HYDROGEOLOGICAL STUDY OF SOMES-SZAMOS TRANSBOUNDARY ALLUVIAL AQUIFER

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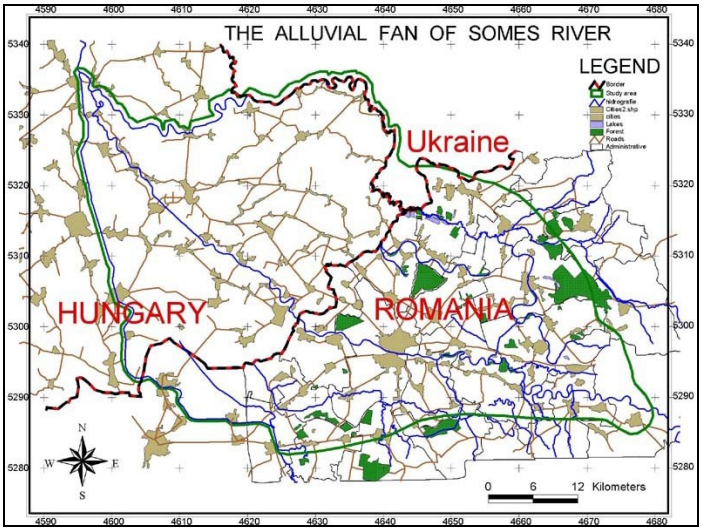
The development of transboundary groundwater resources has generated, and will continue to generate acrimony among states, nations and provinces. But groundwater resources can also promote peace and accommodation, as jurisdictions and decision-makers, who share a common groundwater resource, realize that cooperation is the only way to ensure resource protection and sustainability.

The Somes-Szamos aquifer, which extends on both sides of the Romanian-Hungarian border, supplies drinking water to a population of about 395000 inhabitants in Romania and 50000 inhabitants in Hungary.



The research project named SQUASH (for Somes/Szamos Quantitative/Qualitative Study of the Hydrogeology) carried out between 2000-2004 by a group of teams formed by Belgium, Romanian and Hungarian partners, in the scope and supported by the NATO Science for Peace programme, was intended to develop common tools and guidelines for local end-users (water supply companies and regulatory authorities from Romania and Hungary) in order to be able to manage the groundwater quantity and quality. The project focused on improving the previous understanding of the groundwater conditions

including flow and pollutant transport across many scales, using data acquisition techniques and computer simulation models.
The main steps/tasks of the project were:

- Collecting all existing data (characterizing groundwater quantity and quality);
- Building and development of data-bases;
- New measurements campaigns;
- Regional modelling;
- Groundwater quality studies in pilot zones.

After adopting a common data base structure based on the database developed by the Hydrogeology Group of the University of Liège, each team was in charge to feed the data-base with all collected data. The data-base, linked to GIS, insures a perfect compatibility for data exchanges.

On the basis on the analysis of the available data, new campaigns of measurements were carried out focusing the following aspects: piezometric levels; pumping tests for hydrodynamic parameters; groundwater quality campaign (sampling + analysis); tracer tests for assessment of transport parameters (locally). The priority was given to measurements in areas with low density of observation wells, in order to prepare ideally all the needed data allowing a reliable groundwater modelling.

The lithology put into evidence that the layers developed from 30 m till a maximum depth of 130 m on the Romanian territory and 190 m on the western limit of the Hungarian territory represent the main aquifer due to their extent, hydrogeological parameters and abstracted discharges. One of the most important steps in the mathematical modeling was the choice of the conceptual model of the aquifer. By keeping the essential features of the system, a reasonable compromise between the complexity of the aquifer and the available volume of reliable data concerning the structure and its hydrogeological parameters was proposed. Belgian, Romanian and Hungarian teams agreed on a conceptual model consisting of two aquifers and an aquitard between them. In the same time, a field campaign showed on the Romanian side differences of hydraulic head between the shallow and the deep aquifer in the range of 1 to 5 m, justifying thus the selected simplified model structure.

