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Original Article

ASSESSMENT OF THE MEASURES IMPLEMENTED IN BULGARIAN LEGISLATION TO REDUCE THE CONTENT OF NITRATES IN GROUNDWATER USED FOR PUBLIC WATER SUPPLY

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Summary

The article analyzes the application of the current documents related to reducing nitrate pollution of groundwater bodies used for public water supply in the Pleven administrative region. The requirements of the European legislation are fully implemented in the Bulgarian legislation, but the legislative measures have not led to quick and permanent results, i.e., small drinking water sources contaminated with nitrates still exist. Special attention should be paid to the diffusive sources of pollution (mineral fertilization of soils) since they are of the most significant importance in groundwater contamination with nitrates. For settlements with permanently elevated nitrate content (over 50 mg/L), it is necessary to consider the application of an individual approach in dealing with this long-standing problem: changing the water source, mixing the water from two neighboring water sources or implementing specific purification methods (biological denitrification, ion exchange resins, etc.). We analyzed the data from the monitoring of drinking water carried out by the Regional Health Inspectorate – Pleven and found that in the Pleven region, there are 17 towns or villages (out of a total of 123) for which some of the listed measures should be foreseen. The district's relative share of the exposed population is 3.2%, comparable to the country's exposed population for 2004-2007.

Keywords: nitrates, groundwater, drinking water, agriculture, nitrogen fertilizers.

Introduction

Providing groundwater sources with a sufficient flow rate and satisfactory water quality for drinking purposes is becoming an increasingly urgent problem. Globally, solving this issue is becoming more and more difficult due to the increasing water consumption, decreasing fresh water supplies, and increasing pollution [1, 2]. Apart from hygiene regulations of the harmful substances in the water, measures to protect the soil from contamination must also be regulated. These measures are necessary because most pollutants first enter the soil, groundwater, and

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food products. The most famous and widespread example is the increased content of nitrates in drinking water, which in most cases results from using nitrogen fertilizers in agriculture [3-5]. Over several decades, there has been a tendency for a gradual increase of nitrates contents in groundwater, which coincides with the development of intensive technologies in modern agriculture, mostly related to possibilities for the industrial production of nitrogen fertilizers [6]. Nitrates are easily washed away by precipitation because they are not permanently bound to soil particles and have practically unlimited solubility in water. Even with precise dosing of fertilizers, the entry of the unabsorbed part by the plants into the groundwater is inevitable. According to data from various authors, about 50-60% of applied mineral nitrogen fertilizers are absorbed by plants [7]. The daily intake of nitrates through drinking water containing concentrations borderline or slightly exceeding the maximum permissible value of 50 mg/L is comparable to the average daily intake with food (mainly vegetables) of 30-150 mg/day accepted by the International Agency for Research on Cancer (IARC) [8].

The present study aims to analyze the current regulatory documents related to protecting drinking water sources in Bulgaria and evaluate the effectiveness of the measures included in these documents, intended to reduce the nitrate load of groundwater used for drinking water supply.

Materials and Methods

The current Bulgarian regulations that set out the measures intended to reduce the nitrate load of groundwater used for drinking and domestic water supply were studied and systemized. We studied to what extent European legislation has been transposed into the Bulgarian regulatory framework. An assessment of the quality of the water supplied to the population of the Pleven administrative region from the groundwater sources was carried out according to the nitrate indicator, which can be accepted as a representative of the country region with developed intensive agriculture.

After a preliminary agreement with the Regional Health Inspectorate – Pleven (RHI) (the competent state control authority for the quality

of drinking water), the results of the monitoring of drinking water in the settlements of the Pleven region according to the nitrate indicator for eight years (2010-2017) were collected and interpreted. The district's most heavily contaminated water supply areas were prioritized based on the calculated average values of nitrates in drinking water for this period. We researched the reasons for nitrates' long-term persistence in the Pleven region's ground waters.

Results and Discussion

The management and ownership of water in Bulgaria as a nationwide indivisible natural resource and ownership of water management systems and facilities are regulated by the Water Law, which entered into force on 01.28.2000 [9].

