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THE QUALITY OF DRINKING WATER FROM NADĂȘ VILLAGE – CLUJ COUNTY

Carla NICOARĂ, Ioana PIŞTEA, Carmen ROBA, Cristina ROŞU

Babeş-Bolyai University, Faculty of Environmental Science and Engineering, Department of Environmental Analysis and Engineering, 30, Fântânele Street, RO–400294, Cluj-Napoca, Romania, E-mails: carlanicoara@yahoo.com, pistea_ioana@yahoo.com, carmen.roba@ubbcluj.ro and cristina.rosu@ubbcluj.ro

Corresponding author: cristina.rosu@ubbcluj.ro

Abstract

The aim of the present study was to determinate the groundwater quality from 17 wells, 3 natural springs and 3 samples from a local distribution network. The samples were taken from Nadas village, located in Crisul Repede village, Cluj County. The area has a topography that consists in a valley surrounded by hills (500 - 700 meters high). The main objective was to investigate physico-chemical parameters: pH, TDS, ORP, salinity and heavy metals (Cu, Cd, Cr, Pb, Fe, Zn and Ni). Laboratory analyzes revealed that the waters sampled from well 7 exceeded the permissible limit imposed by US-EPA for TDS value (500 mg/L), wells 4 exceeded the salinity value imposed by US-EPA (0.2 ‰), one well had a pH close to permissible limit (9.5), ORP had negative values (between -6.9 and -143.5 mV), while the heavy metal content varied significantly, depending on the water sources and heavy metal type. Copper and cadmium were not detected in the analyzed water samples, but chromium had values between 1.36 – 40.21 µg/L, zinc between 11.19 –437.6 µg/L, iron increased levels in the wells samples from 10.77 µg/L to 99.90 µg/L, lead was identified in four wells (4.93 - 51.1 µg/L) and nickel ranged between 4.94 - 39.61 µg/L. Were registered significant differences between the water samples collected from wells, natural springs and water samples from the local distribution network.

Key words: *drinking water quality, groundwater, heavy metals, physico-chemical parameters, wells*

INTRODUCTION

Groundwater is an essential component of the water cycle representing more than 97% of the available fresh water on Earth.

It is particularly important due to the fact that it has an important role because is the largest in water supply and has the highest natural wealth represented by groundwater, which is important because of their superior quality compared to other types of freshwater in nature [4].

Knowing the quality of the water is extremely important for human health.

Nadăş village (46°51 '22.27 ", 23°9'5.53") is located in Cluj County and it is crossed by the Nadăş River [12].

It is placed in a valley surrounded by hills with heights between 500-700 meters.

Cluj-Napoca (53.5 km), Huedin (12 km) and Zalău (73.5 km) are neighboring towns [7].

MATERIALS AND METHODS

A total of 23 groundwater samples were collected in March 2014, from 17 wells, 3 natural springs and 3 samples from local distribution network. The study area with sampling points distribution is shown in Fig.1.

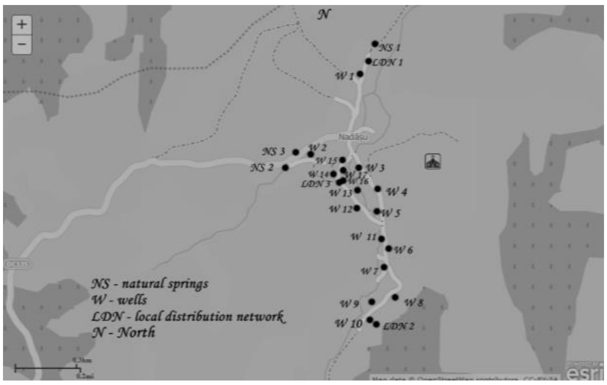

Fig. 1. Study area (Nadăş village) with sampling points
Source: Modified after www.turactiv.ro

The physico-chemical parameters (pH, total dissolved solids-TDS, electrical conductivity-

EC, oxidation reduction potential-ORP, salinity) were analyzed *in situ* using a portable multiparameter 320i WTW, while the chemical parameters were determined in laboratory.

