INVESTIGATION OF GROUND AND ARTESIAN WATERS AS IRRIGATION WATER ON THE GREAT HUNGARIAN PLAIN

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ABSTRACT

One of the most significant attribute of soils is that they function as water reservoirs. Subsurface waters — used as irrigation water — can contribute to nutrient supply, but their pollution has a negative impact on the conditions of cultivation. In our study we present the results of our investigation of ground and artesian water samples from the Great Hungarian Plain, mostly from Kecskemét and its surroundings.

Based on the depth of the sampling points, we divided the samples into three categories: between 10-30, 31-70 and 71-275 meters. The results showed that the salt content is decreasing with the deepness, primarily because of the decrease in sodium, hydro-carbonate and chloride contents in the samples. The level of nitrogen and phosphorous-ions were low in almost all water samples. Iron, manganese and arsenic content were the highest in the middle deep waters (31-70 m depth).

These results — especially in the case of iron and arsenic — can cause problems in the use of these waters in agriculture for cultivation and irrigation. Nowadays decreasing groundwater stocks decrease the water sources of irrigation. Nevertheless usage of subsurface waters for irrigation is important in the future, for example about their function as a potential nutrient sources. Their sensitivity against pollutions draw attention to the essential task of continuous quality parameters monitoring of subsurface waters.

keywords: ground water, artesian water, irrigation, nutrient reservoir, water pollution

INTODUCTION

One of the most significant attribute of soils is that they function as water reservoirs. Subsurface waters — used as irrigation water — can contribute to nutrient supply, but their pollution has a negative impact on the conditions of cultivation.

Almost every year we have problem with water in Hungary, sometimes floods, sometimes droughts are the reason of it. These problems have special significance on the sand ridges between the Danube and Tisza rivers, where cultivation — especially horticulture — is important. But we have to accept, that inordinate precipitation is a typical characteristic of our climate (Rakonczai 2000). That is why irrigation is so important for agriculture in Hungary.

From the point of view of irrigation water sources, we have to point out the zone near the surface — it means groundwater (0-30 m) — which is an infiltration zone with changeable solute, and it is not a complete underground system. That is way investigation of this system is justified. Under this shallow zone, a 31-300 m deep zone can be found, with migrate waters towards centre of Carpathian basin and tempered chemical compounds. In centre and south part of the Great Plain, in the upper 500 m layers usually we can found water bases with less than 1 g l^{-1} solutes which is typical for Pleistocene and Pliocene residual water supply layers. These waters usually have drinking water quality. Waters have Calcium — Hydro-carbonate aspect in infiltration areas, which more and more Alcalic — Hydro-carbonate towards horizontal flow. Because of this phenomenon waters can be too soft in the middle of the Great Plain, which restricts the consumption (Kuti et al. 1999).

Anaerob processes can rise iron, manganese and ammonia content of artesian waters. Grown arsenic content could come forward as a problem in one part of irrigation waters. In some cases salt content can be high of artesian waters near the surface, solutes can be higher than 1 g l^{-1} (Kuti et al. 1999).

We investigated irrigation waters of South Great Plain in our work, in order to submit of utilization in agriculture on the base of our results mainly in case of horticultural irrigation.

MATERIAL AND METHODS

Irrigation water samples from 2007-2014 were examined in Soil and Plants Analysis Laboratory of Kecskemét College. We investigated 110 water samples from different wells. Based on the depth of the sampling points, we divided the samples into three categories: between 10-30, 31-70 and 71-275 meters. We show the position of the wells on Fig. 1. Place of origin is mainly Kecskemét and its surroundings, but we had samples from Bács-Kiskun county and agricultural areas in south part of Tiszántúl region.

Rules of sampling are the following: collection of water sample from drilled wells after streaming a few minutes, washed out with well-water of sample collection containers, and it is necessary to close tight immediately after the sampling. After a longer storage the results of the investigation are not trusty.

