Economic sciences

UDC 556.38

Serbov Mykola
Doctor of Economic Sciences, Professor
Odesa State Environmental University
Сербов Микола Георгійович
доктор економічних наук, професор
Одеський державний екологічний університет

Tkachenko Nataliia
Graduate Student of the
Odesa State Environmental University
Ткаченко Наталія Анатоліївна
аспірант
Одеського державного екологічного університету

ECONOMIC AND ENVIRONMENTAL APPROACHES TO THE DEVELOPMENT OF INTEGRATED WATER RESOURCES MANAGEMENT SYSTEMS IN A ZONE OF INSUFFICIENT MOISTURE

ЕКОНОМІКО-ЕКОЛОГІЧНІ ПІДХОДИ ДО РОЗВИТКУ СИСТЕМ УПРАВЛІННЯ ВОДНИМИ РЕСУРСАМИ В ЗОНІ НЕДОСТАТНЬОГО ЗВОЛОЖЕННЯ

Summary. *This study is devoted to the study of economic and environmental approaches to the development of an integrated water resources management system using the example of one reservoir located in the zone of insufficient moisture in the Northern Black Sea region of Ukraine. To create an integrated and sustainable management system for the basin's water resources*

and assess individual components of the water balance, methodological, statistical, economic, and environmental approaches were used.

The study area, like the entire south of Ukraine in general, belongs to the zone of insufficient moisture. The region is characterized by an increase in turbulent heat exchange between the underlying surface and the atmosphere up to 5,80 kcal/cm^2, which in turn causes a sharp increase in unproductive resource losses.

Taking into account the characteristics of the study area, the specifics of the development of its economic system and the recreational importance of the water body, the work presents the basic requirements for the development of an integrated water resources management system, which are based on the "basin principle" of constructing a management system, the horizontal and vertical hierarchy of the economic system of the basin, and the use of methodology "climate and reserve" models when assessing the resource capabilities of a territory, public participation in the management, financing, planning and development of water infrastructure, as well as the priority use of an ecosystem approach in the implementation of a scheme for integrated management of water resources in the region.

The results show that the development of an integrated water resources management system should be based on an overall calculation of all components of natural and artificial recuperators, which allows water resources to be balanced and a rational management system to be developed. It should also be noted that integrated water resource management systems in the risky farming zone, together with the development of an integrated system for the sustainable use of an extremely scarce resource, should, first of all, prevent precedents of unproductive water losses.

Key words: *integrated management, water resources, zone of insufficient moisture, water as a commodity.*

Аннотація. *Дослідження присвячено вивченню економіко-екологічних підходів до розвитку інтегрованої системи управління водними ресурсами на прикладі водного об'єкту, розташованого в зоні недостатнього зволоження Північного Причорномор'я України. Для створення інтегрованої сталої системи управління водними ресурсами басейну та оцінки окремих складових водного балансу використано методологічний, статистичний, економічний та екологічний підходи.*

Територія дослідження, як і весь південь України в цілому, відноситься до зони недостатнього зволоження. Для регіону характерне підвищення турбулентного теплообміну між підстилаючою поверхнею та атмосферою до 5,80 ккал/см^2, що в свою чергу викликає різке збільшення непродуктивних втрат ресурсів.

Враховуючи особливості досліджуваної території, специфіку розвитку її господарської системи та рекреаційне значення водного об'єкта, в роботі наведено основні вимоги до розробки інтегрованої системи управління водними ресурсами, які ґрунтуються на «басейновому принципі» побудови системи управління, горизонтальної та вертикальної ієрархії економічної системи господарського комплексу басейну, використання методології моделі «клімат-запас» при оцінці ресурсних можливостей території, участі громадськості в управлінні, фінансуванні, плануванні та розвитоку водної інфраструктури, а також пріоритетне використання екосистемного підходу в реалізації схеми комплексного управління водними ресурсами регіону.

Отримані результати показують, що розробка інтегрованої системи управління водними ресурсами має базуватися на комплексному розрахунку всіх складових природних і штучних рекуператорів, що дозволяє збалансувати водні ресурси та розробити раціональну систему управління. Слід також зазначити, що інтегровані системи управління водними ресурсами в зоні ризикованого землеробства разом із розвитком

інтегрованої системи сталого використання вкрай дефіцитного ресурсу мають, насамперед, запобігати прецедентам непродуктивних втрат води.

