



ASPECTS CONCERNING NITRATE AND NITRITE POLLUTION OF GROUNDWATERS

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ABSTRACT. – **Aspects concerning nitrate and nitrite pollution of ground waters.** Water is a basic natural resource for the good functioning of all the biological processes in nature. It is very important for life and for the development of human activities. The quality of the ground water has begun to degrade more and more, as a result of the physical, chemical and bacteriological changes. Nitrogen compounds pollution of the underground has increased lately. This has been caused by the excessive and irrational use of nitrogen derived fertilizers, by the wrong storage of the dejections resulted from zootechnical processes and by other chemical substances discharged into water. Samples were collected from different wells in order to check whether the well water was drinkable. The result of the test revealed the existence of high concentrations of nitrates as well as values exceeding normal microbiological parameters. The value recorded in the town of Segarcea, the county of Dolj, showed extremely high concentrations of nitrates of the drinking water in the wells. Thus, Segarcea is the town with the greatest number of contaminated wells in the country.

Keywords: nitrates, pollution with nitrates, groundwaters, methaemoglobinaemie.

1. INTRODUCTION

Drinking water is an essential component of the environment, and it has a major impact on the quality of life and on the population's health.

Water pollution consists in the alteration of the natural properties of water, as a result of external substances interferences, so that it can no longer serve the purposes it used to. This alteration process can be the consequence of natural phenomena, but it is generally caused by the industrial, agricultural and urban activities.

More than 6 million tons of pollutants are discharged both into water and on the soil yearly. Among these, the most common are: chlorides, nitrates, ammonia, phenol, detergents and pesticides. Irrational and excessive use of chemical fertilizers on the soil leads to its health deterioration. A negative consequence of the process of abusive chemicalization is that mineral substances such as nitrates accumulate both in the soil and in the ground waters, reaching harmful concentrations.

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The most frequent causes of the nitrate contamination of the underground environment are numerous. Some of the major polluting causes are: the nitrous-oxide-impregnated soil is continuously washed by rainfalls, by the irrigation water, as well as by the surface water (rivers, lakes) where nitrate containing water has been discharged. Apart from these quasi permanent sources, there are also the random sources, consisting in the use of the fertilizers that are derived from nitrogen [17].

Nitrates (NO_3^-) are very harmful when they reach high concentrations, but such concentrations are rarely met in water. Nevertheless, the maximum limit of nitrate concentration is often exceeded in the drinking water in Romania.

A higher toxicity is met especially in nitrites (NO_2^-), which are derived from nitrates in certain conditions. Once they are absorbed into the body, they combine with the hemoglobin and result in methaemoglobinaemia, (unable to fix and transport oxygen), which leads to anoxia manifested by cyanosis, anoxia, asphyxia, gastric cancer due to the nitrosamines resulted in certain conditions. In case of concentrations between 3% and 15%, there are changes in the tegument coloration: pallor, grayish or bluish hues. In case of concentrations between 25% and 50%, the symptoms are the following: headache, photophobia, weakness, confusion, dyspnea, palpitations and chest pain. If the concentration is between 50% and 70%, delirium or mental alteration may occur.

Many patients suffering from chronic methaemoglobinaemia show no symptoms. The patients who are exposed to different medications or toxins that rapidly produce the same values that metHM has in chronic patients, can show a severe symptomatology [13].

The consumption of nitrite-contaminated water is harmful especially for infants because of the low blood volume, but also because of their alkaline pH which enables the nitrates to turn into nitrites.

2. TEMPORAL ANALYSIS

In our country, there were 2346 cases of methaemoglobinaemia in infants (less than 1 year old) and 80 deaths; mortality reaching hight values between 1984 and 1995. It is believed that this figure is much underestimated because of the difficulty to diagnose this condition. The morbidity rate increases mainly because of the drinking water contaminated by faeces, but also because of the widespread use of fertilizers in agriculture [12].

In 1994, The Institute of Public Health (Institutul de Sanatate Publica) initiated a program concerning methaemoglobinaemia caused by well waters. About 715 cases were recorded in Romania between 1996 and 2000, with a 0.28% mortality rate.

In 2000, there were 453 cases of acute juvenile methaemoglobinaemia recorded in children aged between 0-1 years old. The mortality rate was 0.9%. The average occurred was 0.033% (the number of cases/1000 new-born babies in the village). The nitrate concentration was between 46-560 mg NO_2/l [15].



The following data originate from The Annual Report of the Institute of Public Health - Bucharest.

Table 1. Water quality between 1997-2000 in the rural settlements where severe cases of methaemoglobinemia were recorded

County	Year	No.of tested wells	No. of wells with NO ₂ concentration >100 (mg/l)	No. of wells where the total no. of coliforms was exceeded	No. of wells where the total no. of fecal coliforms was exceeded
Botoșani	1997	39	36	26	22
	1998	59	44	27	38
	1999	48	33	20	39
Dolj	1997	282	72	226	172
Gorj	1996	3	1	3	0
	1997	5	5	5	3
Iași	1997	87	45	56	77
	1998	81	23	27	49
Ilfov	1997	2	-	0	0
Galați	1999	26	15	6	13
Teleorman	1998	5	2	4	2
Vaslui	1999	4	0	4	1
Covasna	1997	2	2	0	0
	1998	3	3	2	2
TOTAL		646	213	406	417

The quality of ground water in our country has reached an inappropriate level, and more than half of Romania's surface is exposed to nitrate pollution.

