A STUDY ON THE POSSIBILITIES OF USING GROUNDWATER IN RURAL COMMUNITIES IN SOUTH-WESTERN BANAT PLAIN

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Abstract: *This paper is of great ecological, social and economic interest. Water is a vital and vulnerable natural resource for life and society. Nevertheless, it is one of the worst managed resources, being used improperly, wasted and returned to nature in bad condition. As many negative events with pathogenic or toxic risk may occur, water supply monitoring in a human community through sample collection and analysis has become a necessary permanent measure. While completing a cycle that starts from its source and ends with its final use (in households, farms or industries), water can accumulate and carry human activity residues that alter its basic qualities. Monitoring groundwater quality in South-Western Banat Plain was based on two drillings, one in Gătaia and one in Belinţ. Water samples were collected in May and June 2009 and 2011. The main quality indicators were dissolved oxygen concentration, chemical oxygen consumption, nitrate and nitrite concentration, calcium, magnesium, iron, lead and manganese concentration. The analyses were performed at the Laboratory of Basin Water Administration, the Banat Branch. The low concentrations of oxygen dissolved in water indicate that water in both drillings belongs to the third class. As far as the chemical oxygen consumption at the Gătaia drilling is concerned, water belongs to the first class, while at Belinţ the water is second class. The nitrate concentration is much above the limit, reaching values that correspond to the fifth class. The nitrite concentration in both drillings places the water in the fourth class. The calcium level is higher at Gătaia, where water is very hard. The magnesium level indicates that only the water at the Belinţ drilling belongs to the second class, while the iron concentration places both drillings in the second class. The lead level is above limit only at Gătaia, and the manganese level places water in the third class. These results reveal that in both drillings, water quality is low and not suitable for supply, especially because of the nitrate and nitrite concentrations. The very hard water at the Gătaia drilling requires special attention when used for irrigation purposes.*

Key words: *groundwater quality, water supply, irrigation*

INTRODUCTION

Water is an indispensable natural source of life. It is renewable, but at the same time vulnerable and limited by natural and anthropic pollution sources. To answer the consumption needs required by population and socio-economic activities, one relies exclusively on fresh water. Of the total water volume on Earth, fresh water is only 2.5% (about 35 million km^3) and of this 2.5%, only 1% is available for the population; the rest is under the form of glaciers or found at deep-sea levels (PIŞOTA ET AL., 2002; ZĂVOIANU, 2002).

Under the circumstances, water as a natural resource is more valuable than ever in our history, as it is used extensively in agriculture and industry. Much attention is paid to the judicious use of water for the next generations (GĂMĂNECI, 2010). Nevertheless, water is still one of the worst managed resources, it is used improperly, wasted and returned to nature in bad condition.

At present, mankind is facing serious problems in providing drinking water, especially in relation to its use for various economic purposes. Water shortage affects both highly industrialised countries and less developed countries with an arid climate, where lack of water limits agricultural production.

The cycle of water from source to use (in households, agriculture and industry) can include and carry residues resulting from human activity that changes the fundamental qualities of water. Monitoring water supply in a human community through the collection and analysis of water samples has become a permanent measure, as many negative events with pathogenic or toxic potential may occur (STRUCKMEIER ET AL., 2005).

Water used for socio-economic needs is subjected to international legislation and is a factor for man and human communities. Compliance with the norms concerning water warrants safe water supply both for household consumption and irrigation (HOGAN, 2009).

MATERIAL AND METHODS

Monitoring groundwater quality in South-Western Banat Plain was based on two drillings, one in Gătaia and one in Belinţ (figure 1).

