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ORIGINAL PAPER
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RESTRICTIONS ON THE USE OF AGRICULTURAL LAND IN UKRAINE FOR THE PROTECTION OF WATER RESOURCES

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ABSTRACT

Motives: The value of water resources has increased in the 21st century due to global climate change, population growth, and the demand for water in agriculture, industry, and other sectors of the economy. However, increasing demand leads to a deterioration in the quality of water, including drinking water, and it affects the environmental sustainability of water resources and coastal lands. Agriculture plays a major role in water pollution in Ukraine and in other European countries. Therefore, it is important to address the topic of restrictions on the use of agricultural land to reduce the polluting effect.
Aim: The main aim of the study was to examine regulations on the use of agricultural land in Ukraine for the protection of water resources, and the process of imposing water protection restrictions on the use of agricultural land, taking into account the requirements of the Sustainable Development Goals and the prospects for Ukraine's accession to the European Union.
Results: The theoretical principles for establishing the boundaries of water protection zones and coastal protection belts around water bodies were analyzed. The legal framework regulating restrictions on the use of agricultural land in Ukraine was examined, with particular emphasis on the establishment of water protection zones. It was found that the provisions of the Land and Water Codes of Ukraine regulate the size of water protection zones and coastal protection belts. Water bodies are regime-forming objects, and they are systematized according to the requirements for establishing the boundaries of coastal protection belts. The indicators measuring the access to drinking water, as part of the implementation of the Sustainable Development Goals in Ukraine, were analyzed. The study revealed that in Ukraine, regardless of the current legislative regulations relating to the restrictions on the use of agricultural land, which provide for the protection of water bodies from pollution and clogging and the preservation of water resources, there is a need to establish the boundaries of water protection zones and coastal protection belts.

Keywords: water bodies, water protection zones, land management, coastal protection belts, water fund, land management projects, Nitrates Directive, Nitrate Vulnerable Zones (NVZs)

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INTRODUCTION

Anthropogenic activity in one way or another affects the surrounding natural environment and its components: water resources, atmospheric air, animal and plant life, and land resources. As a result of the land reform in Ukraine, land, in addition to the previously performed functions (natural resource, basis of production and living, means of production), became an object of real estate and investment, a market resource. As the basis of the ecosystem, a tool and object of production, an object of property rights, it is the basis of sustainable development, a condition for social progress and public welfare (Novakovska, 2018). That is why, in the interest of ensuring public welfare, it is necessary to regulate the issue of protection and rational use of natural resources, in particular, land resources and water resources, at the legislative level.

Before the full-scale invasion of the Russian Federation, Ukraine ranked 3rd in the world in terms of the area of agricultural arable land per inhabitant, and with 8.7% of the world's chernozem area on its territory, Ukraine can meet the food needs of at least 150–180 million people, i.e. to provide the own population with food products and to organize the export of part of the food, the need for which is constantly growing in the world. It is indisputable that the realization of the specified goal is impossible without frugal, rational and ecologically safe use and all kinds of protection of the unique land and resource potential of the country (Nedashkivska & Dobryak, 2014).

For the sake of rational and ecologically safe use of agricultural and other lands around water bodies in Ukraine, restrictions on the use of land plots are established. The Law of Ukraine "On the State Land Cadastre" defines the term regime-forming object, "an object of natural or artificial origin (a water object, an object of main pipelines, an energy object, an object of cultural heritage, a military object , another object defined by law), under which and/or around which, in connection with its natural or acquired properties, according to the law, land use restrictions are established" (Law of Ukraine "On the State Land Cadastre", 2011).

In Ukraine, water protection zones are established in order to create a favorable regime for water bodies, prevent their pollution, clogging and depletion, destruction aquatic plants and animals, as well as reduce flow fluctuations along rivers, seas and around lakes, reservoirs and other bodies of water.

In order to protect surface water bodies from pollution and clogging and preserve their water capacity along streams, rivers, around lakes and seas, reservoirs and other bodies of water within water protection zones, land plots are allocated for coastal protection belts based on land management projects.

That is, in Ukraine there is a certain legislative and regulatory regulation of the use of agricultural lands and not only those adjacent to water bodies in the format of establishing restrictions, which provide for a regime of regulated economic activity on the territory of water protection zones and a stricter regime of limited economic activity within the boundaries of coastal protection belts, which are defined as nature conservation areas. However, these regulations do not fully fulfill the functions that rely on them, and therefore the main purpose of establishing regulations is not achieved.

Certain reasons for which there are problems with the formation of water protection zones and coastal protection belts, compliance with restrictions on the use of agricultural land for the protection of water resources require research, wider disclosure and the search for solutions, especially in the context of adapting Ukrainian legislation and policies to similar ones in the European Union.

The relevance of the issue disclosed in this article is also correlated with the Sustainable Development Goals of Ukraine for the period up to 2030, which are adapted taking into account the specifics of Ukraine's development and set forth in the National Report "Sustainable Development Goals: Ukraine", which are based on the resolutions of the General Assembly of the Organization United Nations of September 25, 2015 No. 70/1 global goals for sustainable development until 2030. In particular, in the context of this

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publication, the achievement of the following goals should be highlighted:

- overcoming hunger, achieving food security, improving nutrition and promoting the sustainable development of agriculture;
- ensuring availability and sustainable management of water resources and sanitation;
- taking urgent measures to combat climate change and its consequences;
- preservation and rational use of oceans, seas and marine resources in the interests of sustainable development;
- protection and restoration of terrestrial ecosystems and promotion of their rational use, rational forest use, combating desertification, stopping and reversing (reversal) the process of land degradation and stopping the process of biodiversity loss.

