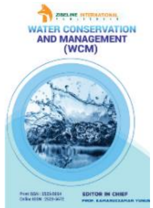
ZIBELINE INTERNATIONAL™ PUBLISHING
ISSN: 2523-5664 (Print)
ISSN: 2523-5672 (Online)
CODEN: WCMABD

Water Conservation & Management (WCM)

DOI: http://doi.org/10.26480/wcm.03.2024.362.367



CrossMark

RESEARCH ARTICLE

EXCESS AND ACTUAL INDICATORS OF WATER CONSUMPTION AND WASTEWATER DISPOSAL IN THE REPUBLIC OF KAZAKHSTAN

Bibigul Botantaeva[a,*], Akmaral Sagybekova[b], Abdi Kiyalbayev[b], Gulsum Espayeva[b], Kabdolgazy Nauruzbayaev[b]

[a] Department of Engineering Systems and Networks, Satbayev University, 050013, 22A Satpaev Str., Almaty, Republic of Kazakhstan
[b] Department of Transport Construction and Production of Building Materials, Kazakh Automobile and Road Institute named after L.B. Goncharov, 050061, 415V Raimbek Ave., Almaty, Republic of Kazakhstan
**Corresponding author email: b_botantaeva@outlook.com*

ARTICLE DETAILS

Article History:

Received 15 April 2024
Revised 23 May 2024
Accepted 14 June 2024
Available online 18 June 2024

ABSTRACT

The purpose of this study is to analyse the current state of water consumption and wastewater disposal systems in the Republic of Kazakhstan (RK) in order to identify problem areas and develop recommendations for improving water resources management. The study used analytical, functional, and statistical methods, classification, synthesis. The study of excess and actual indicators of water consumption and disposal in the RK was conducted in order to analyse the efficiency of water resources use and management of water supply and disposal in the country. To achieve this goal, data on water consumption and wastewater treatment systems in different regions of Kazakhstan were collected and analysed. The study results showed that there are irregularities in the use of water resources between different regions of the country. Some regions are experiencing excessive water consumption, which may lead to a shortage of resources in the future, while other regions have problems with insufficient availability of clean water. Important conclusions of the study are the need to develop more effective water management strategies, considering the characteristics of different regions, and attention to environmental and social aspects of water use and disposal. Such measures can contribute to a more sustainable use of water resources in the RK.

KEYWORDS

Public services; Storm sewer; Environmental stability; Hydrogeological conditions; Water supply systems.

1. INTRODUCTION

The study of the problem of water consumption and disposal in the Republic of Kazakhstan (RK) is an important task due to several factors. With the increase in population and economic growth of the country, there is a growing burden on water resources, which raises serious questions about the sustainability and accessibility of water supply for settlements and industrial enterprises. Climate change introduces uncertainty into the future of water availability, increasing the need to develop adaptive strategies. Ultimately, ensuring the high quality of drinking water and efficient wastewater disposal is important for health and ecology, as well as for the economic development and stability of the country. Therefore, this study is aimed at identifying problem areas and developing recommendations that contribute to improving water resources management and ensuring a sustainable future of the RK.

The scope of the study covers several key aspects. There is a growing burden on the water resources of the RK due to the increase in population, industrialisation and agriculture, which raises doubts about the ability of the current water supply and discharge systems to cope with this load. Climate change and environmental factors may worsen the availability and quality of water resources in the future. An important aspect is also the different distribution of groundwater and surface water in the country, which creates the need to study different approaches to the management of these resources in different regions. Ultimately, ensuring high-quality drinking water and efficient wastewater disposal remains an urgent task to ensure public health and preserve environmental sustainability. All these factors determine the relevance of studying the problems of water consumption and disposal in Kazakhstan in order to develop sustainable strategies and solutions for the future.

According to Valeyev, the uneven distribution of underground and surface water resources on the territory of Kazakhstan highlights the relevance of developing flexible strategies and approaches to water resources management adapted to the unique conditions of different regions in the country (Valeyev, 2021). The aspect that was not taken into account is the need to consider differences in climatic and environmental conditions of different regions of Kazakhstan when developing management strategies for water resources. Ziyabekova suggests that, considering environmental aspects, it is worth noting the high importance of maintaining the cleanliness of water sources in the country, as water pollution can have serious negative consequences for both the natural environment and human health (Ziyabekova, 2023). This underlines the need to take measures to control and protect water resources in Kazakhstan. An underestimated aspect remains the need to develop plans and strategies to ensure the conservation of water resources in Kazakhstan.

