

## **GROUNDWATER AND SURFACE STATUS OF THE SIRET RIVER BASIN FROM THE POINT OF VIEW OF NITRATE CONCENTRATIONS FROM AGRICULTURAL SOURCES; ANALYSIS AND TRENDS**

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### **Abstract**

View of the state and the trends in aquatic environment, as well as agricultural practices carried out in accordance with the requirements of Directive 91/676/EEC transposed in the Romanian legislation by HG 964/2000 concerning the protection of waters against pollution caused by nitrates from agricultural sources, analysis and assess concentrations of nitrate in surface waters (rivers, lakes/accumulations, transitional waters, coastal waters and waters marine) and groundwater, for the purpose of establishing and/or revision of vulnerable zones the pollution with nitrates from agricultural sources. The work proposes a characterisation of the catchment area of the groundwater and surface of Siret river from this point of view, as well as trends in the evolution of nitrate concentrations measured in the sections/stations control and monitored in the period 2004-2011.

**Keywords:** vulnerable areas, nitrates, evolutionary, trends

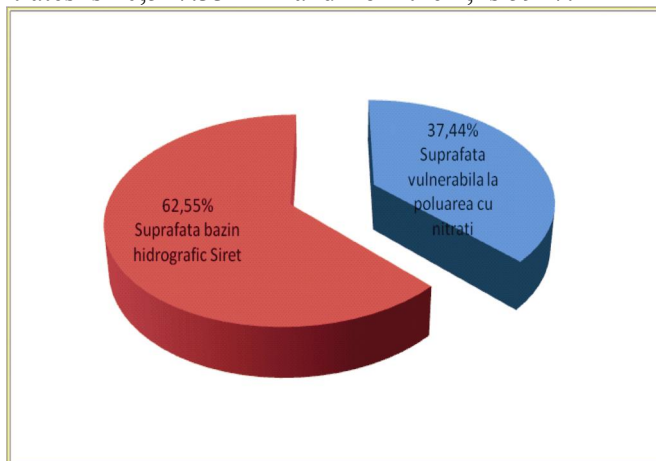
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Water quality is important both for human health and ecosystems balance and protecting it is a pan-European environment policy. To solve the problems related to pollution, the European Union issued a comprehensive legislative framework for environmental protection. The Nitrates Directive is one of the first EU legislation published in 1991, designed to control pollution and improve water quality. The Nitrates Directive is closely linked to other EU policies on water, air, climate change and agriculture, and the implementation of its brings benefits in many areas. Reduction of nitrates is part of the Water Framework Directive, which establishes a comprehensive and border on water protection organized around river basin (RBD) in order to achieve good European water bodies by 2015, and groundwater directive confirms that the threshold value for maximum allowable concentrations of nitrates is 50 mg / l. The Directive 91/676/EEC regarding the protection of waters against pollution by nitrates from agricultural sources transposed into national legislation by Government Decision no. 964/2000, intend to protect thr water quality by preventing pollution of groundwater and surface of the nitrates from agricultural sources and by promoting the Code of good agricultural practice. Implementation of the Directive requires complies with basic requirements related to:

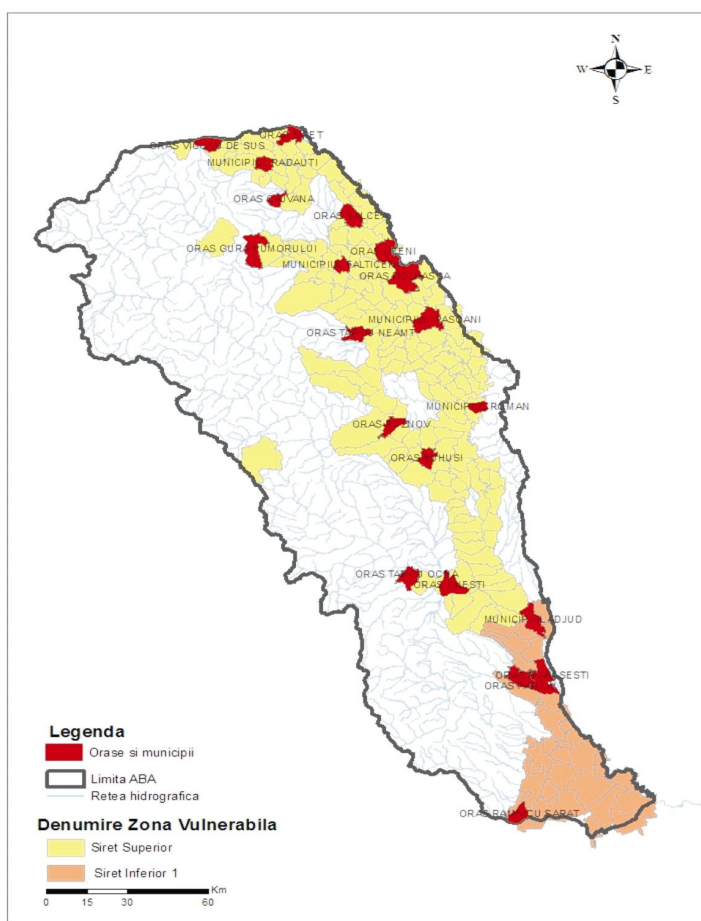
- identifying waters affected by nitrate pollution or likely to be exposed to such pollution, establish of appropriate monitoring and control programs and prepare the cadastre of these waters;
- asignation of the vulnerable areas that drain into waters affected by nitrate pollution or likely to be exposed to such pollution and contribute to their pollution;
- developing a code of good agricultural practices and programs on training and information to farmers to promote the code;
- establish, implement and entry into force of action programs to prevent and reduce pollution caused by agricultural sources.

Identification of vulnerable areas was made by "National Research and Development Institute for Soil Science and Agrochemistry and Environmental Protection", along with the National Administration "Romanian Waters" based on the assessment of areas with potential natural conditions of transmission of nitrates from agricultural system to water bodies surface and groundwater. The report for the Commission on how to implement the Directive in 2004 were identified the nitrate vulnerable zones, the areas of agricultural land in the country which diffuse runoff drains polluted waters or are exposed to pollution by nitrates from agricultural sources, sources that contribute to water pollution. In 2004-2007, the nitrate vulnerable zones in the Siret river basin, were 54 municipalities in four counties, which means an agricultural area of 1708 km<sup>2</sup> (about 5.8% of the total land area). Results of analyzes performed in that period and the need of bordering the vulnerable areas (which is done every four years), required expansion areas designated as vulnerable surfaces, including potentially vulnerable areas, from 5.8% to 37.44 % of the Siret river Basin. Thus,

according Order of the Ministry of Environment 1552/2008, were identified a total of 203 localities where there are sources of nitrates from agricultural activities. The total area located in vulnerable areas and potentially vulnerable to nitrates is 10,527.33 km<sup>2</sup> and from them, is 5947.12 km<sup>2</sup> agricultural area.



**Fig. 1 Share of vulnerable zones in Siret RB**



**Fig. 2 Nitrate vulnerable zones in Siret RB.**

For the implementation of Directive 91/676/EEC on the protection of waters against pollution by nitrates (nitrogen) from agricultural sources, the National Administration "Romanian Waters" is responsible for monitoring the groundwater and surface waters to identify and cadastre affected by nitrate pollution or likely to be exposed to such pollution in order to establish and / or review of areas vulnerable to nitrate pollution from agricultural sources. In this respect, are controlled nitrate concentrations in surface waters and underground sections / drilling control and status checking is eutrophication (freshwater and coastal waters). Concentration limits for nitrates in water is 50 mg / l, given current standards. This requires proper management of agricultural activities and prevent eutrophication of surface waters. The action plans contained in GD 964/2000 (amended GD 1360/2005 and GD 210/2007) to follow the nitrate content of

groundwater and surface water, measured in monitoring points established by the National Administration "Romanian Waters" and the soil monitoring points established by the National Research development of Pedology, Agrochemistry and Environmental Protection-ICPA Bucharest.