The goals of sustainable development of Ukraine for the period until 2030 are guidelines for the development of projects of forecasting and program documents, projects of normative legal acts with the aim of ensuring the balance of economic, social and ecological dimensions of sustainable development of Ukraine.

LITERATURE REVIEW

Research conducted by such European scientists as: Susanne Wuijts, Jacqueline Claessens, Luke Farrow, Donnacha G. Doody, Susanne Klages, Chris Christophoridis, Rozalija Cvejić, Matjaž Glavan, Ingrid Nesheim, Froukje Platjouw, Isobel Wright, Jenny Rowbottom, Morten Graversgaard, Cors van den Brink, Inês Leitão, António Ferreira, Sandra Boekhold shows that the complexity and inconsistency of the European legislation created to protect drinking water resources from agricultural pollution is most clearly manifested at the local level, where cross-sectoral measures need to be taken and the consequences controlled. At this local level, they tend to hinder efforts to achieve water quality goals rather than facilitate them. The upcoming revision of the EU Water Framework Directive (WFD) should strengthen the links between the different directives and how they can be applied at the local level (Wuijts et al., 2021).

The analysis by H. M. Flávio, P. Ferreira, N. Formigo, J. C. Svendsen shows significant progress in efforts to link agriculture and water restoration, but it also demonstrates the urgent need for more and more detailed restoration projects. The first cycle of the EU WFD ended in 2015 and, according to the authors, did not achieve the goal of good ecological status in many European water bodies (Flávio et al., 2017).

The publication of M. K. Cherkashyna is devoted to the consideration of the main issues of the water policy of the European Union regarding water protection and rational water use (Cherkashyna, 2017).

At the basic, review level, T. O. Basiuk, I. A. Boiko, A. G. Borovytska, I. V. Hopchak, M. Mikhalieva, P. Stoliarchuk considered the experience of the European Union in the field of protection and rational use of water resources, but this issue was not comprehensively analyzed by Ukrainian scientists. Issues related to the regulation of regime-forming objects, land protection, rational use of the water fund, and the establishment of coastal protection belts in Ukraine are covered in the works of Yu. Yaremko and N. Dudyak (Yaremko & Dudyak, 2020), T. Nedashkivska and D. Dobryak, V. Peresoliak and S. Malakhova and other scientists.

T. Nedashkivska and D. Dobryak, draw attention to the need to substantiate (economic, ecological and legal) mechanisms for establishing protective, security and sanitary zones and belts around regime-forming objects and determining the extent of damages caused by them, as well as their compensation (Nedashkivska & Dobryak, 2014).

I. Pokydko and A. Martyn highlight issues related to the formation of water protection restrictions in land use through the reform of the already existing organizational and legal system of regulation of coastal land use in Ukraine. They point out that it is worth referring to foreign experience in the issue of forming water protection restrictions in land use (Pokydko & Martyn, 2012).

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V. Peresolyak, S. Malakhova point out that it is necessary to regulate the issue of construction of coastal protective belts, because excessive development near water bodies in turn leads to a negative impact on the ecosystem as a whole (Peresolyak & Malakhova, 2013).

A study (Wilkinson, 1985) noted that often imposed restrictions lead to a significant decrease in the market value of the object to which such restrictions are applied. This is especially evident in relation to limiting the use of land for agricultural purposes. At the same time, another problem is noted regarding the existing legislation of many developing countries, which does not provide for compensation to land owners whose land is subject to restrictions (Wilkinson, 1985).

MATERIALS AND METHODS

Given the relevance of the issue of restrictions on the use of agricultural land in Ukraine within water protection zones and coastal protection belts, the materials of our study include practical examples of violations of the size of coastal protection zones, as well as their use regimes. Special emphasis is given to the issue of implementation in Ukraine of European policies regarding the protection of water bodies. The analysis of the materials of the Methodology for determining zones vulnerable to (accumulation) of nitrates provides for the implementation of some provisions regarding the definition of Nitrate Vulnerable Zones (NVZs) in the process of developing land management projects that define water protection zones and coastal protection belts.

In the process of scientific research, generally accepted methods of scientific research were used: monographic, statistical, analytical, comparative, and abstract-logical methods.

The works of scientists who studied the formation and establishment of water protection zones and coastal protective belts and restrictions on the use of agricultural land, which are established for the protection of water resources, were analyzed using the monographic method.

The statistical evaluation method was used in the evaluation of the data of the monitoring report "Sustainable Development Goals – Ukraine" regarding the safety of drinking water according to microbiological indicators (by % of non-standard samples) and the construction of a graph.

The comparison method was used when comparing the principles of land management for the territories adjacent to water bodies in Ukraine, the relevant legal framework and European policies, such as: Water Framework Directive (2000/60/EC), Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources 91/676/EEC, Directive on the quality of water intended for human consumption (2020/2184), Floods Directive (2007/60/EC).

