

<https://doi.org/10.15407/scine22.05.079>

RADCHENKO, D. V. (<https://orcid.org/0009-0002-4459-0009>)

State Organization “V. Mamutov Institute of Economic and Legal
Research of the National Academy of Sciences of Ukraine,”
60, Shevchenko Blvd., Kyiv, 01032, Ukraine,
+380 44 200 5568, office.iepd@nas.gov.ua

REGULATORY AND LEGAL ASPECTS OF ECONOMIC ACTIVITY MANAGEMENT FOR MITIGATING THE NEGATIVE IMPACT OF CLIMATE CHANGE ON UKRAINE’S WATER RESOURCES

Introduction. Climate change has become an increasingly pressing global challenge, with water resources representing one of the sectors most vulnerable to its adverse impacts.

Problem Statement. Ukraine is among the least freshwater-secure countries in Europe and is experiencing a significant decline in both the quantity and quality of its freshwater resources. This trend is largely attributable to climate change, the adverse impacts of economic activity, and deficiencies in water resource management. Consequently, improving the legal regulation of water relations has become a priority.

Purpose. This study aims to analyze Ukrainian and European water legislation in order to assess potential threats to freshwater resources arising from climate change and inadequate regulation of economic activities, particularly in the agricultural sector.

Materials and Methods. The study is based on key Ukrainian and European legislative acts governing water resources, together with selected international databases on anthropogenic greenhouse gas emissions, the condition of water resources, and the impacts of climate change on aquatic ecosystems. Comparative legal analysis and formal legal methods are employed to evaluate the national legal framework and its consistency with European Union legislation.

Results. The study has examined the evolution of European and Ukrainian legislation on water protection and conservation over the past five decades and analyzed the progress of implementing EU water legislation into the national legal framework of Ukraine. The analysis has revealed a number of inconsistencies

Citation: Radchenko, D. V. (2026). Regulatory and Legal Aspects of Economic Activity Management for Mitigating the Negative Impact of Climate Change on Ukraine’s Water Resources. *Sci. innov.*, 22(5), 79—100. <https://doi.org/10.15407/scine22.05.079>

© Publisher PH “Akademperiodyka” of the NAS of Ukraine, 2026. This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)

between Ukrainian and European legal provisions that require further harmonization through legislative amendments, particularly in the context of climate-related risks. The findings have demonstrated the necessity of broader implementation of a risk-based approach to water resource management and have highlighted the need to strengthen the legal regulation of agrochemical use, which remains one of the major sources of water pollution in Ukraine.

Conclusions. The existing legal framework governing the protection and conservation of water resources has not yet been fully aligned with European Union legislation, and several areas of legal regulation remain underdeveloped. The obtained results have provided a scientific basis for proposing amendments to national legislation aimed at strengthening the legal protection and sustainable management of Ukraine's water resources under conditions of climate change.

Keywords: water legislation, climate security, pollution, water protection, liability for administrative offences, changes to legislation.

Global climate change has become a major challenge for humanity. Adapting to it is now urgent, as the survival of all future generations is at stake. As is well known, the main driver of modern climate change is human activity, which increases greenhouse gas concentrations, causing global warming [1]. According to the World Meteorological Organization (WMO), 2024 was the warmest year in 175 years of observations. The Earth's surface temperature this year was 1.55 ± 0.13 °C higher than the 1850—1900 average [2]. At the same time, warming of the world ocean was observed, with the temperature exceeding the 1981—2010 base level by 0.6 °C. It is noted that about 90% of the heat accumulated in the climate system is stored in the ocean, thereby increasing its temperature [3]. Global warming has a particularly negative impact, on the one hand, on the state of drinking water resources, without which the normal life of terrestrial organisms is impossible, and, on the other hand, it intensifies the negative, or even destructive, impact of water [4]. Already today, such problematic phenomena as floods, sharp temperature drops, droughts and extreme weather conditions are observed. According to the forecasts of the UN Intergovernmental Panel on Climate Change, the number and scale of water-related natural disasters will increase in the coming years [5]. Thus, in 2024, such disasters worldwide displaced 40 million people and caused losses of more than USD 550 billion [6]. In 2025, economic losses from water-related disasters worldwide exceeded USD 360 billion [7].

According to the latest global estimates in the United Nations World Water Development Report 2025 [8], freshwater withdrawals are dominated by the agricultural sector (72%), followed by industry (15%) and domestic (or municipal) use (13%). Global freshwater withdrawals rose by 14% between 2000 and 2021. Approximately 4 billion people, or half of the world's population, experience acute water scarcity for at least part of the year. Climate change is increasing seasonal variability and uncertainty in water availability across most regions.

It should be noted that Ukraine is one of the countries in Europe with the least freshwater supply. Thus, Ukraine ranks 32nd among 40 European countries in terms of drinking water supply and is included in the list of countries most at risk of freshwater shortages due to global warming [10]. According to the World Wildlife Fund, Ukraine is experiencing an increase in the intensity of natural hydrometeorological phenomena, particularly droughts, which, in turn, lead to a shortage of water resources [11]. At the same time, 80% of the water supplied to consumers in our country is taken from surface sources, namely rivers. However, according to the hygienic classification of water bodies by degree of pollution, most river basins are classified as polluted or highly polluted and do not meet the requirements of sanitary legislation for drinking water sources [12]. Based on the above, Ukraine today needs to address the problems associated with the provision of drinking water, its protection, rational use and restoration.

Water quality has also become a global concern due to dramatic deterioration, driven largely by climate change and inefficient water management, and by phenomena such as surface water pollution from industrial and agricultural runoff, including the reuse of untreated wastewater for irrigation, which significantly pollutes groundwater. Similarly, uncontrolled waste management, with the formation of large landfills, causes large-scale pollution of groundwater and surface water [13].

Global urbanisation directly affects water and soil pollution by increasing the generation of solid and liquid waste, which, through leaching, leads to water pollution. Agricultural activities are particularly at risk when, as a result of the use of excess fertilisers, water is polluted through surface runoff from fields [14]. Another significant problem associated with rising temperatures is increased water evaporation, which directly affects both its quantity and quality. Evaporation can reduce water levels by 25%, increasing the concentration of pollutants, including salts, in the water. This makes drinking water salty, saline, or brackish, and ultimately bitter, reducing its use [15]. Ukraine is also experiencing an annual increase in flood and drought losses, exacerbated by the adverse effects of climate change [16].

In addition to the climate-related problems mentioned above, the consequences of Russia's military aggression against Ukraine pose a significant risk to water resources. The occupation of southeastern Ukraine and the annexation of Crimea in 2014 further worsened the state of Ukraine's water resources. The explosion at the Kakhovka hydroelectric power station on June 6, 2023, created a complex of problems. Russia used water as a weapon, leading to an ecological disaster in the region that destroyed 60 thousand buildings and affected 110 thousand residents across 80 settlements in the Kherson, Zaporizhzhia, Mykolaiv and Dnipropetrovsk regions. In addition, approximately 1 million people experienced disruptions to their drinking water supply. According to the Ministry of Environmental Protection of Ukraine, as of January

6, 2025, the total damage caused by the Kakhovka HPP explosion was estimated at USD 14 billion [17]. Water supply and drainage networks, sewage pumping stations, as well as water treatment and purification facilities were damaged. Agriculture suffered significant losses, estimated at USD 406.6 million, most of which (92%) were in crop production [18].

The Kakhovka Reservoir, which supplied water to a large agricultural sector capable of irrigating 800,000 ha of arable land, almost dried up in a few weeks, leaving only the Dnieper Riverbed [19]. According to the State Agency for Water Resources of Ukraine, water resources in Ukraine have decreased by more than 18 billion m³ as a result of the destruction of hydraulic structures, primarily the Kakhovka HPP, as well as hostilities and pollution, creating a critical water shortage in the southern regions. [20]. As a result, more than 306,500 ha of previously irrigated arable land were converted to rain-fed agriculture, which is entirely dependent on rainfall, leading to a 70% drop in yields. In the year before the war, 2 million tonnes of grain and oilseeds were harvested on these lands. In total, the above-mentioned regions accounted for almost a quarter of all cultivated agricultural land and about a fifth of Ukraine's entire harvest [18].

The problems of Ukrainian environmental legislation, particularly regarding the regulation of relations in areas of activity that affect or depend on climate change, were considered in the works of such Ukrainian scientists as V. I. Andreytsev, G. V. Anisimova, G. I. Balyuk, O. O. Bardina, N. S. Gavrish, A. P. Getman, H. A. Grigorieva, O. V. Donets, I. A. Dubovich, N. V. Yeremeyeva, V. A. Zuev, M. V. Krasnova, Y. A. Krasnova, S. V. Kurenda, T. V. Kurman, N. R. Malysheva, K. A. Prokhorenko, V. K. Rybachek, O. V. Shevchenko, O. O. Shynkarev, M. V. Shulga and others. Nevertheless, the growing negative impact of climate change and the related deterioration of the state of water resources in Ukraine, which has become especially noticeable in recent years, require a new analysis and revision of certain legal norms in this area. Thus, in Ukraine, tens of thousands of small rivers have

already partially or completely disappeared due to climate change and anthropogenic impacts [11].

The basis of the work was the key domestic regulatory legal acts governing the water sector and related relations, as well as the European Union's water legislation, which must be implemented in accordance with Ukraine's obligations under the Association Agreement with the EU. In this work, we applied a set of specialised legal methods to study the development of European and Ukrainian water legislation. One of the main methodological approaches was a comparative and formal-legal analysis of domestic legislation to assess its compliance with EU norms, which enabled the identification of several problematic issues arising from inconsistencies between individual legal norms in the Ukrainian legal system and EU legislation.

The empirical basis of the study also drew on separate international databases on anthropogenic greenhouse gas emissions, the state of water resources, and the impact of climate change on them, which are maintained, in particular, by the Emissions Database for Global Atmospheric Research (EDGAR) and the Global Water Monitor (GWM), as well as data from the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change (IPCC), the World Wildlife Fund (WWF), and others. This allowed us to assess the impact of climate change and anthropogenic activity on the state of water resources and to determine the degree of importance and urgency of adopting relevant changes to Ukrainian legislation that relates to or may affect the water sector.

