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ENSURING HYDRO-ECOLOGICAL SAFETY OF WATER MANAGEMENT FACILITIES OF THE CHERKASK REGION

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The article examines the issues of ensuring the hydro-ecological safety of water management facilities in the Cherkasy region. Emphasis is placed on the analysis of the ecological state of rivers, reservoirs and other bodies of water in the region. The main factors that negatively affect the quality of water resources, including industrial pollution, agricultural activity and insufficient effectiveness of water protection measures, have been identified. Special attention is paid to strategic approaches to improving the condition of water bodies, in particular, the implementation of modern cleaning technologies, optimization of the water regime and water quality control. Recommendations are offered to increase the efficiency of water resources management, which will contribute to the stabilization of the ecological situation and the preservation of biodiversity in the region.

***Keywords**: hydroecological safety of water management facilities of Cherkasy region; ecological state of water bodies; sources of water pollution; water quality; water resources management; sustainable development; environmental protection.*

ЗАБЕЗПЕЧЕННЯ ГІДРОЕКОЛОГІЧНОЇ БЕЗПЕКИ ВОДОГОСПОДАРСЬКИХ ОБ'ЄКТІВ ЧЕРКАСЬКОЇ ОБЛАСТІ

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У статті розглядаються питання забезпечення гідроекологічної безпеки водогосподарських об'єктів Черкаської області. Акцент зроблено на аналізі екологічного стану річок, водосховищ та інших водойм, що знаходяться на території області. Визначено основні фактори, які негативно впливають на якість водних ресурсів, включаючи промислове забруднення, сільськогосподарську діяльність та недостатню ефективність водоохоронних заходів. Окрему увагу приділено стратегічним підходам до покращення стану водних об'єктів, зокрема, впровадженню сучасних технологій очищення, оптимізації водного режиму та контролю якості води. Запропоновано рекомендації щодо підвищення ефективності управління водними ресурсами, що сприятиме стабілізації екологічної ситуації та збереженню біорізноманіття регіону. Метою дослідження є забезпечення гідроекологічної безпеки водогосподарських об'єктів Черкаської області шляхом аналізу екологічного стану водойм, ідентифікації основних чинників забруднення та розробки рекомендацій для покращення якості водних ресурсів і управління ними. Проведено аналіз екологічного стану водогосподарських об'єктів Черкаської області, включаючи річки, водосховища та інші водойми; ідентифікувати основні джерела та чинники забруднення водних ресурсів у регіоні; оцінити вплив антропогенних і природних факторів на якість води.

Розроблено рекомендації щодо зниження негативного впливу забруднювачів та покращення екологічного стану водних об'єктів; запропоновано стратегії та заходи для ефективного управління водними ресурсами та підвищення їх гідроекологічної безпеки на прикладі водогосподарських об'єктів Черкаської області (річки, водосховища, ставки та інші водойми, що мають екологічне, соціальне та економічне значення для регіону). Досліджено процеси та фактори, що впливають на гідроекологічну безпеку водогосподарських об'єктів Черкаської області, а також методи та заходи для поліпшення якості водних ресурсів і їхнього сталого використання.

***Ключові слова:** гідроекологічна безпека водогосподарських об'єктів Черкаської області; екологічний стан водойм; джерела забруднення водних ресурсів; якість води; управління водними ресурсами; сталий розвиток; охорона довкілля.*

When assessing the natural environment (ecological state of nature), a complex approach to the selection of the most comprehensive and informative criteria for assessing the state of ecosystems, their biotic and abiotic components is appropriate [64]. The initial conceptual position of this approach is the rejection of the mechanical summation of the state of individual environments, expressed in points, and the assessment of the state of the ecosystem as a whole. And here they take into account the functional unity of natural components, i.e. the overall assessment is formed from assessments of the state of biotic and abiotic factors. The condition of the hydraulic system is evaluated according to a limited number of criteria, which allows obtaining fairly reliable information. With such an approach, it is not only possible to avoid the subjectivism inherent in point assessments, but it is also possible to reveal the cause that determines the condition of the hydro system, which is the basis for the development of specific nature-stabilizing recommendations [1].

In accordance with the main provisions of the current directive documents, the ecological situation is classified according to the increasing degree (level) of ecological disadvantage due to natural and anthropogenic disturbances: relatively satisfactory (norm-N); stressful or conditionally satisfactory (risk-P); crisis or unsatisfactory (crisis-K), adequate to the zone of emergency ecological situation; catastrophic (disaster-B), corresponds to the zone of ecological disaster.

