ZIBELINE INTERNATIONAL™ PUBLISHING

Water Conservation & Management (WCM)

DOI: http://doi.org/10.26480/wcm.02.2024.150.155

ISSN: 2523-5664 (Print)
ISSN: 2523-5672 (Online)
CODEN: WCMABD

REVIEW ARTICLE

MODERN PROBLEMS OF WATER RESOURCES AND WAYS TO SOLVE THEM: THE CASE OF KAZAKHSTAN

Gulnur Baidauletova[a], Saira Yessimzhanova[b], Madina Beisenova[c], Ainur Yesbolova[a*], Lesbek Taizhanov[d]

[a] Department of Economics, M. Auezov South Kazakhstan University, Shymkent, Republic of Kazakhstan
[b] Department of Management and Business, University of International Business, Almaty, Republic of Kazakhstan
[c] Department of Management and Marketing, M. Auezov South Kazakhstan University, Shymkent, Republic of Kazakhstan
[d] Department of Economics, Khoja Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Republic of Kazakhstan
****Corresponding Author Email: ainur_yesbol11@outlook.com***

ARTICLE DETAILS

Article History:

Received 23 September 2023
Revised 15 October 2023
Accepted 24 November 2023
Available online 27 November 2023

ABSTRACT

The article discusses the problems of water resources, as well as various ways to solve these problems. The ecological, economic, social and political aspects are considered of the growing global water crisis and the possibilities of the Republic of Kazakhstan when solving the problems of water scarcity. International and national water management were analysed. The methodology is developed and the procedures for coordinating water use strategies are proposed in conditions of uncertainty and the corresponding complexes of mathematical models, in which, along with the volumes of water resources actually received by water users, there are approximate values of virtual resources ("guaranteed" volumes). Coordination is presented of water use strategies in hierarchical structures and systems using transboundary water bodies. The substantiation is given of long-term strategies of water use and planning of water protection measures, as well as strategies for managing the joint use of surface and underground water. Approaches were developed to form water use and sanitation markets. The methodological foundations of the formation of natural rent and the stability of the functioning of water management systems are studied.

KEYWORDS

Water Scarcity, Industrial Production, River Basin, Sustainable Development.

1. INTRODUCTION

The shortage of fresh water becomes a factor constraining the economic growth of many countries, and therefore, the cause of economic, social, and then political instability, which cannot be kept within the borders of one country in the modern world (Nazarbayev, 2012; Yessymkhanova et al., 2021; Environmental protection, 2021; Moldasheva et al., 2023). This determines the global nature of the problem of water scarcity, despite the fact that economically developed countries have managed to build the structure of the real sector of their economies so that dependence on them practically does not affect the pace of economic development even in cases where they do not have significant water resources. This experience is of great importance. It shows that the problem of fresh water shortage can be solved in principle. Its solution depends on whether modern civilization will be able to realise its responsibility to the future and make reasonable use of the enormous opportunities that it already has today thanks to scientific and technological progress and the unprecedented development of productive forces in rich countries (Liu et al., 2020; Myrzahmetov et al., 2019).

However, no matter how significant scientific, technical and economic achievements are, they must be able to manage them wisely. This requires methods of water resources management that meet the modern level of science. These methods should provide forecasts of changes in available resources, rational determination of the need for them and their effective distribution among users, and all three aspects mentioned are different, but closely interrelated aspects of a single interdisciplinary problem complex (Water, water (not) everywhere , 2016; Umirzakov, 2016). The formulation of its constituent tasks requires consistency, the only way to ensure that the solution of each particular task corresponds to a common goal, a kind of "supertask" – overcoming water scarcity based on the principles of sustainable development, such a solution to this global problem that would contribute to the harmonization of relations and interactions between countries, and not exacerbate economic and political contradictions (How is the water issue, 2019; Danilov-Danilyan, 2020; Theodore and Dupont, 2019).

It is unlikely that a water resources management system should be thought of on the global scale as a single "technical project" developed in all details and resembling either a flight schedule at a good airport or an instruction manual for a complex device. Rather, it should be a set of fundamental principles that must be followed when setting individual tasks, a list of factors whose significance must be understood in each specific case to select the essential ones for it, a register of tools that can be effectively used to solve, first of all, mathematical models. Of course, the set of principles, the list of factors, and the register of funds will always be open, replenished and modified, it cannot be otherwise for problems of such high complexity as water resources management (Schweitzer and Noblet, 2018; Subhoni et al., 2018; Alimbaev et al., 2021).

Both positive and negative experience of water management and, as they say in recent years, integrated water resources management allow us to note some of the most important features of amanagement object and the consequences that follow from them for the construction and selection of management tools.

