THE QUALITY OF UNDERGROUND WATERS IN THE TIMIŞ-BEGA INTERFLUVE, DOWNSTREAM FROM TIMIŞOARA

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ABSTRACT
Although they observe a low percentage among the total water resources, underground waters represent an important water delivery source, for the population and various human activities. Because the water in the analyzed area is largely delivered by underground sources, their quality is especially important. For the qualitative evaluation of the underground waters, during summer 2012, 85 water samples from various sources were collected and analyzed in the field, and during autumn another 21 water samples were collected, which were then analyzed in the laboratory. The determination of some drink water quality evaluation parameters highlights the following aspects: most analysed samples had ammonium concentrations over the maximum admissible limit, a consequence of agricultural and animal breeding activities; approximately 50% of the collected samples observed dissolved oxygen under the established limit admissible for drinking water; the nitrate concentration exceeded the maximum admissible limit in over 50% of the samples collected from wells and decreased parallel to the depth increase; pH values agree with the active legal requirements, and the values obtained in the electric conductivity determination, are registered overall under the maximum admissible value, higher with the samples collected from wells. Thus, in the analyzed area, the underground water quality is „affected" by high ammonium concentrations and low dissolved oxygen values.

Keywords: pollution, wells, bore holes, quality

INTRODUCTION

Underground water is „that water quantity located under the earth surface in such areas where the hydrostatic pressure equals or exceeds the atmospheric pressure" (TEODORESCU, 2007). Although it observes a low percentage among total water resources, underground waters represent an important water delivery source (COPĂCEAN, BORZA, 2012). The interest for underground water manifested from early history periods, the drinking water wells being driven in ancient Egypt and China. Compared to surface waters, underground waters provide a few major advantages: a larger surface, and thus a beneficial geographic distribution, but also a superior quality, being protected by covering layers.
Within the studied perimeter, respectively the Timiş-Bega interfluve, downstream from Timişoara, underground waters can be found in layers located at various depth levels, determining a difference in quality. Because wells and bore holes represent the main source of drinking water, their quality is of utmost importance.

MATERIAL AND METHOD

At the level of the Timiş-Bega interfluve, downstream from Timisoara, in the year 2012 several underground water sample collection points were established, with the purpose of determining the qualitative state as well as quality „differences" on a vertical level.
In summer 2012 (in august) 85 water samples were collected, from bore holes (at various depth levels), 27 samples from wells (underground water) and 10 samples from the centralized water delivery network, which, in co-operation with the National Institute for Research-Development in Pedology, Agrochemistry and Environmental Protection,

Bucharest, were analyzed in the field, according to the active legislation. For the sample field analyses a *water quality evaluation probe, model 4A*, was used, equipment used for momentary determination, in situ, of water quality characterizing indicators, the following parameters applicable the present case: temperature, pH, specific conductivity, water dissolved oxygen quantity, ammonium ions and nitrate concentration in the water.
During autumn (in October) 21 samples were collected from wells and bore holes, and analyzed in the laboratory, in accordance with the specific methodology. From the indicators used for the evaluation of the drinking water quality, the present paper addresses only pH, dissolved oxygen, electric conductivity, nitrates and ammonium.
Analytical result interpretation was carried out by comparing the obtained values with the values established by Law no. 458/2002 regarding Drinking water quality, modified and completed by Law no. 311/2004.

RESULTS

The Timiş-Bega interfluve, downstream from Timişoara, overlaps the Timiş Plain, a subunit of the Banat Plain. The borders of the studied area are: the Bega and Timiş rivers, to the north-west and south-east, Sânmihaiu Român and Şag villages border, to the north-east and the Romanian border, to the south-west (*Figure 1*).

