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Storm runoff generation at a steep pre-alpine hillslope - transmissivity feedback or organic layer interflow?

Philipp Schneider (1), Sandra Pool (1), Ludek Strouhal (2), Jan Seibert (1,3)

(1) Department of Geography, University of Zurich, Zurich, Switzerland (philipp.schneider@geo.uzh.ch), (2) Faculty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic, (3) Department of Earth Sciences, Uppsala University, Uppsala, Sweden

This study investigated storm runoff generation processes of a pre-alpine hillslope prone to slide. The experimental pasture plot is located in the northern front range of the Swiss Alps on a 30° steep hillslope. A gleysol overlies weathered marlstone and conglomerate of subalpine molasse. We conducted sprinkling experiments on a subplot with variable rainfall intensities. During both experiments fluorescein line-tracer injections into the topsoil, and sodium chloride (NaCl) injections into the sprinkling water were used to monitor flow velocities in the soil. The observed flow velocities for fluorescein in the soil were 1.2 and 1.4 × 10-3 m s-1. The NaCl breakthrough occurred almost simultaneously in all monitored discharge levels (0.05, 0.25 and 1.0 m depth), indicating a high infiltration capacity and efficient lateral drainage of the soil. These initial observations suggested 'transmissivity feedback' (a form of subsurface stormflow described in Nordic catchments by Allan Rhode in 1987) as the dominant storm runoff generation process. However, excavation of dye-stained soil horizons from a brilliant blue tracer experiment completely changed our perceptions of the prevailing storm flow paths and its runoff generation mechanisms. The results highlighted the dominance of 'organic layer interflow', a form of shallow subsurface stormflow at the hillslope. The dye stained the entire topsoil horizon, vertical soil fractures, and macropores (mostly worm burrows) up to 0.5 m depth. Lateral drainage in the subsoil horizons or at the soil-bedrock interface was not observed; drainage was limited to the organic topsoil. The subsoil with its low permeability acted locally as a soil percolation and bedrock exfiltration barrier, producing significant lateral drainage in the organic topsoil and pronounced pore water pressure changes in the bedrock.

Reference

Rohde, A.: The origin of streamwater traced by Oxygen-18, 260 pp., Uppsala University., 1987.