Journal of Geography, Regional Planning and Development
Homepage : https://journal.antispublisher.id/index.php/JGRPD
Email : admin@antispublisher.com

e-ISSN : 3032-131X
JGRPD, Vol. 3, No. 3, March 2026
Page 16-22

Increasing the Efficiency of Water Resource Management Systems Through Public-Private Partnership Approaches

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DOI : https://doi.org/10.61796/jgrpd.v3i3.1744

Sections Info

Article history:
Submitted: January 23, 2026
Final Revised: February 11, 2026
Accepted: March 16, 2026
Published: March 31, 2026

Keywords:
Water management systems
Risk-sharing mechanisms
Institutional arrangements
Performance-based contracts
Comparative analysis
Regulatory environments
Financial sustainability
PPP arrangements
Governance structures

ABSTRACT

Objective: *The research analyzes various PPP frameworks and their applicability to water management systems, focusing on risk-sharing mechanisms, institutional arrangements, and performance-based contracts.* ***Method:*** *Drawing on comparative analysis, the study identifies key success factors, including transparent regulatory environments, clearly defined stakeholder roles, and long-term financial sustainability.* ***Results:*** *The findings suggest that well-designed PPP arrangements can significantly improve service quality, operational efficiency, and infrastructure development in the water sector.* ***Novelty:*** *However, the effectiveness of such partnerships depends on strong governance structures, appropriate policy support, and careful alignment of public and private interests.*

INTRODUCTION

In today's environment, sustainable economic development and environmental security largely depend on the effective management of water resources and water management facilities. Water infrastructure plays a key role in agricultural development. However, a number of systemic problems remain in this sector, including high levels of depreciation of fixed assets, limited budget funding, and the ineffectiveness of existing management mechanisms[1].

In this regard, the search for new approaches to the modernization and development of water management facilities is particularly urgent. One promising tool is public-private partnerships, which allow for the pooling of resources and competencies between the state and business. Engaging the private sector facilitates the implementation of innovative technologies, improved service quality, and the optimization of operating costs[2].

An analysis of scientific literature shows that the problem of increasing the efficiency of management of water management facilities on the basis of public-private partnerships (PPP) is widely studied in both international and domestic practice.

Research in the field of water supply and sanitation emphasizes that the introduction of PPP is due to a number of objective factors: a high level of infrastructure

depreciation, a shortage of budgetary funds, as well as the need to introduce innovative technologies and improve the efficiency of facility operation[3].

A number of studies have analyzed the practical experience of using PPPs in the utilities, energy, and water management sectors. Research shows that the use of partnership mechanisms reduces infrastructure accidents and resource losses, demonstrating increased management efficiency.

At the same time, it is noted that the development of PPPs in the water sector often lags behind other industries due to institutional and methodological limitations, including insufficient development of mechanisms for assessing the readiness of facilities for transfer to partnership[4].

Of particular interest are studies on the development of PPPs in Uzbekistan, where partnership mechanisms in water resources management have been actively implemented in recent years. Specifically, this involves transferring a significant portion of water infrastructure facilities to the private sector for management, which aims to improve the efficiency and financial sustainability of the sector.

RESEARCH METHOD

The study utilized a comprehensive approach to general scientific and specialized research methods. Specifically, methods of analysis and synthesis, comparison and grouping, and statistical analysis were employed.

RESULTS AND DISCUSSION

The Ministry of Water Resources of the Republic of Uzbekistan is a specially authorized national executive body implementing a unified state policy in the field of water resources management for all water sources, the formation of accounting, reporting, and balance of water resources, as well as monitoring compliance with water use and consumption regulations[5].

In order to ensure the implementation of the Resolution "On measures to improve water resources management at the lower level and regulate relations between water consumers" and the effective management of water resources, their accounting and reporting, the improvement of water relations between water consumers and the broad involvement of the private sector in these processes, a list of clusters has been compiled that will assume the management of state water management facilities under public-private partnership conditions[6].

The districts have approved the main indicators of state water management facilities transferred to the management of the private sector under public-private partnership conditions, see Figure 1.

