ресурсы межморенных водоносных горизонтов оцениваются в 204,6 тыс. м^3/сут. Следовательно, перспективы этих горизонтов значительны для освоения и проведения поисков и разведки.

На территории города в вендским водоносном комплексе оценены запасы по 7 месторождениям пресных вод в Курортном районе и 13 месторождениям минеральных лечебных вод с запасами 4,45 тыс.м^3/сут.

В 1991 г. по заданию Ленинградского городского водоканала была выполнена оценка солоноватых вод вендского комплекса в границах Санкт-Петербурга. Эта территория тогда же получила название «Петербургского месторождения минеральных вод». Эксплуатационные запасы данного месторождения в количестве 60 тыс.м^3/сут апробированы НТС СЗ РГЦ 25.12.1991 г.

Территория г. Санкт-Петербурга перспективна на минеральные подземные воды различных типов. Месторождения солоноватых хлоридных натриевых вод приурочены в большинстве своем к вендскому водоносному комплексу. Воды относятся к минеральным лечебно-столовым и лечебным типа «Миргородской», «Минской» и «Талицкой». Они используются в санаториях г. Петродворец, Сестрорецкий курорт, Детский ревматологический санаторий «Дюны», а также для розлива на территории г. С.Петербург.

Возможно изучение территории для выявления перспективных участков минеральных вод для организации курортно-санаторного лечения (применение в бальнеологии) и розлива.

SHUVALOVO CONTAMINATED SITE ANALYSIS WITH GROUNDWATER FLOW AND TRANSPORT MATHEMATICAL MODELS

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The work analyses the Shuvalovo pilot area characterized by groundwater oil pollution, by using flow (*Modflow*) and transport (*MT3D*) mathematical models. The general objective is to prove the potential of groundwater models in decision-making. In particular the work aims to:

- simulate groundwater levels and flow rates in the two main aquifers;
- understand the relationships between the two main aquifers;
- simulate the contaminant transport;
- define the contaminant targets.

The work is divided in three principal parts: data collection and interpretation by using Geographical Information Systems (*ArcMap*, *ArcView GIS*); study area conceptual model construction; flow and transport model implementation .

The Shuvalovo area, in the North-Eastern part of St. Petersburg, covers 25 Km^2 and includes green areas and some industrial activities. The territory is quite flat and incorporates rivers, channels, streams, lakes and ponds. The hydrogeological framework is quite complex, characterized by two aquifers, one superficial and one confined, reaching the depth of 50-70 m. The first one is composed of various grain size deposits and the water level rises to the land surface. The second one is hosted by inter-moreine deposits. These two units are separated by a boulder loam layer, which is discontinuous and could allow local exchange between the two aquifers. The pollution case is represented by oil discharge in Shuvalovsky pit, in the Southern part of the area.

The mathematical model was implemented by mean of *Groundwater Vistas* software, which includes *Modflow* and *MT3D* codes. The model grid was composed of 100 rows, 130 columns and 8 layers, with 50m x 50m cell size:

- layers 1, 2 and 3 simulate the superficial aquifer: the first one hosts the hydrologic system, the second one is the central core of the unit, the third one models the loamy sand lens which regulates the water exchange between the two aquifers;
- layer 4 represents the boulder loam layer;
- layer 5, 6 and 7 simulate the different grain size deposits in the inter-moreine aquifer;
- layer 8 represents the clayey bottom layer.

Top and bottom layer surfaces have been built by means of geostatistical processing of 338 study area well stratigraphies.

In relation to the flow model, the boundary conditions represent both the real limits (rivers, ponds, lakes) and the artificial limits (isopiezometric line), simulated by means of a *Cauchy* condition type (head-dependent flow) or a *Dirichlet* condition type (specified head). The hydrogeological properties have been defined as follows: 11 zones of hydraulic conductivity (min value = 10^{-3} m/day, max value = 10 m/day) and 6 zones of effective porosity (min value = 0.1, max value = 0.22).

The flow model calibration has considered the difference between simulated head and observed head in 172 targets, represented by water well measures. The calibration process has required more than 100 progressive simulations (an example in figure 1).

