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Development of the hydrogeological model for investigating the impact of contaminant sources in the Noginsk District, Russia

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ABSTRACT: The regional hydrogeological model (HM) has been created for the Noginsk District, the Moscow Region of Russia. New methodologies were applied in the course of HM building. The model will be applied to evaluate a contamination impact on groundwater, to develop remediation measures at chosen contaminated sites, and to make prognoses of water production of the District.

1 INTRODUCTION

Creating of HM is a part of the Danish-Russian project, which is devoted to the assessment of known contamination sources (mainly municipal waste deposit sites), and to studies of their impact on groundwater, in the area of the Noginsk District. The model has also provided important knowledge regarding groundwater extraction by well fields of the District. Materials about the present state of Noginsk HM are included in the report (Gosk et al. 1999).

The area covered by Noginsk HM comprises 39 km $\times$ 36 km = 1404 km^2. This area is approximated by uniform 0.5 km $\times$ 0.5 km blocks. The height of HM equals 0.3 km. It includes eight aquifers and seven interjacent aquitards. The 3D grid of HM contains $73 \times 79 \times 8 = 46136$ nodes. The model provides a semi-3D steady state solution for the mean annual piezometric head distribution of the aquifers.

2 SOFTWARE USED

In the course of the HM building, two modelling programmes: - REMO (Spalvins et al. 1996) and Groundwater Vistas (Environmental Simulations 1997) were used. The REMO programme was applied as a preprocessor for creating and calibrating of HM. The Groundwater Vistas code environment was applied for supporting and running of the system for contaminant mass transport modelling, in the 3D-groundwater flow. New interpolation technologies were used (Spalvins et al.1999) for creating the very complex geometry of HM (discontinuity of seven geological layers was accounted for) and for overcoming other difficulties of building Noginsk HM. Valuable geometrical data from regional vertical geological cross sections of the HM area were accounted for, and the special Geological Data Interpolation (GDI) programme (Spalvins & Slangens 1995) was applied to solve this task. Various lines, as data carriers (borders and elevation isolines of the geological layers), were applied by GDI simultaneously with ordinary pointwise data. The GDI programme was also used for preparing computer generated permeability maps of aquifers and aquitards, included in HM.

The SURFER for Windows system (Golden Software 1997) was applied for obtaining the graphics of digital maps of HM and for performing mathematical operations on data files of these maps, if necessary.

3 MODELLING OF INFILTRATION FLOW. MODEL CALIBRATION TARGETS

The landscape surface elevation map was used as the piezometric boundary condition on the top surface of HM (represented as an aquifer) and the aeration zone below it was presented as a formal aquitard. Under such an assumption the infiltration rate is auto-modeled as the vertical flow passing through the aeration zone under the difference between the fixed conditions on the HM top and the computed head of the first unsaturated aquifer beneath. Due to the above approach, good simulation results are always guaranteed, because a customary prescribed, practically unknown infiltration rate distribution is not applied as a boundary condition, in Noginsk HM.

The following interdependent HM calibration targets were applied:

- to minimize differences between observed and computed head values (0.97 metre value of the mean deviation was achieved);
- to obtain natural images (not contradicting hydrogeological conditions of the system under investigation) of computed head distributions;
- to keep under control values of groundwater flows;
- to adjust HM, by taking into consideration results of mass transport modelling.

Because the above targets are interdependent, the HM calibration process is an iterative one. Until now, only the first three calibration targets have been achieved.

4 RESULTS AND CONCLUSIONS

The following results have been obtained and conclusions formulated:

- the calibrated 3D flow model for the Noginsk District is developed;
- the first general prognoses regarding the contaminant mass transport in groundwater are obtained;
- valuable knowledge about available groundwater resources is gained;
- model based vulnerability maps for productive aquifers are prepared;
- on the base of the regional model, detailed local sub-models may be created to investigate the contaminant migration at chosen sites of the Noginsk District.

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