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NITRATES AND DRINKING WATER

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Abstract

The presence of nitrates in surface water and groundwater is a problem for many countries from European Union. The Directive 91/676/EEC establishes measures to be followed by agricultural sector to reduce nitrate pollution from nitrate and to prevent further pollution of this type. Measurements of nitrates concentrations in water wells from Sohatu village, Calarasi county, in May 2014 and July 2014, showed higher values than the maximum allowed nitrate concentration of 50 mg/l in some of the samples analyzed. The higher values were registered for ammonium. The presence of nitrates in drinking water is a problem because, in Sohatu, for many people, this is the only source of water. Drinking water with high concentration of nitrates affects the human health. The lack of a sewage system, the distance from well to latrine or stable that it is small, the use of fertilizers in large quantities than normally, the applied fertilizers without observing the periods of prohibition from code of good agricultural practice, the wells which are not covered and where not complied with conditions of hygienic and sanitary, these are some of the causes of high concentrations of nitrates. To reduce the concentration of nitrates in water wells and to prevent a new pollution, it is necessary to stablish some measures.

Key words*: nitrates, pollution, water.*

INTRODUCTION

Nitrates (NO^{3-}) and nitrites (NO^{2-}) are nitrogen compounds there are naturally in the environment. They occur by nitrification of ammonium ions, which is present in soil and water. The ammonium is oxidized, in the presence of bacteria of the genus *Nitrosomonas*, and formed nitrites. Nitrites are oxidized and formed nitrates in the presence of bacteria of the genus *Nitrobacter* (Institut National de Sante Publique du Quebec, 2003). These dynamic processes are presented in Figure 1 (Prakasa Rao, 2002).

Nitrates play a role in the growth of plants and they are used as a means of increasing the fertility of the soil. When fertilizers are used in quantities exceeding the need of plants, it increases the risk of water pollution. Nitrogen compounds can enter surface waters through the discharge of wastewater, as a result of precipitation, by deposition of dust particles, through fixation from atmosphere by bacteria from the nodes of plants (U.S. Environmental Protection Agency, 1993). Nitrogen compounds from soil come to the decomposition of organic materials of plant or animal origin, and from application of fertilizers based on nitrogen. If these compounds are not used by plants in growth process, they get into groundwater.

The Directive 91/676/EEC is one of the programs designed to reduce the water pollution, pollution caused or induced by nitrates formed from agricultural sources. The Directive defines the measured which must be followed in agriculture and there are limitations on the amounts of mineral and organic fertilizers which can be applied per unit area. To achieve this goal were defined the areas vulnerable to pollution with nitrates, the codes of good agriculture practices were developed as the programs of action for the protection of waters from pollution caused by nitrates formed from agricultural sources. The Directive has established the amount of nitrogen that can be applied per unit area of 170 kg N (Directive 91/676/EEC).

Any excess of nitrogen compounds in the soil can leaching in groundwater and can increase the concentration of nitrates in drinking water for the maximum permissible value of 50 mg/l.

Drinking water with high concentration of nitrates affects the human health. The studies indicate that 70% in the total contribution of nitrates come from fruits and vegetables, 21%

from water and the rest from meat. To avoid the adverse effects on human health, daily it is indicated to not consume nitrates over 3.7 mg/kg - body/day (Scăeţeanu and Pele, 2014).

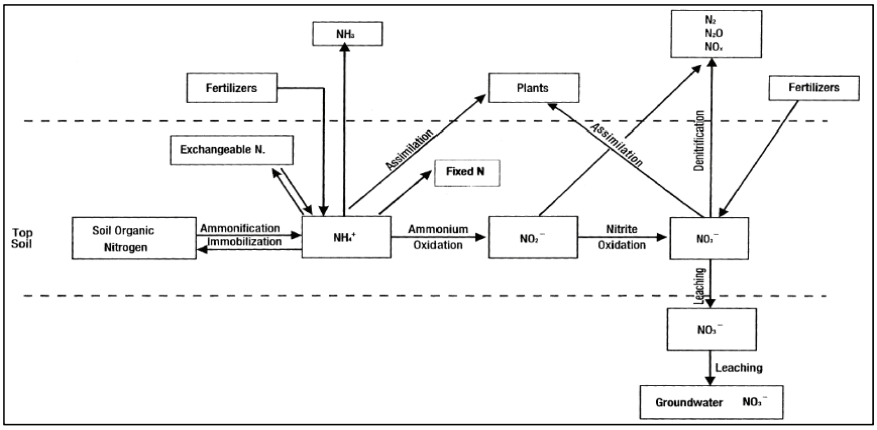

Figure 1. Nitrogen transformations in soil

To children nitrates cause the disease called methemoglobinemia: nitrates metabolize hemoglobin, the oxygen carrying component of red blood cells, into methemoglobin which is incapable of oxygen transportation. Due to the consequential color of the skin, this affection is known as Blue Baby Syndrome and mostly affects children less than six months of age.

