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Use of geochemical and isotope tracers to assess groundwater dependency of a terrestrial ecosystem: case study from southern Poland

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The presented study was aimed at better understanding of the functioning of groundwater dependent terrestrial ecosystem (GDTE) located in the south of Poland. The studied GDTE consists of a valuable forest stand (Niepolomice Forest) and associated wetland (Wielkie Bloto fen). It relies not only on shallow, unconfined aquifer but indirectly also on groundwater originating from the deeper confined aquifer, underlying the Quaternary cover and separated from it by an aquitard of variable thickness. The main objective of the study was to evaluate the contribution of groundwater to the water balance of the studied GDTE and thereby assess the potential risk to this system associated with intense exploitation of the deeper aquifer. The Wielkie Błoto fen area and the adjacent parts of Niepolomice Forest are drained by the Dluga Woda stream with 8.2 km2 of gauged catchment area. Hydrometric measurements, carried out on the Dluga Woda stream over two-year period (August 2011 – August 2013) were supplemented by chemical and isotope analyses of stream water, monitored on monthly basis. Physico-chemical parameters of the stream water (SEC, pH, Na content, Na/Cl molar ratio) and isotope tracers (deuterium, oxygen-18 and tritium) were used to quantify the expected contribution of groundwater seepage from the deeper aquifer to the water balance of the Dluga Woda catchment. The mean transit time of water through the catchment, derived from temporal variations of δ18O and tritium content in the Dluga Woda stream, was in the order of three months. This fast component of the total discharge of Dluga Woda stream is associated surface runoff and groundwater flow paths through the Quaternary cover. The slow component devoid of tritium and probably originated from the deeper Neogene aquifer is equal to approximately 30% of the total discharge. The relationships between the physico-chemical parameters of the stream water and the flow rate of Dluga Woda clearly indicate that the monitored parameters approach distinct values characteristic for groundwater in the deeper aquifer for the lowest discharge rates of the stream. These low flow rates are also accompanied by low tritium contents in the stream water. This collective evidence strongly suggest that discharge of Dluga Woda stream at low stands carries significant contribution of groundwater seeping from Neogene aquifer in the area of Wielkie Bloto fen. Modelling of long-term impact on the regional groundwater flow field of groundwater abstraction by the nearby cluster of water-supply wells suggests that temporal disappearance of stream flow during summer months may occur, with potentially severe consequences for the status of the studied GDTE.

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