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An example of groundwater modeling to predict impact of climate change and to support optimization of a new intake

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For the purposes of forecasting the effects of climate change in the Pirot basin and surrounding karst massifs in South-East Serbia hydrodynamic analysis of groundwater regime has been carried out. The analysis comprises the two steps: 1. Forecasting discharge of the karst springs along the edge of the karst massifs currently tapped for drinking water supply; and 2. Forecasting effects of possible new intake consists of 10 operational wells which could be placed in deeper aquifer parts to compensate reduced groundwater flow. For the late the finite differences method and software package MODFLOW have been used, while calculations were conducted by Groundwater Vistas 5.51 (Environmental Simulations International, Ltd).

The study area consists of three main hydrogeological units: 1. Central unit: Intergranular aquifer of Pliocene and Quaternary sand and gravel deposited in the Pirot basin, covered by recent alluvial sediments of the Nišava and Jerma Rivers 2. Karstic aquifer in massif of Stara Planina in the eastern basin's margin also extending in the basin' bedrock; and 3. Fissured aquifer of the southern slopes of Vlaška Mountain made of Jurassic and Lower Creatceous limestones and clastic rocks. The corresponding aquifers are mostly unconfined, with exception of confined aquifer layers in Pliocene-Quaternary sediments.

A basic dimension of the matrix, which includes the research area, is 31.4 km x 24 km, which covers an area of 753.6 km2. The flow field in the plan is made with the basic cell size of 400 m x 400 m, which is in the zone of karst springs refined with square mesh of 25 m x 25 m. The calibration model was utilized in unsteady flow conditions, with a time step of one month for the time period January 2000 - December 2010 (total of 132 time steps), which is at a lower level of iterations divided into 10 parts of unequal length (factor 1.2).

Prediction calculations include four representative periods: 2020, 2050, 2070 and 2100 and seven different scenarios. For the 2070 and 2010 periods, operation of ten pumping wells ([U+F053] Q = 150 l/s) has been simulated. They are supposed to abstract groundwater along the right bank of the Nišava River where the limestone of Stara Planina comes into close contact with overlying Pliocene sediments.

Overall, despite burdened by some uncertainties obtained results from the model indicate a reduction of groundwater reserves in the karst massif of Stara Planina Mt. as a result of a decrease in annual precipitation. Operation of ten simulated wells could be an alternative but in long-term (in 2100) , a more significant decline in groundwater levels in the Pirot basin and karst massif of Stara Planina Mt is to be expected (decrease in the water table for maximal 28 m).

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