Water management at the national level is carried out by the Ministry of Environment and Water (MOEW). Regional Basin Directorates (BD) carry out the management at the basin level. There are 4 Basin Directorates in the country: Western Sea Region BD stationed in Blagoevgrad; Black Sea Region BD - in Varna; Danube Region BD - in Pleven; Eastern Aegean Sea Region BD – in Plovdiv. The basin directorates carry out management, regulatory, control, and information functions. BDs develop and implement River Basin Management Plans (RBMPs), Flood Risk Management Plans, and Marine Strategies, as well as the determination of natural resources of groundwater bodies (GWBs) and the establishment of water protection zones (WPZs) around water sources. Their regulatory functions are mainly related to activities under the permitting regime for water abstraction and water bodies' use. BDs control all activities related to water bodies, including compliance with prohibitions and restrictions in WPZs.

The most important water management principles introduced by the Law are:

- The priority of the State policy and local authorities is the right of citizens to have access to drinking water as a basic vital need;
- Application of scientific and technical achievements in water management;
- Implementation of economic regulators for sustainable water use;
- Prevention of water pollution at the source of pollution;
- Application of the “Polluter Pays” principle

in case of pollution and damage recovery;

- Guaranteed public access to information on the condition of waters [9].

The Water Law implements into Bulgarian legislation Directive 2000/60/EC of the European Parliament of October 23, 2000, establishing a framework for Community action in the field of water policy, also called the Water Framework Directive [10]. It introduces the main rules and activities that would help to improve the condition of all surface and groundwater in the EU. The Framework Directive sets out clear responsibilities for national authorities, imputing the following duties to them:

- to determine the individual river basins in their territory and monitor the state of the waters in each basin;
- to determine the management authorities and analyze the characteristics of each river basin, including the impact of human activity;
- to register the protected territories, including those for extraction of drinking water for public use;
- to prepare all types of plans for the management of river basins to preserve the quality of the waters and protect the protected areas;
- ensure cost recovery for water services so that resources are used efficiently, and the polluter pays principle is applied;
- provide public information and consultation concerning their river basin management plans.

The rules of the framework directive related to preventing and limiting the discharge of pollutants into groundwater are complemented by Directive 2006/118/EU on the protection of groundwater against pollution and deterioration, aiming to prevent the deterioration of the condition of all groundwater bodies [11]. It introduces criteria and procedures for assessing groundwater chemical composition and measures necessary to prevent or limit discharges of pollutants into groundwater.

The Directive was introduced into the national legislation of Bulgaria by Regulation No. 1 of 10.10.2007 on the exploration, use, and protection of groundwater [12]. This Ordinance aims to ensure the protection of groundwater, a valuable natural resource and the leading source of drinking water supply. To achieve

the aims set by the Ordinance, an assessment of its quantitative and chemical status, risk assessment, and planning of measures to achieve and maintain a good status must be done for each GWB. The data from assessing each GWB is contained in a special passport, compiled and maintained by the BD through the relevant River Basin Management Plan. The RBMP and the characterization of the GWB are updated every six years. The measures to achieve and maintain a good condition of the GWB are controlled in the following areas:

- Issuance of permits for water use by GWB;
- Registration of wells for citizens' own needs;
- Unregulated water extraction from the GWB and compliance with the prohibitions and restrictions of risky activities for the contamination of the GWB;
- Measurement of the flow rate and indicators of water pollution in the GWB.

An important sub-normative document of the Water Law is Regulation No. 1 of 11.04.2011. for water monitoring, which determines the order and method for planning monitoring and for creating water monitoring networks in each region for basin management on the country's territory, as well as operations, maintenance, communication provision, and laboratory information services [13]. It defines the requirements for the monitoring (qualitative and quantitative) waters and water protection zones. This Regulation defines the technical specifications for chemical analysis and monitoring of the water condition and the minimum criteria for the analysis methods applied in the accredited laboratories when monitoring the water condition. Surface and groundwater monitoring programs are approved by the Minister of Environment and Water and are an integral part of the river basin management plans developed by the regional basin directorates. Monitoring surface and groundwater includes various measurements, observations, and assessments of the water status. A typology of water bodies is carried out, their boundaries are determined, the impact of human activity on their condition is analyzed, risk assessment is carried out, and various qualitative and quantitative indicators are monitored.

