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EVALUATION OF GROUNDWATER QUALITY. CASE STUDY: SEINI CITY, MARAMUREȘ COUNTY, ROMANIA

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ABSTRACT. In the present study, in was investigated the groundwater quality from several private wells located in Seini city, Maramureș County (northwestern part of Romania). The investigated quality parameters were pH, redox potential, electrical conductivity, total dissolved solids, salinity, dissolved ions and heavy metals. The analysis showed that some of the investigated wells had a high content of nitrate, ammonium, and heavy metals. The continuous consumption of water from these sources can be a real threat for consumers' health. The inhabitants should limit as much as possible the usage of water from these wells for drinking purposes and they should use the water from the local distribution network.

Key words: *ground water quality, drinking water, chemical quality parameters*

INTRODUCTION

Water pollution is, by a general definition, a direct or indirect change in its normal composition because of human activity, in such extent that it is affecting all other possibilities to use the water in its natural state. Water pollution involves the biological, physical, and chemical pollution and ultimately leads to changes in the ecological balance.

Generally, groundwater is considered to have a higher quality than surface water. During the time when it passes through the soil and rocks, they can act as a filter for both chemical and bacteriological contaminants (Baldwin and McGuinnes, 1963). Nevertheless, contamination can occur, and there are cases when the consumption of groundwater's can be associated with human health risk. Over the last decade increasing attention has been paid to the population's access to water of adequate sanitation. As it is mentioned in the Resolution no. 64/292 of the UN General Assembly, "the right to safe and clean drinking water and sanitation is a human right essential for a normal life and the exercise of all human rights" (Neamțu et al., 2017).

The present paper presents the study regarding the groundwater assessment in the city of Seini, Maramureș County. The water samples used in the study were taken from ten different private wells from the city.

STUDY AREA

The territory of Seini is located in the western part of Maramureș County, at a distance of 26 km from Baia Mare and 41 km from Satu Mare (Seini, 2021) (figure 1). Predominantly on the territory of the city are the luvosols and eutricambosols, which occupy more than half of the territory (Hotima et al., 2018). The climatic regime of Seini city is characteristic of Maramureş county, framed in the continental-temperate climate sector, with cold winters and long and hot summers. The proximity of the mountainous area gives a moderate thermal regime, with relatively high humidity and rich atmospheric precipitation. Air temperatures record annual values between -1°C and +9°C. The annual amount of precipitation is between 700 and 1.400 mm (Hotima et al., 2017).

The inhabitants use the water from their private wells, which are generally shallow wells, having 6 to 8 m in depth and the water from the network system, which undergoes a chlorination treatment (ANPM, 2021).

In figure 2 it is presented the sampling network used to evaluate the groundwater in the city of Seini, Maramureș County. The main objective of this study is to assess the quality of groundwater in ten private wells, located in the city of Seini (Maramureș County). The monitoring and evaluation of the well water quality were performed by analyzing certain chemical quality parameters regulated in the national legislation (Law no. 458 from July 8, 2002). The water samples were collected on October 18-19, 2020.

