

PAPER • OPEN ACCESS

International water development problems in the transboundary Irtys River basin: “new” solutions to old problems

To cite this article: B A Krasnoyarova *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **381** 012049

View the [article online](#) for updates and enhancements.

International water development problems in the transboundary Irtysh River basin: "new" solutions to old problems

B A Krasnoyarova^{1,2}, Y I Vinokurov^{1,2} and T V Antyufeeva²

¹Institute for Water and Environmental Problems SB RAS, Russia, Barnaul

²Altai state University, Russia, Barnaul

E-mail: bella@iwep.ru, iwep@iwep.ru, atv-08@mail.ru

Abstract. The article discusses the problems of water use in the transboundary Irtysh River basin and the characteristics of their manifestation in different national segments. In the basin countries, separate subsystems are distinguished by the nature of the formation and use of water resources. There is a growing position of the Chinese side; it has significantly increased the withdrawal of water resources from Kara-Irtysh, thereby, violating the state of the aquatic ecosystem of the receiving Lake Zaisan and, accordingly, the operation of the Upper Irtysh reservoirs and hydroelectric power plants. In the Russian Federation, the situation is the most complicated in the Tobol River basin, where large industrial centers of the Trans-Urals are located; in Kazakhstan – in the Ishim river basin due to a significant development of its capital Astana (Nur-Sultan). We have analyzed the largest projects on the Ob water transfer to the Irtysh river basin proposed by the Chinese and Kazakh scientists and designers. The Russian side had a somewhat passive role in this process, which focuses mainly on solving specific problems, in particular, providing water resources to the city of Omsk through the construction of the Krasnogorodsk water reservoir at the Irtysh and the inter-basin transfer of river water from the Urals, Kama and Irtysh to the Tobol River basin. Emphasis is placed on the need to establish tripartite institutions for regulating water relations and international cooperation in the field of water use in the Irtysh river basin.

1. Introduction

The UN International Decade for Action "Water for Life" for 2005-2015 has recently ended. The goals of the Decade were aimed at increasing the attention of the world community to water-related issues, water conservation and ensuring the proper quality of life for the population of the planet. Among the many challenges addressed by the strategic documents of the Decade, the further development of international cooperation on water and water-related issues occupied an important place [1]. This is quite natural, considering that more than 250 river basins cross the borders of two or more countries and are home to more than 40% of the world's population. Despite some international agreements in this area, issues of international water allocation and cooperation remain topical in most transboundary basins.

The research object is the Irtysh River. It is the largest tributary of the Ob, which quite recently has contended for its "leadership right". Until the middle of the past century, the Irtysh claimed the status of the main river (according to paleogeographical conditions of formation), and only after long



scientific debates and approvals it was accepted that the Ob River still flows into the Gulf of Ob and the Kara Sea, and the Irtysh River is its largest left tributary. The status of the influx does not diminish the biosphere and economic importance of the Irtysh. The Irtysh is a transboundary river basin. Its territory is located within the borders of three, even four states since the sources of the Irtysh are located in almost uninhabited areas of Mongolia. However, the main territory of the basin is rather disproportionately distributed among three countries, Kazakhstan, China and Russia, and approximately 15.0 million people live within the basin.

The Irtysh River is used in economic activities, there are three large and many small hydroelectric power plants (HPPs), reservoirs and canals located on its watercourses. It is a donor for almost the entire northeastern and eastern Kazakhstan as well as northwestern Xinjiang-Uyghur region of China. The Irtysh tributaries, the rivers Tobol and Ishim, provide water to the major cities of the Trans-Urals and the capital of Kazakhstan, Astana (Nur-Sultan), and the Irtysh itself is the main source of water supply to the Russian million-plus city of Omsk. It is difficult to overestimate the irrigation importance of the Irtysh basin, which is located mainly in the zone of insufficient moisture and is a source of irrigation in both Kazakhstan and the south of Omsk oblast.

