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Current regulation of water relations in Central Asia

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ABSTRACT

As the geopolitical context changes, the development of a certain region is based on a reform of its regulatory approaches. The field of water relations is no exception, as their effective existence requires constant analysis and innovation, including legislation. Thus, in the context of acute geopolitical and natural changes, this issue is of particular relevance both in theory and in practice. The purpose of this research paper is to assess current approaches and instruments for regulating water relations in Central Asia. The methods of analysis, comparison, deduction, generalization, and the formal-legal method were used in the study. As a result, it has been possible to uncover the content and significance of water relations, describe their object and classify them. The structure of water legislation in Central Asian countries was also investigated. This revealed the main ideas and vectors of national public policy on water protection and international cooperation to address such crisis issues. The system of laws and regulations that form the basis of the legal regulation of water relations in Central Asia has been studied. Their relevance, according to current societal conditions, is assessed. Based on the analysis conducted, own recommendations for improving the field of water regulation, namely its use, protection, and restoration, have been formed. The practical value of the work lies in the fact that the findings can be used by other researchers or legislators to improve the norms of national legislation governing water relations.

1. Introduction

The field of water relations has become particularly relevant in recent years. This is mainly due to negative changes in the environment and the critical state of water bodies. Particular attention has been paid to this issue by both academics and practitioners. Ensuring quality regulation of this area of social relations will allow the monitoring of the process of water use, depletion, and restoration. The system of regulations is a key tool in the above process. The effectiveness of legislation determines the quality of water regulation in the region. The complexity of this component is reflected in the dynamism of the social fabric. This is why the question of modernizing and improving regulations to cover all public water and environmental issues is relevant. The article tries to fill the gap in the literature regarding the comprehensive analysis of current approaches and instruments of legal regulation of water relations in the countries of Central Asia.

The study is concerned with establishing the specifics of water control and development in Central Asian countries. The problem is not a new one in society, as there is a wide range of positions regarding its prospective solution. However, there is uncertainty about the nature of national legislation on the protection of water resources in each of the Central Asian states (Orr et al., 2021). For example, W. Goldfarb (2020) revealed the methods of legal regulation of water relations. The analysis of international experience involved a comparison of approaches adopted by various states. The essence of water relations and their provision methods were effectively unveiled in the conclusion. The concept of this type of relationship was specifically described as a collection of public policies governing the protection and efficient utilization of water bodies. This definition can be used to conduct a theoretical analysis of the object of this study.

In turn, X. Wang et al. (2020) set out the vectors, most common in the policies of Central Asian states, in the field of environmental protection. They have shown that one of the leading positions is occupied by water resources, namely issues related to their use, restoration and protection. The main challenge in the approaches of these states is to ensure and develop an optimal algorithm for the consumption and reproduction of water. G.V. Manko (2021) focused on the foreign experience of water relations regulation. The peculiarities of approaches in the sphere of water resources protection in the Federal Republic of Germany were revealed. The researcher evaluated current tools used by

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this state to ensure continuity and regulation of public relations. In his view, the most effective among them is the imposition of stiff penalties involving fines and even imprisonment of the offender.

D. Langlet and A. Westholm (2021) disclosed ways in which people living in coastal areas can reduce the negative impact of their activities on the state of water bodies. They argue that shorelines should only be used for their intended purpose and that their use for the diversion of waterways should be strictly enforced. The researcher concluded that there is a need for systematic measures to protect coastal areas from natural phenomena such as erosion, landslides, destruction, or waterlogging. The findings reveal approaches whose implementation would enhance the regulation of wastewater or chemical intrusion by shorelines into water bodies. The study of transboundary water resources and their regulation under international law has been addressed by Z. Masoumeh et al. (2021). They pointed out that freshwater resources are both technically and legally fragmented. They are made up of surface watercourses as well as groundwater aquifers, which affects the specificities of their legal regulation. The researcher has established that one of the key features of water relations in international law is the transboundary nature. It determines the specificity of the interaction of different states between each other regarding water bodies adjacent to their territories. The transboundary character of water relations in Central Asia is a key feature in international law. This means that the major rivers in Central Asia, such as the Amu Darya and the Syr Darya, flow through multiple countries, and the management and use of these shared water resources require cooperation and agreements between these countries (Tursunov, 2021).

Given that all countries in Central Asia are agrarian, the problem of water use is also increasing. The problem is compounded by the existence of serious global and regional environmental problems, resulting in severe water resource cuts and water shortages. Most of the rivers in the region are transboundary and belong to a number of countries, each of which claims to use water resources. However, according to some researchers, the main problem of water use is "inefficient distribution of water resources, extensive use and the resulting imbalance in water consumption by various countries are the main causes of water scarcity in the Central Asian region" (Burchi, 2019).

Issues of joint water use and efficient distribution of water resources are trying to solve both in national and in joint documents. But it should be noted that the only country that has ratified the Helsinki Convention on the Protection and Use of Transboundary Water bodies and International Lakes is Kazakhstan. Other countries have not signed this agreement, although Kyrgyzstan, Tajikistan and Uzbekistan are considering such a possibility. Analysis of the constitutional and resulting water legislation shows that each country considers water resources an important part of the country's natural resources, historical heritage and national wealth (Zhatkanbaeva et al., 2020).

Based on the above, the study formed the objective, which was to analyse the current means of regulating water relations as defined in the national legislation of the Central Asian countries. The paper also set several tasks, namely to assess the concept of "water relations"; to reveal its object and structure; to study the normative-legal acts of Uzbekistan, Kyrgyzstan, Turkmenistan, Tajikistan and Kazakhstan in the field of water resources use, consumption and protection; to consider their current problems and propose effective ways of their solution. The research paper makes a significant contribution to the field of science by providing a comprehensive assessment of current approaches and instruments for regulating water relations in Central Asia.

2. Materials and methods

The research employed several methods, including comparison, synthesis, deduction, generalization, and the formal-legal method. The method of synthesis was used to study the properties of the Central Asian States. It was used to identify the approaches and methods that affect the development and protection of social relations in the region. It has also been used to examine the characteristics of the implementation of water regulation in Central Asia.

The method of comparison helped to reveal the common and distinctive features of the regulation of water relations in the countries of the study region. Based on this approach, a system of features specific to the area was uncovered. In addition, the method of comparison was used to study the various legal acts that make up the system of legal regulation of water relations. It was applied to study and evaluate them, identifying advantages and disadvantages. The chosen method made it possible to investigate the current state of the legal regulation of the area under study and to consider ways to improve it.

The method of deduction was used during the author's elaboration on the theoretical component of the issue. The results obtained were used to adapt them to the peculiarities of the Central Asian region. The method of deduction allowed the author to study the issues of regulating water relations in a logical and consistent order and to highlight their peculiarities in a particular region. The method of generalisation was applied in assessing the results obtained in the course of the study. Based on this method, the author investigated the current state of legal regulation of water relations in Central Asia. The method of generalization made it possible to systematize the general theoretical provisions considered, as well as the practical ones, based on which the author's position on this issue was formed. This approach was also used in the process of forming recommendations to improve the level of regulation of water relations in the region under study.

