STUDY CONCERNING WATER QUALITY IN THE BISTRITA HILL AREA, BISTRITA-NASAUD COUNTY, ROMANIA

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Abstract: *Ground waters are currently the main source of drinking water. Their usage is extended given that most people in the rural area use it for food and agriculture. The reason why ground water is used more frequently than surface water is that it is less polluted than the latter, and with lower costs. Unfortunately, the irrational use of chemical fertilisers also degraded ground water quality. As ground water circuit is more restricted, human activities can affect them for longer periods. This means that pollution occurred tens of years ago – be it from agriculture, industry, or other human activities – can still threaten water quality nowadays and it will keep doing it for generations and generations. The heritage of the past is obvious in the sites largely contaminated. In many countries, they appeal to ground waters, but this should be done with great caution. First, the regeneration period of these waters increases with their depth. Aquifers need to be drastically protected from pollution if we wish to avoid turning them into useless water sources. This paper aims at establishing the quality of ground waters in the Bistrita hill area (Bistrita-Nasaud County, Romania) as a source of drinking water. To do so, we sampled water from the wells used for drinking water in the following localities: Bistrița, Budacu de Jos, Josenii Bârgăului, Sângeorz-Băi, Zagra, and Caianu Mare. Water was sampled in 2012 and 2013, and analyses aimed at determining oxygen content, pH, nitrite content, nitrate content, ammonia, chlorine, Water hardness, turbidity, and bacterial load. Research results established the quality of the ground water in the area and water usages.*

Key words: *ground water quality, oxygen content, pH, nitrate, nitrite, ammonia, chlorine, turbidity, bacterial load*

INTRODUCTION

Until recently, the attention paid to ground waters concerned mainly its use as drinking water (for instance, about 75% of the European Union inhabitants depend on ground waters for their supply of drinking water); yet, they have acknowledged that ground waters also are an important source for water for the industry (cooling water) and agriculture (irrigations). However, it is more and more obvious that ground waters should be seen not only as a water supply reservoir, but as an environmental asset that needs to be protected. Ground waters play a main role in the hydrologic cycle and are vital for the maintenance of moist areas and for the water courses, acting as a buffer reservoir during periods of drought (ZĂVOIANU, PIȘOTA). In other words, they supply the water necessary to maintain water courses all over the year for surface water systems, of which many are sued as water supply and recreation sources. In many rivers of Europe, more than 50% of the annual water flow comes from ground sources. During low water level periods, this figure can reach more than 90%; thus, ground water quality can affect directly surface waters and land ecosystems they are related to. Since ground waters travel slowly in the underground, the impact of human activities can have a negative effect in the long run. This means that pollution produced tens of years ago – be it in agriculture, industry, or other human activity – can still be a hazard for water quality nowadays; in certain cases, it will still be for generations to come.

Ground waters are "hidden resources" that are quantitatively more important than surface waters and for which pollution prevention, monitoring, and rehabilitation are much more difficult than in surface waters given their inaccessibility (HOGAN). This hidden feature makes difficult both identification and proper characterisation of the pollution, and the understanding of the impact of pollution, which often causes lack of awareness and/or understanding of the true dimensions of risks and pressure (STRUCKMEIER). Yet, recent reports show that pollution from domestic, agricultural and industrial sources is still, despite the progress in different fields, a true reason for concern because of the direct discharge into the water courses, because of indirect discharge through nitrogen fertilisers and pesticides, as well as through leakage from old contaminated industrial sites or from waste storages (e.g., dumping sites for domestic and industrial wastes, mines, etc.). Though pollution sources have caused most of the pollution identified so far, there are data showing that diffuse pollution sources have an increasing impact on ground waters. For instance, nitrate concentrations are currently above maximum admitted limits in almost one third of the ground water bodies in Europe.

In Romania, ground waters are an important source of drinking water. Most of the population use ground waters in agriculture and industry. Unfortunately, many of our wells are already polluted by nitrates and other chemicals from industry and agriculture.

Under these conditions, it is necessary to know the quality of ground waters, particularly in the areas where water is used domestically without being treated previously.

MATERIAL AND METHODS

The present paper aims at establishing the quality of ground waters in the Bistrita hill area to be sued as sources of drinking water. Monitoring ground water quality was done during the period 2012-2013. To do so, we established the following sampling points:

1. Municipium of Bistrita
2. Budacu de Jos
3. Josenii Bargaului
4. Sângeorz Băi
5. Zagra
6. Caianu Mare

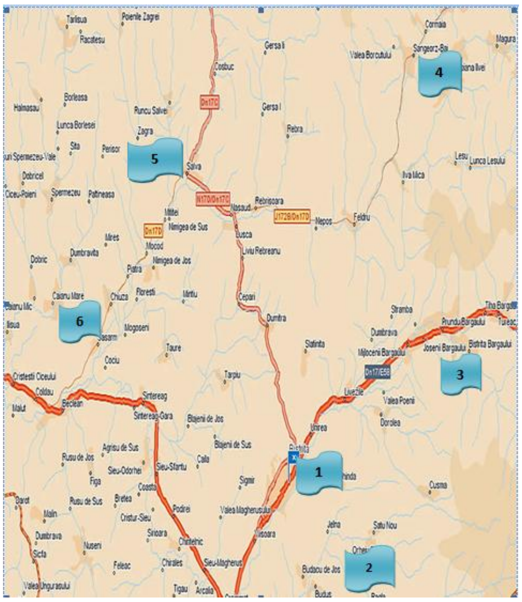

Figure 1. Location of water sampling points

Sampling water is a very important step in the physical and chemical analysis of the water because water samples need to be representative and not affected by improper sampling techniques. Sampling was done according to the Romanian standard SR 2582-94.