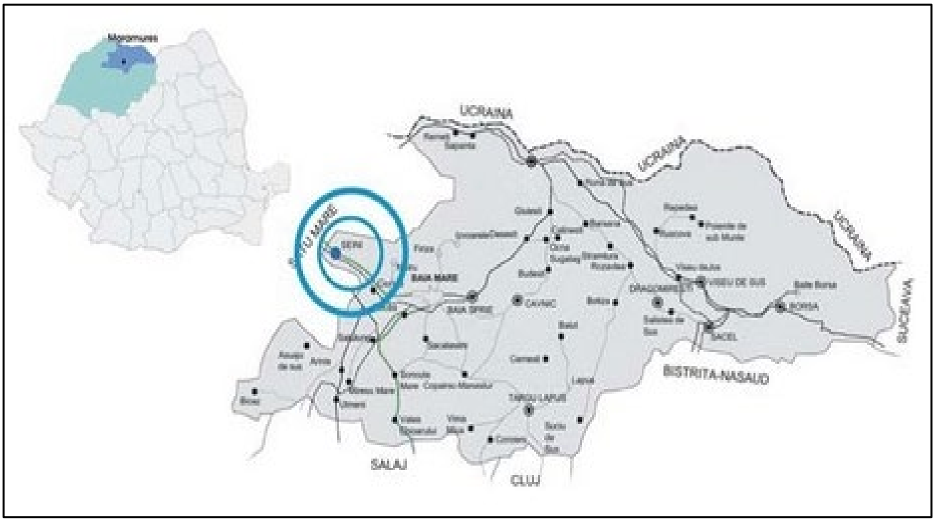

Fig. 1. *Geographical location of the city of Seini (Seini, 2021)*

Fig. 2. *Study area (Seini City, Maramureș County) with sampling points location*

MATERIALS AND METHODS

Water samples were taken from the wells of 10 families at considerable distances from each other (from all parts of the city). It should be mentioned that the wells from where the samples were taken are located in people's yards, the only exception is the sample A2, which is a fountain located in an access area for everyone.

The multiparameter WTW multi350i was used to measure the general physico-chemical parameters: pH, redox potential (ORP), electrical conductivity (EC), total dissolved solids (TDS), and salinity. The dissolved anions (F^-, Cl^-, Br^-, NO_3^-, NO_2^-, SO_4^{2-}, PO_4^{3-}) and cations (Li^+, Na^+, K^+, NH_4^+, Ca^{2+}, Mg^{2+}) were analyzed with ion chromatography, using the IC DIONEX 1500 system. Heavy metals (Ni, Cd, Cr, Pb, Zn, Cu, Fe, Mn) were analyzed by flame atomic absorption spectrometry, by using an AAS ZEEnit 700 Analytik Jena system.

RESULTS AND DISCUSSIONS

In table 1 there are presented several general aspects regarding the depth, age, or the proximity of possible pollution sources of the investigated wells.

Table 1. *General aspects regarding the investigated wells*

Well no.	Depth (m)	Age (years)	Chemical treatment	Possible pollution sources in proximity	Usage purposes
A1	4-5	>50	No chemical treatment	No possible pollution source	Human and animal consumption
A2	4	>200		Animal stable	human and animal consumption
A3	6-7	100		Toilet	Irrigation
A4	12	>100		Gardens with flowers	Irrigation
A5	3-4	>10		Vegetables garden	Irrigation
A6	10	80		Animal stable, green house	Irrigation and animal consumption
A7	10	>100		Animal stable	Irrigation and animal consumption

Well no.	Depth (m)	Age (years)	Chemical treatment	Possible pollution sources in proximity	Usage purposes
A8	5-10	>70		No possible pollution source	Human consumption
A9	5-6	15		Toilet (at a distance of 15 m)	Irrigation and animal consumption
A10	10	>50		Toilet (at a distance of 15 m)	Human and animal consumption

Interpretation of data and the determination of exceeding the maximum permitted concentrations were made using the legislation in force; for the quality of drinking water is Law no. 458/2002. As it can be seen in figure 3, all the physico-chemical parameters were within the maximum permissible limits. The pH presented values within the minimum and maximum limits (6.5 – 9.5), allowed according to Law no. 458 of July 8, 2002. The electrical conductivity showed values far below the maximum allowed limit (2500 μS/cm) and the total dissolved solids showed values below the WHO recommendations (500 mg/l) (CG, 2021).

