


Research article

Institutional dilemmas and optimization pathways for transboundary water resources management in Mongolia

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ARTICLE	INFO	ABSTRACT
History. Received: 28 March, 2026 Revised: 02 May, 2026 Published: 05 June, 2026		Mongolia is the source of major transboundary rivers in Northeast Asia, including the Selenge and Kherlen, making its water management vital for both domestic sustainability and downstream water security. However, increasing pressures from climate change, mining, and urbanization are contributing to water scarcity and pollution. These challenges reveal structural weaknesses in its transboundary water governance system. This paper examines Mongolia's transboundary water resource management through international water law and governance frameworks, focusing on institutional challenges: At the legal level, there is a gap between domestic water rights systems and transboundary obligations. At the information-sharing level, hydrological data exchange mechanisms are limited. At the coordination level, inter-agency responsibilities are fragmented and central-local coordination remains weak. At the capacity level, governance is constrained by limited funding, technology, and human resources. In response, the paper proposes reforms to strengthen legal standards, improve data sharing and coordination, enhance institutional authority, increase technical and financial cooperation, and expand engagement in multilateral water governance frameworks. The paper concludes that while Mongolia's institutional challenges are structural, they can still be addressed. It suggests combining domestic reforms, stronger bilateral cooperation, and multilateral engagement to turn transboundary water resources from a vulnerability into an opportunity for regional cooperation.
Keywords: Transboundary water resources; Mongolia; Institutional dilemmas; optimization pathways; International water law; Integrated river basin management		© 2026, Author(s). This is an open access article under the CC BY-04 license (https://creativecommons.org/licenses/by/4.0/deed.en)

1. Introduction

1.1 Research background

As the source of many major rivers in Northeast Asia, the Mongolian Plateau is often regarded as a key northern component of the "Asian Water Tower." Many river systems such as the Selenge, Kherlen, and Onon Rivers, originating from the Khentii, Khangai, and Altai mountain ranges, are not only lifelines for Mongolia's ecological security and socio-economic development, but also profoundly influence water security in the Russian Far East and vast areas of northern China by flowing into the Lake Baikal and Amur River basins. Among them, the Selenge River contributes nearly 50% to the surface inflow of Lake Baikal, while the Kherlen River serves as an important water source for Hulun Lake in eastern Inner Mongolia, China. Given this hydrological and geographical reality, the practice of transboundary water resource management in Mongolia carries ecological and geopolitical significance beyond its national borders.

In recent years, however, Mongolia has encountered increasingly severe water resource pressures. According to the data sourced from the United Nations Development Programme and the National

Statistics Office of Mongolia, the country is classified as experiencing “water stress,” with a steady decline in per capita renewable water resources since the 1990s (Fan, 2014). Climate change has led to glacier retreat, altered precipitation patterns, and more frequent extreme droughts and floods, further exacerbating the uneven spatial and temporal distributions of water resources. At the same time, Mongolia’s rapidly expanding mining sector - particularly gold, copper, and uranium extraction - and accelerating urbanization have significantly increased industrial and domestic water demand. In some regions, this has resulted in declining groundwater levels, river flow interruptions, and heightened pollution risks. Against this backdrop, it has become a critical issue for the Mongolian government to balance domestic development needs with international obligations to downstream countries for the effective management of transboundary water resources.

From an institutional perspective, Mongolia has made an impressive progress over the past three decades in establishing a legal and policy framework for water resource management. The 1992 Constitution established state ownership of water resources; the 2004 Water Law and its 2012 revision introduced systems such as river basin management, water use permits, and water fees; and the 2011 National Water Programme, along with subsequent national river protection initiatives, reflects the government’s growing emphasis on sustainable water use. At the international level, Mongolia acceded in 1997 to the Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Watercourses Convention) and has signed bilateral memoranda or cooperation agreements with China and Russia on environmental protection and transboundary river utilization (Chen, Rieu-Clarke, & Wouters, 2013). These institutional efforts are commendable.

Nevertheless, a further improvement is required in several aspects for the current system in practice, given the dynamic and complex nature of transboundary water resources. Firstly, there is a lack of sufficient legal alignment between domestic water allocation systems and the principle of equitable and reasonable utilization in transboundary contexts. Water use permits in Mongolia are primarily based on the availability of water within domestic river basins, without adequate consideration given to the legitimate expectations of downstream regions -- particularly Inner Mongolia in China -- during both wet and dry seasons. Secondly, the mechanisms of transboundary hydrological monitoring and information sharing remain significantly underdeveloped. Since China and Mongolia have yet to establish a regularized, real-time data exchange platform for water levels, discharge, and water quality, it is difficult to take coordinated action on flood warning, drought response, and pollution control. Thirdly, there remains a limit on the coordination efficiency across both domestic agencies and international partners. Government bodies responsible for water-related affairs - such as the Ministry of Environment and Tourism, the Ministry of Energy and Water Resources, and the Ministry of Mining and Heavy Industry -- often have overlapping or unclear mandates. Meanwhile, the existing China-Mongolia Joint Committee on Transboundary Waters is limited in terms of effectiveness due to irregular meetings and uneven technical capacity. Fourthly, financial and technical constraints constitute rigid barriers. Mongolia encounters substantial investment gaps and shortages of skilled personnel in various aspects such as hydrological monitoring networks, water-saving irrigation technologies, mine wastewater treatment, and environmental flow maintenance.

These institutional challenges are not unique to Mongolia but are common among inland countries undergoing rapid development while facing ecological vulnerability. However, the practice of transboundary water management in Mongolia - an important neighbor of both China and Russia - has direct implications for the sustainability of the China–Mongolia–Russia Economic Corridor and the implementation of green infrastructure under the Belt and Road Initiative. Therefore, from a perspective of cooperation and mutual benefit rather than assigning blame, the exploration of optimization pathways suited to Mongolia’s national context is not only of academic value but also of urgent practical policy significance.