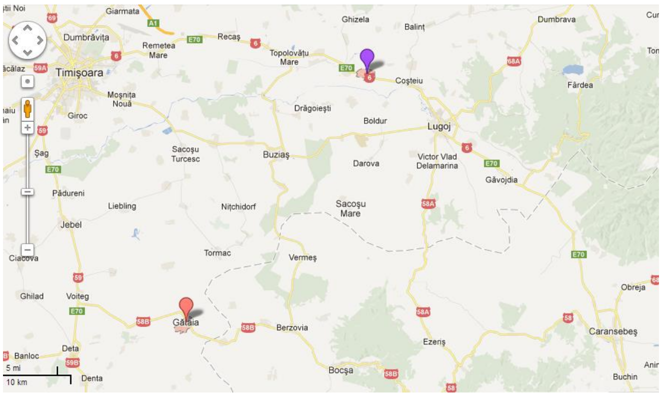

Figure 1. Location of Gătaia and Belinţ

Water samples were collected in May and June 2009 and 2011. The main quality indicators were dissolved oxygen concentration, chemical oxygen consumption, nitrate and nitrite concentration, calcium, magnesium, iron, lead and manganese concentration. The analyses were performed at the Laboratory of Basin Water Administration, the Banat Branch.

The results were interpreted and compared to the physical and chemical quality standards (Table 1) given in the Official Journal of Romania that establish five classes of water quality (I-V).

Table 1

Physical and chemical water quality standards
(OFFICIAL JOURNAL OF ROMANIA, PART I, NO 511/JUNE 13TH, 2006)

No	Quality indicator	Unit of measure	Quality Class				
			I	II	III	IV	V
C.1. Thermal regime and acidification							
1.	pH		6.5 -8.5				
C.2. Oxygen							
1.	Dissolved oxygen	mg/l	9	7	5	4	< 4
2.	CCOCr	mg/l	10	25	50	125	> 125
C.3. Nutrients							
1.	Ammonium (NH_4^+)	mg/l	0.4	0.8	1.2	3.2	> 3.2
2.	Nitrite (NO_2)	mg/l	0.01	0.03	0.06	0.3	> 0.3
3.	Nitrate (NO_3)	mg/l	1	3	5.6	11.2	>11.2

C.4. Salinity							
1.	Filterable residue dried at 105^{o}C	mg/l	500	750	1000	1300	> 1300
2.	Chlorides (Cl^-)	mg/l	25	50	250	300	> 300
3.	Sulphates (SO_4^{2+})	mg/l	60	120	250	300	> 300
4.	Calcium (Ca_2^+)	mg/l	50	100	200	300	> 300
5.	Magnesium (Mg^{2+})	mg/l	12	50	100	200	> 200
6.	Sodium (Na^+)	mg/l	25	50	100	200	> 200
C.5. Specific natural toxic pollutants							
1.	Copper (C^{2+})[5]	µg/l	20	30	50	100	> 100
2.	Lead (Pb)[6]	µg/l	5	10	25	50	> 50
3.	Cadmium (Cd)	µg/l	0.5	1	2	5	> 5
4.	Iron (Fe^{2+}, Fe^{3+})	mg/l	0.3	0.5	1.0	2	> 2
5.	Manganese (Mn^{2+}, Mn^{7+})	mg/l	0.05	0.1	0.3	1	> 1
C.6. Other relevant chemical indicators							
1.	Total phenolic content (phenolic index)	µg/l	1	5	20	50	> 20

RESULTS AND DISCUSSIONS

The laboratory tests results indicated that the water at the Gătaia drilling had a slightly basic pH in the three years of study. The low oxygen concentration (5.5-5.6; the lowest level was recorded in 2011) shows that water is in the third class. The chemical oxygen consumption (13.6-19.2) exceeds the limit admitted for class I quality (figure 2).

As far as the nutrients are concerned (figure 3), the nitrate concentration was very high in all the three years. The highest nitrate value, 14.7%, was recorded in 2009, indicating five-class quality water. The nitrite concentration values which varied between 0.11-0.14 mg/l and 0.22 mg/l in 2010, placed water in the fifth class. Ammonium concentration placed water in the second class in all the three years.