2. Models and methods

The methodological basis for the study of the transboundary river basin of the Irtysh is the system-dialectical approach and structural-analytical methods for the study of river basins, and their territorial organization. The system-dialectical approach allows us to consider the basin as a natural-economic system that functions in the evolutionary regime of formation and development of interactions between its natural basis and anthropogenic component, constantly changing and regulating possibilities of self-restoration of the aquatic ecosystem. Structural and analytical methods allowed for the identification of individual structures/segments of the basin and the peculiarities of manifestation of various water-environmental and water management problems associated with both the excessive extraction of water resources and their chemical, physical and biological pollution. The severity of these problems differs significantly in the individual national segments of the Irtysh unified management system.

3. Results and discussion

3.1. Peculiarities of water management systems functioning in the Irtysh River basin

The Irtysh River with its main tributaries, the Tobol and Ishim, is a large watercourse. National water management systems (WMS) and subsystems have been identified in its river basin:

In China, the Kara-Irtysh water management system meets the needs of the population, industry, agriculture, energy, and tourism of the Xinjiang Uyghur Autonomous Region (XUAR). At present, the region is actively developing, and the "Black Irtysh - Karamay - Urumqi" canal system has been launched to provide oil production facilities in Karamay and irrigation development in the northwestern regions. For economic purposes, approximately 30% of the Kara-Irtysh flow is already withdrawn, and further growth of water consumption up to 50% is expected.

On the territory of the Republic of Kazakhstan, in the basin of the Irtysh River, there are three WMS, the Irtysh (Ertisskaya), Ishim (Yesilskaya) and Tobol-Torgay (Tobyl-Torgayskaya); the latter, together with the basin of the Tobol River, also includes the closed Torgai River basin. The condition of the Irtysh WMS in Kazakhstan is assessed as slightly transformed; the Tobol-Torgayskaya – as moderately transformed, and only the Ishimskaya WMS is a territory with a large anthropogenically transformed river flow [2]. In our opinion, this assessment of the Irtysh WMS is very optimistic, especially in the conditions of increasing flow withdrawal from the Kara-Irtysh. The length of the Irtysh in Kazakhstan is 1637 km; it is very heterogeneous. Within this WMS, we have identified three subsystems that differ significantly in terms of the nature of the hydrological flow, the presence of water management problems and the reasons for their occurrence. The first subsystem includes a part of Kara-Irtysh from the Buran village, Lake Zaisan, which receives its flow, and the source of the

Irtysch itself. The ecosystem of Lake Zaisan can serve as an indicator of the subsystem state and is largely determined by the level of water content, which in recent years has been constantly decreasing due to the increased water withdrawal in China [3, 4]. The second subsystem is a cascade of reservoirs [5]. The largest ones are the Bukhtarma (design volume is 49.6 km³), Ust-Kamenogorsk (0.66 km³) and Shulbinsk (2.39 km³). This subsystem from the upstream of the Bukhtarma reservoir to the downstream of the Shulbinsk reservoir functions practically as a hydraulic structure. The Irtysch HPP cascade annually generates over 80% of the Republic's hydropower, and the reservoirs perform a water-regulating function, removing sharp peaks of flash floods and floods in the spring-summer period as well as increasing the flow of water to generate electricity in winter. From the Shulbinsk reservoir to the city of Pavlodar, the Irtysch flow is free, and then part of the flow (70 m³/sec) is diverted along the Irtysch-Karaganda channel to the central part of Kazakhstan to meet the growing needs of the capital city of Astana, industrial production in Karaganda and agriculture in North Kazakhstan. At the same time, this should consider the growing demand for water resources of metallurgical production and electric power industry of the Pavlodar region and the possible construction of an NPP (nuclear power plant) in the city of Kurchatov [6, 7]. It is this section of the Irtysch basin that constitutes the third final subsystem of the Irtysch EMS. Typical substances, which concentrations periodically exceed the MPC in water bodies of the Irtysch River basin, are organic substances, oil products, phenols, ammonium nitrogen, and compounds of iron, copper, zinc, and manganese [8].

