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GENERAL ASPECTS OF RESTORATION (RECONSTRUCTION) OF DRAINAGE SYSTEMS ON AGRICULTURAL LANDS (REVIEW OF PUBLICATIONS)

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Abstract. *The article presents a review of publications on the actual problem of restoring the functional capacity of drainage systems, which in modern conditions of climate change and military aggression acquires special significance not only from the standpoint of the need to increase the productivity of drained lands, but also to ensure the water security of our country. The study of problems and setting of directions for restoration (reconstruction) of drainage systems in Ukraine and regions of the world was performed using bibliometric analysis. For analytical research, domestic and foreign literary sources of a 55-year period were studied, the main number of which falls on the period 2002–2022. The conducted analysis made it possible to determine the main directions that are considered when solving the problems of restoration (reconstruction) of drainage systems on agricultural lands worldwide and in Ukraine. Approaches to the operation, maintenance, and controlled decommissioning of drainage systems are based on the development of scenarios for the adaptation to climate change, therefore, the priority of the state policy in a number of countries is, first of all, the restoration of systems, which allows to ensure the adaptation of agricultural production to modern climate changes. Worldwide, the assessment of the reclamation fund is carried out constantly and the need for reconstruction and modernization of drainage systems is determined according to the design characteristics and technical condition also providing for the restoration of their water-regulating function. The basis for the reconstruction of drainage systems is the economic and technical justification of feasibility, the application of the progressive methods of drainage, the priority implementation of restoration measures in the areas of drainage systems, which are in working condition, and on the drained territories, where intensive and medium-intensity agricultural use of the drained lands is planned. The scientists' developments are aimed at creating economically viable technical options for the restoration (reconstruction) of drainage systems, which take into account the directions of their use and investment options for reconstruction. Studying the global experience of restoration (reconstruction) of drainage systems on agricultural lands and its use is important for the implementation of the provisions of the "Strategy of Irrigation and Drainage in Ukraine for the period until 2030".*

Key words: *drainage systems, restoration (reconstruction) of drainage systems, drained lands, economic efficiency, bibliometric analysis*

Actuality of research. Drainage land reclamations have been known since ancient times, and the global long-term practice of agricultural production on drained lands shows that carrying out drainage measures ensures: the stability of growing and increasing the yield of agricultural crops, strengthening the economy of farms, and positive socio-economic changes [10; 24; 41; 42].

Reclaimed lands in the world occupy about 425 million hectares, in particular 164 million hectares are drained lands. In the total area of cultivated territories, the specific weight of reclaimed lands does not exceed 30%, but these lands provide 3/4 of the world agricultural production [33].

In the USA, the area of drained lands is about 60 million hectares, among which the area of large massifs is about 40 million hectares, and the are of small farm plots is up to 20 million hectares [7; 36]. Areas of drained lands in Europe make up about 70% of all reclaimed territories [29]. In Great Britain, Germany, Belgium, and Denmark, up to 70–90% of all overmoistened lands are drained [36]. In a number of countries (Finland, Sweden, the Netherlands), all overmoistened agricultural lands are completely drained [31]. More than half of the territory of the Netherlands is below the sea level, so the drainage of waterlogged lands is the basis of the country's livelihood [11].

In Lithuania, Latvia, and Estonia during the Soviet times, more than 8 % of all overmoistened agricultural lands were drained.

Among the almost 3.3 million hectares of drained lands in Ukraine, which is 20 % of the total area of agricultural lands in the humid zone, about 2.9 million hectares are used in agricultural production, in addition, on the area of about 1.1 million hectares there is an opportunity to carry out bilateral regulation of soils' water regime.

Modern global climate changes, their impact on the social, economic, and ecological development of mankind is becoming more and more tangible and vulnerable and is turning into one of the key problems of the global economy and politics. The main consequences of this impact include changes in the quantity and quality of water resources, their provision in various sectors of the economy, first of all, those aimed at solving the food problem, namely agricultural production.

