HYDROLOGICAL PATTERNS AND PROCESSES OF A DEEP SEATED CREEPING SLOPE AT EBNIT, VORARLBERG

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Many mass movements are driven hydrologically through precipitation and infiltration in unsaturated soils and successional groundwater fluctuations. For understanding flow paths and flow dynamics of infiltrating water in the subsurface, hydrological active structures are considered responsible for fast preferential flow and transport. In mountainous regions, high relief gradients are an additional factor driving fast hydrological processes. How these hydrological processes influences soil stability is yet subject of scientific research. It is also of great importance to understand dominating hydrological thresholds to appropriately account for critical trigger situations; e.g. certain climatic conditions. Hydrological prediction is often hampered by insufficient and difficult data gathering in mountainous areas or simply on the fact that focus is not directed to landslides before they happened to occur. This presentation is part of the work of two research groups funded by the German Research Foundation (DFG) with the focus on field investigations and is associated to the presentation of Hinkelmann et al. at this conference.

FIELD SITE

The investigation is conducted at an Alpine slope system which is part of the Dornbirn Ache catchment (~50 km²); located near Bregenz, Austria. The so called Heumös slope comprises catchments of several small creeks with a total size of 1 km² and up to 400 m of relief gradient. The slope is considered to have deep seated translational movement as well as surface creep of up to 10 cm per year. High yearly precipitation values of 2100 mm strongly influence surface, unsaturated and saturated water conditions.

GOAL: DEFINE DOMINATING HYDROLOGICAL PATTERNS AND PROCESSES

The work presented here focuses on field observations covering different subunits identified on Heumös slope with the aim of an effective characterisation of slope hydrology. Subunits include the creeping hillslope body and hydrologically connected steep slopes. The methods applied include soil investigation, artificial tracer tests with surface application to investigate the dynamics of a steep forested subsystem, a measurement cluster for continuous determination of soil moisture profiles (Spatial Time Domain Reflectometry; Schlaeger, 2005) on a pastured area, and distributed soil permeability point measurements. Areas with differing dominating hydrological processes are identified as hydrotopes with the help of a vegetation classification system. Fast hydrologic processes, i.e. infiltration, surface and subsurface lateral flow, are observed, despite low matrix permeability of the soils (silty-clay loam to clay loam). The spatial pattern of these interacting processes is determined by dominating heterogeneities, i.e. preferential pathways like shrinking cracks and strata in the fine-grained slope body. These fast processes dominate hydrotopes adjacent to the creeping hillslope body, whereas the creeping mass is governed by a fast surface runoff response in

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contrast. The adjacent preferential infiltration processes are correlated to fast pore pressure responses within hours to days after heavy precipitation events in the hillslope body (Figure). This lateral pressure propagation (Lindenmaier et al., 2005), measured with piezometers is an essential link towards the creep.

MODEL APPLICATION

We applied a physically based hydrological model (CATFLOW, Zehe et al., 2001) to better understand dominating hydrological processes. The highly distributed model focuses on unsaturated and saturated soil water dynamics using Richard's equation and includes an advanced SVAT model for evapotranspiration calculations. It helps to close the water balance of surface runoff dominated areas as well as shows the influence of preferential infiltration on potential subsurfacen pressure changes in the saturated zone. The model results enhance the concept of lateral pressure propagation from adjacent hydrotopes and inhibited direct infiltration on the creeping hillslope body.

With this presentation we want to show the benefit of detailed hydrological process studies in landslide research for better understanding dominating hydrological patterns which can trigger movement. Deep seated movements are not necessarily triggered by long term climatological or precipitation periods. However, high resolution of measurement signals might reveal fast groundwater level changes which induce movement. With this understanding we want to contribute to the improvement of coupling of hydrological models with subsurface flow or deformation process models.

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LITERATURE

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Link to Website of DFG-Research group: *www.grosshang.de*

Figure: Pressure propagation from adjacent hydrological active hillslopes towards the creep mass which moves towards the east on Heumös slope. Pressure reactions at piezometer in 5.5 m depth are within hours and are not related to vertical infiltration.