Ключові слова: *комплексне управління, водні ресурси, зона недостатнього зволоження, вода як товар.*

Introduction. The development of the modern civilization brought humankind to the realization that water is one of the crucial elements of the environment and requires comprehensive integrative management with regard to all types and categories of water resources on Earth, all categories of water consumers, and the consequences of manmade influence on the state of natural water. Special attention in the concept of integrative water resources management is paid to the assessment of the consequences of the manmade effect from the perspective of further existence, sustainable and effective development of water resources. At present, each person on Earth has up to 750 m3 of usable fresh water per annum [1, p. 145-146]. According to UNESCO predictions, this figure may drop to 450 m^3 on average by 2050, without regard to the predicted climate changes; this means that according to the UN classification, more than 80% of countries will find themselves beyond the water deficiency boundary [2].

Integrated water resources management may be characterized as a permanent assessment of the water balance of an area with the determination of constant trends in its changes, depending on the effect of the multilevel and manifold factors: nature and quality of economic load, both on the water body and on the water basin in general, predicted future climate changes and their effect on the characteristics of water resources in the studied area [3, p. 112-113]. The determination of the impact factors and trends in the change of water balance necessitate subsequent development of plans for integrated water management, the primary goal whereof should be to correlate the existing water

resource potential with the requirements of the economic complex of the area or the water basin [4, p. 420].

The principles of the modern concept of integrated water resources management were formulated in 1992 at the Dublin International Conference; in the following years, these principles were the basis for global reforms of water economies in many countries [1, p. 89].

It is worth noting that water quality is an integral part of the water resource potential of any area or basin, which is why the development of integrated management plans should take into consideration the environmental aspects of the assessment of water quality and the identification of individual water consumers as polluters of the water basin [5, p. 3254].

The formation of integrated freshwater resource management systems in the south of Ukraine - in a zone of insufficient moisture - has its own characteristic specifics, associated, on the one hand, with the general acute shortage of natural resources as such, and, on the other hand, with their most significant role in the development of most sectors of the national economy complex of the region.

Literature Review. The basis of the development of integrated basin water resources management is the general consideration of all the components of the natural and artificial restoration of water volume within certain areas, which enables determining the current water balance and developing plans of rational distribution of the resource in space and time [6, p. 441], including among individual water consumers, assessing the quality of water management, and controlling the permissible levels of manmade influence on the water resource potential of the basin [7, p. 36-38]. Furthermore, the development of integrative water resources management should take into consideration, in addition to the above goals, the financial and economic issues related to paid water use [8, p. 73].

With that, it is necessary to differentiate between two economic concepts – cost and payment. The cost of water is important for the rational use of the resource if it is impossible to satisfy in full the general (total) demand of water consumers with branch or territorial distribution [9]. This fact is especially important during the development of plans for an alternative use of the resource as a regulatory economic tool of integrative water resources management. Payment for water is used as an economic tool for supporting vulnerable groups of water consumers by affecting their behavior in terms of saving the natural resource and using it efficiently, stimulating the management of demand and payback of provided services, and the readiness of certain consumers to pay for additional water management services [10, p. 243-244].

The recognition of the water resource as a commodity is an effective means of decision making in the distribution of the resource among various economic sectors and industries, as well as among various water consumers within a single sector or industry. This is especially important if further increase in the consumption of the resource is virtually impossible [11].

The emergence of estuaries in the Ukrainian Black Sea region was caused by the development of the entire coastline of the Black Sea. Estuary formation is closely related to tectonic phenomena and transgressions in the Black Sea Basin [15, p. 126]. The emergence of Black Sea estuaries in the form of flooded parts of river valleys or ravines is related primarily to the flooding of river valleys by seawater due to the rising sea level and sinking land surface [12, p. 138-140].

The estuaries of the Northwestern Black Sea region are unique natural systems [13, p. 215-216] that are an important component of the country's water resources and are of great natural, recreational, and socio-economic importance for Ukraine [14, p. 18-19].

A total of 21 estuaries are located along the coast of the northwestern part of the Black Sea in the interfluve of the Danube and Dnipro. In terms of water supply, these estuaries are divided into two large groups [15, p. 95-97]:

First group – open estuaries with relatively free water exchange with the sea. This group includes:

- open estuaries with a relatively large inflow of river water (Dnister, Dnipro-Bug, etc.);
- open estuaries with an insignificant inflow of river water (Berezan);
- artificially open estuaries with an insignificant inflow of surface water (Small Adzhalyk, Sukhyi, etc.).