Examination of pH was made by potentiometer, electric conductivity (EC) by conductometer. Cat+, Mg^2+, Na+, K+, PO_4^{3-}, SO_4^{2-} ions, and Fe-, Mn- As-content were measured by ICP-OES spectroscopy. Investigation of ammonia- and nitrate-content were made by photometer (Fig. 2.), chloride by argentometer, carbonate and hydro-carbonate ions by neutralized titration. Methods were based on standards.

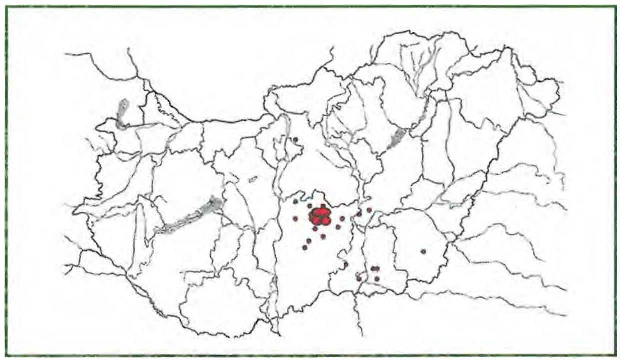

Figure 1: Situation of the sample points

RESULTS

PH values of investigated underground water samples were between 6,5-7,8, the average was 7,3, stand by a medium deviation with decreasing water depth. Conductivity, which refers to the salt content, shows high variability. Average conductivity value exceeded 1000 pS cm^{-1} in higher layers