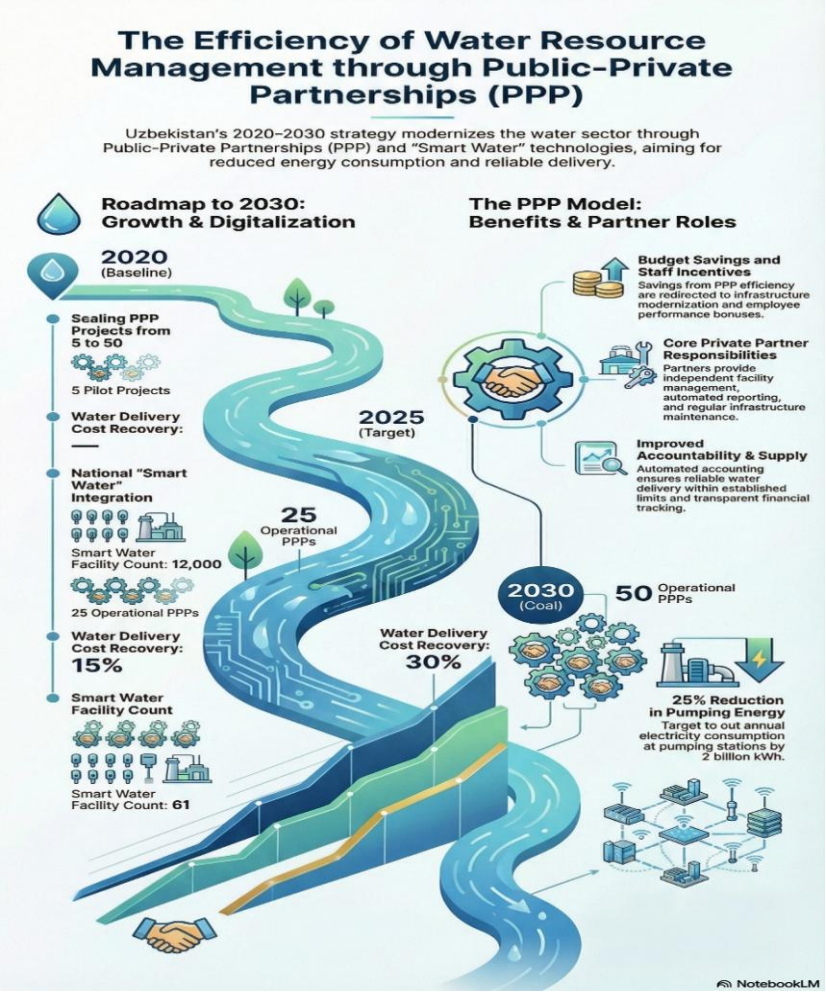

Figure 1. The figure was prepared based on data from the Ministry of Water Resources.

Water management clusters are allowed to enter into agreements without tendering based on direct negotiations with the private sector serving individual water consumers, as well as water management facilities at the discretion of the public partner[7].

The role of private clusters in water resources management in Uzbekistan lies in the active involvement of the private sector in the operation of state water management facilities on the basis of public-private partnerships (PPP).

The main functions and tasks of clusters in this area include:

- Independent management of facilities: Clusters are granted the right to independently manage all water management facilities (canals, collectors, pumping stations, and wells) located in their assigned territories.
- Water supply: Clusters are required to supply water not only for their own needs, but also for the needs of dehkan farms and household plots within established limits.
- Metering and automation: One of the key roles of clusters is to ensure complete water metering and the implementation of automated systems that minimize the impact of human error on reporting[8].
- Infrastructure modernization: Clusters are responsible for the phased modernization of all water management facilities in their service areas.

- Improving efficiency: Involving large agricultural producers in water distribution aims to address the problems of low resource management efficiency at the downstream level.

According to the data presented, an extensive list of clusters has been formed in the republic, taking over the management of facilities. For example, in the Kashkadarya region, clusters manage facilities covering an area of over 20,000 hectares, including dozens of canals and pumping stations. The state supports private partners by paying them a portion of the budget allocated for the operating costs of these facilities[9].

This mechanism allows for the transfer of state functions for providing water to economic sectors to the private sector, which is considered a priority area for water sector reform.