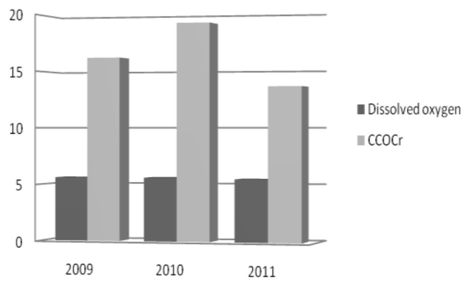

Figure 2. Oxygen regime at the Gătaia drilling

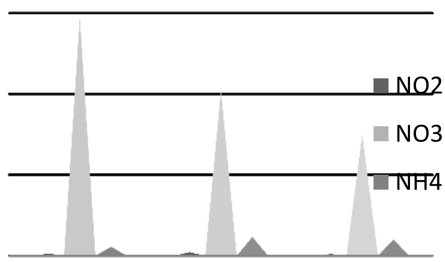

Figure 3. Nutrients regime at the Gătaia drilling

The chloride content limit was not exceeded. Calcium concentration showed a slight increase in the three years, from 65 to 75.6 mg/l, which corresponds to the first and second quality class. The magnesium level varied between 31.3 and 45 mg/l.

The iron concentrations placed water in the first quality class. They were higher in 2009 (0.36 mg/l) and lower in 2010 (0.18 mg/l). The manganese content was high in all three years (0.11-0.25), placing water in the third class. In 2010, the 6.75 µg/l lead levels exceeded the first class, but in 2000 and 2011 they stayed within the limits, so water was of better quality.

At the Belinţ drilling, the dissolved oxygen concentration was low – only 4.9 mg/l – in 2009 (third class), but increased to 7.2 in 2011 (second class). The chemical oxygen consumption indicated first class quality water in 2009 and 2011, but lower quality water in 2010, when its value was 22.4 mg/l (figure 4).

As shown in figure 5, the nutrient content indicates higher levels of nitrites in water, from 0.08 mg/l in 2010 to maximum 0.16 mg/l in 2009, placing water in the fourth class. The high nitrate concentration (12.4 mg/l in 2010) indicates polluted water of the fourth class. However, according to the ammonium levels, water belongs to the first class.

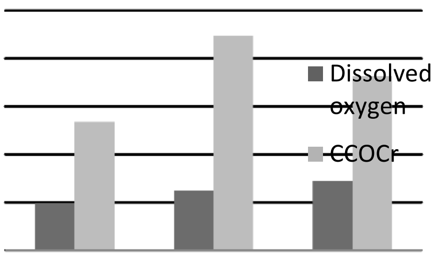

Figure 4. Oxygen regime at the Belinț drilling

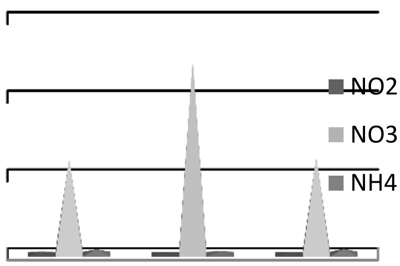

Figure 5. Nutrients regime at the Belinț drilling

Chloride concentration was within the normal range. Calcium levels were within limits as well, and the magnesium level was slightly higher in 2009 (58 mg/l).

The iron level was low in 2010 and 2011. In 2009, it reached 0.42 mg/l, a value corresponding to the second quality class. Manganese concentration was high, between 0.21 and 0.38 mg/l, so for 2009 and 2010 water was placed in the fourth class.

The copper and cadmium concentrations were low, but the lead level was slightly higher (5.5 µg/l).

The comparative analysis of the water at Gătaia and Belinţ indicates that the dissolved oxygen concentration was higher at Belinţ, where water was placed in the third class (figure 6). The lowest values were recorded at both drillings in 2009.