The allocation of these levels is based on the ranking of hydrosystem violations by depth and inevitability, i.e. by real, physically expressed, morphological factors. It is accepted to distinguish the following classes of states and zones of violations:

- Environmental norms (H), or the class of satisfactory (favorable) state of the ORP, which includes territories without a noticeable decrease in the productivity and sustainability of ecosystems, its relative stability; satisfactory health of the population. The value of direct evaluation criteria is below the MPC or background criteria;
- ecological risk (P), or the class of conditionally satisfactory (unfavorable) state of the ORP, which has territories with a noticeable decrease in the productivity and stability of systems, their unstable state, which further leads to the spontaneous degradation of ecosystems, but also with reversible violations. Territories require reasonable economic use and planning of measures for their improvement; the health of the population has partially deteriorated. The values of the direct assessment criteria slightly exceed the MPC
- ecological crisis (K), or the class of unsatisfactory state of ORP (emergency ecological situation) This zone includes territories with a strong decrease in productivity and loss of stability of hydraulic systems, with difficult to reverse violations; a serious threat to public health was noted. There are persistent negative changes in the state of natural water systems (reduction of species diversity, disappearance of certain species of animals and plants, disruption of the gene pool). Selective economic use of territories and planning of their deep improvement are necessary. The values of the direct assessment criteria significantly exceed the MPC;
- Ecological disaster – catastrophe (B), or class of catastrophic state of environments. It includes territories with a complete loss of productivity, deep, practically irreversible violations of hydraulic systems; the health of the population has significantly deteriorated. There is destruction of natural water systems (disruption of the natural balance, degradation of flora and fauna, loss of the gene pool). The values of the direct assessment criteria many times exceed the MPC [2].

There are several approaches to the classification and hierarchy of indicators for assessing the condition (classes) of hydrosystems.

Deep irreversible changes must be considered in a relatively short historical period – not less than the life span of one generation of people.

A significant deterioration in the health of the population means an increase in irreversible health disorders incompatible with life, a change in the structures of the causes of death, and the appearance of specific diseases caused by environmental pollution. A threat to the health of the population means a significant increase in the frequency of reversible health disorders (nonspecific diseases, deviations in physical, neuropsychological development, etc.) associated with environmental pollution.

The state of the ORP and the quality of the environment characterize the criteria of pollution of the aquatic environment, water, soil, depletion of natural resources. The quality of the natural environment is also assessed collectively, both from the standpoint of general ecological and sanitary-hygienic requirements.

The criterion refers to the description of a set of indicators that allow characterizing the deterioration of the health of the population and the environment.

The indicators mean the size, and the parameters are the limits of the intervals corresponding to the degree of ecological disadvantage of the territories.

The parameters are adopted either on the basis of scientific, experimental data, or expert assessments of specialists. [3]

Biotic criteria are of the greatest importance, because they are not only sensitive to environmental disturbances, but also best trace the zones of ecological condition in terms of size in space and stages of disturbance in time. Botanical indicators are very specific, since different plant species and different plant associations in different geographical conditions have different sensitivity and resistance to disturbing influences and, therefore, the same indicators for the classification of ecological status zones can vary significantly for different landscapes. At the same time, signs of negative changes are taken into account at different levels: organismic (phytopathological changes), population (deterioration of species composition and phytoceno-metric features) and ecosystem (ratio of area in the landscape) [4].

Biochemical criteria of environmental disturbance are based on measurements of anomalies in the content of chemicals in plants. Indicators of changes in the content of toxic and biologically active microelements in plant slopes from trial sites and in plant fodder are used to classify the critical ecological disturbance of the territory.

Thus, the proposed systems of methods, most of which are author's, can be used to compile predictive models and create operational computer information.

When monitoring, it is necessary to take into account the speed and time of interaction of the factor and the time of its influence, the probability of the transition of geosystems into an unstable state of degradation. Based on the results of the estimated parameters, it is possible to build express maps of the ecological situation of the region, taking into account the influence of, for example, the system of oil and gas-bearing economy [5].

Risk in the global sense is a measure of damage to people's lives and health, a measure of economic losses, expressed through the probability of an accident and the amount of damage. Individual and integrated risks are distinguished.

Risk is perceived as a probable measure of the danger of the manifestation of adverse phenomena and its consequences from the point of view of a person. Environmental risk means the assumption of the probability of harming the natural environment in order to achieve an economic, ecological or social effect. It is recognized as unreasonable activity that leads to irreversible changes in the natural environment, degradation of ecological resources of nature, which poses a threat to the life and health of the population [6].