Second group – closed estuaries, commonly found in the Black Sea region. These water bodies were formed during the flooding of river mouths due to general geological transgression of the Northern Black Sea region coast and the rising level of the Black Sea [16, p. 56]. The water regime of such water bodies is affected by the river inflow, groundwater inflow, and surface water inflow from precipitation.

In general, the Northwestern Black Sea region and its water bodies play a special role in the development of Ukraine's economy. It is worth noting that this area hosts the largest sea and river ports of Ukraine, which handle almost 90% of the country's annual freight traffic; the routes of transport corridors No. 7 and No. 8 (railway, river, and sea) run through the northwestern part of the Ukrainian Black Sea region, which also increases the importance of this region for the sustainable development of the country's economy. However, these circumstances also cause significant manmade influence on the natural systems of this region [17, p. 67-70].

The implementation of European programs of international transport corridors and the constantly increasing traffic of international transit of natural resources allow regarding the Azov-Black-Sea Basin as a special transportation zone than connects the adjacent countries with Europe [18, p. 22-23]. It is also worth noting the considerable geo-economic interest of many countries in the Azov-Black-Sea region due to the strategic course of the European Union towards the formation of a unified European transportation system.

The Kuyalnik Estuary holds a special place among the estuaries of the Northwestern Black Sea region. The Kuyalnik Estuary is a water body that is located 8.5 km to the northwest of Odessa; in terms of its characteristics, it belongs to the second group of closed estuaries with a relatively small influence of river inflow and precipitation on its water regime.

The total catchment basin area of the Kuyalnik Estuary is 2250 km^2; the main river inflow source is the Velykyi Kuyalnik River, whose catchment basin area is 1860 km^2 (82.7% of the total catchment basin area of the estuary) with a length of 170 km. The distinguishing feature of the Kuyalnik Estuary is the considerable dependence of its morphometric characteristics on the water level. For instance, according to data provided by the Odessa State Environmental University [18, p. 22-23], the length of the estuary was 20.7 km in 2011, while in high-water seasons, it can reach 28-29 km.

The water surface area of the estuary can range from 19 to 74 km^2, depending on the water level; the width of the estuary gradually grows from the north to the south and reaches its maximum – about 3.6 km – near the Krasnoselka village; the average depth is 0.4 m; the maximum depth – 1.8-2.0 m – is found in the mouth of Kubanka River

(Assessment of Over-Years Changes in the Components of the Water Balance in the Kuyalnik Estuary for Drawing Recommendations Regarding the Preservation of Its Natural Resources, 2009). The admission space of the Kuyalnik Estuary can go up to 370 million m^3; however, in recent years (2009-2012), it was 18.8-20.0 million m^3 at most. Another distinguishing feature of the Kuyalnik Estuary is the intensive siltation of the water body basin. For instance, the volume of the estuary reduced by 13.0 million m^3 from 1975 to 2009 due to siltation of the areas with the minimum water level, *i.e.* the average intensity of the estuary volume reduction during the last three decades was 0.38 million m^3 per annum.

The Kuyalnik Estuary is known as a recreational and balneal object of national and world importance. The mud and brine from the estuary has medical properties.

The purpose of this research is to analyze the economic and environmental approaches to developing a system of integrated water resources management in the Kuyalnik Estuary basin.

Methods. The research used the ecosystem approach, which was based on the notion that 'nature is an equal partner'. This premise necessitates the determination of the maximum permissible level of manmade influence on water resources, with a view to ensuring their sustainability and minimizing the negative consequences of interaction between water sources and areas used for economic purposes. Estimate indicators of the water balance of the Kuyalnik Estuary basin in the system of integrated management of water resources were determined based on estimated characteristics of the 'climate and stock' model. Their substantial transformation under the effect of water management, as well as short-term reports regarding the hydro-meteorological characteristics of the Kuyalnik Estuary were taken into consideration.

Results. The design of a system of integrated basin water resources management is based on a number of key principles [11]. It should be noted the study area, like the entire south of Ukraine in general, it belongs to the zone of insufficient moisture. The region is characterized by an increase in turbulent heat exchange between the underlying surface and the atmosphere up to 5.80 kcal/cm^2, which in turn causes a sharp increase in unproductive resource losses.