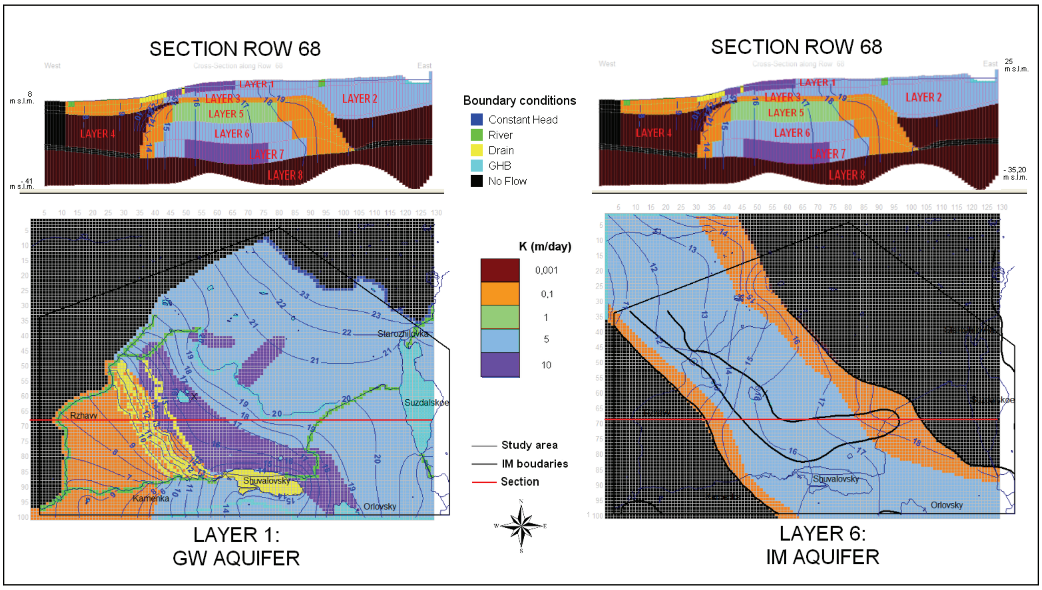

Figure 1: Geometry, boundary conditions and hydraulic conductivity of the model and a flow solution example in superficial and inter-moreine aquifers

In relation to the transport model, three punctual pollution sources have been considered. They have been inserted in the first layer as continuous sources with constant concentration. The model has considered advective-dispersive transport, with biodegradation and sorption reactions. Dispersivity has been defined by 2 zones, while chemical properties refer to Benzene compound. The absence of chemical analysis has not permitted the performing of transport model calibration on real data.

The flow model gives good results and allows underlining of a water exchange between the two aquifers. The transport model identifies the Shuvalovsky pit and the Kamenka river as the principal contamination targets, while the inter-moraine aquifer could be affected by the contamination.

GROUNDWATER MATHEMATICAL FLOW MODEL FOR POLUSTROVO PILOT AREA

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This work analyses the Polustrovo pilot area, which is subject to groundwater flooding, using a flow mathematical model. The main purposes are to:

- simulate a groundwater flow system in the two aquifers, one shallow (GW aquifer) and one confined (IM aquifer);
- understand the relationship between the aquifers in the study area;
- determinate the probable flooding areas;
- hypothesize some engineering solutions.

The study was developed in three main phases including data collection and processing (with GIS and geostatistical analysis), conceptual model elaboration for the complex hydrogeological system and implementation of the three dimensional finite difference groundwater flow model (*MODFLOW*; Mc Donald & Harbaugh, 1998).

The Polustovo pilot area is in the nord-est part of the city and covers about 60 Km^2 of urbanized territory. In the area there are many hydrograph elements like streams, rivers, ponds and swamps. The territory is quite varied, and in the central part of the area the altitude is about 30-25 m a.s.l. and quickly decreases in northern and southern directions to respective values of 18 and 6 m a.s.l.. The hydrogeological framework is quite complex. The GW aquifer is composed of various grain size deposits and the water level rises and sometimes exceeds the land surface. The IM aquifer is composed of an inter-moraine unit which hosts chalybeate water. The two aquifers are separated by a low permeability moraine layer, which is discontinuous and could allow local water exchange.

The spatial domain was represented with a 3D grid which includes 187 rows, 151 columns and 5 layers with cell size of 50x50 m:

- layer 1 represents the upper part of GW aquifer which hosts the hydrograph system;
- layer 2 simulates the GW aquifer main part;
- layer 3 represents the discontinuous moraine aquitard;
- layer 4 simulates the IM aquifer;
- layer 5 represents the aquiclude bottom layer.

The surface geometry of the layers was developed using the 224 study area well stratigraphies. The condition of the selected flux boundaries represents both physical elements (streams, rivers, ponds, etc.) and hydraulic elements (isopiezometric line). In the GW aquifer, second type limits (*Neumann*) were used to simulate recharge, and third type limits (*Cauchy*) were used to simulate rivers and general head elements. In the IM aquifer only *Cauchy* type limits were used. Hydraulic conductivity was defined by 7 different zones with a maximum value of 10 m/d and a minimum value of 10^{-3} m/d, according to data from Russian authorities.