A group researcher focus on the analysis of aspects of social justice and accessibility of water resources for various social groups, in order to identify potential categories of the population that may face water scarcity and its social consequences (Yespolov et al., 2022). This allows for a better understanding and consideration of the most vulnerable when developing water resource management policies. An aspect that has not been sufficiently studied is the analysis of social justice and accessibility of water resources for various social groups in order to identify potential categories of the population at risk of water scarcity and its social

Quick Response Code	Access this article online	
	Website: www.watconman.org	**DOI:** 10.26480/wcm.03.2024.362.367

Cite The Article: Bibigul Botantaeva, Akmaral Sagybekova, Abdi Kiyalbayev, Gulsum Espayeva, Kabdolgazy Nauruzbayaev (2024). Excess and Actual Indicators of Water Consumption and Wastewater Disposal in The Republic of Kazakhstan. *Water Conservation & Management, 8(3): 362-367.*

consequences. According to a study, analysing the economic aspects of the problem, raised questions about financing and effective management of water supply and disposal, and their impact on the economic development of the country (Absametov et al., 2023). The researchers reveal the importance of proper resource allocation and optimisation of water supply and disposal systems to ensure the sustainability and growth of the national economy. One of the insufficiently researched aspects is the study of issues related to the financing and effective management of water supply and disposal systems, and how they affect the economic development of the country.

In recent study, author analysing the geological and hydrogeological conditions of the country, reveals the influence of various factors on the availability of underground water resources in various regions (Baitova, 2021). Her research demonstrates the importance of considering geological factors in the development of water management strategies and ensuring the sustainability of water supply in different parts of Kazakhstan. Specific approaches and measures that consider geological aspects in the development of water management strategies and ensuring the stability of water supply systems in various regions of Kazakhstan have not been properly investigated. According a study, conservation and sound management of water resources play a crucial role in ensuring the future ecological balance and sustainability of the region (Beisembin, 2010). His research highlights that water resources management plays a crucial role in ensuring environmental sustainability and preserving the natural resources of the region. The aspects that have not been sufficiently studied are specific methods and strategies of water resources management that can effectively ensure the future ecological balance and sustainability of the region.

Thus, different authors approach the study of this topic from different angles, which contributes to the development of an integrated approach to solving problems of water supply and disposal in Kazakhstan. The purpose of the study is to identify the main factors affecting the efficiency of the water supply and disposal system in the RK, followed by the development of recommendations for improving water resources management and ensuring environmental and economic sustainability of the country.

2. Materials and Methods

The analytical method has helped in optimising the use of limited water resources and promoting environmental sustainability. By analysing data on water consumption and effluent treatment efficiency, it is possible to identify inefficient points in the drainage system and propose measures to improve them. This helps to reduce water losses and environmental pollution. The analytical method not only contributes to more efficient use of water resources, but also helps to ensure the sustainability and environmental safety of water supply and disposal systems, which is important for public health and the preservation of the natural environment.

Correlations between various factors and indicators of water consumption and disposal were estimated using the statistical method. For example, a statistical study can show how population changes, the level of industrialisation, or climatic factors affect the volume of water consumption and the need for wastewater disposal. This can be very useful information for planning and adapting water supply and disposal systems to changing conditions. Thus, the statistical method plays an important role in providing a scientific approach to water resources management and allows making informed decisions to optimise water supply and disposal systems in the RK. The application of the functional method in the field of water consumption and disposal in the RK contributes to a deeper understanding of the structure and functioning of these systems, which ultimately can lead to more effective management of water resources and access to clean water for the population of the country.

The structural and functional method has provided significant assistance in the study of the water supply and disposal system of the RK. It allowed identifying the main components and elements of this complex system and assessing their interrelationships and functional roles. By decomposing and researching the structure of the system, it was possible to identify its weaknesses and potential bottlenecks, which became the basis for developing recommendations to improve its efficiency and sustainability. The structural and functional method used in the study of water consumption and disposal plays an important role in determining the effectiveness of water supply and disposal systems. It allows the system to be broken down into its constituent parts (structures) and their functions, interrelationships, and impact on the overall result to be studied. This method helps to identify bottlenecks and problem areas in the infrastructure and to optimise processes for more efficient management of water resources.

Using the synthesis, complex models were developed that combined various aspects of water consumption and disposal in the RK. This method allowed integrating data and knowledge from various sources and considering the interaction of various factors, including geological, environmental, economic, and social. The synthesis has become a powerful tool for predicting future changes and developing long-term water management strategies. It helped to foresee possible challenges and risks related to water supply and disposal and to develop appropriate measures to overcome them. This approach enriched the study with a broader context and contributed to the development of the most effective water management strategies to ensure the sustainability and development of the RK.

Applying the observation method, the dynamic aspects of water consumption and disposal in the RK were identified. This method facilitated the systematic observation and recording of data on water consumption and wastewater treatment in real-time. The comparison allowed identifying differences and similarities in water consumption and disposal systems between different regions and localities in the RK. By comparing data and parameters, it is possible to find out which factors have the greatest impact on the effectiveness of systems in different places of the country. Using the method of measurement and data analysis, it was possible to identify the predicted trends in water consumption and disposal. Information on long-term and short-term changes in water consumption and wastewater treatment can be used to develop strategic plans and measures to adapt water supply and disposal systems to changing conditions. The study was conducted by researchers and students of Satbayev University and Kazakh Automobile and Road Institute named after L.B. Goncharov.