The investigated heavy metals (Cu, Cd, Cr, Pb, Fe, Zn and Ni) were analyzed by atomic spectrometry absorption (AAS ZEEnit 700 Analitik Jena).

RESULTS AND DISCUSSIONS

The analysed water proved to be slightly acidic to neutral, having the pH between 6.67 and 9.15. Most of the analysed samples (56.5%) had the pH under 7, while 39% samples had the pH between 7 and 7.5 and only one sampled had a pH over 7.5 (9.15), as it can be seen in Fig. 2.

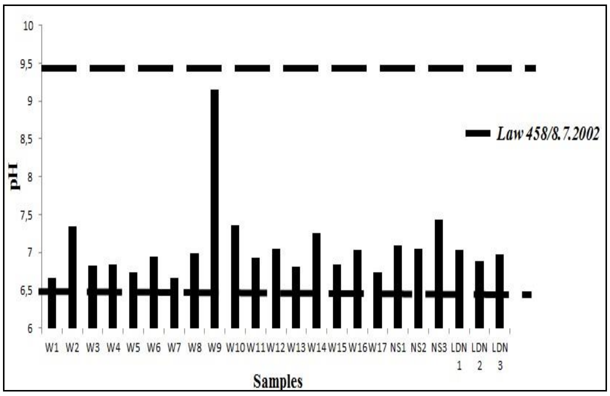

Fig. 2. pH values depending on the sampling points
Source: Own calculation.

Total dissolved solids reflect the presence of dissolved inorganic and organic substances in the water sample. A total of 17% from samples (W1; W4; W5 and W6 - Fig. 1.) exceeded the maximum permitted limit according to US-EPA (500 mg/L) [13]. The lowest TDS value was registered in well W9 (32 mg/L), while 78% of the analysed samples had a relatively low TDS level, between 262 mg/L - 496 mg/L (Fig. 3.).

Electrical conductivity is the property of water to allow the passage of electric current and according to Law 458/08.07.2002 the MPL (maximum permissible limit) is 2500 µS/cm [5].

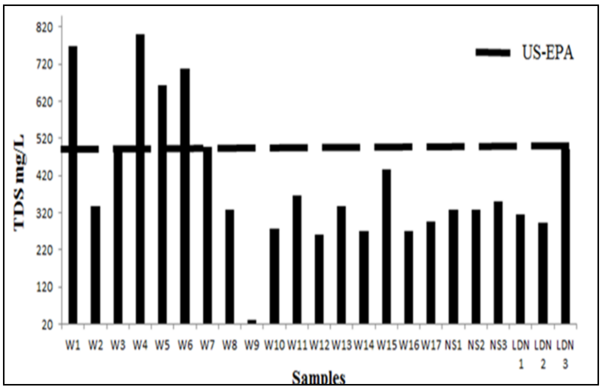

Fig. 3. TDS values depending on the sampling points
Source: Own calculation.

The lowest (49.9 µS/cm) value was observed in sample W9, while the highest level was 1251 µS/cm (W4) and the others samples had values between 409-1203 µS/cm (Fig.4). The analysed waters proved to have a low EC value, all the waters had the EC values below the MPL according to national legislation.

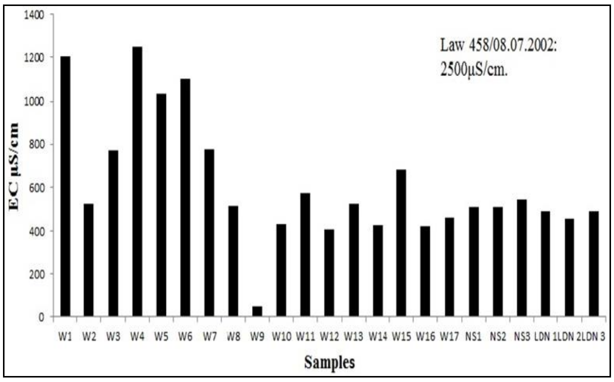

Fig. 4. EC values depending on the sampling points
Source: Own calculation.