Summarizing the results, conclusions were made using the abstract-logical method regarding the shortcomings in the observance of restrictions on the use of agricultural land in Ukraine for the purpose of protecting water resources, regarding the determination of the boundaries of water protection zones and coastal protection belts. Regarding the improvement of land management measures around water bodies, in particular regarding the implementation of the provisions of the Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources 91/676/EEC.

RESULTS

Protection of water resources and ensuring water quality are important problems in Ukraine. First of all, it provides for the protection of water ecosystems from pollution and lowering the water level in rivers, lakes and other water bodies. According to the national atlas, 63,119 rivers and streams with a total length of over 206,000 km flow through the territory of Ukraine. About 60,000 of them (93%) are very small (less than 10 km long). Their total length is 112 thousand km; there are 3,219 small rivers with a length of more than 10 km, and their total length is about 74 thousand km. There are 81 medium

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rivers with a total length of 15,488 km within Ukraine (Sustainable Development Goals, 2021).

Large rivers include the Danube, Tisza, Dnipro, Pripyat, Desna, Dniester, Siverskyi Donets, Southern Bug, and Western Bug. The largest number of rivers belongs to the basins of the Dnipro – 27.7, the Danube – 26.3, the Dniester – 23.7, and the Southern Bug – 9.3% (of the entire number of rivers in Ukraine) (Sustainable Development Goals, 2021).

It is also important to note that such large cross-border rivers as Tisza, Danube, Dniester, Prut, Uzh, Western Bug, Syan and other smaller rivers flow through the territory of Ukraine and European countries. In this regard, the protection of water resources and restrictions on the use of agricultural land in Ukraine and in neighboring countries should be harmonized and agreed, which can be ensured by the implementation of EU policies, rules and EU directives.

Ukraine has a significant amount of water resources, but their pollution and overexploitation can lead to serious problems with water supply and water quality. Ensuring water quality includes monitoring the quality of drinking water, water for industry, population and other purposes. Water pollution can occur naturally, but in most cases it is a consequence of human activity. Insufficient control over pollution can lead to a threat to people's health and to a decrease in the economic potential of regions.

The water strategy of Ukraine for the period until 2025, which was developed by the Institute of Water Problems and Reclamation of the National Academy of Agrarian Sciences of Ukraine, notes the significant negative impact on water bodies, which is exerted by dispersed (diffuse) runoff from agricultural and residential (urbanized) territories, as well as from areas occupied by industrial waste, landfills. There is also a constant danger of cross-border pollution of the river flow. These factors led to the fact that a large part of water bodies is characterized by a high degree of pollution and low water quality. The most tense situation has developed in the basins of the Siverskyi Donets, Ingul, Ingulets, and Priazovia rivers (Hadzalo et al., 2015).

A separate threat is the conduct of military (combat) operations in the territories of territorial communities located in the south and east of Ukraine and subject to both landmines and the catastrophic consequences of hostilities, one of which was the destruction of the Kakhovka Reservoir dam. In addition to human casualties and economic losses, ecological damage and pollution of the waters of the Dnipro River and the Black Sea, which are unprecedented for Europe.

As in pre-war times, as of now and in the period of post-war reconstruction, water resources protection is one of the important components of ensuring water quality in Ukraine. Usually, sources of pollution of water resources include:
– substances used in agriculture;
– waste oil products from water transport;
– wastewater from industrial and other enterprises.

One of the main results of the protection of water bodies should be the improvement of the quality of drinking water, so according to the monitoring report "Goals of sustainable development – Ukraine", the safety of drinking water according to microbiological indicators (in % of non-standard samples) has been slowly but gradually increasing since 2015 of this indicator and as of 2021 was 5.1% for urban areas of residence (orange line), 11.9% for rural areas (green line), by type of water supply: centralized – 7.6% (purple line), decentralized – 22.6% (brown line), which is shown in Chart 1.

Agriculture is one of the key sources of water pollution, which necessitates the establishment of water protection zones with a regime of regulated economic activity and coastal protective belts with a regime of limited economic activity with special conditions for the use of agricultural land.

In Ukraine, there is a regime of regulated economic activity within water protection zones, and the following actions are prohibited:
1. Use of persistent and potent pesticides.
2. Placement of cemeteries, cattle burial grounds, landfills and filtration fields.
3. Discharge of untreated sewage into reservoirs, quarries, streams, etc.