The regional groundwater mathematical model based on all the available data (pre-processed using GIS/data-bases) represents one of the most important outputs of the project. The groundwater model (GWM) and the data-base coupled to GIS integrate all the available data and the new knowledge about the studied aquifer system. They allow a better evaluation of groundwater resources and a sustainable management of these resources.

Groundwater flow and contaminant transport simulations were performed using Modflow and MT3D. Calibration of the hydrogeological parameters was performed in steady-state and in transient conditions. The zonation of the hydraulic conductivities obtained at the end of the steady state calibration was kept unchanged during the transient calibration. The history of groundwater levels, pumping rates, recharge values and time dependent boundary conditions for stress periods of one month were used as additional data. The transient state simulation for the calibration of the specific yield, respectively of the specific storage coefficients was undertaken for the interval January 2001 – April 2002. After the calibration, a transient simulation for the interval May 2002 – December 2002 represented the base for the model validation.

After a sensitivity analysis and a validation procedure, the mathematical model was used to simulate different scenarios for the future. These scenarios were decided in consultation with the end-users and decision-makers (changes in pumping rate, irrigation, drainage, etc.). Among these scenarii, the most unlikely which was tested consists in doubling the present pumping rates for all production wells. A steady state simulation showed that the drawdowns resulted in the 1st layer are less than 0.5 m, while in the 3rd layer representing the main aquifer for water supply the maximum drawdowns are 1.5 m. As

previously mentioned the tested increase of the pumping rates is not likely in the foreseen future. According to these results the aquifer seems not to be at risk from quantitative point of view.

Locally, some groundwater quality problems were observed or foreseen in the basin. Waste disposal sites, due to the lack of any technical design, are often major environmental problems throughout Hungary as well as Romania. Due to the lack of centralized waste management concept in the past decades thousands of legal and illegal waste disposal sites were created. Basically every settlement had at least one disposal site usually without any design or lining concept. Due to the nationwide programs the establishment of regional waste disposal sites is on a dynamic track; however the remediation of former waste disposal sites and their environmental effect is also a problem to solve. For this reason, the waste disposal areas near Fehergyarmat (Hungary) and Satu-Mare (Romania) were chosen as pilot zones for local modeling purposes.

The modular three-dimensional transport model referred to as MT3DMS was applied to build and run two transport models in the investigated region. To build a reliable transport model, some additional accurate information about the hydrodispersive properties was required from the different hydraulic units of the investigated aquifer. Detailed multi-tracer test investigations were carried out in both countries.

Based on available geological data and results from chemical analyses of the samples taken during the last field campaign, local groundwater transport models were developed. For each site, the boundary conditions were deduced from the regional flow model. The flow conditions were re-calibrated at the local-scale, while the transport model was calibrated based on the maps of the concentration. As required for protection zones delineation, transport times were calculated to the main concentration of pumping wells.

The model showed that the municipal waste disposal in Hungary does not represent any hazard for the water quality and the ecosystem of the Szamos-Somes river; the simulated contamination plumes do not reach the well-head protection zones of the local producing water wells.

On the contrary, on the Romanian side of the aquifer after 20 years the whole thickness of the aquitard is contaminated and the plume penetrates into the third layer. Different solutions for preventing the plume extension were imagined:

- A number of 2 pumping wells located outside the limits of the landfill pumping 5l/s each. It is showing that this solution cannot prevent the pollution of the aquitard, but reduces drastically the concentrations.
- 2 pumping wells are located inside the landfill, pumping the same rate of 5 l/s. According to the computed results, the leakage is not completely intercepted; still, this solution prevents the pollution of the aquitard.

The conclusion drawn from these first simulations are the following:

- The contaminant plume from the landfill seems to evolve relatively slowly.
- Rehabilitation of the aquifer in the area is required as a long term solution.
- Installation of a small number of pumping wells can limit the plume extension; a mixed solution (wells located both inside and outside the landfill) provided good results in pollution control.

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