This study is grounded in such a cooperative approach. Rather than aiming to criticize, it adopts a constructive perspective to systematically analyze the key institutional dilemmas facing Mongolia’s transboundary water resource management and to propose feasible optimization pathways. It seeks to address a number of questions below:

1.2 Research questions

1. Under existing legal, institutional, and capacity constraints, how can Mongolia achieve equitable water utilization and ecological protection through domestic policy adjustments and innovations in transboundary cooperation mechanisms?
2. In which specific areas can China and Mongolia enhance cooperation in technology, financing, and data sharing to transform potential water competition into shared benefits of basin governance?

1.3 Research significance

By answering these questions, this paper can provide practical references for relevant policymaking bodies in Mongolia, while offering academic support for deepening China–Mongolia cooperation in the water sector. More broadly, the present study is expected to serve as a case of “non-traditional security cooperation” in transboundary water governance in Northeast Asia, demonstrating that even under relatively weak institutional foundations, neighboring countries can transform shared river systems into bonds of cooperation rather than sources of division, provided they adhere to the principles of common but differentiated responsibilities and mutual benefit.

1.4 Structure

The remainder of this paper is structured as follows. It starts by outlining the natural and institutional background of Mongolia’s transboundary water resources. Then, it analyzes in depth the specific manifestations of institutional dilemmas. Finally, policy recommendations are proposed from five dimensions: legal and policy alignment, information-sharing platform development, technical capacity cooperation, ecological compensation pilot projects, and the integration into multilateral mechanisms.

2. Theoretical Foundations

2.1 Basic Principles of International Water Law and Their Normative Benchmarks

This paper primarily draws on the fundamental principles of international water law as its normative benchmarks. There are several core principles established by the 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses. Among them, the principle of equitable and reasonable utilization requires upstream and downstream states to reach a dynamic balance of interests through negotiation (Chen et al., 2013). As the source of multiple transboundary rivers, Mongolia must carefully assess the impacts of its water development activities on the water rights of downstream countries, namely China and Russia.

The obligation not to cause significant harm emphasizes the adoption of appropriate measures to prevent transboundary damage. Despite no absolute prohibition imposed, it requires states to comply with a standard of “due diligence.” This implies that Mongolia should establish environmental flow benchmarks and pollution discharge limits in water-intensive sectors such as mining and agriculture.

The obligation of cooperation and information exchange directly addresses the current shortcomings in data sharing. It requires watercourse states to regularly exchange hydrological and water quality data and to implement such cooperation through mechanisms such as joint committees. Although Mongolia has not formally ratified the Convention, as a signatory it bears corresponding moral responsibilities. These principles provide a fundamental theoretical basis to evaluate the current situation and envisioning pathways for improvement.

2.2 A Diagnostic Perspective from Institutional Change and Institutional Dilemma Theories

The theories of institutional change and institutional dilemmas are applicable to explain the deeper mechanisms underlying the constraints faced by Mongolia’s current system. Institutional dilemmas typically manifest as institutional voids, conflicts, or rigidity. In the case of transboundary water management in Mongolia, the latter two forms are more prominent. The domestic water rights system was

originally designed primarily for internal industrial and agricultural water use. Although subsequent legal revisions have introduced transboundary provisions, they have not fundamentally restructured the system, resulting in inconsistencies within the regulatory framework.

Meanwhile, a multi-level governance perspective reveals a “hierarchical disconnect” between the diplomatic commitments made at the central government level and the actual practices of local water authorities and water users. Information flows and incentive structures have not been effectively aligned across governance levels. Instead of being unique to Mongolia, this combination of path dependence and coordination failure represents a common challenge for many transitional states operating under capacity constraints (Dombrowsky, Hagemann, & Houdret, 2014). In this sense, theoretical analysis is conducive to moving beyond simplistic attribution of responsibility and instead focusing on how institutional adjustments and vertical integration can alleviate these dilemmas.

2.3 A Cooperative Transformation Framework for Transboundary Water Governance

The analytical frameworks developed for transboundary water governance provide theoretical guidance for transforming interactions along the conflict-cooperation spectrum toward more cooperative outcomes. Integrated Water Resources Management (IWRM) lays emphasis on the basin-wide coordination of upstream and downstream interests, water quantity and quality, and ecological protection (Dombrowsky et al., 2014). Although Mongolia has adopted this principle in its National Water Programme, structural constraints persist at the transboundary level, as downstream countries are not fully incorporated into a unified planning framework.

The water–energy–food nexus further expands the scope for cooperation by linking water resources with mining, agriculture, and energy production. For example, the mature technologies in water-saving irrigation and wastewater treatment from Inner Mongolia in China could be introduced into Mongolia, thereby achieving a win–win outcome of reduced water consumption upstream and increased water availability downstream.

In addition, those institutional design principles proposed by Elinor Ostrom, such as clearly defined boundaries, monitoring mechanisms, and conflict-resolution arrangements, provide direct insights into enhancing the functionality of the China–Mongolia Joint Committee (Dombrowsky et al., 2014). Collectively, these theoretical perspectives point toward a constructive pathway: the potential competition over water resources can be gradually transformed into the cooperative gains in river basin governance through technology- and project-oriented benefit sharing.

3. Research methods

The research adopts a policy-oriented qualitative case study method, aiming to systematically diagnose the institutional predicament of cross-border water resource management in Mongolia and propose optimization pathways. The research did not collect primary data, but was mainly based on in-depth analysis of existing literature and policy documents, combined with the application of theoretical frameworks.