In the European Union, the first regulatory act on water protection was Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community, which introduced the requirement to obtain a permit for discharges of harmful substances [22]. Subsequently, Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment [23] and Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources [24], were

adopted to regulate activities that lead to water pollution. Then, Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control [25] was adopted, which, among other things, addressed the protection of water resources, as did the more specialised Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption [26].

The overall objective of EU water policy, set out in Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (hereinafter referred to as the Water Framework Directive) [27], is to ensure access to sufficient quantities of good-quality water for all Europeans, economic sectors and the environment, and to ensure the good status of all water bodies throughout Europe. Therefore, the European Union is developing policies and action plans to prevent and mitigate the effects of drought and water scarcity. The priority of such a policy is the transition to a water-efficient and water-saving economy [28]. The Water Framework Directive provides an appropriate framework for addressing water scarcity and drought. The Directive promotes sustainable water use by protecting existing water resources in the long term and mitigating the effects of drought, and ensures an adequate supply of good-quality surface and groundwater. However, it should be noted that this key Water Framework Directive, like all other water legislation adopted in the EU before 2000, does not contain any provisions on climate change and its impact on water bodies.

During the Soviet era in Ukraine, water legislation comprised two key acts, namely the Law of the USSR dated 10.12.1970 No. 564-VIII On the Approval of the Fundamentals of the Water Legislation of the Union of Soviet Socialist Republics and the Union Republics and the Law of the Ukrainian SSR dated 9.06.1972 No. 771-VIII On the Approval of the Water Code of the Ukrainian SSR. These acts nominally remained in force until 2022, when, by the Law of Ukraine On the De-

Sovietization of the Legislation of Ukraine dated 21.04.2022, they were included in the List of acts of state authorities and state administration bodies of the Ukrainian SSR that are not applied on the territory of Ukraine in accordance with paragraph 1 of Section XV Transitional Provisions of the Constitution of Ukraine [29]. However, after the adoption of the Water Code of Ukraine on 06.06.1995 [30], Soviet acts in this area were no longer applied in practice.

According to modern Ukrainian water legislation, namely the Water Code of Ukraine, water, as one of the main components of the natural environment, is the national heritage of the Ukrainian people and a natural foundation of its economic development and social well-being. Water resources sustain human, animal and plant life and are limited and vulnerable natural resources; therefore, they require special rules for their treatment, rational use, and environmentally oriented legislative protection. The Water Code of Ukraine, adopted in 1995 to regulate public relations in this area, was the first to introduce the basic concepts and sustainable principles of water resources management [30]. Subsequently, to fulfil Ukraine's obligations to adapt national legislation to EU environmental standards, as stipulated in Article 363 of the Association Agreement between Ukraine and the European Union [31], the Government Committee on European and Euro-Atlantic Integration, International Cooperation, Legal Policy and Law Enforcement, in a decision dated March 20, 2025, approved the official Ukrainian translation of the EU Water Framework Directive [32].

This was another step towards the gradual alignment of Ukrainian water legislation with EU law and policy, namely the adoption of a basin approach to water resources management, following the example of large European river basins, which are managed by river basins rather than by administrative-territorial boundaries. In Ukraine, the relevant provisions of the Water Framework Directive apply to the basins of the Dnieper, Southern Bug, Danube, Desna, Seversky Donets, and Vistula, as well as to rivers in the Black Sea, the Sea of

Azov, and Crimea. The main task of such management is to control water quality and prevent pollution of these water bodies. For this purpose, the legislation provides for continuous state monitoring of water bodies [33].

Modern water legislation is an important tool for climate change adaptation. It regulates the economic use of water resources and measures to protect them from extreme hydrological phenomena, such as floods and droughts, and ensures their protection, conservation, restoration and, in general, water resources management.

As the European experience shows, during droughts, which are becoming increasingly frequent due to global warming, highlight the need for equitable water distribution, a significant challenge for sustainable water resources management [34]. Thus, excessive consumption and water pollution in conditions of scarcity can have serious consequences for nature and society. In particular, reduced water availability in certain regions and seasons can lead to conflicts of interest among users. Therefore, drought management in Europe must address additional challenges in the context of climate change. For example, during water shortages, irrigation might compete with the minimum flow regimes needed to cool nuclear and thermal power plants. Therefore, it is essential to carefully determine and normatively establish user priorities using specific criteria and indicators. Such decisions should be transparent and understandable, ensuring that users whose water rights are restricted, as well as the broader public who may be impacted, are fully informed [34].

As for the direct negative impact of climate change on the state and quality of water resources, it will primarily affect economic activities, particularly the domestic sector, namely the supply of drinking water to the population. The agricultural sector, in particular livestock farming, and the food industry will also be significantly affected [35, 36]. Already now, according to the Water Strategy of Ukraine for the period until 2050 [37], the quality of surface waters, which are a source of drinking water for 80 percent of the population of Ukraine,

is unsatisfactory and characterised by increased levels of organic and biogenic substances.

In this regard, issues related to the regulation of drinking water quality are of particular importance. In this direction, the Law of Ukraine On Drinking Water and Drinking Water Supply dated 10.01.2002 No. 2918-III [38] requires further improvement. Even in the latest version, adopted on March 11, 2026, it lacks a risk-based approach to making management decisions in the field of water resources, in particular, in the event of droughts, salinisation of fresh water, degradation of water bodies, etc. Although the law covers the entire water supply cycle, from requirements for water intake sources to centralised water supply, it does not take into account the threats arising from climate change, which affects the quantity and quality of water. Unlike the EU approach set out in Articles 7, 8 and 9 of Directive (EU) 2020/2184 on the quality of water intended for human consumption [39], which takes into account such possible threats and risks, the Law of Ukraine No. 2918-III [38] does not provide for a phased system of control from source to consumer, as implemented in EU legislation under the “from catchment to tap” principle.

It should also be noted that although Article 7 of the Law of Ukraine on Drinking Water and Drinking Water Supply establishes guarantees for consumers, these guarantees do not cover several important points. In particular, there is no requirement to promptly inform the population of any deterioration in the quality of drinking water or of restrictions on its supply. Also, paragraph ten of part one of the same Article 7 provides for the possibility of a temporary prohibition (suspension) in accordance with the established procedure for the functioning of drinking water supply systems that do not provide drinking water of the required quality. However, this Law does not guarantee the mandatory provision of an alternative drinking water supply to the population in such cases, which, in our opinion, violates human rights. Currently, alternative drinking water is provided to the population only in cases of a technogenic or natural emergency, as regulated by Article 24 of the Law

of Ukraine On Drinking Water and Drinking Water Supply. Therefore, paragraph ten of part one of Article 7 of this Law should be supplemented with the following text, “*with mandatory provision in such cases by an alternative water supply to consumers at the expense of persons guilty of the specified violations.*”

In addition, under the Hygienic standards for the quality of water bodies for drinking, household and other needs of the population as approved by the Order of the Ministry of Health of Ukraine dated 02.05.2022 No. 721, the Maximum Permissible Concentration (MPC) for nitrates in all regions of Ukraine should not exceed 45 mg/l [40], which aligns with the standards of the USA, Canada and India [41]. By contrast, the State Sanitary Norms and Rules Hygienic requirements for drinking water intended for human consumption as approved by the Order of the Ministry of Health of Ukraine dated 12.05.2010 No. 400 (as amended on 17.01.2025), sets this norm at 50 mg/l (ppm) NO_3^- or 11.3 mg/l $\text{NO}_3^- \text{—N}$ [42], which is consistent with the requirements of the EU Nitrate Directive [24].

When comparing these two current regulatory acts, approved by the same ministry, it turns out that water in open water bodies should be cleaner, at least in terms of nitrate content, than the tap water consumed by people. To avoid this rather illogical situation, it is necessary to revise the water quality standards, making them the same across most regions of Ukraine. The only exception should be the standards for southern regions with a dry climate, as discussed below.

Recently, a new Procedure for State Monitoring in the Spheres of Drinking Water, Water Supply, and Sewage was adopted and approved by the Resolution of the Cabinet of Ministers of Ukraine dated January 21, 2025, No. 61, which defines the procedure for conducting such monitoring. However, its financing is planned only from 2028, in accordance with paragraph 2 of clause 22 of the said Procedure [43]. Until 2028, water monitoring should be carried out at the expense of local budgets, which are quite limited, which does not allow for regular

measurements. As a result, timely detection of pollution, which has increased significantly due to both climate change and military actions stemming from Russia's attack on Ukraine, is at risk. Furthermore, this Procedure lacks assessment criteria in accordance with EU standards as defined in Article 5 of Directive (EU) 2020/2184 on the quality of water intended for human consumption [39], and it does not provide for risk assessment and management at water abstraction points and in water supply systems as set out in Articles 7–10 of this EU Directive. Moreover, these risk assessments under Directive (EU) 2020/2184 should be regularly reviewed by the EU Member States, including in response to threats posed by extreme weather events linked to climate change. Therefore, the Procedure for state monitoring in the areas of drinking water and drinking water supply, and wastewater [43] should be amended accordingly, taking into account the requirements of the World Health Organization (WHO) Guidelines on Drinking Water Quality [44] and the WHO Water Safety Plan [45], particularly regarding the identification of hazards associated with catchment areas for abstraction points, i.e. the risk assessment and risk management of catchment areas for abstraction points of water intended for human consumption.

Thus, the Procedure for state monitoring in the areas of drinking water and drinking water supply, and wastewater adopted by the Government of Ukraine, is quite limited and due to a lack of state funding, such monitoring will apparently not be carried out at many water intake points and water supply systems over the next year and a half, posing significant risks to the population. According to the World Health Organization (WHO), more than 80% of diseases today are associated with inadequate drinking water quality [46]. Given that ensuring the safety of drinking water is one of the fundamental constitutional obligations of the state, the government should take urgent measures to ensure continuous monitoring of drinking water, for example, by providing subsidies to local authorities or directly to organisations responsible for such monitoring.