As the topic of the study relates to the legal field, the author used the formal legal method for its successful analysis. It was used to assess the content and role of specific legal acts. In addition, the author used the formal-legal method to examine the general structure of legal documents responsible for regulating water-related social relations in Central Asia. Based on this method, legal acts such as Resolution, 1803 (XVII) of The UN General Assembly (1962); the Water Code of Kazakhstan (2003); the Water Code of Kyrgyzstan (2005); the Water Code of Tajikistan (2020); the Water Code of Turkmenistan (2016) and Law of Uzbekistan On Water and Water Use (1993) were studied.

3. RESULTS

3.1. The legal regulation of water relations of the Central Asian countries

The analysis of the legal regulation of the Central Asian countries involves a study of the legislation of Uzbekistan, Kyrgyzstan, Turkmenistan, Tajikistan, and Kazakhstan. In this case, the focus has been on the water sector, which is of particular relevance today. This is due to the development of public policy vectors such as environmental protection and improvement of the environmental situation. Given the dramatic climatic and natural changes, water resources are particularly negatively affected. Therefore, a qualitative approach to their protection and the improvement of environmental safety in this area is necessary.

To analyse the effectiveness of the regulation of water relations in the legislation of the Central Asian states, it is necessary to establish the content of the concept of "water relations" and to disclose its characteristics. Consequently, the aforementioned category should be understood as social relations concerning the processes of use and protection of state water resources. Their object is a water body as a whole or a detached part of it. In this case, the entire component is the surface water, as well as the land that is covered and touched by it, e.g., the bottom or the shore part of the water body. Separate water resources, which also belong to the object of the relations under study, are closed, small in size or non-flow man-made rivers, which do not have a hydraulic connection with the water structure of the region. It should be noted that the disclosed content of a water body is important as it allows for a description of the specifics of its legal regime. Divided water bodies can be categorized as both immovable property and as a structural component of a land plot. In this case, there is a certain peculiarity

characteristic of the sphere of water relations. In particular, the alienation of water bodies in any way is not allowed. In turn, water bodies can be disposed of and transferred from one person to another (Su et al., 2020; Hoffmann et al., 2020).

Particular attention should be paid to the concept of water legislation, as it is a basic element in the structure of legal regulation of water relations. The purpose of its design and development is to ensure that citizens have the right to clean water and a favourable water environment in an unhindered and effective manner. It also covers the basics concerning the maintenance of proper water use conditions; the quality and chemical composition of surface water and groundwater in a condition that is defined by sanitary and environmental indicators. Approaches to the protection of water bodies from pollution, fouling and depletion are of particular relevance at this time in the structure of the water law. This is due to irreversible negative changes caused by human activities on the planet. Thus, the section of water law that provides for liability and punishment for the perpetrators of the above acts is subject to frequent reforms. As regards the interaction between states on the legal regulation of water relations, it is more concerned with the prevention or elimination of negative effects on waters, to preserve and develop the biodiversity of aquatic ecosystems. To be effective, the process described requires that it be based on the principle of sustainable development. This will ensure a smooth but balanced improvement of the state's economy and the environment (Zipper et al., 2020).

As in other branches of environmental law, international cooperation plays an important role in the development of water law. To a greater extent, it is based on the development of legal norms closely linked to civil, land and administrative law. They are binding on countries that have ratified such instruments. Alternative approaches, which consist of organising joint projects and implementing them at a common expense, play an important role in international cooperation. The regulation of water relations is more concerned with effectively ensuring rational consumption as well as with protecting waters from the negative impact of various human activities (Kazak, 2017; 2018). In addition, the priority of this approach is the reproduction and improvement of water resources.

Having considered the general theoretical aspects relating to the regulation of water relations in Central Asia, it is useful to examine the structure of the national legislation of these States in the selected area. In the constitutions, which have supreme legal force, in most countries of the world, natural resources, which include water resources, are the property of the State and therefore are consumed by the needs of the population and taking into account their interests. As regards the laws adopted as a result of the sovereignty of the Central Asian states, they have been created and implemented taking into account the legislative approaches of other countries, including post-Soviet countries. The specific features of local legal traditions, which are shaped by historical and cultural attributes, are particularly reflected. For their in-depth disclosure, the focus should be more specifically on each of the states (Nesiba and Cuhlova, 2021).

First of all, it should be noted that international resolutions have had a significant impact on the formation of water legislation in Uzbekistan, Kyrgyzstan, Turkmenistan, Tajikistan and Kazakhstan. Among them is Resolution, 1803 (XVII) of the UN General Assembly (1962), which granted peoples and nations the right to inalienable sovereignty over their natural wealth and resources. It thus enshrined the full inherent sovereignty of each state over its natural resources. This international provision has formed the basis for the development and improvement of some legal acts of the Central Asian republics, including their constitutions. Their constitutional approach to the regulation of water relations is revealed in the fact that land, subsoil, waters, and forests are state property and the property of citizens. Thus, the characteristic principles on which the modern legal regulation of this sector is based are the nationwide nature and public nature of nature protection approaches. The legal instruments described are the basis of the Central Asian water law framework and are then responsible for regulating it. This framework also includes the legal provisions adopted by the states for the rational consumption, protection and restoration of water resources. A characteristic feature of modern water legislation in the region under study is a system of legal regulations that are of a general nature and affect a wide range of persons. An example of such regulations is environmental protection laws that cover the whole range of natural resources, including water.

The next, more regional, category of regulations, which are the basis for the development of technical rules and instructions for water resources regulation. They ensure the development, organisation, implementation and use of facilities directly or indirectly affecting water resources. The system of these legal instruments forms specific legislation consisting of laws and codes on water relations, in particular, the Water Code of Kazakhstan (2003). This legal act covers the areas of water resources and its purpose is to ensure an environmentally sound and appropriate degree of consumption of water bodies. It provides guidelines and regulations for the management, use, and protection of water resources. The code covers various aspects related to water, including transboundary waters, water quality, water use permits, water conservation, and water pollution control. The development of technical rules and instructions for regulating water resources is an important part of implementing the Water Code. These technical rules and instructions provide specific guidelines and standards for activities such as water extraction, wastewater treatment, and water resource management.

A Water Code of Kyrgyzstan (2005) also exists and is being developed in Kyrgyzstan. It enshrines general provisions concerning the organisation of water legislation in Kyrgyzstan. Its structure systematically integrates the principles responsible for the use, protection and restoration of water resources. The code consists of 10 chapters and 98 articles, covering a wide range of issues related to water management, including the rights and obligations of water users, water use permits, water quality standards, and the establishment of water user associations. One of the key objectives of the Water Code is to ensure the sustainable use of water resources in Kyrgyzstan. To achieve this, the code establishes a system of water use permits that are issued by the state authorities and are required for any use of water resources, including for irrigation, industrial purposes, and drinking water supply. The code also sets out rules for the allocation of water resources among different users, taking into account the needs of agriculture, industry, and the environment. Another important aspect of the Water Code is the establishment of water user associations (WUAs), which are community-based organizations that are responsible for managing water resources at the local level. The code provides for the creation of WUAs in all water basins in the country and sets out their rights and responsibilities, including the right to collect fees from water users to finance their activities.