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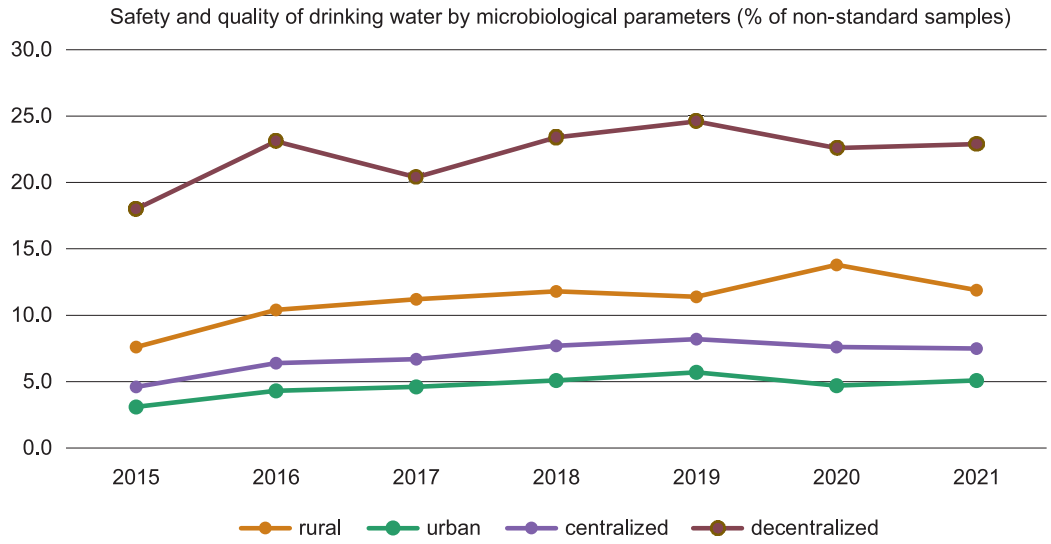

Chart 1. Safety of drinking water in Ukraine according to microbiological indicators (by % of non-standard samples)

Source: own preparation based on data from Sustainable Development Goals. Monitoring Report (2021).

In some cases, when the impact of the planned activity on the environment has been assessed and approved, sand and gravel mining is allowed within the water protection zone, except for the lands of the water fund, on land in floodplains and in the riverbeds, subject to approval by the relevant state authorities. Water protection zones of marine water areas, bays and estuaries in Ukraine usually coincide with the coastal protective belt and have a width of at least 2 km from the edge of the water.

The boundaries of water protection zones are established in accordance with land management projects, which provide for the organization and establishment of boundaries of water fund territories and water protection zones, as well as restrictions on the use of lands and their regime-forming objects. Also, the boundaries of water protection zones can be determined by comprehensive plans for the spatial development of the territories of territorial communities, or by general plans of settlements. The boundaries of water protection zones are established taking into account several factors. First of all, the topography of the area, the level of flooding and submergence, the intensity of coastal erosion and the presence of engineering coastal protection structures are taken into account. The purpose of the lands included in the water protection zones is also taken into account.

The water protection zone has internal and external boundaries. The inner boundary coincides with the minimum water level in the water body. The outer boundary is usually attached to the existing contours of agricultural land, roads, forest belts, floodplain borders, supraflood terraces, slope edges, gullies and ravines. It is determined by the line furthest from the water body, which takes into account flooding at the maximum flood water level, coastal erosion, temporary and permanent flooding of land, erosion activity, coastal slopes and heavily eroded land.

The outer boundary of the water protection zone on the lands of rural settlements, lands of agricultural purpose, forest fund, on the territories of water management, forest management and fishery enterprises, as well as on the lands of other owners and users is determined taking into account:

– zones of sanitary protection of sources of drinking water supply;
– calculation zone of coastal processing;
– forest plantations, which to the greatest extent contribute to the protection of waters with an outer boundary of at least 1,000 meters from the boundary water level cut;

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– of all land set aside on existing reclamation systems, but at least 200 meters from the edge of canals or dams.

For mountain and foothill rivers, the outer boundary of the water protection zone is determined taking into account geomorphological and hydrological conditions, as well as the risk of mudslides and landslides.

Within the water protection zones, land plots are allocated for coastal protection belts with a stricter regime of limited economic activity. Land plots under coastal protection belts are allocated for the purpose of protecting surface water bodies, such as rivers, seas, lakes, reservoirs and other bodies of water, from pollution, clogging and preserving their water quality. These protective belts are located along the shores and create a barrier that prevents harmful substances from entering water bodies, ensuring the preservation of the natural environment and its ecological balance. Coastal protective belts, which are a nature protection area, where there is a regime of limited economic activity, which is prohibited:

1. Use of land for plowing (with the exception of soil preparation for liming and afforestation), as well as horticulture and gardening.
2. Storage and use of pesticides and fertilizers (including nitrates).
3. Arrangement of summer camps for cattle.
4. Construction of any structures (except hydraulic, navigation, hydrometric, linear, engineering and fortification structures, fences, border signs, border crossings and communications), including recreation centers, cottages, garages and parking lots.
5. Washing and maintenance of vehicles and equipment.
6. Creation of landfills, manure storages, landfills, liquid and solid waste storage facilities, cemeteries, cattle burial grounds, filtration fields and other similar facilities.
7. Burning of dry vegetation or its remains in violation of the procedure established by the central executive body responsible for the environmental protection policy.

Objects located in coastal protection zones can be exploited, provided that the regime of limited economic activity is observed. Structures that are not subject to operation or do not meet the established management regimes must be removed from the coastal protective belts. Reconstruction, restoration and overhaul of existing objects (buildings) are allowed in the coastal protection belts.

