Geophysical Research Abstracts
Vol. 12, EGU2010-12825, 2010
EGU General Assembly 2010

A sprinkling experiment using multiple tracers and ERT to conceptualize subsurface storm flow

R.D. Rothuizen, T.A. Bogaard, M.C. Westhoff, and H.H.G Savenije

Water Resources Section, Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, The Netherlands.

Rapid subsurface flow is one of the most important water flow processes in hillslopes. This process shows significant threshold behaviour as a certain amount of rainfall has to be added to the hillslope before the rapid subsurface flow process becomes active. Moreover, many tracer studies have shown a large fraction of ‘old’ water in the rapid subsurface flow. The magnitude of the threshold and the fraction of ‘old’ and ‘new’ water still get significant research attention. However, this behaviour and magnitude can be explained by different hydrological concepts.

In this study, we aim to identify and quantify the hydrological processes responsible for the threshold behaviour of the rapid subsurface flow and the extent of new water contribution during 5 sprinkling experiments on a 150 m2 plot, just uphill of a previously identified groundwater source.

Five consecutive days we added approximately 9 mm of artificial rain on an experimental plot during one hour with salt and deuterium as artificial tracers. The analysis is based on a combination of hydrometric, hydrochemical and Electrical Resistivity Tomography (ERT) observations. The time lapse ERT observations gave most information on the saturation of and the salt content within the unsaturated soil, while the hydrometric observations quantified the storage in the saturated soil. The hydrochemical information was useful to differentiate between old and new water.

We developed a conceptual model of the hydrological processes in the subsurface. The main hydrological processes that were identified and modeled are the unsaturated zone storage, the rapid subsurface flow and the slow matrix flow. By constraining the model only on the observed source outflow and not using the water quality information, we obtained a good fit between measured and modeled outflow. However, the simulated salt concentrations did not resemble the observations. This was caused by an overestimated exchange between the unsaturated zone and the slow matrix flow and rapid subsurface flow. By constraining the model with both, source outflow and salt concentration, the model performance for source outflow was slightly less, but the salt concentration simulation was improved. In the adjusted model, the unsaturated zone stores most of the applied rain with limited exchange with the slow matrix flow and rapid subsurface flow. Changes in source outflow during the 5 days experiment is mainly controlled by rapid subsurface flow.

We conclude that adding hydrochemical and ERT data to the hydrometric data of the sprinkling experiment, improves our understanding of the hydrological behavior in the subsurface, and that it helped constraining the parameter space of the hydrological model.