Azerbaijan: Transitioning to Efficient Water Sector Institutions and Programs for Addressing Water Security Challenges

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Smita Misra
Sr. Water Supply and Sanitation Specialist
World Bank

Foreword

There is an urgent need for addressing the water security related challenges in Azerbaijan given the increasing water scarcity, mainly due to high dependence on transboundary water sources. The water scarcity is expected to increase with climate change and further impact the performance of water supply, sanitation, and irrigation services.

The Government of Azerbaijan recognizes the need for modernizing its water sector institutions and investing in adaptation measures that promote water efficiency, reduce losses, and develop the institutional and policy landscape to promote a more sustainable, inclusive, and resilient water sector. This is a prerequisite for future economic and demographic growth in the context of transboundary sources and climate change related impacts.

As a critical step in addressing the fragmented responsibilities, the Government has recently established a water sector agency – the Azerbaijan State Water Resources Agency (ASWRA). The roles and responsibilities of the sector institutions are still evolving, and the government is keen to implement good practices for making these institutions efficient in addressing the water scarcity issues.

This report provides timely recommendations on how to strengthen these institutions, with a focus on water supply and sanitation sector, to adapt and be more efficient and effective in addressing the water security challenges, along with specialized digital tools to inform water resources management and planning in the country.

Priority strategic programs are needed for reducing non-revenue water in Baku and the surrounding areas, improving operational efficiency of the wastewater treatment plants, and introducing licensed (professional) services in rural areas and small towns. These need to be complemented with performance and target-based financing for the larger cities. These programs will help in improving climate resilience, reducing subsidies, and building credit worthiness of the water supply and sanitation sector institutions. Regulation of water tariff, including the level and the structure of the tariff, is a significant feature of the reforms envisaged.

Mr. Zaur Mikayilov — (Chairman, ASWRA)

Stefanie Stallmeister — (Country Manager, Azerbaijan)

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Part A: Improving institutional efficiency and effectiveness

(i) Advice on strengthening of the water sector institutions for efficient services with a focus on water supply and sanitation services.
(ii) Developing models for sustainable drinking water supply and waste-water management in rural areas.

Part B: Digital tools for water resource management

(iii) Informing country-wide sustainable water resource management based on mapping of reservoirs and water accounting systems.

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List of Acronyms

ASWRA	Azerbaijan State Water Resources Agency
AWM	Amelioration and Water Management OJSC
BOT	Build Operate Transfer
CA	Contracting Authority
CAPEX	Capital Expenditure
CBM	Community Based Management
CIP	Capital Investment Plan
CSO	Civil Society Organization
DBO	Design Build Operate
DBFO	Design Build Finance Operate
DPS	Delegation of Public Service
EPC	Engineering Procurement Contracting
GoAZ	Government of Azerbaijan
ILI	Infrastructure Leakage Index
IWRM	Integrated Water Resources Management
HH	Household
KPI	Key Performance Indicator
LA	Local Authorities
LPCD	Liter per capita per day
MES	Ministry of Emergency Situations
MFD	Maximizing Finance for Development
NAHC	National Asset Holding Company
NRW	Non-Revenue Water
O&M	Operation & Maintenance
OPEX	Operational Expenditure
PBC	Performance Based Contract
PBL	Performance Based Affermage Contract
PBM	Performance Based Management Contract
PCE	Private Capital Enabling
PCM	Private Capital Mobilizing
PFI	Private Finance in Infrastructure
PLE	Public Legal Entity
PO	Private Operator
PPP	Public Private Partnership
PPCP	Public Private Community Partnership
PSP	Private Sector Participation
3Rs	Repair, Replace, Renew
RAHC	Rural Asset Holding Company
RBM	River Basin Management
RBO	Rehabilitate Build Operate
RFP	Request for Proposal
RWAS	Regional Water Amelioration Service
TA	Technical Assistance
UAHC	Urban Asset Holding Company
UWSSLC	United Water Supply Service of Large Cities
WSS	Water Supply and Sanitation
WWTP	Wastewater Treatment Plant
WUA	Water User Association

Report Part A: Improving Institutional Efficiency and Effectiveness

(i) Advice on strengthening of the water sector institutions for efficient services with focus on water supply and sanitation services.

(ii) Developing models for sustainable drinking water supply and waste-water management in rural areas.

EXECUTIVE SUMMARY

The water and sanitation sector in Azerbaijan is currently undergoing important institutional reforms for improving services including addressing its fragmentation and the existing overlaps between water-related agencies and institutions. To do so, the Government of Azerbaijan (GoAZ) has set up a single public body, the Azerbaijan State Water Resources Agency (ASWRA), in charge of formulating the country's water policy, ensuring its implementation, fulfilling water-related economic regulation functions, fostering sector coordination, and supporting sector overall development. Furthermore, ASWRA is tasked with ensuring water security, improving efficiency and service quality, and setting the stage for much needed coverage expansion, while giving enhanced attention to demand management in a water scarce environment.

Establishing a robust and comprehensive framework for economic regulation is an important feature of the ongoing reform. This includes developing rules and standards for WSS service providers, monitoring their performance as well as regulating tariffs. A proposed WSS Regulatory Unit (WSSRU) under ASWRA is foreseen to fulfil these tasks with the aim of improving operating and economic efficiency, enhancing accountability to customers, and strengthening performance monitoring and benchmarking, while increasing capital flowing into the sector. However, being able to attract and retain skilled staff will be key to build professional capacity within this unit.

Based on a series of strategic studies, several key areas of efforts for ASWRA were identified.