Regarding other freshwaters used for irrigation and other industries, it should be noted that, due to increased evaporation caused by global warming, the amount of water in freshwater bodies is decreasing, which will lead to pollutants becoming less diluted, i.e. their concentration will increase. This, together with higher temperatures and reduced dissolved oxygen levels, will render the water unfit for drinking and seriously affect the overall balance of ecosystems [34]. Therefore, in our opinion, it is already necessary to revise the threshold indicators of freshwater quality by differentiating them and introducing stricter standards for arid regions, where evaporation increases pollutant concentrations, especially nitrogen-containing compounds, which have an extremely negative impact on the state of water bodies.

It is worth noting the agricultural sector's impact on water resources in the context of climate change. According to the Rules for ensuring soil fertility and the use of certain agrochemicals as approved by the Order of the Ministry of Agrarian Policy and Food of Ukraine dated 24.11.2021 No. 382 [47], the use of nitrogen fertilisers for growing crops should aim to minimise the risk of leaching of nitrogen compounds and pollution of water bodies. However, Appendix 2 of these Rules, among the restrictions, only establishes periods that are undesirable for the application of mineral nitrogen fertilisers. These Rules are not consistent with the EU Nitrate Directive (as amended by Regulation (EC) No. 1882/2003 [48]), which provides for a complete ban on the use of nitrogen fertilisers in certain periods of the year [24]. Under the Association Agreement between the European Union and the European Atomic Energy Community and their Member States, on the one hand, and Ukraine, on the other, which was ratified by the Verkhovna Rada on 16.09.2014 [31], the provisions of this EU Nitrate Directive were to be implemented within 3 years of the Agreement's entry into force. However, the Rules on ensuring soil fertility and the use of certain agrochemicals adopted in Ukraine do not meet the requirements of

EU legislation, as they do not explicitly prohibit the application of nitrogen fertilisers at any time.

By the way, paragraph 1 of section VIII of these Rules for ensuring soil fertility and the use of certain agrochemicals states that “agricultural activity and the use of agricultural land should be carried out taking into account the need to adapt to climate change and its mitigation” [47]. Given the significant impact of climate change on water resources, as shown above, the agricultural sector should adopt stricter standards for the use of mineral fertilisers, herbicides, insecticides, and organic livestock waste, which are among the main water pollutants. First of all, this should apply to regions with limited freshwater supplies that require special legal protection for water bodies.

According to the EU Nitrate Directive, the main cause of water pollution is nitrates from agricultural sources. Therefore, the Directive aims to reduce nitrate pollution, the maximum permissible concentration of which in surface and spring waters, as already mentioned above, is set at 50 mg/l [24]. To detect nitrate pollution in a timely manner and prevent its spread, it is necessary to regularly monitor nitrate levels in water bodies, taking into account not only climatic zones but also changes driven by global warming. This allows the quick identification of the areas that are most exposed to such pollution due to excessive use of fertilisers in agriculture.

Currently, in Ukraine, inspections of water bodies for nitrate content, in accordance with the Procedure for State Water Monitoring as approved by the Resolution of the Cabinet of Ministers of Ukraine dated 19.09.2018 No. 758 [33], should be carried out once a month without reservation, whereas Article 6 of the EU Nitrate Directive emphasises the need for more frequent water inspections during periods of flooding [24]. In our opinion, inspections of water bodies for nitrate content should also be conducted more frequently during significant temperature increases, when nitrate and other pollutant concentrations rise due to evaporation. Due to global warming, this is becoming critically important for arid southern

regions. Therefore, it is necessary to improve the legal framework for implementing the EU Nitrate Directive, taking into account not only regional but also local climatic, soil, and landscape characteristics, including a differentiated approach to fertiliser use that accounts for climate change.

In countries around the world, including Ukraine, only average fertiliser application rates are currently recommended, which usually leads to their excessive use. Thus, according to the data provided in the announcement of the 2nd World Congress on Fertilizers and Nutrients, which took place on June 1—2, 2026, in Chicago (Illinois, USA), even in leading countries of the world, in particular in the USA, there is still excessive use of fertilisers, which mostly does not meet real needs and leads to their excessive runoff into waterways [49].

To ensure alignment of Ukrainian water legislation with EU legislation, the Cabinet of Ministers of Ukraine’s Resolution No. 1412-p of 10.12.2025 approved the Operational Plan for the Implementation of the Water Strategy of Ukraine for the Period Until 2050 in 2025—2027 [50]. Paragraph 6 of this plan, for the implementation of the EU Nitrate Directive, establishes “the determination of zones vulnerable to (accumulation of) nitrates, in accordance with the Methodology for determining zones vulnerable to (accumulation of) nitrates, approved by the Order of the Ministry of Environmental Protection of Ukraine of 15.04.2021 No. 244, and their regulatory implementation in order to regulate diffuse water pollution” [51]. The specified Operational Plan provides for the approval of “mandatory action plans for all agricultural producers operating in areas vulnerable to (accumulation of) nitrates of agricultural origin.” However, this regulatory legal act does not contain a specific step-by-step action plan or measures to identify such vulnerable areas, nor does it provide for the development of a general action plan. In addition, there are no regulatory documents on the creation and maintenance of the State Register of Areas Vulnerable to Nitrate Accumulation. The Ministry of Economy and other interested central executive bodies are responsible for imple-

menting paragraph 6 of the Operational Plan. Given that this is a crucial issue for our country in preserving the quality of drinking water and that nitrates have the most significant impact on it, a specific action plan and specific bodies, institutions and organisations responsible for its implementation should be determined, rather than “other interested central executive bodies,” which makes the responsibility for its implementation vague.

Moreover, according to part one of section IV of the above-mentioned Methodology for determining zones vulnerable to (accumulation of) nitrates [51], the ecological state of a surface water body is determined by indicators of biogenic elements that drive eutrophication, namely nitrogen and phosphorus compounds, in accordance with the Methodology for assigning a surface water body to one of the classes of ecological and chemical states of a surface water body. However, the latest Methodology, approved by the Order of the Ministry of Ecology and Natural Resources of Ukraine dated 14.01.2019 No. 5 [52], does not even provide for the determination of the content of nitrogen and phosphorus compounds, and for natural surface waters these compounds are not included in the List of pollutants for determining the chemical state of surface and groundwater bodies and the ecological potential of an artificial or significantly modified surface water body, approved by the Order of the Ministry of Ecology and Natural Resources of Ukraine dated 06.02.2017, No. 45 [53]. Similarly, the Ecological standards for water quality for determining the ecological state of a surface water body, approved by the Order of the Ministry of Environmental Protection and Natural Resources of Ukraine dated April 1, 2024, No. 332 [54], do not include any standards for nitrates, even though the ecological state of a surface water body primarily depends on them. Nitrates cause eutrophication of water bodies, leading to hypoxia and mass mortality of living aquatic organisms [55, 56], thereby rendering such water bodies unsuitable for drinking water supply.

All this provides grounds to argue that the EU Nitrate Directive [24] has so far been only partially

implemented in Ukraine, although it is part of the obligations under the Association Agreement with the EU and should aim to protect waters from nitrate pollution. It should be noted that nitrates are readily transported by water and pose a serious risk to both ecosystems and human health [57]. Although nitrogen fertilisers can increase crop yields, high concentrations of nitrates entering aquatic environments through field runoff can promote rapid phytoplankton growth, which, as already mentioned, causes a number of other problems. That is, if an effective legal model is not developed to control and strictly restrict the use and storage of nitrogen-containing organic substances, including a complete ban on their use during periods of the year when the risk of their entering water bodies is greatest, this could lead to significant further losses of drinking-quality water sources, which would be catastrophic for our country, which is poorly supplied with fresh water.

Monitoring of nitrate concentrations should be regular and cover all regions where there is a risk of such pollution. It should be noted that, in addition to the application of the main nitrogen-containing fertilisers, such as urea, ammonium nitrate, ammonium sulphate and calcium nitrate, a significant proportion of nitrogen is supplied through the application of manure, which is characteristic of modern organic farming [58]. However, this activity is poorly regulated, especially in the absence of effective controls on the use of manure and other fertilisers. In addition, legal liability for offences in this area is extremely weak. In particular, the norms established in Art. 83 of the Code of Ukraine on Administrative Offences [59] for violating the rules for handling pesticides and agrochemicals cannot be considered effective, which is especially dangerous in the context of climate change, as it can cause large-scale pollution of freshwater bodies. Therefore, such activity requires clear normative regulation, taking into account the zonal features of our country.

The Institute of Water Problems and Reclamation of the National Academy of Agrarian Sciences of Ukraine conducted a zoning of the territory of

Ukraine, which identified six main typical zones: excessively wet — 4.5% of the territory; wet — 30.0%; insufficiently wet — 16.0%; arid — 20.0%; dry — 22.0%; very dry — 7.5%. From 1991 to 2015, compared with 1961—1990, the area with a significant deficit of natural moisture supply (dry and very dry zones) increased by 7% and now covers more than 29.5% of the area of Ukraine, or 11.6 million ha (37%) of the country's arable land [60]. As a result, there is a tendency for water runoff from the territory of Ukraine to decrease, leading to a decline in local water resources in the eastern and southern regions. At the same time, in certain seasons and months, water runoff increases in parts of the western region, contributing to catastrophic floods. These are the main trends in the transformation of water resources in Ukraine due to climate change [35]. Given this, differentiated norms should be established when developing and amending existing water legislation. In particular, this applies to surface water quality standards. Thus, in the Hygienic standards for water quality of water bodies for meeting drinking, domestic and other needs of the population [40], the MPC for nitrates (NO_3) in dry and very dry zones should be reduced by 20%, setting it at 40 mg/dm³ for the period from September to May, in accordance with the potential 25% increase in the concentration of these pollutants due to evaporation of water from water bodies in hot, dry weather, as indicated above. For all other periods and all other zones, regardless of the season, this parameter should remain at 50 mg/dm³, which is in accordance with the EU Nitrate Directive [24].

