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ANALYSES OF THE NITRATES CONCENTRATIONS EVOLUTION IN WATER RESOURCES ACCORDING WITH THE EUROPEAN DIRECTIVES REQUIREMENTS

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Abstract

One of the most significant water management issues is water pollution with nitrates. Council Directive 91/676/EEC (Nitrates Directive) concerning the protection of waters against pollution caused by nitrates from agricultural sources was fully transposed in the national legislation through Government Decision nr. 964/2000 on the approval of the Action Plan for the water protection against pollution with nitrates from agriculture sources. The surveillance of nitrates level in surface waters and in groundwater in the monitoring sites and checking the surface waters trophic status (both fresh and marine/coastal waters) are done for identification and mapping the affected waters or those which could be affected by pollution with nitrates. This is necessary, in order to protect human health and aquatic ecosystems to reduce water pollution caused or induced by nitrates from agricultural sources and to prevent further such pollution. Maximum value for nitrates in drinking water (Law no. 458/2002 which transpose Drinking Water Directive), in surface water (GD 100/2002 which transpose the European Directive 75/440/EEC) and in groundwater (GD 53/2009 that transpose European Directive 2006/118/EC) is 50 mg/l NO_3. In order to identify the water affected or likely to be affected by nitrates from agricultural sources, the following criteria are used:

- Exceeding of the limits set by legislation for surface water used for drinking purposes;
- Exceeding of the limits set by legislation for groundwater used for drinking water abstraction;
- Freshwater sources (natural lakes, reservoirs, canals), coastal and marine waters are eutrophic or may become eutrophic in the near future.Based on analytical data (average, minimum and maximum values) obtained in each monitoring section, the surface water and groundwater quality assessment should be done. Very important is also the trend assessment of the nitrates concentrations both in surface and groundwater. For this purpose, the monitoring data considered are physico-chemical parameters: nitrates, nitrites, total nitrogen, phosphates and total phosphorous, dissolved oxygen and organic substances (measured through BOD_5), chlorophyll "a" (in those stations were the risk of eutrophication exists). To identify the eutrophication phenomena, is necessary to use the monitoring data obtained especially in summer period.

Keywords: vulnerable zones, eutrophication phenomena, trend value, pressure and impact analyses, point and diffuse pollution, environmental objectives.

1.INTRODUCTION

The Nitrate Directive 91/676/EEC on water protection against pollution with nitrates from agriculture sources was fully transposed in the Romanian legislation through the Government Decision nr. 964/2000 for the approval of the Action Plan for the water protection against pollution with nitrates from agriculture.

The main requirements of the Action Plan are:

- Identifying waters affected by nitrate pollution or susceptible to pollution and establish the appropriate monitoring programes;
- Identification and designation of the vulnerable zones and potentially vulnerable zones;
- Developing a code of good agricultural practices and programes for training and information of the farmers in order to promote this code;
- Development, implementation and put in practice of the action programs.

2.MONITORING NETWORK

At the end of 2006, the National Administration "Apele Romane" has completed the designing of the Integrated Water Monitoring System, taking into consideration the provisions of the Water Framework Directive 2000/60/EC and of the others EU Directives in the water field, including the Nitrates Directive 91/676/EC.

The National Monitoring System integrates:

- Investigation area: surface waters: rivers, natural lakes/reservoirs, transitional waters, coastal waters; groundwaters; wastewaters;
- Investigation media: water, sediments/suspended solids, biota;
- Monitored elements: physico-chemical, biological, microbiological and hydro-morphological.

For the implementation of the Nitrates Directive, National Administration "Apele Romane" has as main task the water monitoring for identification and mapping the affected waters or those which could be affected by pollution with nitrates, in order to establish or review the nitrates vulnerable zones (Figure 1).