- There is a critical need to fast track NRW reduction. This can be done using a performance-based PPP contract for Baku in view of the upcoming desalination investments. The private sector can bring the much-needed experience and know-how for reducing NRW while providing blended finance opportunities. A phased PPP approach is recommended to minimize risks. This may consist in introducing a private sector participation arrangement in selected service areas with new assets, and gradually moving towards a more complex and advanced form of PPP when all preconditions are met.
- The former Azerbaijan WSS operator (Azersu) regularly incurred huge financial losses over the last 10 years (2012-2022), with the MoF financing its debt. During this period, operating costs were nearly twice as high as the revenues of the operator. Although Azersu achieved O&M cost recovery in 2021, it is facing persistent inefficiencies related to NRW, receivables and payables, and energy consumption. They can be addressed by making targeted investments to reduce leaks and/or implement a performance improvement plan while gradually raising tariffs to cost recovery levels. This will eventually help recover investment costs over the long-term, and reduce subsidy flows from the MoF.
- Coverage and access to safe drinking water supply and adequate sanitation lag behind in rural and small-town areas, largely due to poverty issues in these areas. To bridge this gap, a preferred option would consist in establishing a separate national asset holding company with a dedicated focus on rural WSS (RAHC), at national level and under ASWRA.

As part of the current reforms happening in Azerbaijan, two public legal entities were recently created, under the authority of ASWRA, to ensure water service delivery.

The United Water Supply Service of Large Cities (UWSSLC) is responsible for water, sanitation, and urban drainage provision to the population of five large cities (Baku, Ganja, Sumgait, Mingachevir and Shirvan) in Azerbaijan.

The Regional Water Amelioration Service (RWAS) ensures the operation of reclamation and irrigation systems, and oversees water resources facilities such as reservoirs, canals, and pipelines.

These two new entities were established with the aim of improving access, performance, and financial sustainability of WSS services while bridging the infrastructure gap through strategic asset management and enhancing the water sector monitoring and benchmarking. To achieve these goals, a stepwise approach is proposed using performance-based contract and time-bound target values for Key Performance Indicators (KPIs) and empowering city-based cost centers for billing and collecting tariff revenues from customers (metered and non-metered). Introducing such an incentivized performance-based culture will involve a chain of performance-based contractual relationships. This process is conditional on the availability of suitable and experienced personnel. Therefore, different development paces among the two entities may be envisaged. Furthermore, the creation of these two entities presents an opportunity to design and implement an enhanced accountability framework towards customers.

INTRODUCTION

In response to the request by the Government of Azerbaijan, the main objective of this report is to present recommendations for enhancing performance of the newly established Azerbaijan State Water Resource Agency (ASWRA), with a focus on Water Supply and Sanitation (WSS) services.

Structure of the Report

Section 1 provides a functional overview of the water sector entities.

Section 2 reviews the WSS sector challenges.

Section 3 reviews the urban and rural WSS service provision for improving performance.

Section 4 provides recommendations for rural and small-town water supply and sanitation services.

Section 5 introduces Public-Private Partnerships (PPP) in the WSS sector.

1 A FUNCTIONAL OVERVIEW OF WATER SECTOR AGENCIES: FRAGMENTATION AND RESPONSIBILITY OVERLAPS

Introduction

Azerbaijan relies on transboundary water resources which are increasingly affected by rising upstream demand and climate change impacts. Azerbaijan has a population of 10.32 million (2022), of which 23 per cent (2.4 million) reside in its capital city Baku. Azerbaijan relies extensively on transboundary water inflows due to its geographical and climatic conditions. The largest share (78 percent) of Azerbaijan's runoff enters through transboundary Kura and Araz Rivers from the three neighboring states of Georgia, Iran, and Armenia. However, water availability is on the decline due to increasing upstream demand and climate change impacts. Water resilience needs to be substantially strengthened to address future consequences of climate change and inadequate water storage, which otherwise will fuel potential conflicts among water users.

Water resources management functions and responsibilities are allocated among several institutions in Azerbaijan thus creating overlaps. The Ministry of Ecology and Natural Resources, the State Agency for Water Resources (ASWRA), the Azerenergy OJSC are all involved in the management of the water sector. Along with the research centers of the above agencies, the Azercosmos OJSC under the Azerbaijan National Academy of Sciences and the Ministry of Digital Development and Transport are also involved in research activities. While co-ordination for efficient use of water resources is the responsibility of the National Water Commission, established recently in 2020, there is a pressing need for addressing the overlapping responsibilities.

The ongoing institutional reform in the water sector provides an opportunity to address the fragmentation of the water sector. The GoAZ has embarked on water sector reforms to improve the integrated management of water resources. The creation of the State Water Resources Agency brings water service providers from the irrigation and water supply sectors together along with the development of fundamental water policy instruments, such as the new water law and the upcoming water strategy.

The following public organizations are currently involved in the water sector in Azerbaijan:

- MoF
- Ministry of Economy
- Ministry of Ecology and Natural Resources
- Ministry of Agriculture
- Azerenerji OJSC
- Ministry of Health
- State Committee for Urban Planning and Architecture
- Tariff Council
- Municipalities / Local Government
- Water Commission
- Azerbaijan Water Users Association
- Azerbaijan State Water Resources Agency

Ministry of Finance

The MoF is responsible for the development and implementation of fiscal policies and strategies aimed at financial stability, promoting economic growth, and improving the standard of living of the population. The main responsibilities of the MoF include:

- Formulating and implementing the state budget, including revenue and expenditure plans, and ensuring the effective use of budget resources;
- Monitoring and managing public debt, including the negotiation of loans and bonds, and ensuring the sustainability of public finances;
- Regulating and supervising the financial sector, including banks and financial institutions, to ensure the stability and integrity of the financial system;
- Providing advice to the government on economic and financial matters and contributing to the development of economic policies and strategies;
- Coordinating with other government agencies and international organizations on financial and economic issues, including macroeconomic and fiscal policies, financial sector regulation and supervision, and fiscal transparency and accountability.

Ministry of Economy

The Ministry of Economy (MoEc) plays a key role in creating the regulatory framework and policies that support the growth and development of the water supply and sanitation sector in Azerbaijan. The MoEc specifically works to ensure that the water supply and sanitation sector is developed in a manner that is sustainable and that supports the health, well-being, and economic development of the population. This may involve developing policies to promote investment in the sector, to encourage the use of environmentally responsible practices, and to ensure that water resources are managed in a sustainable manner.