3. Results

A planned increase in urban population and the expansion of industrial production will lead to an increased demand for water resources to meet municipal needs (Pluchinotta et al., 2021; Easa et al., 2024). Ensuring a stable water supply is of strategic importance for maintaining economic stability and improving the living standards of the population. The development of water supply and sewerage infrastructure in cities, with an increase in the degree of improvement and coverage of centralised water supply, remains a key task (Skarbøvik et al., 2010; Shuka et al., 2011). Table 1 presents weighted indicators of improvement of housing infrastructure in cities and towns. It is predicted that the growth of water consumption will continue, and by 2021 the volume of water intake will reach 1237.13 million m³ (Tian et al., 2021). To ensure this growth, it is necessary to attract public investment, search for alternative sources of drinking water, improve the management system and more efficient use of water resources in various sectors of the economy.

Table 1: Average indicators of improvement in the cities of the RK from the total population

Years	Coverage by centralised water supply			Centralised sewerage coverage
	Total	Including:		
		Water supply for the house	Collapsible columns	
2006	94,126	79513	14613	61226
2010	95	83	12	65
2016	97	89	8	73
2021	99	94	5	80

Special standards are used when calculating water intake volumes, which are slightly lower than those set in the building code, since they factor in the presence of metering devices, which leads to a slight decrease in the figures. It is predicted that in the future the volume of wastewater disposal will grow and will correspond to the planning of housing construction at the estimated levels of development. The distribution of water intake volumes for municipal needs in different regions of the RK is presented in Table 2.

Table 2: Planned water intake for the needs of public utilities of the RK, million m³

Year	TWV	WIU	TWINR	Including:				RW	IWC	Drainage	
				SW	UW	Sea water	AMWS			Total	of which into a water body
2010	992.24	992.24	986.34	469.45	488.02	15.59	13.28	5.9	378.06	614.18	206.54
2015	1110.02	1110.02	1102.98	540.76	528.06	18.85	15.31	7.04	342.91	767.11	247.86
2021	1244.51	1244.51	1237.13	621.08	576.39	21.61	18.05	7.38	295.51	949	288.18

Note: TWV – Total water volume; WIU – Water intake for use; TWINR – Total water intake from natural reservoirs; SW – Surface water; UW – Underground water; AMWS – Astrakhan Mangishlak water supply; RW – Recycled water (but pure cogeneration water); IWC – Irrevocable water consumption.

3.1 Water intake for industrial water supply and wastewater disposal

The industrial sector in the RK is one of the largest and most significant consumers of water resources, providing its water needs both at the expense of surface fresh sources (accounting for 88.5% of the total water intake) and at the expense of underground sources (11.5%). Industry plays a key role in the economy of the republic, which has contributed close to half of the country's total gross product (Suieubayeva et al., 2022; Adamkulova and Aitbaev, 2024). The main feature of the industrial sector of Kazakhstan is its strong dependence on local resources and its own reserves of fuel and raw materials. Kazakhstan has extensive reserves of coal, oil, non-ferrous and ferrous metals, chemical raw materials, and construction materials necessary for the development of heavy industry. The country's diversified agriculture provides raw materials for the light and food industries. The variety of mineral and raw materials resources in Kazakhstan contributes to the successful development of industries producing means of production and consumer goods. The use of water resources varies depending on the field of activity of enterprises. For example, in the ferrous metallurgy and petrochemical industries, up to 80% of the total volume of water consumed is used for cooling, while in non-ferrous metallurgy and the pulp and paper industry, up to 70-90% of water is used as a medium and extractant.

The type of output and its volume have a significant impact on the total water consumption in industrial enterprises. The water consumption for the production of one unit of product can vary from several m³ to several thousand m³. For example, the production of 1 tonne of coal requires 3-5 m³ of water, while the production of 1 tonne of synthetic fibres requires 2500-5000 m³ of water. Water consumption standards are set considering specific production processes. High volumes of water consumption and discharges into natural water bodies may indicate the imperfection of technological processes and water management systems at enterprises. Sometimes the amount of water consumed depends on its quality.

The quality of water used in production processes is determined by the purposes of use, technological requirements, the properties of the raw materials used, the characteristics of the equipment, and the quality of the finished product. Water quality requirements in industry are often consistent with the nature of the technological processes used. For example, in the food industry, water quality standards are similar to drinking water requirements. In thermal power engineering, the water used in the processes should not contain hardness salts and oxygen. The rigidity requirements also apply to water used for cooling equipment and products in heat exchangers. The strictest water quality standards are set in the pharmaceutical industry, where demineralised, distilled, and bidistilled water is used. An important means for saving water resources, especially in the field of industry, is a reverse water supply system (Scanlon et al., 2023; Myskovets and Molchak, 2023). The introduction of such a system can reduce water intake by 5-10 times and, consequently, reduce emissions. The volume of circulating and water recycling in the RK in 2016 is presented in Table 3 and amounted to 7,370.88 million m³.