Quick Response Code	Access this article online	
	Website: www.watconman.org	**DOI:** 10.26480/wcm.02.2024.150.155

Cite The Article: Gulnur Baidauletova, Saira Yessimzhanova, Madina Beisenova, Ainur Yesbolova, Lesbek Taizhanov (2024). Modern Problems of Water Resources and Ways to Solve Them: The Case of Kazakhstan. *Water Conservation & Management, 8(2): 150-155.*

The need for an integrated and interdisciplinary approach has already been mentioned above. It is largely determined by such a property of the management object as its stochasticity, moreover, the uncertainty of the occurring processes both natural, united by the concepts of the hydrological cycle, water balance, ecological balance, climate change, and socio-economic, depending on market conditions, production location, scientific and technical shifts, social factors, political games, etc. (Doroshkevich et al., 2017; Gudkov et al., 2017).The consequence of all these circumstances is the expediency of focusing on the formalisation of emerging problems using stochastic programming with the mandatory use of deterministic problems, a combination of dynamic and static approaches, continuous and discrete models.

The huge number and variety of water users, fundamentally different ways of using surface water bodies and underground water deposits, the "embeddedness" of water users in various administrative and economic structures and "contours" force them to rely on the principle of "open" management, on the development of a plan as a game of many participants with non-contradictory interests (Mazakov et al., 2020). The scope and complexity of the system make it inevitable to consider it as hierarchically organised, more precisely, poly-hierarchical, since several hierarchies are manifested and synthesised in it: the natural hierarchy of the river system, the administrative hierarchy, the temporal hierarchy, dictated by the need (more than anywhere else) to consider both ultra-long-term aspects of development and super-operational measures to respond to situations associated with the negative impact of waters with all intermediate horizons and periods (Pichakhchi and Saenko, 2020; Water resources and food security, 2015; Subbotina, 2020).

The interactive application of all formal components of a water resources management system (super system) is the most important consequence of this forced accumulation of difficulties. In fact, this super system should be a legally defined administrative structure with a complex of decision-making support systems, with all the powers and responsibilities of each of its links. Such super systems are the matter of the future (first at the level of basin administrations, then at the federal level, and someday, perhaps, at the international level).

In all the tasks solved in this work, water resources management takes place within the framework of natural and technical complexes i.e., water management systems (WMS), which are infrastructure elements that meet the needs of society in water resources. The coordination of water use strategies is considered under the uncertainty of hydrological, environmental and socio-economic conditions. The peculiarity of the methodological approach to the development of coordinated strategies for managing water resources under conditions of uncertainty, developed in this paper, is the consideration, along with the volumes of real water resources, their benchmarks (guaranteed values), which act as virtual resources that affect the economic activity of water resources and related systems. This approach made it possible to develop management strategies that are adaptable to possible changes in the conditions of functioning and development of the WMS.

The formalised representation of the analysed and solved problems of coordinating water use strategies is based on the flow structure of the WMS, in which there is a network with flows of water and impurities. The functioning and development of the WMS are described by nonlinear two-stage tasks of stochastic programming and management, where landmark flows play the role of strategic variables (the first stage), the flows corresponding to the realised expenditures and volumes of water resources and the masses of impurities act as tactical variables (the second stage). In the problems under consideration, the random processes of water supply and use are approximated by a finite set of options. Depending on the class of problems under consideration, the dynamics of the WMS is presented in a static formulation, in discrete or continuous time.

Since Kazakhstan is a country dominated by steppes and arid climate, the problem of access to water resources and their protection is the most urgent. This article reveals both the advantages and disadvantages of the current state of the water resources of Kazakhstan, since the entire water body of the country can directly affect the water resources of Central Asia. Insufficient protection of water resources can have dire consequences for the entire Central Asian region, namely: water pollution, lack of aquatic fauna, limited access to water resources for civil purposes.

The purpose of this article is to analyze the current state of water resources in Kazakhstan, to study the level of water pollution and the vectors for solving this problem.

2. Materials and Methods

With the growth of industrial production and environmental pollution, people's access is reduced to usable sources of fresh water. The solution to the problem lies in the development and implementation of new technologies and management mechanisms, as well as in a more conscious approach to nature. Two-thirds of our planet is occupied by water. This is more than enough for all people, but the preservation of water is a global problem for humanity. The thing is that most of the water resources are unsuitable for drinking – it is a salty liquid, and humanity needs fresh water not only to drink but also for growing crops and fattening livestock.

There are solutions to this problem. Saving a resource is the first and simplest. This will give much more significant results than it seems at first glance, allowing not to develop new water deposits. Cleaning technologies are the second way to save money, which will allow you to repeatedly use this important resource. Water protection from pollution due to urbanisation is the third because pollution causes great harm to the entire ecosystem. To this end, Governments develop joint programmes that prevent waste dumping into water bodies and involve the installation of treatment facilities at all industrial enterprises. But the use of glaciers, which were previously proposed as an alternative source of fresh liquid, according to experts, can lead to irreversible climate changes.

