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RESEARCHES REGARDING THE MONITORING OF UNDERGROUND WATER QUALITY IN VULNERABLE COMMUNITIES TO NITRATE POLLUTION FROM AGRICULTURAL SOURCES IN BOTOȘANI COUNTY, ROMANIA

BY

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Abstract. The object of the national water monitoring programs is the evaluation and control of their quality. Monitoring data can be used to establish initial conditions, final pollutant concentrations, but most of the time they cannot be used to identify the stages and processes that occur during pollution. In Botoşani County, a number of four communes were diagnosed as vulnerable areas. This paper presents the results of the groundwater quality monitoring in the period 2012 – 2019, in a number of 37 wells, located both in vulnerable areas, and in zones diagnosed as not being vulnerable. The selected parameters for the monitoring are the indicators of the nutrient regime: concentrations of nitrate, nitrite, phosphate, and ammonium ions. By processing filed data, there is observed a decrease in the nitrate ions concentration from two wells, during 2017 year. It was found that in 2017 – 2019 there was a deterioration of its quality in terms of the ammonium indicator, and in some localities both regarding nitrite and nitrate parameters. Following the research carried out, we have proposed a detailed action program for each area analyzed separately.

Keywords: monitoring; nitrate; pollution; underground; water quality.

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1. Introduction

The object of the national water monitoring programs is the evaluation and control of their quality. Monitoring data can be used to establish initial conditions, final pollutant concentrations, but most of the time they cannot be used to identify the stages and processes that occur during pollution. The purpose of groundwater monitoring is a long-term research of the distribution area for pollutants, and of their concentrations in the underground. For the groundwater monitoring, we follow both chemical and quantitative stage. The investigation environments are represented by water, sediments, and biota, with qualitative elements, parameters, and minimum monitoring frequencies, in accordance with requirements of the Water Framework Directive, depending on the type of program.

Areas vulnerable to nitrates from agricultural sources represent 8.64% of our country's surface, and 13.93% of the total agricultural area of Romania. In order to determine the vulnerable areas, they were delimited following the analysis of each subsystem (soil, climate, water bodies, sources of nitrates from agricultural activities), from the perspective of the production and/or transmission of nitrates from the agricultural sources to water bodies.

The vulnerable areas were differentiated according to the type of nitrate sources: current sources (present agricultural activities, which produce a surplus of nitrates due to the high density of animals from individual households and/or zoo-technical complexes), and historical sources (zoo-technical complexes that have worked in the past and are decommissioned now).

In Botoşani County, a number of four communes were diagnosed as vulnerable areas: Corni, Prăjeşti, Ştefăneşti and Truşeşti. Depending on the characteristic of each municipality, the action programs have been established to lead to the prevention of pollution with nitrates from the agricultural sources.

2. Materials and Method

In order to prevent the pollution of groundwater with nitrates, a monitoring program for the physical – chemical indicators of the water collected from hydro-geological wells located in Botoşani County was prepared. This paper presents the results of the groundwater quality monitoring in the period 2012 – 2019, in a number of 37 wells, located both in vulnerable areas, and in zones diagnosed as not being vulnerable.

The selected parameters for the monitoring are the indicators of the nutrient regime: concentrations of nitrate, nitrite, phosphate, and ammonium ions.

From the analysis of the nitrate ions concentration of the water samples from 20 wells, we found very large exceeding of the maximum allowed limit (50 mg/L).

From the nitrite loading point of view, the groundwater in monitored wells falls within the maximum permissible limits (0.5 mg/L), with two drilling exceptions, where exceeding of the maximum concentration allowed for the nitrite parameter are recorded, achieving values of 1.54 mg/L (at Sadoveni - F1), respectively 1.37 mg/L (at Ştefăneşti - F3) (Fig. 1).

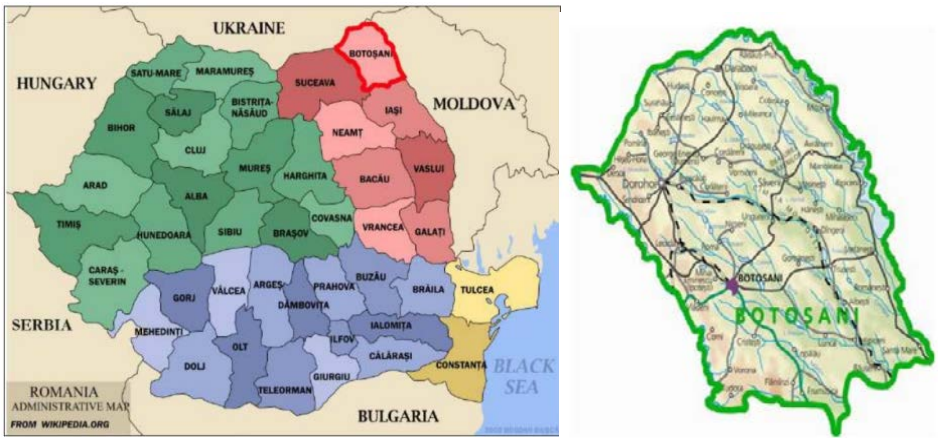

Fig. 1 – Geographical location and map of Botoşani County, Romania.