MATERIALS AND METHODS

The water samples used in the study were seized from the countryside, located in the South-Eastern of Romania. The types of soil - chernozem (black earth) and the little slopes - allow the practice of agriculture and the cultivation of grain crops (ICPA Bucharest).

In 2013, in the same village, were measured the water quality parameters and were registered the concentrations of nitrates more than the maximum value allowed, for many of the samples analyzed.

To trace the dynamics of nitrate concentrations, in 2014 were analyzed, in May and July, samples of water obtained from the well of residents and street well.

The wells have a depth of 6 to 60 m. For analysis was used a multiparameter test well that offered data on the concentration of nitrates water analyzed, temperatures, carbon species, dissolved oxygen, chlorophyll, pH, ammonium, geographic coordinates, water depth. The system of pumping the water in the well does not always allow the introduction of test well. In this case used a container - a bucket - where to put water and insert the test well to measure.

In May 2014 were measured the water quality parameters in 7 well. The well number 2 and 3 are in the street, they are not system of pumping the water, it is not used a bucket to read the water quality parameters. The well number 1, 4, 5, 6 and 7 are in households, they have systems of pumping the water and, to read the water quality parameters, we used a bucket and put water.

In July 2014 were measured the water quality parameters in 7 wells. The well number 7 from July 2014 it is not the same with the well number 7 from May 2014. In July 2014, the well number 7 is a street well.

The analysis of water quality parameters was made in accordance with the applicable provisions (Law 458/2002; Law 311/2004).

RESULTS AND DISCUSSIONS

Table 1 reproduces the recorded values for the nitrates and ammonium concentration, in the water samples analyzed in May 2014.

After the degree of pollution caused by nitrates, water samples are analyzed and can be categorized: no pollution waters - nitrate concentration from 0 to 25 mg/l, low pollution

waters - nitrate concentration from 25 to 40 mg/l, water with the risk of pollution - nitrate concentration from 40 to 50 mg/l, water highly polluted - nitrate concentration from 50 to 100 mg/l, water very polluted - nitrate concentration more than 100 mg/l.

Table 1. Nitrate and ammonium concentration in water samples - Sohatu, May 2014

No. well	Recorded values with test well	
	Nitrates NO_3^- (maximum accepted concentration 50 mg/l)	Ammonium NH_4^+ (maximum accepted concentration 0.50 mg/l)
1	38.47	0.44
2	57.50	0.18
3	22.48	2.34
4	5.67	0.46
5	38.17	0.63
6	22.80	0.16
7	3.31	1.92

The dates from Table 1 show: 4 samples have values of nitrate concentration under 25 mg/l - the wells number 3, 4, 6 and 7 and the water is not polluted, the samples from wells 1 and 5 have values of nitrate concentration from 25 to 40 mg/l and the water is low polluted, the sample from well 2 has value of nitrates concentration from 50 to 100 mg/l and is a water highly polluted. In this well number 2, the value of nitrate concentration is more than value maximum accepted from 50 mg/l.
The results show great values for ammonium in samples from wells 3, 5 and 7.
In July 2014, the measurement of water quality parameters shows concentrations of nitrates as in Table 2.

Table 2. Nitrate and ammonium concentration in water samples - Sohatu, July 2014

No. well	Recorded values with test well	
	Nitrates NO_3^- (maximum accepted concentration 50 mg/l)	Ammonium NH_4^+ (maximum accepted concentration 0.50 mg/l)
1	21.22	0.13
2	21.53	0.16
3	15.29	0.08
4	0.54	5.25
5	23.77	4.92
6	9.35	0.96
7	21.51	0.18