The Ministry works with other water sector related agencies, such as the State Committee for Urban Planning and Architecture, AWM, and ASWRA to coordinate efforts and ensure that irrigation, land reclamation, water supply and sanitation system are developed and operated in a manner that is consistent with the overall economic goals of the country. This includes providing technical and financial support for water supply and sanitation projects and working with international organizations to access financing and technical assistance for the sector.

Ministry of Ecology and Natural Resources

The Ministry of Ecology and Natural Resources (MENR) is the central executive body for the protection of the environment in Azerbaijan. The MENR was Established on May 23, 2001, as per the Presidential Decree No. 485 in accordance with structural reforms within the Azerbaijani Government, the MENR is the central executive body responsible for developing and implementing state policy in the field of water resource management and protection, hydrometeorology management, biodiversity and climate change, control over water resources, use of water bodies and discharges of pollutants into water bodies, control of permits for special water use, and compliance with environmental safety requirements during design, construction, and operation of water management facilities.

It is also responsible for environmental management, for the effective use of groundwater, mineral resources and surface natural resources, for their protection and restoration, and monitoring of hydro-meteorological processes. The MENR is composed of the following entities:

- Department of Environmental Protection;
- Department of Forestry Development;
- National Department of Environmental Monitoring;
- Department for the Conservation and Protection of Biodiversity in Waters;
- Department for Biodiversity Conservation and Development of Specially Protected Areas;

- National Hydrometeorological Department;
- Baku city department of ecology and natural resources;
- State Expert Department;
- Department of the Caspian Integrated Environmental Monitoring;
- Regional bodies and local departments of the MENR.

The ministry has several functions related to water resources use and protection, including the regulation of water use, the management of water quality, and the protection of aquatic ecosystems. The ministry also works to ensure that water resources are used in a sustainable manner, and promotes the efficient use of water in agriculture, industry, and domestic settings.

Ministry of Agriculture

The Ministry of Agriculture (MoAg) is responsible for overseeing and regulating the country's agricultural sector, with a focus on promoting the development and sustainability of the sector. The main responsibilities of MoAg include:

- Developing and implementing policies and programs aimed at improving the competitiveness and productivity of the agricultural sector, including support for the modernization and diversification of agricultural production, and the promotion of sustainable and environmentally friendly agricultural practices.
- Providing technical and financial support to farmers, including support for the implementation of innovative technologies and the adoption of sustainable agricultural practices.
- Participates in the monitoring and managing the use and protection of land and other natural resources, including water resources, forests, and wildlife, with a focus on ensuring the sustainable use and conservation of these resources for the benefit of the agricultural sector and overall society.
- Collaborating with other government agencies, international organizations, and other stakeholders to address cross-cutting issues, such as the impacts of climate change on agriculture, the protection of biodiversity, and the promotion of sustainable development.

Azerenerji Open Joint Stock Company (Azerenerji)

Azerenerji is the primary electricity utility company in Azerbaijan, responsible for generating, transmitting, and distributing electricity to the population. Azerenerji is involved in the development of hydropower projects, which have an impact on the water supply and sanitation system, as they can affect the availability and quality of water resources. In such cases, Azerenerji work with other government agencies and stakeholders, such as the MoEc, the State Committee for Urban Planning and Architecture, State Agency for Water Resources, and Azersu OJSC, to ensure that hydropower projects are developed and operated in a manner that supports the broader goals of the water supply and sanitation system, including environmental protection, sustainable resource management, and access to clean water and sanitation services. In the Kura- Araz region most irrigation systems pump water from the river to the main canal. Therefore, reliable power supply is essential during the crop growing period.

Ministry of Health

The Ministry of Health has a role in ensuring that water resources of Azerbaijan are safe for human consumption and use. This involves monitoring the quality of drinking water and other water sources, developing, and implementing water safety plans, and collaborating with other agencies, such as ASWRA, to ensure the protection of water resources. The Ministry conducts the hygiene oversight under the law of the Republic of Azerbaijan on “Sanitary epidemiological safety”.

State Committee for Urban Planning and Architecture

The State Committee for Urban Planning and Architecture (SCUPA) plays an important role in the formulation and development of the country's water supply and sanitation system. Particularly, the committee works to ensure that new urban areas are planned and developed in a manner that is sustainable and that provides adequate access to clean water and proper sanitation facilities for residents. This may involve working with other government agencies, such as the MENR, ASWRA, and local authorities to ensure that water resources are protected, and that water supply and sanitation systems are designed and operated in an environmentally responsible manner.

Tariff Council

The Tariff Council of the Azerbaijan Republic is an independent government council responsible for setting and regulating tariffs and prices for certain goods and services in Azerbaijan, including water supply. Its main responsibilities include:

- Developing and recommending water related tariff policies to the government of Azerbaijan;
- Monitoring market trends and making recommendations for changes in water tariffs and pricing;
- Conducting research and analysis to inform water tariff and pricing decisions;
- Ensuring that water tariffs and prices are set in a manner that is transparent and fair to consumers and businesses.

The Tariff Council also works with other government agencies and stakeholders to ensure that tariffs and prices are set in a way that supports the broader economic goals of the country. This may include promoting competition, encouraging investment, and promoting economic growth.

Water Commission

The role of the Water Commission is to ensure the efficient use of water resources in the country by coordinating water sector management activities. Created by the Presidential decree dated 15 April 2020, the Water Commission plays a regulatory role, and is responsible for analyzing the current situation of water resources use and management, for elaborating measures to increase efficiency, , and for ensuring operational coordination in the sector. The head of the Commission is the Deputy Prime Minister. The members of the Commission come from the following entities:

• Minister of Ecology and Natural Resources
• Minister of Economy
• Minister of Agriculture
• Minister of Finance
• Chairman of Azerenerji OJSC
• Chief of the State Agency for Water Resources of the Ministry of Emergency Situations of the Republic of Azerbaijan.