The drainage systems in Ukraine are also one of the important factors of sustainable agricultural production in the humid zone, and the economic, ecological, and social stability of the regions with drainage land reclamation largely depends on the efficiency of the use of drained lands [43]. The global development of agricultural production shows that the greatest success was achieved by those countries that implemented large-scale national programs for the development, restoration, or reconstruction of both irrigation and drainage systems [5].

Today, the construction of new drainage systems in most countries [4; 8; 14], as well as in Ukraine, has practically stopped, and works on restoration, comprehensive reconstruction, and technical modernization of existing systems have been reduced to a minimum [25]. At the same time, in the current conditions of climate change and military aggression, the importance of restoring the functional capacity of drainage systems is growing not only from the standpoint of the need to increase the productivity of drained lands, but also to ensure the strategic and water security of our state.

The analysis of the latest researches and publications shows that few scientific works are dedicated to the study, analysis, and generalization of the global experience of conducting drainage land reclamations. General trends in the development of reclamation of overmoistened lands in the countries of Western Europe, the USA, Japan, and others indicate that their development was determined primarily by the needs of agriculture [10; 15; 29; 31; 35; 47].

According to literary sources, land drainage in the leading countries is a recognized necessity, and the area of drainage is an indicator of the technical level and possibilities of agricultural production [35]. At the same time, the modern period of drainage land reclamation in Ukraine, which began with the independence of our country, is characterized by difficult conditions for finding new forms of management and uncertainty of ownership of drainage systems' individual components and the lack of appropriate experience and legislative framework. To this day, the state is the main investor in the maintenance of inter-farm networks, and the existing level of funding does not allow to ensure their full maintenance, restoration, comprehensive reconstruction, and modernization. Therefore, taking into account that the land reclamation rate of the humid zone of Ukraine is quite high (60.5 %) and corresponds to the level of such countries as the USA, Germany, and the Netherlands, it is important to study the global experience of restoration (reconstruction) of drainage systems on agricultural lands for its use in the implementation of the provisions of the "Strategy of Irrigation and Drainage in Ukraine for the period until 2030" [52].

The aim of the research is to study the experience and directions of restoration (reconstruction) of drainage systems on agricultural lands based on the materials of domestic and foreign publications and their use for the development of drainage land reclamations in Ukraine.

Research materials and methods. The methods of research are based on the use of historical-logical (identification of the most important existing domestic and global developments on the issues of restoration (reconstruction) of drainage systems), logical-abstract (expansion of information from literary sources, establishing the correctness of the use of the term "restoration (reconstruction) of drainage systems" in modern literary sources), analytical and synthetic methods (processing of the obtained information using the bibliometric method, systematic analysis, generalization and synthesis of research results).

Research results. The definition of the concept of "restoration (reconstruction) of drainage systems" in modern literary sources implies a set of measures. They are aimed at increasing the technical level of existing reclamation systems by changing the structures and basic parameters of the engineering infrastructure, replacing outdated structures with new ones, introducing automated management of soil's water regime in order to increase the productivity of reclamation lands on the basis of new equipment and advanced technologies,

scientific organization of work, improvement of conditions, and productivity growth [39]. The following is used in literary sources and is considered as the reconstruction (modernization) of working and restoration of non-working drainage systems [25]: reconstruction [1; 21], construction or reconstruction of the drainage network [6], reconstruction of the irrigation and drainage system with options for segmental reconstruction [56], restoration and reconstruction of drainage systems [22], restoration of drainage systems [2; 9; 22], reconstruction, rehabilitation and restoration [17], restoration and modernization [28].

To confirm the correctness of the use of the term "reconstruction", an analysis of its use in recent publications in the countries of the Organization for Economic Cooperation and Development (OECD) was conducted [3; 17; 23; 19]. In the cited sources, it is observed that the term "reconstruction" in the normative documents of the OECD does not include the construction of new systems and hydraulic structures. The autonomous use of the term "reconstruction", which is used in the texts together with the restoration, modernization, and rehabilitation of reclamation objects, indicates that when preparing proposals, plans, projects, recommendations it is permissible to limit the use of the term "reconstruction" with its clarifications, such as, e. g., "complete", "comprehensive", etc.