Nitrates occupy the leading place among quality indicators. The methods for establishing, limiting, and preventing the pollution of water with nitrates from agricultural sources, as well

as the rights and obligations of the competent authorities in this regard, are introduced into the Bulgarian legislation by Regulation No. 2/2000 on the protection of water from pollution with nitrates from agricultural sources replaced by Regulation No. 2 of September 13, 2007, on the protection of waters from nitrate pollution from agricultural sources [14, 15].

The subject of this Ordinance covers surface and groundwaters contaminated or threatened by contamination with nitrates from agricultural sources. Contaminated, threatened, or vulnerable areas are surface water or groundwater containing nitrates at a concentration higher than 50 mg/L or that would contain nitrates at a concentration higher than 50 mg/L if the actions provided for in the Regulation are not taken. In addition to the nitrate content, another indicator is used for surface waters, namely whether they are affected or may be affected by eutrophication. Competent authorities for implementing the Regulation are the Ministry of Environment and Water, the Basin Directorates, the Ministry of Agriculture and Food, and the Ministry of Health. The requirements for good agricultural practice (GAP) are introduced in the Annex to this Regulation. GAP is approved by order of the Minister of Agriculture and Food to regulate types of land use; the periods during which the introduction of fertilizers is prohibited; the conditions for fertilizing sloping, flooded, frozen and snow-covered terrains; the ways of storing fertilizers and fodder; the frequency and method of applying solutions of inorganic and organic fertilizers.

With the introduction of Regulation No. 2, these rules are not mandatory and are applied voluntarily by farmers. However, when these rules were updated in 2016, the cases in which farmers were obliged to apply the Rules of Good Agricultural Practice to protect water from nitrate pollution from agricultural sources had already been mentioned in more detail [16, 17].

The GAP must be applied in the following cases:

- For farms that are located on the territory of nitrate vulnerable zones (NVZs), in which the “Program of measures to limit and prevent pollution with nitrates from agricultural sources in vulnerable zones” is applied for the period 01.01.2016 –

31.12.2019,” approved by Orders of the Ministry of Agriculture and Food (MOAF) and the MOEW [18].

- For farmers who apply for financial support under the programs for the development of rural areas under measure 214 Agroecology payments, measure 10 Agroecology and Climate, and measure 11 Organic agriculture [19, 20, 21].

The application of the measures mentioned above gives us reason to assume that linking the financial stimulation of agricultural producers (coming from various European programs and projects) with the observance of the rules of good agricultural practice would yield good results in the fight against pollution of drinking water with nitrates from agricultural sources.

In order to receive full financial support under the various schemes and measures of the Common Agricultural Policy, farmers undertake to maintain the land in good agricultural and ecological condition (GAEC). Such a GAEC is achieved through mandatory compliance with National Standards for good agricultural and ecological conditions, approved by the Minister of Agriculture and Food with Order No. RD 09-122/23.02.2015 [22].

National Standard 1 mentions the measures and restrictions related to the use of mineral and organic nitrogen-containing fertilizers in the buffer strips around surface water bodies, as well as the width of these buffer strips depending on the slope of the terrain. National Standard 2 is related to using water for irrigation, and Standard 3 prohibits the discharge of certain substances into groundwater (List I and II in Annex to NS 3).

National standards 4, 5, 6 and 7 are related to protecting the land from erosion, maintaining soil fertility, and preserving the existing field boundaries of the properties.

To assist farmers in complying with the requirements and prohibitions introduced through these 7 National Standards for the maintenance of GAEC, the Ministry of Agriculture and Food prepared a Manual for the Practical Application of the Conditions for Maintaining the Land in Good Agricultural and Ecological Condition in 2016 [23]. It details the seven National Standards, as well as recommendations and exemplary actions farmers can take to facilitate

compliance with the National Standards. The controlling authority for compliance with these standards is the Agriculture State Fund Payment Agency (SFA-PA), which conducts on-site inspections through its Technical Inspectorate. In the event of irregularities found during the inspection related to non-compliance with standards, the SFA-PA sanctions the farmer by reducing payments.

Regulation No. 2 of September 13, 2007, on the protection of waters from nitrate pollution from agricultural sources, introduces into Bulgarian legislation the Council Directive of December 12, 1991, on the protection of waters from nitrate pollution from agricultural sources (91/676/EEC), also called the Nitrate Directive [14, 24]. It aims to reduce water pollution with nitrates from agricultural sources and prevent such new pollution.