It should be noted that key macronutrients such as nitrogen and phosphorus, contained in fertilisers, are lost under different conditions, with losses ranging from 40 to 70% for nitrogen and from 80 to 90% for phosphorus due to leaching and microbial uptake, as a result of which farmers are trying to increase the amount of fertilisers applied to the soil [61]. In addition, climate change, accompanied by prolonged summer droughts, leads to even less efficient use of fertilisers, especially nitrogen-containing ones, which, due to insuffi-

cient moisture during the field season, are only partially absorbed by plants. As a result, significant fertiliser residues are washed out during the off-season and enter surface groundwater [62]. Large amounts of fertiliser are washed out of agricultural fields into water bodies, especially in waterlogged regions, during heavy rains and floods, which are also caused by climate change [63]. This development requires greater control and stricter regulations for fertiliser application.

In this context, the adoption of advanced nanofertilisers and smart delivery systems for their targeted application to crops is of particular importance, as these technologies can substantially improve fertiliser use efficiency [64]. Their implementation can significantly reduce nutrient losses and, consequently, mitigate fertiliser-induced water pollution. However, the widespread adoption of these innovations is constrained by the relatively high cost of nanofertilisers and the associated implementation expenses.

Given the global importance of protecting the environment, particularly freshwater resources, which are already severely limited in many regions of Ukraine, together with the considerable economic and environmental losses resulting from the eutrophication of water bodies caused by nitrates and other fertilisers, as well as the high costs of removing these contaminants from drinking water, the establishment of a state support programme to promote the adoption of nanofertiliser-based technologies by agricultural producers appears to be well justified.

In general, there is weak control over fertiliser use in Ukraine. Two years ago, the government introduced a draft Law of Ukraine On Plant Protection Products and Fertilisers [65], which, to fulfil its obligations under the Association Agreement with the EU, was intended to implement European rules to ensure the safety of agrochemicals. However, due to numerous comments on the draft law, including its inconsistency with European Union law, it was withdrawn from consideration. As a result, the issue of regulating relations in the sphere of fertiliser circulation, which, after the adoption of

the Law of Ukraine On Pesticides and Agrochemicals [66] in 1995, has not been significantly revised in Ukraine for over 30 years and does not correspond to modern realities, has remained open.

Maintaining an agrochemical passport for a field or land plot is crucial for the optimal regulation of fertiliser use on agricultural fields, providing significant protection against the risks of nitrates and other pollutants entering water bodies. The conduct of agrochemical passporting is regulated by the Laws of Ukraine On Land Protection [67], On State Control over the Use and Protection of Lands [68], On Land Assessment [69], the Decree of the President of Ukraine dated 2.12.1995 No. 1118 On Comprehensive Agrochemical Passporting of Agricultural Lands [70], and the orders of the Ministry of Agrarian Policy of Ukraine dated 26.02.2004 No. 51 On Approval of the Regulations on Soil Monitoring on Agricultural Lands [71] and dated 11.10.2011 No. 536 On Approval of the Procedure for Maintaining an Agrochemical Passport of a Field or Land Plot [72].

Unfortunately, under the maintenance procedure, the data in agrochemical passports are updated only once every five years, which is extremely insufficient in the current context of intensive farming and global climate change. However, in Ukraine, this situation has developed due to a significant decrease in the number of agrochemical laboratories and the catastrophic decline in the training of specialists — agrochemists and soil scientists — which has already led to their critical shortage [73]. Therefore, without a significant increase in the number of qualified specialists in these specialties, as well as the expansion of the network of agrochemical laboratories, which will contribute to the optimisation of fertiliser use and the timely detection of excess concentrations, it is extremely difficult to overcome the problem of pollution of water bodies with fertilisers washed away from the fields. The negative consequences of such phenomena will be exacerbated by global warming [74].

However, although paragraph 3.2 of the Regulations on Soil Monitoring on Agricultural Lands provides for soil monitoring on such lands only

once every five years, paragraph 4.2 of the same Regulation requires the preparation and publication of an annual (periodic) Report on the State of Soils on Agricultural Lands [71]. Therefore, the data provided in such annual reports correspond to the actual state of soils for a specific year, on average, for only 20% of the total area of agricultural lands. This indicates the need for more frequent studies of agrochemical indicators of soils, especially the determination of the total concentration of mineral nitrogen ($N_{\min}$), which is considered one of the most important indicators of productivity [75]. At the same time, nitrogen-containing compounds are the main pollutants of water [24].

According to the Food and Agriculture Organization of the United Nations (FAO), 85 million tonnes of nitrogen were applied to arable land worldwide in 2020, four times the amount in 1961 [76]. At the same time, the efficiency coefficient of this substance, as noted above, averaged about 55% during this period, which may indicate excessive use of nitrogen fertilisers in fields.

Unlike other nutrients such as P, Ca, Mg, K and S, nitrogen lacks a chemical equilibrium between available and reactive ions and those in the soil solution, making it difficult to determine threshold values for nutrient concentrations [77]. As a result, when nitrogen is in excess, it is either emitted to the air as ammonia (NH_3), nitrogen oxides (NO_x), nitrous oxide (N_2O) or dinitrogen (N_2), or enters groundwater and surface water, mainly as nitrate (NO_3). In addition, $N_{\min}$ varies greatly with soil properties, crop and climate. Therefore, $N_{\min}$ concentration should be estimated annually by farmers [77].

Significant pollution from fertilisers washed off fields is observed not only in surface waters but also in groundwater. Unfortunately, due to martial law during 2022—2025, the State Service of Geology and Subsoil of Ukraine, which is responsible for monitoring the state of groundwater, did not conduct monitoring because the laws on the State Budget of Ukraine for those years did not provide the necessary funding, which significantly complicated groundwater monitoring [78]. In December

2025, the International Atomic Energy Agency transferred equipment to Ukraine to monitor groundwater and determine the extent of its contamination following the Kakhovka Dam explosion [79]. However, this equipment will only be sufficient to conduct research in the area of the former Kakhovka Reservoir.

Of particular note are the significant negative projections in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [80]. The risks associated with drought, including rivers drying up, are projected to increase with warming of 3 °C above normal, creating a cascade of problems not only for the water sector but also for many other sectors, from agriculture to energy, posing a threat to food, energy, and economic security. As for the aquatic environment, the change in lake surface temperature over the decade from 1970 to 2010 is estimated at 0.21—0.45 °C, which directly affects changes in sea surface temperature. There are also observed changes in river water temperatures, ranging from –1.21 °C to +1.076 °C per decade between 1901 and 2010. Hypoxic conditions are expected to increase by more than 25% in the deepest layers of water. All this threatens the resilience of ecosystems, biodiversity, and water quality, which directly affects water security [80].

Most of Ukraine is already characterised by low water availability and high vulnerability to climate change [35]. However, current Ukrainian water legislation contains only a limited number of references to the impacts of climate change. For example, the Water Code of Ukraine, in its latest edition dated 22.03.2026, does not mention climate change at all. Even the Law of Ukraine On Amendments to Certain Legislative Acts of Ukraine Regarding the State System of Environmental Monitoring, Information on the State of the Environment (Environmental Information) and Information Support for Environmental Management dated 20.03.2023 No. 2973-IX [81], which will amend the Water Code of Ukraine six months from the date of the abolition or termination of martial law introduced by the Decree of the President of Ukraine On the Introduction of Martial Law in Ukraine dated

February 24, 2022 No. 64/2022 [82], approved by the Law of Ukraine on Approval of the Decree of the President of Ukraine “On the Introduction of Martial Law in Ukraine dated February 24, 2022 [83], contains no norms related to climate change. Although the same Law of Ukraine No. 2973-IX provides for the introduction of provisions that take into account climate change into the Law of Ukraine on Environmental Protection [84], in which, by the way, the first mentions of climate change appeared only two years ago, this is based on the Law of Ukraine on the Basic Principles of State Climate Policy dated 08.10.2024 No. 3991-IX [85].

Another problem related to climate change is flooding, which is the most widespread and costly natural disaster in Europe. It is precisely because of climate change that floods in Europe are becoming more frequent, with devastating consequences, threatening lives and causing significant economic losses [86]. In light of this, the European Parliament and the Council of the European Union adopted Directive 2007/60/EC of 23 October 2007 on the assessment and management of flood risks [87]. This Directive establishes 6-year cycles to reduce the risk of flood damage in the EU. The third cycle is currently underway, covering 2022—2027. EU countries are required to produce and update Flood Hazard Maps and Flood Risk Maps. These maps form the basis for developing flood risk management plans and must cover the geographical areas likely to be flooded, as well as the potential adverse consequences of flooding.

To implement the provisions of Directive 2007/60/EC in Ukraine, the Order of the Ministry of Internal Affairs of Ukraine dated 28.02.2018 No. 153 approved the Methodology for the Development of Flood Hazard and Risk Maps [88]. Currently, the State Emergency Service has carried out a preliminary assessment of flood risks, and flood hazard and risk maps are being developed and updated. However, for some regions at risk of flooding, such maps have not yet been developed, and preliminary flood hazard assessments, flood hazard and flood risk maps have not been upda-

ted [89], which does not allow for the creation of adequate action plans for floods that can have catastrophic consequences.

Also, in implementing Directive 2007/60/EC, the Law of Ukraine of 24.02.2026 On Amendments to Certain Legislative Acts of Ukraine on Flood Risk Management and Ensuring Ukraine's Participation in the Union Civil Protection Mechanism [90] was recently adopted, amending the Water Code of Ukraine and the Civil Protection Code of Ukraine. In particular, it assigns to the central executive body implementing state policy in the field of civil protection the responsibility for developing, adjusting and updating, together with the central executive body ensuring the formation of state policy in the field of environmental protection and the central executive body implementing state policy in the field of water management, flood risk management plans, as well as for conducting a preliminary assessment of flood risks and, based on its results, determining a list of territories with potentially significant flood risks. Such legislative changes should help reduce disaster risks during significant floods.

As already noted, in Ukraine the level of administrative liability for violations of water legislation remains extremely low, which significantly weakens the preventive effect on public relations aimed at preventing such violations. Therefore, the government proposes to strengthen administrative liability for violations in the field of water resources protection. Accordingly, the Draft Law of Ukraine On Amendments to the Code of Ukraine on Administrative Offences in Order to Strengthen Responsibility in the Field of Protection and Rational Use of Water and Regeneration of Water Resources has already been submitted to the Verkhovna Rada [91]. It is expected that the adoption of this law will reduce the number of violations and serve as a preventive factor in the legal relations under study.

