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MAIN DIRECTIONS FOR RATIONAL USE OF WATER RESOURCES IN THE REPUBLIC OF KAZAKHSTAN

Abstract. The article examines major directions of the rational management of water resources in the Republic of Kazakhstan, specifically the South Kazakhstan region. Rational water use plays a huge role in the water sector and the country's economy as a whole. Rational water management is a pragmatic process that comprises the efficient utilization and conservation of water resources, which guarantees the preservation of water bodies from excessive anthropogenic impact. Rational water management is the main moderator in supplying the population and the national economy with water resources. The analysis of the foundations of rational water management is conducted, the basic economic instruments affecting the process of water management are examined, and the structure of water resources management in the South Kazakhstan region is investigated.

Keywords: rational water management, water resources, virtual water, sustainable water use, river runoff, total surface water resources.

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Аннотация. В статье выявлены основные направления рационального использования водных ресурсов в Республики Казахстан, в частности Южно-Казахстанской области. Для водохозяйственного сектора и экономики страны в целом, рациональное водопользование имеет огромную роль. Рациональное водопользование – это процесс прагматического характера, включающий в себя эффективное использование и охрану водных ресурсов, гарантирующий сохранение водных объектов от избыточного антропогенного воздействия. Рациональное водопользование является основным модератором в обеспечении населения и отрасли народного хозяйства водными ресурсами. В данной работе проведен анализ основ рационального водопользования, рассмотрены основные экономические инструменты влияющие на процесс водопользования и сделан обзор структуры управления водными ресурсами в Южно-Казахстанской области.

Ключевые слова: рациональное водопользование, водные ресурсы, виртуальная вода, устойчивое водопользование, речной сток, суммарные ресурсы поверхностных вод.

Түйіндеме. Мақалада Қазақстан Республикасының, соның ішінде Оңтүстік Қазақстан облысының су ресурстарын тиімді пайдаланудың негізгі бағыттары анықталды. Жалпы ел экономикасы мен су шаруашылық кешені үшін су ресурстарын тиімді пайдалану өте маңызды. Су ресурстарын тиімді пайдалану – прогматикалық сипатта су ресурстарын шектен тыс антропогендік ықпалдан қорғау және ысырапсыз пайдалануға кепілдік беретін процесс. Су ресурстарын тиімді пайдалану халық шаруашылығын және тұрғындарды су ресурстарымен қамтамасыз етудің негізгі модераторы болып табылады. Берілген жұмыста су ресурстарын тиімді пайдаланудың негіздері, су ресурстарын пайдалану процесіне әсер ететін негізгі экономикалық құралдар қарастырылды және Оңтүстік Қазақстан облысының су ресурстарын басқарудың құрылымы талданды.
Түйінді сөздер: су ресурстарын тиімді пайдалану, су ресурстары, виртуалды су, суды орнықты пайдалану, өзен ағындысы, жер беті ағындысының жиынтық ресурстары.

Introduction. General formulation of the problem and its connection with important scientific and practical problems. Rational water use is a set of measures to reduce water consumption and improve the efficiency of wastewater treatment in order to save resources, protect nature and to increase economic efficiency in industry, housing and communal services and agriculture. At one time I.A. Shiklomanov noted the fact that Central Asia has the greatest anthropogenic load on water resources in general. There is no similar natural and ecological region in the whole world as in Central Asia, where more than 75% of all water resources of the world are used. In this regard, there is a very deep lack of water resources in this region, which in turn reveals the need to change traditional methods of water use [1].

According to the Water Code of the Republic of Kazakhstan: “Water resources are the most important component of the natural environment, a limited, renewable and vulnerable natural resource, are protected and used on the territory of Kazakhstan as the basis for the life of peoples and ensure the ecological, social and economic well-being of the population, as well as the existence of flora and fauna. The classification of water resources is shown in Figure 1. The main goals achieved by measures to rationalize water use:

1. Renewability. To ensure the availability of water resources for future generations, fresh water intake should not exceed the natural water replacement rate.