The new Water Code of Tajikistan (2020) is sufficient. This fact demonstrates an absolute change and reform of the state's approach to ensuring state policy in the regulation of water resources. The Water Code of the Republic of Tajikistan 2020 regulates social relations related to the ownership, use, and disposal of water and water bodies. The purpose of the Water Code is to ensure the rational use of water for the needs of the country. The Water Code consists of five sections, containing 24 chapters that comprehend 146 articles. In 2020, Tajikistan revised the Water Code endorsing the integrated water resources management principles and concurrently created river basin organizations. The country has also enacted the Law on Drinking Water Supply and Wastewater, which enshrines the right to drinking water as a priority. Water plays a critical role in Tajikistan's economy, contributing to the development of the most important sectors.

The Water Code of Turkmenistan (2016) has been improved. The Code regulates relations in the sphere of sustainable use and management of water resources. The main objectives of the Code are to enhance the sustainability of the water sector, promote efficient water

use, and address existing water security issues. The Code establishes rules for the use of water resources, including the allocation of water rights and the conditions for water use permits. The Code sets standards for water quality and establishes measures to protect water resources from pollution. The Code regulates the construction, operation, and maintenance of water infrastructure, including dams, reservoirs, and water supply systems. The Code establishes the legal framework for water management institutions and defines their roles and responsibilities. The Code provides for the establishment of water user associations to promote the participation of water users in water management and decision-making.

The Republic of Uzbekistan still lacks such a codified law; instead, the Law of Uzbekistan On Water and Water Use (1993) is in force. The law designates the Cabinet of Ministers of Uzbekistan, local government authorities, and designated state bodies as responsible for public governance in the field of water use. The designated state bodies regulating water use directly or through basin (territorial) administrations and other government bodies including the Ministry of Water Resources of the Republic of Uzbekistan, the State Committee of the Republic of Uzbekistan for Ecology and Environmental Protection, and the State Committee of the Republic of Uzbekistan for Geology and Mineral Resources. More integrated planning and coordination would be beneficial for improved water security and help achieve sustainability of water sector development.

The development of technical rules and instructions for water resources regulation in Central Asia can be based on both national and international levels. An assessment of the state of water resources in Central Asia, taking into account factors such as climate change, is crucial in understanding the challenges and needs for regulation. Each Central Asian country has its own water management policies, which may include regulations for reservoirs and irrigation. These policies can serve as a basis for developing technical rules and instructions (Abdullaev, 2004). Integrated water resources management: Integrated water resources management (IWRM) is an approach that promotes the coordinated development and management of water resources (Imanaliyev et al., 2022). Central Asian countries have been working on developing an analytical framework for the water sector and proposing actions for sustainable water management. The Interstate Commission for Water Coordination of Central Asia is an organization that promotes cooperation among Central Asian countries in water management. It plays a role in developing agreements and regulations for water resources management (Global Water Partnership, 2014).

To accelerating structural and institutional reforms of the economy would allow the water sector to achieve economic and financial sustainability. A study on the sustainability and long-term impact of community-managed water supply in rural Kyrgyzstan found that a Community-Based Approach (CBA) maximized the sustainability and long-term impact of its Community-Managed Water Supply (CMWS) (Wardle and Zakiriaeva, 2022). A study on the water demand-supply gap and scarcity index in Lower Amu Darya River Basin emphasized the importance of clarifying the dynamic relationship between the water supply and demand for the optimal allocation and sustainable management of regional water resources (Wang et al., 2022). The lack of institutional capacity and weak institutional governance can hinder the implementation of clean water supply programs while accelerating structural and institutional reforms of the economy can allow the water sector to achieve economic and financial sustainability. A community-based approach can also maximize the sustainability and long-term impact of community-managed water supply. Finally, clarifying the dynamic relationship between the water supply and demand is important for the optimal allocation and sustainable management of regional water resources.

The analysis of the legal acts conducted shows that there is a lack of uniform approaches to the regulation of water relations in Central Asian countries. This conclusion is based on the fact that in some states the laws and codes are up-to-date so that they cover and correspond to the current state of the ecological environment and pollution of water bodies. However, some contain completely outdated provisions. Thus, they are unable to fully provide the appropriate principles and means for the implementation of a successful state water policy. This suggests that the current level of regulation of water bodies is not perfect in Central Asian countries and therefore needs to be developed. The author has formulated recommendations that can be implemented at both the international and national levels, which have a positive impact on the overall state of the water environment in these states (Zebek, 2020).

In this case, it is advisable to develop effective both legal and organizational conditions, based on which water use will acquire rational character. This can be achieved through the introduction of water-saving forms of management, which are based on closed water use processes, and their negative impact on water resources is minimal. An environmentally-social focus on the consumption of water bodies should also be developed to ensure that citizens have the right to use a quality water environment, taking into account its ecological capacity.

To improve the effectiveness of existing regulations, their full implementation should be ensured. The principles on which this process should be based are cooperation of economic development and restoration of water bodies; rationed consumption of water resources for all types of activities; compensation of costs to economic entities associated with measures and tools for river reproduction. It is important to increase the transparency of the procedures for imposing fines and other penalties on violators of water legislation in Central Asian countries. Legislative mechanisms should be developed, possibly in the form of an interactive project that would allow for tenders for the signing of contracts and other contracts for the implementation of water protection activities. As a result, the quality of regulation of water relations in Central Asian countries is expected to improve, and public policy approaches to this issue should be reformed to take account of current conditions.

3.2. An evaluation of the effects of the present water regulations in Central Asia countries

Water resources in Central Asia vary among the countries in the region. The impact of climate change on water relations in Central Asia is a significant concern, given the region's scarcity of fresh water and related transboundary water-sharing issues. The current situation is the result of economic policies, lack of regional engagement on water use, global climate change, population growth, and increased consumption of water resources. The Central Asian drainage system has an extremely uneven distribution of water resources, which does not allow republics to take full advantage of water resources in ensuring their national interests. The major water sources of the region are located on the territory of two countries, the Kyrgyz Republic and the Republic of Tajikistan, which causes difficulties in relations with other countries such as the Republic of Kazakhstan, Turkmenistan, and the Republic of Uzbekistan (Zakharova, 2018).

The region is prone to droughts due to its semi-arid to arid climate, and the temperature has risen by 2°C since the beginning of the 20th century due to an increase in greenhouse gas emissions. This has led to an increase in glacial melting, which can initially lead to an abundance of water resources and as a result to floods, land- and mudslides in highlands. However, in the long term, the melting of glaciers can lead to a decrease in water resources, which can cause drought conditions and desiccation of water in the Aral Sea basin (Akhmetkaliyeva, 2018). However, the availability of water is at risk due to climate change. According to the 2018 report by the Intergovernmental Panel on Climate Change, temperatures in Central Asia are rising faster than the global average, and scientists predict that the region will become dryer, and more parts of it will turn into deserts (Summary for Policymakers., 2018). Glaciers are melting at unprecedented speed, and the World Bank report published in September 2021 estimated that Central Asia could see as many as 5 million internal climate migrants by 2050 (Talant, 2022).