Currently the Commission is leading the implementation of the short-term action plan on water resources management, as approved by the government, and other regulatory activities in this area.

Municipalities and local authorities

Municipalities are responsible for providing public services at local level, including:

- Urban planning and development, including land-use planning and building codes;

- Provision and maintenance of local infrastructure, such as roads, water supply and sewage systems, and public transportation;
- Collection and disposal of waste and garbage;
- Providing local public services, including education, healthcare, and social services;
- Ensuring public safety through police and fire services;
- Management of local parks, public spaces, and other communal areas.

In relation to water, municipalities in Azerbaijan work closely with water sector related entities, such as ASWRA, to ensure access to clean and safe drinking water. Municipalities may also be involved in water conservation and management efforts, such as promoting public awareness about water conservation through dedicated campaigns, implementing water-efficient technologies in public buildings and facilities, and developing local water management plans. Additionally, some municipalities may work with local water user associations to manage and distribute water resources at the community level.

Water Users Association

Water Users Associations (WUA) are non-governmental organizations representing the interests of water users, including farmers, households, and businesses in Azerbaijan. The WUAs aim to promote sustainable water resources management and to improve the livelihoods of water users through capacity building, O&M of irrigation and drainage systems in their own service area; purchase, installation and operation of hydraulic structures; training of water users on improved water usage behaviors and techniques, including advanced irrigation practices and technologies, and promotion of their application.

WUAs coordinate their activities with the Local Irrigation Department and the State Agriculture Development Center for timely water and distribution among the farmers.

Azerbaijan State Water Resources Agency (ASWRA) – recently established.

The Azerbaijan State Water Resources Agency (ASWRA) is responsible for activities related to water abstraction, processing, transportation, and supply in Azerbaijan. Recently established by the presidential decrees dated March and November 2023, ASWRA oversees the operation of state-owned irrigation systems, drinking water supply, rain and wastewater processing and discharge systems.

ASWRA activities include participation in formulating a coordinated state policy and overseeing its implementation, water sector regulation and norm-setting, and fostering the overall development of the sector. ASWRA is also tasked with ensuring water security, operations and protection of water management facilities, and conducting regular technical assessments. Moreover, it implies monitoring surface and underground water resources, water facilities, hydrotechnical structures, and water supply systems across the Republic of Azerbaijan. State control over the protection and utilization of water bodies is within its purview. Ensuring the integrated management of water resources is a key focus of the ASWRA's multifaceted responsibilities.

Legal oversight is a cornerstone of the Agency's activities, ensuring compliance with water-related laws and taking legal action against violators. Information management, facilitated through the Geographical Information System (GIS), involves the application of modern methods in water resources management.

Environmental protection forms a significant aspect of ASWRA's functions, as it actively proposes bans on facilities detrimental to water quality. Additionally, it plays a pivotal role in establishing and managing sanitary protection zones for water bodies, aligning with legal provisions. ASWRA is equipped to propose measures for water facilities damaged by natural disasters. It takes a proactive stance in construction and restoration efforts in the aftermath of floods, contributing to the resilience of water infrastructure.

Strategic planning is another core responsibility of ASWRA taking the lead in developing master plans for water resource use and determining the utilization of water protection zones.

International cooperation is actively pursued to facilitate the joint operation of transboundary water bodies and contribute to the drafting of international agreements. User registration and control mechanisms are in place, with ASWRA playing a pivotal role in registering water users and maintaining oversight of their water abstraction activities.

ASWRA's commitment extends to water forecasting and research, water infrastructure oversight, flood management, water-related public communication, budget management, and safeguarding human rights to water. It consistently seeks to improve its structure, spearheads educational initiatives, and ensures compliance with laws and regulations.

Public Legal Entities (PLEs) under ASWRA

As per the decree of the President of the Republic of Azerbaijan the following Public Legal Entities (PLE) are established. There will also be a policy-making unit and a regulation unit separately installed under ASWRA.

1) Regional Water Amelioration Service (RWAS) – former Amelioration and Water Management (AWM) OJSC
2) United Water Supply Service of Large Cities (UWSSLC) – former Azersu OJSC
3) Water and Amelioration Scientific Research Institute – former Amelioration Scientific Research Institute of AWM OJSC
4) Water and Amelioration Complex Design Institute – former Azerbaijan State Institute for designing of water facilities under the auspices of "Azdovsutaslayiha" under AWM and Sukanal Scientific Research and Design Institute under former Azersu OJSC
5) Directorate of Facilities Under Construction - Combined directorate of amelioration and irrigation facilities under construction under former AWM OJSC

Regional Water Amelioration Service PLE (RWAS)

RWAS is a pivotal entity that specializes in delivering services within the realm of reclamation and irrigation. As a public legal entity, it assumes a critical role in the operation of state-owned reclamation and irrigation systems, overseeing water resources facilities such as reservoirs, canals, and pipelines currently in operation. Moreover, it actively engages in the management, treatment and discharge of rainwater and wastewater. In summary:

- The regional services function will align with the former Amelioration services.
- The water supply and sanitation system, including rural WSS, will be integrated into the structure as a separate department.
- The billing and accounting systems will be separated.
- The primary focus of the RWAS will be on operational expenditure (OPEX).
- The headquarters will be situated in Baku.

Regulation and capital expenditure (CAPEX) will constitute separate departments under the HQ of ASWRA.

United Water Supply Service of Large Cities PLE (UWSSLC)

UWSSLC is responsible for providing water supply and sanitation and urban drainage services to the population of five large cities (Baku, Ganja, Sumgait, Mingachevir and Shirvan) in Azerbaijan. Each city operates as a distinct department for supervision.

In summary, the main functions of UWSSLC include:

- Providing clean drinking water services to customers
- Collecting and treating wastewater
- Maintaining water supply and sanitation infrastructure

- Developing and implementing programs to improve efficiency and sustainability of WSS system.
- Ensuring that water resources are managed in an environmentally responsible manner.
- Providing customer service and billing for water and sewer services.
- The headquarters will be situated in Baku.

