Geophysical Research Abstracts
Vol. 15, EGU2013-685, 2013
EGU General Assembly 2013

Spatial and temporal simulation of groundwater age distributions of a small mountainous catchment

Anita Gundel (1), Markus Weiler (1), and Mario Schirmer (2)

(1) Albert-Ludwigs-University, Institute of Hydrology, Freiburg, Germany (anita.gundel@ihf.uni-freiburg.de), (2) EAWAG: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland

The spatial and temporal storage characteristics of catchments are relevant to identify the vulnerability of catchments to climate change. Areas with high mean groundwater ages imply long residence times of water particles in the aquifer and are therefore a good indicator for high storage capacity of a catchment. Groundwater age in general is strongly influenced by porosity, flow direction and flow velocity. Hence, the great challenge for moutainous catchments is the steep topography and the complex geology which has the greatest impact on the groundwater age distribution. The main purpose of this study is the simulation of the groundwater age of a well-instrumented pre-alpine catchment in time and space to identify storage characteristics. One possibility to simulate groundwater age distributions in space and time is the application of a numerical groundwater model, which takes into account complex geological structures as well as the flow and transport processes of the unsaturated and saturated zone. In our study, we used the numerical 3D-finite-element groundwater flow and transport model FEFLOW with a transient direct mean age simulation method based on a mass-weighted average age. The study catchment Rietholzbach is located in the north-east of Switzerland, for which an adequate data set of discharge, groundwater level, and isotopic composition of the groundwater and stream water exists. First of all, a steady-state groundwater flow model was developed to validate the stability and accuracy of the flow simulation and model structure. Secondly, the steady-state results provide the initial conditions for the transient flow and transport simulation of the groundwater age distribution. Residence time simulations of this model were benchmarked against the stable isotope signal $\delta^{18}O$ of groundwater and discharge. The results show that less water is stored along the creek in the shallow aquifer (young water) whereas substantial storage capacities (old water) are available at the hillsides and in greater depths. The Rietholzbach catchment has heterogeneous storage characteristics, strongly influenced by the topography, with good storage capacities in the hillsides. The 3D direct simulation of the mean groundwater age in combination with residence time simulation of an environmental tracer provides reasonable results and is a useful approach to increase the understanding of hydrological processes of a hydrogeological complex study site.