The oxidation reduction potential (ORP) was other investigated parameters. A high negative ORP indicates that the water is a more powerful antioxidant, while a positive ORP indicates oxidizing water. By analysing the water samples it was found that ORP had negative values (between - 6.9 mV and - 143.5 mV), as it is presented in Fig. 5.

With the exception of 17% of collected samples (W1, W4, W5, W6) which had a salinity level higher than the MPL value (0.2 ‰, US-EPA), the other samples had a low salinity (0.1‰), while for 70% samples the salinity was lower than 0.1‰ (Fig. 6).

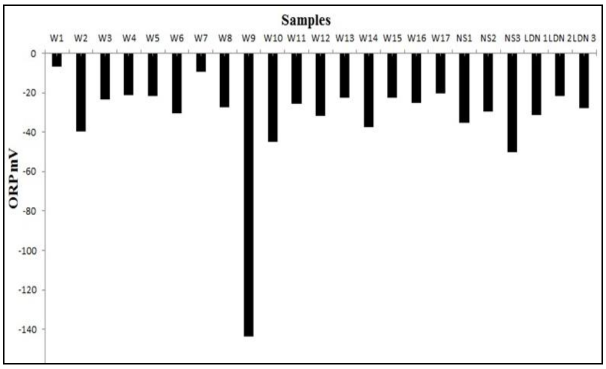

Fig. 5. ORP values depending on the sampling points
Source: Own calculation.

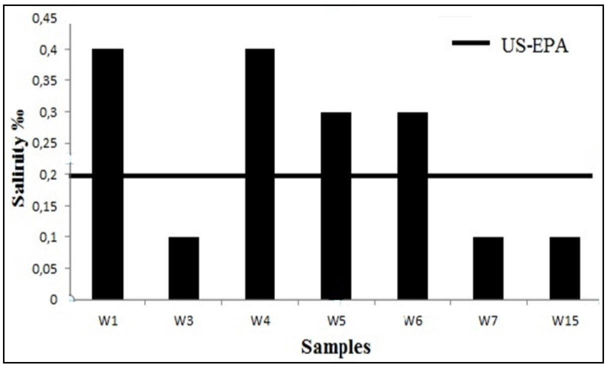

Fig. 6. Salinity values depending on the sampling points
Source: Own calculation.

It is known that some of heavy metals (Ni, Cd, Cr, Pb, As, etc.) are toxic and their presence in drinking water can cause serious health and environmental problems [2]. Heavy metals can be accumulated in liver, bones and kidneys, or other organs [11].

In the analysed water samples the heavy metal content varied significantly, depending on heavy metal type and water sources. Copper and cadmium were not detected, while the other heavy metals were detected in the majority of the samples: 96% (Cr), 87% (Zn), 17% (Pb), 100% (Fe), 100% (Ni).

The heavy metals concentrations ranged between 1.36 - 40.21 μg/L (chromium), 11.19 μg/L - 437.6 μg/L (zinc), 4.93 μg/L - 51.1 μg/L (lead), 10.77 μg/L - 99.90 μg/L (iron), 4.94 μg/L - 39.61 μg/L (nickel). As it can be seen in Fig. 7. and Fig. 8., lead and nickel exceeded the MPL in 50 % (Pb), respectively in 69.56 % (Ni) of the analysed samples. Lead is one of the metals which are highly toxic and can cause serious health effects [1,10].

Nickel can appear in groundwater due to the dissolution from rocks which contains nickel [3].

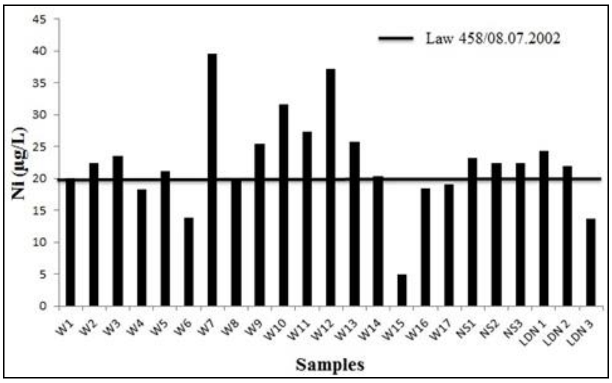

Fig. 7. Nickel concentrations depending on the sampling points
Source: Own calculation.