The Ishim WMS is focused on the water supply of Astana, Petropavlovsk and other cities of North Kazakhstan, as well as the agricultural water supply of its central regions. Water resources of the Ishim River are formed mainly within Kazakhstan, and more than 65% of its flow has run previously to Russia, to the south of Tyumen Oblast. Currently, the allocation of the Ishim annual flow has changed. The largest one, the Astana (Vyacheslav) reservoir with a useful volume of 375.4 million m³, has recently been the main source of water supply in Astana, but nowadays it does not cover the growing needs of the city. Since 2001, to replenish the Astana reservoir, a daily water volume of 288,000 m³ is transferred from the K.I. Satpayev canal to the upper reaches of the Ishim River [9]. As a result, both water intake and pollution of water bodies in the basin have increased. Their quality is assessed as "moderately polluted" and "polluted". The main pollutants in the Ishim River basin are manganese and copper.

The Tobol-Torgay WMS has a high flow regulation with significant water withdrawal to meet the needs of mining and processing plants, towns and villages with the same high level of wear of hydraulic structures built in the second half of the twentieth century. Within Kazakhstan, the Tobol is regulated by seven reservoirs with a total volume of 1.46 km³, of which only the largest Verkhnetobolsk (816.6 million m³) and Karatomarsk (586.0 million m³) reservoirs are perennial, and the other ones are seasonal [10]. Water quality in the Tobol River and reservoirs is moderately polluted with an excess of MACs for copper and nitrite nitrogen [11].

In the Russian part of the transboundary basin of the Irtysch River, three large water management systems can be identified: the Irtysch River itself from the border with Kazakhstan to the mouth at Khanty-Mansiysk city; the Tobol River and the Ishim River.

The Irtysch WMS involves the Irtysch, its right tributaries, the Om, Tara, etc., and a number of hydrological systems, dams, etc., located mainly in Omsk and Tyumen oblasts. They regulate flow for water supply and irrigation purposes. At the same time, the capacity of reservoirs is not sufficient to ensure uninterrupted water supply to the city of Omsk and maintain the ecological and sanitary state of the Irtysch water.

The Ishim River basin is the least loaded part of the Russian segment of the Irtysch basin. It is represented by Ishim River, which is a source of water supply for the population and the economy of the city of Ishim and Ust-Ishimsky Region, as well as six small reservoirs, which regulate the flow and accumulate water for irrigation and household consumption. The main problems in the basin are associated with high fluctuations in the water level, as well as the increased withdrawal of water

resources in Kazakhstan. In recent years, the quality of river water has declined; the self-purification ability is insufficient, and there are practically no additional inflows in the Russian part.

In the Russian part of the Irtysh basin, the most problematic is the Tobol WMS. The Iset and Miass rivers, as its tributaries, allocate large industrial cities, such as Yekaterinburg, Chelyabinsk and Nizhny Tagil, which have a high level of water consumption and water disposal. In some parts of the basin (the Tagil and Miass rivers), the share of water withdrawal reaches 50-70% of the flow. To solve the problems of water supply in the basin, more than 600 reservoirs of different capacities were constructed, which are distinguished by long-term operation and high wear. The oldest reservoirs, the Nevyansk and Alapaevsk, were built in 1696-1700.

Organic substances, oil products, phenols, ammonium nitrogen, iron, copper, zinc, and manganese compounds are typical substances, which concentrations are steady or periodically higher than MPC in water bodies of the Irtysh basin. The situation with high metal concentration is typical of both the Tobol and Irtysh rivers; the excess of fish and water management MPCs is found both on the border of Russia and Kazakhstan, and at the estuaries of these rivers. In recent years, there has been a reduction in the discharge of pollutants into water bodies, but the content of iron, copper, zinc, and manganese compounds remains high [12].