These actions plans specific to each locality situated in vulnerable areas, the measures implemented are aimed in: reducing pollution caused or induced by nitrates from agricultural sources and prevent water pollution by nitrates, rationalization and optimization of chemical and organic fertilizers by applying the Code of Practice agricultural. The first report issued by the European Commission containing the monitored period 2004-2007, based on analyzes leded by AN "Romanian Waters" Water Basin Administration Sirena on a number of sections 122 and 157 surface water monitoring points for groundwater. The second report issued by the European Commission includes monitoring period 2008-2011, in which were evaluated the results of analyzes performed on a total of 46 surface sections (33 rivers and 13 natural lakes and storage) and 284 wells (Table no.1).The selection criteria of the sections are taken into account their location in ZV and downstream of it, if sections used for surface water extraction for drinking purposes, if sections are representative of TNMN and EIONET network with four years of monitoring in the reporting period, or specific sections (middle lake dam / lake outlet) for natural lakes / reservoirs. Quality elements and analyzed parameters reefer to: nutrients (nitrate, nitrite, total nitrogen, phosphates and total phosphorus), dissolved oxygen and organic chemicals (measured by BOD5), transparency (Secchi disk) and chlorophyll. The Monitoring frequency for surface water is 4-26/year. The analysis of the nitrate concentrations in groundwater evaluation was made considering the quality of data from the 284 monitoring points, frequency of monitoring is the sixth year (for all wells and springs) and for points 2/an operational monitoring program, including those located in vulnerable areas.

**Table 1 Groundwater monitoring sections**

Type of ground water	Number of wells monitored 2004-2007	Number of wells monitored 2008-2011	Number of common wells of two reports
<b>Groundwater table (0-5)</b>	49	67	33
<b>Groundwater table (5 -15)</b>	90	150	63
<b>Groundwater table (15 -30)</b>	17	48	12
<b>Groundwater table &gt; 30m</b>	3	19	1
<b>Captive groundwater (under pressure)</b>	-	-	-

Concentrations of the oxide resulting from agricultural activities is reflected in the groundwater quality. The last report on their implementation of Directive 91/676/EEC, it is found that 89.97% of monitoring points have average values below 50 mg / l and 78.52% of these maximum values as limit. (Table no.2).

**Table 2 Classification of wells (including springs) according to the average and maximum concentrations of nitrogen (expressed as the number of wells / springs) in b.h Siret**

Type of ground water	Number of drilling monitored	No. wells with average values > 50mg/l NO3	Nr. wells with maximum value >50 mg/l NO3
<b>Groundwater table (0-5)</b>	67	3	14
<b>Groundwater table (5 -15)</b>	150	14	29
<b>Groundwater table (15 -30)</b>	48	11	15
<b>Groundwater table &gt; 30m</b>	19	3	3
<b>Captive groundwater (under pressure)</b>	-	-	-

For a more accurate determination of the pollution of aquifers, the concentration of nitrogen was calculated on different levels of depth: 0-5m, 5-15m 0.15-30m,> 30m. Analyzing data summarized in Table 2, we find that higher values of averages and peaks were recorded nitrate concentrations in groundwater table

to comprise between 5-15m depth, located in the groundwater body ROSI03-Meadow Siret and its tributaries (fig. no. 3).