EU member states should focus their actions on the following to achieve this goal:

- to determine Nitrate Vulnerable Zones (NVZs). These are all areas feeding the waters and which are or could be affected by high levels of nitrates and eutrophication. The determination of the NUS is reviewed and revised every four years;
- to create and observe the effectiveness of mandatory action programs in the NVZs, which are based on the available scientific and technical data and the general conditions of the environment. These action programs must contain measures and rules guaranteeing the introduction of no more than 170 kg of nitrogen per hectare of cultivated land;
- to measure the concentration of nitrates in fresh surface and ground waters at least once a month;
- to submit a comprehensive report on the implementation of the Directive once every four years;
- to provide training and information to farmers.

Directive 91/676/EEC implementation in the EU member states is monitored through consolidated reports from the Commission to the Council and the European Parliament based on the reports of the 27 member states that they have submitted for the periods 2008-2011 and 2012-2015 [25, 26]. The reports contain the following main topics:

1. Development of pressure from agriculture – number of farm animals, use of mineral fertilizers, nitrogen balance, and release of nitrogen into the environment.
2. Water monitoring: quality and trends.
3. Indication of nitrate-vulnerable zones.
4. Action programs.
5. Derogations regarding the maximum amount of 170 kg of nitrogen per hectare per year.
6. Water quality forecast.
7. Derogations and infringement procedures.
8. Future challenges.

The reports describe the measures from the Action Programs (AP) that are crucial to reducing water pollution with nitrates from agricultural sources, namely:

- Determination of standards for spreading artificial fertilizers that ensure balanced fertilization /including nitrogen and phosphorus/;
- Manure storage;
- Reinforcement of measures in some “hot spots” of pollution;
- Strengthening the control over compliance with the obligations of farmers.

Regarding water quality forecasts, according to the report for the period 2012-2015, only 12 member states forecast that through the implementation of the AP in combination with the implementation of some agro-ecological measures from the *Rural Development Programme* (RDP), they will achieve a further reduction of nitrate concentrations in ground and surface water. The water quality forecasts for seven Member States are unclear; three countries did not report forecasts (Greece, Portugal, and Croatia).

The literature data available on the dynamics of nitrate content for Denmark (1950 to 1980) demonstrate a trend of increasing nitrate in drinking water and decreasing concentration after 1990 [27].

By the end of 2015, derogations related to the maximum amount of 170 kg of nitrogen/ha/year came into force in six Member States in respect of the whole territory or the part of the territory (Denmark, Ireland, and the Netherlands, Flanders in Belgium; Emilia Romagna, Lombardy, Piedmont and Veneto in Italy; and England, Scotland, Wales and Northern Ireland in the United Kingdom). In

mid-2017, eight infringement proceedings were opened against seven Member States. Some of the proceedings are related to the designation of Nitrate Vulnerable Zones (France, Greece, Poland, Slovakia) and others to the Action Programs (Greece, Poland, Bulgaria, Germany, and Belgium).

One of the future challenges this report poses is that the measures in AP need to be adapted to the burdens in different regions and hotspots.

This goal could be achieved through a more flexible approach to action within agricultural holdings, including setting clear environmental goals and objectives; support and consultation of farmers in selecting and implementing the correct measures in the respective area [26].

Particular attention should also be paid to the development and use of scientific research and innovation to solve current and future problems related to loading waters with nitrates from agricultural sources.

Coordination between all interested parties – the authorities in agriculture and the environment, farmers, companies in water supply, and consumers, to mention a few, is also a challenge.

The requirements for the quality and safety of drinking water in Bulgaria are regulated in Regulation No. 9 of March 16, 2001, for the quality of water intended for drinking and domestic purposes [28]. It obliges the water supply organizations to take the necessary measures (appropriate treatment methods and water purification technologies before its distribution in the water supply network) to ensure the supply of the population with safe and clean drinking water. The conditions that clean and safe drinking water must meet are the following:

- not to contain microorganisms, parasites, chemical, radioactive and other substances in number or concentration that pose a potential danger to human health;
- to meet the minimum requirements defined in Annex No. 1, Tables A and B of the regulation (microbiological and chemical indicators);
- drinking water must meet the values of the indicators defined in Annex No. 1, Tables A, B, C, D.1, and D.2. (microbiological, chemical indicators, indicators with an indicator value, and radiological indicators),

such as the values of the indicators from Annex No. 1, tables B, D.1, and D.2, serve to monitor water intended for drinking and domestic needs.