Water and Amelioration Scientific Research Institute PLE

The Public Legal Entity, the Scientific Research Institute of Water and Amelioration, is actively engaged in both fundamental and applied research within the domain of water and reclamation. The institute plays a pivotal role in advancing knowledge in this field by providing valuable insights through comprehensive research endeavors.

Water and Amelioration Complex Design Institute PLE

The Public Legal Entity known as the Water and Amelioration Complex Design Institute specializes in the design of water management and reclamation facilities, as well as water supply, wastewater processing, and discharge systems. This institute plays a crucial role in the planning and design phases, contributing to the development of efficient and sustainable water infrastructure.

Directorate of Facilities Under Construction PLE

The Directorate of Facilities Under Construction is a legal entity responsible for overseeing the execution of construction activities as approved by project-estimate documents. It plays a crucial role in ensuring the efficient management of funds allocated from the state budget and other funding sources. The Directorate is actively involved in the construction and reconstruction of water management and reclamation facilities, as well as water supply and sewage systems. Additionally, it functions as a procurement organizer for restoration-related activities within the public domain.

ASWRA is accountable to the Cabinet of Ministries of Azerbaijan and operates in close coordination with the Ministry of Ecology and Natural Resources and other related organizations to ensure that the provision of water and sanitation services, and irrigation as well, is carried out in accordance with national laws and regulations, and that the protection of the environment and water resources is given due consideration.

Water sector institutional setting 2024

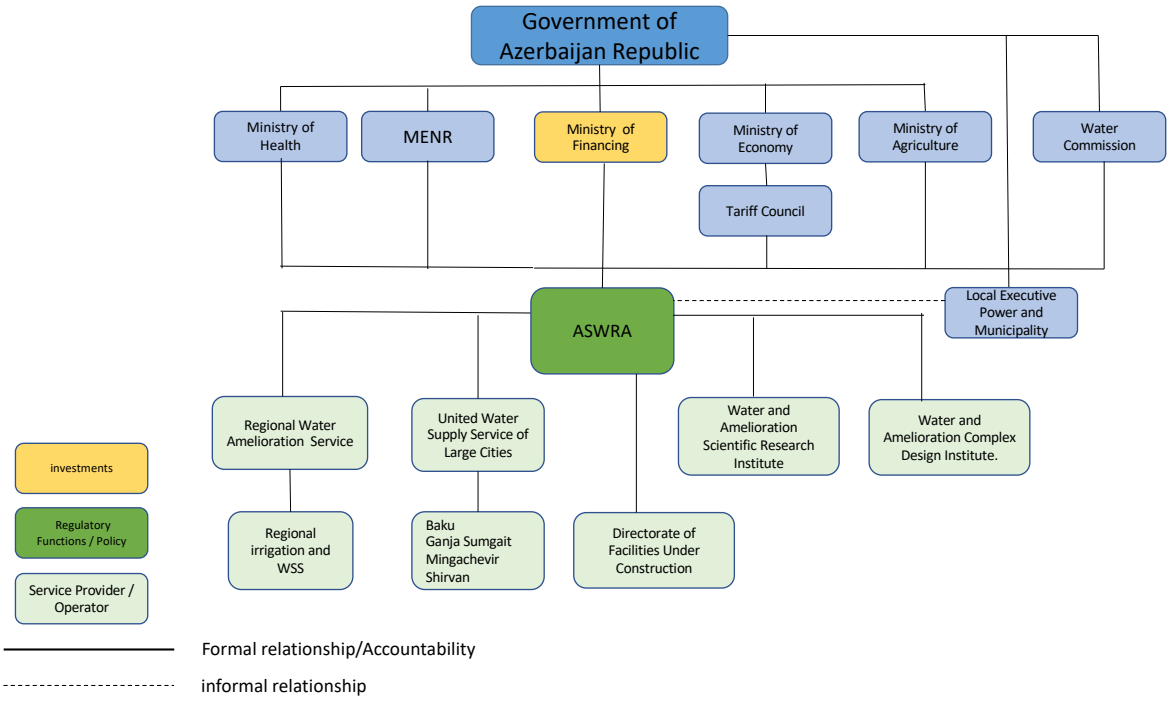


Figure 1: 2024 water sector institutional setting

2 WHAT ARE THE KEY CHALLENGES FACED BY THE WATER SUPPLY AND SANITATION SECTOR?

The establishment ASWRA is a forward-looking step in the water sector reform process. However, the current structure and allocation of roles and responsibilities in the water supply and wastewater sectors reflect the legacy of the past combined with the newly created institutions. The on-going transition offers an opportunity to improve water security, efficiency and service quality, and boost coverage expansion, while giving enhanced attention to demand management in a water scarce environment.

The key drivers for reform resulting from the water sector assessment include:

a. Need to improve sector and service provider corporate governance.
b. Need to improve operational efficiency (performance), effectiveness (access), service quality, and financial sustainability.
c. Need to address the challenge of bridging the WSS infrastructure gap through strategic asset management and finance.
d. Need to improve water sector monitoring and benchmarking.

This transformational process will imply a change in the governance paradigm and a new take on development policies, programs, and action plans, and on means of implementation that will need to be result-oriented.