The reconstruction of reclamation systems is a set of measures aimed at increasing the technical level of existing systems with the goal of increasing the efficiency of natural resources use by changing structures, the main parameters of the system and its elements, and changing obsolete equipment [39].

In a number of domestic studies and publications, it is noted that the complex reconstruction of reclamation systems is a radical technical solution in the improvement and modernization of existing systems. Modern developments define a number of criteria that should be followed when justifying the necessity and expediency of reconstruction, and principles that include technical excellence, economic efficiency, and environmental reliability [42; 45; 53; 56].

The study of problems and establishment of directions for restoration (reconstruction) of drainage systems in the countries and regions of the world was carried out using bibliometric analysis.

Domestic and foreign literary sources of the 55-year period were used for analytical research (Fig. 1). These are, in addition to domestic publications, the publications of the OECD countries, which include the most economically developed countries in the world and which also actively cooperate with Ukraine within the framework of the specialized programs and international projects.

The majority of literary sources selected for analysis fall on the period 2002–2022.

Studies on the global experience of creating, operating, and restoring drainage systems show that in the most developed countries (Great Britain, Belgium, the Netherlands, Germany, France, Denmark, etc.) permanent reconstruction of drainage systems is carried out.

In Great Britain, where reclamation measures have been carried out on almost all overmoistened

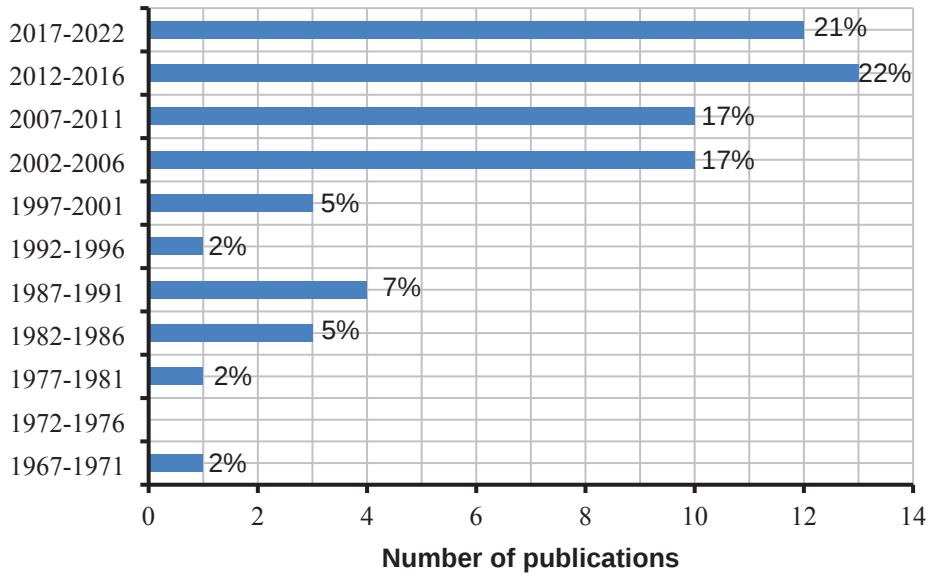

Fig. 1 Distribution of literary sources selected for analysis by 5-year intervals (1967–2022), %

lands (only about 1% of anthropogenically undisturbed lands have been preserved), the share of drained lands is more than half of all agricultural lands. The land reclamation fund is constantly evaluated in the country, and the need for reconstruction and modernization of drainage systems is determined according to their design characteristics and technical condition. Along with this, it is mandatory to solve the environmental problems that arise in the ecosystems of drained peatlands [12]. Drained lands, which are economically impractical to use (if they have not been used in agricultural production for more than 10 years), are removed from the reclamation fund [8; 15; 35; 37; 38; 42].