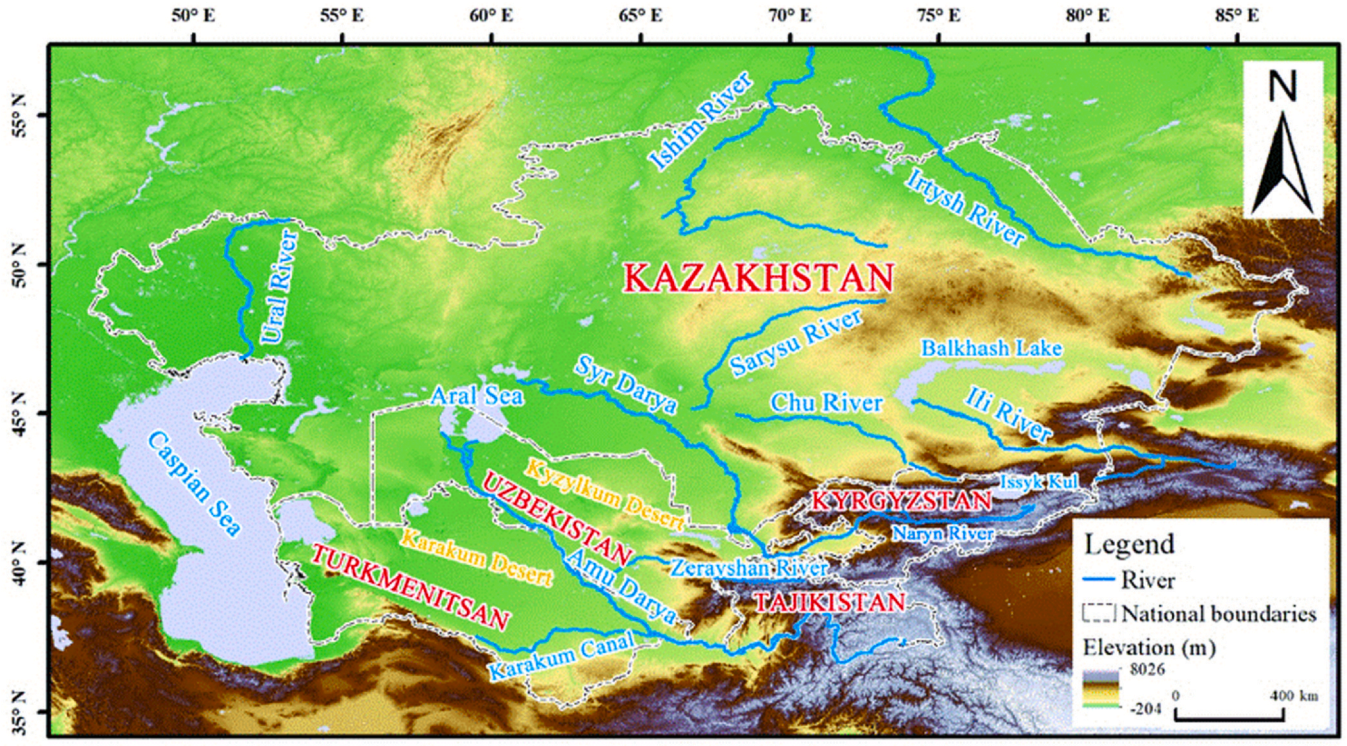

Fig. 1. Map of the geographical location of the five Central Asian countries (Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan, Kyrgyzstan).

Water distribution, consumption, and management are critical issues in Central Asia, particularly in the Kyrgyz Republic, the Republic of Tajikistan, the Republic of Kazakhstan, Turkmenistan, and the Republic of Uzbekistan (Fig. 1). Kazakhstan, being a large country, benefits from significant water resources. It is home to major rivers such as the Irtysh, Ishim, and Syr Darya, which provide surface water for irrigation, industrial use, and drinking water supply. Additionally, Kazakhstan has several lakes, including the Caspian Sea and Lake Balkhash, which further contribute to its water resources. By the end of 2023, the level of accessibility of the water supply is expected to reach 98.8% in cities and 96.3% in rural areas. In 2019, approximately 90.2% or 16.5 million people out of Kazakhstan's 18.4 million population had access to a centralized water supply. The goal is to increase this indicator to 97% in 2021 and eventually reach 100% by 2023. In rural areas, 6.5 million people or more than 84% had access to centralized water supply services in 2019. Kazakhstan exhibits "moderate water stress" (Kazakhstan: Residents…, 2023). The government has set targets to further enhance the water supply infrastructure and ensure that all citizens, both in urban and rural areas, have access to clean drinking water by 2025.

In contrast, Uzbekistan faces challenges related to water resources (Zonn et al., 2020). The country heavily relies on the Amu Darya and Syr Darya rivers for irrigation, drinking water supply, and industrial use. However, due to the arid climate and increased water demand, Uzbekistan experiences water scarcity issues. To address this, the country has implemented water management strategies such as the construction of reservoirs and canals to optimize water usage (Koybakov et al., 2020). The main water sources of Uzbekistan are the surface flow of the Amu Darya and Syr Darya rivers and their tributaries. Approximately 80% of the total water resources used by Uzbekistan fall to the share of the transboundary rivers originating from the neighbouring countries. Uzbekistan's average use of water resources over the last years is 51–53 km^3/year, which shows a substantial reduction (by 20%) of the allocated water intake due to the natural drop in river flow and water sources affected by climate change, as well as issues related to transboundary water use. Agriculture is the main water user in Uzbekistan, consuming about 90% of the total water resources. Uzbekistan has developed a national strategy for water management and development of irrigation for 2021–2023 (On approval of the concept., 2020). The priority indicators to implement the Water Concept by 2030 include increasing irrigation systems' efficiency from 0.63 to 0.73 and irrigated lands with improved water supply from 1.4 million ha to 1.6 million ha (Normatovich, 2023) The Uzbekistan government has implemented measures to develop the water supply and sanitation sector in the country, such as the PP-4040 “On additional measures for development of water supply and sanitation sector in Uzbekistan” dated November 30, 2018 (On approval of the concept., 2020).

Turkmenistan, another landlocked country in Central Asia, also faces water scarcity challenges. The country primarily relies on the Amu Darya River for irrigation purposes due to limited water availability and competing demands (Zonn et al., 2020). To manage its water resources more efficiently, Turkmenistan has adopted water-saving technologies and practices. Turkmenistan is an arid country with a very low population density and a significant portion of its territory is covered by deserts, which makes it prone to water scarcity. Agriculture is the main water user in Turkmenistan, consuming 95% of the water supply. The country's water demand is defined as 746.5 million m^3 per year, while the actual water supply is 438.0 million m3 or 60% of demand (Berdiev, 2017). Water is allocated to each farm on the basis of standard crop water requirements, and a fine is applied if a farm exceeds its allocation, based on the extra volume of water. Turkmenistan's water demand is mainly supplied by four rivers passing through several nations: Amu Darya, Atrek, Murghab, and Tedzhen. Despite having major water scarcity issues, Turkmenistan has not yet invested in desalination technology to address its water shortage (Satymov, 2022).