In particular, under Article 59 of the Code of Ukraine on Administrative Offences [59], for violations of water-protection rules related to pollution and clogging, citizens are fined from 51 UAH (≈ 1.16 USD) to 119 UAH (≈ 2.7 USD), and officials

from 85 UAH (≈ 2 USD) to 136 UAH (≈ 3 USD). The new bill proposes increasing these fines for citizens to 1700—3400 UAH (≈ 39 —78 USD) and for officials to 4400—5100 UAH (≈ 100 —116 USD). However, under modern conditions, such an offence can, as a rule, be proven only in cases of direct discharge of pollutants through sewage systems or as a result of surface runoff during emergencies. It is much more difficult to establish cause-and-effect relationships between farmers' actions, even in cases of excessive fertiliser use, and the pollution of a specific water body.

However, no corresponding legislative amendments have yet been adopted, and the penalties for violations involving the improper use of fertilisers—one of the primary sources of surface and groundwater pollution—remain negligible. Under Article 83 of the Code of Ukraine on Administrative Offences [59], violations of the rules governing the use, storage, transportation, neutralisation, disposal, and destruction of pesticides, agrochemicals, toxic chemicals, and other hazardous substances are punishable by fines ranging from three to seven non-taxable minimum incomes for citizens (UAH 51—119, equivalent to USD 1.16—2.70) and from seven to ten non-taxable minimum incomes for officials (UAH 119—170, equivalent to USD 2.70—3.90). The same fine amounts have remained unchanged for almost three decades, having last been revised in February 1997, when the average monthly salary in Ukraine was UAH 126 [92] (approximately USD 67 at the prevailing exchange rate). By April 2026, the average monthly salary had reached UAH 30,515 [93] (approximately USD 693), representing a 242-fold increase in UAH. Consequently, the maximum fine currently amounts to well below 1% of the average monthly salary. Given the extremely low level of these financial penalties, the existing system of administrative liability cannot be regarded as an effective deterrent against violations of legislation governing the handling and use of agrochemicals. In practice, Ukraine's current legal framework provides little incentive to prevent activities that contribute to the pollution of surface and groundwater resources.

One measure to conserve water in the face of climate change could be rainwater harvesting, particularly in the private sector and among enterprises. Rainwater harvesting systems are gaining popularity in Europe, especially in Germany, Austria, and Switzerland, as they have strong potential to mitigate the adverse effects of climate change [94]. However, such activities require economic incentives and regulatory approval. In this regard, it is useful to draw on the experience of Germany, where subsidies are provided for installing rainwater harvesting systems, and where such systems are even included in national building codes [95].

In addition, the European Water Sustainability Strategy, announced on 4 June 2025 by the President of the European Commission, Ursula von der Leyen, aims to reduce water consumption by at least 10% by 2030 [96]. In Ukraine, which is among the European countries most affected by climate change and drinking-water shortages, it is now necessary to develop regional action plans for the conservation, restoration and efficient use of drinking-water resources, and to establish stricter standards for drinking-water use in regions with low water supply.

Thus, due to global warming and military operations in Ukraine, the amount of both drinking-quality fresh water and water for irrigation of agricultural fields and other economic purposes has significantly decreased, requiring the urgent adoption of amendments to regulatory legal acts aimed at establishing more stringent requirements for the protection, conservation, restoration and rational use of water, as well as strengthening control in this area.

Although Ukraine has already implemented numerous regulatory and legal measures to mitigate the adverse effects of climate change on water bodies, several issues remain insufficiently regulated or unregulated, in part due to the slow implementation of EU water legislation. Modern Ukrainian water legislation requires a broader application of European risk-based principles in making management decisions in the field of water resources.

To implement the EU Nitrate Directive, it is necessary, in all regulatory documents governing the study of the state of water bodies, to provide for

the mandatory determination of the concentrations of nitrates and other nitrogen- and phosphorus-containing compounds, which is currently absent from many relevant methods, and to include these chemical compounds in the List of Pollutants for determining the chemical state of surface water bodies, with the establishment of the corresponding maximum permissible indicators.

All rules and methods for studying the state of surface waters, as well as other relevant regulatory legal acts governing relations in the water sector, should require an increased frequency of sampling from water bodies for monitoring during the summer, particularly in periods of drought, when global warming causes significant evaporation and a decrease in the level of surface waters, leading to a significant increase in the concentration of pollutants, and during floods, when there is a threat of significant leaching of fertilisers from fields into water bodies. This allows for more prompt measures to prevent and overcome the negative consequences of such events and to ensure compliance with the norm set out in Part One of Article 6 of the EU Nitrate Directive.

Since the agricultural sector is the main polluter of water resources, a situation that is even more evident due to global climate change, it is necessary to significantly strengthen state control over the use of fertilisers, primarily nitrogen-containing ones, and to normatively approve more frequent agrochemical analyses of soil nitrate content. To this end, paragraph 3.2 of the Regulations on soil monitoring on agricultural lands should be supplemented with a paragraph stating that *“Agricultural lands are tested for nitrate content annually.”* In addition, to implement subparagraph 1 of paragraph 1 of Annex III to the EU Nitrates Directive, Ukraine should establish a complete ban on the application of fertilisers during periods when the risk of contaminating water sources is greatest, particularly in light of climate change. For this purpose, it is necessary to amend Part II and Annex 2 of the Rules for ensuring soil fertility and the use of certain agrochemicals by replacing the phrase *“is undesirable”* with *“prohibited.”*

Special attention is warranted for the widespread implementation of the latest nanofertilisers and innovative “smart” systems for their targeted delivery to plants, which will significantly increase fertiliser-use efficiency and, at the same time, significantly reduce losses and, therefore, pollution of water bodies. The use of such innovations will significantly reduce fertiliser-related water pollution. The implementation of such innovations requires their regulatory consolidation and the adoption of government decisions on appropriate targeted support for farmers.

To effectively protect Ukraine’s water resources from fertiliser pollution, administrative liability

for violations of legislation governing the handling and use of agrochemicals should be substantially strengthened. This requires amendments to Article 83 of the Code of Ukraine on Administrative Offences, including a significant increase in the fines imposed for such violations.

Funding. This article was prepared and partially funded within the framework of the competition for research papers by young scientists of the National Academy of Sciences of Ukraine for 2025—2026 (research project entitled *Legal support of climate security as a component of national security of Ukraine*; state registration number: 0125U002904).

REFERENCES

1. Causes and Effects of Climate Change. United Nations Climate Actions. URL: <https://www.un.org/en/climatechange/science/causes-effects-climate-change> (Last accessed: 25.06.2026).
2. WMO confirms 2024 as warmest year on record at about 1.55°C above pre-industrial level. World Meteorological Organization. Press release, 10 January 2025. URL: <https://wmo.int/news/media-centre/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level> (Last accessed: 25.06.2026).
3. Cheng, L., Abraham, J., Trenberth, K.E., Reagan, J., Zhang, H.-M., Storto, A., ..., Gues, F. (2025). Record High Temperatures in the Ocean in 2024. *Advances in Atmospheric Sciences*, 42(6), 1092—1109. <https://doi.org/10.1007/s00376-025-4541-3>
4. Smith, P., Singh, P. K., Ballal, V. P., Cherubini, F. (2025). Impacts of climate change interventions on biodiversity, water, the food system and human health and well-being. *Global Change Biology*, 31(4), e17234. <https://doi.org/10.1111/gcb.70444>
5. Caretta, M. A., Mukherji, A., Arfanuzzaman, M., Betts, R. A., Gelfan, A., Hirabayashi, Y., ..., Supratid, S. (2023). Water. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Eds. H.-O. Pörtner, D. C. Roberts, M. Tignor and others]. Cambridge University Press, Cambridge, 551—712. <https://doi.org/10.1017/9781009325844.006>
6. Van Dijk, A. I. J. M., Beck, H. E., Boergens, E., de Jeu, R. A. M., Dorigo, W. A., Edirisinghe, C., ..., Rozas Larraondo, P. (2025). *Global Water Monitor 2024, Summary Report*. Published by Global Water Monitor Consortium. URL: <https://www.globalwater.online/globalwater/wp-content/uploads/2018/09/GWM-Report-2024.pdf> (Last accessed: 25.06.2026).
7. Van Dijk, A. I. J. M., Beck, H. E., Boergens, E., de Jeu, R. A. M., Dorigo, W. A., Edirisinghe, C., ..., Rozas Larraondo, P. (2026). *Global Water Monitor, 2025 Report*. Published by Global Water Monitor Consortium. URL: <https://www.globalwater.online/globalwater/wp-content/uploads/2018/09/GWM-Report-2025.pdf> (Last accessed: 25.06.2026).
8. *Mountains and glaciers: Water towers. The United Nations World Water Development Report 2025*. UNESCO, Paris. URL: <https://www.unwater.org/publications/un-world-water-development-report-2025> (Last accessed: 25.06.2026).
9. *Valuing Water. The United Nations World Water Development Report 2021*: UNESCO, Paris. URL: <https://www.unesco.org/reports/wwdr/2021/en> (Last accessed: 25.06.2026).
10. Manoiu, V.-M., Costache, M.-S., Nica, M.-A. (2026). The impact of the Russia–Ukraine war on water resources and infrastructure of Ukraine — a comprehensive review. *World*, 7(1), 3, 1—30. <https://doi.org/10.3390/world7010003>