At the same time, the growth of the world's population, the widespread development of irrigation and drainage, as well as the acceleration of industrialization have led to an increase in the use of an increasing number of already limited fresh water resources. The issues are relevant to the protection and rational use of water resources in the Republic. Water supply is one of the strategic state tasks. Having a vast territory, a diversified national economic complex, the Republic experiences insufficient and uneven provision of water resources.

There are eight river basins in Kazakhstan: Balkhash-Alakol, Shu-Talas, Aral-Syrdarya, Ural-Caspian, Tobol-Torgai, Ishim, Irtysh and Nura-Sarysu. At the same time, seven basins are transboundary, except for the Nura-Sarysu basin. The eastern region accounts for 34.5% of resources, the south-eastern region for 24.1, the southern region for 21.2, the western region for 13.4, the northern region for 4.2, the central region for 2.6%. The East Kazakhstan region is the most provided with water – 290 thousand m^3 per km^2. At the same time, there is an acute shortage in Atyrau, Kyzylorda and especially Mangistau regions, where there are practically no sources of fresh water (Nazarbayev, 2012; Yessymkhanova et al., 2021).

3. Results and Discussion

3.1 Territorial Comparison of Water Resources and Methods of Their Protection

Let's consider the volume of water resources formed on the territory of the Republic of Kazakhstan and from neighbouring states in Figure 1.

It follows from Figure 1 that the surface water resources of Kazakhstan on average in terms of water content per year amount to 122,900 km^3, of which only 66,500 km^3 is formed on the territory of the republic. The remaining volume of water – 42,600 km^3 - comes from neighbouring countries: 18.9 $km^3$from China, 14.6 km^3 from Uzbekistan, 7.5 km^3 from Russia, etc. It should be noted that since 2015, the volume of water resources has been falling. At the same time, the flow is still reduced more from neighbouring countries.

It can be seen from Figure 1 that, comparing the values of determination $R^2$for calculating the forecast values of the volume of water resources in the country for the future, a power equation should be used $y = 111489x^{0,0521}$, where R^2= 0.2117. The forecast values of the volume of water resources formed in the territories of the Republic of Kazakhstan in the total volume of water resources of formations for the future reflects the trend equation $y = -739{,}29x^2 + 5597{,}9x + 59520$, where R^2= 0.1888. The reserves of underground water resources increased slightly – 200 thousand m^3 for the period from 2014 to 2019 (Figure 2).

