THE ESTIMATION OF NATURAL GROUNDWATER RECHARGE ON THE EXAMPLE OF TWO RESEARCH SITES ON THE DANUBE-TISZA INTERFLUVES

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ABSTRACT

The Danube-Tisza Interfluves is one of the largest recharge areas in Europe. We selected two research sites in Hungary to investigate the natural groundwater recharge. These sites are located at Méntelek and Kecskemét. The previous measurements were based on the isotope hydrology and the transport modeling. Generally, the tritium is formed in the upper atmosphere during \( -\beta \) decay. It has a half time, during the tritium decays to \(^3\text{He}\), which is 12.4 years in this case. From the 1950s the high-altitude nuclear tests introduced large amounts of tritium into the atmosphere. Because the relatively short half-time of the tritium we can receive some information from the last 50 years happening. MODFLOW is a U.S. Geological Survey modular finite-difference flow model. This computer code can solve the groundwater flow equation. In addition to the numerical simulations, in this paper we show the results of our pedological investigations on the test sites to clarify the result of the recharge models.

INTRODUCTION

The importance of the quantity and quality of the drinking water resources for the inhabitants on the Earth is significantly increased. Different quality and quantity of water is necessary for the residential, agricultural and industrial usage of the water. The simulations, lab tests and the field measurements are increasingly important for the hydrogeologist for the hydraulic researches (Szűcs et al. 2009). There were some transport calculations for different test sites near Méntelek and Kecskemét with the Processing MODFLOW Pro software package in the previous researches dealing with groundwater flow systems. The aim of those studies was to clarify the recharge rate on the Danube-Tisza Interfluves. During the isotope hydrogeological researches an average groundwater level was assumed around the tests sites (Kompár et al. 2012).

The task of this paper to obtain confirmation for our axiom; could we calculate a unified groundwater level on the Danube-Tisza Interfluves, or we must to considered some different groundwater levels on the above mentioned areas. The investigation of the natural recharge is a very important task for the groundwater management purposes in hydrogeological researches. The rate of the recharge from the precipitation is basically determined by the amount and intensity of the rainfall. The evapotranspiration is determined by the vegetation of the soil surface, which has also a big effect for the infiltration processes. The physical properties of the soils play a key role under hydraulic conditions; the permeability of the soil show, how fast the infiltrated water can flow in the soil (Szűcs et al. 2011; Szűcs 2012). The average occurrence level of the groundwater can be determined by the depth of gleicy properties occurring in the soil profile. Dobos et al. (2012) developed several GIS and digital terrain model based approaches to define the likelihood of the occurrence of these properties in the soils. The results of the previous researches show that nearly vertical movement was assumed for the groundwater. The wells near Méntelek and Kecskemét were installed between the Danube and the Tisza rivers. There is no effect of these rivers for the
Figure 1. Regional recharge area on the Danube-Tisza Interfluves

groundwater level on the research sites, because of the large distance. The Danube-Tisza Interfluves is one of the largest recharge areas in Hungary, and also in the Carpathian Basin (Figure 1). We had to know accurately the geological parameters and the soil properties to understand the flow conditions operated partly by groundwater replenishment.

DESCRIPTION OF THE TEST SITES

The Danube-Tisza Interfluves is a part of the 3rd geochemical landscape of Hungary, which expands from Komárom to Szeged, wherein the cations especially Ca, Mg and Sr; the anions are mainly sulphates and carbonates. The shape of the location of this landscape reliably linked to the manly north-west and north wind. The ridge built up from sand, but the loess is also determinative. There is an important thing that the lime is highly accumulated in the soil in this region.

This lime accumulation has some specialities in this region. The carbonates dissolved from the sediments, which cover the surface. In this region there is a research work, which demonstrates that the carbonates are dissolved from the sediments, but not originates peel of the rock.

The sand is the bedrock in the region, which originates from the alluvium of the Danube. There are some ideas for the presence of the sand. Some researcher note about the differences between the Danube and the Tisza; while some carbonate particle were found in the Danube, these particles are completely missing in case of the Tisza (Várályai 1967).

We know from some studies, that the carbonate minerals have been transported with the wind from the Transdanubian Mountains mostly mixed with loess. There are two mean reasons of the lime accumulation; firstly originates from the capillary water, on the other hand from the bottom of the lakes. (Újházi 2003)
The abstract CO\textsubscript{2} by the plants may be the first reason of these lime accumulations, and the Ca and Mg ions have high concentration value during the drying of the lakes.

These processes determine the chemical composition of the lime mud. Fügedi et al. (2008) wrote about the geochemical characteristics of the lime accumulation near Fülöpháza in their studies. They explored two cross-sections, which show the geological, hydrogeological parameters and the levels of the lime accumulations. (Figure 2–3) It was found that the aeolian sediment flow is one of the reasons of the horizontal differences; furthermore the ionic migrations may also occur. (Fügedi et al. 2008)
RESULTS AND DISCUSSIONS

We explored two soil profiles on the Danube-Tisza Interfluve in December 2012 (Figure 4–5). The soil profile by the Figure 3 locates in Méntelek, which place is periodically covered by water. This profile is characterized by calcareous, shallow humous layer and humous sandy layer, according to the Hungarian classification (WRB: Endogleyic CALCISOL (Arenic)).

Figure 4 shows the profile of the test site in Kecskemét; this site is loamy sand with medium growing layer, and typical chernozem soil (WRB: Calcic CHERNOZEM (Pachic)).

Our goals with the two profiles were to explore soil parameters, which characterize groundwater and infiltration conditions of the sites. In this aspect the important physical characteristic of the soil is the gleyization and its features, furthermore the lime accumulation levels in the capillary zone. We could not reach the groundwater level at the investigated two sites despite the fact that the profile of Méntelek further we drilled from the bottom of the trench to 4 meters.

The soil profile of Méntelek indicates periodically high water table in the area. This fact comes from the geomorphology position and the recognizable features of the profile. The vegetation contains sandy grassland and the planted pine forest. It is clearly visible the dual-carbonate accumulation level from 0 to 0.33 m and under 0.55 m. Furthermore, the characteristics of the water flow influences show gleyization level in the upper 0.20 m and the thickness from 0.30 m to 0.55 m. There is a significant difference in the genetic parameters between the two lime accumulation levels. The reason of the formation of the whitening level is the CO₂ in the A-horizon. During the lime continuously spread to lower layers the CO₂ concentration is decreasing and the solubility of the lime is also decreasing form the lime accumulation level. These processes indicate that the pore volume of the soil
The aim of this study was to characterize the water balance and the groundwater dynamic terms with the help of the pedological investigations. We explored two different sites near Méntelek and Kecskemé on the Danube-Tisza Interfluves. Our conclusions are necessary to calculate the vertical and also the horizontal groundwater flow at the test sites. There is a significant lateral groundwater flow to the deeper level, which is indicated by the lime accumulations. We found that the vertical groundwater flow values are not the same inside one profile. If the lime accumulations levels slope, the groundwater can flow in lateral direction. These facts are very important during the hydrodynamical tests and the groundwater modeling. As a result, the flow and transport models of the investigated sites will be modified based on the described results. It is nearly sure that the calibration parameters of the numerical models will be improved, which can guarantee more accurate recharge estimation.

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REFERENCES