2.1 Water Supply and Sanitation

The identified challenges of water and sanitation (WSS) service provision, include:

a. Policy and planning
   - Weak legal and regulatory provisions
   - Inadequate tariff policy, and lack of economic regulation
   - Lack of integrated water resources planning
   - Lack of climate-resilience and climate adaptation measures
b. Infrastructure
   - Aging infrastructure (water supply and sewerage) and dilapidated distribution network; inadequate waste-water treatment
   - Inadequate asset management
   - High NRW, estimated at above 50%
   - Intermittent supply (total population: 10 million; population with access to piped water: 7.5 million or 75%; population with access to improved sanitation: 6.9 million or 69%; metering ratio of connected customers: 90%). Above data relate mostly to urban population with most small-towns and rural areas lacking access to professionally operated services and lacking adequate data and information systems.
c. Operation and maintenance
   - Inadequate NRW management
   - Lack of operationalization of monitoring system to enable adequate network management.
   - Inadequate maintenance of assets, lacking capital maintenance
   - Lack of modern management systems (risk prioritization of CAPEX)
d. Finance
   - Insufficient CAPEX, mostly for Baku and surrounding settlements rehabilitation network
   - Poor cost accounting systems of districts (sub-ordinate entities)
   - Historically low tariffs, below operating costs
   - Lack of performance incentives for districts entities
   - Limited utility revenue and resources, highly dependent on subsidies

- Long-term business planning and forecasting of revenues and expenditures not operational.

e. Inadequate management and human resources issues
   - Lack of managerial autonomy
   - Lack of staff incentives and accountability, and uncompetitive salary structure for staff
   - Lack of skilled staff
   - Insufficient training and human resource development

2.2 Wastewater treatment plants and pumping stations

The identified challenges include:

- Operations and energy efficiencies of WWTPs and pumping stations: Despite the introduction of innovative technologies in wastewater treatment processes, the operational efficiency and sustainability of WWTPs remain significantly low. This issue primarily stems from the improper operation and management of these advanced systems, including inadequate optimization of power consumption during off-peak hours.
- Design flow optimization: Optimizing the design flow of WWTPs would involve addressing several challenges that may jeopardize the balance between operational efficiency, environmental compliance, and financial sustainability.
- Staff competence, training and capacity: Staff competence and the need for ongoing training are critical, with the push towards automation requiring skilled oversight for these systems. The Shamakhi WWT provides a compelling case study of the operational challenges and staff capacity issues. Furthermore, limited staff capacity is a significant bottleneck. Existing teams lack the necessary skills and knowledge to operate the plant effectively
- Manual operation: Many WWTPs that were designed as fully automated, currently rely on manual operation due to non-functional SCADA system since operational takeover.
- Partially Functional Systems: Critical components of WWTPs, such as mechanical treatment and aeration systems, are often only partially operational, which compromises the effectiveness of the wastewater treatment process.
- Lack of operational and maintenance support: Due to insufficient O&M, WWTPs are experiencing rapid wear and tear, with many key sections either broken or not operating as designed.
- Reusing treated water from WWTPs: Reusing treated wastewater from WWTPs presents a sustainable approach for managing water resources, addressing the critical issue of water scarcity, and minimizing the environmental impact of wastewater disposal. This will require a multi-faceted approach, blending technological innovation, policy development, community engagement, and strategic investments.
- Sludge management: Considering that most WWTPs in Azerbaijan have been designed and constructed with adaptation and innovation technology, the challenges of sludge management systems still encompass a broad spectrum of issues. Yet some of these challenges present unique opportunities for leveraging the existing technological base.

The need for strengthening the WSS sector institutions along with improving services for small-towns and rural areas and operationally efficient WWTPs requires attention.

3 HOW CAN ASWRA ENHANCE ITS INSTITUTIONAL AND PROFESSIONAL CAPACITY?

3.1 Policy-Institution-Regulation (PIR) Concept[1]

The proposed transformational recommendations build on the referenced PIR framework by using its main principles: (i) holistic, (ii) best-fit, placing solutions in context to local realities, and (iii) incrementalism, leading to more likely positive outcomes and providing incentives to stakeholders already inclined to adopt policy measures.

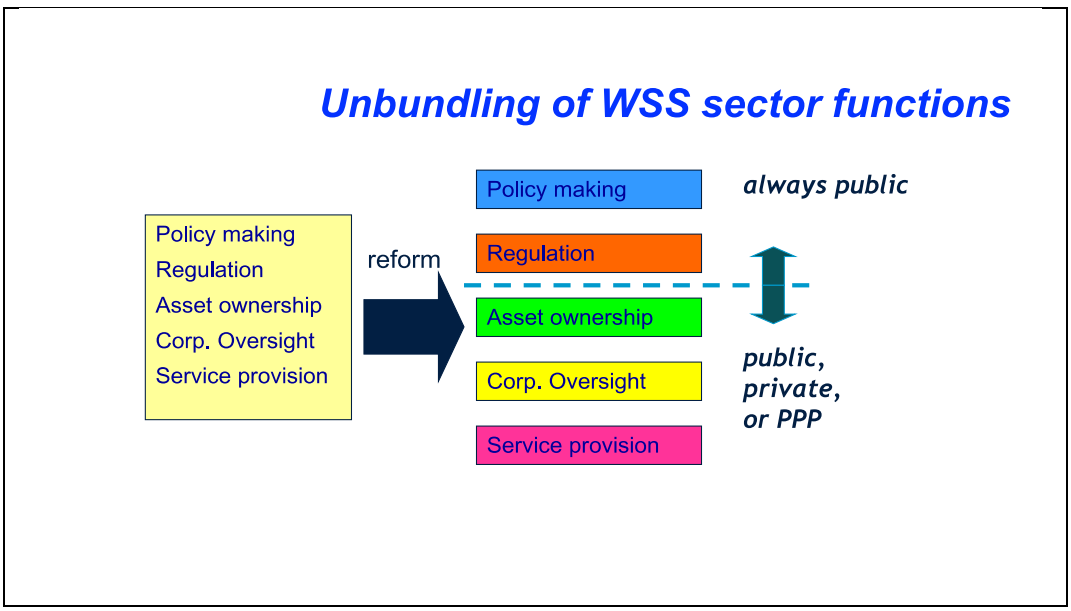
Empirical evidence has shown that specific factors should be present before starting a utility transformational process:

- Competent and incentivized manager—Committed and capable leadership is required to guide a utility through the process.
- Minimal level of managerial autonomy—Decision-making power over resources and strategy, for all department managers, is required. Specifically, autonomy over operations, finances, and contracts is necessary.
- Government champion—Government leader committed to making changes to enable the right legal and regulatory framework, promote the right governance incentives, and provide reliable and stable resources.

While these conditions alone do not ensure transformational success, they provide the opportunity and resources for starting one.