Table 1. Dimensions of coastal protection belts in Ukraine

Regime-forming water objects	Requirements for establishing the border of coastal protection belts
Rivers, reservoirs and islands	– for small rivers, streams and streams, as well as ponds with an area of less than 3 hectares – 25 meters f or medium-sized rivers, reservoirs on them and ponds with an area of more than 3 hectares – 50 meters – for large rivers, reservoirs on them and lakes – 100 meters
Seas, around sea bays, estuaries	a coastal protective belt with a width of at least 2 kilometers from the edge of the water

Source: own preparation based on Water Code of Ukraine and Land Code of Ukraine.

In Ukraine, not only the observance of usage regimes, but also the establishment of boundaries of water protection zones and coastal protective belts in the area remains a problematic issue. Both on agricultural lands and on lands of other categories, landowners and land users often do not observe the boundaries of water protection zones and coastal protection belts in the area, arguing that the relevant land management projects for the purpose of establishing the boundaries of water protection zones and coastal protection belts do not developed and not approved (Fig. 1–3).

Thus, the current Procedure for determining the size and boundaries of water protection zones and the regime of conducting economic activities in them, approved by Resolution No. 486 of the Cabinet of Ministers of Ukraine dated May 8, 1996, provides that the size and boundaries of water protection zones are determined by the project on the basis of regulatory and technical documentation, which

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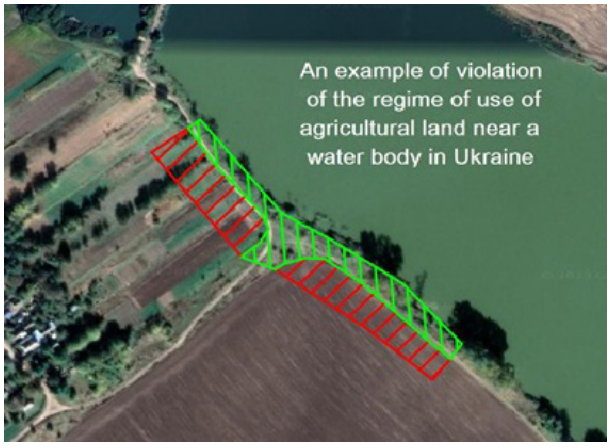

Fig. 1. An example of violation of the mode of use and dimensions of the coastal protective belt in Kyiv region, Ukraine
Source: own preparation based on various materials (2022).

Fig. 2. An example of violation of the regime of use and dimensions of the coastal protective belt in the Cherkasy region, Ukraine
Source: own preparation based on various materials (2022).

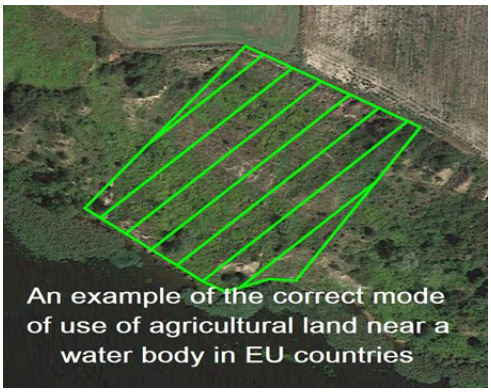

Fig. 3. An example of the complied requirements for the size of the coastal protection belt
Source: own preparation based on various materials (2022).

is coordinated with relevant bodies, land owners, land users and approved by relevant local bodies of state executive power.

It is important to note that the Supreme Court of Ukraine has established a legal position, which is that the absence of such a project and the uncertainty of the boundaries of the coastal protective belt in the area by the relevant state authorities cannot be considered as the absence of the coastal protective belt itself. The actual size and boundaries of the coastal protective belt are determined in accordance with the law, and the land management project that establishes the coastal protective belt is only a document containing graphic materials and information about the calculated area in the sizes and limits defined by the law (the Supreme Court of Ukraine, 2018). However, it should be noted that these provisions still do not remove the issue of the necessity and feasibility of developing relevant land management projects.

Restrictions on the use of agricultural land in Ukraine for the purpose of protecting water resources are important to consider in the context of the political and institutional rapprochement of Ukraine and the EU, because on June 23, 2022, the European Council decided to grant Ukraine the status of a candidate for the EU. Thus, Ukraine should take on the obligations envisaged by the prospect of EU membership, first of all, align the legislation with the EU regulatory framework (acquis) – a set of general EU rights and obligations. This also applies to issues of water protection and land use regulation.

The European policy of relations in the water sector is regulated by a number of directives, among which are the following: Water Framework Directive (2000/60/EC), Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC), Directive on the quality of water intended for human consumption (2020/2184), Floods Directive (2007/60/ EC), as well as a number of other directives (Osadcha et al., 2013).

Since the storage and use of pesticides and fertilizers is prohibited within the coastal protection zones, as nature conservation areas, where there is a regime of limited economic activity according to the Water Code of Ukraine, it is important to note

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the implementation of Directive No. 91/676/EU on the protection of waters from pollution, caused by nitrates from rural and agricultural sources, the purpose of which is:

1. Reduction of water pollution caused or caused by nitrates from agricultural sources.
2. Prevention of such pollution in the future.

Directive No. 91/676/EC establishes requirements for:

1. Adoption of national legislation and determination of the authorized body (bodies).
2. Definition of nitrate vulnerable zones (NVZs): all known land parcels in their territories from which there is a runoff of nitrates to waters affected by pollution and waters that may be affected by pollution. With the notification of the Commission about such initial determination (Article 3).
3. Introduction of action programs for NVZs (Article 5).
4. Introduction of programs for monitoring the concentration of nitrates in fresh waters (Article 6).