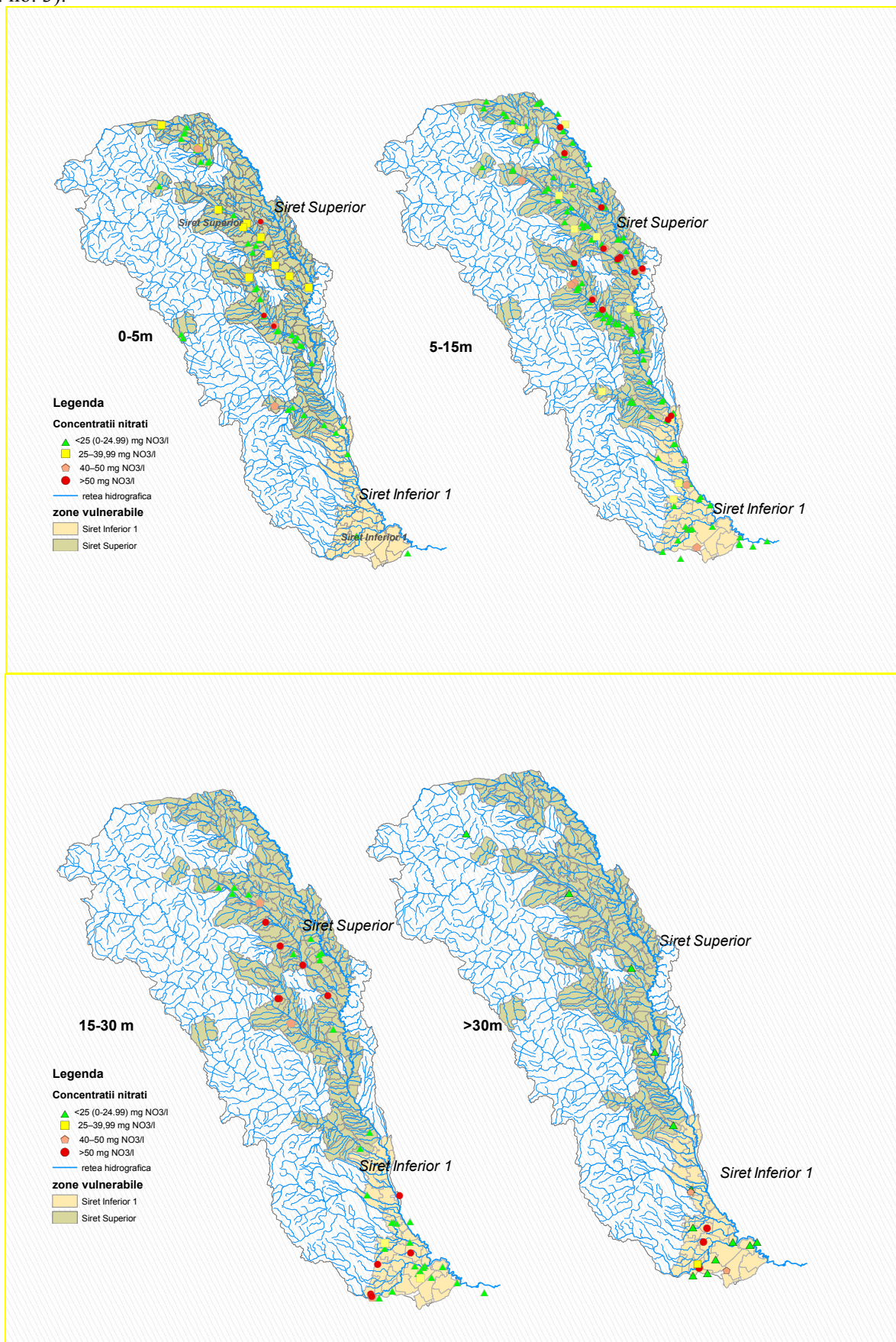


Fig. 3 Evaluation of nitrate concentrations in groundwater in Siret RB.

As the groundwater source is deeper, the more it tends to be cleaner, this is shown in the analysis and plotted. The Aquifer pollution with nitrates causes are multiple and can be cumulative in nature. Sources with significant share in pollution of groundwater with nitrates may be due to permanent Laundering soil impregnated with oxides of nitrogen by atmospheric precipitation. Also, water from irrigation and surface water (rivers, lakes) that were discharged waste water loaded with nitrates, can be sources of contamination of aquifers. They have long lasting character, but the character they add randomly generated sources of chemical and organic fertilizer application on some categories of arable land in farms of improper storage manure, etc.. The excess of nutrient concentrations can still be registered in the chemical platforms (or former chemical plants) and the large animals farms (current or historical), but these overruns are specific, typically found in their premises. Looking at the hydrodynamic and hydraulic conductivity of the water, these sources are a fairly high risk of contamination of aquifers in the area. Analyzing the average and maximum concentrations of nutrients for both the reporting period, we can say that in terms of groundwater quality there is a tendency to exceed the threshold allowed by 50mg / l for for aquifers at depth 5-15m. This can be seen in Table no.3.