The analysis of this study is based on a clear normative theoretical foundation. International water law, especially the core principles such as fair and reasonable utilization, non-causing significant damage and cooperation established by the Convention on the Law of Non-navigational Uses of International Watercourses in 1997, provides a basic normative yardstick for this study to evaluate the institutional practice of Mongolia (Chen et al., 2013). Furthermore, institutional change theory and cross-border water governance frameworks (e.g. integrated water resources management) provide a diagnostic perspective for understanding the structural roots of coordination failure and implementation gap in Mongolia's governance system (Karthe, Heldt, Houdret, & Borhardt, 2015). Specifically, this study is mainly carried out through a systematic review and comparative analysis of multi-level institutional texts. This includes a detailed review of Mongolia's domestic legal and policy framework (e.g. the Constitution, the Water Law,

the National Water Plan, etc.) as well as relevant international documents (e.g. bilateral cooperation memorandums with China and Russia, the United Nations Watercourse Convention). The focus of the analysis lies in identifying the "normative gap", conflicts or ambiguations existing among these formal rules and between them and the aforementioned principles of international law (Chalov et al., 2013). Meanwhile, the study extensively integrated existing academic research and institutional reports on Mongolia's water resources situation, mining impacts, and climate change adaptation (such as country assessments by the Asian Development Bank and the World Bank) to confirm the operational effects and challenges of the system at the practical level (Fan, 2014).

The entire analysis process follows the logic of diagnostic policy analysis. First of all, establish the natural and institutional background of cross-border water resources in Mongolia. Secondly, by applying theoretical lenses, a critical analysis of the collected document evidence is conducted, thereby specifically clarifying the manifestations and root causes of institutional dilemmas in four key dimensions (legal coordination, information sharing, coordination mechanisms, and capacity building). Finally, based on this diagnosis, a multi-level optimization path is studied, derived and proposed. These suggestions aim to enhance the operability of the law, build a cooperation pattern and improve governance capacity. Their logic closely corresponds to the problems identified in the paper and the final conclusion.

4. Natural and Institutional Status of Mongolia's Transboundary Water Resources

4.1 Physical Geography and Transboundary Hydrological Characteristics

Mongolia is a landlocked plateau situated between Central Asia and Northeast Asia, with an average elevation of about 1,500 meters and a total land area of approximately 1.56 million square kilometers (Zeitoun, Mirumachi, & Economics, 2008). Its terrain is dominated by mountains and high plateaus, with the Khangai, Khentii, and Altai mountain ranges forming the principal headwaters of its river systems. The hydrological systems in Mongolia can be broadly divided into three categories: the Arctic Ocean basin, the Pacific Ocean basin, and inland drainage basins. Among these, the Selenge River system (Arctic Ocean basin) and the Kherlen-Erguna River system (Pacific Ocean basin) are of greatest transboundary significance.

As the largest river system in Mongolia, the Selenge River has a total length of approximately 992 kilometers (about 600 kilometers within Mongolia) and a basin area covering roughly one-third of the country's territory. Originating on the northern slopes of the Khangai Mountains, it is fed by numerous tributaries such as the Orkhon, Tuul, and Kharaa Rivers before flowing northward into Lake Baikal in Russia. It is estimated that the Selenge River contributes nearly 50% of the surface inflow to Lake Baikal, playing a decisive role in maintaining ecological balance for the lake. The Selenge basin is also the most important agricultural region, pastoral base, and population center across Mongolia, hosting major cities such as Ulaanbaatar, Darkhan, and Erdenet.

The Kherlen River originates on the southern slopes of the Khentii Mountains, with a total length of approximately 1,264 kilometers (about 1,090 kilometers within Mongolia). It flows eastward into Inner Mongolia, China, and ultimately drains into Hulun Lake, the largest freshwater lake in northern China, which is crucial for sustaining regional wetland ecosystems and biodiversity. Additionally, the Onon River (an upper tributary of the Amur River) originates on the eastern slopes of the Khentii Mountains, flows through Mongolia and Russia, and eventually joins the Amur River system. These rivers form natural linkages between Mongolia and its neighbors, China and Russia, endowing the practice of water resource management in Mongolia with an inherently transboundary character.

In Mongolia, the hydrological regime exhibits pronounced seasonal variation. Precipitation is concentrated in the summer months (June-August), accounting for 60%–80% of annual rainfall. In contrast, winters are long and dry, with rivers often frozen and runoff significantly reduced. Although spring snowmelt may generate short-lived floods, most rivers are fed by rainfall and snowmelt, making them highly sensitive to climatic fluctuations. Over the past six decades, the average temperature in Mongolia has risen by about

2.1°C, exceeding the global average. This has led to glacier retreat, permafrost degradation, and increased evaporation, all of which further exacerbate the instability of water resources.

4.2 Water Stress and Major Challenges

Firstly, climate change has accelerated glacier retreat. Mongolia has approximately 3,800 glaciers, primarily located in the Altai Mountains. Studies indicate that the total glacier area has decreased by about 30% over the past 50 years (Nikitin, Abasov, Osipchuk, & Berezhenykh, 2019). While glacier melt may temporarily increase river runoff in the short term, continued retreat will ultimately reduce water availability, particularly for those rivers heavily dependent on glacial meltwater.

Secondly, mining development causes the dual pressures of water consumption and pollution. Mongolia is rich in mineral resources such as coal, copper, gold, and uranium, with the mining sector constituting a pillar of the national economy. Major mining projects, such as the Oyu Tolgoi copper-gold mine and the Tavan Tolgoi coal mine, are located in the water-scarce South Gobi region, where large volumes of groundwater are extracted for mineral processing, dust suppression, and cooling. As a result, there has been a significant local decline in groundwater levels. At the same time, mine wastewater discharge and tailings leakage pose potential threats to river water quality. For instance, the elevated concentrations of heavy metals in the Kharaa River, linked to upstream mining activities, have raised transboundary concerns with Russia (Karthe et al., 2015).

Thirdly, urbanization and the expansion of livestock production have contributed to the intensified water demand. Ulaanbaatar, as the capital city, concentrates nearly half of the country's population, with the Tuul River (a tributary of the Selenge) serving as its primary water source. However, due to the high leakage rates in urban water supply networks and insufficient wastewater treatment capacity, some domestic sewage is discharged into rivers without adequate treatment. Meanwhile, the traditional pastoral system in Mongolia has undergone market-oriented expansion, with livestock numbers increasing from about 20 million in 1990 to approximately 70 million today (Nikitin et al., 2019). Overgrazing has led to grassland degradation, reduced water retention capacity, and increased ecological vulnerability in riverine areas.