According to the Interdepartmental Commission on Environmental Safety, the internal threats of man-made activity near Ukraine include the environmental risk of groundwater and surface water pollution and flooding of the territory. The concept of risk is used as an integral assessment of danger.

Ecological risk is an integral assessment of the level of ecological danger of a polluted natural object, which is defined as the product of the amount of damage caused by the impact of a polluted natural object on populated areas by the probability of this impact:

The system of hydro-ecological safety has a single goal: maintaining the necessary level of ecological safety of water management facilities.

For the study of natural and anthropogenic changes in water management objects, we propose a system of methodological developments that allow us to reveal the degree of anthropogenic geochemical influence of urbanized and agricultural areas on different blocks of the basin, to give quantitative characteristics to migration flows, to determine the nature of the distribution of pollution both in space and. The calculation of bioenergy for different stages of landscape development made it possible to show the orientation of that development. Along with the specified methods, the method of combined analysis, physical-geographical, cartographic and system analysis was used. These methods helped to substantiate the spatial distribution of the substance, its dynamics and peculiarities of functioning at water management facilities [7].

Currently, the formation of the chemical composition of water systems occurs under the influence of both natural and anthropogenic factors.

Natural factors (climate, topography, rocks, soils) that determine the geochemical features of water bodies in the given territory change little over a relatively short period of time. The relationships established as a result of their combined influence are more or less stable, which determines the relatively constant chemical composition of waters, Dnipro sediments, vegetation and certain patterns of migration of elements in aquatic systems. Under the influence of man-made factors, the existing natural balances are disturbed, new connections arise, the intensity and character of the migration of substances change. Moreover, the rate of anthropogenic changes is much higher than natural, and the system as a whole is moving away from its original natural state. This most important situation is the basis for detecting anthropogenic changes in water bodies.

The main methods of detecting such changes include:

- Comparison of average statistical parameters of water bodies for different periods of time (multi-year average values, content of elements in water flow).
- Determination of the man-made component in modern substance flows.
- Calculation of background and anomalous parameters of water bodies and selection of man-made anomalies.
- Calculation of the complete balance of chemical elements in water systems.
- Comparison of features of formation and quantitative parameters of water bodies located in the zone of influence of anthropogenic factors and in the background area. [8]
- Comparison of the results of repeated ecological and geochemical mapping of the same water body.

Universal hydrochemical parameters are the average annual and long-term values of the content of individual elements and their compounds and the average annual flow of chemical elements and their compounds. They are relatively constant for certain periods of time and allow comparing hydrochemical indicators of different years, taking into account short-term natural changes in the chemical composition of water.

Hydrochemical parameters calculated for different periods of time reflect the anthropogenic dynamics of the chemical composition of water, as well as its changes in connection with the introduction of one or another man-made factor (construction of dams and hydraulic nodes, industrial facilities, land irrigation).

In order to quantify the influence of anthropogenic factors on the hydrochemical regime of the year, the anthropogenic component of ion flow is calculated. When determining the ion flow in the period preceding intense anthropogenic influence, it is possible to use data calculated for many rivers and reflecting their chemical composition close to natural. Currently, the man-made component of the water flow of most rivers in industrial and agricultural areas can be compared with the natural one, and in some cases it significantly exceeds it.

In order to identify areas of accumulation of technogenesis products in water bodies based on the results of field ecological and geochemical research, background and anomalous parameters of the distribution of elements and the selection of man-made anomalies are calculated. When performing the specified calculations, the methods of mathematical statistics are used, with the help of which the law of distribution of elements, dispersion and root mean square deviation, background and anomalous values are determined for water areas that are homogeneous in terms of natural and geochemical conditions. Sections of water bodies are distinguished, in which the content of the analyzed element exceeds the calculated abnormal value.

The calculation of the complete balance of chemical elements in water bodies or in their individual sections is carried out to quantify the influence of anthropogenic factors and the changes caused by them. It is advisable to perform balance calculations for groups of chemical substances that are similar in properties in accordance with the migration scheme and the material balance equation.

The balance equation of dissolved conservative elements for the river basin has the form:

By comparing the obtained results on the background and controlled areas, the anthropogenic changes that have occurred are carried out, and their qualitative and quantitative assessment is carried out. An important condition when choosing a background area is a complete analogy with the natural environment within the background and controlled water areas.

Ecological and geochemical maps are the most important tool for studying anthropogenic transformations and assessing the state of water bodies.