Drinking water monitoring is also the responsibility of water supply organizations that develop drinking water monitoring programs coordinated with regional health inspectorates. Control monitoring for the conformity of the water supplied to consumers according to the quality indicators is carried out by the authorities of the State Health Control (SHC) at the Ministry of Health in a volume of 50% of the volume of the main monitoring conducted by the water supply companies.

Regulation No. 9 of March 16, 2001, on the quality of water intended for drinking domestic purposes, introduced into the Bulgarian legislation European Directive 98/83/EU on the quality of water intended for human consumption [29]. This Directive guarantees the purity and safety of water used for drinking and domestic needs in the EU by setting standards for drinking water and aims to protect human health from the harmful effects caused by the pollution of water intended for human consumption. These are all waters intended for drinking, cooking, preparing foodstuffs (in households and the food industry), or for any other domestic purpose, regardless of their origin and regardless of whether a water supply network supplies them – in cisterns, bottles or containers.

According to this Directive, all EU member states are obliged to:

- take the necessary measures to ensure that the water reaching the consumer does not contain a concentration of microorganisms, parasites, or harmful substances that could pose a danger to human health;
- carry out regular water control at agreed sampling points and take the necessary corrective actions if necessary;
- prohibit or restrict a water supply if it is considered to pose a potential threat to public health;
- publish a report on the quality of drinking water every three years.

In 2015, the Commission adopted Directive (EU) 2015/1787, amending Annex II and Annex III to Directive 98/83/EC on the quality of water intended for human consumption, introducing

new rules for the control of drinking water, allowing greater flexibility in how drinking water is controlled across the EU [30].

In order to provide the population with safe drinking water that meets the standards laid down in Regulation No. 9, it is necessary to build water protection zones around each water source whose water is used for drinking and domestic purposes. The national document regulating the organization of WPZs is Regulation No. 3 of October 16, 2000. on the conditions and procedures for research, design, approval, and operation of the WPZs around the water sources and facilities for drinking and domestic water supply and around the water sources of mineral waters used for medical, prophylactic, drinking, and hygienic needs [31].

WPZs are designed and constructed in such a way as to provide physical protection of the water source and water catchment facilities, to protect the water sources from the entry of pollutants into them, as well as to guarantee the design quantity and quality of water for the term of the water use permit. The Regulation introduces an absolute ban on operating a water source and/or facility without established WPZs [31]. WPZs are established by order of the director of the relevant basin directorate, on whose territory the WPZ is located, upon application by the owner or user of the water source. Appendices No. 1 and No. 2 of the Regulation specify the activities that are prohibited, restricted, and, if necessary, limited in Zone II and Zone III of the WPZs. If it is established during water use that any restricted activities lead to deterioration of the water quality, it is prohibited, and the relevant BD controls the implementation of the prohibition. With the introduction of Regulation No. 3, Bulgaria begins the implementation of its obligations under Art. 7 para. 3 of the Water Framework Directive obliges the member states to ensure the protection of water bodies used to produce drinking water to preserve the quality of the water by introducing safety zones around them [10, 31].

Although in the regulatory framework of Europe and Bulgaria regarding the pressure of water pollution with nitrates from agricultural sources, rigorous requirements and sanctions for farmers are laid down, these requirements are not fulfilled in some places. Therefore, in some

European countries, other ways are being sought to reduce the pollution of drinking water sources with nitrates from agriculture. Many studies suggest voluntary cooperation between water supply organizations, farmers, and authorities, based on financial incentives from water supply organizations to farmers rather than financial penalties on the polluter [32]. Cooperation agreements include actions such as:

- Informing water supply organizations about the fertilizers and pesticides used by farmers in a given area and their efforts to reduce or prevent pollution;
- Free consulting and financial stimulation from the water supply companies to farmers when integrating new production methods related to reducing the pressure on the environment and introducing more sustainable agricultural practices;
- Minimizing the costs of both sides – the farmers, by modernizing agricultural technologies, and the water supply companies – by reducing the costs of corrective measures (water purification, closing some water sources, and transporting water from more distant water sources) [32].