Table 3: Recycling and reuse of water in industry, million m³

Total by RK	2016	2018
Total	7370.88	7893.89
including recycled water supply	6975.65	7574.97
water recycling	395.23	318.93

3.2 Prospects for the development of industrial water supply

In the future, in accordance with the tasks and plans of socio-economic development of the republic, economic strengthening will continue. Additional development will be provided by the mining industry, the sector of oil products production, the production of building materials, mechanical engineering, as well as light, food, processing, and textile industries. An analysis of the dynamics of industrial production growth until 2021 and its comparison with the 1990 level and the current situation approximately determined the volume of water intake for the needs of industry. It is considered that in the conditions of increasing competition and the planned entry of the RK into the World Trade Organisation, industrial enterprises will not strive for excessive water consumption, as this will increase operating costs and, consequently, increase the cost of manufactured products, which may reduce its competitiveness.

In the future, it is expected that the volume of water intake from natural water bodies will amount to approximately 6141.05 million m³, and the volume of water intake for industrial needs will reach 6120.95 million m³. With an increase in the total volume of water consumption, the volume of wastewater disposal, including discharges into natural water bodies, will also increase. It is predicted that the total volume of wastewater disposal in the future will be approximately 5205.41 million m³, of which about 4647.82 million m³ will be directed to natural water bodies (Aslam et al., 2022). Detailed data on the volumes of water intake at prospective levels, calculated based on the forecast of industrial production growth, improvement of technological methods of water resources utilisation and their careful use, are presented in Table 4.

Table 4: Water intake for the needs of the industry of the RK, million m³

Year	TWV	WIU	TWINR	Including:						WW	IWC	Drainage	
				SW*	UW	Wash-off		Sea water	AMWS			Total	of which into a water body
						CE	IU						
2010	5611.45	5463.28	5495.76	3728.2	338.78	351.09	202.92	1058.82	18.87	115.69	964.28	4647.17	4272.64
2015	5923.27	5768.55	5793.34	3909.62	385.3	387.98	233.26	1088.24	22.2	129.93	1034.88	4888.39	4429.65
2021	6282.86	6120.95	6141.05	4104.24	435.14	425.05	263.14	1150.62	26	141.81	1077.45	5205.41	4647.82

Note: * – considering the water intake from the Kanysh Satpayev Canal; TWV – Total water volume; WIU – Water intake for use; TWINR – Total water intake from natural reservoirs; SW – Surface water; UW – Underground water; CE – Completely enclosed; IU – Intake for use; AMWS – Astrakhan Mangishlak water supply; WW – Wastewater; IWC – Irrevocable water consumption.

Compared to the current situation, the volume of water reuse and water recycling by 2021 will increase by 40% and reach 10106.11 billion m³. This volume includes 9620.05 billion m³ of reverse use and 486.06 million m³ of reuse water.

3.3 The nature of urban and industrial wastewater and the state of its treatment

In modern conditions, environmental protection is one of the highest priority tasks in economic and other spheres of activity. Wastewater treatment has become an integral part of the way of life and the structure of society in the developed countries of the world. Maintaining stability and gradually reducing the negative impact on the natural environment and its elements are the most important priorities in the environmental programme (Martini et al., 2021). In this regard, reducing the negative impact of human activity on water resources becomes a key task. The increase in pollution of water supply sources is primarily conditioned by the expansion of the range and variety of concentrations of man-made substances that enter rivers and lakes with industrial and domestic wastewater.

Waste generated by enterprises is one of the main sources of water pollution (Papamichael et al., 2022). In addition to industrial, mining and processing enterprises, water pollution is also associated with urban development, agricultural fields and irrigation systems, various settling tanks and storage facilities for solid and liquid waste, and petroleum products. There are 150 sewage receivers operating on the territory of the republic, including 7 wastewater discharges into the environment, 38 discharges into filtration fields, 20 into storage ponds, 18 into evaporation ponds, and 7 into biological ponds. The discharged wastewater is mainly domestic, industrial, quarry, mine, and mixed effluents. Cleaning procedures include mechanical, natural and artificial biological cleaning. Despite the efforts being made, in a number of regions of the republic, problems remain with the inefficiency of the work of treatment facilities. Some cities, such as Kyzylorda, Uralsk, Kostanay, Kokshetau, Taraz, and Petropavlovsk, face environmental problems due to the long-term operation of outdated treatment facilities, which often work with overloads and do not meet design specifications.

The flow of wastewater into the territory can also cause contamination of groundwater. In some cases, wastewater is discharged into storage tanks without prior treatment. Half of all operating industrial enterprises have their own wastewater treatment systems. However, in almost all cities, except Almaty and Astana, the existing mechanical and biological treatment facilities are ineffective due to excessive load and insufficient technical equipment, which leads to the fact that the quality of treated wastewater discharged into surface reservoirs, filtration fields and irrigation systems does not meet the established wastewater standards. In some areas, it is necessary to carry out major repairs of existing treatment facilities and consider the possibility of building new treatment facilities, including Karaganda, Ulytau, Atyrau, West Kazakhstan, and Mangystau regions.