In Ukraine, the aforementioned directive is expected to be implemented through the adoption of a package of documents, which includes the Methodology for determining NVZs and establishing codes of good agricultural practices and measures, which would allow balancing agricultural and economic needs with the need to ensure the good condition of water and water ecosystems.

The methodology for determining "vulnerable zones" to nitrate pollution will allow monitoring and identifying areas where there is already an excess of the safe level of nitrates (over 50 ml/l). In such areas, action plans should be applied to reduce the risks and manifestations of pollution. Codes of good agricultural practices and measures will contain measures and restrictions for the use of fertilizers, their storage, pre-treatment, crop rotation and agricultural practices that prevent leaching of nutrients from the soil (for example, diversification of agricultural crops grown on the same field, use of seedless methods agriculture or cover crops).

The implementation of the provisions of Directive No. 91/676/EC on the protection of waters from pollution caused by nitrates from agricultural sources into Ukrainian legislation is a component of the Association Agreement between Ukraine and the EU, and the development of relevant documents is stipulated in Appendix XXX to Chapter 6 "Environment" Agreement on association, with the definition of specific tasks and schedules, as well as written in the Plan of measures for the implementation of the Agreement. In different years, several EU projects for technical support of Ukraine were involved in the development of the Methodology and the Code, and in the end, the relevant documents were developed through the joint efforts of relevant ministries, institutions and experts.

Currently, the documents are undergoing the procedure of coordination with the relevant bodies of the central government and are published for public discussion on the website of the Ministry of Environmental Protection and Natural Resources. After their agreement and adoption, the following steps in the practical implementation of the provisions of the Nitrate Directive will become possible: a list of zones vulnerable to nitrate pollution will be formed, where systematic measures will be taken to reduce and prevent this problem, and mechanisms for economic stimulation of economic entities will be determined regarding compliance with the best agricultural practices (Ihnatenko, 2021).

In conclusion, it should be noted that according to the analytical report of the European Commission, which assessed Ukraine's ability to assume the obligations envisaged by the prospect of membership in the European Union, published as of February 2, 2023, it was ascertained that there is a certain level of training in water management. Ukraine updated the Water Code and established areas of river basins. Ukraine joined the Water Convention and ratified the Water Protocol. In addition, Ukraine has developed the State Program for the Construction and Reconstruction of Drinking Water Supply Infrastructure for 2022–2026, but it still needs improvement to bring it in line with the latest EU standards. Alignment with the Urban Wastewater Treatment and Bathing Water Directives and the revised Drinking Water Directive is still needed.

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From an enforcement perspective, clean water services are in place, but drinking water and wastewater responsibilities need to be clarified.

In the aforementioned analytical report of the European Commission, it was also noted that the general principles of marine water protection are reflected in Ukrainian legislation. Monitoring of sea waters, including protected areas, is planned. The Marine Environmental Strategy was approved in 2021 with the aim of achieving and maintaining good environmental status in accordance with the Marine Strategy Framework Directive. Measures have been taken to comply with Directive No. 91/676/EC on the protection of waters against pollution caused by nitrates from agricultural sources. Nitrate-vulnerable zones still need to be defined (European Commission, 2023).

On April 15, 2021, the Ministry of Environmental Protection and Natural Resources of Ukraine approved the Methodology for determining zones vulnerable to (accumulation of) nitrates. This technique is an element of the implementation of Directive No. 91/676/EC on the protection of waters against pollution caused by nitrates from agricultural sources and the Association Agreement with the EU.

Every year, a process of eutrophication is observed in the reservoirs of Ukraine, the cause of which is the entry into the water of an excessive amount of nitrogen and phosphorus compounds, primarily nitrates and phosphates. This deteriorates water quality and threatens to turn water bodies into swamps altogether. After all, the high content of nitrates causes the growth of blue-green algae and the reproduction of bacteria that absorb oxygen in the water, and leads to the death of aquatic inhabitants. Nitrate contamination of groundwater and water in wells is especially dangerous. After all, almost 75% of the rural population in Ukraine use water from underground sources. Consumption of nitrate-contaminated drinking water harms the life and health of the population. As mentioned earlier, one of the main polluters of reservoirs and groundwater in Ukraine is the agricultural sector, which has problems with irrational and uncontrolled use of mineral and organic fertilizers, as well as improper management practices with livestock waste and other waste. The data of the state record of water use indicate that last year 45 thousand tons of nitrates got into reservoirs (Luhyn community, 2021). In connection with this, it is necessary to introduce restrictions on the use of agricultural lands for the protection of water resources.

Currently, it is difficult to determine and control the impact of agriculture on open water bodies and groundwater. Polluting substances originating from agricultural lands, places where animals are kept and grazed, directly fall into water bodies, but the places of pollution are not clearly defined and their influence extends over large areas. As part of the implementation of Directive No. 91/676/EC on the protection of waters against pollution caused by nitrates from agricultural sources, "vulnerable zones" that are constantly exposed to nitrate pollution should be established in Ukraine in order to take measures to prevent and reduce such pollution. Based on the determination of such vulnerable zones, the rules for maintaining soil fertility and preventing nutrient losses due to soil leaching into water bodies can be applied. These zones and measures to reduce and prevent pollution will become parts of river basin management plans, which are strategic documents for achieving a "good" state of water resources (Luhyn community, 2021).