Fourthly, limited water management capacity constrains the capability of responding to these challenges. The density of hydrological monitoring stations remains low, and many small and medium-sized rivers lack long-term, continuous data on water levels, discharge, and water quality. Aging technical equipment, the loss of skilled personnel, and insufficient financial investment are all widespread issues. These capacity constraints directly hinder the scientific and refined management of water resources.

4.3 Domestic Legal and Policy Framework

At the constitutional level, Article 6 of Mongolia's 1992 Constitution stipulates that "land, subsoil resources, forests, water, wildlife, and other natural resources in Mongolia shall be owned by the State." This provision establishes the legal status of water resources as public property, providing a constitutional basis for unified state management and the issuance of water-use permits.

The Water Law constitutes the fundamental legal framework for water resource management. Mongolia adopted its first comprehensive Water Law in 2004, with significant amendments in 2012 and 2017. The current law includes the following key elements: the establishment of river basin management principles, dividing the country into several basin management units; the introduction of a water-use permitting system regulating water abstraction, use, and discharge; provisions on water fee collection and utilization to encourage conservation and recycling; and clarification of the rights and responsibilities of different levels of government, basin authorities, and water users (Karthe et al., 2015). Notably, the 2012 revision introduced a series of specific provisions on transboundary water resources, requiring that major projects on shared rivers be subject to transboundary environmental impact assessments and that relevant neighboring countries be duly notified.

Other relevant legislative provisions include the Law on Environmental Protection (1995, revised in 2012), which sets out basic requirements for water environmental protection, involving pollution discharge

standards, water quality monitoring, and ecological restoration; the Minerals Law (2006, revised in 2014), which requires mining projects to prepare water use and protection plans and to pay water resource compensation fees; the Land Law (2002), which imposes restrictions on land use along riverbanks; and the National Security Concept (2010), which identifies water security as a key component of national security and emphasizes the protection and rational use of transboundary rivers.

In terms of national plans and strategies, the Mongolian government has adopted a series of medium- and long-term policies related to water resources. Approved in 2011, the “National Water Programme” is the highest-level strategic document in the water sector, setting management objectives through 2021 (later extended to 2030), including the improvement in water-use efficiency, the expansion of hydrological monitoring networks, and the protection of water sources. The “National Programme for River Protection,” launched in 2013, specifically targets major rivers such as the Selenge and Kherlen, establishing the goals of pollution reduction and ecological restoration (Karthe et al., 2015). In addition, various broader strategic documents such as the “Green Development Policy” (2014) and the “Sustainable Development Vision 2030” (2016) incorporate the sustainable use of water resources.

From a design perspective, the legal and policy framework developed in Mongolia for water resources appears relatively comprehensive on paper, reflecting modern governance principles such as integrated river basin management, the precautionary principle, and public participation. However, as noted earlier, the effectiveness of institutions is determined not only by formal provisions but also by implementation capacity, coordination mechanisms, and the adaptability to external conditions. This tension will be further elaborated in the next chapter.

4.4 International Agreements and Cooperation Mechanisms

At the global level, Mongolia signed the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses in 1997. Although it had not formally ratified the Convention as of 2025, as a signatory Mongolia is obliged not to act in ways that defeat the object and purpose of the treaty. In practice, the Mongolian government has repeatedly indicated that it will address transboundary water affairs in line with the Convention’s principles (Karthe et al., 2015). Mongolia is also a party to several multilateral environmental agreements, including the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity, whose provisions on water-related adaptation and ecosystem protection exert indirect influence on transboundary water governance.

At the bilateral level, Mongolia has established transboundary water cooperation mechanisms with both Russia and China. Mongolia and Russia signed the Intergovernmental Agreement on the Protection and Use of Transboundary Waters in 1995, creating a Mongolia–Russia Joint Commission on Transboundary Waters. This body meets regularly to exchange hydrological data and to coordinate water use and protection, playing a positive role in the management of the Selenge-Lake Baikal basin.

However, there is currently no dedicated bilateral treaty signed between Mongolia and China to specifically focus on transboundary water resources. Instead, the relevant provisions are embedded in broader agreements. For example, the Agreement on Environmental Protection Cooperation between the Government of the People’s Republic of China and the Government of Mongolia (2008) includes references to the protection of transboundary rivers (Chalov et al., 2013). With a comprehensive strategic partnership established in 2014, water resource cooperation has been identified as a priority area under the framework of the China-Mongolia-Russia Economic Corridor. In addition, subnational communication channels have been established between China’s Inner Mongolia Autonomous Region and eastern provinces of Mongolia, focusing mainly on water quantity and quality issues related to the Kherlen River.

At the regional and multilateral level, Mongolia is an active participant in the UNESCO International Hydrological Programme (IHP) in the Asia-Pacific region, through which it gains access to technical training and experience in data sharing. Mongolia is also an observer in the Greater Tumen Initiative, which involves transboundary water governance in Northeast Asia (Chalov et al., 2013). Furthermore, additional capacity-building support is provided for transboundary cooperation under the water resource projects

implemented in Mongolia by international organizations such as the Asian Development Bank, the World Bank, and the Global Environment Facility.

5. Analysis of Institutional Dilemmas in Transboundary Water Resource Management

5.1 Insufficient Legal Alignment and Applicability

Firstly, there is an absence of a transboundary dimension in the water rights allocation system.

The water-use permitting system established under Mongolia's current Water Law fundamentally follows the logic of "intra-basin balance", that is, coordinating water abstraction among different users within the same river basin. However, under this context, the "basin" primarily refers to administrative basin divisions within Mongolia, without incorporating the water rights of downstream countries into the allocation framework (Lukat, Schoderer, & Salvador, 2022). In other words, when an upstream user in the Selenge River basin applies for a water-use permit, the approving authority mainly assesses the impact of the abstraction on other users within Mongolia, rather than systematically evaluating its potential effects on inflows to Lake Baikal. Despite being reasonable within a single sovereign state, such an institutional design creates a normative blind spot when applied to transboundary rivers.