11. Ukraine is rapidly losing water resources: how climate change affects aquatic ecosystems and exacerbates the negative effects of droughts. WWF. 05.08.2025. URL: <https://wwf.ua/?18810941/Ukraina-strimko-vtrachaye-vodni-resursy-yak-zmina-klimatu-vplyvaye-na-vodni-ekosystemy-ta-posylyuye-nehatyvni-diyi-posukh> (Last accessed: 25.06.2026).
12. *National report on the quality of drinking water and the state of drinking water supply and wastewater disposal in Ukraine in 2024*. Ministry of Community and Territorial Development of Ukraine, Kyiv, 2025. URL: <https://mindev.gov.ua/storage/app/sites/1/uploaded-files/nacionalna-dopovid-pro-ukrainu-pitnoyi-vodi-ta-stan-za-2024-rik.pdf> (Last accessed: 25.06.2026).
13. Kaur, T., Sinha, A. (2019). Pesticides in Agricultural Run Offs Affecting Water Resources: A Study of Punjab (India). *Agricultural Sciences*, 10, 1381—1395. <https://doi.org/10.4236/as.2019.1010101>.
14. Nayak, P., Mishra, S. (2024). Climate Change, its Impact of Air, Water, and Soil on Agriculture. In: *Current Trends in Agriculture & Allied Sciences Publisher: SP Publishing*. Bhubaneswar, Odisha, 3(32), 324—334.
15. Haghighi, E., Madani, K., Hoekstra, A. Y. (2018). The water footprint of water conservation using shade balls in California. *Nature Sustainability*, 1 (7), 358—360. <https://doi.org/10.1038/s41893-018-0092-2>
16. Wilson, L., New, S., Daron, J., Golding, N. (2021). *Climate Change Impacts for Ukraine*. Met Office. URL: <https://www.metoffice.gov.uk/services/government/international-development/climate-change-impacts-for-ukraine> (Last accessed: 25.06.2026).
17. The Ministry of Ecology estimated the losses from the Kakhovka Hydroelectric Power Plant explosion at \$14 billion. Ministry of Finance, 07.01.2025. URL: <https://minfin.com.ua/ua/2025/01/07/143024217/> (Last accessed: 25.06.2026).
18. *Post-disaster needs assessment. Kakhovka Dam Disaster, Ukraine*. (Balakrishnan Balachandran ed.), United Nations, 17.10.2023. URL: <https://ukraine.un.org/sites/default/files/2023-10/PDNA%20Final%20and%20Cleared%20-%2016Oct.pdf> (Last accessed: 25.06.2026).
19. Shumilova, O., Sukhodolov, A., Osadcha, N., Oreshchenko, A., Constantinescu, G., Afanasyev, S., ..., Grossart, H.-P. (2025). Environmental effects of the Kakhovka Dam destruction by warfare in Ukraine. *Science*, 387(6739), 1181—1186. <https://doi.org/10.1126/science.adn8655>
20. The explosion of the Kakhovka HPP dam is the largest act of ecocide committed by Russia since the beginning of its full-scale invasion of Ukraine. State Agency of Water Resources of Ukraine. 07.06.2023. URL: <https://www.davr.gov.ua/news/pidriv-dambi-kahovskoi-ges--ce-najbilshij-akt-ekocidu-yakij-rosiya-vchinila-z-pochatku-povnomasshtabnogo-vtorgnennya-v-ukrainu> (Last accessed: 25.06.2026).
21. Bytsyura, L., Szczepanik-Scislo, N., Desyatnyuk, O., Shakhovska, N., Scislo, L., Sachenko, A., ..., Sofinska, O. (2025). Research on surface water state for rivers in Western Ukraine using time series forecasting methods. *Water*, 17, 3148. <https://doi.org/10.3390/w17213148>
22. Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community. Document 31976L0464. URL: <https://eur-lex.europa.eu/eli/dir/1976/464/oj> (Last accessed: 25.06.2026).
23. Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment. Document 31991L0271. URL: <https://eur-lex.europa.eu/eli/dir/1991/271/oj/eng> (Last accessed: 25.06.2026).
24. Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. Document 31991L0676. URL: <https://eur-lex.europa.eu/eli/dir/1991/676/oj/eng> (Last accessed: 25.06.2026).
25. Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control. Document 31996L0061. URL: <https://eur-lex.europa.eu/eli/dir/1996/61/oj/eng> (Last accessed: 25.06.2026).
26. Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption (1998). Document 31998L0083. URL: <https://eur-lex.europa.eu/eli/dir/1998/83/oj/eng> (Last accessed: 25.06.2026).
27. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Document 32000L0060. URL: <https://eur-lex.europa.eu/eli/dir/2000/60/oj/eng> (Last accessed: 25.06.2026).

28. Preventing and mitigating water scarcity and droughts in the EU. European Commission, 2025. URL: https://environment.ec.europa.eu/topics/water/water-scarcity-and-droughts_en (Last accessed: 25.06.2026).
29. On the de-Sovietization of Ukrainian legislation: Law of Ukraine dated April 21, 2022 No. 2215-IX. URL: <https://zakon.rada.gov.ua/laws/show/2215-20#Text> (Last accessed: 25.06.2026).
30. Water Code of Ukraine dated 06.06.1995. No. 213/95-VR (as amended on 22.03.2026). Official Bulletin of the Verkhovna Rada of Ukraine. 1995, No. 24, Art. 189. URL: <https://zakon.rada.gov.ua/laws/show/213/95-%D0%B2%D1%80#Text> (Last accessed: 25.06.2026).
31. Association Agreement between Ukraine, on the one part, and the European Union, the European Atomic Energy Community and their Member States, on the other part, ratified by the Verkhovna Rada of Ukraine on 16 September 2014 (as amended on 14 October 2025). URL: https://zakon.rada.gov.ua/laws/show/984_011#Text (Last accessed: 25.06.2026).
32. Decision of the Government Committee on European and Euro-Atlantic Integration, International Cooperation, Legal Policy and Law Enforcement of 20.03.2025 (Minutes No. 3) on the approval of Directives 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. URL: https://zakon.rada.gov.ua/laws/show/994_962#Text (Last accessed: 25.06.2026).
33. Procedure for State Monitoring of Waters. Approved by Resolution of the Cabinet of Ministers of Ukraine dated September 19, 2018. No. 758 (as amended on December 26, 2025). URL: <https://zakon.rada.gov.ua/laws/show/758-2018-%D0%BF#Text> (Last accessed: 25.06.2026).
34. Canelas de Castro, P. (2011). Climate change and water management: is EU Water Law adapted to climate change? *Water Resources Management VI. WIT Transactions on Ecology and the Environment*, 145, 827—839. <https://doi.org/10.2495/WRM110741>
35. Snizhko, S., Shevchenko, O., Didovets, Y. (2021). *Analysis of the impact of climate change on water resources of Ukraine*. (Ed. S. S. Sadogurska) Centre for Environmental Initiatives “Ecodia,” Kyiv. URL: <https://ecoaction.org.ua/wp-content/uploads/2021/06/analiz-vplyvu-vodni-resursy-full.pdf> (Last accessed: 25.06.2026).
36. Krakovska, S., Kryvobok, O., Palamarchuk, L., Chygareva, A., Kryshchuk, L. (2025). *Synthesis report of the assessment of risks and vulnerability of agriculture to climate change. EU4ClimateResilience: Decarbonization and climate resilience in the Eastern Partnership countries*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Ukraine, Kyiv. URL: <https://me.gov.ua/download/ea3e3656-3860-4ae9-ba07-1f8ac27d00ab/file.pdf> (Last accessed: 25.06.2026).
37. Water Strategy of Ukraine for the period until 2050. Approved by the Resolution of the Cabinet of Ministers of Ukraine dated 09.12.2022 No. 1134-r (as amended on 06.01.2026). URL: <https://zakon.rada.gov.ua/laws/show/1134-2022-%D1%80#Text> (Last accessed: 25.06.2026).
38. On drinking water and drinking water supply: Law of Ukraine dated 10.01.2002. No. 2918-III (as amended on 11.03.2026). Official Bulletin of the Verkhovna Rada of Ukraine. 2002, No. 16, Art. 112. URL: <https://zakon.rada.gov.ua/laws/show/2918-14#Text> (Last accessed: 25.06.2026).
39. Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast). Document 32020L2184. URL: <https://eur-lex.europa.eu/eli/dir/2020/2184/oj/eng> (Last accessed: 25.06.2026).
40. Hygienic standards for the quality of water in water bodies to meet drinking, household and other needs of the population. Approved by Order of the Ministry of Health of Ukraine dated 02.05.2022 No. 721, registered with the Ministry of Justice of Ukraine on 16.05.2022 under No. 524/37860. URL: <https://zakon.rada.gov.ua/laws/show/z0524-22/ed20230222#Text> (Last accessed: 25.06.2026).
41. Brindha, K., Parimalarenganayaki, S., Elango, L. (2017). Sources, toxicological effects and removal techniques of nitrates in groundwater: An Overview. *Indian Journal of Environmental Protection*, 37(8), 667—700. URL: <https://www.e-ijep.co.in/wp-content/uploads/2024/11/IJEP-378-667-700-2017.pdf> (Last accessed: 25.06.2026).
42. Hygienic requirements for drinking water intended for human consumption. State Sanitary Norms and Rules (SSanNaR 2.2.4—171—10). Approved by the Order of the Ministry of Health of Ukraine dated 12.05.2010 No. 400