The condition of wastewater tanks is in general emergency condition and there is a risk of their destruction (Ramírez-Coronel et al., 2023). In many cities, sewage tanks are filled to the limit, which poses a danger to natural reservoirs and settlements. In some regions, such as Abai, East Kazakhstan, Zhambyl, Ulytau, Karaganda, Zhetysu, and Almaty regions, untreated or insufficiently treated wastewater is discharged directly, without prior accumulation and purification in special tanks, to filtration fields, irrigation lands and even to ground and underground water intake sources, without observing the compliance with the regulatory requirements for drainage. This unorganised and unmanageable practice of using water resources has led to the development of significant zones of contamination of groundwater and soil layers, which reduces the biological productivity of crops and, in some cases, contributes to an increase in the morbidity of animals and the population in these regions. Basically, wastewater discharges are accounted for by calculation, and only a few enterprises are equipped with special devices for monitoring the volume of water discharge. However, due to insufficient technical equipment, the volume of wastewater discharge also does not always correspond to actual data. In 2016, the total volume of wastewater disposal in the country reached 4387.85 million m³. Of this amount, housing and communal services disposed of 525.08 million m³ (12%), while industry dumped 3862.77 million m³ (88%). Detailed data on wastewater and mine water discharge are presented in Table 5.

Table 5: Discharge of sewage, mine waters of public services and industry enterprises, million m³

Year	TVWG	Into natural surface reservoirs					OG	FFS	By quality category:		
		Total	Polluted		SC	SA			wastewater	extraction	collector-drainage
			WC	NCE							
1990	6366.02	5463.64	58.62	191.66	4914.51	298.85	60.81	841.57	6206.61	159.41	
2016	4387.85	3764.44	10.14	85.03	3390.17	279.1	31.12	592.29	4257.17	130.68	
2021	6154.39	4936.01	14.56	111.76	4446.23	363.46	72.64	1145.75	5971.58	182.82	

Note: TVWG – Total volume of wastewater generated; WC – without cleaning; NCE – not clean enough; SC – Standard cleaning; SA – Standard authorisation; OG – On the ground; FFS – Filtering field storage.

Solving the problem of urban wastewater treatment in the republic is a complex task that requires research at the regional level, scientific study, development of technological solutions and consistent implementation of measures. The main goal of these efforts is to optimise the use of water resources and reduce potential threats to the environment, primarily to human health.

3.4 Storm sewer

The development of cities in terms of construction has led to the fact that land embankments, on which roads and buildings with deep foundations are located, now create obstacles to the diversion of surface water in low-lying areas. In case of intense rains and snow melting, water is delayed on roads and in the courtyards of apartment buildings. When it penetrates into the soil, it leads to a rise in the groundwater level, sometimes even at a shallow depth. There are two methods to manage the discharge of water from the territory from both existing and planned construction sites: open and closed drainage. The open method assumes that atmospheric water from district plots can drain through a special open drainage system installed along the streets. This open part of the system should include ditches and places for water retention.

To prevent the discharge of contaminated surface water from built-up areas collected using an open drainage system, it is planned to create a closed storm sewer system with special treatment facilities. It is important to note that technical solutions for this system have not yet been developed, and at the moment, there is no clear scheme for the drainage and treatment of stormwater from urban areas. Based on these circumstances, all urban planning decisions must be approved to create independent networks for the discharge of stormwater and meltwater that are not associated with urban sewerage. Local authorities should take responsibility for the effective management of storm and meltwater drainage, and the improvement and design of urban areas. Information on the amount of surface runoff from urban areas has been prepared in accordance with the time instructions, taking into account the design of facilities for the treatment of surface wastewater in accordance with CH 496-77, and is presented in Table 6.

Table 6: Data characterising the volume of surface runoff from urban areas

Water management district number	Volume of surface runoff from urban areas, million m³/year			Amount of pollutants discharged from surface runoff from urban areas into water bodies, t/year		
	Total	Including:				
		Dumped on sewage treatment plants	Discharged into water bodies without cleaning	suspended substances	Organic impurities by biochemical oxygen demand full	petroleum products
Total for the RK	327.66	0	327.66	3,68149	36,815	10,281

From the information provided, it can be concluded that the annual volume of surface runoff from urban areas in the country is 327.66 million m³. At the same time, the amount of pollutants that enter water bodies through surface runoff from urban areas is 368149 tonnes per year for suspended solids, 36815 tonnes per year for organic impurities, and 10281 tonnes per year for petroleum products. After 2021, it will be necessary to install storm sewer systems in all settlements where there is a threat of contamination of surface and groundwater.

4. Discussion

Kazakhstan has significant water resources, including rivers, lakes and groundwater. However, the distribution of water resources is uneven across the country. Accordingly, water supply in some Kazakh cities and regions may be uneven and insufficient. This is due to various factors, including old infrastructure, outdated technologies and population growth. In some cases, this can lead to problems with the quality of drinking water. Agriculture is a major consumer of water in Kazakhstan. It is important to develop and implement methods and technologies of agriculture with low water consumption in order to reduce pressure on water resources and ensure food security. Equally important is the issue of wastewater disposal and management (Shahini and Bali, 2023). Insufficient drainage systems and improper wastewater management can lead to water pollution and environmental degradation (Melnyk et al., 2023; Dzihora and Stolyarenko, 2020).