**Table 3 Trends in the evolution of nitrate concentrations in groundwater in b.h.Siret**

Type of ground water	Number of wells monitored	No. wells with average values > 50mg/l NO3	No. wells with maximum values >50 mg/l NO3
Groundwater table (0-5)	67	8	9
Groundwater table (5 -15)	150	16	25
Groundwater table (15 -30)	48	2	4
Groundwater table > 30m	19	-	-
Captive groundwater (under pressure)	-	-	-

Regarding the water surface quality as calculated, this shown that the rivers, natural lakes and accumulation of Siret BR, in the monitored sections have no cases of exceeding the limit of 50 mg/l (Table no.4)

**Table 4 Classification of monitoring sections according to the average concentration of parameter nitrates**

Type of surface water	Total	>50 mg NO3/l
Rivers – average	33	0
Rivers– winter average	33	0
Rivers –maximum value	33	0
Lakes– average	13	0
Lakes– winter average	13	0
Lakes – maximum value	13	0

**Table 5 Classification tendency regarding eutrophication in function of chlorophyll a (expressed as the number of sections)**

Type of surface water	<-5µg/l chlorophyll a	Intre -5 si -1 µg/l chlorophyll a	Intre -1 si +1 µg/l chlorophyll a	Intre+1 si +5 µg/l chlorophyll a	>+5µg/l chlorophyll a
Rauri	0	0	4	0	1
Lacuri	0	4	1	7	0

The data presented above, we can see that water quality status in monitored lakes in sections is good, reveals a slight increase in chlorophyll, which supplies information on biomass and photosynthetic activity.

Currently, the "Code of Good Agricultural Practice" adopted by Ord 1270/2005, to reduce pollution from agricultural fertilizers and soil degradation phenomena prevent damages caused by agricultural practices. Under this code, account of conditions specific to each region of the country, located in vulnerable areas such as: compliance periods for land application of fertilizer avoiding freeze-thaw periods, the land application of fertilizer to steeply sloping, conditions land application of fertilizer to water-saturated, flooded, the land application of fertilizer near water courses, maintaining topsoil during rainy periods for nitrogen from soil, preventing water pollution.

## **COCLUSIONS**

The requirements of Directive 91/676/EEC on the protection of waters against pollution by nitrates from agricultural sources were implemented in each village located in vulnerable areas, including measures action programs, deadlines for completion and financing sources. Besides farming, an important contribution to pollution with nitrates and nutrients, in general, have urban agglomerations that are not consistent in terms of collection systems (sewers) and treatment plants (Otherwise, lack of speed treatment, lack of modernization, malfunction, etc.). Even if in evolution was a decreasing trend of the influence of pollution sources on groundwater aquifers, significant reduction in recent years due to industrial production and agro-livestock production, but also through the implementation of wastewater treatment measures, groundwater quality has remained poor because of their slow self-cleaning. Looking on assessments made, the most intense forms of multiple depreciation remain the groundwater quality in certain areas, especially in rural areas where, due to lack of minimum facilities equipped with utilities, go underground liquid waste, both in directly (through waterproof latrines, ditches and drains, etc.) and indirectly by slow infiltration (from deposits of manure, garbage pits improvised etc.). In this respect, is necessary a rigorous management of waste by building, expanding or upgrading sewage treatment plants, aquifer pollution mainly because it is an almost irreversible and has serious consequences for using groundwater reserves to supply drinking water. Remediation of groundwater water sources is extremely difficult and sometimes impossible. It is necessary that in addition to the Code of Good Agricultural Practice to be local, regional, media, information sessions and public awareness regarding the causes and effects of water pollution of both surface and underground, the impact it may have on drinking water quality and thus human health. Integrated Pollution Control Project with World Bank funded Nutrients funds Global Environment Facility (GEF), the Romanian government and participating local councils, supports the implementation of the Nitrates Directive as follows: (a) reduction of nutrient discharges into bodies of water (b) promoting behavioral change at the regional level, and (c) support for strengthening the regulatory framework and institutional capacity. Global environmental objective is long-term reduction of nutrient discharges into the waters flowing into the Danube and Black Sea, through integrated management of soil and water.

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Project Integrated Nutrient Pollution Control, MMDD Bucharest, 2009

Government Decision no.964/2000, approving the Plan of action for protection of waters against pollution by nitrates from agricultural sources

[www.inpcp.ro](http://www.inpcp.ro).