Today, drainage systems in the Czech Republic are practically not constructed or reconstructed, but most of them are maintained in working condition. Their use is determined by the prospects and directions of the development of agricultural production and the expediency of reconstruction is determined by the need to ensure water regulation on drained lands [14].

In Latin America, there is a trend of reviving the old methods of reclamation of waterlogged lands, which are based on the principle of small contours or small sizes of drained massifs with the possibility of local collection of drainage water in special storage reservoirs. An an example we can mention the meliorative systems in the floodplain of the San Pedro River (Tabasco state, Mexico), the operation of which allows ensuring environmental safety within the limits of their influence [4].

Approaches to the operation, maintenance, and controlled decommissioning of drainage systems in the Netherlands are based on the development of climate change adaptation scenarios for artificial polders with marine clay soils along the coast, lowland areas with peat soils in the west and north, sandy and semisandy soils in the center, in the south and east of the country [20].

The experience of drainage systems reconstruction in the countries of the former members of the Council for Economic Mutual Assistance (Bulgaria, Germany, Poland, and the Czech Republic) shows that the basis of the reconstruction of the systems was economic and technical justification, the use of progressive methods of drainage, the priority of work on areas with high soil fertility, increasing the technical level of those sections of drainage systems that are in working condition [47].

One of the main problems agricultural production in Bulgaria is facing today is the technical condition of drainage systems. Literary sources indicate that on many systems within individual farms their condition is unsatisfactory, they are neglected and need reconstruction and modernization [28]. The priority of modern state policy is, first of all, restoration of systems, as this will allow adaptation of agricultural production to the consequences of climate change [18].

The change in soil's water regime and the development of degradation processes, the inadequate technical condition of the drainage systems is accompanied by a poor reclamation condition on almost 7% of drained agricultural lands in Lithuania. When substantiating the need for reconstruction of drainage systems, the needs of land users and their financial capabilities are taken into account. General approaches to the restoration of drainage systems are based on the expediency of such a measure in territories where intensive and medium-intensity agricultural use of drained lands is planned (according to the national strategy for the development of rural areas) [9]. The developments of Lithuanian scientists are aimed at creating economically viable technical options for the reconstruction of drainage systems, which take into account the directions of their use and investment options for reconstruction [26].

In Latvia, the rationale for the reconstruction of drainage systems is based on detailed mapping using geospatial research; on considering the need to protect the environment and improve the quality of water resources [22]. When choosing objects of reconstruction, the need to restore existing or build new drainage systems on overmoistened agricultural lands is determined [2].

A number of literary sources consider the feasibility of developing technological solutions that use drainage systems with selective drainage and the feasibility of the restoration and modernization of drainage systems based on the restoration of their water-regulating function thanks to the installation of irrigation systems [13; 16].

Modern results of scientific research indicate that it is important to use methods of statistical modeling and probability theory, on the basis of which mathematical models are developed, to justify projects of drainage systems reconstruction [13].

In China, during the reconstruction of drainage systems, the tasks of protecting rural areas from floods and agricultural lands from droughts are additionally solved by improving drainage and irrigation infrastructure, cleaning canals and increasing the efficiency of water resources use [30].

The reconstruction of drainage and irrigation systems in Indonesia was carried out simultaneously with the elimination of the consequences of the tsunami [1].

In general, global experience indicates that the restoration of drainage systems is a necessity, as they are one of the important means of minimizing the impact of modern climate changes on the social, economic, and ecological development of many countries [5].

The experience of reconstruction of drainage systems in Ukraine even in Soviet times shows that in the first post-war years (1945–1951) works were carried out to restore systems destroyed during the war. During the period of the fastest pace of construction (1965–1984), 38,000–72,000 hectares of reclaimed land with reconstructed systems were put into operation annually. In the period from 1965 to 1970, 190 thousand hectares were reconstructed in Ukraine, from 1971 to 1975–203 thousand hectares, from 1976 to 1980–214 thousand hectares, from 1981 to 1985–211 thousand hectares, from 1986 to 1990–240 thousand ha of drainage systems.