2. Conservation of energy. Water pumping, delivery and wastewater treatment activities consume significant amounts of energy. In some

regions of the world, 15% of total energy consumption is spent on water management activities.

3. Preservation of natural habitat. Reducing human consumption of water helps to preserve the natural aquatic environment, which is important for local flora and fauna, and also increases the total water flow. It also reduces the need to build new dams and other facilities for water intake.

Water management measures include:

1. Any significant reduction in water loss, use or pollution, as well as preservation of the quality of water resources.

2. Reducing water use by introducing water conservation measures or increasing water use efficiency.

Implementation of water resource management systems that reduce or favor the reduction of excess water consumption.

Research objects. Kazakhstan is not rich in water resources, and they are not evenly distributed on its territory. There are over 85 thousand rivers and temporary reservoirs in the republic. (Periodically drying up rivers due to climatic conditions of the year). The main source of their filling is glaciers and snow. In total, there are 2,724 glaciers with a total glaciation area of about 2 thousand square km. There are 48 thousand lakes in the republic, of which 45 are small, the area of which is less than 1 sq. km. The lakes are located unevenly on the territory: either they are hundreds of kilometers apart from each other, or they are located so densely that they form lake areas. The renewable water resources of the basins usually consist of the runoff recorded in the outlet sections of the rivers, the inflow of water below these sections, as well as the runoff of unexplored rivers. Since in the lower reaches of rivers in lowland Kazakhstan, the runoff is usually scattered, sometimes even to the point of complete disappearance, when calculating the total water resources, data were used for the sections with the maximum runoff [2].

The most recent data on river flow in the Republic of Kazakhstan include the work carried out within the framework of the project “Rational use of water resources with an increase in the areas of regular and inundation irrigation in all water basins of the Republic of Kazakhstan until 2021” (Figure 1). Where, on the scale of 8 water basins, both average water resources and resources in water-specific years were estimated (50, 75, 95% of availability). Studies have shown that the total resources of surface waters formed in Kazakhstan and coming from the territories of neighboring states are on average 122.0 km^3. Water resources formed within Kazakhstan amount to 58.0 km^3.

The inflow from neighboring states is determined at 67.2 km^3, including about 26 km^3 from China, 10.6 km^3 from Russia, 26.5 km^3 from Uzbekistan, and 4.1 km^3 from Kyrgyzstan. As a result, if in the 50s of the last millennium, the surface runoff resources of Kazakhstani rivers were estimated at 150 km^3/year, in the 70s and 80s - at 115...125 km^3/year, then, as follows from the above data, they have decreased even more [3].

At the moment in the Republic of Kazakhstan there is a pressing problem of lack of water resources. In this regard, Kazakhstan has introduced a system of full and partial management of water resources for separate water basins. Since most of the country's renewable water resources are transboundary rivers, our country (in the case of 7 water basins) is entirely dependent on neighboring countries. With the growth of the population, respectively, the demand for water resources is increasing every year. The problem of water scarcity is acutely reflected in economic activities and water use in general in South Kazakhstan. Population growth, widespread development of irrigation, growth rates of infrastructures have led to an increase in the use of more and more water supplies. In general, the country has implemented many projects for the integrated management of water resources of transboundary rivers and there are effective strategies. "Strategy Kazakhstan - 2050" [4] is a vivid example of one of such large-scale undertakings. The main concept of the strategy is a gradual transition to integrated water resources management based on global experience, new methods and approaches to solving the water problem. Currently, the resource-based approach prevails in water management, that is, meeting the needs of water users in general, rather than settling the demand. Low efficiency of water management, especially in key areas such as irrigation, leads to an acute shortage of water resources. There are 150 wastewater receivers on the territory of the Republic of Kazakhstan. Including wastewater discharges to the terrain - 7, to filtration fields - 38, to storage ponds - 20, to ponds with evaporators - 18, and to biological ponds - 7 and others. The category of discharged wastewater is mainly domestic, industrial, quarry, mine and mixed. Purification type: mechanical, natural and artificial biological [4].