Tajikistan, a mountainous country in Central Asia, is known for its abundant water resources. The Vakhsh and Panj rivers, tributaries of the Amu Darya River, provide a substantial amount of water for irrigation and hydropower generation. Tajikistan has also developed large reservoirs like the Nurek Dam to store water for various purposes (Guo et al., 2016). In Tajikistan, the main water consumer is agriculture,

particularly irrigation, which accounts for up to 93% of total freshwater intake. It is worth noting that Tajikistan has not experienced a high rate of urban population growth compared to other countries. However, water consumption in urban areas is marked by negative factors such as excessive use (Haleemazi and Sediqi, 2018). This suggests that there may be issues related to water management and efficiency in urban areas. In terms of water resources management, Tajikistan adopted a new Water Code (2000), which includes market economic tools for water use and establishes a regulating body for water management. This indicates that the government is taking steps to improve water governance and ensure sustainable water use in the country.

Similarly, Kyrgyzstan, another mountainous country, benefits from significant water resources. The country has numerous lakes, including Lake Issyk-Kul and Lake Song-Kul, which contribute to its water supply. The Syr Darya and its tributaries are relied upon for irrigation and hydropower generation. To effectively utilize its water resources, Kyrgyzstan has developed reservoirs and hydroelectric power plants (Yu et al., 2019). Water distribution and consumption in the Kyrgyz Republic primarily revolve around irrigated agriculture and municipal water supply. Approximately 90% of water consumption in the Kyrgyz Republic is used for irrigated agriculture (Pingua, 2020). This highlights the importance of agriculture in the country's water usage. The water sources for irrigation are controlled by Kyrgyzstan and Tajikistan, while Kazakhstan and Uzbekistan are the main water consumers. The remaining 10% of water is used for municipal water supply (How Running Water., 2022). Access to clean and running water in rural areas has been a challenge in the Kyrgyz Republic. However, efforts are being made by organizations like the World Bank to improve water supply systems and bring clean drinking water to rural communities.

The water resources in Central Asian countries vary based on factors such as geography, climate, and river systems. Some countries face water scarcity challenges and have implemented strategies to optimize water usage, while others benefit from abundant water resources due to their mountainous landscapes. Additionally, the evolution of the cost of water in Central Asia has seen a transition from heavily subsidized water during the Soviet era to a greater emphasis on cost recovery in the post-Soviet period. This transition aims to promote sustainable water management practices and ensure the financial viability of water supply systems. Furthermore, social equity considerations play a role in determining the cost of water. Efforts are made to balance the need for cost recovery with ensuring affordable access to water for all segments of the population, especially low-income communities (Anatoliy, 2021; Getman et al., 2019).

It is important to note that the specific cost of water varies among Central Asian countries and even within regions of the same country. Factors such as local water availability, infrastructure quality, and governance practices can lead to variations in the cost of water services. Overall, the evolution of the cost of water in Central Asia is influenced by a combination of factors, including water scarcity, infrastructure development, regional cooperation, economic conditions, and social equity considerations (Mosello, 2008). Balancing these factors is crucial for achieving sustainable and affordable access to water resources in the region.

Despite the overall growth in consumption per capita, there are disparities among Central Asian countries. Some countries, such as Kazakhstan and Uzbekistan, have experienced more significant increases in consumption per capita compared to others, like Tajikistan and Kyrgyzstan. The cost of water in Central Asia has also experienced changes over time. As the region transitioned from a centralized economy to a market-oriented system, there has been a gradual shift towards cost recovery and increased user fees for water services (Yormirzoev, 2022). This transition aimed to promote sustainable water management practices and ensure the financial viability of water supply systems. The specific costs of water services, including tariffs and fees, have been influenced by factors such as infrastructure development, water scarcity challenges, and government policies.

The price of water in Central Asia is closely tied to the cost of water services and reflects the value placed on water resources. Water prices can vary among different user categories, including residential, industrial, and agricultural sectors. Factors influencing water prices include the cost of infrastructure, operation and maintenance expenses, energy costs, and the level of water demand. The price of water is subject to regulation by national water authorities, and pricing mechanisms can differ among countries in the region (Eurasian Development Bank, 2022). It is essential to consider that the availability and reliability of secondary data on water resources, cost of water, price of water, and consumption per capita may vary across Central Asian countries. Data collection methods, reporting standards, and data accessibility can differ among countries, which may affect the comparability and accuracy of the information.

The water resources, cost of water, price of water, and consumption per capita in Central Asia are complex and multifaceted issues influenced by various interrelated factors. Geographical factors, such as the availability of major rivers and lakes, play a significant role in determining water resources in the region. Economic factors, including the transition from a centralized to a market-oriented economy, impact the cost and pricing of water services. Social considerations, such as equity and affordability, are important in balancing the need for cost recovery with ensuring access to water for all segments of the population. Regulatory frameworks and regional cooperation initiatives also shape the management of water resources and the evolution of water-related policies. To ensure sustainable and equitable access to water, it is crucial to understand and address these complex factors through effective water management strategies and policies in Central Asia. Further research and collaboration among stakeholders are needed to enhance water governance and promote sustainable development in the region.

Central Asia is a region with complex water management issues, and the uneven regulation of water resources has led to conflicts between countries in the region. Unifying legislation could potentially help to address some of these issues, but it would require cooperation and agreement between the countries involved. The Aral Sea crisis is a prime example of the consequences of poor water management and the need for cooperation between countries in the region. The control of water resources in Central Asia is a complex issue that involves multiple stakeholders, including governments, international organizations, and local communities. Any effort to unify legislation and improve water management in the region would require the involvement and cooperation of all these stakeholders. The United Nations has been involved in efforts to address water management issues in Central Asia and has established the International Fund for Saving the Aral Sea (IFAS) to coordinate regional efforts to address the crisis. In summary, unifying legislation could potentially help to address the uneven regulation of water resources in Central Asia, but it would require cooperation and agreement between the countries involved. The control of water resources in the region is a complex issue that involves multiple stakeholders, and any effort to address it would require the involvement and cooperation of all these stakeholders.