It was recommended to reconstruct the existing drainage systems on a technical basis that was new at the time: replacement of the open drainage network with horizontal and vertical drainage; replacement of existing collectors on a closed network with new ones that can ensure the passage of estimated water flows; laying of new (additional) drain-dryers to thicken the drainage; deepening, expansion, and strengthening of existing collection canals; replacement of separate open conducting canals with closed collectors of large diameters (0.3–1 m), which made it possible to increase the net drainage area by 10–12 %; arrangement of an additional interception network to ensure drainage of surface runoff; combination of gravity drainage with mechanical drainage; the use of strong and durable materials in the construction of hydrotechnical structures; construction of reservoirs, storage ponds for guaranteed regulation of water, air, thermal, and nutrient regimes in the root layer of soil during the growing season of crops.

The reconstruction of previously constructed drainage systems was preceded by a detailed study of the reclamation condition at the sites.

Specific capital investments in Soviet times for the reconstruction, for example, of the Irpin drying-moistening system in Kyiv region, amounted to 1,100–1,300 rubles/ha with a payback period of 4–5 years and a land use ratio of 0.95–0.97; Berehiv cross-border polder system in Transcarpathian region – up to 1,200 rubles/ha, the payback period is 3–4 years with a land use coefficient of 0.97–0.98 [39].

At the current stage, the main goal of the complex reconstruction and modernization of drainage systems in the area of drainage reclamation is to increase the productivity and efficiency of the use of drained lands, the technical level of the systems, the preservation and restoration of soil fertility, the rational use of the natural potential of agricultural landscapes, and the provision of sustainable agricultural production in the years with different weather conditions [44].

It was determined that during the complex reconstruction and modernization of drainage systems of the humid zone, constructive solutions, water regulation technologies, and technical means for their implementation should be based on the following principles [44]:

– ensure maximum use of working elements that are in operational condition, have sufficient technical resources, and are suitable for further use;

– provide a system of engineering solutions and measures for the rational use of material, energy, water, and land resources, preservation and increase of fertility of reclamation lands, ensure their rational agro-landscape development, protection of adjacent territories, and water-receiving rivers from pollution;

– ensure a high level of efficiency in managing their work, simplicity and reliability in the operation of technical means, minimal operating costs;

– provide for autonomous management of individual plots and be flexible to implement different crop rotations in accordance with modern market needs and interests of land users of various forms of ownership.

General approaches to justifying the reconstruction of drainage systems in each specific case should be detailed taking into account the type of water supply, the existing design of the system and its technical condition, features of the terrain, soils, economic conditions, etc. [44].

One of the examples of modern (2019) positive experience is the reconstruction of the drainage system located within the Precarpathian Highlands, on which a drip irrigation system was built (on an area of 39.9 hectares, for blueberry and blackberry cultivation). Drainage is carried out with the help of pottery drainage built more than 35 years ago [13].

At the same time, the current stage of drainage reclamation development in Ukraine is characterized by a complex of unsolved problems, which are related to the peculiarities of the functioning of drainage systems in complex and changing conditions of the humid zone.

Today, there are a number of scientific developments aimed at substantiating drainage system reconstruction projects. However, the available scientific support for their restoration

(reconstruction and modernization) does not sufficiently cover all priority directions, which are determined by the current state and peculiarities of their functioning in the conditions of climate change [26; 42; 44–46; 48; 50; 51; 54; 56; 58].

Most of the drainage systems of the humid zone of Ukraine are in an unsatisfactory technical condition, which is manifested in the physical and moral aging of the main reclamation funds, low level of operation of the drainage network, failure, and in many cases the absence of hydromechanical equipment. Based on analytical and statistical sources, it was determined that the technical condition of drainage systems is characterized by general wear and tear of engineering infrastructure elements as a result of their long-term operation by an average of 60% (inter-farm network – 55% and intra-farm network – 65%) [56]. Consequently, the effectiveness of the use of drained lands and their role in the food and resource provision of the state has significantly decreased.