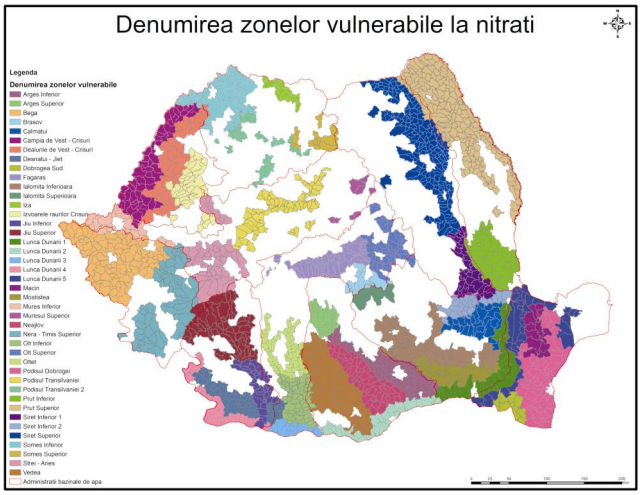

Figure 1. Nitrates Vulnerable Zones in Romania

In the process of establishing the monitoring program, pressures from agricultural sources and their impacts, as well as, the identified vulnerable zones have been taken into consideration.

2.1. Groundwater monitoring network

The monitoring of the groundwater is made taking into consideration all the parameters required by the Water Framework Directive (WFD), including nutrients (nitrates, nitrites, ammonium, phosphates), with the frequency of 1/6 years (all wells and springs) for surveillance monitoring programs and with 2-4/year frequency for the monitoring points of the operational program, including those located in vulnerable zones. The monitoring results obtained from 1809 monitoring points have been analyzed and groundwater quality assessment was performed according to the types of groundwaters. Different types of phreatic layers were analyzed (0-5 m; 5-15 m; 15-30 m; >30 m) and also the captive and karstic groundwaters. The assessment of the trend evolution was realized having in view the monitoring results obtained in 930 common monitoring points between the current and the last period of analysis.

2.2. Surface monitoring network

For surface waters (rivers, lakes, costal, transitional and marines), the monitored quality elements/parameters have been established in accordance with the WFD requirements. Thus, among the monitored physico-chemical parameters are nutrients (nitrates, nitrites, inorganic nitrogen, total nitrogen, phosphates and total phosphorous), dissolved oxygen and organic substances (measured through BOD_5), transparence (Secchi disc), and chlorophyll "a" (in those stations where the risk of eutrophication exists). In general, these mentioned parameters are monitored with frequencies between 4-26 times/year. In the relevant sections for the agricultural pressures, sampling frequencies are consistent with the Nitrates Directives requirements (12/year) but other sections were selected for a comprehensive assessment of surface water body status even if the frequencies is lower. Surface water quality assessment was performed in 1186 monitoring sections. The trend of nitrate concentrations was assessed in 1039 common monitoring sections having in view current evaluation period (2008-2011) prior to the last evaluation performed between 2004 - 2007.

3. ASSESSMENT OF NITRATES CONCENTRATION IN GROUNDWATER

The nitrates concentrations in groundwater have been assessed taking into account both *average and maximum* concentrations registered in the period 2008 – 2011 in all monitoring section (1809 monitoring points) at the national level as well as in vulnerable zones (1711 monitoring points).

The performed analysis regarding the average values for all monitoring points (wells and springs) has pointed out that approximately 85 % from these points were recorded values below 40 mg/l nitrates and 11.50 % from these points are more than 50 mg/l nitrates. Regarding the maximum values of the nitrate concentrations, the analyses has pointed out that 74.52 % from the all monitoring points have below 40 mg/l nitrates and 21.28 % from total have more than 50 mg/l nitrates, which represents standard limits for nitrates according Drinking Water Law no. 458/2002 (Figure 2).