- (as amended on 17.01.2025) and registered with the Ministry of Justice of Ukraine on 01.07.2010 under No. 452/17747. URL: <https://zakon.rada.gov.ua/laws/show/z0452-10#Text> (Last accessed: 25.06.2026).
43. Procedure for state monitoring in the areas of drinking water and drinking water supply, and water disposal. Approved by the Resolution of the Cabinet of Ministers of Ukraine dated 21.01.2025. No. 61. URL: <https://zakon.rada.gov.ua/laws/show/61-2025-%D0%BF#Text> (Last accessed: 25.06.2026).
 44. *Guidelines for drinking-water quality: fourth edition incorporating the first addendum*. Geneva: World Health Organization, 2017. URL: <https://iris.who.int/server/api/core/bitstreams/1b7a285e-3635-45dd-a1a9-6068c8fbe173/content> (Last accessed: 25.06.2026).
 45. *Water safety plan manual: step-by-step risk management for drinking-water suppliers*. Second edition. Geneva: World Health Organization, 2023. URL: <https://iris.who.int/server/api/core/bitstreams/5d8682eb-9151-4878-8c88-be90077822f4/content> (Last accessed: 25.06.2026).
 46. Lin, L., Yang, H., Xu, X. (2022). Effects of water pollution on human health and disease heterogeneity: a review. *Frontiers in Environmental Science*, 10, 880246. <https://doi.org/10.3389/fenvs.2022.880246>
 47. Rules for ensuring soil fertility and the use of certain agrochemicals. Approved by the Order of the Ministry of Agrarian Policy and Food of Ukraine dated 24 November 2021 No. 382, registered with the Ministry of Justice of Ukraine on 14 January 2022. No. 34/37370. URL: <https://zakon.rada.gov.ua/laws/show/z0034-22#Text> (Last accessed: 25.06.2026).
 48. Regulation (EC) No 1882/2003 of the European Parliament and of the Council of 29 September 2003 adapting to Council Decision 1999/468/EC the provisions relating to committees which assist the Commission in the exercise of its implementing powers laid down in instruments subject to the procedure referred to in Article 251 of the EC Treaty. Document 32003R1882. URL: <https://eur-lex.europa.eu/eli/reg/2003/1882/oj/eng> (Last accessed: 25.06.2026).
 49. The premier forum for fertilizers and nutrient management. 2nd Annual Fertilizer & Nutrient Congress 2026. June 1—2, 2026. Chicago, USA. URL: <https://www.fertilizer-summit.com/> (Last accessed: 25.06.2026).
 50. On approval of the operational plan for implementing the Water Strategy of Ukraine for the period until 2050 in 2025—2027. Resolution of the Cabinet of Ministers of Ukraine dated 10.12.2025. No. 1412-r. URL: <https://zakon.rada.gov.ua/laws/show/1412-2025-%D1%80#Text> (Last accessed: 25.06.2026).
 51. Methodology for determining zones vulnerable to (accumulation of) nitrates. Approved by Order of the Ministry of Environmental Protection and Natural Resources of Ukraine dated April 15, 2021. No. 244, registered with the Ministry of Justice of Ukraine on June 10, 2021. No. 776/36398. URL: <https://zakon.rada.gov.ua/laws/show/z0776-21#Text> (Last accessed: 25.06.2026).
 52. Methodology for assigning a surface water body to one of the classes of ecological and chemical states of a surface water body, as well as assigning an artificial or significantly modified surface water body to one of the classes of ecological potential of an artificial or significantly modified surface water body. Approved by Order of the Ministry of Ecology and Natural Resources of Ukraine dated January 14, 2019. No. 5, registered with the Ministry of Justice of Ukraine on February 5, 2019. No. 127/33098. URL: <https://zakon.rada.gov.ua/laws/show/z0127-19#n14> (Last accessed: 25.06.2026).
 53. List of pollutants for determining the chemical state of surface and groundwater bodies and the ecological potential of an artificial or significantly modified surface water body. Approved by Order of the Ministry of Ecology and Natural Resources of Ukraine dated 06.02.2017. No. 45, registered with the Ministry of Justice of Ukraine on 20.02.2017. No. 235/30103. URL: <https://zakon.rada.gov.ua/laws/show/z0235-17#n13> (Last accessed: 25.06.2026).
 54. Ecological water quality standards for determining the ecological state of a surface water body. Approved by Order of the Ministry of Environmental Protection and Natural Resources of Ukraine dated 01.04.2024. No. 332, registered with the Ministry of Justice of Ukraine on 29.05.2024. No. 789/42134. URL: <https://zakon.rada.gov.ua/laws/show/z0789-24#Text> (Last accessed: 25.06.2026).
 55. Water: Monitoring & Assessment. 5.7 Nitrates. U.S. Environmental Protection Agency, 2012. URL: <https://archive.epa.gov/water/archive/web/html/vms57.html> (Last accessed: 25.06.2026).

56. Soullignac, F., Anneville, O., Bolognesi, T., da Costa, P., Ibelings, B.W., Richard, A., ..., Jacquet, S. (2025). A global overview of the impacts of phytoplankton blooms on lake and reservoir ecosystem services. *Environmental Research Letters*, 20 (12), 123005. <https://doi.org/10.1088/1748-9326/ae2696>
57. Chaudhary, I.J., Chauhan, R., Kale, S. S., Gosavi, S., Rathore, D., Dwivedi, V., ..., Yadav, V. K. (2025). Groundwater Nitrate Contamination and its Effect on Human Health: A Review. *Water Conservation Science and Engineering*, 10, 33. <https://doi.org/10.1007/s41101-025-00359-y>
58. Tanchyk, S. P., Tsyuk, O. A., Vyaly, S. O. (2009). Development of organic farming in Ukraine. *Bulletin of Agrarian Science*, 1, 11—15 [In Ukrainian].
59. Code of Ukraine on Administrative Offences dated 7.12.1984. No. 8073-X (as amended on 11.12.2025). Official Bulletin of the Verkhovna Rada of the Ukrainian SSR 1984, Supplement to No. 51, Art. 1122. URL: <https://zakon.rada.gov.ua/laws/show/8073-10#top> (Last accessed: 25.06.2026).
60. Romashchenko, M., Husyev, Y., Shatkovskiy, A., Saidak, R., Yatsyuk, M., Shevchenko, A., Matiash, T. (2020). Impact of climate change on water resources and agricultural production. *Land Reclamation and Water Management*, 1, 5—22. <https://doi.org/10.31073/mivg202001-235>
61. Avila-Quezada, G. D., Ingle, A. P., Golińska, P., Rai, M. (2022). Strategic applications of nano-fertilizers for sustainable agriculture: Benefits and bottlenecks. *Nanotechnology Reviews*, 11(1), 2123—2140. <https://doi.org/10.1515/ntrev-2022-0126>
62. Rajj-Hoffman, I., Dahan, O., Dahlke, H. E., Harter, T., Kisekka, I. (2024). Assessing nitrate leaching during drought and extreme precipitation: Exploring deep vadose-zone monitoring, groundwater observations, and field mass balance. *Water Resources Research*, 60, e2024WR037973. <https://doi.org/10.1029/2024WR037973>
63. Michalak, A. (2016). Study role of climate change in extreme threats to water quality. *Nature*, 535, 349—350. <https://doi.org/10.1038/535349a>
64. Nisha, R., Deori, C., Kamble, M. V., Jayakrishna, S., Mahawar, P., Gavit, S. J., ..., Singh, A. (2025). Nano-fertilizers and smart inputs: Enhancing nutrient use efficiency in agronomy. *International Journal of Research in Agronomy*, 8(7), 1365—1376. <https://doi.org/10.33545/2618060X.2025.v8.i7r.3387>
65. On plant protection products and fertilisers. Draft Law (Reg. No. 11062 of 04.03.2024). URL: <https://www.kmu.gov.ua/bills/proekt-zakonu-pro-zasoby-zakhystu-roslyn-i-dobryvni-zasoby> (Last accessed: 25.06.2026).
66. On pesticides and agrochemicals: Law of Ukraine dated 02.03.1995. No. 86/95-VR (as amended on 15.11.2024). Official Bulletin of the Verkhovna Rada of Ukraine, 1995, No. 14. Art. 91. URL: <https://zakon.rada.gov.ua/laws/show/86/95-%D0%B2%D1%80#Text> (Last accessed: 25.06.2026).
67. On land protection: Law of Ukraine dated 06/19/2003. No. 962-IV (as amended on 11/08/2024). Official Bulletin of the Verkhovna Rada of Ukraine, 2003, No. 39, Art. 349. URL: <https://zakon.rada.gov.ua/laws/show/962-15#Text> (Last accessed: 25.06.2026).
68. On state control over the use and protection of lands: Law of Ukraine dated 06/19/2003. No. 963-IV (as amended on 11/08/2024). Official Bulletin of the Verkhovna Rada of Ukraine, 2003, No. 39, Art. 350. URL: <https://zakon.rada.gov.ua/laws/show/963-15#Text> (Last accessed: 25.06.2026).
69. On land valuation: Law of Ukraine dated 11.12.2003. No. 1378-IV (as amended on 08.08.2025). Official Bulletin of the Verkhovna Rada of Ukraine, 2004, No. 15, Art. 229. URL: <https://zakon.rada.gov.ua/laws/show/1378-15#Text> (Last accessed: 25.06.2026).
70. On the comprehensive agrochemical certification of agricultural lands: Decree of the President of Ukraine dated 02.12.1995. No. 1118/95. URL: <https://zakon.rada.gov.ua/laws/show/1118/95#Text> (Last accessed: 25.06.2026).
71. Regulations on soil monitoring on agricultural lands. Approved by order of the Ministry of Agrarian Policy of Ukraine dated 26.02.2004 No. 51, registered with the Ministry of Justice of Ukraine on 29.03.2004. No. 383/8982. URL: <https://zakon.rada.gov.ua/laws/show/z0383-04#Text> (Last accessed: 25.06.2026).
72. The procedure for maintaining an agrochemical passport of a field or land plot. Approved by the order of the Ministry of Agrarian Policy and Food of Ukraine dated 11.10.2011 No. 536, registered with the Ministry of Justice of Ukraine on 23.12.2011 under No. 1517/20255. URL: <https://zakon.rada.gov.ua/laws/show/z1517-11#Text> (Last accessed: 25.06.2026).

