GROUNDWATER QUALITY MONITORING STUDY IN THE WEST REGION OF ROMANIA

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Abstract

In the present study it was investigated the groundwater quality and its suitability for drinking purposes in several urban and rural areas from Timis, Arad and Bihor counties (West Region of Romania). We have established general and specific techniques for the analytical investigation of the inorganic and organic matrix in the environmental components of water from underground sources, for the identification and quantification of persistent pollutants with toxic potential, especially considering the presence of chlorobenzenes and organo-chlorinated pesticides, organophosphorus pesticides, plant treatment agents (triazine pesticides), benzene and benzene derivatives, polycyclic aromatic hydrocarbons and toxic metals, specifically tracking the presence of arsenic in groundwater resources in the Western Region of Romania.

Introduction

Although groundwater is considered safe, high concentrations of heavy metals such as arsenic (As) can present potential problems and hazards to human health.

With several newly affected regions reported in the last decade, a significant increase has been observed in the global scenario of arsenic contamination [1].

Almost 108 countries are estimated to be affected by arsenic contamination in groundwater (with a concentration exceeding the maximum permissible limit of 10 ppb recommended by the World Health Organization) [2].

The largest of these are from Asia (32) and Europe (31), followed by regions such as Africa (20), North America (11), South America (9) and Australia (4) [3].

Arsenic, even if it is part of the class of metalloids, according to European Union legislation, is included in the category of heavy metals alongside other elements (antimony, cadmium, chromium (VI), copper, lead, mercury, nickel, selenium, tellurium, thallium and tin).

Special attention must be paid to the monitoring and removal of arsenic from water, as it is known that long-term exposure to arsenic can cause health problems.

Underground sources of drinking water are considered to be one of the most important causes responsible for chronic health problems related to arsenic poisoning of the population, at the world level, but also at the national level. Arsenic toxicity is a complex phenomenon and is generally classified into acute and subacute [4].

We pay special attention to the Pannonian Basin. This basin covers a large part of Hungary, the Western Plain of Romania, Northern Serbia, North-Eastern Croatia, a small part of Slovenia, Slovakia and Austria. It is in fact a large area of South-East Central Europe affected by arsenic contamination of natural water resources.

According to a European study in 2011, it is considered that approximately 500.000 people living in Hungary and Romania are exposed to increased levels of arsenic in drinking water [5].

The application of pesticides and other chemical agents for plant protection and to weeds control, as well as the expansion of industrial production have led to land pollution and direct threat to groundwater, rivers and lakes that are sources of drinking water [6].
Due to the critical role of groundwater in numerous fields of life, the dynamic changes in groundwater resources are among the main subjects of sustainable management of groundwater assets.
Groundwater monitoring is nowadays mandatory in all member state level in European Union (i.e., Water Framework Directive (EU) 2020/2184 of the EUROPEAN PARLIAMENT and of the COUNCIL of 16 December 2020 on the quality of water intended for human consumption) [7].
In this study, we mainly focus to act in accordance with the legal provisions of this directive adopted, whereas it is clearly specified on pct. 17: ″When necessary in light of the identification of hazards, Member States should monitor pollutants which they identify as relevant, such as nitrates, pesticides or pharmaceuticals identified under Directive 2000/60/EC, or because of their natural presence in the abstraction area, such as in the case of arsenic, or because of information from water suppliers, for example regarding a sudden increase of the concentration of a specific parameter in raw water″.
For the purpose of appropriate monitoring, as mentioned in the first paragraph letter (c) of Article 8, we have proposed adequate conventional monitoring in groundwater, in the Western Region of Romania, in the catchment areas for abstraction points, or in groundwater sources, of some relevant parameters, substances or pollutants.

Experimental

Groundwater quality monitoring was carried out in 35 sampling points selected from the three different counties: Timis, Arad and Bihor, located in Western part of Romania.
The sampling campaign took place during May 2023, the groundwater sources analyzed had varying depths, between 10 and 300 m, most of them being located in the rural area.
To determine the degree of pollution of groundwater resources intended for human consumption in the Western Region of Romania, 35 representative drills were selected and analyzed: groundwater samples from Timiș County (14 locations: 6 communes, 8 villages), Arad County (8 locations: 7 cities, 1 commune), Bihor County (13 locations: 2 peri-urban areas, 7 communes, 4 villages) (Figure 1).
In addition to many physical-chemical water quality indicators analysed, for the identification and quantification of persistent pollutants with toxic potential, the presence of chlorobenzenes and organochlorinated pesticides, organophosphorus pesticides, plant treatment agents (triazine pesticides), benzene and benzene derivatives, polycyclic aromatic hydrocarbons were analysed by gas chromatographic methods (GC-ECD, GC-FPD, GC-MS) and liquid chromatographic methods (HPLC-FLD, HPLC-UV). The detection technique used for Hg was Atomic Fluorescence Spectrometry (AFS) and for As was Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES).

Figure 1. The sampling locations investigated in the Western Region of Romania

Results and discussion

The chemical status of groundwater is determinated with respect to the quality of groundwater, and concentrations in monitoring points selected must be compared to the European standards and Threshold Values (TV) which are considered the main objectives for a good status of the groundwater body status. The list of minimum parameters which must be considered for each groundwater body are stiplulated in Groundwater Directive (2006/118/EC) [8].