Secondly, there is an incomplete integration between domestic law and international principles.

As noted earlier, Mongolia has signed the United Nations Watercourses Convention and has repeatedly indicated that it will deal with transboundary water affairs in accordance with its principles. However, these principles have not been systematically translated into the specific provisions of domestic law. For instance, the principle of "equitable and reasonable utilization" requires consideration of both existing and potential uses by all watercourse states, yet Mongolia's Water Law lacks procedural requirements for quantitatively assessing downstream water use. Similarly, the obligation not to cause significant harm requires the exercise of "due diligence," but Mongolia has not established environmental flow standards or pollution discharge limits specifically for transboundary rivers. Because of this gap between legal principles and implementation rules, the practical operability of international obligations is compromised (Lukat et al., 2022).

Thirdly, there are both fragmentation and lag in legal revisions. Mongolia's Water Law has undergone several revisions (2004, 2012, and 2017), with each typically addressing some specific issues such as increasing water fees or strengthening permit management. However, these revisions have yet to systematically integrate the transboundary dimension. As a result, those provisions related to transboundary water resources are scattered across different chapters, lacking internal coherence, and in some cases even presenting potential conflicts. For example, the Law on Environmental Protection requires special safeguards for transboundary rivers, while the Water Law encourages mining development as a national economic priority. When conflict arises between these objectives, the legal framework does not provide a clear hierarchy or coordination mechanism. This institutional fragmentation increases uncertainty for implementing agencies, providing opportunities for stakeholders to evade responsibility.

5.2 Deficiencies in Data Monitoring and Information-Sharing Mechanisms

Firstly, monitoring network coverage is insufficient and technical capacity is limited. Although Mongolia has a vast territory and complex terrain, the density of its hydrological monitoring network is far below the standards recommended by the International Association of Hydrological Sciences. Many small and medium-sized rivers lack monitoring stations altogether. The spatial distribution of stations is uneven even for major transboundary rivers such as the Selenge and Kherlen, with some critical sections lacking long-term continuous observation data (Zeitoun et al., 2008). In addition, the existing monitoring equipment is generally outdated, with low levels of automation. Some stations remain reliant on manual observation and recording, which causes difficulty in ensuring the timeliness and accuracy of data transmission. There is also a shortage of professional hydrological personnel, particularly in remote areas, where staff turnover is a serious issue.

Secondly, the level of transboundary data exchange is low. At present, there is still no regularized mechanism established by China and Mongolia for transboundary hydrological information sharing. Since sporadic data exchanges rely mainly on diplomatic channels or temporary project-based arrangements, institutionalized platforms and standardized procedures are absent (Chalov et al., 2013). The data exchanged are usually limited to basic indicators such as water levels and discharge, with low frequency (e.g., monthly or quarterly) and often significant time lags of several weeks or even months. There is almost no substantive data sharing in areas such as water quality monitoring, groundwater dynamics, environmental flows, and pollution source information. In this circumstance, when one side experiences sudden floods, droughts, or pollution incidents, the other side cannot access timely information or take coordinated response measures.

Thirdly, data standards and monitoring methodologies are inconsistent. Even where there is willingness to exchange data, technical differences can create barriers. China and Mongolia differ in hydrological monitoring methods, data classification standards, and quality control procedures. That is to say, the observations conducted at the same monitoring section may not be directly comparable (Zeitoun et al., 2008). For example, the two sides may use different calculation methods for “runoff” or rely on different hydrological rating curves, requiring additional calibration and conversion. Due to the lack of unified technical standards, the practical effectiveness of data sharing is significantly reduced.

Fourthly, political willingness and technical trust are limited for information sharing. Transboundary hydrological data can be sensitive, involving the considerations given to national sovereignty and security. Some Mongolian policymakers are concerned about the potential use of detailed hydrological data by downstream countries as leverage in negotiations or as a basis for exerting pressure (Batnasan, 2003). While such concerns are understandable, they have contributed to delays in advancing information-sharing mechanisms. At the same time, the level of trust between technical agencies on both sides remains relatively weak and requires gradual cultivation, which is due to the absence of a long-standing and stable history of cooperation.

5.3 The Need to Improve Cross-Sectoral and Cross-Border Coordination Efficiency

Firstly, domestic inter-agency coordination mechanisms are fragmented. The practice of water resource management in Mongolia involves multiple government bodies, including the Ministry of Environment and Tourism (responsible for environmental protection and water policy), the Ministry of Energy and Water Resources (in charge of water infrastructure), the Ministry of Mining and Heavy Industry (regulating mining water use), the Ministry of Food and Agriculture (overseeing agricultural irrigation), and the Ministry of Construction and Urban Development (responsible for urban water supply). The functional boundaries among these agencies often overlap or remain unclear, leading to duplicated responsibilities or shirking of duties in areas such as water-use permitting, pollution control, and basin planning. For instance, a mining project’s water-use plan may require approval from several agencies, with each applying different standards and procedures (Zeitoun et al., 2008). As a consequence, approval processes are prolonged and regulatory loopholes increase. Although Mongolia has established a National Water Resources Committee as a coordinating body, its authority and operational effectiveness remain limited, making it difficult to reconcile inter-agency interests effectively.

Secondly, there is a hierarchical disconnect between central and local governments. Mongolia operates under a decentralized administrative system in which provinces and the capital city possess a certain degree of decision-making autonomy. In the context of transboundary water management, there is often a gap between the international commitments made by the central government and the actual practices at the local level (Zeitoun et al., 2008). In some cases, the agreements or cooperative intentions reached by the central government with neighboring countries are not effectively transmitted to provincial water authorities and grassroots water users. As a result, local officials tend to prioritize local economic development and water demand, with insufficient awareness of or emphasis on transboundary obligations. Moreover, their ability to implement central policies is further limited by the constraints in technical capacity, staffing, and financial resources at the local level. The effectiveness of transboundary cooperation is undermined by this “strong at the top, weak at the bottom” dynamic.