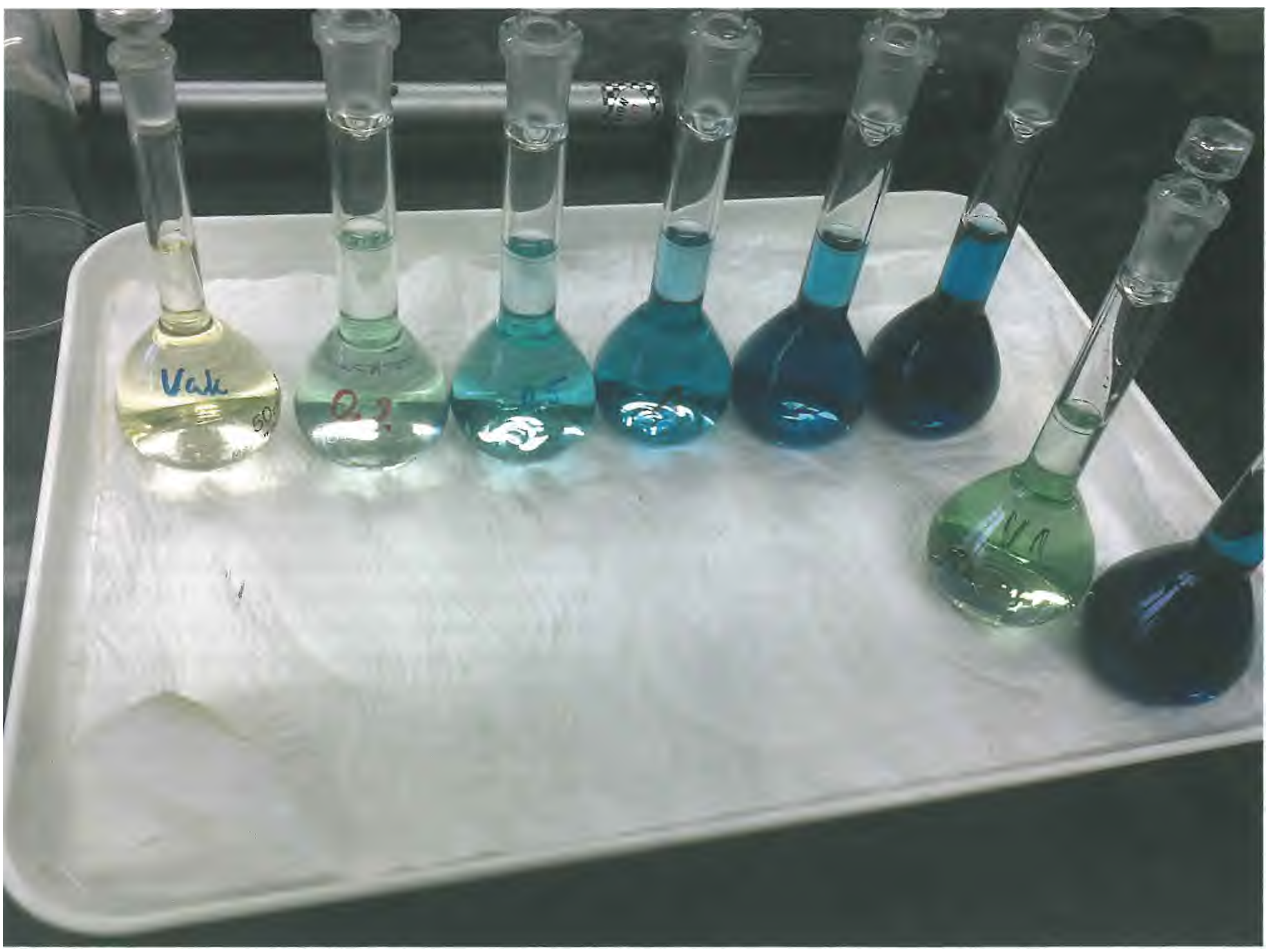

Figure 2: Some water samples for NH_4* analysis via photometric method

Table 1: Changes of pH and EC values by depth							
	10-30 m		31-70 m		71-275 m		limit value
	average	deviation	average	deviation	average	deviation	
pH	7,26	0,37	7,32	0,38	7,29	0,25	6,5-7,8
EC, NS cm-'	1020	763	975	833	682	267	1000

which is recommended in irrigation waters, while values in medium depth were close to this. Salt content of waters reduced and balanced in lower layers (Table 1.)

Most typical metal ions in the nature are Na, K, Ca and Mg. Chloride and hydro-carbonate ions are the most important among accompanying anions. On the basis of our results, potassium ion was in minimum quantity with low value, which hardly changed with depth (from 1,86 to 2,45 mg I^{-1}). Carbonate ion was not detected in either samples. We show changes of other samples with the depth on Fig. 3. Practically decreasing tendency of concentration was detected of all ions with the depth.

Average values of ions did not exceed the limit values for irrigation waters, in any cases of ions or depth. It is important, that in case of water samples from shallow depth, and especially of sodium and chloride ion concentration, deviation was large. 4 % of samples had very high (>400 mg I-' Nat >500 mg M CO concentrations in wells shallower than 42 m.

Different forms of nitrogen and phosphorus show antropogenic pollution principally. Most important ions of N and P can be seen on Fig. 4. Investigated water samples were not near the limit values for nitrate and phosphate (50 and 30 mg 11. It was not the case with ammonium ion, where values exceeded the limit value (0,5 mg I-') in many cases, in higher layers. But under 45 m it was not case occurred. Probable farmyard manure was the reason of the higher NH_4+pollution.

Iron, manganese and arsenic are the most important micro-pollutants. Concentration changes of these ions can be seen on Fig. 5.

Iron exceeds the limit value, which can be seen clearly. We can see very large deviation in case of every investigated pollutants. We detected the highest concentrations in middle depth.