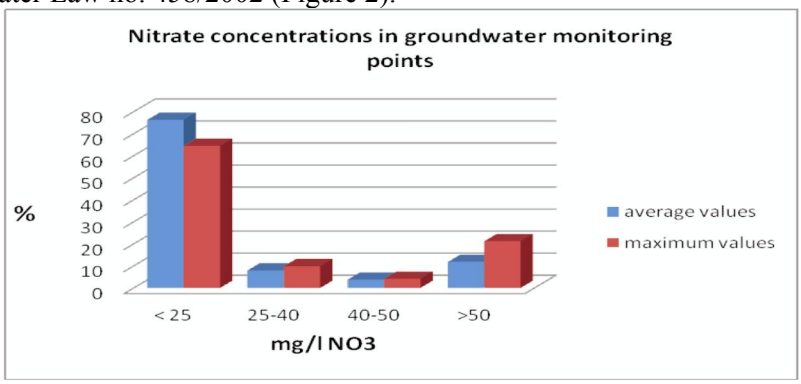

Figure 2. Monitoring points depending on the nitrates concentrations

The same situation is found regarding the average values for monitoring points placed in vulnerable zones: 1443 monitoring points of 1711 total monitoring points had concentrations below 40 mg/l nitrates and in 203 monitoring points, the average values exceed the 50 mg/l nitrates. Regarding trends (between the current and previous analyzed period) in 930 common groundwater monitoring points for nitrates concentrations based on average values, decrease trend was recorded in 42.36 % and increase trend was recorded in 36.34 %. Regarding trend evaluation for nitrates concentrations based on maximum values, decrease trend was recorded in 46.13 % and increase trend – in 43.87 % from all monitoring points. High concentration of nitrates are recorded in the plains area (Câmpia Romana, Southern Oltenia, Campia de Vest) and less in the hilly area (Podisul Moldovei and Depresiunea Colinara a Transilvaniei).

4. ASSESSMENT OF NITRATES CONCENTRATION IN SURFACE WATER BODIES

Assessment of nitrates concentrations in surface waters was done taking into account average concentration, winter average (October to March) and the maximum concentration registered in the analyzed period (2008-2011) in all monitoring section (1186 monitoring points) at the national level (Figure 3) as well as in all 42 vulnerable zones (861 monitoring points).

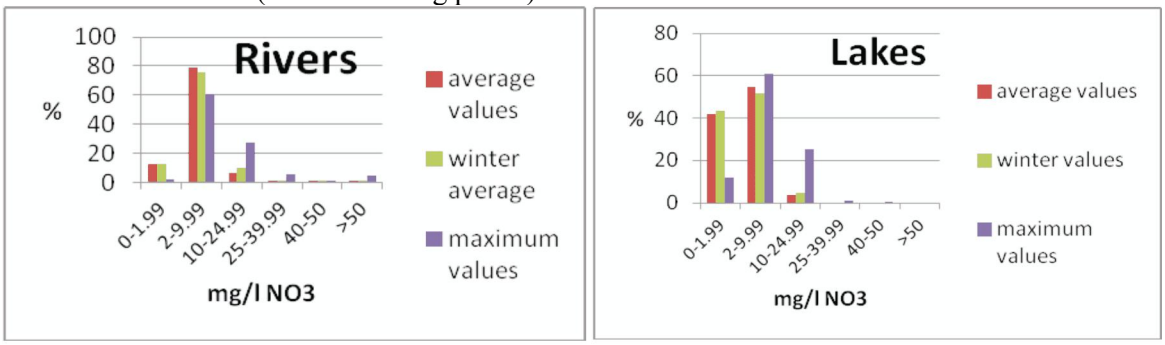

Figure 3. Monitoring sections based on nitrates concentrations at the national level

The performed analysis based on average values established that in 99.23 % of rivers monitoring sections (Figure 4) the values are below 50 mg/l nitrates and a small number of sections registered values greater than the limit value of 50 mg/l NO_3. For lakes, in all monitoring sections (Figure 5) the nitrates concentrations values are below limit value.

