Geophysical Research Abstracts, Vol. 7, 08227, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08227

Where does this old water come from? – Some insights gained from sprinkling and tracer experiments on different hill slopes

Peter Kienzler, Felix Naef
Institute of Hydromechanics and Water Resources Management, ETH Zurich

Fast lateral subsurface flow in the vadose zone can contribute significantly to stream flow response during a storm event. It can also lead to a fast drainage of the soil and therefore influence the retention capacity particularly during rainfall events with a long duration. However, the assessment of flow rates and lag times of subsurface flow is connected with large uncertainties, due to the large spatial variability of subsurface flow.

To understand the factors influencing the initiation of subsurface flow, subsurface flow processes were studied on test slopes in three different catchments during sprinkling experiments and natural rainfall events. Highly resolved measurements of overland and subsurface flow were conducted as well as of soil moisture, soil suction and water table heights. Event and pre-event water fractions in the different flow components were determined using artificially traced sprinkling water and ^{222}Rn as natural tracer. This allowed an insight into the origin of the water flowing off. Additionally, instantaneous tracer injections were used to estimate flow velocities and proportions of preferential flow.

Differing behaviour of pre-event water mobilization was observed. On a test slope with a loamy macropore-rich cambisol over dense moraine bedrock, the shallow flow component and even the overland flow showed relatively high fractions of pre-event water. By contrast, on another test slope, where the soil evolved from loess and is characterized by a high content of silt, nearly no pre-event water was observed in the subsurface flow during flood events. In the third catchment, covered by sandy soil with relatively high matrix hydraulic conductivity, two adjacent sites with different soil depths were investigated. Lag times and pre-event water fractions of subsurface

flow emanating from individual macropores varied substantially on these two plots. Interestingly, the amount of pre-event water was correlated with the lag time.

We conclude that the initiation process of subsurface flow controls the amount of pre-event water. The mobilisation of pre-event water in the shallow soil layer was possible because the whole layer, although thin, became rapidly saturated. As the preferential flow was isolated from the soil matrix, nearly no pre-event water was mobilised in the loess soil. Inhomogeneous local saturation of the sandy soil caused high pre-event water fractions in macropore flow initiated from saturated parts of the soil and low pre-event water fractions in macropore flow interacting only to a low degree with the soil matrix.

The study shows that pre-event water can be mobilised out of limited parts of the soil column, even in surface-near, thin layers. This information helps to understand the initiation and intensity of fast subsurface flow: It consists of event water flowing through preferential pathways and of pre-event water mobilised in saturated zones in the soil matrix. The extent of these saturated zones and the degree of interaction between the saturated soil matrix and preferential flow paths determine the amount of pre-event water in the subsurface flow.