Clearly separating responsibilities and functions between policymaking, regulation and operational service provision is a key step to (Figure 2) get the institutional set-up right and clarify duties such as asset ownership, corporate oversight, or service provision. There is the need to align institutions to meet sector objectives and generate positive incentives, through:

- Conditional results-based access to finance
- Appropriate institutional arrangements, e.g. corporatization, commercialization, and
- Regulation (water resources (environment), water quality (public health), tariffs (economic)).



[1] The analysis uses the main principles of the PIR Framework to provide guidance for the evolving sector institutions. It does not use the detailed PIR Tool for the diagnostics.

Figure 2: Unbundling WSS sector functions

3.2 Establishing a comprehensive regulatory framework

As illustrated in Figure 3, there are three key areas of regulation with regard to the WSS sector:

- Economic regulation
- Public health regulation, e.g. drinking water quality standards
- Environmental regulation. e.g. abstraction of water, water resources protection, wastewater discharge

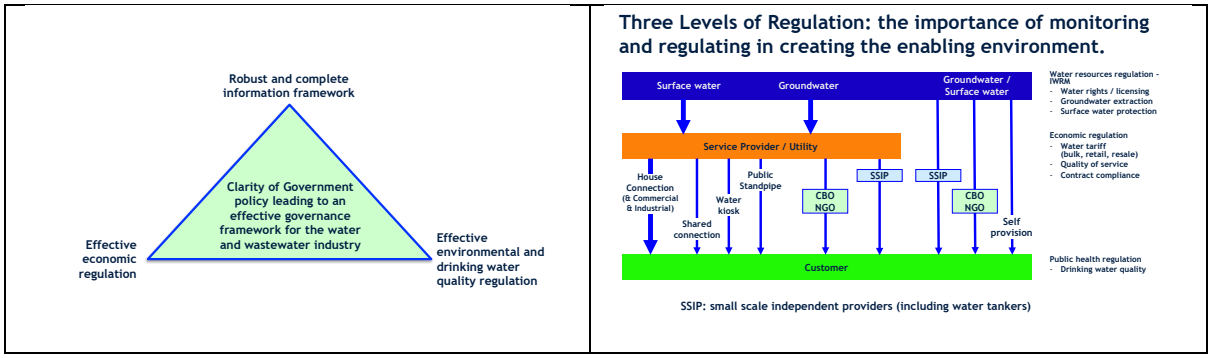


Figure 3: The Effective Governance Framework

To meet the WSS sector challenges in Azerbaijan, reforms are needed in two areas: (i) institutional and organizational development of water utilities, and (ii) the establishment of a regulatory framework. Reforms are considered being an important intervention to enhance the performance of the existing agencies and entities operating in the water sector. Regulation of water tariff (including the level and structure of the tariff) is a significant feature of the reforms envisaged.

3.2.1 Economic regulation

The main objectives of economic regulation of water supply and sanitation services are to ensure that:

- All households have access to services at affordable tariffs that reflect the cost of efficient and sustainable services.
- The quality of service for households and other customers is appropriate, safe and reliable.
- The services are financially viable and sustainable.
- Services are managed and operated in an efficient and technically effective manner.

Water and wastewater tariffs constitute a primary avenue for utilities to generate revenue towards covering the costs associated with water and wastewater services provision. The tariffs need to consider the financial and economic costs associated with old infrastructure, the need for subsidies, related energy costs, and a shift to alternative water resources such as desalination. Good practices comprise a volumetric component and a basic service charge. The fixed charge accounts mainly for the infrastructure costs regardless of consumption thus providing a stable minimum (although largely insufficient) revenue for the utility. Volumetric charges somehow give consumers an incentive if not a possibility to lower their consumption and thus reduce their final bill as it is based on consumption. However, where the fixed component constitutes most of the tariff, consumers have limited control over the final bill which provides less incentive for the consumer to conserve water. Some utilities do not separate the fixed and variable charges but instead set a minimum charge that consumers must pay for a basic level of consumption.

Azerbaijan has a fixed flat tariff at 0.70 AZN/cum of water consumed. This needs to be reviewed to incorporate a volumetric component which would provide an incentive to reduce

consumption and help manage demand. Further analysis is needed to provide a holistic understanding of the required balance between affordability and cost-recovery objectives for water and sanitation services provision.

Regulators must determine which objectives are most important and design regulatory approaches and efforts to address them. The affordability of services for low-income households presents a challenge. Economic regulators focus on ensuring the financial viability of service provision, while governments should provide guidance on how to achieve social policy objectives, including affordability, in a transparent manner that does not undermine the financial viability of services.

Establishing a framework for economic regulation, would involve developing rules and standards for regulating WSS service providers and starting performance monitoring of service providers. Specific outputs would include:

- Drafting adequate rules and standards for economic regulation of WSS service provision, including (i) financial management regulations, (ii) tariff adjustment and review methodologies, (iii) service standards and key performance indicators, and (iv) customer service regulations to protect the interest of consumers.
- Introducing and enforcing regulatory accounting (including the financial management, and finance operating and reporting requirements).
- Preparing monitoring reports on the performance of service providers.
- Initiating preparation for the establishment of a water supply and sanitation regulatory unit within ASWRA, including preparation of the road map for its establishment including capacity building.

The WSS sector in Azerbaijan is characterized by the need for reduction of non-revenue water, implementation of cost reflexive tariffs, improvement of utility autonomy, and more efficient operations.

The need for a Water Regulatory Unit, within ASWRA that would however be independent from the government, is to be underlined. This unit would serve as the economic regulator for water supply and sanitation, in urban, small-town, and rural areas.

The proposed Water Supply and Sanitation Regulatory Unit (WSSRU) should promote improved operating efficiency, improved accountability to customers through monitoring and benchmarking of performance, tariff levels aligned with operating expenses needs, and increased levels of capital flowing into the sector.

The WSSRU should also address issues associated with consumer interest protection and quality assurance. Regulation will also give service providers an opportunity to set tariffs, covering efficient costs of service provisioning.