More than 0.81 km^3 of wastewater is discharged into water bodies annually. Industrial enterprises are considered the main pollutants, they account for 63.1% of all wastewater, housing and utilities - 24.9% and agriculture - 11%. The water management complex of the Republic of Kazakhstan has 44 thousand water facilities, which are distributed as follows (Figure 2).

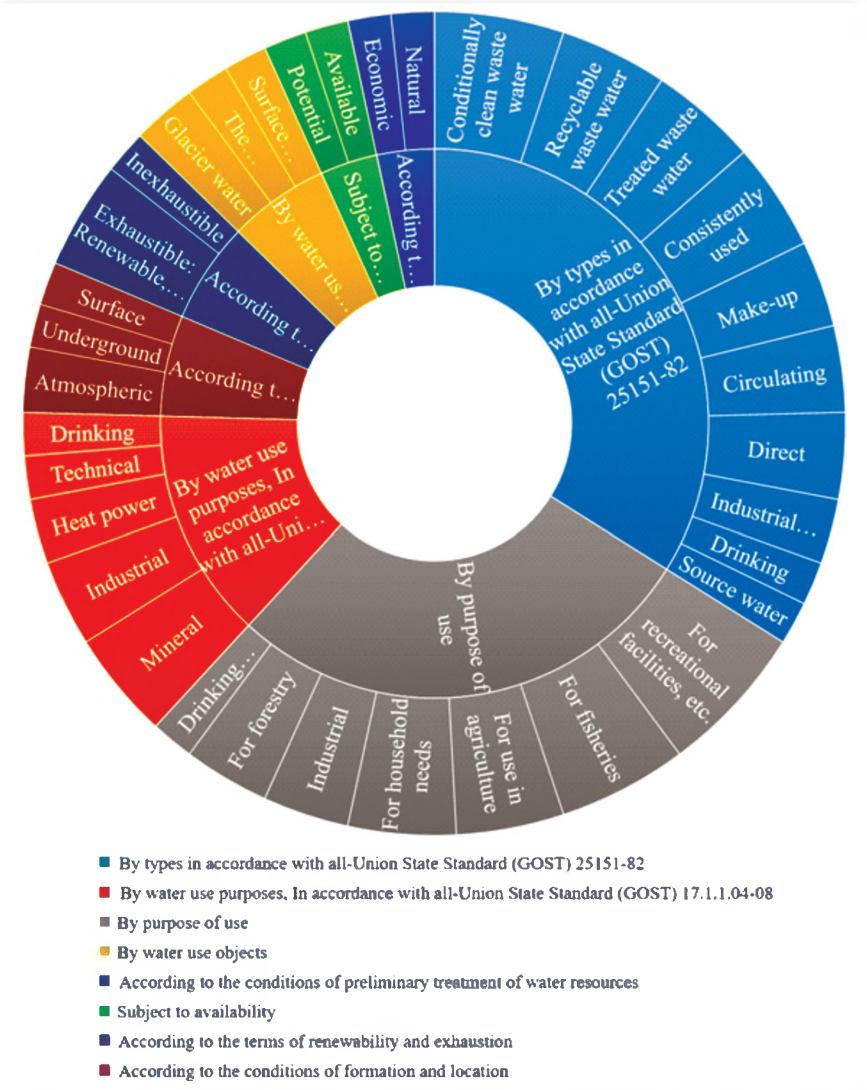

Figure 1 - Classification of water resources [7]

The largest are complex hydroelectric complexes, which include 35 hydroelectric power plants with a total capacity of 2.7 thousand MW, theoretically, the capacity of all the country's hydro resources is 170 billion

kWh per year, which is about 23% of the total capacity in the Republic of Kazakhstan as a whole (Figure 2).

