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Comparing Flow Mechanism Hypothesis with Mobility Data of Natural Tracers

M. Sanda, Z. Chárová, D. Zumr , and M. Císlerová

Faculty of Civil Engineering, Czech Technical University in Prague. Czech Republic (martin.sanda@fsv.cvut.cz)

Hillslope rainfall-outflow interactions, groundwater fluxes and hydrological balance have been examined in the small mountainous headwater catchment Uhlířská (1.78 km^2), Jizera Mountains, Czech Republic. The hillslope soil profile is formed by paleozolic crystalline bedrock overlaid by shallow highly permeable Cambisol, whereas the thick saturated glacial deposits in the valley are overlaid by Histosols. Quick communication of the vadose zone with the granite bedrock via preferential subsurface flowpaths is hypothesized, in agreement with the observation of instant water transformation through the permeable Cambisols, to outflow caused by storms. There is regularly a quick response of high magnitude, although surface runoff occurs very rarely. Standard climatic and hydrological monitoring is supplemented by measurements of the soil moisture, soil pore water suction, hillslope stormflow in the vadose zone and water table fluctuation in the saturated subsurface. Water sampling for analysis of the isotopes ^{18}O and ^{2}H and geochemical tracer silica in the form of SiO_2 is performed throughout the catchment. The episode based isotopic data serve for the separation of the particular components of the outflow hydrograph and for the determination of the contribution of event and pre-event water in the hypodermic hillslope outflow and in the catchment outflow as a whole. Variation of silica content in the water cycle components was examined to assess contributions from the soil profile and the aquifer. Significant portion of event catchment runoff was assigned to pre-event water, partly stored in the shallow soil layers on hillslopes and partly in the valley aquifer. Here, a significant mixing (in form of attenuation of the input signal of ^{18}O or ^{2}H measured for precipitation) occurs as proven by sampling and modeling by means of physically based models for vadose and saturated zones. Hydrological balance of the catchment shows only minor discrepancies in averaged value of the either isotope in the whole balanced mass on the input (precipitation) and the output (streamflow). There is a strong mixing of water already in the root zone, where transpiration takes place. Preferential flow in the soil profile proved to be a major transporting mechanism for water in the form of quick subsurface runoff. The hypothesis that the hillslope soil layers controls the distribution of the flow into the groundwater recharge and/or the shallow subsurface flow during the rainfall-runoff episode, was confirmed. Porous structures of the catchment play dominant role in initial mixing of the water.

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