Taking into consideration the features of the studied area, the specificity of the development of its economic system, and the recreational importance of the waterbody, the system of integrated water resources management for the Kuyalnik Estuary should be based on the following requirements:

1. Integrated management should follow the 'basin principle' within the hydrographical borders in accordance with the basin morphology, *i.e.* the water

resource potential is assessed across the entire catchment basin area of 2250 km^2 without distinguishing as separate zones (regions, waterbodies) any components of the area regardless of their geographic location in the basin, landscape, peculiarities of development, presence of hydraulic facilities, etc. [8, p. 53-54; 11; 18, p. 22]. The system of integrated management should take into account the entire set of factors that constitute the water balance equations for the area (possible water exchange with the sea, inflow of river and surface water, precipitation, groundwater, evaporation, and wastewater). The Kuyalnik Estuary basin can be divided into morphologically homogenous sections that have approximately similar levels of effect of separate water balance components. The water resource potential was assessed in each section of the estuary basin with regard to the features of the water balance, which ultimately combined to form a unified system of the entire basin. For instance, the total catchment basin of the Kuyalnik Estuary can be divided into at least three sections: the basin of the Velykyi Kuyalnik River, the Kuyalnik Estuary itself with adjacent 200-250 m shorelines, and the lower (southern) part of the basin – bar lakes and the Korsuntsi ponds; the entire scope of abovementioned works was done in all these sections; in the final variant, they will be presented as a unified water balance.

2. Coordination of all forms of water use within the Kuyalnik Estuary basin and for all economic facilities (water consumers) horizontally among separate branches of the economic system (agriculture, utilities, manufacturing, recreation, etc.) and vertically among various levels of the water management hierarchy (higher hierarchy – the basin in general, with subsequent division into systems of a lower hierarchy of natural resource use, down to individual small private water consumers). The water basin of the Kuyalnik Estuary is characterized by a high level of agricultural development of the area – about 48-50%. Agricultural land constitutes about 81% (184.9 thousand ha) of the total area of the basin, 74.8% of which is arable land. Within the shorelines of basin

waterbodies, the composition of the land is as follows: arable land – 14%, hayfields – 16%, pastures – 29%, smallholdings – 20%, forests, woodland belts, and bushland – 9%, other land – 12% [21, p. 49-53]. Industrial facilities in the Kuyalnik Estuary mostly include agricultural processing facilities and several quarries of building materials [7, p. 34]. The coordination of the main water consumers in the system of integrated water resources management in the Kuyalnik Estuary basin should take into consideration the active use of water resources in this area, which is 60-100% of the annual basin river flow. Studies [7, p. 21] show that the total annual demand for the resource in the Kuyalnik Estuary basin is about 12.5 million m^3, while the consumptive use is about 9.32 million m^3. With that, the annual withdrawal of water by various consumers is as follows: 5.84 million m^3 from the Velykyi Kuyalnik River; 0.46 million m^3 from reservoirs and ponds; 6.19 million m^3 from underground sources. The discharge of return water is about 3.16 million m^3. Volleys of sewage from the city of Podilsk are discharged periodically through the Korozeya ravine.

3. The estimated components of the water balance of the Kuyalnik Estuary basin in the system of integrated water resources management with regard to their significant transformation under the effect of water management and relatively short-term monitoring of hydro-meteorological characteristics were determined based on the estimated characteristics of the 'climate and stock' model [12, p. 143, 176].

The assessment of the inflow of fresh water in the Kuyalnik Estuary basin based on the 'climate and stock' model shows that most of it comes from the inflow of Velykyi Kuyalnik River. The total volume of the river inflow in natural conditions (unmodified by water management) is about 24.0 million m^3; 22.3 million m^3 (92.9%) of this volume comes from the Velykyi Kuyalnik River [20, p. 1155]. The average over-years amount of water inflow from precipitation is about 26.6 million m^3; however, considering the loss due to evaporation from

the water surface, the volume of the estuary is replenished annually only by 2.24 million m^3.

At that, the various investigated scenarios of global warming show that in the near future, evaporation from the water surface of the Kuyalnik Estuary will exceed the inflow of precipitation to its surface significantly. The main factor in water management in the Kuyalnik Estuary basin are artificial water bodies, which serve as artificial evaporators in areas with moisture shortage. According to different sources, the relative area of the water surface of artificial water bodies varies from 0.20% to 0.40%. At that, the consumptive interception of the river flow can reach 40% in low-water years, while dropping to 10% in high-water years. Most artificial water bodies within the studied area are presently dried-up, while their negative effect on the formation of the river water inflow into the estuary reaches its peak in the warm season during snowmelt and rain showers, when in medium-water and high-water years, up to 35-40% of the river flow is consumed to fill these water bodies, while in low-water years, these consumptive losses may reach 90% of the natural flow.