The introduction of digital technologies in Uzbekistan's regions aims to fundamentally transform the water metering system, making it more transparent and accurate. According to sources, this process includes the following key aspects:

- Minimizing the human factor: One of the main goals of digitalization is the transition to automated metering systems that enable reporting with minimal dependence on human actions[10].
- Obligations of private partners: Clusters and private enterprises that assume management of water management facilities through public-private partnerships (PPPs) are required to ensure full water metering and implement automated systems in this process.
- Creation of unified databases: Digital technologies are being implemented to maintain the State Water Cadastre and create comprehensive databases for all water management facilities.
- Transparency of energy consumption: Along with metering the water itself, digitalization aims to ensure transparency in electricity consumption, which is critical for the operation of pumping stations.
- Institutional support: Within the Ministry of Water Resources, specialized units are responsible for this area, such as the Central Dispatch, Communications, and Cadastre Service, as well as the Information, Analytical, and Resource Center.

Thus, digitalization is transforming water metering from manual to automated, which is essential for effective resource management in the face of growing water scarcity.

The PPP (Public-Private Partnership) Working Group is responsible for the broad involvement of the private sector in the use of public water supply facilities, as well as the transfer and organization of these facilities to the private sector under public-private partnerships[11]:

- Monitoring the safety, reliable operation, and protection of high-risk hydraulic structures, as well as ensuring their stable operation when using irrigation systems and networks;
- Implementing market economy principles, public-private partnership mechanisms, and outsourcing in water management;

- Organizing the widespread use of resource-saving technologies, modern building materials, and advanced international practices in water management;
- Implementing digital technologies in the management of water management structures, water resource accounting and reporting, as well as in the State Water Cadastre and the creation of a corresponding database;
- Efficient use of electricity and transparency of its consumption;
- Developing interstate relations in the management and use of transboundary water resources, actively participating in attracting foreign investment, grants, and technical assistance;
- Systematic organization of advanced training for specialists in water management, strengthening integration between water management organizations.

In recent years, to mitigate the negative impacts of water scarcity resulting from global climate change, our country has undertaken extensive reforms aimed at further improving water resource management, accounting and reporting, water relations, and the economic and efficient use of water[12].

However, the effectiveness of water resource management at the grassroots level, water distribution among consumers under water scarcity conditions, water accounting and reporting, and water consumption remains low.

The goal is to effectively manage water resources, fully account for and report on them, improve relations between water consumers, and broadly engage the private sector in these processes.

1. At the grassroots level, the following priority areas for water resource management have been identified:
    - Reliable supply of water resources to agricultural producers and household plots;
    - Continuous maintenance of irrigation systems and networks, as well as their hydraulic structures, in good technical condition;
    - İnvolvement of large agricultural producers in water resource management and distribution within their territories;
    - Widespread implementation of public-private partnership principles to transfer government functions related to water supply to economic sectors to the private sector;
    - Water resource accounting and reporting using automated systems that are minimally dependent on the human factor.

2. The Ministry of Water Resources, the Ministry of Agriculture, the Council of Peasants, Farmers, and Landowners of Uzbekistan, the Council of Ministers of the Republic of Karakalpakstan, and regional khokimiyats are instructed to:
    - Transfer all water management facilities in their territories to clusters that own agricultural land, based on public-private partnership principles;
    - Engage the private sector in the management of water management facilities in districts specializing in fruit and rice production, based on public-private partnership principles.

3. When transferring water management facilities to organizations operating under public-private partnership principles, clusters must independently manage all existing water management facilities on the land plots under their control, while private enterprises in the service area must independently manage them[13]:

- Provide water management facilities and household plots with water within established water intake limits;
- Ensure full accounting and reporting of water consumption and implement automated systems in this process;
- Ensure the gradual modernization of all water management facilities in the service area[14].

In this case, a portion of the funds allocated in the state budget for operating expenses of water management facilities in the controlled area will be paid to the private partner.

Particular attention is being paid to addressing issues at the lower management level, where resource allocation and water accounting remain inefficient in the face of global climate change[15].

CONCLUSION

Fundamental Finding : The analysis demonstrates that public-private partnership (PPP) approaches offer a viable and effective pathway for increasing the efficiency of water resource management systems. **Implication :** By combining public sector oversight with private sector innovation, investment capacity, and operational expertise, PPP models can address critical challenges such as infrastructure deficits, financial constraints, and service inefficiencies. **Limitation :** However, the success of PPP implementation depends on the establishment of robust institutional and regulatory frameworks, transparent governance, and equitable risk-sharing mechanisms. **Future Research :** It is essential to ensure that public interests—such as affordability, accessibility, and environmental sustainability—remain central to all partnership arrangements.

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