4. Discussion

Several researchers from different fields, including legal experts, environmentalists and even political scientists, have analysed the specifics of water regulation. This demonstrates that the positions in scientific doctrine vary considerably. To assess them objectively, it is useful to compare these ideas of researchers with the results obtained by the author within the framework of the study. S. Wanniarachchi and R. Sarukkalige (2022) focused on such a water resource component as water management. Their study is theoretical because it studied the content and role of this component in the state policy aimed at the protection and rehabilitation of water bodies. Researchers revealed this concept as a separate sphere of domination, the purpose of which is the

qualitative provision of the population with necessary needs and benefits concerning water resources, their preservation and protection. The level of development and perfection of water management regulation affects the reproduction of the water fund, as well as the prevention of negative changes in the composition of regional waters (Luchenko and Georgiievskyi, 2021). This category is characterised by certain features of the structure, technologies and approaches to water use. The described properties are somewhat at odds with the regenerative capacity of natural aquatic ecosystems. Thus, the regulation of water management should be carried out at a high level. factor affects the development and improvement of water sources, as well as the solution to global environmental water problems. The authors agree with the above position, as they believe that water management plays an important role in the process of regulating water relations. That is why this component should be given special attention and problems related to it should be solved.

A. Jimenez et al. (2020) studied the directions of the state-legal policy concerning water consumption, protection and restoration. In their opinion, such vector, namely the realization of qualitative implementation of water and general ecological legislation, for the conservation of water funds of the state is a priority. Also, they pay attention to approaches to implementation of optimal development of state water policy in interrelation with other spheres related to the environment. For this purpose, it is necessary to organize scientific and practical measures to provide water-environmental and social benefits. The researchers point out that the proportional use of water resources is possible if the negative impact of human activity on the environment is systematically reduced. In this way, the human impact can be significantly reduced and future environmental problems can be prevented. This position is consistent with the results of this study. Its implementation will ensure the interests of a wide range of entities without significant harm to nature.

In contrast to the previous researcher, P. Burek et al. (2020) propose slightly different approaches that contribute to the development of public policy in a different vector. To a greater extent, they focus on international ways of developing a framework for the regulation of water relations in the state. Researchers have characterised such an instrument as an international treaty, the purpose of which is to cooperate with the activities of different actors to improve water quality, including in transboundary water bodies. Their approach is prioritised for use by “neighbouring states” that share access to water bodies. Thus, by creating and adopting a common approach between such states, it is possible not only to prevent the depletion or destruction of shared water resources but also to safeguard against political conflicts in these areas. The provisions of international organisations designed to protect the environment should be used to shape and provide a common approach. The idea expressed is a priority when dealing with transboundary water relations. Although this area is governed by international law, additional regional agreements will only increase the level of assurance that the generally established principles are respected (Stankevičius et al., 2020). The authors also consider it appropriate to improve how environmental expertise and monitoring take place, thereby improving the quality of the results. This aspect is important as it influences the selection of methods and approaches to improve the state of water resources and solve current water problems.

It is also important to consider the findings of F. Parween et al. (2021) in their study on public water policy. They believe that it is this component that determines the system for regulating water relations in a particular region. This position they justify by the fact that the state policy expresses the approaches of public authorities to the organisation, as well as the implementation of measures aimed at approving the basis for the rational consumption and protection of water bodies. These actors are also charged with the task of reproducing the state of water resources to normal values, which contributes to preventing disasters and environmental crises. The process of regulating public relations, including water, takes place based on provisions regulated by various legal acts. The issues of water consumption, protection, and restoration form three categories of legal documents. These documents hold strategic significance for the water sector's overall development and the establishment of comprehensive water relations. Notably, these legal documents do not operate in isolation but converge to address diverse areas, including drinking water protection, civil water supply, and river basin improvement. Simultaneously, the normative legal documents lay down fundamental principles and approaches governing the execution of state policies concerning water resources. This stance aligns with the viewpoints of the authors, as they similarly delve into the intricacies of water regulation through the classification and analysis of various legal and regulatory acts.

For their part, M. Sit et al. (2020) are not fans of either of the above positions. They propose to regulate the field of water relations based on completely new approaches, digital. This requires considerable scientific and technological work, which concerns the development of tools for tracking indicators and detecting exceedances in water bodies. This approach will minimise the influence of subjective factors on the regulation of water relations. The use of specially designed tools will make it possible to promptly monitor changes in the state’s water environment and facilitate its restoration to a normal state. The researchers propose to make the process of water regulation automatic based on digital technology and artificial intelligence. The authors believe that such an idea needs to be refined, as it contains some contention. It is not clear how an automated approach can be used to identify and prosecute those responsible for violating water legislation. This position can only be used as one of the priority tools for implementing the regulation of water relations.

One way that digital tools can help address this challenge is through the use of remote sensing and satellite imagery. These tools can be used to monitor water resources and detect changes in water quality and quantity, which can help identify potential violations of water laws (Vystavna et al., 2018). For example, satellite imagery can be used to detect illegal water withdrawals from rivers or lakes, which can then be investigated and prosecuted. Another approach is through the use of blockchain technology, which can provide a secure and transparent record of water transactions (Angara and Saripalle, 2022). This can help prevent illegal water use and ensure that water is allocated fairly and efficiently. For example, California is using blockchain technology to track water usage and ensure compliance with water regulations (State of California Tackles., 2019). However, the effectiveness of these digital tools depends on a range of factors, including the quality and availability of data, the capacity of regulatory agencies to analyze and act on this data, and the willingness of stakeholders to comply with water laws. It is also important to ensure that these tools are used in a way that is transparent, equitable, and respectful of human rights, particularly the rights of marginalized communities and indigenous peoples (Raposo, 2023).

Particular attention should be paid to the study of F. Kwadade-Cudjoe (2021), in which he studied current approaches to normative solutions to water relations problems. In his opinion, it is advisable to develop a system of legal documents, the nature of which would be hierarchical. The state must have legal acts that will enshrine general provisions on the use, protection and reproduction of water bodies. Such acts would express the approaches of public policy in general, based on which the people should implement their water-related activities. Given the high legal force of such instruments, as well as the duration of their development and adoption, additional regional norms should be formed. They can be updated more frequently, thereby meeting the challenges of modern society. The authors agree that it is advisable to specify approaches to water regulation in local acts, as they are more flexible. Based on the disclosed method, it is possible to form a qualitative state regulatory framework in the sphere of water relations. Constant updating of the content of normative legal acts, instructions and noon will allow avoiding the formation of collisions or gaps in the system of legislation.

The role of non-state actors in the regulation of water relations in Central Asia is significant and has been increasing in recent years. NGOs play an important role in advocating for the rights of local communities and promoting sustainable water management practices. For example, the International Water Management Institute (IWMI) has been working with local NGOs in Central Asia to develop community-based water management systems that are more efficient and sustainable. Similarly, the Aral Sea Foundation, a German NGO, has been working with local communities in Uzbekistan to promote sustainable water use and restore the Aral Sea (Xenarios et al., 2019). Communities also play a crucial role in the regulation of water relations in Central Asia. In many cases, they are the primary users of water resources and are directly affected by changes in water availability. As a result, they have a vested interest in ensuring that water resources are managed sustainably. For example, in Kyrgyzstan, local communities have been involved in the development of water user associations, which are responsible for managing water resources at the local level. Private companies also play a role in the regulation of water relations in Central Asia (Sehring, 2020). In some cases, they are involved in the construction and operation of water infrastructure, such as dams and irrigation systems (Ziganshina, 2022). However, there are concerns that private companies may prioritize profit over sustainable water management practices, which could lead to negative impacts on local communities and the environment.