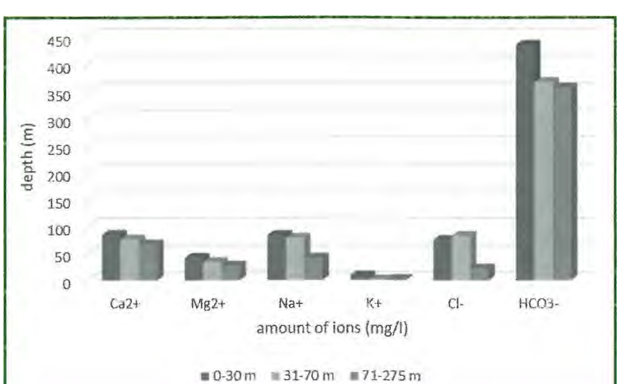

Figure 3: Changes of different ions with the depth

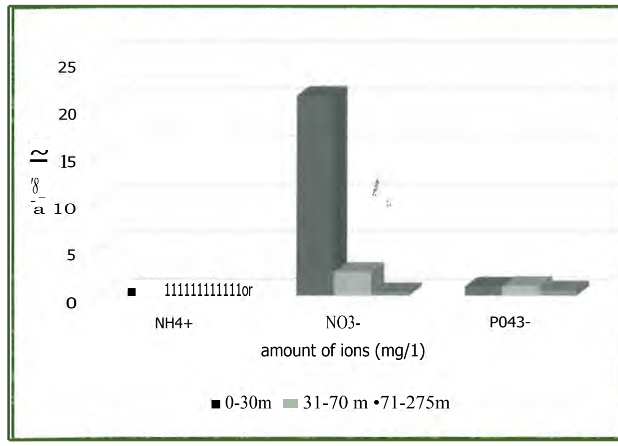

Figure 4: Changes of different ions with the depth

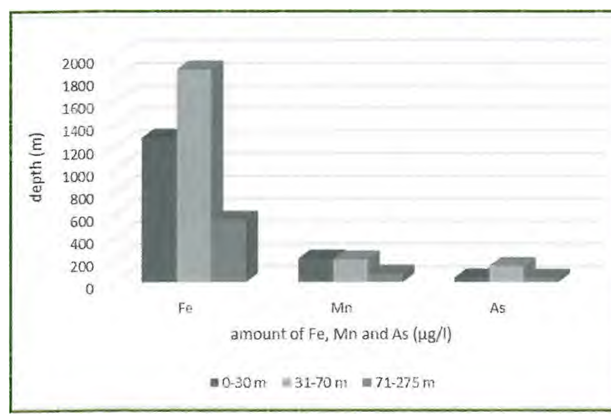

Figure 5: Concentration changes of iron, manganese and arsenic ions with the depth

DISCUSSION

Lower part of investigated irrigation water samples is groundwater from 10-30 m depth, majority is artesian water from deeper depth (31-70 and 71-275 m). On the base of our investigation we can concluded, that pH values of water samples were near neutral, average value was 7,3. Hydro-carbonate with its slightly alkaline effects affects the acid-base balance.

Water samples from deepest layers had the most stable composition both pH and ion content in respect. Salt content decreased going down, which is favourable influenced irrigation use of these waters (Terbe 1995; Cserni 1991). Reduction of salt content thanks to decrease of potassium- and chloride-ions in one hand, on the other hand primarily it thanks to decrease of hydro-carbonate ions.

It is a curiosity of groundwaters in Great Plain that different salts dissolved in the most diverse concentration. Salt content of these waters usually exceed 1000 mg M. Sodium - hydro-carbonate is the most frequent salt in our region, in other places sodium-sulphate and magnesium-sulphate waters also occur. Depth around 30 m means a transition between groundwater and artesian water, while depth between 250-300 m is a border of a geological formation. Elderly waters occur in artesian wells under 300 m with high content of dissolved materials and high chloride concentration which were not investigated (Liebe 2000; Borsné Pető et al. 2011). Waters in shallower depth are probably younger. These waters dissolved from the surface directly, or not too far from the place where we can find it nowadays. Composition of water samples is varied because of the water flows beneath the surface, moving up and down. Investigated waters are medium hardness, potassium content is expressly low, because of the minor clay content.