The highest (2010) and lowest (2009) chemical oxygen consumption values were both recorded at Belinţ, in 2009 (figure 7). If the Gătaia drilling water was placed in the second quality class in all three years, at Belinţ it belonged to other classes than the first only in 2010. The oxygen regime showed that the water at Belinţ was better than the water at Gătaia.

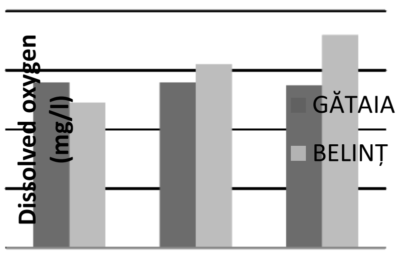

Figure 6. Evolution of dissolved oxygen concentration

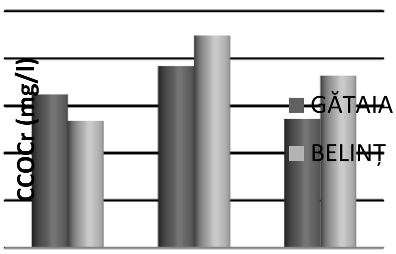

Figure 7. Evolution of chemical oxygen consumption

The nutrient regime indicated that the water at Gătaia had the highest nitrate concentration, which was exceeded at Belinţ only in 2010 (figure 8). This places water in the fourth and fifth quality classes. According to figure 9, nitrite levels were high at both drillings (fourth class); they reached the maximum value of 0.22 mg/l at Gătaia, in 2010, and the minimum value at Belinţ, in 2010.

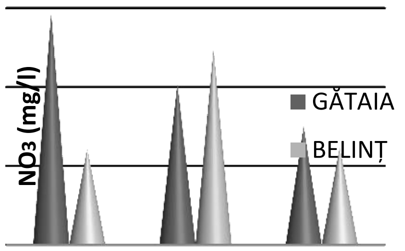

Figure 8. Evolution of nitrate concentration

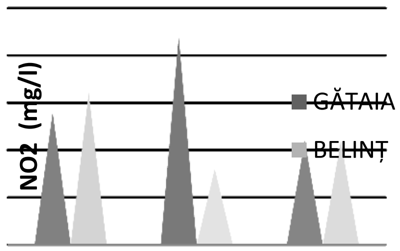

Figure 9. Evolution of nitrite concentration

The comparative analysis of the two drillings revealed that the highest calcium concentration was recorded at Gătaia (figure 10), while the lowest was recorded at Belinţ (30 mg/l) in 2011. These calcium levels place water in the first and second quality classes. Figure 11 indicates that the magnesium level was the highest at Belinţ, in 2009, where the best value was reached in 2011 (26.2 mg/l). Magnesium concentrations were within limits at Gătaia in all three year. At Belinţ, they exceeded the limits in 2009.

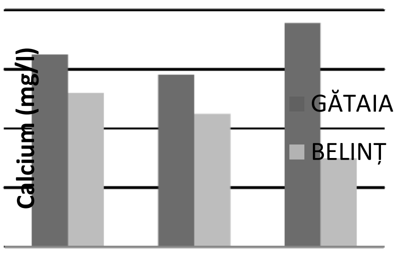

Figure 10. Evolution of calcium content

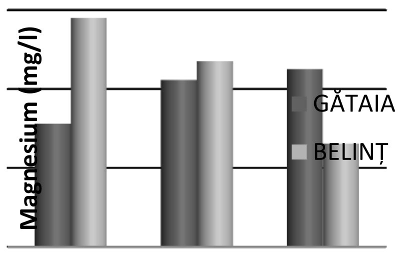

Figure 11. Evolution of magnesium content

Figure 12 shows that the iron content at Belinţ is high; the highest values were recorded in both drillings in 2009 (second class). However, judging from the iron levels, water is of good quality.

The lead level was higher than the first class limit only at Gătaia, in 2010 (figure 13). The other values were small in both drillings.