Thirdly, the functionality of China–Mongolia bilateral coordination mechanisms is insufficient. As noted earlier, China and Mongolia have yet to establish a bilateral treaty dedicated to addressing transboundary water resources. Existing cooperation arrangements are dispersed across broader frameworks such as environmental protection and economic corridor initiatives, causing a lack of coherence and continuity (Dombrowsky et al., 2014). The China–Mongolia Joint Committee on transboundary waters (if comparable to the Mongolia–Russia mechanism) does not meet regularly, its agenda tends to be broad, and it lacks specialized technical working groups and measurable cooperation targets. Substantive collaboration in areas such as joint monitoring, joint inspections, and joint research remains limited. There is no rapid-response consultation channel or effective dispute resolution mechanism when specific transboundary water issues arise—such as disputes over water allocation during dry periods or sudden pollution incidents.

Fourthly, there is a need to do comparison with the Mongolia–Russia mechanism and to understand its implications. In contrast, the transboundary water cooperation mechanism established between Mongolia and Russia is relatively more mature. Since the signing of their intergovernmental agreement in 1995, the joint commission has operated more consistently, with regular data exchange and tangible progress in the protection of Lake Baikal. This comparison suggests that dedicated bilateral agreements and institutionalized joint commissions are effective in enhancing cooperation efficiency (Fuertes, 2023). However, the hydrological and geographical conditions of China–Mongolia transboundary rivers differ from those of Mongolia–Russia. Rivers between China and Mongolia mainly flow through arid and semi-arid regions, where water scarcity is more pronounced, and water demand is rapidly increasing on the Chinese side. It is indicated that China–Mongolia cooperation should develop the mechanisms tailored to their specific conditions rather than simply replicating the Mongolia–Russia model but must.

5.4 Constraints in Capacity Building, Funding, and Technology

Firstly, fiscal investment is insufficient. Water resource management is a public service that requires sustained financial input. Stable fiscal support is significant to the maintenance and upgrading of hydrological monitoring networks, operation of water quality laboratories, training of professional personnel, and implementation of basin protection projects. However, Mongolia is limited in terms of fiscal capacity and must contend with competing priorities such as economic development and poverty reduction. As a result, budgets for water management agencies have remained chronically constrained, with some monitoring stations ceasing operation or functioning at reduced capacity due to lack of maintenance funding (Horlemann & Dombrowsky, 2012). Although international aid projects provide some support, their sustainability is uncertain, and activities often cannot be maintained once projects conclude.

Secondly, technical equipment is outdated. Mongolia lags behind international advanced levels in technical equipment for hydrological monitoring, water quality analysis, and data processing. The application of modern tools, such as automated monitoring systems, remote sensing technologies, geographic information systems (GIS), and hydrological models, remains at an early stage (Horlemann & Dombrowsky, 2012). For example, although satellite remote sensing could help compensate for gaps in ground-based monitoring networks, its effective use requires specialized software and trained personnel, which are not yet widely available within the Mongolian water management institutions. Technological limitations directly affect the accuracy, density, and timeliness of data, thereby constraining evidence-based decision-making.

Thirdly, there is a shortage of professional personnel. For effective water resource management, the expertise across multiple disciplines is required, including hydrology, water engineering, environmental science, law, and economics. The higher education system in Mongolia has limited capacity to train specialists in these fields. Moreover, many qualified graduates move to the private sector or seek employment abroad due to salary levels and career prospects (Karthe et al., 2015). Existing staff also face various challenges such as insufficient opportunities for continuing education and the limited access to updated knowledge. In addition to affecting routine management, this shortage of human resources also limits the capacity of Mongolia to engage effectively in international technical cooperation and negotiations.

Fourthly, the diffusion of water-saving and pollution control technologies is insufficient. On the demand side, water-use efficiency remains relatively low in the fields like agriculture, industrial cooling, and urban water supply. Also, the adoption of water-saving technologies, such as drip irrigation, dry mineral processing, and leakage control in distribution networks, is not yet widespread (Karthe et al., 2015). On the pollution control side, wastewater treatment coverage and treatment depth are insufficient, with some domestic sewage and industrial wastewater discharged into rivers without adequate treatment. These technological gaps intensify domestic water stress, increasing the risk of transboundary pollution.

6. Optimization Pathways for Transboundary Water Resources Management

Firstly, the operability of transboundary regulations should be enhanced by improving the domestic legal framework and strengthening policy coherence. Mongolia can, within its existing Water Law framework, introduce dedicated provisions on transboundary rivers or formulate separate implementing regulations. These provisions and regulations should operationalize principles from the UN Watercourses Convention, such as equitable and reasonable utilization, the obligation not to cause significant harm, cooperation, and information exchange, into concrete procedural rules (Lukat et al., 2022). For example, it should be explicitly required that a transboundary environmental impact assessment must be conducted prior to approval for major water abstraction projects, hydraulic engineering works, or mining projects located in transboundary basins, and it should be mandated that the assessment report be communicated to downstream countries (Lukat et al., 2022). Additionally, environmental flow standards for major transboundary rivers should be established, including minimum ecological base flow requirements and pollution discharge limits, which can provide a legal base for water-use permits and environmental regulation.

At the same time, it is recommended to systematically review and harmonize those inconsistent or ambiguous provisions across the Water Law, Environmental Protection Law, and Mining Law, and to clarify the priority order and adjudication mechanisms in case of any conflict arising between mining development, agricultural water use, and transboundary ecological protection. In addition, Mongolia may consider formally ratifying the UN Watercourses Convention to strengthen its negotiating position and normative authority under international law, while promoting comprehensive alignment between domestic legislation and international norms.