Restoration of drainage systems in the drainage area should be carried out according to two options, which are prescribed in the "Strategy of irrigation and drainage…": the modernization of working reclamation systems and the modernization of non-working reclamation systems [52].

The reconstruction of the working drainage systems is planned to be carried out taking into account the division of the existing systems into draining, drying-moistening, polder, and water circulation systems, which involves a complex of works to improve their parameters by adding the ability to regulate soil moisture. On drainage systems of one-way action, the basis of modernization measures is the improvement of water-regulating structures and the installation of irrigation systems; on drying-moistening ones – it is to ensure the possibility of implementing a guaranteed two-way regulation of water regime of soil under conditions of climate change. Modernization of polder and water circulation systems to the level of drainage and irrigation systems is carried out by building irrigation systems (drip irrigation or sprinkler systems) on them. The complex of modernization measures is determined on the basis of inventory data and should include different types of works on different types of drainage systems. The total area of such systems is 1311.2 thousand hectares.

Restoring the functionality of non-working drainage systems should be carried out taking into account the list of works on the modernization of working systems according to their various types and the restoration of such systems to the design level by performing repair and restoration works both on the inter-farm and on-farm networks. These works include cleaning canals and culverts; restoration of water control structures (gates, lifts, etc.); washing of collectors and drains, partial restoration of drainage; arrangement of wells-filters for removal the surface water; arrangement of existing dams, strengthening of mouths of drainage collectors, etc. The total area of such systems is 1962.9 thousand hectares.

Taking into account the current state and technical and technological features of the functioning of drainage systems of Ukraine, modern requirements for their structures should take into account changes related to the reform of the agrarian sector, agrotechnical and ecological requirements of land users on drained lands, modern climate changes. These requirements are determined based on the analysis of design materials of drainage systems located in different natural and climatic conditions of the humid zone and include the need to take into account the features of modern land management and changes in the specialization of agricultural production in the humid zone; ensuring operational management of technological processes of water regulation and maintaining the optimal water regime of the active soil layer; the expediency of using effective technological schemes along with resource-saving and environmentally sound technologies for regulating the water regime on drained lands; ensuring increased efficiency of agricultural production on drained lands by land users of various forms of ownership and management [25].

Analytical studies of the influence of modern climatic factors on the formation of soils' water regime established that modern agricultural production is under the direct influence of climatic changes, therefore, its effective management is possible provided that agricultural producers create suitable conditions for adaptation to them and minimize the impact [49]. At the same time, the impact of climate change on agricultural production by agro-enterprises today is particularly noticeable in the area of drainage reclamation, where the most changes in the production structure have recently taken place [27].

The current structure of cultivated areas is subject to both climatic changes and the market situation, which dictates the cultivation of economically attractive crops. Climate changes make corrections to technological maps and the structure of crop rotation of agricultural enterprises in the zone of drainage land reclamation. The fact that the period of a significant increase in the sum of active temperatures coincides with the period of rapid

development of agricultural holdings in Ukraine (the beginning of the 21st century) contributes to the fact that such economically attractive crops as corn, sunflower, soybean are now gradually turning into the main ones. The main crops of traditional specialization (long flax, sugar beet, rye, oats, and others) of the humid zone have ceased to be a priority in modern agricultural production, however, due to the naturalness of domestic products and the uniquely favorable ecological and geographical position of their cultivation, they have the prospect of conquering the domestic and global markets, however today they are becoming mostly niche cultures [48].