4. Public participation in management, funding, planning, and development of the water economy infrastructure.

Public participation implies the participation of not only public organizations and associations, but also local authorities, self-government agencies, and municipal water consumers. Public participation should create a transparent and open environment, in which the possibility of making a decision that goes against the interests of the local communities is reduced significantly.

5. Priority of environmental requirements in the activity of governing bodies during the implementation of the system of integrated water resources management in the Kuyalnik Estuary basin. The ecosystem approach is based on an important notion – 'nature is an equal partner'. This premise necessitates the determination of the maximum permissible level of manmade influence on water resources, with a view to ensuring their sustainability and minimizing the

negative consequences of interaction between water sources and areas used for economic purposes [14, p. 20; 17, p. 87, 115].

Discussion. According to S. Romashchenko *et al.* [18], Ukraine has no regions in which the use of the water resource potential is lower than the environmentally permissible level. In eight oblasts, this level is critical (0.30); in the Zhytomyr, Kharkiv, Luhansk, and Donetsk Oblasts, this index is 1.0, 1.60, 1.40, and 1.20, respectively, which means that water management in these administrative territories of Ukraine uses water resources generated in other territories. In the Odessa Oblast, where the Kuyalnik Estuary basin is located, the index of water resource potential use is 0.50, which exceeds the critical value.

Using the ecosystem approach when developing the system of integrated water resources management in the Kuyalnik Estuary basin is necessary due to the unique natural and landscape systems in this area, the concentration of various steppe, petrophyte, shrub, and semi-aquatic field biocenoses and the expedience of creating a national natural park within the area of the water basin in the near future.

It is also worth noting that the Kuyalnik Estuary and its adjacent areas are used based on the principles of balanced development, *i.e.* with regard to the environmental, economic, and social components. After signing the Ukraine-European Union Association Agreement, Ukraine took upon itself to implement in the environmental laws a number of directives, six of which concern the quality of water and water resources management. Therefore, the rational use of water resources of the estuary and the preservation of its ecosystems should be the foundation of the systems for managing this object.

Water should be defined as a commodity with economic and social value that is determined by its importance.

Managing the water resources of the Kuyalnik Estuary as a socioeconomic commodity is a means of achieving not only financial and

economic goals of sustainable development of separate regions and the country in general, but also social goals related to effective and equal water use, encouragement of saving and protection of water resources.

The 'polluter pays' approach is the basic principle of the European environmental policy. The guarantees of adequate compensation for the cost of water consuming and water using services, including environmental and resource costs, are provided by the national legal groundwork. However, it is possible to reduce the cost of restoration of water resources on the basis of economic, environmental, and social considerations, with regard to geographic conditions and climate.

Informational support of the management system, economic and financial stability of the support of the system of integrated water resources management.

The environmental component of the model of integrative water resources management in the Kuyalnik Estuary should be a priority as an integral part of the water resource potential of the area. It is necessary to consider that the deterioration of water quality reduces the economic and social cost of the basin's water resource potential, reduces the economic attractiveness of the area, and narrows down the possibilities of sustainable development significantly.

Conclusion. Integrated water resource management systems in the zone of risky agriculture, together with the development of an integrated system for the sustainable use of an extremely scarce resource, should, first of all, prevent precedents of unproductive water losses in various distribution systems.

The development of a system of integrated water resources management should be based on the general calculation of all the components of natural and artificial water restorers, which enables balancing water resources and developing a rational system of management. The environmental component of the model of integrative water resources management in the Kuyalnik Estuary should be a priority as an integral part of the water resource potential of the area. It is necessary to consider that the deterioration of water quality reduces the

economic and social cost of the basin's water resource potential and reduces the economic attractiveness of the area. This narrows down the possibilities of sustainable development significantly.

The methodological economic and environmental approaches to the creation of a system of integrated water resources management in the Kuyalnik Estuary basin were investigated. Specific components of the basin water balance were assessed.

The impact factors and trends in the change of water balance necessitate subsequent development of plans for integrated water management, the primary goal whereof should be to correlate the existing water resource potential with the requirements of the economic complex of the area or the water basin.