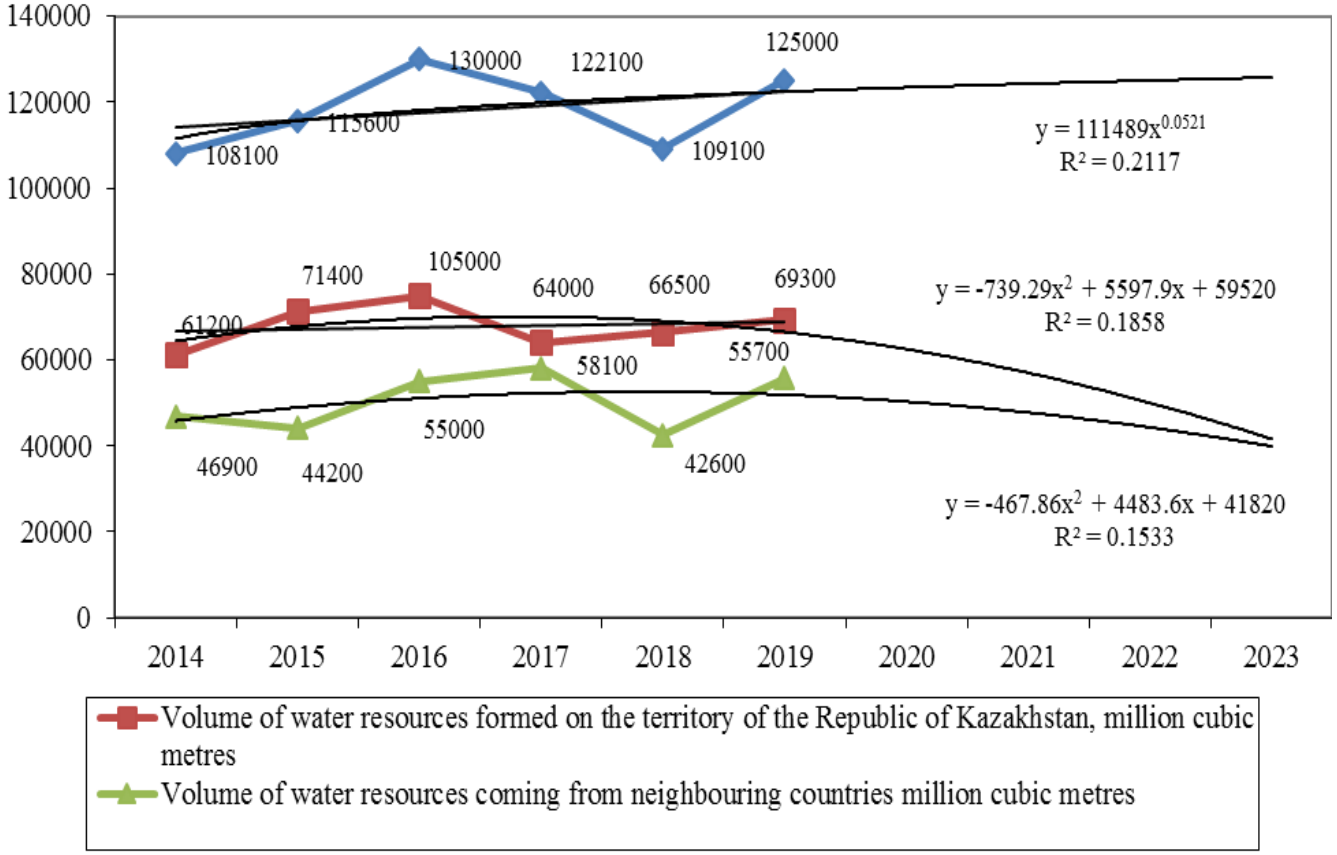

Figure 1: Volume of water resources in the Republic of Kazakhstan

*(Environmental protection, 2021).

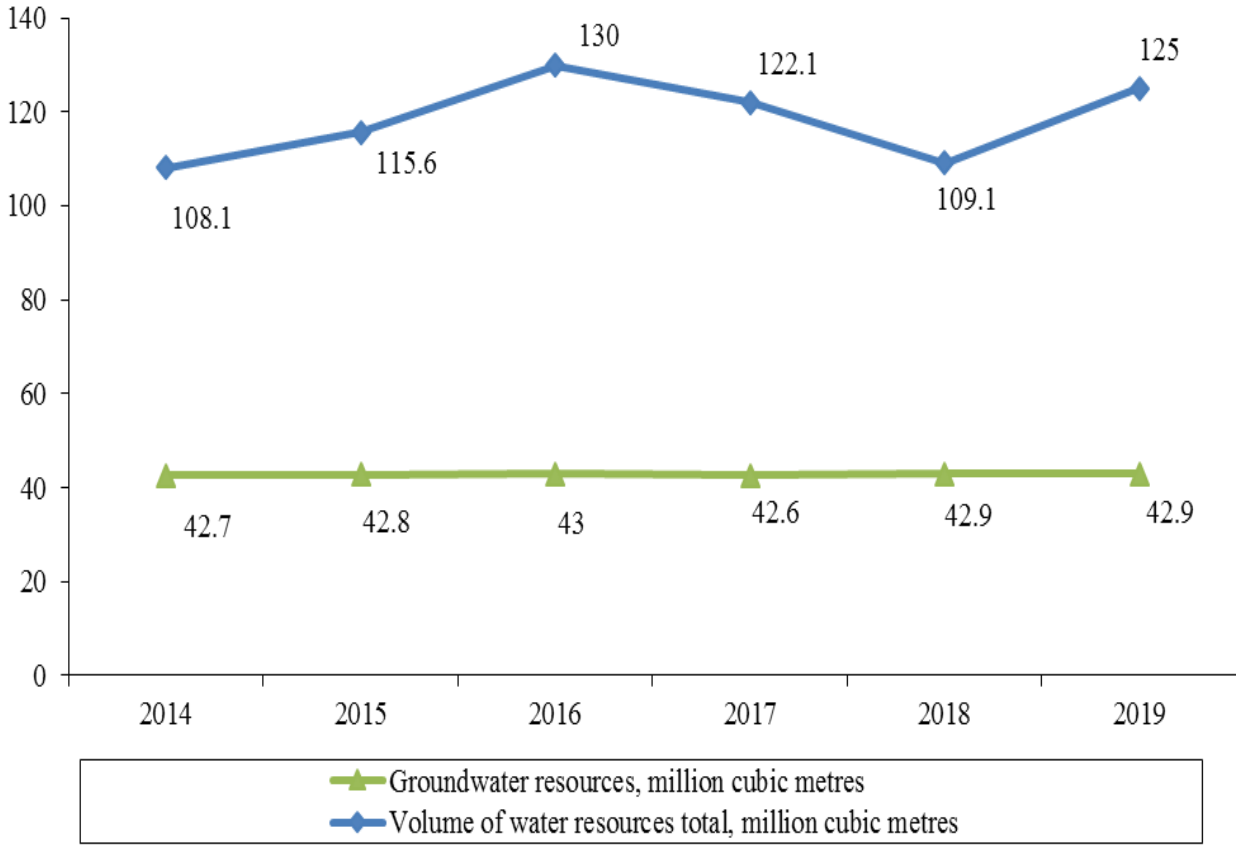

Figure 2: Underground water resources

*(Environmental protection, 2021).