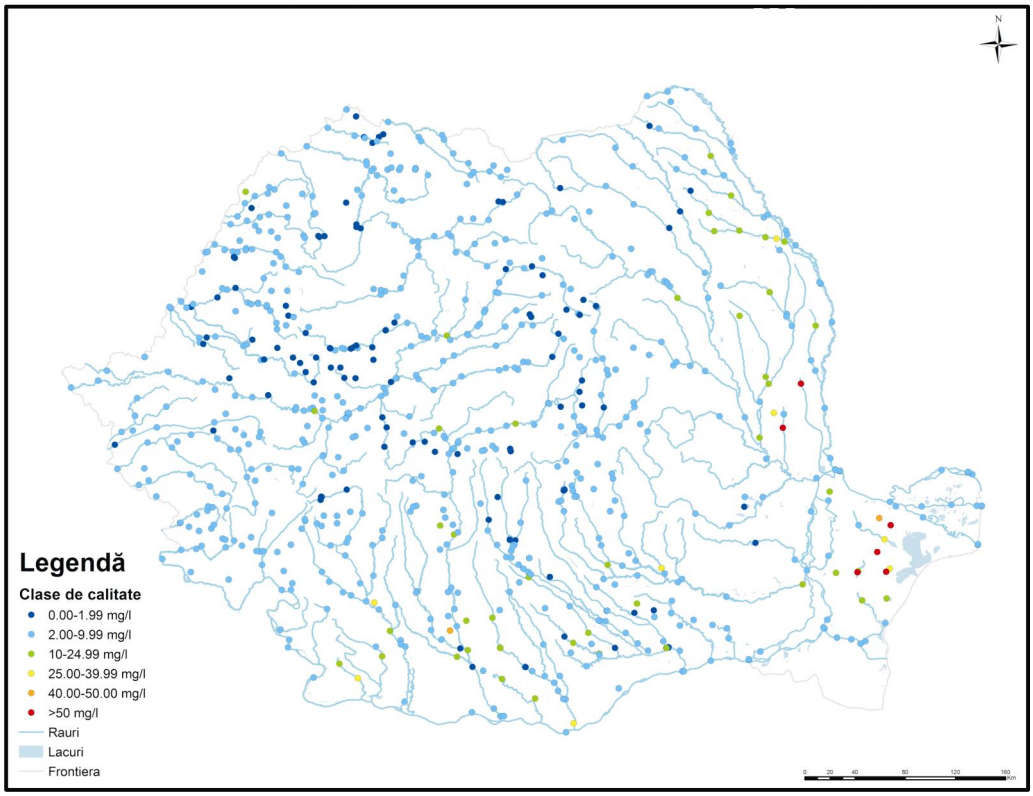

Figure 4. Average values of the nitrates concentrations in rivers

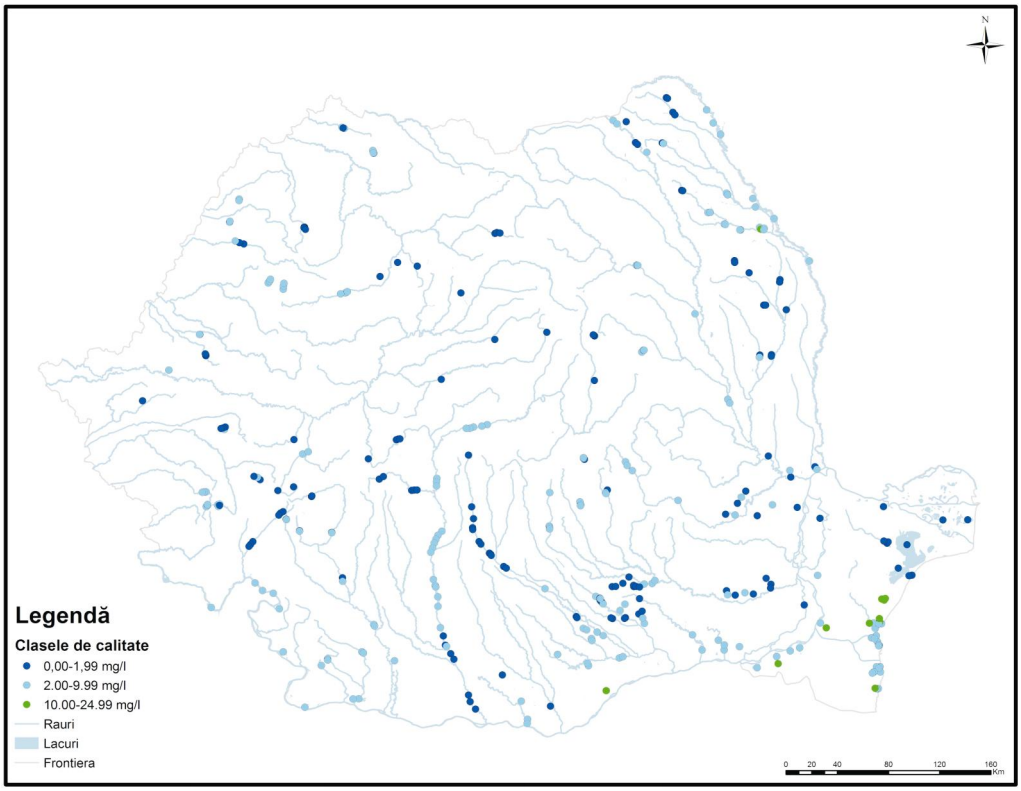

Figure 5. Average values of the nitrates concentrations in lakes

The same analysis based on maximum values established that out of rivers monitoring stations, values below 50 mg/l are registered in 96.53 %. Most of the monitoring sections belong to the range between 2-9.99 mg/l NO_3. In order to assess the nitrates concentrations trend all common monitoring stations (998) between current (2008 – 2011) and previous analysis period (2004 -2007) were taken into consideration (Table 1). The winter average values represent average values measured in the period between October-March.

Table 1. Trend classification based on nitrates concentrations

	<-5 mg/l NO_3	Intre -5 si -1 mg/l NO_3	Intre -1 si +1 mg/l NO_3	Intre+1 si +5 mg/l NO_3	>+5 mg NO_3/l
Rivers – average values	3.11%	20.45%	53.92%	20.59%	1.93%
Rivers – winter average values	4.44%	17.93%	52.44%	21.63%	3.56%
Rivers – maximum values	27.40%	25.78%	24.45%	12.74%	9.63%
Lakes – average values	4.95%	26.32%	49.23%	17.03%	2.47%
Lakes – winter average values	9.35%	25.86%	38.32%	20.24%	6.23%
Lakes – maximum values	20.43%	26.32%	19.82%	12.38%	21.05%

It can be noticed that the decreasing trend was registered for 23.56% of the rivers monitoring stations and for 31.27 % of lakes sections. The maximum values of the nitrates concentrations have decreasing trends in the greater number for both rivers and lakes monitoring sections. The monitoring sections of the rivers with decrease and stable trend exceed 75 % of the analyzed sections and 80 % in lakes from the average values point of view. The same analysis was performed in monitoring sections from vulnerable zones. It can be observed that the most of the monitoring sections on rivers and lakes (Figure 6) have the average and maximum nitrate concentrations under the 25 mg/l NO_3, very few values exceeding 40 mg/l NO_3.