For sustainable development and management of water resources, Kazakhstan should actively work on the creation of modern infrastructure systems of water supply and sanitation, develop and implement innovative agricultural methods, comply with environmental standards and cooperate with international partners. Raising public awareness about water conservation and the need for sustainable water resources management also plays an important role. Educational programmes and information campaigns can help create a more responsible attitude to water resources. Kazakhstan can cooperate with neighbouring countries and international organisations in the field of water resources management, especially within the framework of basin approaches to river and lake management, in order to solve common problems and promote sustainable development.

There is an uneven distribution of water resources in Kazakhstan, and this has an impact on water consumption and disposal in different regions of the country. The northern regions, such as Astana and Almaty, have richer water sources, which allows them to have a stable water supply. While the southern and south-western regions are experiencing a shortage of water resources, which can cause problems with providing the population with water. It is worth objecting to the ambiguity in the issue of disposal and pollution. In some regions of Kazakhstan, wastewater disposal and treatment systems do not always meet modern standards. This can lead to pollution of water resources and create environmental problems. Uneven distribution of water and problems with water supply and disposal are urgent challenges that require attention and appropriate measures on the part of the state and society.

According to the results of recent studies by some researhcer, low-voltage electrocoagulation of iron is an effective method of tertiary treatment of urban wastewater, which can be especially useful for removing indicators of intestinal pathogens and bacteria, including those that may be resistant to antibiotics (Bicudo et al., 2021). This method is based on the process of electrocoagulation, in which an electric current is passed through the wastewater, which leads to the formation of microdrops of iron precipitation. These iron droplets serve as coagulants that aggregate and collapse bacteria and suspended particles, making them easier to remove from the water. Iron can also affect the molecular structures of bacteria, which contributes to their inactivation. These data are consistent with the theses given in the previous section, the use of low-voltage electrocoagulation of iron in the wastewater treatment process demonstrates technological progress in the field of water treatment and allows improving the quality of treated water, reducing the risks of diseases and minimising the impact of antibiotic-resistant bacteria on the environment.

Referring to the definition by a group researchers solution related to the availability and use of water for electrolysis in the production of hydrogen play an important role in modern energy and ecology (Simoes et al., 2021). Electrolysis of water is a process in which water is decomposed into hydrogen and oxygen using electrical energy. The hydrogen produced in this way can be used as a clean energy source or for the production of hydrogen fuel cells, which makes this process an important element of the transition to more environmentally sustainable technologies. According to the authors' conclusions and analysing the results obtained, the availability and use of water for electrolysis may raise some questions, especially in regions where water resources are limited. This can increase competition for water resources between industry, agriculture, and hydrogen production. Therefore, it is important to develop and implement effective electrolysis technologies that minimise the need for water and promote the lean use of this resource.

A group researcher determined that the situation with wastewater treatment and reuse in the main Asian countries is of particular importance, given the population growth and industrial development in the region (Cheng et al., 2022). Many Asian countries face challenges in the field of water treatment and wastewater management. The authors' conclusions confirm the results of this study – solving these problems requires not only investments in water treatment infrastructure, but also the development of effective strategies for water resources management and creative water use. The importance of international cooperation and exchange of experience to develop the most effective solutions in the field of water treatment and sustainable management of water resources in the Asian region is highlighted.

In recent studies, authors identified that wastewater infrastructure plays an important role in achieving the Sustainable Development Goals set by the United Nations (Delanka-Pedige et al., 2021). One of the key goals related to water supply and disposal is Sustainable Development Goal No. 6: "Guarantee the availability and management of water and sanitation for all". This goal includes ensuring access to clean drinking water and sanitation for all citizens, which is of great importance for creating sustainable cities and improving the quality of life of the population. Despite the results obtained, the wastewater infrastructure in cities should be designed and developed in such a way as to ensure the collection, treatment, and disposal of wastewater with minimal negative impact on the environment. This includes the construction of modern water treatment systems, as well as the management and processing of treated wastewater. A sustainability-oriented approach also implies compliance with environmental standards and consideration of future needs and climate change.

Kumar and Hong have shown that the Internet plays an important role in ensuring the safe monitoring and management of wastewater treatment systems (Kumar and Hong, 2022). This technology allows collecting and analysing data on the condition and operation of treatment facilities in real-time, which allows operators to quickly respond to any problems or accidents. One of the key advantages is the ability to monitor various water parameters, such as pollution level, oxygen level, pH, and other characteristics. This allows the detection of anomalies and changes in water quality, which may indicate potential problems with the purification processes.

As noted by some researchers, the problem of water stress and water footprint accounting are becoming increasingly relevant in the context of increasing demand for water resources in the world (Wang et al., 2021). Water stress occurs when the demand for water exceeds the available resources in a certain region or locality. This can be caused by various factors, including climate change, population growth, and economic development. Water footprint accounting is a methodology for estimating and accounting for the total volume of water used in production and consumer processes. This includes water used in agriculture, production of goods and services, and water consumed by the population. Water footprint accounting identifies which economic sectors and products are the main users of water resources. These findings confirm the results of this study. Both of these aspects are related to sustainable management of water resources and minimisation of water stress. Understanding the water footprint helps companies and governments develop strategies to reduce water consumption, increase resource efficiency, and improve the sustainability of water systems. It is also important to combat global challenges such as climate change and reduced availability of clean drinking water.

