Observations on Groundwater Contamination with Nitrogen Compounds: A Case Study from Medias town, Sibiu County

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ABSTRACT

Worldwide, the groundwater (water well and public spring) is used as drinking water source. The water quality is important due to the possible negative effects on the consumers' health, especially for infants. Nitrogen compounds (NO_2^- , NO_3^- , NH_4^+) are present as natural components of the nitrogen cycle and their presence in the groundwater is ubiquitous. But, due to the anthropogenic activities high concentrations of nitrogen compounds are release into the groundwater; thereby the chemical compounds concentrations exceed the maximum allowable concentrations (MACs). The purpose of the present study was to assess the content of nitrogen compounds in groundwater; namely private water wells and public springs used as drinking water sources by the Medias town population. The study results show alarming NO_2^- and NO_3^- concentrations; the NO_3^- concentrations exceed 5 times the MAC and NO_2^- concentrations exceed 3 times the MAC.

Keywords: *drinking water, groundwater, NO_2^- , NO_3^- , NH_4^+ contamination*

INTRODUCTION

Groundwater is a vital resource, the main source of water supply, especially for people who have no other source of water. Groundwater is a natural, limited, fresh and clean source of water. Nitrogen compounds (NO_2^- , NO_3^- , NH_4^+) are natural resources idem, but the anthropogenic activities are sources of nitrogen compounds in the natural factors (soil→groundwater→ surface water→ plants→human) (Uwah et al., 2009; Belkhiri et al., 2011; Kent and Landon, 2013). Therefore, normal concentrations of nitrogen compounds are exceeded due to anthropogenic activities (agriculture, industry, household activities) (Du et al., 2011, Wick et al., 2012). Nitrate and nitrite are important compounds that sustain and maintain the soil matrix, but high concentrations have

a direct and negative impact on groundwater composition. Hence higher concentrations as the maximum admissible concentrations – MACs (Law 311/2004, Order 621/2014) of nitrogen compounds represent a worldwide health problem (Croll and Hayes, 1988, Bru and Pedreno, 2003, Chan, 2011). China, India, SUA, Finland are only a few of the countries with significant nitrogen contamination issues (Salo and Turtola, 2006, Darwish et al., 2011, Chaudhuri 2014). Romania confronts also with high levels of nitrogen compounds, especially in water wells from rural areas (Rowland et al., 2011). The aims of this study were (i) to determine the NO_2^- , NO_3^- , NH_4^+ pollution status of groundwater and (ii) to assess the quality of water wells from Medias town and vicinity.

Fig.1. Variation of the NO₃⁻ content

Fig. 2. NO₂⁻ and NH₄⁺ concentration for the water samples

MATERIALS AND METHODS

Study area and water sampling

Groundwater samples from private water wells and public springs were collected in the wet season from Medias town and the nearby vicinity. The study area is localized in the southern part of Transylvanian hilly depression; a temperate climate characterizes it with an annual average air temperature of 7-8 °C, and 600-700 mm as the annual precipitation range. The geology structure is represented mainly by interlaid layers of sands, chad, grey marls and smooth lime. Tarnava Mare river (Mures drainage area) is the main surface water source with 221 km length (Chira and Malacu, 2008) which represents a drinking water source as well.

Groundwater samples were collected from 19 private water wells (F1-F19) and 2 public springs (I1 and I2). For the sampling, hydrophore pumps

and buckets were used. The water samples were collected in clean polyethylene bottles and stored at 4°C until the chemical analyses.

Analytical methods

The NO₂⁻ and NO₃⁻ concentrations were determined by ion chromatography (IC 761 Compact Methrom A.G.), while NH₄⁺ as indophenol blue complex was measured by UV-VIS spectrometry (Perkin - Elmer Lambda 25). The pH of the samples was measured by a 350I multi-parameter (WTW).

RESULTS AND DISCUSSION

The high NO₃⁻ concentration found shows contamination of all water samples. The NO₂⁻ contents were also high, indicating contamination of 2 samples (F10, F11). The NO₂⁻ concentrations exceed 3 times the MAC (0.5 mg/l) and NO₃⁻

Fig. 3. Representation of nitrogen compounds and pH correlations

concentrations exceed 5 times the MAC (50 mg/l) (Law 311, 2004). All water samples (except F1 and F6) present significant high NO_3^- concentrations (Figure 1). NO_3^- values exceed 5 times MAC (Law 311/2014, WHO, 2011).

Ammonium concentrations were below the MAC (0.5 mg/l), as Figure 2 indicates.

Possible sources for the nitrogen compounds are represented by leakage of waste waters and

fecaloid compounds from dry toilets, collecting tanks, cattle house and cattle faeces deposits. An important aspect is the short distance (1-10 m) between the pollution and the drinking water sources.

In our samples the dominant concentration is represented by NO_3^- , likewise the variable is significantly correlated with the high concentrations which exceed the MAC.

Cross plots are used to correlate the nitrogen compounds and (Figure 3). Higher NO_2^- values are observed for the medium NO_3^- values (between 50-100 mg/l). The highest concentrations of NH_4^+ correlate with the NO_3^- concentrations and the lowest NO_2^- values correlate with the lowest NO_3^- values. The highest NH_4^+ concentrations are measured at groundwater samples characterized with a pH ranging between 7.0 and 7.5 pH units, while the lowest concentrations are scatter between 6.9 and 7.9 pH units; whereas NO_3^- concentrations are scatter between 6.9 and 7.9 pH units for all groundwater samples.

CONCLUSIONS

The obtained results demonstrate that, although there are no fertilizers used for the agricultural activities and no industrial activities (in present days), there are still high concentrations of NO_2^- , NO_3^- , NH_4^+ which characterize the well waters and springs from Medias town and the vicinity. The NO_2^- and NO_3^- concentrations exceed the MACs five times as MAC (NO_3^-). Field observations attest a possible pattern regarding the source of high concentrations of nitrogen compounds. Therefore, the septic tanks and collecting tanks are plausible explanations for the high nitrogen compounds concentrations. The studied water samples from Medias town present organic contamination due to the anthropogenic activities.

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