Water sources under the surface are compromised in many ways. High concentration of nitrate and chloride ions refers to pollution from the surface, but iron, manganese and ammonium concentration can rise in natural circumstances because of the dissolution from base rocks around the water sources. Presence of ammonium can refer to fresh pollution. Iron can be an original component of the water, or can appear as a secondary pollution in obtaining water, as a consequence of large free carbonated water's aggression (Nemes 2007). Iron and manganese content should be avoided under drip irrigation because of the risk of clogging. Higher content of iron and manganese in waters (1,5 mg M) is not a problem from plant nutrition perspective. We can expect increase of arsenic content in case of middle layer irrigation waters on the South Great Plain, based on our results.

CONCLUSIONS

Drought and inland water have similar frequency on the Great Plain, but drought affects much bigger area than inner water. Sand ridges between the Danube and Tisza rivers is the most sensitive to drought, moreover the middle and lower parts 1f Tisza region. This is the reason, why irrigation and quality control of waters are so important. Because of inland water sensitivity, application of facilities which are suitable both of irrigation and drainage is particularly justified in our region (Pálfai 1995).

Half part of obtaining waters originates from artesian waters in Hungary, quantity is 1,0-1,1 million m^3 per day (daily amount has halved from 1985 in the country- parallel with water price increase -, nowadays the quantity is stagnant)..

Artesian water levels permanently decreased due to obtaining artesian water. From 5-10 m decreasing in water level and decompression occurred from the 1970s, especially around larger waterworks (for example Kecskemét). Due to decrease of obtaining waters, some places have seen a rise in the artesian water level nowadays.

The situation is different in the groundwater, because groundwater level decreases on the sand ridges between the Danube and Tisza rivers since decades. Decreasing groundwater stocks decrease the water sources of irrigation. Particularly worrisome that we can find thousands of illegal groundwater wells on the sand ridges, through this usage of water sources is unchecked.

Nevertheless usage of subsurface waters for irrigation is important in the future, for example about their function as a potential nutrient sources. Their sensitivity against pollutions draw attention to the essential task of continuous quality parameters monitoring of subsurface waters both as drinking and irrigation water. Our investigation drew attention primarily possibilities of iron and arsenic pollution which can be harmful and disturbing in cultivation and irrigation.

REFERENCES

1. Borsné Pető J. - A. Hüvely - I. Cserni - J. Nagy 2001. A termálvíz összetételének jellemzése Kecskeméten, (12.) AGTEDU 2011. Magyar Tudomány Ünnepe, 169-174.
2. Cserni, I. 1991. A sókimosódás és szerepe öntözéses zöldség- és növénytermesztésben sós sivatagi homoktalajon, ZKI bulletinje, 17-32.
3. Kuti L. - T. Tóth -L. Pásztor - U. Fügedi 1999: Az agrogeológiai térképek adatainak és a szikesedés elterjedésének kapcsolata az Alföldön. Agrokémia és Talajtan, 3-4 (48): 501-516.
4. Liebe, P. 2000. Az Alföld felszín alatti vízkészlete. In: A víz szerepe és jelentősége az Alföldön. A Nagyalföld Alapítvány kötetei 6. 105-117.
5. Nemes, Zs. J. 2007. Öntözővizek minősége a hazai vízkultúrás zöldségtermesztésben, PhD értekezés, BCE, 1-179.
6. Pálfai, I. 2000. Az alföld belvízi veszélyeztetettsége és aszályérzékenysége. In: A víz szerepe és jelent cége az Alföldön. A Nagyalföld Alapítvány kötetei 6. 85-95.
7. Rakonczai, J. 2000. A környezet-átalakítás hidrogeográfiai összefüggései az Alföldön. In: A víz szerepe és jelentősége az Alföldön. A Nagyalföld Alapítvány kötetei 6. 26-36.
8. Terbe, I. 1995. A fajlagos elektromos vezetőképesség (EC) mérése a gyakorlatban. Hajtatás, korai termesztés. 26:4. 14-18.