Mapping objects can be individual components of the water system or parameters of their chemical composition, as well as homogeneous water complexes consisting of certain regular combinations of individual components.

In the process of ecological-geochemical mapping, homogeneous plant communities, Dnipro biocenoses, water areas with different chemical composition of water, types of geochemical situation, forms of underwater relief differing in migration conditions, suspended and attractive material, types of Dnipro sediments are identified and outlined [9].

Based on the results of repeated surveys of the same water body, an analysis of changes in the ecological and geochemical characteristics of the Dnipro, the disappearance of existing and the appearance of new taxonomic units, the dynamics of anthropogenic transformations in hydro-chemical and hydrobiological regimes, and the rate of accumulation of substances on geochemical barriers are established.

The discovery of new ecological aspects of the pollution of water ecosystems of the Cherkasy region, the study of the spectrum of chemical compounds as a medical and ecological well-being of the environment stimulated the development of new ecological approaches to solving the tasks.

The basis of the work methodology is the principle of integral assessment of natural and anthropogenic factors affecting the quality of the surface and near-surface hydrosphere of the region, as well as the surface layer of the atmosphere, using a data bank of ecological parameters of the environment, methods of large-scale surveying, field research, the method of weighted points, which allows geochemical population health criteria, mathematical cartographic and computer modeling methods.

To create a data bank of actual material, the following types of work were carried out: field research, chemical-analytical research, camera processing of materials.

During the field period, the following was carried out: reconnaissance survey of the territory, hydrogeological survey of objects – potential sources of groundwater pollution, operating water intakes, wells in the private sector; lithological testing of soils and soils of the aeration zone; hydrogeological research of ponds, rivers, streams and water sources; rainwater samples were taken, and snow samples were taken in the winter period.

The laboratory work consisted in carrying out chemical analyzes of samples of underground water, rivers, streams, atmospheric precipitation, sewage and soil samples. Photometric methods provided the necessary sensitivity, reproducibility and correctness of analyzes in the chemical-analytical study of natural waters. All components in the samples were determined separately according to known methods.

In the statistical modeling of any system, the conditions of mass, homogeneity, randomness and independence of the sample set of analytical data were observed [10].

In this work, one-dimensional statistical models were used to estimate the average, natural background and man-made concentrations of pollutants in natural and wastewater, as well as to test the hypotheses of the distribution of random variables.

Tasks in which attempts were made to identify correlational dependencies of quantities were solved using two-dimensional statistical models. In the conducted research, we encountered both linear and non-linear dependencies. Both those and others were approximated by the corresponding regression equations. An investigation was conducted into the causes of pollution of water bodies as a result of emergency and volley discharges.

There are criteria for water pollution according to IZV and criteria for improvement (deterioration) of water quality. The data given in Table 1 [63] is used to compare water quality and determine the dynamics of changes in water quality.

Table 1

Assessment of water quality according to BOD_5

Oxygen consumption (BOD_5)	The amount of mg O_2/l is accepted according to standards
up to 3 mg O_2/l inclusive	3
more than 3 to 15 mg O_2/l	2
More than 15 mg O_2/l	1
For dissolved oxygen At the content in mg/l	The amount of mg O_2/l is taken as a norm
More than 6	6
less than 6 to 5	12
less than 5 to 4	20
less than 4 to 3	30
less than 3 to 2	40
less than 2 to 1	50
less than 1 to 0	60

The calculation of the water pollution index (WPI) showed that a certain contribution to pollution is made by the transit contribution and removal from the Lipetsk region, and in turn, the Cherkasy region supplies polluting substances to the lower regions (Table 2).

Table 2

Values of calculated IZV for surface waters

Water quality class	Text description	The value of IZV	Change in the value of IZV in % determination of water quality trends
I	Very clean	Less than or equal to 0,3	100
II	Clean	More than 0,3 to 1	Over 50
III	Moderately warm	Over 1 to 2,5	More than 30
IV	Contaminated	Over 2,5 to 4	More than 25
V	dirty	Over 4 to 6	More than 20
VI	Very dirty	Over 6 to 10	More than 15
VII	Extremely dirty.	More than 10	more than 10

According to the IZV indicator, it is possible to determine the dynamics of natural water quality and spatial differences. The cartographic method is used to assess spatial patterns. The series of cards must be built in the system of GIS technology.

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We conducted a geoecological assessment of the state of natural waters of the Cherkasy region as a factor shaping the biosocial level of population health.