At the same time, with the republic's water demand of 100 km³ per year, the existing supply is 30.3 km³ (Figure 3).

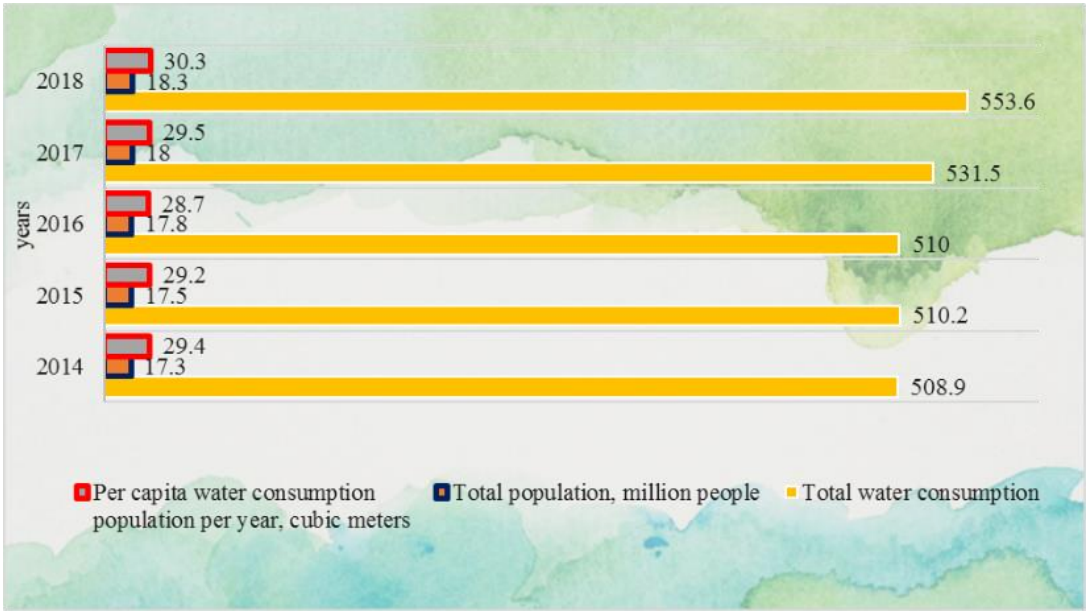

Figure 3: Total water consumption in Kazakhstan

*(Environmental protection, 2021).

Figure 3 shows that against the background of an increase in the population in Kazakhstan by 1.0 million people for the period 2014-2019, the total water consumption, including municipal water supply and self-sufficiency, increased by 44.7 million cubic meters/year.

Economic growth and population growth cause a gradual increase in the need for water resources. Water is vital both for ensuring full-fledged daily activity and for the high-quality implementation of production tasks. A decrease in the volume of water consumed can cause a drop in the pace of economic development. Not so long ago, a report was published by the organisation responsible for the development of fundamental principles for the use of water resources at the World Bank, which was called "Hot and dry: climate change, water resources and the economy". According to the presented data, water scarcity can cause a drop in economic growth rates in some regions by 6% of the current GDP in the future until 2050 (Liu et al., 2020; Myrzahmetov et al., 2019). At the same time, it is planned to introduce economically justified tariffs that ensure the return of investment taking into account low tariffs for irrigation water in Kazakhstan, which do not allow covering the costs of reconstruction and repair of canals and hydraulic structures. These measures will be supported by the state in the form of subsidies for irrigation water supply services (Water, water (not) everywhere ..., 2016; Umirzakov, 2016; How is the water issue...., 2019).

This problem can be effectively solved by several methods: from supplying usable water in larger volumes than before to large-scale desalination of seawater. In addition, it is supposed to be guided by criteria of an economic, environmental and social nature when organising water use processes, to increase their overall efficiency and rationality. When it is impossible to discover and develop new sources of usable water, the task comes to the fore of ensuring the effective management of existing water resources. The measures taken at the state level can and should lead to the implementation of programs that provide a qualitatively new solution to this issue that can fully meet the needs of all water users. The increase in demand for water, combined with the extensive growth of the world economy, has become the causes of crisis phenomena in the field of water use, which are also aggravated by large-scale harmful emissions of industrial waste into reservoirs and violations of water use rules. Healthy market relations are designed to become the key to improving the overall efficiency of water use and the quality of water resources management against the background of a gradual transition from an administrative management model to economic methods, taking into account modern market realities.