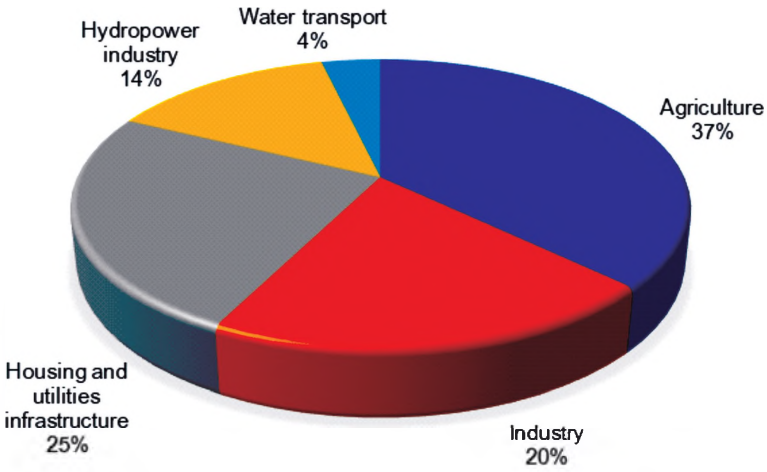

Figure 2 - Percentage ratio of the main water users of the Republic of Kazakhstan [10]

Research methods. Water resources, their peculiarities and functional structure, the possibility of their rational management, which is determined by the water-resource potential of the territory, were studied by A.B. Avakyan, O.F. Balatsky, Yu.P. Belichenko, A.M. Gareev, N.I. Koronkevich, L.M. Korytnyi, S.N. Kritsky, M.I. Lvovich, N.F. Menkel, V.V. Morokov, I.A. Shiklomanov and etc. The works of many scholars (A.B. Avakyan, V.V. Varankin, V.N. Gerasimenko, A.A. Golub, K.G. Hoffman, A.A. Mints, T.S. Khachaturov, etc.) are dedicated to the issues economic assessment of water resources of the territory. However, the changes taking place both in the country's economy and in its ecological situation and in water management as a whole necessitate an additional in-depth study of the problems of rational use of the region's water resources, their protection and restoration based on the formation of effective economic relations in water use.

The aim of this work is to analyze the foundations of rational water management and the main economic instruments that affect the water use process in Kazakhstan, as well as the structure of water resources management in the South Kazakhstan region. To fulfill the solution of tasks and goals, the main methods of statistical and system-oriented analysis were applied, general scientific methods of comparison, an abstract-log-

ical method, economic and mathematical methods, expert assessments were used. General summary and quantitative indicators were given for the main characteristics of river flow and water use. Besides, analytical research methods have created a structure of units in the main field of study. The information data base is legislative and regulatory legal acts, instructive and methodological documents in the field of water resources and water management, statistical data of the Agency on Statistics of the Republic of Kazakhstan, reports on monitoring water resources of the Hydrometeorological Center of the South Kazakhstan region, theoretical and factual materials in the works of domestic and foreign specialists in the field of hydrology, ecology and conservation of natural resources. The main factors of irrational use of water resources include:

- deterioration and unsatisfactory technical condition of hydraulic structures and water supply and sewerage facilities;
- the use of outdated water-intensive production technologies;
- excessive pollution of water bodies, emergency discharges of polluted waters;
- high level of water losses during transportation;
- insufficient equipment of water intake facilities with metering systems;
- orientation towards extensive development, as well as neglect of water use efficiency issues;
- lack of a unified management system for the water management complex, lack of qualified personnel and, as a result, a large number of inadequate decisions in the field of water use;
- imperfection of the tariff policy, both in terms of water use and wastewater disposal, and in terms of penalties and preventive sanctions;
- the lack of effective economic mechanisms stimulating business to actively introduce progressive water-saving production technologies, systems of recirculating and re-sequential water supply and reducing unproductive water losses.