The analysis of water samples from wells shows values of nitrate concentration from 0 to 25 mg/l. The water of wells is not polluted.
A comparison of the values registered for the nitrate concentration in the 6 wells analyzed in May and July 2014, shows a decrease in the value of nitrate concentration (Figure 2). The heavy rainfall can explain the low concentration of nitrate - the water was diluted and the concentration of nitrate was decreased.
According to statistics on rainfall, the years 2011-2012 are dry years and 2013-2014 are rainy years (Sandu, 2015). It is known that, in dry years, nitrates accumulate in the area from the root layer and groundwater layer. If, after dry years, succeed rainy years, nitrates, compounds of nitrogen soluble in water, penetrate into groundwater - called the piston effect.
The May 2014 was the most rainy month from 1961-2014, and July 2014 the fourth most rainy month from 1961-2014 (Sandu, 2015). The 2013, a rainy year, was succeeded by 2014, another rainy year, cause decrease of nitrate concentration as a result of dilution of water. This explains the little values of nitrate concentration in samples in May 2014, and less in July 2014. We can say that rainfall from 2013-2014 affects values registered for nitrate concentration in water samples analyzed in 2014.
The results in July 2014, show great values for ammonium in samples from well 4, 5 and 6. The presence of ammonium ions in water of well, may indicate o recent contamination with products of cellular decomposition from manure or waste water. The presence of one of nitrogen compounds in environment depends on the presence or absence of oxygen. In environment with low oxygen concentration, there are ammonium and nitrite; in environment with great oxygen concentration there is nitrate.
The studies indicate four main sources of pollution with nitrate: nitrates from the process of mineralization of waste and household waste, nitrates from waste or wastewater fermentation in the livestock sector, fermentation that is not controlled or is poorly conducted, nitrates from fertilizers, nitrates from mineralization of humus (ICPA

Bucharest, Ord. 1182/1270/2005). The order in which were given to the classes reflects the order as pollutants. The presence of nitrates in wells may be due: the natural composition of the soil, the use of chemical fertilizers with nitrogen, wells which are not covered and where not complied with conditions of hygienic and sanitary, the accumulation of nitrates in the area from root layer and groundwater layer, and penetrate into groundwater in dry years.

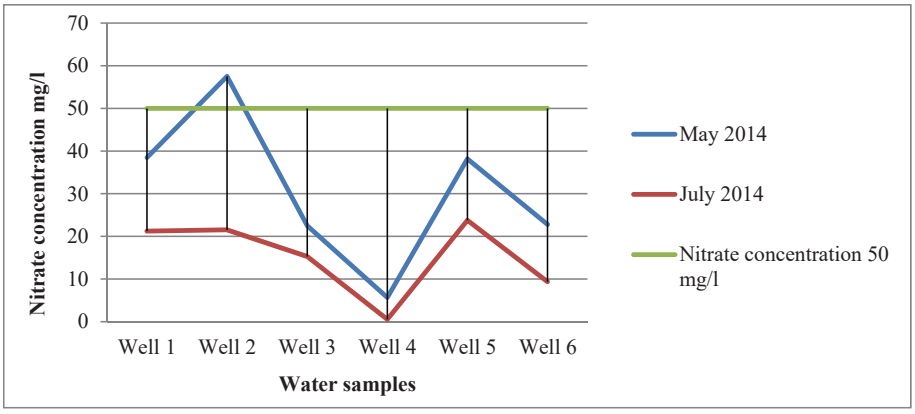

Figure 2. Nitrate concentration in wells, Sohatu, May-July 2014

The analysis of values registered for nitrate concentration in wells from Sohatu village, showed the following issues: in the wells from people that have animals (well 1, May 2014) or vegetables (well 6, May 2016) were registered great nitrate concentrations; great concentration were registered for street wells (wells 2, 3 and 7 - only July 2014). Low nitrate concentrations were found in wells that are deep - over 60 m. In addition, the street wells are not covered and not complied with conditions of hygienic and sanitary, the casings of the wells are fissured or deteriorated and the water from rain can infiltrate, the paving around the wells is missing or is fissured.

CONCLUSIONS

In this paper is present a study about monitoring of groundwater quality from Sohatu village, Călărași county. Water samples analyzed were from street wells or household wells.

In samples from street wells, elevated concentration of nitrates due to the fact that wells are not covered, hygienic and sanitary conditions are not good enough, the casings of the wells are fissured or deteriorated, the water infiltrated and get into the groundwater.

In samples from household wells, elevated concentration of nitrates due to the fact that sewage system is missing and wastewaters are discharged into the soil; the septic tanks do not have waterproofed walls and nitrate can get into the soil.

Wells are placed near latrine or stable.

Platforms for manure are missing and with rain, the liquid from manure get into the soil and into the groundwater and nitrate concentration increase.

Nitrates from fertilizers are accumulated, in dry years - 2011-2012, in the area from the root layer and groundwater layer; in the rainy years - 2013-2014, nitrates, compounds of nitrogen soluble in water, get into groundwater - increase nitrate concentration.

2013 and 2014 are rainy years and decrease the nitrate concentration as a result of dilution of water.

The presence of ammonium in water indicate a recent contamination with products of cellular decomposition from manure or wastewater.

For the protection of waters against pollution caused by nitrates from agricultural sources and for the prevention a new pollution, it is necessary to respect provisions from code of good agricultural practice and hygienic and sanitary conditions in order to place the wells.

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