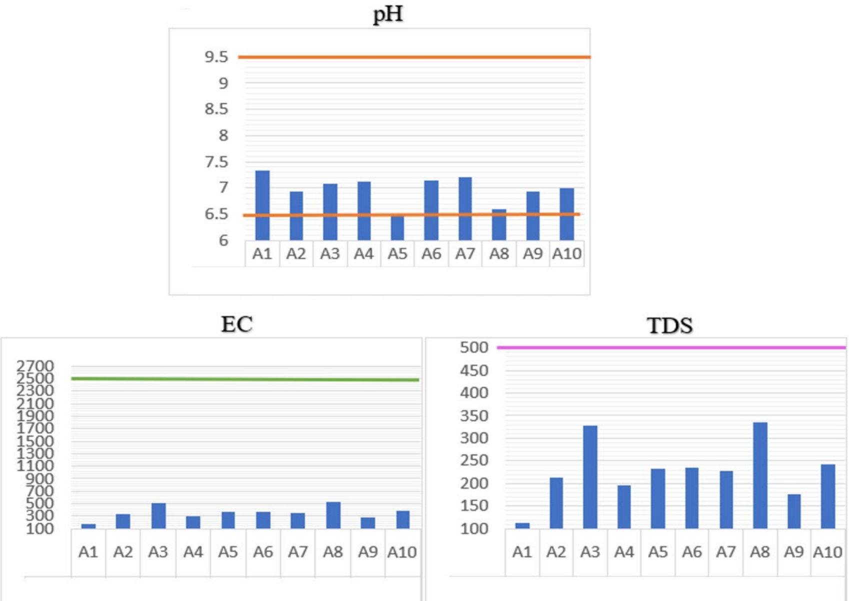

Fig. 3. *The values of pH, electrical conductivity (EC) (μS/cm) and total dissolved solids (TDS) (mg/l) compared to the limits imposed by national legislation (Law 458/2002 for pH and EC) and the WHO recommendations (for TDS)*

Generally, the content of the analyzed dissolved ions was within the safe limit for human consumption (figure 4). Still, in the case of A3 and A5 samples, the content of nitrate and ammonium were higher than the permissible