Results and discussion. The economy of Kazakhstan uses more than 20-24.8 km^3 of water annually. The state of the water management complex of Kazakhstan and the presence of a number of major problems in water use indicate the need to take measures to rationalize it [5]. And although at the present time a complete solution of problems in the field of water use seems impossible, there are a number of directions that allow solving existing problems and smoothing out the contradictions that arise. The classification of the main directions of the rational use of water resources is presented in table 1.

Table 1 - Classification of the main directions of rational use of water resources

Directions of rationalization of water use	
Organizational	1. Ensuring Integrated Water Resources Management 2. Basin principle application 3. Norm setting 4. Carrying out timely preventive and current repairs of hydraulic structures and pipelines
Economic	1. Promotion of rational water use 2. Application of penalties for irrational use of water resources 3. Improving the efficiency of tariff policy 4. Payment for all types of water use
Legal	1. Restoration of water sources: cleaning of river beds and reservoirs; reducing the number of discharges of pollutants; restoration of sanitary zones 2. Protection of water bodies 3. Creation of reserve sources of water supply: groundwater; precipitation; treated waste water 4. Introduction of water-saving technologies 5. Organization of water monitoring systems 6. Development of methods for predicting the qualitative and quantitative state of water resources 7. Improving the quality of hydro forecasts
Technical	1. Implementation of innovative technologies for water resources purification 2. Development of low water and ahydrous technologies 3. Development of machinery and equipment with less water loss 4. Creation of group systems of recycling water supply 5. Improvement of schemes and technologies for the use of water resources 6. Implementation of water pipe self-cleaning technologies

The water intensity of the country's gross domestic product significantly exceeds that of the economies of such developed countries as Germany, France, the USA and Canada. A high level of water capacity is characterized not only by the country's economy as a whole, but also by individual industries and agriculture. Reducing water capacity is a prerequisite for the transition to rational water use. It is necessary that at the "entrance" to the system, water resources are rationally used, and at the "exit" - the established standards for the negative impact of production

factors on water bodies and product quality indicators are observed. The presence of a large number of factors of irrational use of water resources and a high level of water capacity of the country lead to the need for measures to rationalize the process of water use as a whole [6-8]. The main strategic goal of state water management is to achieve and maintain an economically efficient and environmentally safe level of water use. Achievement of the dialectical unity of "economically efficient and environmentally safe level of water use" is defined by us as "sustainable water use", which is characterized:

- balanced satisfaction of the needs of economic development and ensuring the reproduction of water resources;
- balancing the implementation of the rights of present and future generations to use economically efficient and environmentally safe water resource potential.

To achieve this goal in conditions of limited economic opportunities, both for water users and the state, when determining the main directions for the effective development of water management, it is necessary to proceed from the principle of ergonomizing decisions made (minimizing costs in water use and choosing environmentally effective solutions that have at the same time a positive economic effect). One of the most topical and innovative ways to solve the problems of rational water use is virtual water. The concept of the XXI century, which has been widely studied in the scientific community in recent years. According to the research of Christian Opp, [9, 14, 16] the relevance of this topic dates back to 1998, when the world community raised the alarm about the irrational use and lack of fresh water. Since then, there has been a lot of research on this topic, and now in the "Age of Water", it is relevant for every person.

Research into virtual water and the water footprint has attracted the attention of many scientists from different angles. Scientists from China, the Netherlands, USA, Germany, Sweden and Great Britain can be considered the leaders of research, who in turn have introduced many new concepts. In theory, the studies pay more attention to the countries of the Middle East, Central Asia and Africa, which are currently considered the driest regions with water deficiency [17]. The range of implementation of related water protection tasks should be limited to the most urgent and socially significant ones, as well as those implemented by the state within the framework of state and regional programs for the protection and restoration of water resources and water users at the expense of their own profits in the framework of economic activities in accordance with the current legislation.