3.2. Common problems and their feasible solutions

The main problems in all national segments of the transboundary basin of the Irtysh River are quite traditional and related primarily to the depletion of water resources due to the increased water withdrawal in China and Kazakhstan; reservoir evaporation losses at the Upper Irtysh HPPs and other hydraulic structures; a high level of water pollution with heavy metals and oil products from the mining and metallurgical and thermal power enterprises operating in the upper reaches of the Irtysh river; radiation contamination of the territory due to the operation of the Semipalatinsk test site, the Lobnor test site in the People's Republic of China, production association "Mayak", etc; a highly regulated river flow; emergency state of hydraulic structures; the lack of effective legal mechanisms for regulating water use in transboundary countries. They can be resolved in various ways: technological, i.e. introduction of technological innovations at all stages of water management; technical, i.e. replacement of outdated hydraulic structures and equipment; and institutional, i.e. improvement of existing and establishment of new water management institutions. The latter is especially important in the context of the international transboundary basin located within the borders of such countries as Kazakhstan, China and Russia with emerging institutions of ownership of natural resources and insufficient experience in international cooperation. The situation is complicated by the position of China, which is not a party to international conventions in the field of water management and refuses Russia's participation in water allocation in the basin of the Irtysh River.

Among the ways of solving water management problems and preserving the Irtysh basin ecosystem, projects of inter-basin and intra-basin water resources transfer are not the least mentioned. The construction and operation of the Irtysh-Karaganda canal named after K.I. Satpayev in Kazakhstan, the Kara-Irtysh-Karamay and Urumqi canals in China can be named as examples of the projects implemented. In addition, since the 1960s, many projects of "transfers" within the Ob-Irtysh basin have been discussed. The most ambitious of them is connected with the Main Channel for the transfer of a part of the flow of Siberian rivers, which construction was to save Lake Aral and provide water to the population and economy of Kazakhstan and other then-Union republics of Central Asia. There were also projects on the transfer of the Ob waters into the Irtysh basin, e.g. connected with the construction of the Belokatunskaya HPP [13] and the transfer of a part of the Tikhaya River flow (the Katun River basin). More modern projects for the construction of the Trans-Kazakhstan Canal with four additional branches, Astana, Petropavlovsk, Kostanay, and Aktyubinsk, can also be named. In addition, to preserve Lake Balkhash, which is of national importance for the country, a scenario of transferring a part of the Irtysh flow towards the Bukhtarma River-Lake Balkhash has been proposed [14].

All projects consider the Irtysh River basin as a potential donor basin; to preserve and replenish the basin, two options have been proposed. The first option was proposed by China and first announced in the Russian-language press by the Minister of Agriculture of the Russian Federation Alexander Tkachev. It provided for the withdrawal of 70 million m³ of floodwater from the Gilevo reservoir of the Aleysk irrigation system and the Kulunda Canal feeding from the Ob reservoir [15]. In 2018, the Chinese environmentalists returned to the project, turning to the Russian Prime Minister Dmitry Medvedev to support the construction of a water pipeline from Altai Krai to China. The project proposed for Russia includes two stages. The first stage, until 2026, involves the construction of the first stage of the Russia-Kazakhstan-Western China main water pipeline with a capacity of 600-700 million m³ and a network of distribution pipelines. At the second stage, until 2040, "modern agrotechnical" and other projects aimed at "increasing the efficiency of water management in the border areas of China, Kazakhstan and Russia" can be implemented. It is also expected to construct the second stage of the main water pipeline, which will increase the total capacity to 1.8-2.4 billion cubic meters per year. According to experts' estimates, the length of the water pipeline from Russia to China will be 1.2-1.5 thousand km. [15]. Infrastructure development at the first stage is proposed in the form of an interstate project between China, Russia and Kazakhstan in the status of state property and under the control of a single operator. At the second stage, it is planned to involve water users and water treatment facilities in financing. The water pipeline built at the first stage will make it possible to eliminate at least 5% of the water deficit in China. Upon completion of the second stage of the project, the water deficit in the border areas of China and Kazakhstan should be reduced by at least 50%. Russia can get "financial advantages, as well as modernization of the water supply system of Altai Krai, reduction of damage from floods, capacity utilization of suppliers and contractors, and access to modern agricultural technologies" [16].