Secondly, a multi-level transboundary data-sharing and joint monitoring mechanism should be established to strengthen the information foundation for scientific decision-making. To address the deficiencies in information sharing, Mongolia may in the short term initiate a “gradual data exchange” pilot through China–Mongolia and Mongolia–Russia bilateral channels, starting with the annual exchange of hydrological statistical reports, and progressively moving toward quarterly and monthly data sharing, for the sake of real-time or near real-time data exchange at key monitoring sections (Nikitin et al., 2019). In the medium-to-long term, it is necessary to develop a formalized “China–Mongolia Transboundary Water Information Sharing Platform,” leveraging IoT, satellite remote sensing, and GIS technologies to integrate hydrological, meteorological, water quality, and groundwater data resources from both sides, while standardizing data formats and quality control procedures.

This platform could adopt a “joint construction with tiered authorization” model-co-funded and co-managed by both parties, with each side retaining full control over its raw national data, while only exchanging mutually agreed shared datasets-to balance cooperation needs with data security concerns. Meanwhile, it is advisable to restore and strengthen the functions performed by the China-Mongolia Joint Commission on Transboundary Waters, granting it clear technical mandates and a permanent secretariat, and holding regular technical working group meetings to conduct joint monitoring, joint research, and joint training, thereby adapting successful experiences from the Mongolia–Russia mechanism to China–Mongolia cooperation.

Thirdly, there is a necessity to optimize domestic inter-agency coordination mechanisms and promote the institutional upgrading of cross-border coordination. Domestically, it is recommended to elevate the

authority and operational efficiency of the National Water Resources Committee. This could be chaired directly by the Deputy Prime Minister or Prime Minister, with key ministries integrated into a unified coordination framework, such as the Ministry of Environment and Tourism, the Ministry of Energy and Water Resources, the Ministry of Mining and Heavy Industry, and the Ministry of Food, Agriculture and Light Industry (WATER, 1996). Regular inter-ministerial meetings should be held to jointly review major transboundary water-use projects and pollution control plans.

At the same time, the division of responsibilities among departments in transboundary water governance should be clearly defined to avoid overlap or buck-passing, and an inter-agency information-sharing and joint enforcement mechanism should be established. In terms of central–local relations, the central government should not only incorporate transboundary obligations into the performance evaluation indicators of local governments and basin management agencies, but also improve local implementation capacity and compliance incentives through fiscal transfers and targeted training.

At the transboundary level, China and Mongolia could consider signing a “Memorandum of Understanding on Transboundary Water Protection and Utilization” under the existing environmental cooperation framework, or upgrading it into an intergovernmental agreement. This agreement is supposed to define cooperation principles, information-sharing standards, the operational rules of joint commissions, and dispute resolution procedures (Chen et al., 2013). It may incorporate internationally recognized provisions such as “prior informed consent” and “emergency notification,” thus providing rapid response channels for sudden pollution incidents or extreme hydrological events.

Fourthly, capacity constraints should be addressed through technological cooperation, financial mobilization, and human resource development. In terms of technology, Mongolia should prioritize the introduction of mature, cost-effective water-saving and pollution-control technologies. In terms of agriculture, it is necessary to promote efficient irrigation methods such as drip and sprinkler irrigation, and to learn from successful arid-region water-saving agricultural practices by strengthening the cross-border technological cooperation with China’s Inner Mongolia Autonomous Region (Chen et al., 2013). In terms of mining, dry beneficiation, wastewater recycling, and tailings dam seepage prevention technologies should be promoted to reduce groundwater dependence and river pollution risks. In the field of urban water supply, pipeline network rehabilitation and district metering should be implemented to reduce leakage rates, and wastewater treatment plants should be constructed or upgraded for the increase in reclaimed water reuse rates.

In terms of financing, in addition to concessional loans and grants from international financial institutions such as the Asian Development Bank, the World Bank, and the Green Climate Fund, Mongolia may attempt to establish a “Transboundary Water Ecological Compensation Fund,” financed by downstream beneficiary regions or enterprises (Dombrowsky et al., 2014). Thus, compensation funds can be directed into upstream watershed protection and community development, transforming potential upstream–downstream competition into a benefit-sharing relationship.

Regarding human resources, Mongolia is advised to cooperate with UNESCO and the International Water Management Institute in launching the specialized training programs related to hydrological monitoring, water law, and international negotiation. Mongolian scholars and officials are also encouraged to participate in academic exchanges and joint research on Northeast Asian transboundary water governance, for the gradual cultivation of a professional workforce familiar with international rules and advanced technologies.

Fifthly, multilateral governance networks should be applied to expand external support and institutional resources for cooperation. Mongolia can actively participate in multilateral water governance agendas and integrate bilateral cooperation into broader regional frameworks by fully leveraging its status as a signatory to the UN Watercourses Convention, a member of UNESCO’s International Hydrological Programme, and an observer of the Tumen River Area Development Programme (Zeitoun et al., 2008). For instance, a dedicated water resources working group could be established under the China–Mongolia–Russia

Economic Corridor framework to coordinate transboundary water management with cooperation in transport, energy, and trade, thereby generating policy synergies.

In addition, Mongolia could jointly apply with downstream countries for Global Environment Facility transboundary water projects, exercising international funding and technical resources to undertake integrated basin management demonstration projects. Mongolia is also recommended to establish a “Northeast Asian Transboundary Water Scientists Network,” bringing together research institutions from different countries to jointly conduct hydrological modeling, climate change impact assessments, and adaptive management studies, thereby fostering policy trust through scientific consensus (Fan, 2020). In addition to providing external technical and capacity-building support for Mongolia, these multilateral mechanisms also contribute to the diffusion of political pressure in bilateral negotiations, shaping to a more balanced and sustainable cooperative framework.