These voluntarily adopted commitments for changing agricultural practices are often more stringent than legally formulated rules and improve the effectiveness of environmental regulations. Therefore, water authorities are interested in promoting such voluntary agreements and advising farmers and water supply organizations when applying for funding under various environmental and agricultural programs.

Authorities also accept these voluntarily agreed commitments as a substitute for mandatory rules. They believe such kind of agreements will make enforcement of the regulations more effective. In 2002, a study was conducted in 15 EU member states concerning a pan-European research project, “Cooperation Agreements in Agriculture as a Tool for Improving the Economic Efficiency and Environmental Efficiency of the European Water Policy.” In 9 of these 15 Member States, such voluntary agreements have been established between water supply organizations and farmers, and the authorities are directly or indirectly involved in them – Austria, Denmark, Netherlands, Germany, France, Luxembourg,

Great Britain, Sweden, and Finland [32]. Significant differences were found, however, in their number (Great Britain – 1, Germany – 435, France – 70.), goals, commitments of the respective countries, and funding sources. In France, the main objective is to consult farmers. It is financed from various sources with very little involvement of water supply organizations, while in Germany, there is a direct payment of compensation to farmers by water companies through bilateral binding agreements. According to the authors of this study, there are various reasons for the unbalanced distribution of voluntary agreements in EU countries, namely:

- Different share of groundwater that is used for drinking and domestic purposes;
- Differences in the determination of the legally established zones for the protection of groundwater;
- Difficulties in implementing the mandatory rules for the protection of groundwater;
- Different attitudes and willingness of water supply organizations and water users to pay farmers' costs to change their production methods.

In some countries, such as Denmark and Germany, consumers prefer water that does not need chemical treatment and is even cleaner than the standards defined in the regulatory framework. Such practices motivate water companies and authorities to work on measures to protect water by controlling the source of pollution and, more specifically, changing agricultural practices [32].

Status of the public water supply in the Pleven administrative region

With a view to the fulfillment of the set goal – to evaluate the effect of measures to limit nitrate pollution of groundwater used for drinking purposes, a study was conducted of the public water supply in the Pleven administrative region, which can be considered as a representative region for the country with a developed modern intensive agriculture.

The Pleven region is located in the central part of the Danube hilly plain. For the water supply of the settlements in the district, underground water sources are used exclusively, capturing water from the first aquifer, in which rainwater filtered through the soil accumulates. The average depth of boreholes is from several meters to tens of

meters below the earth's surface.

As a result of the analysis of the current Bulgarian legislation, it was established that the current normative documents generally include the European requirements for limiting the contamination of groundwater with nitrates. Competent national and regional executive and control authorities have been established and are functioning. Thanks to the preliminary and current control of the public water supply throughout the country, particularly in the Pleven region, large water supply systems and settlements are supplied with standard drinking water according to the nitrate indicator (< 50 mg/L). However, a problem exists for small systems (< 5000 inhabitants) supplying water mainly to small villages located in areas with developed intensive agriculture, as is practiced in about half of the 28 administrative districts in the country. For the USA, it has also been shown that problems with excessive nitrate concentrations in groundwater most often exist in small and medium-sized water supply systems. Such concentrations are relatively rare in large water supply systems [33].

On the territory of the Pleven region, there are 123 villages and towns with a total of 269 752 inhabitants, of which 14 cities (171 821 inhabitants) and 109 villages (97 931 inhabitants). The relative share of the exposed population in the district is 3.2%, comparable to the country's exposed population for the period 2004-2007 [34]. The water supply of the settlements is organized in 103 water supply zones, of which 96 are small systems – settlements with a population of fewer than 5 000 inhabitants. In the Pleven region, excessive nitrate content is present in 17 settlements organized in 16 small water supply zones. In 8 of the settlements (8 zones), drinking water with a permanently excessive nitrate content of more than 50 mg/L is supplied for the entire 8-year period 2010-2017. In 2 areas supplying water to 3 of the eight settlements, the average nitrate concentration was permanently above 100 mg/L - the village of Gigen and the village of Iskar - respectively 150.68 mg/L and the town of Koinare 106.84 mg/L. In the remaining 5 settlements, the average concentrations for the period vary between 50.61 mg/L and 95.34 mg/L (the villages of Zgalevo, Cherkovitsa, Izgrev, Dragash voivoda, and Gradina) (Table 1).