Water sampling points consisted in private and public wells in the localities mentioned above, except for Bistrita and Budacu de Jos, where water was sampled from the springs.

When sampling from the wells, water sampling was done 10-30 cm below water surface.

Water analysis was done at the Bistrita Public Health Office and the results were processed and compared with the water quality standards stipulated by Order no. 161 from 2006.

The main parameters monitored and the analysis methods are presented in Table 1 below.

Table 1.

Quality indices analysed and specific analysis methods

Quality indices	Measure unit	Quality class					Maximum admitted values	Analysis referential
		I	II	III	IV	V		
pH	pH units	6,5-8,5					≥6.5; ≤9.5	SR EN ISO 10523/2012
Nitrates	mg/l	1	3	5.6	11.2	> 11.2	50	SR ISO 7890-3/2000
Water hardness	German degrees	≥ 5					≥ 5	SR ISO 6059/2008
Water oxidability	mgO_2/l	9	7	5	4	< 4	5	SR EN ISO 8467/2001
Total coliform bacteria	UFC/100 ml	0					0	SR EN ISO 9308-1/2004

RESULTS AND DISCUSSION

In *Bistrița*, we sampled water from two springs: Izvorul Poligonului and Izvorul Valea Budacului in May 2012 and May 2013. Laboratory analyses show that in Izvorului Poligonului water pH was 7.03 in 2012 and 7.05 in 2013, which means water is slightly basic (figure 1). Nitrate content was, in 2012, 11.56 mg/l, which ranks water in the 5th quality class, and, in 2013, about 6.96 mg/l, ranking it 4th quality class (figure 2). Water hardness was high: 28.21 German degrees in 2012 and 22.44 German degrees in 2013 (figure 3). Water oxidability (figure 4) was 1.8 in 2012 and slightly higher (2.08) in 2013. As for the bacteriological analysis, we could see the presence of total coliform bacteria in both 2012 (56) and 2013 (26). In Izvorul Budacului, water pH was 6.85 in 2012 and 6.92 in 2013, respectively, i.e. slightly acid. If, in 2012, nitrate amount was very high (33.46 mg/l), in 2013 it ranked 5th reaching 24.39 mg/l. Water hardness was high: 19.27 German degrees in 2012 and slightly lower (14.58 German degrees) in 2013. Water oxidability was 1.96 in 2012 and 2.16 in 2013. The number of coliform bacteria was 9 in 2012 and 8 in 2013, respectively.

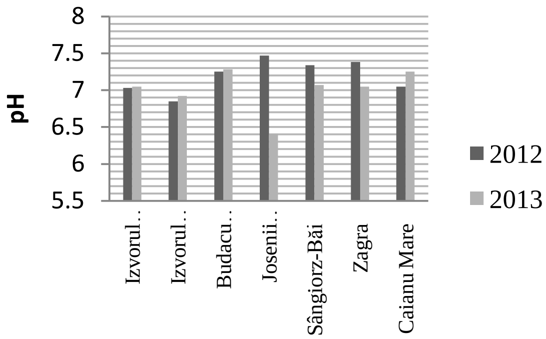

Figure 1. Evolution of pH

In *Budacu de Jos*, water was sampled from a non-collected spring in May 2012 and May 2013. Water pH was slightly basic: 7.25 in 2012 and 7.28 in 2013. Nitrate content was 1.62 mg/l in 2012 and 2.29 mg/l, which ranked water 2nd in quality class. Water hardness was high: 24 German degrees in 2012 and 23.56 German degrees in 2013. Water oxidability was 2.96 in 2012 and 2.16 in 2013. Bacteriological analysis pointed out a total number of coliform bacteria of 72 in 2013 alone.

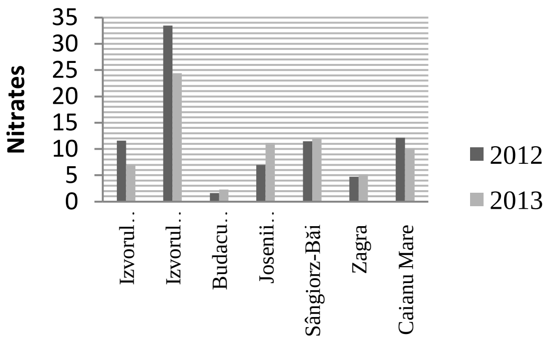

Figure 2. Evolution of nitrates content

In *Josenii Bârgăului*, water was sampled from the public well in August 2012 and August 2013. Water pH oscillated between 7.47 in 2012 and 6.41 in 2013. Nitrate content reached 7.00 mg/l in 2013 and 11.14 mg/l in 2013, which ranked water 4th in quality. Water hardness was 20.3 German degrees in 2012 and 22.4 German degrees in 2013. The highest water oxidability was in this locality, i.e. 4.98 in 2012 and 4.76 in 2013. Bacteriological analysis pointed out the absence of coliform bacteria in the two study years.