7. Conclusion

In this article, the institutional challenges facing transboundary water resources management in Mongolia are systematically analyzed to propose multidimensional pathways for optimization. The findings indicate that, as the source of several important transboundary rivers, Mongolian water governance is closely linked not only to its own ecological security and sustainable development, but also to the water use rights and interests of downstream countries. However, the existing institutional framework exhibits structural deficiencies in four key areas: legal coherence, information sharing, coordination mechanisms, and capacity building. Instead of stemming from a single policy failure, these challenges reflect the common governance dilemmas faced by transition economies under the combined pressures of rapid industrialization, climate change, and capacity constraints.

It is important to emphasize that the effectiveness of institutions depends not only on the completeness of rules themselves, but also on the coherence and adaptability of their implementation. In Mongolia, water legal system has formally incorporated modern concepts such as integrated river basin management. However, the lack of procedural rules for transboundary dimensions has hindered the translation of international obligations into concrete actions (Dombrowsky et al., 2014). Due to the weakness of information-sharing mechanisms, coordination failure is further amplified. In this circumstance, the lack of reliable data makes it difficult for any form of transboundary cooperation to move beyond political declarations toward substantive implementation. This is an implication that institutional development should shift from “quantity of legislation” to “quality of implementation,” and from “principle-based statements” to “technical operationalization.”

From the perspective of optimization pathways, there is no single “silver bullet” solution. Instead, it is required to adopt a combined strategy of “domestic reform first, bilateral coordination in parallel, and multilateral support as reinforcement.” Mongolia can, without any reliance on external conditions, prioritize domestic reforms such as legal revision, upgrading hydrological monitoring networks, and strengthening inter-agency coordination mechanisms. These internal reforms are not only crucial for improving governance performance, but also requisite for building external trust. At the bilateral level, specialized agreements and institutionalized joint commissions represent the most reliable means of improving cooperation efficiency. Nevertheless, their effectiveness hinges on whether both parties are willing to grant sufficient technical authority and resource support. At the multilateral level, platforms such as the UN Watercourses Convention and the International Hydrological Programme provide not only financial and technical assistance, but more importantly, normative reference points and political buffers for bilateral negotiations.

Finally, the deeper logic of transboundary water governance is to shift from a “zero-sum allocation” approach to a “positive-sum co-creation” paradigm. A zero-sum competition over water quantity easily leads to deadlock, whereas focusing on areas such as ecological compensation, technological cooperation, and joint disaster response can generate mutually beneficial outcomes for all parties. Therefore, Mongolia is advised to demonstrate the feasibility of benefit-sharing models in practice by piloting ecological

compensation schemes in small and medium-sized river basins such as the Khalkh River. Future research could be conducted to further explore the long-term adaptability of institutions under climate change scenarios, as well as under-examined areas such as transboundary aquifers. In summary, the institutional challenges facing Mongolia are solvable, while the key to addressing them is to transform water resources from a potential vulnerability into a strategic asset for sustainable development under a pragmatic, gradual, and cooperation-oriented approach.

Монгол Улсын хил дамнасан усны нөөцийн менежментийн байгууллагын хүндрэлүүд ба оновчтой болгох арга замууд

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Хураангуй. Монгол Улс нь Сэлэнгэ, Хэрлэн зэрэг Зүүн Хойд Азийн хил дамнасан томоохон гол мөрний усны эх бүрэлдэх цэг бөгөөд усны нөөцийн менежмент нь дотоодын экологийн аюулгүй байдал, тогтвортой хөгжил төдийгүй доод урсгалын бүс нутаг дахь улс орнуудын усны аюулгүй байдалд ч чухал ач холбогдолтой. Гэвч уур амьсгалын өөрчлөлт, уул уурхай, хотжилтын дарамтын улмаас усны хомсдол, бохирдлын эрсдэл нэмэгдэж байгаа нь хил дамнасан усны засаглалын тогтолцоонд сул тал болж байна. Энэхүү өгүүлэлд олон улсын усны эрх зүй болон засаглалын хүрээний зарчимд тулгуурлан Монгол Улсын хил дамнасан усны нөөцийн менежмент, институцийн тулгамдсан асуудлыг системтэйгээр шинжилсэн: Хууль, эрх зүйн түвшинд дотоодын усны засаглалын тогтолцоо болон хил дамнасан үүрэг хариуцлагын хооронд зөрүүтэй; мэдээлэл солилцооны түвшинд гидрологийн өгөгдөл солилцоо тогтолцоо хангалтгүй; зохицуулалтын түвшинд байгууллагуудын чиг үүрэг хуваагдмал, төв болон орон нутгийн уялдаа сул хэвээр байгаа бол чадавхын түвшинд санхүүжилт, технологи, хүний нөөцийн хязгаарлагдмал байдал нь үр дүнтэй засаглалын хэрэгжилтийг сулруулж байна. Иймээс тус өгүүлэлд эрх зүйн орчныг сайжруулах, мэдээлэл солилцоо болон уялдаа холбоог бэхжүүлэх, институцийн эрх мэдлийг нэмэгдүүлэх, техникийн болон санхүүгийн хамтын ажиллагааг өргөжүүлэх, мөн олон талт усны засаглалын тогтолцоонд илүү идэвхтэй оролцох зэрэг шинэчлэлийн арга замуудыг тусгасан. Дүгнэхэд, Монгол Улсад тулгамдаж буй тогтолцооны сорилтууд нь өргөн хэмжээний бүтцийн шинжтэй боловч даван туулах боломжгүй зүйл биш юм. Дотоодын шинэчлэл, хоёр талын хамтын ажиллагаа болон олон талт оролцоог хослуулах замаар хил дамнасан усны нөөцийг эмзэг байдал бус, бүс нутгийн хамтын ажиллагааны боломж, давуу тал болгон ашиглах нөхцөлийг бүрдүүлэх боломжтой.

Түлхүүр үг: Монгол Улс; Хил дамнасан усны нөөц; Институцийн тулгамдаж буй асуудлууд, Оновчтой шинэчлэлийн арга замууд; Олон улсын усны эрх зүй; Гол мөрний сав газрын нэгдсэн менежмент

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