The methodology for determining zones vulnerable to (accumulation) of nitrates establishes the criteria and procedure for determining zones vulnerable to (accumulation) of nitrates of agricultural origin, and is aimed at reducing water pollution by biogenic elements and preventing the occurrence of eutrophication in accordance with the provisions of Annex I to the Council Directive 91/676/EEC of December 12, 1991 on the protection of waters against pollution caused by nitrates from agricultural sources, as amended by Regulation (EC) No. 1882/200. The mentioned technique contains the following sections:

1. General provisions.
2. Determination of zones vulnerable to (accumulation of) nitrates in surface waters.

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3. Determination of zones vulnerable to (accumulation) of nitrates in groundwater.

According to the methodology, a zone is a limited part of land that has uniform characteristics regarding water pollution with nitrate compounds. A zone is considered vulnerable to (accumulation of) nitrates if: in surface and/or underground waters used for drinking water supply, or intended as sources of drinking water supply:

– an excess of nitrate (NO_3^-) content of more than 50 mg/dm^{-3} (11.3 mg N dm^{-3}) was recorded;
– in the future, if appropriate measures to prevent water pollution are not taken, the nitrate content (NO_3^-) may exceed 50 mg/dm^{-3} (11.3 mg N dm^{-3}).

Taking into account the biogeochemical instability of nitrogen compounds in water, the total content of inorganic nitrogen compounds (inorganic N) = ($NH_4^+ + NO_2^- + NO_3^-$) is considered for the definition of zones vulnerable to (accumulation) of nitrates. The inorganic N criterion>11.3 mg N dm^{-3} is used for rivers with a Strahler coefficient <5 and groundwater.

It should be noted that according to the mentioned methodology, based on the water regime of soils and their filtration coefficients (Fig. 4), as well as the nitrogen balance in soils, calculated for the purposes of the Nitrate Directive and at a level not exceeding the administrative district (Fig. 5), determine the potential conditions for the leaching of nitrogen compounds from the catchment area of water bodies.

Based on the above information, 3 types of nitrate vulnerable zones (NVZs) are distinguished:

1. Zones of high risk of water pollution, where a positive balance of nitrogen in the soil is observed with the washing and periodic washing-water regime of the soils.
2. Zones of potential water pollution, where a deficient nitrogen balance in the soil is observed with the washing and periodic washing water regime of the soils.
3. Zones of short-term pollution, where there is a positive balance of nitrogen in the soil with non-washable water regime of the soil.

Determination of zones vulnerable to (accumulation) of nitrates is carried out on the basis of water monitoring data, which can be supplemented by modeling results.

It is also important to introduce the European Union Directive 2007/60/EU "Assessment and management of flood risks", which declares the latest strategic approaches to increasing the level of hydro-ecological safety of river basins, which provide for the transition from the "paradigm of protection" to risk management and ensure coordination, pooling of efforts and material resources

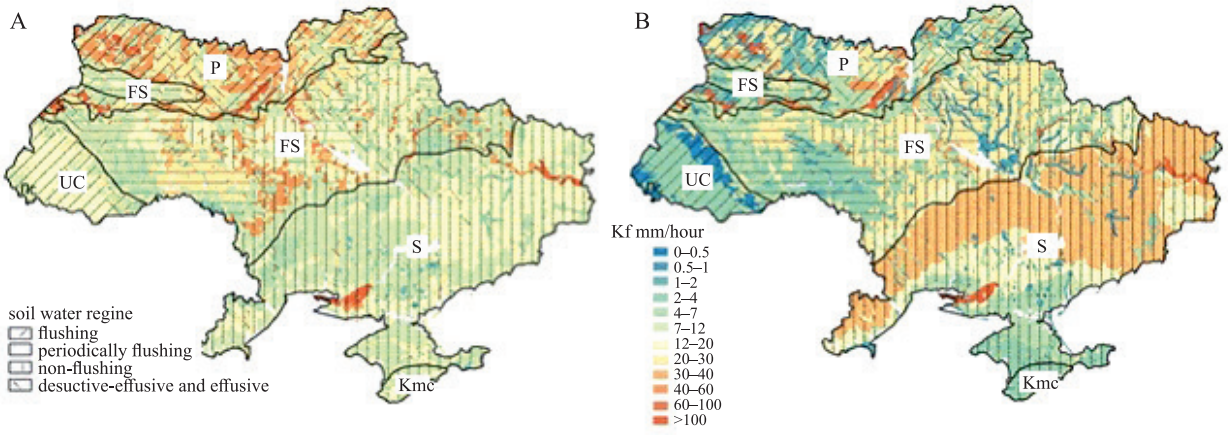

Fig. 4. Soil water regime (hatching) and filtration coefficients of A – top layer (A0, A1) and B – bottom layer (A2, B, C) of soils of Ukraine according to agro-soil zoning zones of Ukraine (P – Southwestern part of mixed forest zone, Ukrainian Polissya (P), FS – forest-steppe zone, S – steppe zone, UC – Ukrainian Carpathians, Kmc – Crimean mountainous country)
Source: data from the Methodology for determining zones vulnerable to (accumulation of) nitrates.