Along with this, modern agricultural production on drained lands is characterized by inefficient use of the existing potential of drainage systems, therefore their water-regulating capacity is an unused resource for increasing productivity and sustainable agricultural production in the conditions of climate change. Given that the reform of the agrarian sector in Ukraine was carried out without taking into account the technological conditions of drainage systems operation, the established technologies of land use and management of drainage systems are currently violated. The formation of new conditions for the cultivation of agricultural crops and changes in the direction of the use of drained lands require the expansion of the functional tasks of drainage systems, which must be taken into account when carrying out the restoration (reconstruction) of drainage systems in the humid zone [52].

At the same time, literary sources testify to the importance of using agricultural drones (for example, Geoscan 201 A type), which allow solving the problems of operational decision-making regarding reclamation regimes on restored drainage systems based on the information obtained by remote determination of the drainage collectors location according to the state of vegetation [6].

The analysis of literary sources made it possible to determine the main directions that are considered when solving the problems of restoration (reconstruction) of drainage systems on agricultural lands worldwide and in Ukraine (Table 1).

Among the selected directions there is a number of developments aimed at creating economically profitable projects for the reconstruction of drainage systems, taking into account the directions of their use and possible investment options.

In general, literary sources indicate that the reconstruction of drainage systems is economically beneficial. Its average cost is 20–30 % less than the cost of new construction and allows increasing land productivity by 25–40 % [34].

The most economically expedient option is the reconstruction of systems in Ukraine with a source of financing from the equity capital of agro-industrial complex enterprises, for which the non-discounted (RR) and discounted (DPP) payback periods are 3.4 and 4.7 years, respectively [25].

1. The main directions of solving the problems of restoration (reconstruction) of drainage systems on agricultural lands worldwide and in Ukraine

Directions of restoration (reconstruction) of drainage systems	Source according to the bibliography
Expanding the functionality (water-regulating capacity) of drainage systems through their restoration (reconstruction)	[7; 19; 29; 38; 39; 40; 42; 45; 52]
Complex approaches when making decisions on restoration (reconstruction) of drainage systems	[21; 35; 36; 37]
Technical aspects of restoration (reconstruction) of drainage systems and reconstruction projects justification	[46; 48; 54; 55; 58]
Restoration of individual elements of the engineering infrastructure of drainage systems	[30; 57]
Taking into account the impact of climate change when making design decisions for the reconstruction of drainage systems	[18; 20; 22; 23; 34]
Modernization of drainage systems	[16; 17]
Features of the use of reconstructed drainage systems by agricultural enterprises	[1; 2; 5; 8; 9; 10; 11; 12; 13; 14; 15; 24; 27; 28; 30; 31; 33; 41; 42; 44; 48; 49]
Economic feasibility of drainage systems reconstruction	[9; 25; 26; 30; 32; 42; 43; 47; 50]
Ecological (nature-saving) aspects of drainage systems reconstruction	[3; 4; 5; 6; 12; 42; 44; 51; 53; 56]

It is noted that during the restoration (reconstruction) of drainage systems, it is important to take into account the possibilities of participation of international organizations, the role of beneficiaries (land users, territorial communities, associations of water users) [30]; the need to involve technologies of construction and reconstruction of systems that are certified according to international standards [28]; the expediency of application in scientific research and in the justification of projects of economic and statistical models and the importance, in addition, of compliance with normative indicators of economic and environmental efficiency.

At the same time, the need for complex reconstruction of drainage systems is substantiated by a resource-saving form of restoration of reclamation means with the maximum use of the engineering infrastructure of drainage systems and under the condition of maintaining soil fertility. The transition to a resource-saving form allows, due to the redistribution of capital investments, ensuring the growth of soil fertility, increasing the efficiency and reliability of drainage systems, land acculturation, the level of intensity of their use, and the extension of the term of their use by increasing the level of operation [32].

Conclusions. In modern conditions of climate change and military aggression (flooding of drained lands and direct destruction of individual elements of the systems), the problem of restoring drainage systems and their functional capacity acquires particular importance from the standpoint of the need to increase the productivity of drained lands and the role of Ukraine in solving the global food problem, as well as water security of Ukraine.