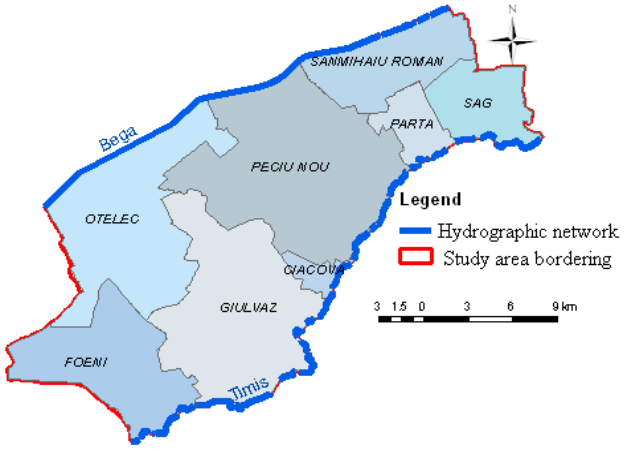

Figure 1. Study area bordering

In the past, the Timiş Plain, a subsidence plain, used to display, while in natural "state", divagations and extended swamps on large surfaces. Nowadays, after hydrotechnical and land improvements were carried out, one can observe old abandoned and bent streams, the entire surface being dominated by drainage channels (POSEA, 1997).
Within the studied area eight communal territories are totally or partially included (*Figure 1*), which indicates the "strongly" rural character of the area. Underground waters are used as sources for drinking water and various human activities in all rural settlements.
In the following we will present the results obtained from the field and lab determinations, for the qualitative characterization various drinking water sources.
During the summer season, 48 samples were analyzed in the field, determining the following parameters: pH, electric conductivity, dissolved oxygen, ammonium, nitrates.
From the viewpoint of the **(pH) reaction**, in the case of the 85 field analyzed water samples values were obtained ranging from 7.26-8.62 pH units, values slightly higher than in the centralized delivery networks samples (7.39-8.62). All samples were analyzed in accordance to the active legal quality requirements (≥6.5-≤9.5 pH units).
Electric conductivity values were differentiated as follows:

- with the 48 *bore hole* samples the values range between 358–2228 цS/cm^{-1}, with an average of 993, thus, the maximum admissible limit was not exceeded; the values differ on a vertical level: parallel to the depth level increase, their reduction is observed, the resoluble salts penetration being „restricted" by superjacentlayers
- in *well* samples values ranging between 518-4532 цS/cm^{-1} were obtained, with an average of 1933; the maximum admissible limit (2500 цS/cm^{-1}) exceeded by 9 of the 27 analyzed samples (Sânmartinu Maghiar, Ionel, Diniaş, etc)
- in the case of the *centralized delivery network* samples, values ranging from 526-3342 цS/cm^{-1} were obtained, with an average of 949,4; the maximum admissible limit exceeded only in one case, at Peciu Nou, the other samples observing values under 800 цS/cm^{-1}, which indicates a low resoluble salt level and thus an optimal qualitative state of the analyzed water.

Dissolved oxygen, in the 48 *bore hole* samples, displays values ranging between 2.41-10.48 mgO_2/l, with an average of 5.58; approximately 50% of the analyzed samples do not agree with the active legal requirements (*Figure 2*).

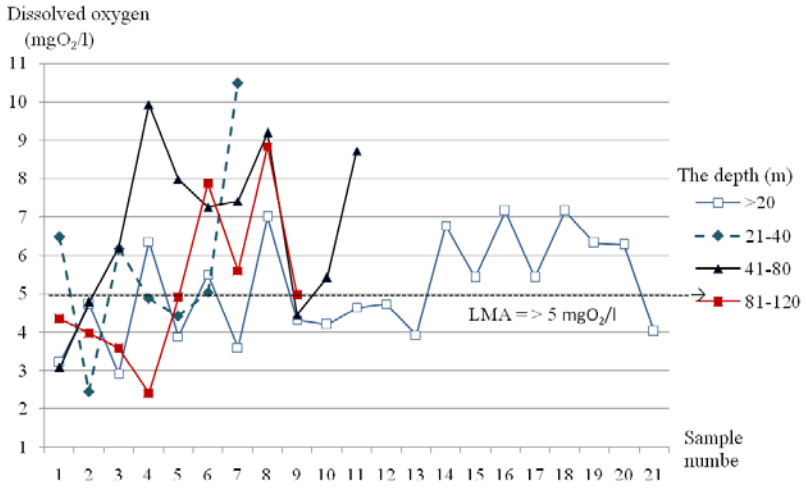

Figure 2. Dissolved oxygen value variation in bore holes water

In most cases, on a vertical level, the dissolved oxygen values increase parallel with the increase of depth levels (*Figure 2*), the penetration of oxygen consuming microorganisms being hindered by the covering layers "filter", however, there are situations when these layers also hinder oxygen penetration, so that, in some deep bore hole samples, the oxygen concentration is reduced. The lowest levels were measured in samples collected from Diniaş and the highest values were observed in Cruceni samples.

In the case of *well* samples, dissolved oxygen presents values ranging between 1.69-1.86 mgO_2/l, with an average of 5.72 mgO_2/l. Just like the previous case, 50% of the analysed samples display a dissolved oxygen concentration lower than 5 mgO_2/l, a fact that „restricts" the usage of these sources as drinking water. The highest values were registered Cruceni, and the lowest values in Şag, Diniaş samples.

On determining the dissolved oxygen in the case of *centralized delivery network* samples, the obtained values register between 2.97-10.45 mgO_2/l, and 50% of the analyzed samples observe a under 5 mgO_2/l concetration (Giulvăz, Peciu Nou, Cruceni).

The ammonium concentration of the 48 *bore hole* water samples present high values in all cases (*Figure 3*). The obtained values range between 0.57-13.27 mg/l, with an average of 1.98 mg/l. The highest ammonium concentrations were identified in samples collected from low depth bore holes (Peciu Nou, Sânmartinu Maghiar).