3. SPATIAL ANALYSIS

In order to test the quality of the ground water, many samples have been collected from the wells in the town of Segarcea, county of Dolj, as well as from the wells in the villages and towns neighbouring the Nicoresti-Tecuci irrigation system: Podoleni, Salcia and Tecuci.

The samples for the microbiological analyses were collected by pouring. The techniques of pumping, streaming, inserting the probe into the bucket, or collecting the samples straight from the bucket of the well were avoided.

The prelevation and the transportation of the samples met the standards SE EN ISO 19458/2007 – Water Quality. Prelevation for Microbiological Analysis.

There are many wells with contaminated water (substances such as nitrates, nitrites, chlorides and faeces) not only in the villages, but also in the towns of the county of Dolj. The physico-chemical analyses conducted in The Water Microbiology and Chemistry Laboratory within ASP Dolj, as presented in the table below, showed that the nitrate levels were much over the admitted threshold.



Table 2. Values exceeding water quality thresholds in the wells of the town wells Segarcea, the county of Dolj

Units for testing	U.M.	Recorded values	Thresholds - Law 458/2002; Law 311/2004
Well of D. Viilor Street	mg/l	323	50
Well of Rozelor Street	mg/l	378	50
Well of Hăniciei Street	mg/l	395	50

The pollution of the ground water in Segarcea is much over the admitted threshold. The water is not suitable for drinking, and it can only be used for household purposes. The results of the bacteriological analysis also showed the presence of faeces in water: 20 mg/l in the water of the well of Hăniciei Street and 40 mg/l in the water of the well of Transilvania Street.

In the town of Tecuci as well as in communes of Podoleni and Salcia, the concentration of nitrates and nitrites in the ground water reached a higher value than during the previous years. The use of nitrogen derivated fertilizers in the neighbouring agricultural fields may be a possible cause for this. Denitrifying bacteria reduce the nitrates and the nitrites into ammonia, azotites and sometimes into molecular nitrogen. The process of denitrification can take place both into water and on the soil level of the organic substance is high.

The data concerning the level of the azotates and azotites in the wells of the town of Tecuci and of the communes of Salcia and Podoleni were collected from the Annual Report of the Environmental Monitoring - stage 2008; this was accomplished during the project "Reform and Rehabilitation of the Irrigation Systems", contract no. 4212/6135/2008, between the Ministry of Agriculture and Rural Development as a beneficiary and S.C. AQUAPROJECT S.A. as consultative party in matters regarding the rehabilitation areas within the irrigation system Terasa Nicoresti – Tecuci and Sadova Corabia. They are shown in table 3.

Table 3. Data concerning the level of the azotates and azotites in the wells of Tecuci, Salcia and Podoleni

Units for testing	U.M.	NO ₃	NO ₂
Well of Tecuci	mg/l	27.52	0.1166
Well of Salcia	mg/l	99.20	0.0408
Well of Podoleni	mg/l	79.60	0.0550

High levels of azotates were recorded in the well of Salcia: 99.20 mg/l and in the well of Podoleni: 79.20 mg/l, whereas the maximum admitted limit is 0.50 mg/l. Nitrite indicator, of wells analyzed, remains within acceptable limits with values less than 0.50 mg/l.