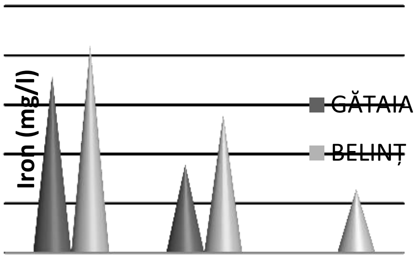

Figure 12. Evolution of iron content

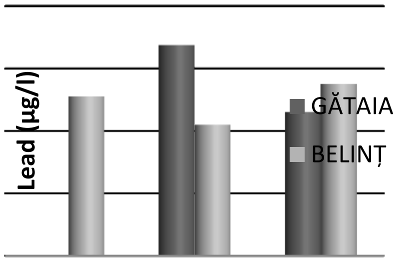

Figure 13. Evolution of lead content

Figure 14 shows that the water at Belinţ contains too much manganese (fourth class), while the manganese level at Gătaia belongs to the third class.

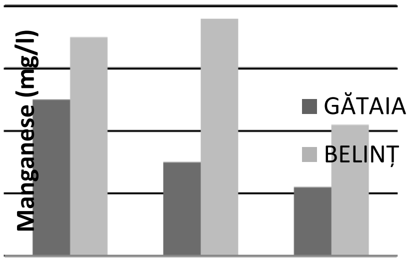

Figure 14. Evolution of manganese content

The nutrient content reveals that water is polluted both at Gătaia and Belinţ. Pollution occurs due to the evacuation in water of manure resulting from livestock breeding activities and the excessive use of chemical and ecologic fertilizers that may reach the groundwater through percolation if stored improperly. In addition, there are no sewerage systems and water purification stations in the adjacent villages. Due to the high nitrite and nitrate concentrations and their toxic effects on organisms, water is unusable for supply purposes.

Special attention must be paid when using water from the Gătaia drilling for irrigation, as it is very hard and may affect the functioning of the irrigation equipment.

CONCLUSIONS

The following conclusions were drawn following the analysis of water collected from the Gătaia and Belinţ drillings:

1. The dissolved oxygen concentration was higher at Belinţ (second class) than at Gătaia, where water was third class;
2. At Gătaia, the chemical oxygen consumption placed water in the first class, while the water at Belinţ was only second class in 2010;
3. The nitrate concentration was much above the limit, reaching values that corresponded to the fifth class, while the nitrite values placed water in both drilling in the fourth class;

4. The calcium level was higher at Gătaia, where water was very hard; the magnesium level indicated that only the water at the Belinţ drilling belonged to the second class;
5. The lead level was above the first class limit only at Gătaia in 2010, the other values in both drillings being rather small;
6. The iron content was within the limits, which indicated a superior water class, except 2009, when it was included in the second class;
7. Manganese values were high both at Belinţ (forth class) and Gătaia (third class);
8. In both drillings, water quality was low and unsuitable for supply, especially because of the nitrate and nitrite concentrations. The very hard water at the Gătaia drilling requires special attention when used for irrigation purposes.

BIBLIOGRAPHY

1. GĂMĂNECI GH., 2010 – Apă curată pentru o lume sănătoasă, Ziarul Vertical
2. HOGAN M. C., 2009 – Groundwater, The Encyclopedia of Earth, www.eoearth.org
3. PIȘOTA I., ZAHARIA LILIANA, 2002 – Hidrologie, Ed. Universității din București, pg. 50-52
4. STRUCKMEIER W., RUBIN Y., JONES J.A.A., 2005 – Groundwater, reservoir for a thirsty planet, Earth Sciences for Society Foundation, Leiden, Olanda
5. ZĂVOIANU I., 2002 – Hidrologie, Ed. Fundației România de Mâine, București, pg. 21-24
6. *** Official Journal of Romania, Part I, No 511/June 13th, 2006