5. Conclusion

Issues of water consumption and wastewater disposal in the RK have a significant impact on economic development and the state of the environment. Unresolved problems in this area can cause serious consequences for the country. The most important aspects of this problem require a coherent and multifaceted approach that covers both economic and environmental aspects. First of all, it is necessary to ensure stable and uniform water supply in all regions of the country. This is important to meet the needs of the population, agriculture, and industry. Solving this problem requires investments in the modernisation of water supply infrastructure and the creation of efficient wastewater disposal systems.

The uneven distribution of water resources in the country leaves some regions in short supply, which requires the development of infrastructure and technologies to ensure a stable water supply. Agriculture, as a major consumer of water, should switch to more efficient methods and technologies to reduce the burden on water resources. Water disposal and pollution problems also require attention. It is necessary to modernise wastewater disposal and treatment systems in order to minimise the negative impact on the environment and ensure cleaner water resources. Strengthening education and information campaigns on water conservation issues can help change behaviour and instil a culture of water conservation among citizens. International cooperation in water resources management is also important, especially in the framework of basin approaches. Kazakhstan should continue to cooperate with neighbouring countries and international organisations in order to solve common problems and ensure sustainable management of water resources.

In general, water resources management in the RK requires a comprehensive analysis, joint efforts and strategic planning to ensure access to clean water for all, maintain ecological balance, and promote sustainable development of the country. It is also necessary to investigate the impact of climate change on the availability and quality of water resources in different regions of the RK, and to develop adaptation measures to ensure the sustainability of water supply and water treatment.

References

Absametov, M.K., Zhakibayeva, A.Z., Murtazin, Y.Z.H., Livinskiy, Y.U.N., Jabassov, A.M., 2023. Assessment of supportability, condition and the outlook for the groundwater resources use for drinking water supply in the West Kazakhstan region. Geography and Water Resources, 2, Pp. 3-15.

Adamkulova, C., Aitbaev, Z., 2024. Ensuring climate resilience in Central Asia through the establishment of a water management education program. Journal of Water and Climate Change, 15 (4), Pp. 1551-1564. https://doi.org/10.2166/wcc.2023.560

Aslam, A., Khan, S.J., Shahzad, H.M.A., 2022. Anaerobic membrane bioreactors (AnMBRs) for municipal wastewater treatment-potential benefits, constraints, and future perspectives: An updated review. Science of The Total Environment, 802, Article number 149612.

Baitova, A.A., 2021. Features of engineering and geological properties of Kazakhstan. Soils. Innovative Scientific Research, 2-1 (4), Pp. 188-196.

Beisembin, K.R., 2010. Way to increase the effective management of water resources in Kazakhstan. Science and New Technologies, 9, Pp. 28-31.

Bicudo, B., van Halem, D., Trikannad, S.A., Ferrero, G., Medema, G., 2021. Low voltage iron electrocoagulation as a tertiary treatment of municipal wastewater: Removal of enteric pathogen indicators and antibiotic-resistant bacteria. Water Research, 188, Article number 116500.

Cheng, Z., Zhao, Y., Wang, N., Song, T., Song, Z., 2022. Assessing the impact of the strictest water resources management policy on water use efficiency in China. Water, 14 (15), Article number 2291.

Delanka-Pedige, H.M.K., Munasinghe-Arachchige, S.P., Abeysiriwardana-Arachchige, I.S.A., Nirmalakhandan, N., 2021. Wastewater infrastructure for sustainable cities: Assessment based on UN sustainable development goals (SDGs). International Journal of Sustainable Development & World Ecology, 28 (3), Pp. 203-209.

Dzihora, Y., Stolyarenko, H., 2020. Membrane regeneration methods in wastewater treatment. Bulletin of Cherkasy State Technological University, 25 (2), Pp. 97-104. https://doi.org/10.24025/2306-4412.2.2020.196814

Easa, H.K., Majid, A., Al-Hatem, A.I., Othman, N.A., Bloh, A.H., Ali, A.H., Kalmatov, R., 2024. Sustainability in irrigation practices through 5G optimization of water resources. Conference of Open Innovation Association, FRUCT (Pp. 201-210). Tampere: IEEE Computer Society.

Kumar, P.M., Hong, C.S., 2022. Internet of things for secure surveillance for sewage wastewater treatment systems. Environmental Research, 203, Article number 111899.

Martini, S., Larras, F., Boyé, A., Faure, E., Aberle, N., Archambault, P., Bacouillard, L., Beisner, B.E., Bittner, L., Castella, E., Danger, M., Gauthier, O., Karp-Boss, L., Lombard, F., Maps, F., Stemmann, L., Thiébaut, E., Usseglio-Polatera, P., Vogt, M., Laviale, M., Ayata, S.D., 2021. Functional trait-based approaches as a common framework for aquatic ecologists. Limnology and Oceanography, 66 (3), Pp. 965-994.

