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Recharge and mixing of groundwater in small mountainous catchments in the northern Czech Republic

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Role of groundwater in the water cycle of small mountainous catchments dominated by rapid discharge variations is still poorly understood. Most studies to-date have attributed the groundwater to a more or less delayed baseflow transmitted through preferential flow pathways. New approaches are needed to address how much of deeper (and presumably older) groundwater is recharged and how this groundwater mixes with presumably younger components to generate stream runoff.

Recent studies using data from almost two decades of hydrological research in the catchment Uhlířská (1,78 km2) and surrounding catchments in the Jizera Mountains, northern Czech Republic, have demonstrated that groundwater recharge in that area is dominantly formed through extended infiltration during sustained rain and snowmelt. Groundwater is also recharged through the near-surface weathered sedimentary layers on hillslopes and further mixing with deeper components in the peat Histosol zone.

Measurements of stable hydrogen and oxygen isotopes, tritium, noble gases and CFC were conducted over the last five years in a set of sampling points in stream, soil and boreholes up to 30 m depth. They were interpreted using two lumped-parameter approaches (FLOWPC and LUMPY) to address groundwater apparent ages, mean residence times and mixing proportion of young and old components. Approximately 150-300 mm of precipitation were attributed to deep percolation, which is approximately 10-20% of annual precipitation. Samples of apparent 3He/3H age of about 40 years consist of a 70% admixture of a linear-piston flow pattern with mean residence time of about 80 years, and a 30% admixture of exponentially distributed flow pattern with a mean residence time of about 4 years. This confirms that groundwater in the catchment includes portion of both young (presumably recharged from the adjacent stream), and old from various pathways transmitting water recharged on hillslopes and accumulated typically in snowmelt periods. The multi-isotope approaches allowed to distinguish groundwater of different origin and demonstrated that groundwater may play a critical hydroecological role through buffering the impact of rapid runoff variations during reforestation/forestation.

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