Based on the results of the literary sources analysis, the main directions that are considered when solving the problems of restoration (reconstruction) of drainage systems on agricultural lands worldwide and in Ukraine are determined. Approaches to the operation, maintenance, and controlled decommissioning of drainage systems are based on the development of scenarios for climate change adaptation, therefore the priority of the state policy of a number of countries is, first of all, the restoration of systems, which allows to ensure the adaptation of agricultural production to modern climate changes. Worldwide, the evaluation of the reclamation fund is mainly carried out on a permanent basis, and the need for the reconstruction and modernization of drainage systems is determined according to the design characteristics and technical condition involving the restoration of their water-regulating function.

The basis for the reconstruction of drainage systems is the economic and technical justification of feasibility, the use of progressive methods of drainage, priority for the implementation in areas of drainage systems that are in working condition, and in drained areas where intensive and medium-intensity agricultural use of drained lands is planned. The scientists' developments are aimed at creating economically viable technical options for the restoration (reconstruction) of drainage systems, which take into account the directions of their use and investment options for reconstruction.

Studying the global experience of restoration (reconstruction) of drainage systems on agricultural lands and its use is important in implementing the provisions of the "Strategy of Irrigation and Drainage in Ukraine for the period until 2030".

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ДОСВІД ВІДНОВЛЕННЯ (РЕКОНСТРУКЦІЇ) ДРЕНАЖНИХ СИСТЕМ НА ЗЕМЛЯХ СІЛЬСЬКОГОСПОДАРСЬКОГО ПРИЗНАЧЕННЯ (ОГЛЯД ПУБЛІКАЦІЙ)

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Анотація. *У статті представлено огляд публікацій з актуальної проблеми відновлення функціональної здатності дренажних систем, яка в сучасних умовах змін клімату та військової агресії набуває особливої значимості не тільки з позицій необхідності підвищення продуктивності осушуваних земель, але і забезпечення водної безпеки нашої держави. Вивчення проблем та встановлення напрямів відновлення (реконструкції) дренажних систем в Україні та регіонах світу відбулося з використанням бібліометричного аналізу. Для аналітичних досліджень вивчені вітчизняні та закордонні літературні джерела 55-річного періоду, основна кількість яких припадає на період 2002–2022 рр. Проведений аналіз дозволив визначити основні напрями, які розглядаються при вирішенні задач відновлення (реконструкції) дренажних систем на землях сільськогосподарського призначення у країнах світу та в Україні. Підходи щодо експлуатації, утримання та контрольованого вилучення з експлуатації дренажних систем базуються на розробленні сценаріїв адаптації до змін клімату, отже пріоритетом державної політики низки країн є, насамперед, відновлення систем, що дозволяє забезпечити адаптацію агровиробництва до сучасних кліматичних змін. У країнах світу оцінювання меліоративного фонду проводиться постійно, а необхідність реконструкції та модернізації дренажних систем визначається відповідно до проєктних характеристик, технічного стану і передбачає також відновлення їх водорегулюючої функції. Основою проведення реконструкції дренажних систем є економічне та технічне обґрунтування доцільності, застосування прогресивних способів осушення, першочергова реалізація відновлювальних заходів на ділянках дренажних систем, які перебувають у робочому стані, та на осушуваних територіях, де планується інтенсивне та середньої інтенсивності сільськогосподарське використання осушуваних земель. Розробки науковців спрямовані на створення економічно вигідних технічних варіантів відновлення (реконструкції) дренажних систем, які враховують напрямки їх використання та варіанти інвестицій в реконструкцію. Вивчення світового досвіду відновлення (реконструкції) дренажних систем на землях сільськогосподарського призначення та його використання є важливим при реалізації положень, які закладені у «Стратегії зрошення і дренажу в Україні на період до 2030 року».*

Ключові слова: *дренажні системи, відновлення (реконструкція) дренажних систем, осушувані землі, економічна ефективність, бібліометрічний аналіз*