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Environmental water requirements of groundwater dependent ecosystems: conflict between nature and man

S. Witczak (1), J. Kania (1), K. Rozanski (2), P. Wachniew (2), A. Zurek (1), and M. Dulinski (2)

(1) AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Krakow, Poland, (2) AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland

The presented study was aimed at investigating possible interactions between the porous sandy aquifer intensively exploited for drinking water purposes and the groundwater dependent ecosystem (GDE) consisting of a valuable forest stand. The investigated aquifer (Bogucice Sands) and the associated GDE (Niepolomice Forest) are located in the south of Poland. The aquifer covers the area of ca. 200 km2 and belongs to the category of medium groundwater basins in Poland. The Niepolomice Forest is a lowland forest covering around 110 km2. This relic of once vast forests is protected as a Natura 2000 Special Protection Area "Puszcza Niepolomicka" (PLB120002) that supports bird populations of European importance. Additionally, a fen in the western part of the Niepolomice Forest comprises a separate Natura 2000 area "Torfowisko Wielkie Bloto" (PLH120080), a significant habitat of endangered butterfly species associated with wet meadows. The Niepolomice Forest contains also several nature reserves and the European bison breeding centre and has an important recreational value as the largest forest complex in the vicinity of Krakow. Due to spatially variable lithologies and groundwater levels, the Niepolomice Forest is a mosaic of various forest and non-forest habitats, including wetlands, marsh forests, humid forests and fresh forests.

Dependence of the Niepolomice Forest stands on groundwater is enhanced by low available water capacity and low capillary rise of soils in the area. Groundwater conditions in the Niepolomice Forest, including Wielkie Bloto fen have been affected by meliorations carried out mostly in the period 1900-1930 and after the Second World War and by forest management. Due to artesian conditions in the area and relatively thin clay layer separating Tertiary aquifer layers from shallow Quaternary aquifer, the upward leaching of deeper groundwater may contribute in a significant way to the water balance of the investigated GDE. In September 2009 a cluster of new pumping wells has been set up close to the northern border of Niepolomice Forest. There is a growing concern that exploitation of those wells may lead to lowering of water table in the Niepolomice Forest area and, as a consequence, trigger drastic changes of this unique groundwater dependent ecosystem.

In order to quantify dynamics of groundwater flow in the area of the Niepolomice Forest and Wielkie Bloto fen, physicochemical parameters and concentrations of environmental tracers (stable isotopes of water, tritium, radiocarbon) were measured in wells located in the recharge area of the Bogucice Sands aquifer and in the newly established wellfield. Also, surface water appearances in the area of Wielkie Bloto fen were investigated. To detect potential discharge of deeper groundwater in the area of Wielkie Bloto fen a dedicated Geoprobe sampling of water from different levels of shallow phreatic aquifer was performed for chemical and isotope analyses. Appropriate modeling runs of the existing 3D flow and transport model of the Bogucice Sands aquifer were also made to investigate possible impact of the newly establish wellfield on the groundwater flow in the Niepolomice Forest area.

The chemical and isotope data available to date indicate that in the recharge area, upstream of Wielkie Bloto fen groundwater is relatively young. Presence of appreciable amounts of tritium points to recharge in the past several decades. Radiocarbon content fluctuates between 48 and 65 pmc. In contrast, in the newly established wellfield tritium is absent while radiocarbon content drops to a few pmc. Significant age of groundwater in this area is confirmed by stable isotopes of water revealing characteristic shift towards more negative delta values indicating glacial origin of water.

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