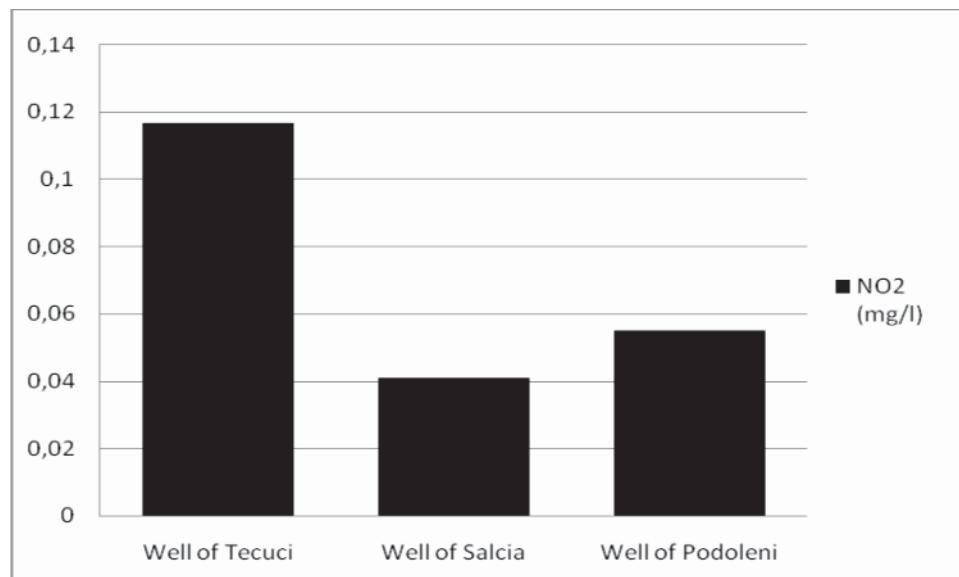


Fig. 1. Variation of the azotite concentration for the tested wells

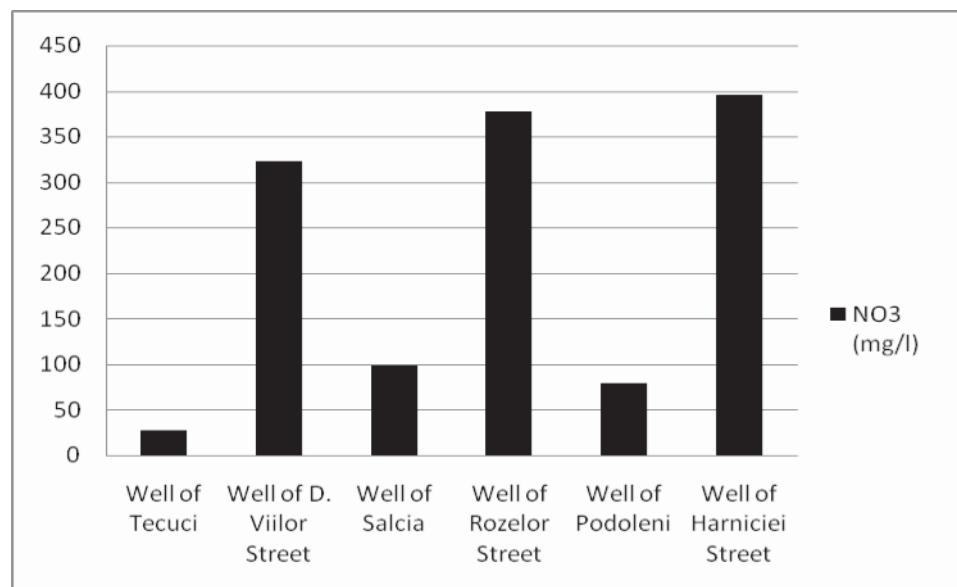


Fig. 2. Variation of the azotate concentration for the tested wells



4. MICROBIOLOGICAL ANALYSIS

The wells that were tested also showed dense microbiological flora, such as: Escherichia Coli, enterococci, coliform bacteria and colonies (germs at 37°C), which are potentially dangerous for people's health because they can alter the quality of drinking water.

The results following the analysis regarding the physico-chemical and bacteriological indicators were collected from the Annual Report of the Environmental Monitoring – stage 2008, conducted by S.C. AQUAPROJECT S.A., within the project "Reform and Rehabilitation of the Irrigation System"; they are presented in table 4.

Table 4. Values exceeding water quality thresholds - microbiological parameters – in the wells used locally for drinking

Section	Recorded values			
	Escherichia coli	Enterococci	Coliform bacteria	Total no.of colonies at 37°C
Tecuci, the well on 122 Ana Ipatescu Street	24	6	33	>300
Salcia, the well on 288 Main Street	9	4	14	128
Podoleni, the well on 103 Main Street	400	53	600	>300
Thresholds - Law 311/2004	0	0	0	0

The highest values of microbiological parameters were found in the well of Podoleni, where the value for Escherichia Coli was 400/100 ml, for enterococci was 53/100 ml, for coliform bacteria was 600/100 ml, and more than 300 for colonies developing at 37°C. Compared to these results, the well of Salcia showed only 9 escherichia Coli/100 ml, 4 enterococci/100 ml, 14 coliform bacteria/100 ml and 128 colonies developing at 37°C; nevertheless, the water in this well is not drinkable, either.

Other dangerous microorganisms were also found in the contaminated water: Giardia, Proteus vulgaris, Salmonella and the hepatitis virus which causes the disease called leptosirosis.

5. CONCLUSION

The analyzed data show that ground water pollution, especially due to the discharge both on the soil and into water of various pollutants such as pesticides, chemical fertilizers derived from nitrogen, detergents, ammonia and chloride, has a



negative impact on the quality of the drinking water, on the neighbouring ecosystems and on people's lives quality.

If nitrate-contaminated water is consumed, it affects people, especially infants, because it combines with the hemoglobin and it causes methaemoglobinaemia, which, most frequently, leads to death.

According to the results of the analyses regarding the physic-chemical indicators of the water samples collected from the tested wells, the concentration of azotates in the drinking water exceeded the maximum admitted limits (the highest concentrations were found in the wells of the town of Segarcea, county of Dolj); in additional, the microbiological flora was very dense, indicating the presence of different types of bacteria, enterococci and other microorganisms which make the water in the tested wells undrinkable, and which are a great danger for the population.

In order to reduce the high levels of nitrates in the water, a possible solution can be finding an alternative to supply the population with water, or treating the water within a plant where the water quality indices are continually being monitored; for agricultural activities, it is recommendable that the farmers should be checked on whether they use the appropriate quantity of fertilizers.

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