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Hydrological functioning of the mountainous peatlands – oxygen isotopes study

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Mountainous peatlands are important hydrological component of the headwater catchments in Jizera Mountains, The Czech Republic. The hillslopes of experimental catchments Uhlířská (1.78 km^2) and the Nature Reserve of Mires of Jizera (1.3 km^2) are formed on paleozolic crystalline bedrock overlaid by shallow highly permeable Cambisols and Podzols, whereas the thick saturated alluvial deposits in the valley are overlaid by Histosols. Standard meteorological and hydrological monitoring at these test sites is supplemented by measurements of soil moisture, soil pore water suction, and the water table fluctuation in the saturated riparian zone of the streams. Since 2006, the water sampling to detect the ^{18}O and ^{2}H isotopes is performed throughout the catchments on hourly to monthly time basis.

The detailed dataset of water quantity (precipitation, outflow, soil suction, soil moisture, groundwater table) linked to environmental tracers (oxygen isotopes, pH, electrolytic conductivity, UV absorbance 254 nm for organic matter and silica content in waters) gathered since then, enables to seek answers to frequently posed questions: *What are the sources and flowpaths of water in wetlands? What is the water residence time of water in the catchment or its subsections? How the water bodies interact?* Conservative nature of the stable isotopes enables to balance water masses in the wetlands as a binding element of streamflow and groundwater.

Multiple methods have been applied: simple plotting of data with high time resolution, cross-plots linking e.g. streamflow with tracer data, or two tracer datasets comparison (e.g. oxygen isotopes and silica). Simple and advanced modeling tools were used: the linear reservoir model and FLOWPC model to estimate the catchment water residence time; Advanced tools as the S1D numerical code based on Richards' equation to simulate the vertical 1D soil water flow and the advection-dispersion transport of stable oxygen isotope ^{18}O; the groundwater flow models MODFLOW/MODPATH/MT3D have been used to test posed hypotheses.

Based on the data analysis, the water regime features can be summarized:

The examined peatlands are primarily groundwater driven fens, with the secondary precipitation impact via infiltration. Baseflow is dominantly controlled by the groundwater discharge. During rainfall–runoff episodes, water is conducted in the weathered zone of mineral soils on the upslopes along the slope, percolates into the aquifer and discharges into the peatlands on its lower interface with the sedimentary aquifer. The pre-event water, stored in the valley wetlands, the upslope saturated areas or the sedimentary aquifer, is replaced/pushed into the stream due to the pressure gradients mobilized by the water infiltrating on the hillslopes. The mean residence time of water in the catchment examined by simple linear reservoir model is in the range of 7 months, while the application of FLOWPC model finds two pools of water of approximately similar volume (groundwater, and weathered soil mantle of the upslopes together with wetlands in the valley). The isotopic separation proves 50-75% of pre-event water in the flood flow. The S1D simulations of flow and transport in Cambisols and Histosols demonstrate intensive mixing even when preferential flow occuring in Cambisols is included. The groundwater flow models employing the stable isotopes data show that even the shallow layer of the aquifer water masses are well mixed.

This study is a part of IAEA Coordinate Research "Isotopic Techniques for Assessment of Hydrological Processes in Wetlands", comprising 14 countries on 6 continents, where further questions regarding element cycling, chemical processes and biophysical indicators with the support of isotopic tools are targeted as well. The research is supported by IAEA research contract 14007 and by the Czech Science Foundation projects No. 205/09/0831, No. 205/08/1174, Czech Ministry of Environment No. SP/2e7/229/07.