3.2 Administrative Protection of Water Resources: Current State, Methods, Further Development

Administrative measures are the most effective mechanism for ensuring their preservation in the conditions of the state monopoly on the management of natural resources aimed at controlling and managing the state's water resources, combined with measures of economic impact. Management powers are differentiated at different levels, which ensures the timely attraction of financial resources to ensure the timely implementation of a set of measures to protect the water sector from uncontrolled emissions of harmful substances. The development and phased implementation of a set of measures contribute to a gradual reduction of pollution of water management facilities and solve the problems of water regeneration, in conditions of excessive human influence (Asgerov et al., 2022).

The state bodies should ensure the timely implementation of the above-mentioned measures and are responsible for the state of water management facilities and the timely implementation of environmental control on them. However, this becomes fully possible only with the participation of local self-government bodies, public organisations and representatives of the business community. The involvement of the latter is extremely important from the economic point of view since it has not yet had analogues in the Kazakh realities and requires the practical application of the accumulated foreign experience in this area. The timely implementation of a set of measures aimed at combining the efforts of various management bodies is limited by the discrepancy between the boundaries of water bodies and the adopted rules of territorial division into administrative responsibility areas. It is necessary to coordinate the issues of allocating funds at different levels to meet the needs of water management facilities in the specified regions.

It is possible to note the following main problematic issues of water management of the state and the choice of methods for their practical resolution.

1. The improvement of the activities of the water bodies management structure in Kazakhstan should be carried out in several main directions at once:

- accurately determine the role and composition of management organisations (in the main areas of territorial responsibility);
- strictly delineate the roles, rights and responsibilities of state bodies that solve issues of monitoring the state of water bodies and their practical use;
- development and implementation of interaction methods of all state structures involved in the process.

Consistent implementation of reforms in the country's water management system is impossible without timely strengthening the positions of local self-government bodies, with powers to them to attract a wide range of business partners and collective coordination of decisions taken.

2. Based on the geographical division of river basins and recognised as the main one in water use, the principle of water bodies management, makes

it possible to take into account all the difficulties of managing the state's water resources, taking into account various aspects of economic and social activity. At the state level, it is necessary to work out a clear definition of status, duties, rights and responsibilities.

3. Consistent improvement of the system of compensation for losses incurred due to the negative impact on water bodies can be carried out by:

- reducing the total volume of harmful substances subject to classification as polluting water bodies;
- using optimal technological solutions that allow you to effectively determine the intervals of changes in the rates of basic payments.

Payments should ensure the fullest possible coverage of the costs caused by the problems of their assessment, calculation and collection.

Carrying out mutual settlements to cover the costs associated with the pollution of water bodies is caused by a significant number of polluting elements, as well as their discharge points, in addition, the complexity of determining the parameters of the calculation system should be taken into account. The main difficulty lies in the need to allocate a given volume of pollutants with their further tracking. If there are insignificant volumes of toxic substances dumping, it is not necessary to carry out their system monitoring, you can limit yourself to fixing the volumes of harmful emissions and the terms of payment of costs caused by them.

Many questions are raised by the determination of the maximum permissible parameters of harmful effects on the objects of the water management system. The best option is to use a technology in which a given amount of pollutants is used as a separator between the amounts of payments that compensate for the consequences of negative impact. The introduction of material compensation for environmental pollution is not enough, it requires a system of fines for law violations in the field of environmental protection. It is irrational to focus on accepting small payments for such violations, much more optimal should be considered the introduction of an environmental tax on manufactured products, like economically developed states.

4. It is necessary to legally consolidate the sequence of mutual settlements for the use of water resources at the state level, including legislative consolidation of adjustments made to the basin level taking into account these conditions.

5. It is advisable to form targeted, budgetary funds of water resources to accumulate funds received by accepting payments for their use. The current lack of them causes the need to raise finance to improve the current state of water management mainly from the republican budget.

6. Improving the water management system results from the improvement of the legislation of the Republic of Kazakhstan in the field of protection of water bodies and natural resources. The issues of planning large-scale and costly events are not affected. At the same time, the optimisation of such costs can lead to budget savings in the amounts of 25-40%. When designing dams, this parameter is 8-12%.

Consistent improvement of the water bodies management system requires the development and the subsequent implementation at the state level of an integrated management system, involving the latest electronic computing systems, based on mathematical, hydrological and environmental models. This requires attracting budget funds for new equipment, conducting necessary research and training personnel. The difficulties of financing are associated with a lack of understanding of the importance of this issue at the state level. The quality of water resources management will consistently decrease in the country without the necessary support from the state. Otherwise, it will be simply unrealistic to achieve a successful resolution of all the tasks set. The high-quality optimisation makes it possible to effectively solve the problems of choosing the most effective methods for the development of water resources management systems and carrying out measures to protect the water sector from pollution. This affects not only the state of the water economy of Kazakhstan but also the development of adjacent territories, primarily allocated to the needs of the agricultural and industrial sectors of the national economy.