At the research stage, blocks of geoecological assessment of water resources have been selected. Each block is a logically complete unit for research purposes. At the same time, each subsequent block is a logical continuation of the previous one, on the basis of which a surface water research system is built, the purpose of which is to create a system of rational and safe water use.

Within the framework of the first block, an analysis of the factors of formation of the ecological state of surface waters was carried out. According to the nature of their influence, the factors that determine the formation of the chemical composition of natural waters should be divided into the following groups: physical and geographical; geological; physical and chemical; biological; anthropogenic.

The environmental factors listed above together have a direct and indirect impact on the ecological state of surface waters. The direct action is manifested in the fact that, entering the atmospheric waters, salts change into a soluble state, solid and liquid aerosols and gases are formed; in surface waters, chemical substances form suspended, colloidal, dissolved complex, ionic and non-dissociated compounds.

In underground waters, as a result of physical and chemical processes, dissolved forms are deposited and further migration of chemical elements is carried out. The indirect impact is that the level and dynamics of surface water pollution depends on natural factors that determine the ability of freshwater ecosystems to self-restore and reproduce.

The second block is an integrated geoecological assessment of water quality. The hydrochemical index of water pollution of IZV belongs to the category of the most often used indicators for the purpose of assessing the quality of water bodies.

The water pollution index is usually calculated based on six indicators that can be considered hydrochemical.

Ecological and geochemical maps are the most important tool for studying anthropogenic transformations and assessing the state of water bodies. Mapping objects can be individual components of the water system or parameters of their chemical composition, as well as homogeneous water complexes consisting of certain regular combinations of individual components. In the process of ecological-geochemical mapping, territories with different chemical composition of water, type of geochemical situation are identified and outlined. Based on the results of repeated surveys of the same water body, an analysis of changes in the ecological and geochemical conditions of the Dnipro is carried out, the dynamics of anthropogenic transformations in the hydrochemical and hydrobiological regimes, and the rate of accumulation of substances on geochemical barriers are established.

Within the framework of the third block, environmental management is carried out, which includes the organization and improvement of systemic hydrochemical monitoring; engineering and technological modernization; ecological and economic regulation.

Environmental management makes it possible only at the level of each specific organization to formulate policies and goals, taking into account the requirements of legislation, regulatory and technical acts and information about significant environmental aspects and environmental impact. The environmental management system considers those environmental aspects of the organization's activities that it can control and the impact on which is expected.

The core of the environmental management system is a program – a comprehensive document that describes the organization of the enterprise's activities in the field of environmental management, as well as specific measures and actions for its implementation, developed in accordance with the environmental policy, goals and objectives. When developing environmental management programs, enterprises are guided by the principle of continuous improvement, i. e. achieving the best indicators in all environmental aspects of the enterprise's activities where it is practically possible [11].

According to the nature and intensity of anthropogenic influence, local and field sources of surface water pollution of the Cherkasy region are distinguished.

Among the local sources of pollution in the region, four types of industrial units can be distinguished:

Nodes that have an integrated effect on the entire complex have large volumes of polluted discharges and effluents, which differ in the complex chemical composition and toxicity of the components. The volume of industrial wastewater in the region is approximately 70 % of the volume of all wastewater. The composition and amount of pollutants in these effluents depends on the type of production, raw materials, and various additional products in the technological processes.

Nodes with a predominant impact on the atmosphere include, mainly, enterprises of the fuel and energy complex that emit dust, nitrogen oxides, sulfur dioxide, and carbon monoxide into the atmosphere. Due to the war of intensive emissions of these substances, there is pollution in the area where the enterprises are located, not only the atmosphere, but also the ground cover, surface and underground water. Examples of such nodes are thermal power plants and boiler houses. The emission structure of these enterprises contains solid, liquid and gaseous substances, in particular sulfur dioxide, carbon monoxide, and nitrogen oxides.

Nodes affecting the Earth's surface, combine enterprises of the mining industry - quarries, mines. The consequences for the natural environment are anthropogenic forms of relief, violation of the underground and surface water regime, and dust pollution.

In the Cherkasy region, the Shkurlatov quarry of the Pavlov district of JSC «Pavlovskgranit» belongs to such nodes. Although according to the generally accepted classification, it is considered that the contents of the dumps are non-toxic, studies have shown that they have accumulated tens to hundreds of tons of heavy toxic metals.

Landfills for the storage of solid household waste (SWW) and warehouses for the storage of highly active toxic substances (PSW).