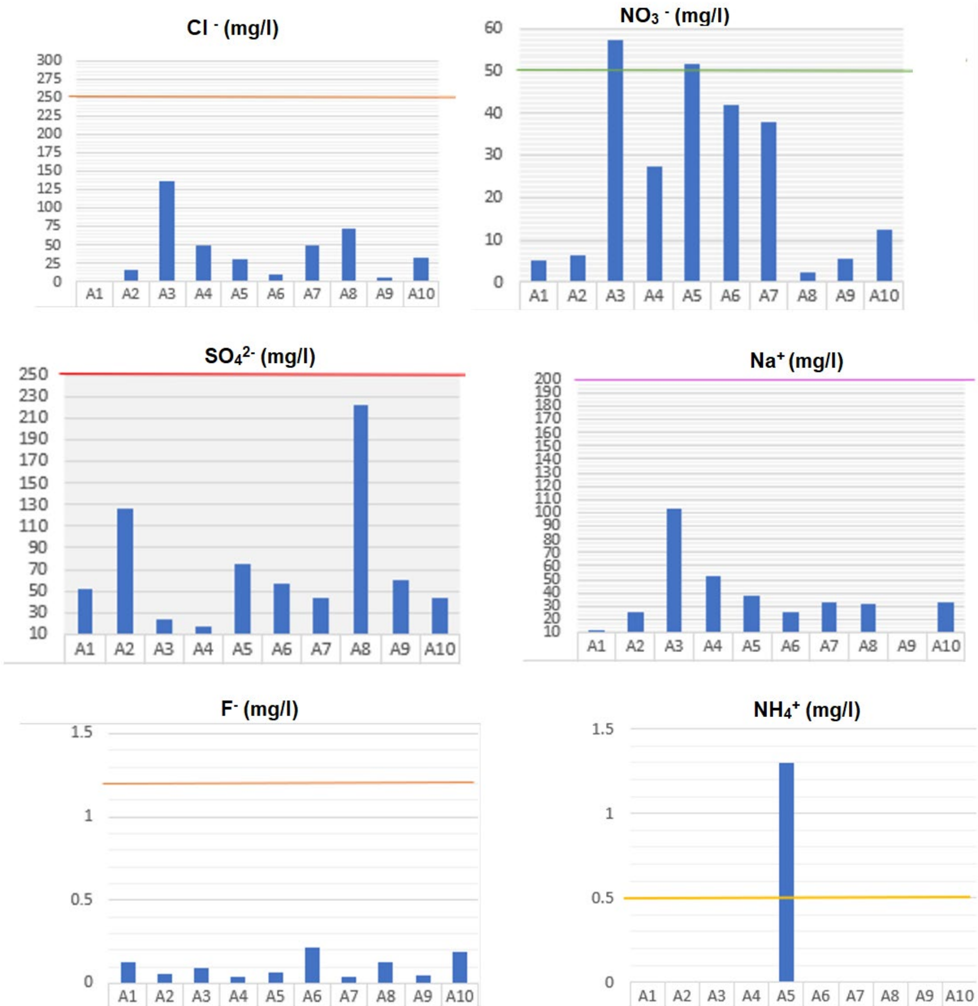

Fig. 4. *Ions content in the analyzed wells versus the maximum permissible limits imposed by national legislation (Law 458/2002)*

limits. The well A5 had the lowest depth (3-5 m) which can indicate a high vulnerability to anthropic pollution. Furthermore, the high content of nitrate from well A3 can be correlated with the presence of a toilet in proximity. The presence of nitrates in water is very dangerous, having the greatest effect on infants. Acute infantile methemoglobinemia, a condition also known as acute nitrate poisoning or the blue sickness of newborns, is the first consequence of the consumption of well water polluted with nitrogenous substances by children in the age range of 0-1 years, water used in the preparation milk powder (Iacob et al., 2012). This nitrogen excess generally moves through the soil into groundwater or is carried by precipitation into surface water. Some natural degradation may occur, for example denitrification. Other sources of nitrates are sewage, sewage treatment plants, private septic systems, manure, and leguminous crops (Kross, 2002).

Chlorine showed concentrations in the range of 2-138 mg/l, being below the maximum allowed limit (250 mg/l), according to Law no. 458 of July 8, 2002. The highest concentration was found in area A3, 137 mg/l, this well, being located in the center of Seini. The concentration of SO_4^{2-} showed values in the range of 23-223 mg/l, being below the maximum allowed limit (250 mg/l), according to Law no. 458 of July 8, 2002. The highest value was found in sample A8, but it is kept below 250 mg/l, so there is no cause for concern. The concentration of Na^+ showed values in the range of 11-103 mg/l, being below the allowed limit value (200 mg/l), according to Law no. 458 of July 8, 2002. The highest value was recorded in sample A3 (103 mg/l). The F^- concentration showed values between 0.04 and 0.22 mg/l, being below the maximum permissible limit (1.2 mg/l) (Law 458/2002). The highest value was recorded in sample A6 (0.22 mg/l).

The analyzed wells proved to have a low level of Cu, Cd, Pb and Zn, being within the safe limit for human consumption (figure 5). Lead was not detected in any of the analyzed samples.

On the other hand, the iron (Fe) concentration was above the maximum allowed limit for the majority of the analyzed samples (figure 5). The increased amount of iron worsens the taste, facilitates the development of iron bacteria and the continuous consumption of water with a high content of iron can lead to health negative effects such as the development of liver diseases, allergic reactions, etc. (Ciobanu, 2009). The high iron content from wells can be correlated with natural sources, the presence of minerals rich in iron from the background.