The second scenario is proposed by Kazakh scientists. It is based on the transfer of a part of the Katun flow (one of the sources of the Ob River) to the Bukhtarma reservoir. Thus, "the Katun water, entering the Irtysh, will be used to generate electric power at the hydroelectric power station, from which the Russian party will have the share, and then it will cross Kazakhstan and run through Omsk city to the Ob, compensating Russians for the shortage of water. The volume of flow transfer is approximately 5 km³". At the same time, Kazakh scientists consider that "no one loses anything in the project implementation", but the Republic of Kazakhstan "compensates for the amount of water that is taken by China" [17, 18].

Closer to this scenario, but more ambitious, is the project on the establishment of the Interstate Water and Energy Consortium "Irtysh", proposed in late 2017 by the Institute of Technological Holding (Kazakhstan) [19]. According to the developers, the project is aimed at normalizing water regime of the Irtysh, Ishim, Altai, and Xinjiang; it is integrative with the participation of the states within the SCO + NURLY ZHOL + Economic Belt program and includes the construction of two water lines. The first one envisages the transfer of 4 km³ of water from the Ob (Novosibirsk) reservoir to the Irtysh downstream Pavlodar. The second water line is expected to transfer 1-5 km³ from the upper reaches of the Katun River downstream the Bukhtarma reservoir, and then to the Ishim to provide water supply in Astana (2 km³) and Karaganda. The Russian interests in this project can be realized by the transfer of 3 km³ to Omsk Oblast across the Irtysh, 0.5 km³ to the Tobol and 1.0 km³ to the Ishim. At the same time, it is not quite clear what amount of transferred water will reach the final Russian consumer, considering the likely additional withdrawal and losses for evaporation and filtration.

The Russian side is currently taking a somewhat passive position, neither supporting nor denying any of these projects. At the same time, scientists and representatives of the water sector have noted their insufficient elaboration and weak consideration of local flow conditions, as well as the negative impact of their implementation on water supply in the southern regions of Omsk Oblast and the city of Omsk, aggravating the current difficult water-related situation. The city is already experiencing a shortage of water resources, especially in low-water years and periods. The construction of the Krasnogorodsk node started in 2011 downstream the city of Omsk is still far from completion and

unlikely to solve all the problems of the Omsk Irtysh region, although there were suggestions for less radical interference in the hydrological regime of the river by building underwater artificial rapids and limiting sand production up to a complete ban in low-water years.

Acute issues of increasing water availability in large cities and industrial centers located in the Tobol basin are being addressed through the construction of new and reconstruction of existing reservoirs and the planned transfer of the Tobol, Ural and Kama water flow.

4. Conclusion

In conclusion, the conflicting interests of three countries within the basin should be noted; they can only be solved at the supranational level by searching for consensus, coordinating the interests of all the participants in water relations and preserving all natural systems in the basin.

These issues cover not only the quantity and quality of water flow in different periods of the hydrological year, the state of aquatic biological resources, and the regimes of floodplain flooding. Unfortunately, the existing institutions of regulation of Kazakhstan-Russian and Kazakhstan-Chinese relations do not cover the whole range of the above-mentioned tasks. Moreover, the Chinese side does not consider the Irtysh River to be the object of common interests of Russia and China; it coordinates the issues of water management in the basin only with the Republic of Kazakhstan. At the same time, China does not turn down the proposals on the transfer of the Ob waters through Kazakhstan to Northwest China. In our opinion, until the three countries find a consensus on water management in the Irtysh basin and establish a tripartite commission to develop a unified water policy and form a system for regulating water relations, the ecological state of the basin will only worsen. Under these conditions, scientists need not only to state the emergence of new problems in the region but also to propose new ways to solve them, taking into account the interests of all water users and, most importantly, with a guarantee of preserving the very object of these interests, i.e. water resources of the basin and the transboundary Irtysh ecosystem as a whole.