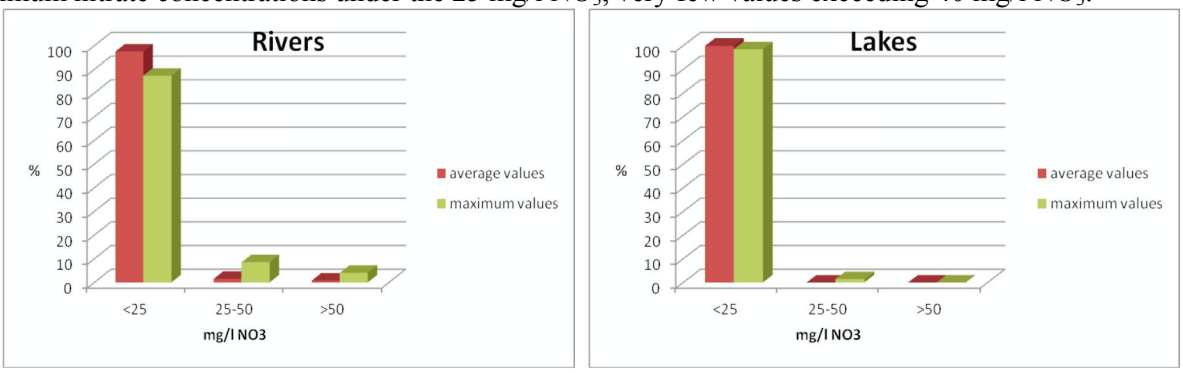

Figure 6. Monitoring sections based on nitrates concentrations in the vulnerable zones

Analysis done on the 54 monitoring stations located on transitional, coastal and marine water bodies has the next results: nitrate average and winter average values are found in the range of 0 – 9.99 mg/l. Maximum values registered in transitional and coastal stations exceed the value of 10 mg/l but not more than 25 mg/l (Figure 7).

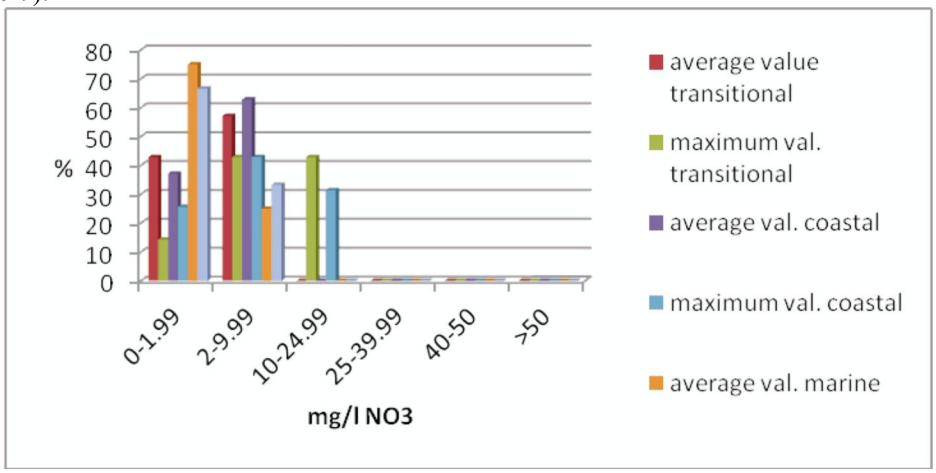

Figure 7. Monitoring sections based on nitrate concentrates in transitional, coastal and marine water bodies

Regarding classification of nitrate concentrations trends for transitional, coastal and marine water bodies from analysis of all common monitoring sections (41) having in view the current and previous analysis, it can be observe that all type of the above waters are maintained in areas of stable and increasing

trend. On sections where eutrophication phenomena have been observed (especially in summer) is specified as a percentage of 51.7 % of all sections of lakes analyzed and 50 % of all sections of transitional, coastal and marine waters analyzed presents such phenomena. This situation has improved for transitional, coastal and marine waters, which showed in previous analysis 100 % sections with eutrophication phenomena observed.

The causes which led to water pollution with nitrate are multiple. The main sources of groundwater pollution are grouped as follows:

- Lack of wastewater collection systems for agglomerations;
- Historical pollution sources;
- Agricultural activities;
- Non conforming landfill of urban and industrial waste.

Surface water pollutions are caused by point pollution sources (lack of urban wastewater treatment plants, industrial units, agrozootechnical farms, etc) and diffuse sources (agricultural and urban activities).

In order to improve the water resources quality, measures are necessary to be implemented for agricultural sources/activities according to the Nitrates Directive requirements and also, measures required by other directives in the water quality field (Urban Waste Water Treatment Directive, Water Framework Directive). The requirements of the Action Programs and the Good Agricultural Practices Code should be applied in the -Nitrate Vulnerable Zones.

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