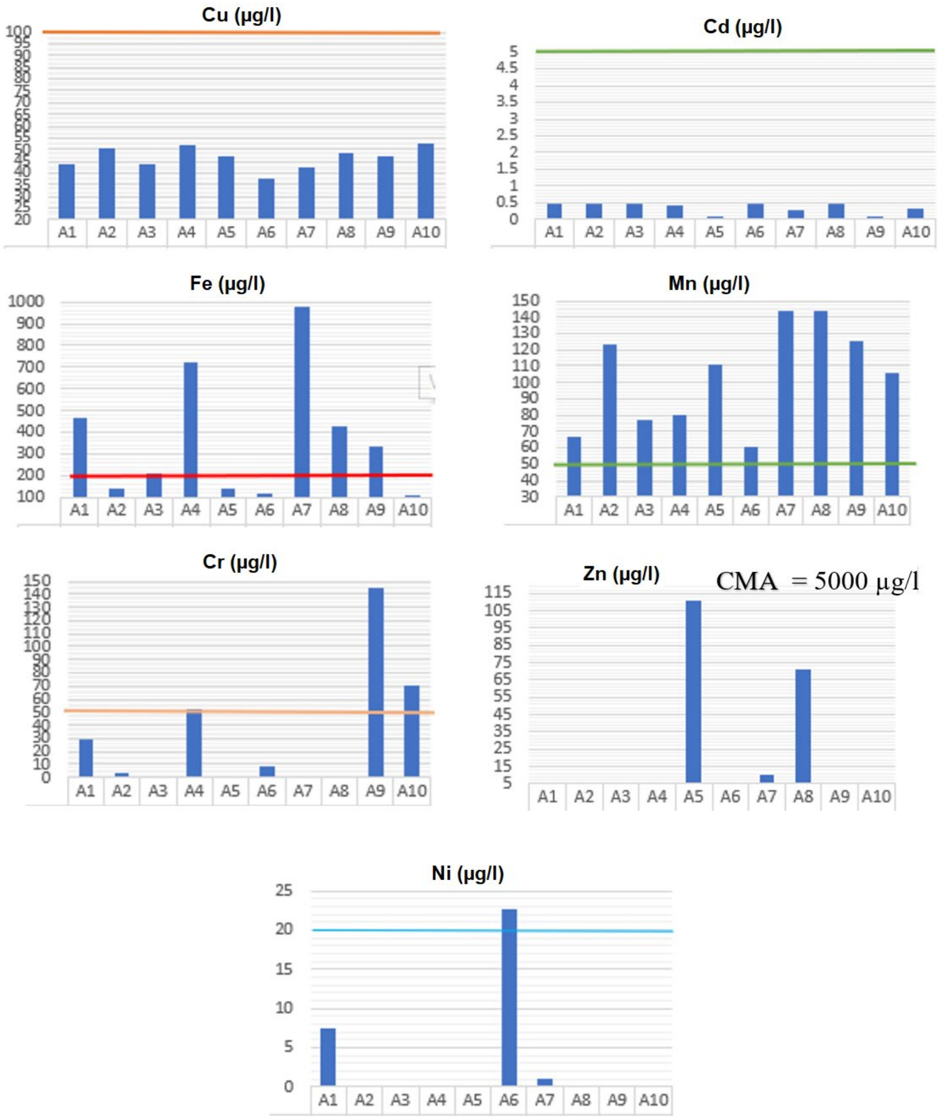

Fig. 5. *Heavy metals content in the analyzed wells versus maximum permissible limits imposed by national legislation (Law 458/2002)*

All the investigated wells had a high content of manganese, exceeding the safe limit imposed for human consumption (figure 5). Manganese concentration showed values in the range of 60-144 µg/l, far above the maximum allowed limit (50 µg/l) (Law 458/2002). The presence of high Mn levels in ground water can be associated with natural sources, like the presence of rocks rich in manganese minerals. Also, high concentrations of manganese can cause problems with memory, attention, and motor skills (MDH, 2021).

The chromium (Cr) was detected only in six samples, three of them being above the maximum allowed limit. The samples that exceeded the limit are A4, A9 and A10. Excessive consumption of water with high content of chromium can cause digestive problems, hypoglycemia, and damage the liver, kidneys, and heart.

Nickel had a low level, except for sample A6 where the maximum permissible limit was exceeded. Continuous consumption of water with high nickel content can lead to negative impact causing lung tissue disease with the slow development of malignant formations, teratogenic effects, such as exencephaly, fragility of the ribs and decomposition of the soft palate (Purici, 2013).

The presence of high levels of heavy metals in the investigated wells cand be associated with the anthropogenic activities from the area, namely the former metallurgical activities.

CONCLUSIONS

Considering the high content of nitrate, ammonium and heavy metals, the continuous consumption of water from these sources can be a real threat for consumers' health. The inhabitants should limit as much as possible the usage of water from these wells for drinking purposes and they should use the water from the local distribution network.

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