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An evapo-transpiration controlled landslide in Switzerland: The Steinernase case

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Between Zürich and Basel the highway passes close to Germany only separated by the Rhine River. At this point the main road and the railway have to pass the slope dipping toward the Rhine. This whole slope is creeping with faster sliding parts attending velocities up to 6 cm per year respectively 4 cm per month during crises. The slope is located in the forest, dipping 25° northwards and lies between 510 and 280 m a.s.l. The biggest sliding area in this slope covers about 130'000 m2 from which 30'000 m2 are sliding faster. It is a translational slide with a sliding surface at a depth of 3 (top of the slide) to 20 meters (on the slide base). Because of several slope stability problems during building of the roads and the railroad, the slide has been studied since 1911. Due to this much data is available.

The aim of this study is to create a model of the hydrological conditions in the landslide body and link them to the movements. Starting with a large amount of data, the model is calibrated for two years (2000 and 2001) and validated for 2006. But it appeared that raw rainfall data is not relevant in this case. By analysing the different data some special relationships were discovered: From the inclinometer data it is obvious that acceleration phases occur manly in winter. The same is valuable for the piezometric heads. They have clearly seasonal variations with a drop in summer and a rise of the water table in winter. Further on, only rainy winters lead to an important acceleration of the sliding mass, which leads to the assumption of a threshold effect. But in contrary to the movements, the precipitations are spread over the whole year and the area doesn't have important snowfall or soil freezing to explain seasonality. The proposed explanation is the evapo-transpiration, the whole area is covered by foiled trees especially beeches which consume much water during the vegetation period and

nearly nothing during winter. Apart from the trees, the soil is completely uncovered and the rain can infiltrate directly during wintertime. The runoff is estimated to be very small due to the rough topography.

The evapo-transpiration is calculated with a water balance model called WBS3 which was developed by Matzarakis et al. at the meteorological institute of the University of Freiburg (Germany). The WBS3 was also validated for a beech forest in Germany. It is a deterministic model and needs only two time variant inputs: the daily rainfall and the daily mean temperature. In addition the study site is characterised by the following parameters: soil type, forest stand, forest type, latitude so as the slope inclination and exposure. With these parameters a daily discharge is calculated and considered as total infiltration, which is the input for the hydrogeological model. The calculated infiltration follows the trend of the piezometric heads. This is not the case for the rainfall, due to the evapotranspiration, in summer most of the rainfall is consumed and the discharge is very low. With the hydrogeological model (Feflow 5.2) and the calculated infiltration, the slope hydrology can be simulated and the piezometric heads are then used as input for the geomechanical model to simulate the movements.