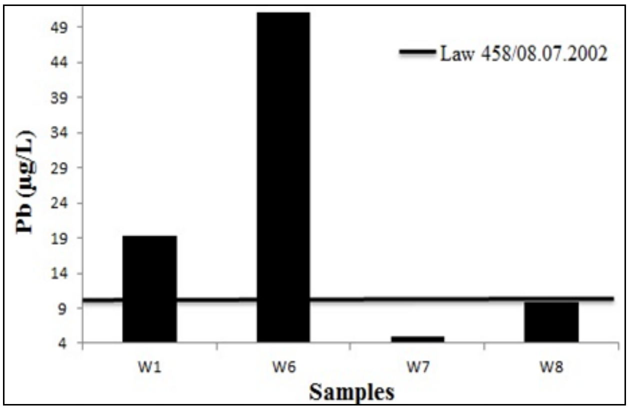

Fig. 8. Lead concentrations depending on the sampling points
Source: Own calculation.

The spread of heavy metals is becoming increasingly important because they accumulate fast in the environment (water, soil, air) and from there in the human body, which can suffer severe pathological changes because the effects of these metals [8].

Lead is a frequent heavy metal and may cause chronic poisoning: sickness, by attacking the motor nerve endings, the kidneys and cancer. Children up to 6 years age and pregnant women are most sensitive to the adverse health effects of lead [14].

Nickel is a metal that is revealed frequently in drinking water, generally at concentrations less than 10 μg/L. Exposure to Ni by the intake from drinking water induces toxicity, lung cancer and allergies [9].

Cadmium is slightly soluble in water (1 mg/L) and its toxicity in water is influenced by water hardness. Exposure to cadmium cause acute and chronic effects: headache, fever, lung diseases, has a strong bioaccumulation and affects kidney and bones in the human body.

Chromium is an essential element for life in quantities between 0.05 - 0.2 mg/day for humans, but a higher concentration can cause toxic effects. Chromium VI is carcinogenic and at a low level may cause dermatitis [6].

CONCLUSIONS

The laboratory analysis showed the water sample from one of the wells had a pH (9.15) close to the permissible limit according to Law 458/2002 (6.5-9.5).

17.4% of the wells exceed the permissible limit for TDS imposed by US EPA (500 mg/L) and other 17.4% samples were near the acceptable limit (W3 – 496 mg/L, W7 – 496 mg/L, W15-437 mg/L, LDN3 – 492 mg/L).

Electrical conductivity was low for all the analysed samples, being lower than the MPL (2500 µS/cm) set by Law 458/2002. EC ranged between 49.9 µS/cm (W9) and 1251 µS/cm (W4). The analysed water had a negative ORP (between - 6.9 mV and -143.5 mV).

Copper and cadmium were not detected, but chromium concentrations ranged between 1.36 µg/L - 40.21 µg/L, zinc concentrations were between 11.19 µg/L - 437.6 µg/L, lead concentrations were identified only in four wells and its concentrations were between 4.93 - 51.1 µg/L, iron concentrations ranged between 10.77 µg/L and 99.90 µg/L while nickel had values between 4.94 µg/L - 39.61 µg/L.

People have been announced regarding their wells water composition. Those sources of drinking water should be monitored, also there are waters filters which can be used and for cleaning the water.

The present studies indicated that some of the investigated water sources (exceeded lead-W7, W12 and nikel-W1, W2, W3, W5, W7, W9, W10, W11, W12, W13, W14 ; salinity level higher than the MPL - W1, W4, W5, W6; total dissolved solids- W1; W4; W5 and W6 and one sample had a pH close to the acceptable limit-W9) may pose some health problems for the people who use the water as drinking water.

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