In matters of legislative regulation of these issues, first of all, attention should be paid to:

- protection priorities of water bodies and management of their subsequent development;
- legal protection of the water bodies management system;
- regional regulatory bodies of the Republic of Kazakhstan responsible for monitoring the implementation of the current legislation in the field of ensuring the activities of water management facilities;
- providing representatives of public formations with access to monitoring systems for the rational use and protection of water resources.

Competent use of available water resources is extremely important for any state, at any stage of its economic development. Protection of water from pollution by industrial facilities plays a decisive role in this context, which implies the need to implement a set of measures for wastewater treatment (Kuybida et al., 2019). Industrial enterprises that are the least polluting should gradually reduce the tariff for the emission of pollutants, which will stimulate the reduction of such emissions in the future. In this context, a high-quality legislative framework is a basis that could guarantee reliable legal protection of the environment from harmful emissions, which is very difficult in the modern economic realities of the Republic of Kazakhstan.

4. Conclusions

To improve the efficiency of water use management on the territory of Kazakhstan, it is advisable to introduce such measures: formation of the procedure for issuing special permits for conducting harmful emissions into the atmosphere and water management facilities; control of payments for the actual disposal of water and the implementation of harmful emissions into the environment; issuing subsidies to reduce the volume of water pollution; providing tax breaks to water users; limiting the volume of emissions of harmful substances into the environment.

Gradual reduction of pollution of water management facilities can be achieved by: making qualitative changes to the wastewater treatment system that improve its functioning; bringing catchment areas in order and maintaining it at the proper level; strict adherence to legislative measures aimed at maintaining the management and disposal of natural resources at water management facilities and adjacent territories; eliminating the consequences of irrational use of water resources and water management facilities.

The following main problematic issues of state water management can be noted: the principle of water bodies management based on the geographical division of river basins; the principle of water bodies management based on the geographical division of river basins and recognized as the main one in water use; consistent improvement of the system of compensation for losses incurred due to the negative impact on water bodies; it is necessary to legally consolidate the sequence of mutual settlements for the use of water resources at the state level; it is advisable to form target, budgetary funds of water resources, to accumulate funds received by accepting payments for their use; improvement of the functioning of the water management system is due to improvement of the legislation of the Republic of Kazakhstan in the field of protection of water bodies and natural resources.

So, we can conclude that the well-being of the water resources of any state is influenced by two main factors: the territory and location of the country, as well as its state apparatus. Because of the warming and dry climate, more and more often in Kazakhstan they pay attention to state regulation of water resources: laws and regulations are signed that will help not only protect, but also expand the water body of the republic.

References

Alimbaev, T., Omarova, B., Tuleubayeva, S., Kamzayev, B., Aipov, N., Mazhitova, Zh., 2021. Ecological problems of water resources in Kazakhstan. E3S Web of Conferences, 244, Pp. 1-11. https://doi.org/10.1051/e3sconf/202124401004

Asgerov, E.B., Beskrovnyy, A.I., Doroshkevich, N.V., Mita, C., Mardare, D.M., Chicea, D., Lazar, M.D., Tatarinova, A.A., Lyubchyk, S.I., Lyubchyk, A.I., Doroshkevich, A.S., 2022. Reversible Martensitic Phase Transition in Yttrium-Stabilized ZrO2 Nanopowders by Adsorption of Water. Nanomaterials, 12 (3), Pp. 435. https://doi.org/10.3390/nano12030435

Danilov-Danilyan, V.I., 2020. Water security. Environmental Safety and Environmental Management. Available online: https://iwp.ru/upload/iblock/e25/e25ad4b0f2b86fe36a129df9bcad5a48.pdf .Accessed November 16 2022.

Doroshkevich, A.S., Lyubchyk, A.I., Islamov, A.K., Turchenko, V.A., Glazunova, V.A., Yu. Zelenyak, T., Burkhovetskiy, V.V., Shylo, A.V.,

Balasoiu, M., Saprykina, A.V., Ohmura, S., Lygina, O.S., Lyubchyk, S.I., Konstantinova, T.E., Lakusta, M.V., Bodnarchuk, V.I., Lyubchyk, S.B., Bacherikov, Y.Y., Aliyeva, Y., Kholmurodov, K.T., 2017. Nonequilibrium chemo-electronic conversion of water on the nanosized YSZ: Experiment and Molecular Dynamics modelling problem formulation. Journal of Physics: Conference Series, 848 (1), 012021. https://doi.org/10.1088/1742-6596/848/1/012021

Environmental protection and sustainable development of Kazakhstan, 2021. Available online: www.stat.gov.kz. Accessed November 16 2022.