Table 1 Excessive content of nitrates in water supply areas in the Pleven region for the period 2010-2017.

nitrates - average value [mg/L]	water supply areas		water-supplied settlements / number/	exposed population /number of inhabitants/
	large over 5000 inhabitants	small under 5000 inhabitants		
over 100	-	2	3	5 976*
50-100	-	6	5	2 641*
35-50	-	8	9	7 441
total	-	16		

*- The total number of exposed population with excessive nitrate content for the period is 8 617 inhabitants, which is 3.2% of the total population of the Pleven region / Census 2011/

In the remaining 8 zones supplying water to 9 villages, excessive nitrate values (> 50 mg/L) were recorded in individual months and years. However, the average values for the period were between 35 and 50 mg/L (the villages of Pelishat, Tuchenitsa, Radishevo, Borislav, Obnova, Bozhuritsa, Peternitsa, Gortalovo, and Gornik).

During the inspections of the territories around the water sources with registered excessive nitrate values, no point sources of pollution were identified, such as functioning livestock farms, poultry farms, pig farms, warehouses for organic or inorganic fertilizers, and near the places for capturing groundwater. No fecal-domestic or industrial wastewater discharges were detected in the areas around the catchments.

According to data from the regional control authority (BD-city of Pleven) around the contaminated village with higher than required values of nitrates, groundwater sources supplying water to 17 small settlements, only one WPZ was established with 3 zones with a total area of about 1200 acres (for water supply to the villages of Gigen and Iskar). At the same time, it was found that intensive agricultural activity is being carried out immediately around the wells with high nitrate values (including on the territory of the established WPZs) – the cultivation of grain and technical crops such as wheat, corn, barley, rapeseed, sunflower. Intensive technologies are applied – modern mechanical soil treatment, mineral fertilization, and application of chemical preparations for plant protection. There are practically no protective areas around the water supply facilities due to the lack of established WPZs, which makes it impossible to implement the administrative introduction of restrictions or bans on nitrogen fertilization. Based on these

findings, it is apparent that the primary cause of groundwater nitrate contamination of the vulnerable first aquifer is diffuse contamination due to applying nitrogen fertilizers over hundreds and thousands of acres of land, including the immediate vicinity of wells.

Conclusions

As a result of the analysis of the current Bulgarian legislation, it was established that the current regulatory documents generally include the European requirements for limiting the pollution of groundwater with nitrates.

The analysis of the application of the normative requirements for preventing the pollution of water sources with nitrates in the Pleven region shows that some of the requirements are not fulfilled, namely:

For many of the small water supply systems in the district, the process of establishing WPZs around the water sources has not been completed, as provided for by Regulation No.3/2000. It is significant that out of 16 small water supply systems with excessive nitrate content, only one WPZ has been established. In this situation, the control authorities are deprived of the legal possibility to restrict the territories around the water sources.

The specific groundwater body – the source of the extracted water - has not been unambiguously determined for some of the contaminated water sources.

Our study results showed an increased exposure to nitrates was found in the Pleven region for 8 617 inhabitants, or 3.2% of the region's total population, which is comparable as a relative share to the exposed population for

Bulgaria compared to the period 2004-2007.

During field inspections, it was established that intensive agricultural activity is carried out immediately around the wells with high nitrate values - the cultivation of grain and technical crops such as wheat, corn, barley, rapeseed, and sunflower using intensive technologies - mineral fertilization and pesticide application. There are no protective areas around the water sources due to the lack of established and sized WPZs.

As a first step, it is recommended to speed up the activities for establishing WPZs around the water sources, with priority for those of them with permanently high values of nitrates.

Adequate dimensioning of the relevant protection sections of WPZs is necessary, taking into account the type of GWB, the properties of the main types of soil, and the direction of movement of the underground flow in the first aquifer, which requirements are not elaborated in detail in Regulation No. 3/2000.

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