In accordance with the Resolution of the administration of Cherkasy region, in 2013, an inventory of places of storage and disposal of production and consumption waste was carried out. It was aimed at identifying, assessing the state and degree of danger for the environment of such objects, taking measures to eliminate the detected violations. As a result, 6,510 waste disposal sites with an area of more than 0,01 ha were established. Among them: 70 solid waste landfills, 2920 authorized.

As it has been established, a large amount of phosphorus and nitrogen compounds - biogenic elements – are carried out with surface runoff from agricultural lands into water bodies, the amount of which is much higher than what comes with household and industrial wastewater. 54 % of nitrogen is removed from surface runoff, while only 22 % from household runoff, and 24 % from industrial runoff. About 20 – 40 % of nitrogen, up to 2 % of phosphorus and up to 30 % of potassium from the introduced amounts are washed into natural reservoirs by stormwater (Table 3). Their arrival in the reservoirs of the region leads to mass flowering and deterioration of water quality.

Table 3

Removal of biogenic substances from different types of water bodies

Catchment area	Arrival of biogenic substances, kg/ha	
	Nitrogen	Phosphorus
The grassland area is extensively used, including protected forests.	3,63	0,36
Forest-meadow area	3,86	0,33
Swampy valleys	4,27	0,30
Pastures	26,03	1,10

On the basis of the above analysis of local and field sources of pollution, data of stock statistics, results of field observations and data of laboratory analyzes, the author investigated the dynamics and current state of the quality of surface and underground waters of the studied region. Based on the analysis of the map scheme, it can be seen that during the period of research, the quality of water in the Dnipro River of the Cherkasy Region, it remained only at the level of 3 (moderately polluted) – 4 (polluted) purity classes.

Thus, the dynamics of quality changes slightly. However, the water quality changes during the course of the river through the territory of the region.

A large contribution to the increase in the morbidity of the population of the region is made by the excess of concentrations of nitrogenous compounds in underground water sources. There are a number of points in the territory where concentrations of nitrogen compounds significantly exceed the background and threshold values. In the groundwater of the Dnipro lowland, nitrate pollution is observed in the Novoarkhangelsk district and within the city of Cherkasy. In the Novoarkhangelsk district, the concentration of nitrates was 67,5 mg/dm^3, and in the wells of the village Kryve-Kolino -267,9 mg/dm^3. It should be noted that elevated concentrations of nitrates are noted in many village wells. Yes, in the village Thorn content of nitrates reaches 255 mg/dm^3 [12].

Therefore, the quality of water resources and their hydroecological safety of water bodies are affected by natural and man-made factors. Among the natural processes, the following are distinguished: climatic, geological, physical and chemical. As a result, the migration of ions and cations and their transition into different aggregate states occurs. Yes, the concentration of organic compounds according to BOD_5 IN rain runoff it ranges from 40 to 90 mg/dm^3, and in sewage – up to 150 mg/m^3. In this regard, during spring floods and torrential rains, the concentration of pollutants increases. 54 % of nitrogen is removed with surface runoff from arable land. The region is characterized by local areas with high background and threshold water pollution with nitrogen (up to 267 mg/dm^3). Man-made influence is associated with a high volume of wastewater discharge.

It was established that the main causes of emergency situations on water bodies are an increase in anthropogenic influence on hydrosystems; anomaly of changes in hydrometric, hydrological and hydrochemical parameters; placement of objects of economic activity in zones of potential natural danger; imperfection of monitoring systems on some components of the natural environment; low reliability of forecasting dangerous natural phenomena; poor condition, and in some places the absence of hydrotechnical, anti-slide protective structures;

The conducted research made it possible to identify areas with high indicators of ecological danger (up to 5, 4, 3) points, with an average indicator (2), and with relatively low ones (1).

When assessing the ecological safety of water bodies, you can use ecological and economic indicators of water use. The main one is economic losses, which are presented as an ecological component of socially necessary costs caused by a negative impact on water resources. It was found that the amount of damage caused to surface water by pollution depends on the structure of wastewater. According to the calculations, the greatest damage to surface waters was caused by wastewater containing biogenic components and heavy metals. The total amount of losses on average during the year is UAH 22,260.4 thousand. within the established limits.

The hydrological safety of regional water management facilities depends on the hydrological regime of the watercourse, the relief of the area, engineering-geological, hydrogeological conditions, the presence of engineering structures in the channel and on the floodplain: dams, reservoirs, bridges, roads, intakes, dams, quarries of building materials, economic facilities may be subject to flooding during a flood.

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