The ammonium concentration decreases on a vertical level, still the values are high.

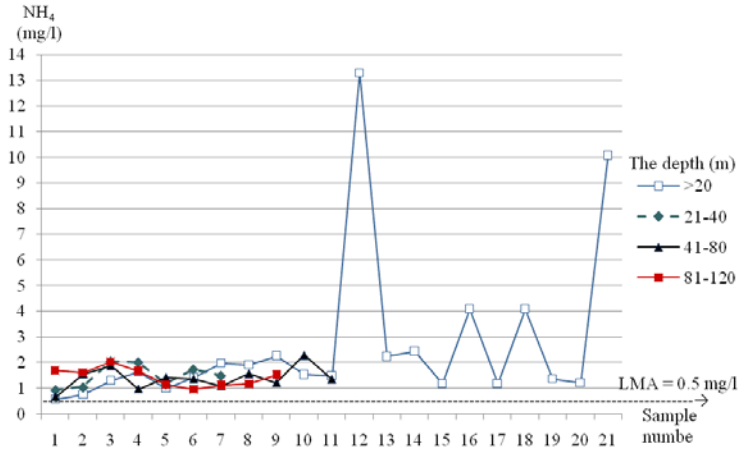

Figure 3. NH_4 value variation in bore hole water

The ammonium concentration determined by the 27 *well* samples observes values ranging between 0.38-12.26 mg/l, with an average of 4.48 mg/l. Of the 27 samples, 26 display higher ammonium values than the maximum admissible limit, as *Figure 4* shows.

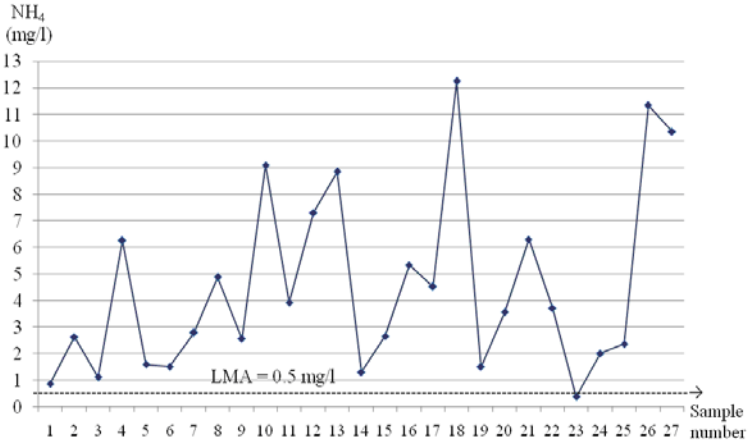

Figure 4. NH_4 value variation in well water

The highest values were signaled in Giulvăz, values which exceed sometimes 20 times the maximum admissible limit and the smallest value was registered, in Sâmnartinu Maghiar.
In *centralized delivery network* waters, the maximum admissible limit is exceeded in all cases, with values ranging between 1.06-2.99 mg/l and an average of 1.50 mg/l.
The highest ammonium concentration was obtained in Peciu Nou, and the lowest concentrations – which also exceed the maximum admissible limit - in Ionel and Foieni.
The **nitrate** concentration varies between broad limits, depending on the water source and, implicitly, on the depth level the water sample was collected, as follows:

- in *bore holes*, between 0.29-100 mg/l; the maximum admissible limit was exceeded in 4 samples, from low depth bore holes (Parţa, Peciu Nou), and under 20 m depth, the nitrate presence is highly diminished, under 10 mg/l
- in *well* samples a large variation interval is observed, between 0.73 and over 100 mg/l; the maximum admissible limit is exceeded in 14 out of 27 analyzed samples, of which 9 with concentrations over 100 mg/l (Diniaş, Rudna, Cruceni, etc)
- in *centralized delivery network* waters values vary between 0.32-2.28 mg/l, with an average of 0.91; the analyzed samples agreeing with the active legal requirements regarding drinking water quality.

During autumn season 21 water samples were collected from wells and bore holes, for

which the most important drinking water quality evaluation parameters were used.
We will only refer to pH, dissolved oxygen, electric conductivity, nitrates and ammonium.
Regarding the aspect of **reaction,** the obtained values range between 6.5-8.4, with the average of 7.12. The values decrease from the near surface towards the increasing depth layers. All analyzed samples are according to the active legal quality requirements.
With all analyzed samples **dissolved oxygen** present values under the minimum admissible limit, ranging from 1.0-4.7 mgO_2/l, with the average of 2.68 mgO_2/l. The lowest values were noticed in the case of well samples, where the penetration and activity of oxygen consuming microorganisms is more intense.
Electric conductivity values range between 414-4390 $\mu S/cm^{-1}$, with an average of 1476 $\mu S/cm^{-1}$. Of the 21 analysed samples, 3 samples (Cruceni, Diniaş and Ionel) hold values that exceed the maximum admissible limit 2500 $\mu S/cm^{-1}$, which makes the water undrinkable due to the high resoluble salt content.
The **nitrate** concentration in the analyzed samples ranges between 7.5-330.0 mg/l, with an average of 91.23 mg/l. The results show that 11 out of 21 analyzed samples do not agree with quality requirements established by this parameter (*Figure 5*).