Most of the water used in the region is taken from the two main rivers, the Syr Darya and the Amu Darya, which form in the Pamir and Tien Shan mountains. The Syr Darya flows from Kyrgyzstan through Tajikistan to Uzbekistan (including through the densely populated Fergana Valley) and Kazakhstan, the Amu Darya - from Tajikistan to Uzbekistan and Turkmenistan. The water resources of the Syr Darya, the average annual flow of which is 37 km^3, are distributed as follows: 74% falls on Kyrgyzstan, 14% on Uzbekistan, 9% on Kazakhstan and 3% on Tajikistan. More than 80% of the Amu Darya runoff, the average long-term runoff of which is 78 km^3, is formed in Tajikistan, 6% in Uzbekistan, 2.4% in Kyrgyzstan, 3.5% in Turkmenistan (with Iran) and 7.9% in Afghanistan [10,15].

Water bodies on the territory of the South Kazakhstan region (hereinafter - water bodies) are represented by the main reservoirs, the Syrdariya and Amudaria rivers and their tributaries, natural and artificial reservoirs, rivers, lakes, ponds and swamps. The modern structure of water management in Kazakhstan and on the territory of the South Kazakhstan region, the main direction of water use in the lower reaches of the Syr Darya is agriculture, mainly regular irrigation. The main water users: the North Aral Sea and the Saryshyganak Bay, the Syrdarya river delta, ecosystems on the Syrdarya river section from the Shardara reservoir to the city of Kazalinsk [10]. The developed joint operating mode of the Shardara reservoir and the Koksaray counter-regulator, as well as the reconstruction of irrigation networks with an increase in the efficiency, allow achieving sufficient water content in the planned irrigated areas for the entire period. The reserve for growing fodder is the Koksarai counter-regulator operating in the mode of deep-water estuaries, which will compensate for the shortage of products associated with the exclusion of flooded hayfields in very dry years (95% supply). The requirements of other sectors of the economy are small compared to the requirements of regular irrigation and are constantly met.

As a rule, programs for the protection and rational use of water are initiated at the local level, either by local municipal authorities or regional structures. All water resources management structures are poorly equipped with tools for supplying and exchanging information at the present stage. Water management organizations and local water resources management bodies do not have access to the most basic and important data on water utilization for economic activity. The modern structure of water management in the Republic of Kazakhstan on the territory of the South Kazakhstan region is shown in Figure 3.

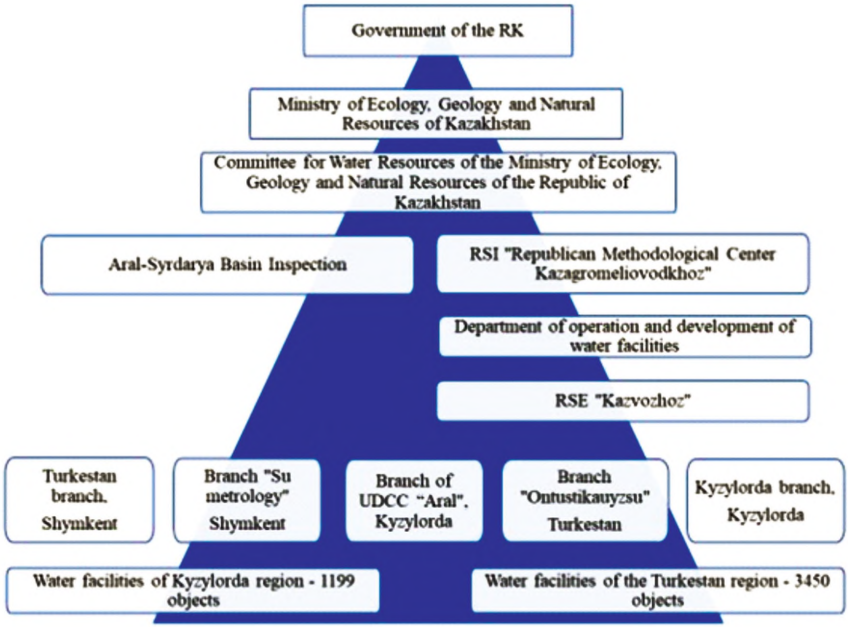

Figure 3 - The structure of water resources management of the Republic of Kazakhstan on the territory of the South Kazakhstan region