References

1. Solanes M., Gonzales-Villareal F. The Dublin Principles for Water as Reflected in a Comparative Assessment of Institutional and Legal Arrangements for Integrated Water Resources Management. TEC Background Paper 3. Stockholm: Global Water Partnership. 1999. 347 p.
2. UNESCO-WWAP. Water a Shared Responsibility. The UN World Water Development Report 2. 2006.
3. De Maria S.C. Water balance implications of switching from continuous submergence to flush irrigation in a rice-growing district. *Agricultural Water Management*. 2016. 171. P. 108-119.
4. Cheng G. Integrated study of the water ecosystem economy in the Heihe River Basin. *National Science Review*. 2014. 1(3). P. 413-428.
5. Haddeland I. Global water resources affected by human interventions and climate change. *Proceedings of the National Academy of Sciences*. 2014. 111(9). P. 3251-3256.

6. Reed P.M. Evolutionary multiobjective optimization in water resources: The past, present, and future. *Advances in water resources.* 2013. 51. P. 438-456.
7. Report on Research: Assessment of Over-Years Changes in the Components of the Water Balance in the Kuyalnik Estuary for Drawing Recommendations Regarding the Preservation of Its Natural Resources. Odessa: Odessa State Environmental University. 2009. 90 p.
8. Plans of Integrated Water Resources Management: Study Guide and Manual. *Cap Net.* 2005. 104 p.
9. Huang J., Hu, Y., Qiao Y. Study on the Water Right and Water Market Construction of the Yellow River. *Yellow River.* 2013. 7: 016.
10. Serbov M. Methodological approaches to the development of a system integrated water resources management of territories (on the example of the estuaries of the Northern Black Sea region of Ukraine). *Наукові інновації та передові технології. Economics Series.* 2022. № 4(6). P. 239-250 doi: https://doi.org/10.52058/2786-5274-2022-4(6).
11. Stashuk V.A., Romashchenko V.I., Mikhaylov Yu.O. The Features of Integrated Water Resources Management in Ukraine based on the Basin Principle. *Collection of Materials of the International Coordination Water Management Commission.* 2012. 15. 9 p.
12. Loboda N.S., Hopchenko Ye.D., Kuza A.M., Bozhok Iu.V. Assessment of the Fresh Water Inflow to the Estuaries of the Northwestern Black Sea Region. *Estuaries of the Northwestern Black Sea Region: Relevant Hydro-Ecological Problems and Ways of Solving Them.* Odessa: Odessa State Environmental University, 2012. 264 p.
13. Yachina N.P. *et al*. The Method of the Content Selection for Formation of Technological Culture among Students Based on Ethnological Values. *International Electronic Journal of Mathematics Education*. 2016. 11(1). P. 211-219.

14. Berlinskiy N.A., Garkavaya G.P., Bogatova Yu.I. Problems of Man-Induced Eutrophication and Development of Hypoxia in the Northwestern Part of the Black Sea. *Sea Ecology*. 2003. 6. P. 17-22.
15. Polishchuk V.S., Zambriborshch F.S., Timchenko V.M. Estuaries of the Northern Black Sea Region: Monograph. Kyiv: Scientific Thought. 1990. 224 p.
16. Balabanov I.P., Izmaylov Ya.A. Changes in the Level and Hydro-Chemical Regime of the Black and Azov Sea during the Last Twenty Thousand Years. *Water Resources*. 1988. 6. P. 54-62.
17. Tuchkovenko Yu.S., Ivanov V.A., Sapko O.Yu. Assessment of the Effect of Coastline Manmade Sources on the Water Quality in the Odessa Region of the Northwestern Part of the Black Sea. Odessa-Sevastopol: Odessa State Environmental University. 2011. 169 p.
18. Romashchenko V.I., Mikhaylov Yu.O., Stashuk V.A. Territorial Organization of Water Resources Management. *Reclamation and Water Management*. 2014. 90. P. 22-23.
19. The Scientific Groundwork for the Protection and Rational Use of Irrigated Land in Ukraine. Kyiv: Agrarian Science, 2009. 624 p.
20. Serbov M. Economic and Environmental Approachers to Developing a System of Integrated Water Resources Management in the Kuyalnik Estuary Basin. *Advanced Research in Law and Economics*. 2016. V. YII, 5(19). P. 1153-1159.
21. Report on Research: The State of the Hydrographic Border of the Velykyi Kuyalnik River under Water Management Transformations in its Catchment Basin. Odessa: Odessa State Environmental University. 2017. 165 p.