TOWARDS SUSTAINABLE MANAGEMENT OF TRANSBOUNDARY HUNGARIAN – SERBIAN AQUIFER

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Abstract

The project "Sustainable development of Hungarian – Serbian transboundary aquifer (SUDEHSTRA)" started in June 2007 and is completed in August 2008. It is one of the Cross-border cooperation programmes fully funded by the European Agency for Reconstruction (EAR). Experts from leading national institutions of the two countries have jointly drafted and worked on this important "mirror" project aiming at improving the management of common groundwater resources. This initiative is fully in line with the EU Water Frame Directive (EC2000/60) and EU Groundwater Daughter Directive targets.

Fig1. Studied area

Groundwater (GW) resources are vital for the economy and the society, as well as for the development of large flat parts with very thick Tertiary deposits between the Danube and Tisza Rivers in both countries: that is, the southern part of the Great Hungarian Plain and the northern part of the Republic of Serbia, Vojvodina province (Fig. 1). Within the framework of International Commission for the Protection of the Danube River (ICPDR) activities and the Roof Report for 2004, the transboundary aquifer system of Hungary - Serbia was separated into two parts (Djuric et al, 2005): one large GW body in Serbia named CS_DU 10, and 5 in Hungary (P.1. and P.2. groups). The total area is assumed to cover around 27000 km^2. In fact, the region is completely satisfying its demands for drinking water from the ground. There are more than 300 sources and centralized waterworks, and over 1,200 operational deep wells.

Most of the wells for water supply are drilled to a depth of 50-150m, but some reach 250m or even more

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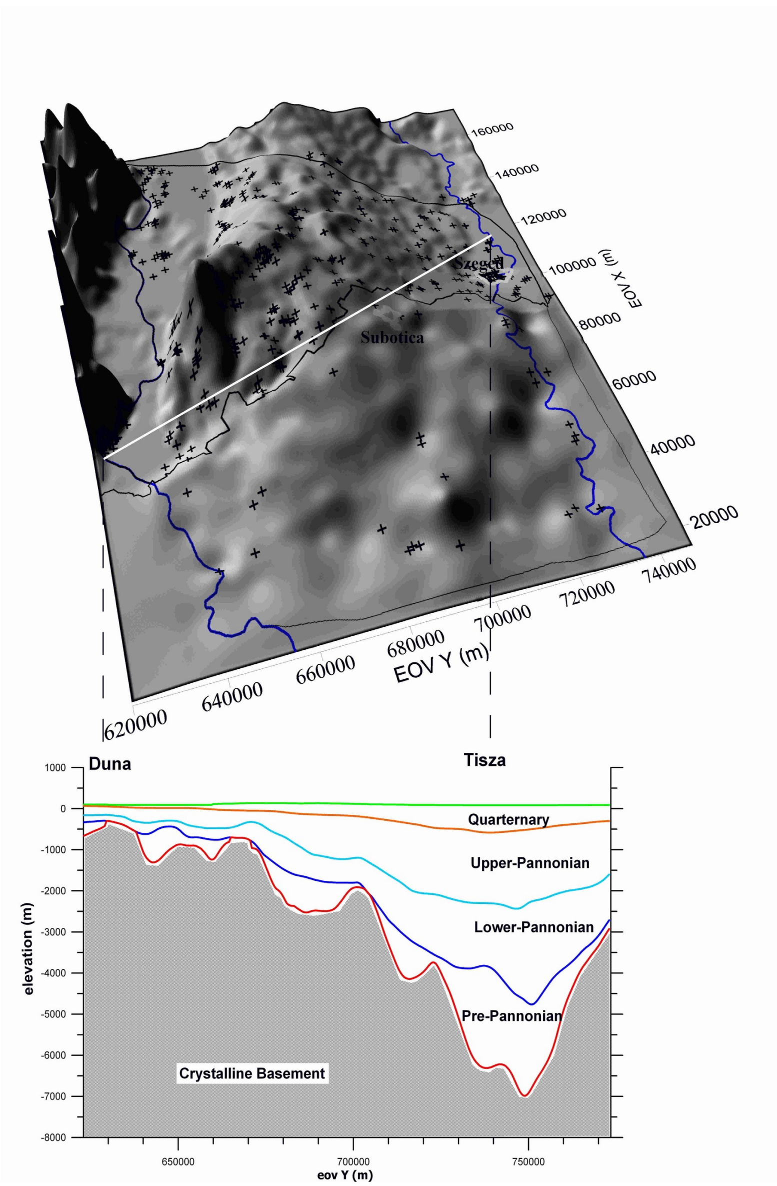
(600m in Szeged). The well capacity ranges from 5 - 25 l/s, depending on geology, applied drilling techniques, construction materials, well-development and other factors. In the past, many wells were over-pumped and forced beyond their optimal capacities, which caused them to deteriorate quickly. Therefore, many were replaced or revitalised. There are some indications of regional drawdown; thus many wells which were previously artesian today are characterised by a static groundwater table lower than 10m below the surface (mainly nearby existing waterworks' sources). The conceptual hydrogeological model includes 5 main aquifer layers to a depth of some 2500 m. The first two (Quaternary and Upper Pliocene), which are most prominent and characterized by the presence of fresh groundwater, are utilized mostly for drinking water supply and for irrigation. The deeper layers are also used in the water supply of some cities (e.g. Szeged) or for geothermal or balneotherapeutical purposes (Almasi, 2000): thermal water is used for recreation and medical purposes in several spas in both countries, while geothermal energy is more efficiently used in Hungary. For example, the city of Hodmezovasarhely widely uses deep thermal waters from a depth of 2000m for the central heating system. The number of wells that tap deeper aquifer layers with thermal waters is over 100 on the Hungarian side, while in Serbia there are some 15-20 such wells.