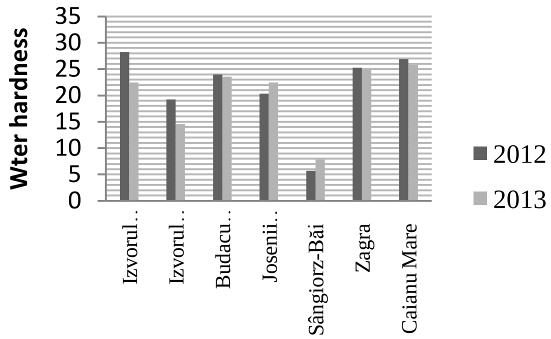

Figure 3. Evolution of water hardness

To characterise the water in *Sângeorz Băi*, we sampled water from the public well in July 2012 and 2013. Water pH was 7.34 in 2012 and 7.07 in 2013. Nitrate content was 11.45 in 2012 and 12.14 in 2013, ranking water 5th in quality. Water hardness was much lower compared to the other localities in the study: only 5.72 German degrees in 2012 and 7.85 German degrees in 2013. In 2012, Water oxidability reached 1.96, and in 2013 it was slightly increased (2.36). If, in 2012, there were no total coliform bacteria, in 2013 we found 8 coliform bacteria in the water sample.

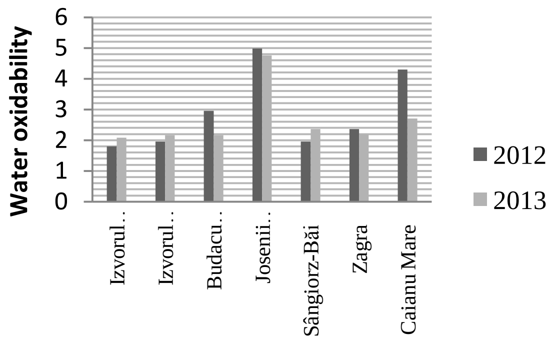

Figure 4. Evolution of water oxidability

In *Zagra*, water was sampled from the public well in September 2012 and September 2013. The water pH was slightly basic: 7.38 in 2012 and 7.05 in 2013. Nitrate content was 4.73 mg/l in 2012 and 5.21 mg/l in 2013, ranking it 3rd class quality. Water hardness was high: 25.24 German degrees in 2012 and 25.00 German degrees in 2013. Water oxidability reached 2.36 in 2012 and 2.20 in 2013, i.e. below maximum admitted limits. Bacteriological analysis pointed out the absence of coliform bacteria in the two study years.

In *Caianu Mare*, water was sampled from a private well in May 2012 and 2013. Water pH was slightly basic: 7.05 in 2012 and 7.25 in 2013. Nitrate content was 12.10 mg/l in 2012 ranking the water 5th quality class, and 10.10 mg/l in 2013, ranking water 4th quality class. Water hardness was 26.90 German degrees in 2012 and 25.80 German degrees in 2013. Water oxidability reached 4.30 in 2012 and was lower in 2013 (2.70). Bacteriological analysis pointed out total coliform bacteria: 99 in 2013 and 140 in 2013.

CONCLUSIONS

Water analyses made in the six localities mentioned above shows the following:

1. In Bistrița, water pH ranged within normal limits in both springs; nitrate content ranked water quality 5th, except for 2013, when water quality in Izvorul Poligonului ranked 4th; total coliform bacteria reached low values in both springs;
2. In Budacu de Jos, water pH was slightly basic; nitrate content ranked water 2nd quality class; water hardness was high; and total coliform bacteria number was high in 2013;
3. Water pH in the public well of Josenii Bârgăului was normal; nitrate content was high, ranking water 4th quality class; water hardness was about 20 German degrees; and bacteriological analysis pointed out the absence of coliform bacteria in the two study years;
4. In Sângeorz Băi, water pH in the public well was slightly basic; nitrate content ranked water 5th quality class; water hardness was the lowest of all locations under study; total coliform bacteria number was low only in 2013;
5. Water Ph in the public well of Zagra was slightly basic; nitrate content ranked water quality 3rd class; water hardness was about 25; and bacteriological analysis pointed out the absence of total coliform bacteria in the two study years;
6. In *Caianu Mare*, water samples were taken from a private well; water pH was slightly basic; nitrate content was high, ranking water 5th quality class in 2012 and 4th quality class in 2013; water hardness reached 26.9 German degrees; and bacteriological analysis pointed out a large number of total coliform bacteria.

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