Melnyk, V., Shafarenko, M., Ostapenko, Zh., Kosova, V., Rhuzinska, L., 2023. Interaction of microbiological and membrane technologies of wastewater treatment. Scientific Reports of the National University of Life and Environmental Sciences of Ukraine, 6 (106), Article number 2. http://dx.doi.org/10.31548/dopovidi6(106).2023.002

Myskovets, I., Molchak, Y., 2023. Environmental problems from rainfall runoff. Scientific Horizons, 26 (8), Pp. 109-116. https://doi.org/10.48077/scihor8.2023.109

Papamichael, I., Chatziparaskeva, G., Pedreño, J.N., Voukkali, I., Candel, M.B.A., Zorpas, A.A., 2022. Building a new mind set in tomorrow fashion development through circular strategy models in the framework of waste management. Current Opinion in Green and Sustainable Chemistry, 36, Article number 100638.

Pluchinotta, I., Pagano, A., Vilcan, T., Ahilan, S., Kapetas, L., Maskrey, S., Krivtsov, V., Thorne, C., O'Donnell, E., 2021. A participatory system dynamics model to investigate sustainable urban water management in Ebbsfleet Garden City. Sustainable Cities and Society, 67, Article number 102709.

Ramírez-Coronel, A.A., Mohammadi, M.J., Majdi, H.S., Zabibah, R.S., Taherian, M., Prasetio, D.B., Gabr, G.A., Asban, P., Kiani, A., Sarkohaki, S., 2023. Hospital wastewater treatment methods and its impact on human health and environments. Reviews on Environmental Health, 1, Pp. 1-6. https://doi.org/10.1515/reveh-2022-0216

Scanlon, B.R., Fakhreddine, S., Rateb, A., de Graaf, I., Famiglietti, J., Gleeson, T., Grafton, R.Q., Jobbagy, E., Kebede, S., Kolusu, S.R., Konikow, L.F., Long, D., Mekonnen, M., Schmied, H.M., Mukherjee, A., MacDonald, A., Reedy, R.C., Shamsudduha, M., Simmons, C.T., Sun, A., Taylor, R.G., Villholth, K.G., Vörösmarty, C.J., Zheng, C., 2023. Global water resources and the role of groundwater in a resilient water future. Nature Reviews Earth & Environment, 4 (2), Pp. 87-101.

Shahini, E., Bali, F., 2023. Economic impact of restructuring the municipal wastewater treatment system in San Francisco: Possibilities for application in Ukrainian realities. Scientific Bulletin of Mukachevo State University. Series "Economics", 10 (1), Pp. 29-36. https://doi.org/10.52566/msu-econ1.2023.029

Shuka, L., Çullaj, A., Shumka, S., Miho, A., Duka, S., Bachofen, R., 2011. The spatial and temporal variability of limnological properties of Bovilla reservoir (Albania). Water Resources Management, 25 (12), Pp. 3027-3039. https://doi.org/10.1007/s11269-011-9788-z

Simoes, S.G., Catarino, J., Picado, A., Lopes, T.F., di Berardino, S., Amorim, F., Gírio, F., Rangel, C.M., de Leão, T.P., 2021. Water availability and water usage solutions for electrolysis in hydrogen production. Journal of Cleaner Production, 315, Article number 128124.

Skarbøvik, E., Shumka, S., Mukaetov, D., Nagothu, U.S., 2010. Harmonised monitoring of Lake Macro Prespa as a basis for integrated water resources management. Irrigation and Drainage Systems, 24 (3-4), Pp. 223-238. https://doi.org/10.1007/s10795-010-9099-1

Suieubayeva, S., Denissova, O., Kabdulsharipova, A., Ozpen, A.I., 2022. The agricultural sector in the Republic of Kazakhstan: Analysis of the state, problems and ways of solution. Eurasian Journal of Economic and Business Studies, 4 (66), Pp. 19-31.

Tian, X., Engel, B.A., Qian, H., Hua, E., Sun, S., Wang, Y., 2021. Will reaching the maximum achievable yield potential meet future global food demand? Journal of Cleaner Production, 294, Article number 126285.

Valeyev, A.G., 2021. Use of underground and surface water resources for the economic and drinking needs of the North Kazakhstan region. Geography and Water Resources, 4, Pp. 48-52.

Wang, D., Hubacek, K., Shan, Y., Gerbens-Leenes, W., Liu, J., 2021. A review of water stress and water footprint accounting. Water, 13 (2), Article number 201.

Yespolov, T.I., Tireuov, K.M., Kerimova, U.K., 2022. Water resources in agriculture of the Republic of Kazakhstan: A view of scientists on rational use, prospects and management. Problems of AgriMarket, 3, Pp. 155-163.

Ziyabekova, L.M., 2023. Improving the water resources management system in the Republic of Kazakhstan. Astana: Academy of Public Administration under the President of the Republic of Kazakhstan.

Cite The Article: Bibigul Botantaeva, Akmaral Sagybekova, Abdi Kiyalbayev, Gulsum Espayeva, Kabdolgazy Nauruzbayaev (2024). Excess and Actual Indicators of Water Consumption and Wastewater Disposal in The Republic of Kazakhstan. *Water Conservation & Management, 8(3): 362-367.*