In Serbia it is assumed that current exploitation of the transboundary aquifer is around 2.8 m^3/s, half of that for centralized waterworks and half for industrial purposes. Groundwater is often used for irrigation purposes, but to a greater extent for municipal and industrial water supply (Milosavljevic et al, 1997) Soro et al, 1997). In Hungarian part of the model domain the estimated exploitation is 2 m^3/s, 60 % is used for municipal and the rest industrial water supply and irrigation. It is assumed that the aquifer recharge potential, mostly through infiltrated rainfall and underground flow from remote areas, is enabling the replenishment of some 60-90% of the current extraction rate.

The alternative water sources are also analyzed. As one of the most promising for the regional water supply of Northern Serbia and the border area the Danube alluvium has been studied. In Apatin vicinity, 40-50 m thick and very permeable alluvial deposits gravel and sands (average transmissivity $T = 2 \times 10^{-2}\ m^2/s$) enable tapping of some 0.25 -0.3 m^3/s per 1 km distance along the riverbank (Institute "J.Cerni", 2001).

For this project numerous activities have been undertaken, such as local waterworks inquiry, field survey and measurements, establishment of GW monitoring network, creation of GW initial database, common workshops and seminars for local capacity building, and water-saving promotional activities (Stevanovic et al, 2008). As a final result of the project, the common conceptual hydrogeological and hydrodynamical model has been created and tested. It is intended to be an important tool for transboundary water management and future sustainable water use and monitoring.

For groundwater modeling Processing Modflow has been used: forecasting of the effects of groundwater extraction under different scenarios for the next 15-20 years. The regional model covers the studied area of 135 km x 145 km (Fig. 2). Discretization of the flow field is generated by primal cell dimensions of 1000m x 1000m, which are reduced in zones of groundwater sources to 125m x 125m. The hydrodynamical model was conceived and built as a multi-layer model with ten layers (five water bearings and five semi permeables). Hydraulic parameters are approximated on the basis of provided documentation as representative values for the whole layer. There were several problems require to be solved before completing the model: different reference systems, different geological nomenclature, missing transboundary aquifer maps, different well density, materials in native languages, deficient hydraulic parameters, absence of monitoring data out of the main sources, etc.



The model has some limitations which are quite normal for such prognosis computation. Primarily, due to the missing values of hydraulic parameters such as specific yield, storage coefficient, both the model calibration and the prognosis computation are practised in steady state flow conditions. In addition, the real influence of the Dunav and Tisza Rivers and the drain channels on the groundwater regime is unknown and so was approximated. However, the obtained results are useful for preliminary evaluation and will be further discussed behind this project. They show insignificant depletion for the forecasted period and for the simulated extraction rates (in accordance with more sustainable use). However, there is demand for appropriate monitoring and mitigation measures to fill the gap between extracted water and recharge values. Some of proposed water management measures are as follow: Centralize the waterworks at municipal and regional levels; Keep existing sources functional as an integral part of future water supply systems; Delineate the sanitary protection zones of water sources in accordance to criteria taking into consideration primarily the local hydrogeological conditions and residence time for the pollutant transport; Improve water quality by systematically implemented measures aiming at the reduction of pollution. These measures include: proper waste water treatment, solid waste disposal control, limited pesticides and herbicides use, etc; Introduce complex water treatment, particularly where problems with organic components or increased concentration of Fe, Mn, As and some other ions in potable waters are recognized; Introduce river bank filtration wherever possible; Initiate artificial recharge where natural conditions would be assumed as promising for such interventions; Ensure rational water use and stimulate diminution of water demands; Reduce losses in distributive system; Increase water taxes in Serbia to enable reinvestment into modernization of the infrastructure.

Fig. 2 The 3-D model and general cross section through the study area between Danube (west) and Tisza River (south). Note: "Pannonian" layers are considered the local Hungarian classification; In fact the Upper Pannonian is of Pliocene age.

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