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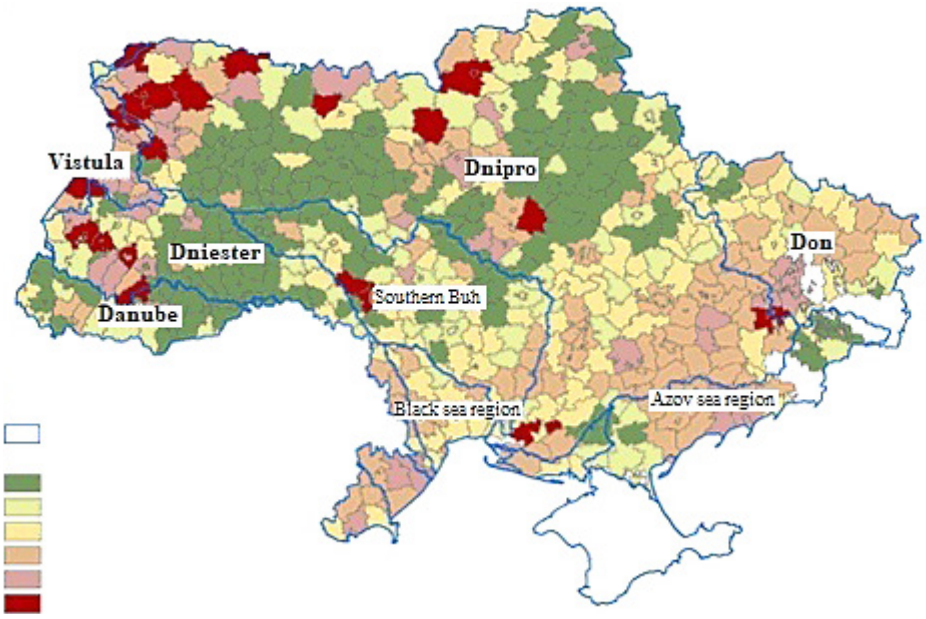

Fig. 5. Nitrogen balance in soils at the level of individual administrative districts of Ukraine as of 2018

Source: data from the Methodology for determining zones vulnerable to (accumulation of) nitrates.

of all interested parties of society, local, regional and state authorities. The strategy for managing risks from the harmful effects of water should provide for the integration of the organization of land use and water resources management in river basins with a complex of nature protection, anti-flood and other measures and is aimed at the simultaneous preservation of river ecosystems and related biodiversity, ensuring normal living conditions and management in the conditions of manifestations of harmful effects of water, lowering the level of vulnerability of territories, as well as increasing the efficiency of the use of river floodplains (Hadzalo et al., 2015).

CONCLUSIONS

The problem of drinking water quality in Ukraine and the world is socially significant. In Ukraine, there are a number of legal acts regulating the protection of water resources and ensuring water quality. Among them are the Water Code of Ukraine, the Land Code of Ukraine, the Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Procedure for Determining the Size and Boundaries of Water Protection Zones and the Mode of Conducting Economic Activities in Them", Law of Ukraine "On Environmental Protection". At the same time, Ukraine, having signed the Association Agreement with the EU, undertook to implement a number of Directives regulating the use and protection of water resources.

The procedure for determining the size and boundaries of water protection zones and the mode of conducting economic activities in them, which is in force in Ukraine, defines that the boundaries of water protection zones are established taking into account: the topography of the area, inundation, the intensity of coastal erosion, the construction of engineering protection of the shore, purpose of the lands included in the water protection zone. On the territory of water protection zones, the use of persistent and potent pesticides is prohibited and other prohibitions apply. Within the boundaries of water protection zones, land plots are allocated for coastal protection belts.

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However, the specified procedure was approved in 1996 and did not take into account the need to implement EU Directives, including Directive No. 91/676/EC on the protection of waters from pollution caused by nitrates from agricultural sources. Since there is a regime of limited economic activity and the storage and use of pesticides and fertilizers are prohibited within the coastal protection zones as nature protection areas, it is important to conclude that the establishment of water protection zones and the allocation of land plots for coastal protection zones should take into account the zones vulnerable to (accumulation) of nitrates of agricultural origin, determined according to the relevant Methodology. From the point of view of land management, this will be the practical implementation of Directive No. 91/676/EC.

An important problem that needs to be solved is the actual establishment of water protection zones and coastal protective belts. Including, but not limited to, financing the development of relevant documentation on land management with an indication of the boundaries of coastal protection belts, beach zones and marking by executive authorities and local self-government bodies on the territory of such objects with informational signs, which in practice does not happen often.

Information about the boundaries of coastal protection belts, beach zones must be entered into the State Land Cadastre as information about land use restrictions. It is important to note that the absence of documentation on land management and the failure of the appropriate state authorities to determine the border of the coastal protective belt in the area cannot be interpreted as the absence of the coastal protective belt itself and the corresponding restrictions on the use of agricultural land.

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