XXXVIII IAH Congress

Groundwater Quality Sustainability
Krakow, 12–17 September 2010

Extended Abstracts

Editors:
Andrzej Zuber
Jarosław Kania
Ewa Kmiecik

University of Silesia Press 2010

abstract id: **449**

topic: **5**
Data processing in hydrogeology

5.1
Modelling as a tool of groundwater assessment

title: **A complex flow system model of the Muszyna region (Beskid Sądecki Range, Polish Outer Carpathians)**

author(s): **Jarosław Kania**
AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Department of Hydrogeology and Engineering Geology, Poland, jkania@agh.edu.pl

Stanisław Witczak
AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Department of Hydrogeology and Engineering Geology, Poland, witczak@agh.edu.pl

Nestor Oszczypko
Jagiellonian University, Institute of Geological Science, Poland, nestor.oszczypko@uj.edu.pl

Marta Oszczypko-Cloves
Jagiellonian University, Institute of Geological Science, Poland, m.oszczypko-clowes@uj.edu.pl

Irena Józefko
Geological Research Company "GEOPROFIL" Ltd., Poland, i.jozefko@geoprofil.pl

Bogusław Bielec
Geological Research Company "GEOPROFIL" Ltd., Poland, b.bielec@geoprofil.pl

keywords: conceptual model, numerical flow model, GIS, GMS

The studied area is located within an open hydrogeological structure in the Carpathian mountain basin. Regional model of the Muszyna area takes into account the presence of complex fold and fault structures as well as the interaction between groundwater, and surface water as well as fresh water with mineral water (Kania et al., 2010, submitted). The diagram (Fig. 1) showing the conditions of water flow system was used to construct the numerical model.

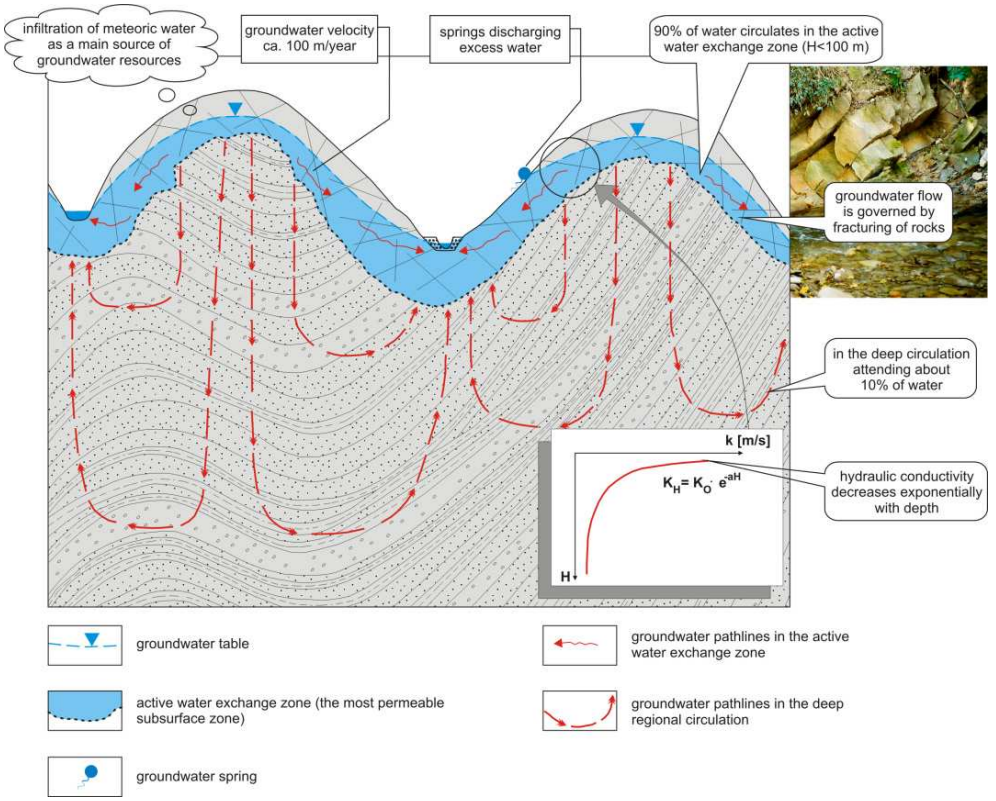

Figure. 1. Conceptual model of groundwater flow system in the studied area (Kania et al., 2010, submitted).

Within the model were separated 10 layers with different hydrogeological characteristics. The first layer includes Pleistocene-Holocene deposits. All other layers are built of fissured-porous flysch rocks. The hydraulic conductivities in studied flysch rocks decreases exponentially with depth (Oszczypko et al., 1981; Witczak et al., 2002). The most permeable subsurface zone is about 100 m thick. This is active water exchange zone recharged from the atmospheric precipitation. When the permeability of this zone is sufficient the groundwater supplies the main streams, as shown in the given diagram (Fig. 1). When the permeability is too low, the water table intersects the terrain surface and the flow of water from the spring, which usually initiates small stream. The varied morphology makes the elevated parts, where water table is much higher than in the valleys supplying the deeper water-bearing zone. Despite the decreasing fracturing and permeability of rocks the exchange of water can reach a depth of over 1000 m, although it is less intensive. The regional groundwater flow system also return to drainage areas, which are the river valleys.

Conceptual and numerical model of Muszyna hydrogeological region is based on the GMS software package — Groundwater Modeling System (Jones, 2005), working in close cooperation with the GIS environment, and using a software package ESRI ArcGIS (McCoy, 2004). Among the several methods for implementing the model in the GMS the LPF (Layer Property Flow) method was used to create a structure of the model. It involves the separation of the model space for many layers of varying thickness, within which zones of different hydraulic conductivities are separated.

The procedure of the model construction begins with the initial conceptual model of groundwater flow system. On completion of this, information about the structure of the model, hydrogeological properties and boundary conditions were included in the ArcGIS database. The data contained in the ArcGIS database is then transferred to the GMS conceptual model. The transfer process to GMS numerical model divided into blocks is done automatically. The model was therefore used, inter alia, to assess the disposable resources of medicinal and fresh waters of the studied area.

The experience gained from modeling for the Muszyna region show effectiveness of the principles of the creation of regional hydrogeological models. Such a quasi 3D model seems to be a good tool to carry out the rational exploitation of fresh and mineral water in a complex groundwater flow system (Kania et al., 2010, submitted).

ACKNOWLEDGEMENTS

This abstract was partly financed through statutory funds of the AGH University of Science and Technology (Project No. 11.11.140.139).

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International Association of Hydrogeologists

AGH University of Science and Technology

2-vol. set + CD
ISSN 0208-6336
ISBN 978-83-226-1979-0