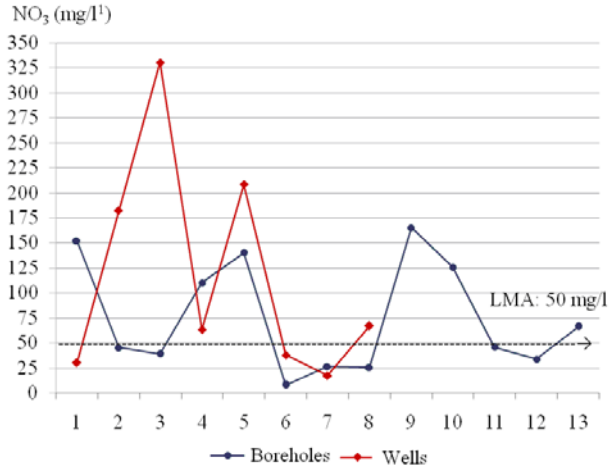

Figure 5. NO_3 value variations in bore holes and wells

The highest nitrate concentrations were identified in the well samples due to reduced depth
Ammonium concentration values range between 0.36-3.50 mg/l, with an average of 1.05 mg/l. With 16 out of 21 samples the maximum admissible limit is exceeded *(Figure 6*).

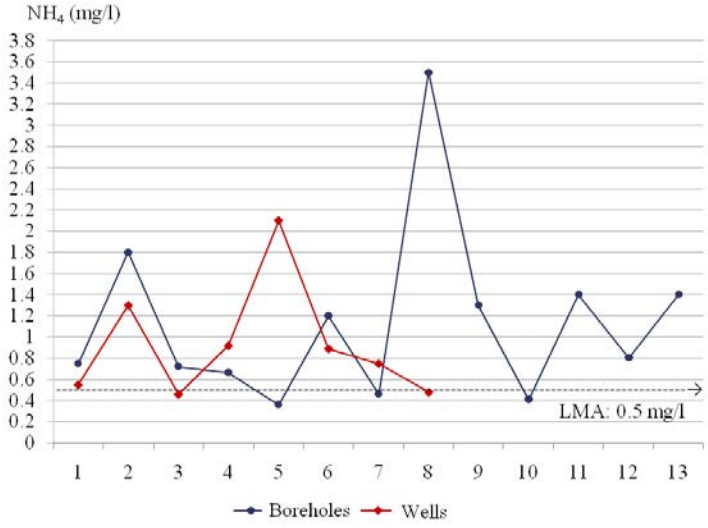

Figure 6. NH_4 value variations in bore holes and wells

Regarding the "vertical" concentration of the ammonium there are no obvious differences, values obtained at various depth levels being high in all cases (*figure 6*), largely due to agricultural and animal breeding activities carried out in the researched area, activities which can be considered large „generators" for these pollutants.

CONCLUSIONS

The quality of the underground waters from the analyzed area, defined with the help of indicators analyzed in the present paper, is „conditioned" by the presence of some pollutants, which sometimes hinder their use drinking water.
The values obtained during the pH analysis respect the active legal limits, and in the case of the electric conductivity some sample exceed these limits, especially well samples.
From the samples collected during the summer season (in August), the dissolved oxygen observes very low values (either due to high depth level of the water source, either due to oxygen consuming organism penetration) especially in bore holes, a fact that „restricts" the usage of the sources as drinking water.
The ammonium concentration is very high, the maximum admissible limit (0.50 mg/l) being exceeded in all cases from all collecting points (even by 20 times).
In the case of the analyzed samples, the nitrate concentration ranges between very extended limits, depending on the source and the depth level of the collecting layer. The highest values were registered in wells and the lowest in the centralized water delivery.
With samples collected during the autumn season, the dissolved oxygen is situated under the legal minimum limit established by the Law no. 458/2002 in all collecting points. Regarding the nitrate concentration**,** 11 out of 21 analyzed samples do not correspond with the quality requirements established by this parameter. Although the ammonium concentration is very high, 16 out of 21 analyzed samples exceeding the maximum admissible limit. The high ammonium and nitrate concentrations are largely due to agricultural and animal breeding activities in the researched areas.

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