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Permanent seismic monitoring of slope dynamics caused by a slow-moving landslide in the Vorarlberg Alps, Austria

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Our work within the research unit 'Coupling of flow and deformation processes for modeling the movement of natural slopes' is mainly focused on the monitoring of seismic signals caused by the slow-moving Heumoes slope in the Vorarlberg Alps, Austria. The slope is set up by loamy scree and glacial till, mostly clayey material with embedded hard rock components of varying size, and moves with several cm per year at the surface. During several field campaigns within the last three years we were able to detect and locate single fracture processes (-0.7 $\leq$ ML $\leq$ -2.4) during the movement of the Heumoes slope by applying seismic mini-array techniques. The spatial distribution of the fractures correlates with slope areas of higher movement rates. They are mainly clustered in the western part of the slope, while no events have been located in the eastern part. By contrast to the slope material of the eastern part of the slope, the water saturation of the slope material in the western part varies with the season. We therefore preliminary assume, that the recorded fractures have been generated in dependence of the water saturation of the unstable sediments. The temporal occurrence of the detected fractures, up to 26 hours after intense rain events, seems to approve the assumption of a rainfall-triggered movement of the slope caused by fast subsurface water dynamics. Beside strong rain events, we identified weak local earthquakes as possible trigger mechanisms, having a direct effect to the slope stability.
A network consisting of three mini-arrays has been installed in summer 2009 for a permanent monitoring in order to verify the first observations and to determine the spatiotemporal occurrence of the fractures. Especially the permanent seismic observation in wintertime (additional load by snow) and during the melting processes in spring allows the integrated determination of any influences to the slope stability. The identification of the process chain "rain events/melting processes – subsurface hydraulics – fracture processes" can be achieved by additional information given by geotechnical (e.g. inclinometer), hydraulic (e.g. piezometer) and hydrological measurements (e.g. weather station). Only the permanent monitoring over a long period of time can also clarify the influence of weak local earthquakes to the slope stability.
Some details regarding the installation of the seismic network as well as first findings of the permanent seismic monitoring of the dynamics at the Heumoes slope will be presented.