Hydrogeological study of the Opitsvet-Dragovishtenski karst basin

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The main objective of the study is clarifying of hydrogeological conditions in the Opitsvet-Dragovishtenski karst basin, located in western Bulgaria. An outstanding ecological phenomenon in the area is Dragoman marsh, which is a protected zone for conservation of natural habitats within the Bulgarian Natura 2000 network.

The methodology includes systematisation, analysis and summary of the available information, water balance calculation, field measurements and modelling studies.

The climate of the study area is temperate. The yearly precipitation sum for the rainfall station Slivnitsa is about 612 mm. The potential evapotranspiration is evaluated using the method of Thorntwaite based on mean monthly air temperatures typical for the study area, with yearly sum of 625 mm. The aridity index for the study region is about 1.02.

For evaluation of the yearly water balance, the method of Budyko was used. According to the Budyko curve, the yearly sum of the actual evapotranspiration cannot exceed the value of 437.5 mm. The difference between enhanced evapotranspiration (due to standing water and hydrophyte vegetation) and this value is due to inflow of karst waters. The evaluated value for the marsh with area of 4 km² is 24 l/s, and after correction (taking into account reduced area during summer) – 19 l/s. The inflow of karst waters into the Dragoman marsh is about 25% of the precipitation sum.

A hydrodynamic map of the deep karst aquifer within the study area (289 km²) is prepared. The regional flow is directed from north to south. The hydraulic gradients vary in the range 0.003 - 0.037. Main groundwater recharge areas are situated in karst plateaus, where the recharge intensity reaches 295 mm/y. The rest territory is characterized with recharge values below 120 mm yearly. The karst aquifer is discharged mainly by large springs in the south part of the study area. The springs fed the Blato River, a tributary of the Iskar River.

A numerical hydrogeological model is prepared for the area. MODLFOW software is used, which is incorporated into the Groundwater Modeling System. As a result, a transmissivity map of the karstic aquifer is prepared. The most permeable zones (>500 m^2/d) are close to the largest karstic springs.

During a field trip in March 2010, the electrical conductivity and temperature of water in 50 points within the Dragoman marsh were measured. High values of the electrical conductivity (>1000 μ S/cm) mark locations of the inflow of karst waters into the marsh. Most possibly, these locations are tectonically predetermined (through numerous faults).

Dragoman marsh shows typical attributes of humid land ecosystems – presence of standing water over certain period of time, undrained soils and hydrophyte vegetation.

The obtained results correspond to general statements valid for humid and sub-humid environments – significant subsurface lateral flows associated with either topographic slopes or enhanced groundwater recharge. For the Opitsvet-Dragovishtenski karst basin both statements are valid.

The main results of the study are both hydrodynamic and transmissivity maps of the karstic aquifer. The role of karst waters into water balance of the Dragoman marsh is quantified on multiannual basis. The inflow of karst waters is characterized by substantial spatial heterogeneity. The groundwater discharge in the area depends on the faults' location.

Keywords: Opitsvet-Dragovishtenski karst basin, Dragoman marsh, hydrogeological setting, karst water, water balance