Agricultural land use represents the largest diffuse pollution threat to groundwater quality on a global scale.

As a result of decades of fertilizer application and surface spreading of animal manure, significant increases in nutrient concentrations have been documented in both private and municipal well systems.

Nitrate (NO_3^-) is one of the main groundwater pollutants.

High nitrate concentrations in groundwater can cause public health risk and environmental pollution that have already become a common problem in many parts of the world.

Nitrate threats depend on scales which can take on chronic or acute forms (Leclerc, 2008).

3. Results and Discussions

Three treatment plants were monitored: from Dorohoi, Darabani, and Săveni. A special situation is represented by localities where the water supply system is built, but there is no sewerage – treatment system. In these cases, all wastewater is discharged in natural receptors, diffuse, without prior treatment (Table 1).

Table 1
Groundwater Quality

Drilling no.	Sampling section	Outdated indicators
F1	Ștefănești	Ammonium, manganese
F1	Dorohoi	Ammonium
F1	Săveni	Ammonium, sulphates
F1	Bălușeni	Nitrogen
F2	Ștefănești	Manganese
F2	Măşcăteni	Ammonium, manganese
F3	Dângeni	Nitrogen, manganese
F3	Sadoveni	Nitrogen
F3	Ștefănești	Nitrogen, sulphates
F3	Dracșani	Sulphates, manganese

Due to different pollutants concentrations (suspensions, organic substances, petroleum products, detergents, metal ions, ammonium, nitrites etc.) of untreated or insufficiently treated wastewater, the impact produced on surface waters is appreciable and manifested by negative effects on the aquatic biotope and biocenosis, through the physical, chemical and bacteriological changes they cause (Sousa *et al*., 2014).

In most cases, this leads to a modification of the quality category of the receptor or in an increase of the indicators values within the same quality category (Jean, 1975).

Out of 1216 physical-chemical and bacteriological analysis performed in the Bucecea and Cătămărăşti water stations, only 0.02 % of the samples did not correspond to the drinking parameters.

There were recorded twenty-five physical-chemical and seven bacteriological unsuitable samples.

4. Conclusions

The probable causes for which in most cases groundwater does not meet the requirements to be used for drinking purposes are the following:

• surface water pollution;

• natural hydro-geochemical conditions and processes that favours the passage into solution of various anions and cations;

• the intensive development of agriculture in recent decades with the excessive use of chemical fertilizers based on nitrogen and phosphorus, also pesticides has led to the accumulation in the soil of some of these substances (or their degradation products);

• the negligence effect of the former high-capacity of zoo-technical complexes, regarding the measures for the conservation of environmental factors;

• climatic, hydro-geological features and the exploitation of irrigation systems that contributes to the mineralization of organic matter in the soil and the migration of substances resulting from these processes (WHO, 2011).

The elaboration of a medium and long term strategy is opportune and necessary, giving the possibility to draw up possible scenarios for the modernization and development of the community services of local public utilities.

This contributes greatly to major decisions on directions for action in the coming stages (Roscoe, 1990).

The basic principle from which we started in structuring this strategy is to create those conditions of European quality at affordable prices, the existence of consumers determining the need for the service, and not the other way around (Haller *et al*., 2014).

Our researches show that significant improvements can be achieved (reduced fertilizer inputs, for example) while maintaining crop yields, and thus maintaining the economical potential of agriculture.

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CERCETĂRI PRIVIND MONITORIZAREA CALITĂȚII APEI SUBTERANE ÎN COMUNITĂȚI VULNERABILE LA POLUAREA CU NITRAȚI DIN SURSE AGRICOLE ÎN JUD. BOTOŞANI, ROMÂNIA

(Rezumat)

Obiectul programelor naționale de monitorizare a apei este evaluarea și controlul calității acestora. Datele de monitorizare pot fi utilizate pentru a stabili condițiile inițiale, concentrațiile finale de poluanți, dar de cele mai multe ori nu pot fi utilizate pentru a identifica etapele și procesele care apar în timpul poluării.

În județul Botoșani, un număr de patru comune au fost diagnosticate ca fiind zone vulnerabile. Această lucrare prezintă rezultatele monitorizării calității apelor subterane în perioada 2012 - 2019, într-un număr de 37 de puțuri, situate atât în zone vulnerabile, cât și în zone diagnosticate ca nefiind vulnerabile.

Parametrii selectați pentru monitorizare sunt indicatorii regimului nutrienților: concentrații de ioni de nitrați, nitriți, fosfați și amoniu.

Prin prelucrarea datelor depuse, se observă o scădere a concentrației de ioni de nitrați de la două fântâni, în cursul anului 2017.

S-a constatat că în 2017 - 2019 a existat o deteriorare a calității sale în ceea ce privește indicatorul de amoniu, și în unele localități atât în ceea ce privește parametrii nitriților, cât și ai nitraților. În urma cercetărilor efectuate, am propus un program de acțiune detaliat pentru fiecare domeniu analizat separat.