The discussion reveals a set of ideas about approaches to the regulation of water relations in the state. This demonstrates that it is possible to use each of them alone or in combination. In this way, it will be possible to ensure the interests of a wide range of people, while at the same time contributing to the reduction of negative impacts on water bodies, their protection and purification.

5. Conclusions

The study has established that water regulation in Central Asia is uneven. This conclusion was reached through a theoretical analysis of the concepts of “water relations” and “water legislation”. It was revealed what properties characterise these concepts, as well as what factors influence them. To assess the effectiveness of legal regulation of water resources in Uzbekistan, Kyrgyzstan, Turkmenistan, Tajikistan and Kazakhstan, their national legislation was studied. The main vectors of state policy of the above states in the field of use, protection and restoration of water bodies were investigated. It has been established that their approaches are characterized by common features, as all of them aim at rational consumption and exploitation of water resources for the realization of different types of activities.

However, an analysis of the legislation of the Central Asian states shows that in some of them, the regulations are outdated and in need of updating. This is particularly the case in the Republic of Uzbekistan, which still lacks a separate codified law in the form of the Water Code. In turn, in other states, national legislation has changed. There is no doubt that this has a positive impact on the quality of legal provisions for water relations. However, this level is not perfect and therefore could be improved by introducing modern methods. The author has proposed to change the tendering procedures as well as the financing of activities related to the use or protection of water resources. It is proved that this issue is relevant today as the state of the environment in Central Asia, as well as water bodies, depends on it.

The priority for each of the countries belonging to the selected region to rapidly and effectively modernise the process of water regulation is high. At the same time, the network state of rivers and other waters within Central Asia depends on the combined activities and policies of all states in the region. Thus, it is important to reform approaches in each of them to increase the level of protection and reduce the negative impact on water resources. The issue under study is not exhaustive, so it needs to be explored further, in particular in the context of the analysis it is advisable to use digital technologies in the process of protecting the environment, namely water bodies.

References

Abdullaev, I., 2004. Water management policies of Central Asian countries. Integr. Or. Disintegration. Proc. Pap. Presente USDS Organ. Conf. Celebr. 10, 1–14.

Akhmetkaliyeva, S. 2018. Impacts of Climate Change in Central Asia. ⟨https://www.eurasian-research.org/publication/impacts-of-climate-change-in-central-asia/⟩.

Anatoliy, G., 2021. Access to justice for the protection of environmental rights in ukraine. Access Justice East. Eur. 4 (2), 118–127.

Angara, J.S., Saripalle, R.S., 2022. Towards a virtual water currency for industrial products using blockchain technology. Water Policy 24 (6), 923–941.

Berdiev, A. 2017. National report of Turkmenistan on regional water partnership. Republic of Turkmenistan—Country Report. ⟨https://www.gwp.org/globalassets/global/gwp-cacena_files/en/pdf/turkmenistan.pdf⟩.

Burchi, S., 2019. International and domestic water law in Central Asia-implementing international law obligations regarding transboundary waters: the role of domestic water legislation. Cent. Asian J. Water Res. 4 (2), 59–68.

Burek, P., Satoh, Y., Kahil, T., Tang, T., Greve, P., Smilovic, M., Wada, Y., 2020. Development of the Community Water Model (CWatM v1.04) – a high-resolution hydrological model for global and regional assessment of integrated water resources management. Geosci. Model Dev. 13 (7), 3267–3298.

Eurasian Development Bank. 2022. The economy of Central Asia: A fresh perspective. ⟨https://eabr.org/en/analytics/all-publications/the-economy-of-central-asia-a-fresh-perspective/⟩.

Getman, A.P., Getman, Y.A., Lozo, V.I., 2019. Climate protection laws: European reality and Ukrainian prospects. Environ. Policy Law 49 (2-3), 190–195.

Global Water Partnership. 2014. Integrated water resources management in Central Asia: The challenges of managing large transboundary rivers. ⟨https://www.gwp.org/globalassets/global/toolbox/publications/technical-focus-papers/05-integrated-water-resources-management-in-central-asia.pdf⟩.

Goldfarb, W., 2020. Water law 2. CRC Press, pp. 243–247.

Guo, L., Zhou, H., Xia, Z., Huang, F., 2016. Evolution, opportunity and challenges of transboundary water and energy problems in Central Asia. SpringerPlus *5*, 1918.

Haleemzai, H.A., Sediqi, A., 2018. Impacts of water development plans on regional water cooperation—a case study of amu river basin. J. Water Resour. Prot. 10 (10), 1012–1030.

Hoffmann, S., Feldmann, U., Bach, P.M., Binz, C., Farrelly, M., Frantzeskaki, N., Udert, K.M., 2020. A research agenda for the future of urban water management: exploring the potential of nongrid, small-grid, and hybrid solutions. Environ. Sci. Technol. 54 (9), 5312–5322.

How Running Water is Changing Rural Lives in the Kyrgyz Republic and Uzbekistan. 2022. ⟨https://www.worldbank.org/en/news/feature/2022/03/22/how-running-water-is-changing-rural-lives-in-kyrgyz-republic-and-uzbekistan⟩.

Imanaliyev, T., Koybakov, S., Karlykhanov, O., Amanbayeva, B., Bakiyev, M., 2022. Prospects for the development of water resources management in the south of kazakhstan. News of the National Academy of Sciences of the Republic of Kazakhstan. Ser. Geol. Tech. Sci. 6 (456), 80–95.

Jimenez, A., Saikia, P., Gine, R., Avello, P., Leten, J., Liss Lymer, B., Ward, R., 2020. Unpacking water governance: A framework for practitioners. Water 12 (3), 827.

Kazak, R., 2017. Development of legal norms on biodiversity protection reflecting eu trends. Environ. Policy Law 47 (3-4), 147–152.

Kazak, R., 2018. Periodization of nature protection in Ukraine in the latter half of the 20th century: Legal aspect. Espacios 39, 19.

Kazakhstan: Residents suffer from lack of water. 2023. ⟨https://novastan.org/en/kazakhstan/kazakhstan-residents-suffer-from-lack-of-water/⟩.

Koybakov, S.M., Maliktaiuly, M., Joldassov, S.K., Sarbasova, G.A., Yeskermessov, Z., 2020. New methods to protect year-around operation canals from snow. News of the National Academy of Sciences of the Republic of Kazakhstan. Ser. Geol. Tech. Sci. 6 (444), 102–109.

Kwadade-Cudjoe, F., 2021. Assessment of sustainable water resources management using water rights database system. Modern perspectives in Economics. Bus. Manag. 10, 58–79.

Langlet, D., Westholm, A., 2021. Realizing the social dimension of EU coastal water management. Sustainability 13 (4), 2261.

Law of Uzbekistan on water and water use. 1993. ⟨https://lex.uz/docs/93202⟩.

Luchenko, D., Georgiievskyi, I., 2021. Administrative restrictions in ports: practice of crew rotations during covid-19 pandemic. Lex. Portus 7 (3), 7–31.

