaches. In order to quantify the eccentric growth, Braam's eccentricity-index approach was modified: instead of comparing the eccentricity of tilted trees with the eccentric growth of an unaffected reference site, eccentricity was evaluated tree-internally. By combining detailed geomorphological maps and the dated growth anomalies (temporal information) event-response maps were derived. These maps show the affected trees in each active phase of the landslide.

In addition to the only known sliding-event of 2005, active phases could be detected for 1939, 1965, 1980, 1986, 1992-94 and 2004. All of these years or phases are located within periods of higher-than-average monthly or annual precipitation. As this study is concentrated on a small part of the slide only, it lacks spatial explanatory power. Applying the described methods to the whole complex landslide would show the differentiated spatiotemporal development of the complex landslide over the last 80 years.

Three anthropogenic impacts generated a higher instability of the slope. At the end of the 19th century a road was built on the upper part of the slope; in 1975 a wetland habitat was created directly below that part of the slope which collapsed in 2005. This caused both an increase in the slope's gradient and permanent moisture penetration of its lower part. A drainage system installed in 2001 constitutes the third interference. After numerous deformations of the road due to slope movements, water from above the street was channeled through a drainage-system to the lower part of the slope. This also contributed to the failure of the slope in 2005.

This study has shown that dendrogeomorphology is a strong tool to date landslides on a local scale. Although the intensive forest cultivation of Central Europe only allows to create time series of at most 100 years, these are sufficient to better understand slope-systems and produce frequency-magnitude relationships essential for modern landslide risk assessments. This study is part of the project InterRisk (Integrative landslide risk analysis and risk evaluation in the Swabian Alb, Germany) funded by the German Research Foundation (DFG).