References

- [1] *International Decade for Action "Water for Life"* Income accessed online on 12th Apr. 2019 via <https://www.un.org/ru/waterforlifedecade/faqs.shtml>
- [2] *Water Resources of Kazakhstan: Assessment, Forecast, Management 2012* Renewable surface water resources of Western, Northern, Central and Eastern Kazakhstan (Almaty: Institute of Geography) p 624.
- [3] Dzhamalov R G and Hasiev R C 2012 *Current Problems of the Water Triangle: Russia - China - Kazakhstan* Nature vol 4 (Moscow: Russian Academy of Sciences) pp 3-10
- [4] Savinkova O V 2015 Current ecological state of Lake Zaisan by hydrochemical parameters *Almanac of Modern Science and Education* **1** 92-5
- [5] Elzhasov A 2012 Water scarcity for water supply in Astana *Water Economy of Kazakhstan* **2**(40) 8-9
- [6] *NPP Should Have Been Built not in Kazakhstan, but in Omsk* Income accessed online on 2th March 2019 via <http://bk55.ru/news/article/39273/>
- [7] *Construction of Kazakhstan NPP* Income accessed online on 22th Aug. 2016 via <https://riss.ru/analitics/27353/> 01.03.2016
- [8] Beisembaeva M A, Dubrovskaya L and Zemtsov B A 2016 Irtysh mineral runoff in the plain part of the basin in the territory of the Republic of Kazakhstan under anthropogenic load *News of Tomsk Polytechnic University. Georesource Engineering* **4** 35-43
- [9] Veshkurceva T M 2010 Transformation of water regime of the Tobol and Ishim rivers under anthropogenic impact *Bulletin of Tyumen State University* **7** 130–7
- [10] *Environmental Newsletter* 2010 (Astana: Kazhydromet) p 89
- [11] *Conservation of the Krasnogorsk Hydrological Node* Income accessed online on 24th Apr. 2019 via <http://kvnews.ru/gazeta/2016/aprel/-13/82365>
- [12] Vinokurov Yu I 2013 *Environmental Risks in the Transboundary Basin of the Irtysh River*

- (Novosibirsk: SB RAS publ.) p 165
- [13] Mal'kovskij I M and Toleubaeva L S 2010 To formation of the unified water supply system of the Republic of Kazakhstan *Issues of Geography and Geo-Ecology* **2** 19-23
- [14] Abishev I A, Medeu A R, Mal'kovskij I M and Toleubaeva L S 2016 Water resources of Kazakhstan and their use *Central Asia Water Resources: Proceedings of UN "Water for Life" conference* **1** 9-19
- [15] *China Claims the Russian Water* Income accessed online on 29th May 2019 via <https://rusplt.ru/society/kitay-voda-irtyish-tkachev-24447.html>
- [16] Sukhorukova E, Starostina Yu and Kostina E *Great Chinese Water Supply System: why China needs the Altai water* Income accessed online on 20th May 2019 via <https://yandex.ru/turbo?text=https%3A%2F%2Fwww.rbc.ru%2Fpolitics%2F10%2F12%2F2018%2F5c0e600c9a79472f13feb7e6>
- [17] Malkovsky I M 2012 *Territorial Allocation of Kazakhstan Water Resources: Opportunities and Expediency* (Almaty: Institute of Geography) p 414
- [18] *Kazakh Scientists are Going to "Take" the Altai Water Through the Canal Between the Katun and Irtysh* Income accessed online on 29th Apr. 2019 via URL:<https://www.bankfax.ru/news/102818/>
- [19] *Information About the Meeting of the Working Group on the Irtysh River Basin of the Russian-Kazakhstan Commission on the Joint Use and Protection of Transboundary Water Bodies* Income accessed online on 2th March 2019 via URL: <http://nobwu.ru/index.php/7-news/231-workgroup03-18>