In order to comprehensively evaluate the degree of pollution of groundwater, a wide range of physical-chemical indicators was analysed and the results of the present study are generally similar to what was reported in other studies, especially regarding the fluctuation of pH and electrical conductivity (Figure 2).

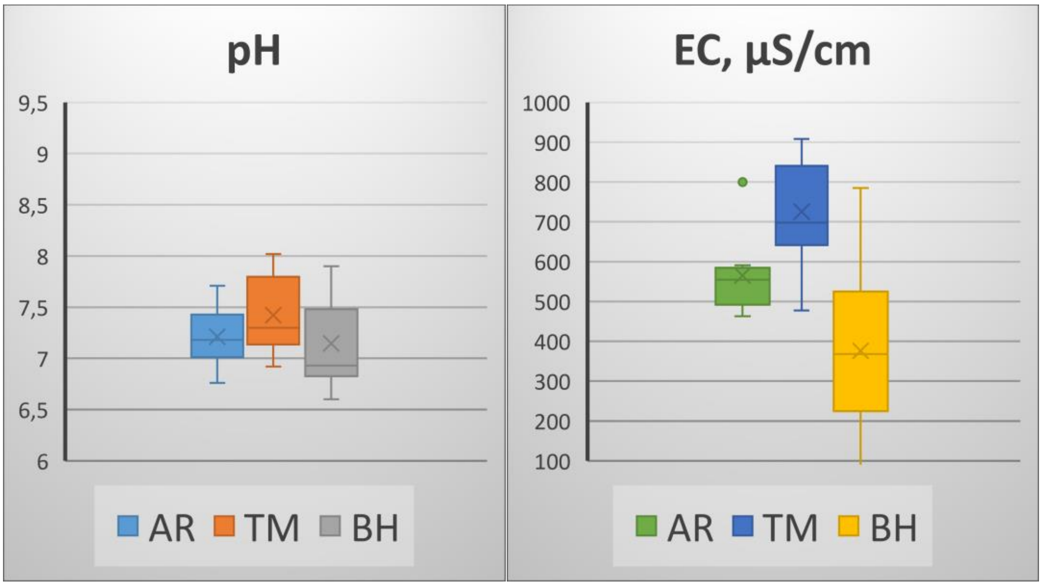

Figure 2. The fluctuation of pH and electrical conductivity (EC) depending on the investigated areas

Nutrients such as nitrogen, that are not taken up by plants, are lost to the environment and become pollutants when present in excessive amounts. This includes high levels of nitrate (NO_3) in groundwater, which pose a threat to the environment and to human health. Reducing high levels of nitrate in groundwater has been a target of European Union (EU) policy since the adoption of the Nitrates Directive. Mineral fertilisers and manure are the main sources of nitrate concentrations in EU groundwaters and an estimated 80% of the nitrogen discharge to the EU aquatic environment stems from agriculture. The Groundwater Directive [8] and the Drinking Water Directive [7] set the maximum allowable concentration for nitrate at 50mg NO_3/L and for pesticides at 0,1 µg/L individual and 0,5 µg/L total, in order to protect human health and water resources.

The presence of chlorobenzenes (1,2,4,5-tetrachlorobenzene; pentachlorobenzene; hexachlorobenzene and organochlorinated pesticides (α-HCH; β-HCH; γ-HCH; δ-HCH; 4,4'-DDD; 4,4'-DDT; 4,4'-DDE; heptachlor; heptachlorepoxide; aldrin; dieldrin; endrin; alachlor; α-endosulfan), organophosphorus pesticides (malathion; parathion; dichlorvos; diazinon; chlorfenvinfos; chlorpyrifos; metamidofos; mevinfos), plant treatment agents (triazine pesticides: simazine, atrazine, propazine), benzene and benzene derivatives (toluene, ethylbenzene, o-xylene, m-xylene, p-xylene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene) and polycyclic aromatic hydrocarbons (PAHs) was analysed.

The contents for all types of pesticides, plant treatment agents and PAHs analyzed, nitrate and mercury content were within the maximum permissible limits for all the 35 representative drills analyzed.

The groundwater sources from the West Region of Romania that require water treatment, are generally characterized by high concentrations of iron and manganese, also arsenic being present in fairly high concentrations (even about 400 µg/L in two isolated Timis County locations) and in certain situations exceedances may occur for ammonium (e.g the rural area around Ineu city, Arad County).

This study provides a comprehensive review of these 35 groundwater resources selected according to their current status. More appropriate monitoring programs need to be designed to ensure the quantity and quality of data for the West Region of Romania.

Conclusion

Conventional groundwater quality monitoring methods depend on wells and site analysed, which is expensive, time-consuming, and labor-intensive, but these types of methods applied in this monitoring study provide point-in-time measurement and are accurate.

This study results improve groundwater monitoring for a better quality of life in rural communities using local groundwater sources, contributing to the risk assessment and risk management of the catchment areas in the West Region of Romania, for abstraction points of water intended for human consumption. Concluding, the quality of the groundwater from the West Region of Romania is of good quality and applying specific treatment procedures, these groundwater sources can be used for drinking purpose.

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