73. Tonkha, O. (2025). There is a critical shortage of soil scientists in Ukraine. Kurkul is an online assistant for farmers. 11.01.2025. URL: <https://kurkul.com/news/37658-v-ukrayini-kritichniy-defitsit-gruntoznavtsiv--tonha> (Last accessed: 25.06.2026).
74. Akter, S., AbdElgawad, H., Beemster, G. T. S. De Boeck, G., Schoelynck, J. (2024) Synergistic effect of nitrate exposure and heatwaves on the growth, and metabolic activity of microalgae, *Chlamydomonas reinhardtii*, and *Pseudokirchneriella subcapitata*. *Scientific Reports*, 14, 2764. <https://doi.org/10.1038/s41598-024-53198-7>
75. Wysokinski, A., Sienkiewicz, S., Wiśniewska-Kadżajan, B., Nogalska, A., Becher, M., Krzobietke, S. J. (2025). The effect of split application of mineral nitrogen on biomass yield and nitrogen content, uptake, use efficiency and harvest index in spring rye. *Scientific Reports*, 15, 38343. <https://doi.org/10.1038/s41598-025-22332-4>
76. FAO (2022). New data to measure cropland nutrient budgets. Food and Agriculture Organization of the United Nations, News, 15/11/2022. URL: <https://www.fao.org/newsroom/detail/new-data-to-measure-cropland-nutrient-budgets/en> (Last accessed: 25.06.2026).
77. Baritz, R., Amelung, W., Antoni, V., Boardman, J., Horn, R., Prokop, G., ..., de Vries, W. (2021). *Soil monitoring in Europe. Indicators and thresholds for soil quality assessments*. EEA ETC/ULS Report, 21.09.2021. 148 pp. URL: <https://www.eionet.europa.eu/etcs/etc-uls/products/etc-uls-reports/etc-uls-report-2021-soil-monitoring-in-europe> (Last accessed: 25.06.2026).
78. *Special report of the Ukrainian Parliament Commissioner for Human Rights on the state of observance of citizens' rights to clean and accessible water under the legal regime of martial law*. Ombudsman of Ukraine, 2025. URL: <https://www.ombudsman.gov.ua/storage/app/media/uploaded-files/cpetsdopovidruk-1.pdf> (Last accessed: 25.06.2026).
79. The IAEA provided equipment for groundwater monitoring. Ukrainian Geological Survey, 16.12.2025. URL: <https://www.geo.gov.ua/mahate-nadalo-obladnannia-dlia-provedennia-monitorynhu-pidzemnykh-vod/> (Last accessed: 25.06.2026).
80. IPCC (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Eds. H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegrna, ..., B. Rama). Cambridge University Press, Cambridge, UK and New York, NY, USA. <https://doi.org/10.1017/9781009325844>
81. On Amendments to Certain Legislative Acts of Ukraine Regarding the State System of Environmental Monitoring, Information on the State of the Environment (Environmental Information) and Information Support for Environmental Management: Law of Ukraine of March 20, 2023. No. 2973-IX. Official Bulletin of the Verkhovna Rada of Ukraine, 2023, No. 63, Art. 208. URL: <https://zakon.rada.gov.ua/laws/show/2973-20#Text> (Last accessed: 25.06.2026).
82. On the introduction of martial law in Ukraine: Decree of the President of Ukraine of February 24, 2022. No. 64/2022. URL: <https://zakon.rada.gov.ua/laws/show/64/2022#Text> (Last accessed: 25.06.2026).
83. On approval of the Decree of the President of Ukraine "On the introduction of martial law in Ukraine": Law of Ukraine dated 02/24/2022. No. 2102-IX. URL: <https://zakon.rada.gov.ua/laws/show/2102-20#Text> (Last accessed: 25.06.2026).
84. On Environmental Protection: Law of Ukraine dated 25.06.1991. No. 1264-XII (as amended on 08.08.2025). Official Bulletin of the Verkhovna Rada of Ukraine, 1991, No. 41, Art. 546. URL: <https://zakon.rada.gov.ua/laws/show/1264-12#Text> (Last accessed: 25.06.2026).
85. On the basic principles of state climate policy: Law of Ukraine dated 08.10.2024. No. 3991-IX. Official Bulletin of the Verkhovna Rada of Ukraine, 2025, No. 9, Art.19. URL: <https://zakon.rada.gov.ua/laws/show/3991-20#Text> (Last accessed: 25.06.2026).
86. Floods. EU measures to manage the risks floods pose to human health, the environment, the economy and cultural heritage. European Commission, Energy, Climate change, Environment, 2.06.2025. URL: https://environment.ec.europa.eu/topics/water/floods_en (Last accessed: 25.06.2026).
87. Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. Document 32007L0060. URL: <https://eur-lex.europa.eu/eli/dir/2007/60> (Last accessed: 25.06.2026).

88. Methodology for developing flood hazard and risk maps. Approved by the order of the Ministry of Internal Affairs of Ukraine dated 28.02.2018. No. 153, registered with the Ministry of Justice of Ukraine on 22.03.2018. No. 350/31802. URL: <https://zakon.rada.gov.ua/laws/show/z0350-18#Text> [In Ukrainian]
89. Disaster Risk Reduction — Climate Change Adaptation Measures. Approved by the Accounting Chamber's Decision of 19.12.2024. No. 58—3. IDI Learning Management System. URL: https://rp.gov.ua/upload-files/Activity/Collegium/2024/58-3_2024/Zvit_58-3_2024.pdf (Last accessed: 25.06.2026).
90. On Amendments to Certain Legislative Acts of Ukraine on Flood Risk Management and Ensuring Ukraine's Participation in the Union Civil Protection Mechanism: Law of Ukraine of 24.02.2026. No. 4790-IX. URL: <https://zakon.rada.gov.ua/laws/show/4790-20#Text> (Last accessed: 25.06.2026).
91. On Amendments to the Code of Ukraine on Administrative Offenses to Strengthen Liability in the Field of Water Protection, Rational Water Use, and Water Resources Restoration: Draft Law of Ukraine, Registration No. 15096, dated April 7, 2026. URL: <https://itd.rada.gov.ua/billinfo/Bills/Card/69740> (Last accessed: 25.06.2026).
92. Indicators of average monthly wages of workers employed in sectors of the national economy for 1992—2002. Pension Fund of Ukraine. URL: <https://www.pfu.gov.ua/70128-pokaznyky-serednomisyachnoyi-zarobitnoyi-platy-pratsivnykiv-zajnyatyh-u-galuzyah-natsionalnoyi-ekonomiky-za-1992-2002-roky-shho-zastosovuyutsya-pid-chas-pryznachennya-ta-pererahunku-pensij-vidpovidno/> (Last accessed: 25.06.2026).
93. New on the site: wages, financial results of enterprises, capital investments, the state of business activity of enterprises, environmental protection, and other data sets. State Statistics Service of Ukraine, 29.05.2026. URL: <https://stat.gov.ua/uk/news/nove-na-sayti-zarobitna-plata-finansovi-rezultaty-pidpryemstv-kapitalni-investytsiyi-stan> (Last accessed: 25.06.2026).
94. Wartalska, K., Grzegorzek, M., Bęćcik, M., Wdowikowski, M., Kolanek, A., Niemierka, E., ..., Kaźmierczak, B. (2024). The Potential of RainWater Harvesting Systems in Europe — Current State of Art and Future Perspectives. *Water Resour Manage* 38, 4657—4683. <https://doi.org/10.1007/s11269-024-03882-0>
95. Schuetze, T. (2013). Rainwater harvesting and management — policy and regulations in Germany. *Water Science & Technology: Water Supply*, 13(2), 376—385. <https://doi.org/10.2166/ws.2013.035>
96. European Water Resilience Strategy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, 04.06.2025. COM(2025) 280 final. URL: https://environment.ec.europa.eu/publications/european-water-resilience-strategy_en (Last accessed: 25.06.2026).

Received 30.06.2026

Revised 30.06.2026

Accepted 01.07.2026

Д.В. Радченко (<https://orcid.org/0009-0002-4459-0009>)

Державна установа «Інститут економіко-правових досліджень
імені В.К. Макутова Національної академії наук України»,
бульвар Тараса Шевченка, 60, Київ, 01032, Україна,
+380 44 200 5568, office.iepd@nas.gov.ua

НОРМАТИВНО-ПРАВОВІ АСПЕКТИ РЕГУЛЮВАННЯ ГОСПОДАРСЬКОЇ ДІЯЛЬНОСТІ, ЯКІ ЗАБЕЗПЕЧУЮТЬ ПОМ'ЯКШЕННЯ НАСЛІДКІВ НЕГАТИВНОГО ВПЛИВУ ЗМІНИ КЛІМАТУ НА ВОДНІ РЕСУРСИ УКРАЇНИ

Вступ. Проблеми зміни клімату набувають все більшої гостроти, а одними з найбільш уразливих до таких змін є водні ресурси.

Проблематика. Україна належить до найменш забезпечених прісною водою країн Європи й зазнає суттєвого скорочення кількості прісних вод та погіршення їхньої якості. Це здебільшого пов'язано як зі зміною клімату, так і з негативним впливом господарської діяльності й неефективним управлінням водними ресурсами. Тому правове регулювання відносин в цій сфері є вкрай актуальним.

Мета. Аналіз українського та європейського водного законодавства для оцінки потенційних загроз прісним водам, що виникають внаслідок зміни клімату та недостатнього регулювання господарської діяльності, зокрема в аграрному секторі.

Матеріали й методи. Матеріалами слугували ключові акти вітчизняного та європейського водного законодавства, використано окремі міжнародні бази даних щодо антропогенних викидів парникових газів, стану водних ресурсів і впливу на них кліматичних змін. Застосовано порівняльний та формально-правовий аналіз вітчизняного законодавства в цій сфері та його узгодженість з нормами ЄС.

Результати. Досліджено розвиток європейського та українського законодавства за останні 50 років, пов'язаного з охороною і захистом водних ресурсів. Проаналізовано хід імплементації правових актів ЄС у водній сфері в українське національне законодавство. Показано окремі розбіжності між нормами права, які потребують адаптації шляхом внесення відповідних законодавчих змін, зокрема й з урахуванням кліматичних загроз. Відзначено необхідність широкого впровадження ризик-орієнтованого підходу до прийняття управлінських рішень у сфері водних ресурсів і посилення правового регулювання обігу агрохімікатів, які найбільше забруднюють води в Україні.

Висновки. Наявні нормативно-правові акти, які регулюють охорону та збереження водних ресурсів не завжди узгоджуються із законодавством ЄС, і є ціла низка відносин, які залишаються недостатньо врегульованими. Отримані результати дають змогу запропонувати відповідні зміни до національного законодавства, які посилять правовий захист та охорону водних ресурсів України в умовах зміни клімату.

Ключові слова: водне законодавство, кліматична безпека, забруднення, захист вод, адміністративна відповідальність, зміни до законодавства.