As can be seen from Figure 3, water resources management bodies are closely interconnected with each other, but do not belong to a single base of water resources management in the country, and those countries with transboundary rivers. This means that the system itself cannot allow timely and unified data exchange, which could be a unified database on water resources throughout the Syr Darya basin in the territory of all three countries through which the river flows. Whereas, the integrated water resources management at the interstate level should gradually resolve this problem. At the State level, by the Decree of the President of the Republic of Kazakhstan dated June 17, 2019 No. 17 "On measures to further improve the system of public administration of the Republic of Kazakhstan", the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan was created with the transfer of functions from the Ministry of Agriculture of the Republic of Kazakhstan in the field of use and protection of the water fund, water supply, sewerage, forestry. Thus, the quality and quantity of water resources are the main development criteria for any state, on which the health and well-being of citizens of the republic directly depends [8-11].

The concept of the new State Program for Water Resources Management of the Republic of Kazakhstan was developed in accordance with the Water Code of the Republic of Kazakhstan and the Protocol of the Security Council meeting dated June 26, 2019 "On ensuring water security". In this regard, the main goal of the Concept is to determine the main ways to solve the problems of conservation and rational use of the country's water resources, to ensure the balance of socio-economic development and the possibility of reproduction of water resources at the level of the requirements of the standard water quality - "sustainable water use". The concept will serve as a basis for improving the legal framework, developing measures for the development of the water sector of the economy and state policy on water resources management and water use. Thus, water resources are a factor of life and habitat, as well as the most important economic resource for all spheres of human economic activity. Currently, it is necessary to ensure the rational use of natural resources, their protection from pollution and degradation, as well as skillfully restore, multiply and control them for the benefit of human society.

Conclusions.

1. The urgency of the problem of water management is determined by the deplorable state of the industry, and repeated attempts to solve separate issues did not change the situation as a whole.

2. There is a need for a transition to modern methods of management, active involvement of the experience of developed countries. For the most efficient use of water resources and sustainable economic growth, a coordinated development of economic sectors is required, taking into account the limited water resources and variability of surface and ground waters within river basins and the permissible environmental load on water bodies.

3. In connection with the uneven territorial distribution of water resources and their transboundary character, it is advisable to allocate areas for the development of water-intensive industries, increasing the development of hydropower potential, the development of irrigated agriculture, fisheries, etc.

4. Water resources as an object of management are a complex phenomenon and require a special approach for the formation of governing bodies with a clear division of their sphere of influence and responsibility. The main drawback of the existing management system is poorly established processes of exchange and access to information.

5. The issues of improving the economic mechanism for stimulating rational water use in the South Kazakhstan region, in particular, increasing the functional effectiveness of the restrictive and incentive tools of this mechanism, remain insufficiently studied. Also, the interaction of elements of the economic mechanism has been poorly studied.

Water resources management in the country is not very well established in terms of information exchange. The basin management principle provides a full range of broad possibilities of the structural component in water resources management, however, the practice shows that water use expenditures do not always coincide with the expected-predicted surface runoff resources. There are many factors influencing this inaccuracy: environmental, economic, climatic, demographic, etc. All these factors significantly affect the overall picture of rational water resources management. The processes of exchange and access to information are poorly established. Water management organizations do not have access to information from other governmental organizations. There is no organization technically capable of forming and maintaining a complete database on the water sector, which leads to a lack of environmental and economic information for interested persons and reduces the objectivity of decisions regarding the management and use of water resources. It would be preferable to consider new concepts in the use of water resources. The concept of virtual water can help water consumers to use more rational ways of irrigation of the drainage system and change the opinion about the cultivation of traditional crops and change over to crops that are less sensitive to frequent and abundant irrigation, and to reconsider priorities.

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