Gudkov, D., Shevtsova, N., Pomortseva, N., Dzyubenko, E., Yavnyuk, A., Kaglyan, A., Nazarov, A., 2017. Aquatic plants and animals in the chernobyl exclusion zone: Effects of long-term radiation exposure on different levels of biological organization. Genetics, Evolution and Radiation: Crossing Borders, The Interdisciplinary Legacy of Nikolay W. Timofeeff-Ressovsky, Pp. 287-302. https://doi.org/10.1007/978-3-319-48838-7_24

How is the water issue in Kazakhstan, 2019. Italic-republican business weekly for the economically active population of Kazakhstan, 2019. Available online: https://kursiv.kz/news/ekonomika/2019-02/kak-v-kazakhstane-obstoyat-dela-s-vodnym voprosom. Accessed November 16 2022.

Kuybida, V.V., Nekrasova, O.D., Kutsokon, Yu.K., Lopatynska, V.V., Truskavetska, I.Ya., 2019. Summer fish kills in the Kaniv Reservoir. Hydrobiological Journal, 55 (1), Pp. 103-106. https://doi.org/10.1615/HydrobJ.v55.i1.110

Liu, Y., Wang, P., Ruan, H., Wang, T., Yu, J., Cheng, Y., Kulmatov, R., 2020. Sustainable use of groundwater resources in the transboundary aquifers of the five Central Asian countries: Challenges and perspectives. Water, 12 (8),Pp. 1-18. https://doi.org/10.3390/w12082101

Mazakov, T., Jomartova, S., Ziyatbekova, G., Aliaskar, M., 2020. Automated system for monitoring the threat of waterworks breakout. Journal of Theoretical and Applied Information Technology, 98 (15), Pp. 3176–3189.

Moldasheva, R., Ismailova, A., Turmukhanova, G., Mailybayeva, A., Yelezhanova, S., Zhanuzakova, Z., Zhamangara, A., 2023. Method for controlling phytoplankton distribution in fresh open water. International Journal of Environmental Studies. https://doi.org/10.1080/00207233.2023.2249791

Myrzahmetov, M., Umbetova, Sh.M., Ashiryayev, K.Sh., Kozhakhan, A.K., Kanarbay, A.U., 2019. On the strategy of intergrated water resources management in Kazakhstan. Journal of Environmental Management and Tourism, 9 (8), Pp. 1821-1826. https://doi.org/10.14505//jemt.v9.8(32).23

Nazarbayev N., 2012. Strategy Kazakhstan-2050 – a new political course of an established state. Available online: https://www.akorda.kz/ru/official _documents/strategies_and_programs. Accessed November 16 2022.

Pichakhchi, A.G., Saenko, N.A., 2020. Modern problems of water resources and ways to solve them. Fire and Technosphere Safety: Problems and Ways of Improvement, 2 (6), Pp. 336-342.

Schweitzer, L., Noblet, J., 2018. Water contamination and pollution, in: Török, B., Dransfield, T. (Eds.), Green Chemistry. An Inclusive Approach. Elsevier, Amsterdam, Pp. 261-290.

Subbotina, O., 2020. Modern problems in the consumption of water resources and the increase in water tensions in the world. Quality of Life Magazine. Available online: https://greenologia.ru/eko-problemy/gidrosfera/potreblenie-vodnyx-resursov.html. Accessed November 16 2022.

Subhoni, M., Kholmurodov, K., Doroshkevich, A., Asgerov, E., Yamamoto, T., Lyubchyk, A., Almasan, V., Madadzada, A., 2018. Density functional theory calculations of the water interactions with ZrO2 nanoparticles Y2O3 doped. Journal of Physics: Conference Series, 994 (1), 012013.

Theodore, L., Dupont, R.R., 2019. Water Resource Management Issues. Basic Principles and Applications. Boca Raton: CRC Press.

Umirzakov, S.I., 2016. Improving the efficiency of water resources use in rice irrigation systems in the Kyzylorda region. International Research Journal, 5 (47), Pp. 2227-6017.

Water resources and food security and nutrition, 2015. Available online: http: //www.fao.org/3/av045r/av045r.pdf.Accessed November 16 2022.

Water, water (not) everywhere: improving the efficiency of water use is an urgent task. World Bank Report, 2016. Available online: https://www.vsemirnyjbank.org/ru/news/feature/2016/08/18/the -imperative-of-increasing -water-use-efficiency. Accessed November 16 2022.

Yessymkhanova, Z., Niyazbekova, Sh., Dauletkhanova, Zh., Satenova, D., Zhumasseitova, S., A T Kadyraliev, A.T., Supaeva, G.T., Dzholdosheva, T., Dzholdoshev, N., 2021. Water resources management in Kazakhstan in conditions of their shortage. IOP Conference Series: Earth and Environmental Science, 937, Pp. 1-7. https://doi.org/10.1088/1755-1315/937/3/032012