Manko, G.V., 2021. Foreign experience in implementation of administrative procedures in the field of environmental and natural resources protection. Expert. Paradig. Leg. Sci. Public Adm. 3 (15), 175–181.

Masoumeh, Z., Bozorg-Haddad, O., Singh, V.P., 2021. Rights and international laws of transboundary water resources. Econ. Political Soc. Issues Water Resour. 1, 103–129.

Mosello, B., 2008. Water in Central Asia: a prospect of conflict or cooperation? J. Public Int. Aff. *19*, 151–174.

Nesiba, J., Cuhlova, R., 2021. Analysis of legislative acts in water management. Glob. J. Environ. Sci. Manag. 7 (4), 587–598.

Normatovich, A.S., 2023. Indicators for managing the efficiency of water consumption in agriculture in the regions of Uzbekistan. Asian. J. Technol. Manag. Res. 13 (1), 117–121.

On Approval of The Concept of Development of Water Management Sector of The Republic of Uzbekistan for 2020-2030. 2020. https://water.gov.uz/en/posts/1545735855/396.

Orr, H.G., Ekstrom, M., Charlton, M.B., Peat, K.L., Fowler, H.J., 2021. Using high-resolution climate change information in water management: a decision-makers' perspective. Philos. Trans. R. Soc. A 379 (2195), 20–21.

Parween, F., Kumari, P., Singh, A., 2021. Irrigation water pricing policies and water resources management. Water Policy 23 (1), 130–141.

Pingua, R., 2020. The distribution of water resources in Central Asia. World Aff. J. Int. Issues 24 (1), 118–131.
Raposo, V.L., 2023. Eugenics in Europe – the history of development and reasons for abandoning the doctrine of human selection on the European continent. European. Chronicle 8 (1), 5–15.
Resolution 1803 (XVII) of The UN General Assembly. 1962. https://legal.un.org/avl/pdf/ha/ga_1803/ga_1803_ph_r.pdf.
Satymov, R. 2022. Water shortage: Can desalination help Turkmenistan? 〈https://progres.online/en/society/water-shortage-can-desalination-help-turkmenistan/〉.
Sehring, J., 2020. Unequal distribution: academic knowledge production on water governance in Central Asia. Water Secur. 9, 100057.
Sit, M., Demiray, B.Z., Xiang, Z., Ewing, G.J., Sermet, Y., Demir, I., 2020. A comprehensive review of deep learning applications in hydrology and water resources. Water Sci. Technol. 82 (12), 2635–2670.
Stankevičius, A., Novikovas, A., Bakaveckas, A., Petryshyn, O., 2020. Eu waste regulation in the context of the circular economy: peculiarities of interaction. Entrepreneurship and Sustainability. Issues 8 (2), 533–545.
State of California Tackles Drought with IoT & Blockchain. 2019. 〈https://newsroom.ibm.com/2019-02-08-State-of-California-Tackles-Drought-with-IoT-Blockchain〉.
Su, Y., Gao, W., Guan, D., Zuo, T.A., 2020. Achieving urban water security: a review of water management approach from technology perspective. Water Resour. Manag. 34 (13), 4163–4179.
Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments. 2018. 〈https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/#:~:text=Besides%20Global%20Warming%20of%201.5,land%20management%2C%20food%20security%2C%20and〉.
Talant, B. 2022. How Is Climate Change Affecting Central Asia? https://www.rferl.org/a/central-asia-climate-change-water-talant/31924317.html.
Tursunov, A., 2021. Insights for central asia from the principles and disputes of international water law. Review of Law. Sciences 2, 183–189.
Vystavna, Y., Cherkashyna, M., van der Valk, M.R., 2018. Water laws of Georgia, Moldova and Ukraine: current problems and integration with EU legislation. Water Int. 43 (3), 424–435.
Wang, X., Chen, Y., Li, Z., Fang, G., Wang, Y., 2020. Development and utilization of water resources and assessment of water security in Central Asia. Agric. Water Manag. 240, 106–109.
Wang, Z., Huang, Y., Liu, T., Zan, C., Ling, Y., Guo, C., 2022. Analysis of the water demand-supply gap and scarcity index in lower Amu Darya River Basin. Cent. Asia. Int. J. Environ. Res. Public Health 19 (2), 743.
Wanniarachchi, S., Sarukkalige, R., 2022. A review on evapotranspiration estimation in agricultural water management: past, present, and future. Hydrology 9 (7), 123.
Wardle, C., Zakiriaeva, N., 2022. Sustainability and long-term impact of community-managed water supply in rural Kyrgyzstan, central Asia. Waterlines 41 (1), 51–64.
Water Code of Kazakhstan. 2003. 〈https://online.zakon.kz/Document/?doc_id=1042116〉.
Water Code of Kyrgyzstan. 2005. 〈http://cbd.minjust.gov.kg/act/view/ru-ru/1605〉.
Water Code of Tajikistan. 2020. 〈http://ncz.tj/content/〉〈водный-кодекс-республики-таджикистан-0〉.
Water Code of Turkmenistan. 2016. 〈https://continent-online.com/Document/?doc_id=38999429〉.
Xenarios, S., Schmidt-Vogt, D., Qadir, M., Janusz-Pawletta, B., Abdullaev, I., 2019. The Aral Sea basin: water for sustainable development in Central Asia 252 Routledge.
Yormirzoev, M., 2022. Economic growth and productivity performance in Central Asia. Comp. Econ. Stud. *64*, 520–539.
Yu, Y., Pi, Y., Yu, X., Ta, Zh, Sun, L., Disse, M., Zeng, F., Li, Y., Chen, X., Yu, R., 2019. Climate change, water resources and sustainable development in the arid and semi-arid lands of Central Asia in the past 30 years. J. Arid Land *11*, 1–14.
Zakharova, K.S., 2018. Modern hydro-energy problems in Central Asia. Post-Soviet. Issues 5 (3), 298–308.
Zebek, E., 2020. Water-law permission as an administrative and legal instrument for the management and protection of water resources. Acta Sci. Pol. Adm. Locorum 19 (2), 119–130.
Zhatkanbaeva, A., Jangabulova, A.K., Aydarkhanova, K., 2020. Problems of legal regulation of the use of transboundary water bodies in Central Asia. J. Actual Probl. Jurisprud. 1 (93), 94–101.
Ziganshina, D., 2022. Water law reforms in Central Asian Countries: recent trends and developments. Chinese. J. Environ. Law 6 (2), 295–322.
Zipper, S.C., Jaramillo, F., Wang-Erlandsson, L., Cornell, S.E., Gleeson, T., Porkka, M., Gordon, L., 2020. Integrating the water planetary boundary with water management from local to global scales. Earth'S. Future 8 (2), 1–23.
Zonn, I.S., Zhiltsov, S.S., Semenov, A.V., 2020. Evolution of water resources management in Central Asia. In: Zonn, I.S., Zhiltsov, S.S., Kostianoy, A.G., Semenov, A.V. (Eds.), Water resources management in Central Asia. Cahm: Springer, pp. 31–46.