International experience has shown a variety of regulatory designs, which involve different combinations of instruments and settings. The appropriate combination of legal instruments and setting works best will be determined by local circumstances. There is no “one-size-fits-all” regulatory solution. The following table summarizes the key lessons learned from international experiences, and puts them into perspective for the Azerbaijan context.

Box 1: Regulation is most likely to be successful when it is characterized by

- Cost-effectiveness
- Transparency
- Predictability and credibility
- Legitimacy and accountability
- Fairness
- Independence

Table 1: Lessons from international case studies and possible learnings for the Azerbaijan context

Key aspects of water regulation	Lesson from international experience	Potential learnings for the Azerbaijan context
Tariff adjustment	Tariff can be effectively used as a tool to not only achieve financial/economic objectives, but also to send signals for better service provision to utilities, and judicious use of water to the customers.	Instead of establishing a regulator that solely works towards revising water tariffs, the WSSRU may be empowered to handle tariff adjustments by using tariff as a tool to facilitate achievement of objectives including financial, economic, social, and environmental.
Independence and accountability of the regulator	Regulator's reporting to the government or other agencies may result in regulatory capture. On the other hand, absolute independence may result in irrational/unjustified decision-making.	To manage the tension between independence and accountability, procedural accountability mechanisms may be proposed. These mechanisms will make the WSSRU decision-making transparent.
Autonomy of utilities	Excessive regulation (micro-management) by the regulator defects efficiency and good judgement of the utilities to make decisions best suited for them.	The principles of transparency, accountability, and participation need to be extended to cover service provider decision making. The service providers are to seek public comments on their proposals (such as tariff, customer interest protection plan etc.) on which the WSSRU would pass the final order subject to the participatory processes applied.
Information provided in a standardized **format**	It is important to have the service providers provide key operating and financial data to the regulator in a standardized format to facilitate effective analysis and benchmarking.	The performance monitoring and reporting regulation and the regulatory accounting guidelines define the data to be provided by the service provider and the required formats. To further standardize the process, the WSSRU may use the data provided to calculate the agreed upon KPIs to ensure accuracy and facilitate benchmarking.

In the process of designing the proposed WSSRU, the following considerations may be taken into account:

- Support at the highest levels of government is essential for the establishment of the regulatory framework.
- The current system of implicit operating subsidies being provided to WSS service provision (former Azersu) should be replaced with a system of explicit subsidies targeted to customers and intended to increase access to the piped water supply network.
- A foundation for effective regulation should be developed through regulatory accounting guidelines and business planning (Refer to Section 4.3.3 below).
- Tariffs should be adjusted based on proper levels of operation and maintenance expenditures intended to extend the useful life of the fixed assets and improve the operational efficiency and sustainable asset management of the utilities.
- The level of managerial autonomy and accountability for service provision and for the management of the WSSRU should be enhanced.
- The functions regarding policy (government), regulations (WSSRU), and operations (utilities) should be clearly separated, and,

- Time should be provided for the changes to be implemented. The key stakeholders will need time to develop the needed capacities and trust in the newly established regulatory framework.

The operationalization of a regulatory framework within ASWRA will involve the challenge of building regulatory capacity and the preparation of strategies and procedures. Operationalization may include the following actions:

1. Formulating objectives to guide the regulator during an initial transitional period.
2. Initiating performance monitoring of service providers and operators, and reporting regulations (metric and performance benchmarking), which is a critical activity.
3. Developing a compliance and enforcement strategy.
4. Developing customer engagement guidelines, setting out the approach to customer engagement, going beyond ad-hoc involvement of customers.

3.2.2 Public health and environmental regulation

Public health and environmental regulation, including water resources regulation (monitoring and control of industrial wastewater discharge) needs to be strengthened and adequately resourced.

Guidelines on drinking water quality and effluent monitoring would need to be further developed and enforced. The purpose of these guidelines is to:

- Promote transparency in the methods used for water quality monitoring by the water service provider, and thus build public confidence.
- Ensure, through regular monitoring, that the quality of water provided, and effluents discharged are compliant with applicable potable water and environmental standards.
- Ensure that the service provider complies with a systematic water quality monitoring.
- Ensure a minimum standard for water quality monitoring at acceptable costs, and,
- Create awareness among consumers that information regarding water quality will be made available by the service provider.

The guideline would contain information on establishing the minimum number of samples to be taken, water quality parameters to be measured, recording and reporting/ publication of results.

The purpose of the IWRM regulatory framework is to exercise the following permanent tasks and powers:

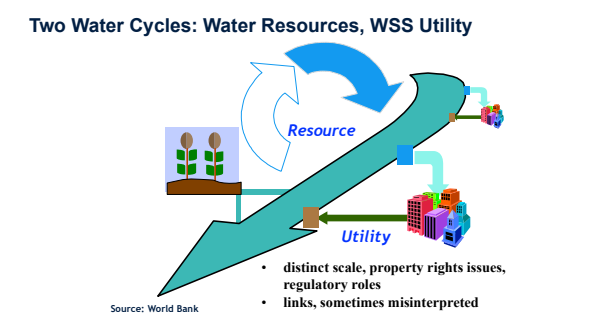
- The development of water development and management plans by basin or sub-basin.
- The collection and analysis of hydrometric and hydrological information.
- Planning, implementation, management and monitoring of the arrangements and installations relating to the management and development of water resources.
- The valuation of water as an economic resource, i.e. designing and setting water abstraction charges and water pollution charges.
- Determining the quality standards of natural waters appropriate to each basin or sub-basin.
- Production, management, and dissemination of information on water resources and hydraulic facilities.
- Participation in the preparation of water resource management tools.
- Support for basin or sub-basin committees and decentralized territorial entities for the management and development of water resources.

The following new and additional IWRM tasks may include:[2]

- integrating diverse datasets, providing decision-makers with a holistic understanding of the interconnected nature of water bodies, agriculture practices, land management, and climate change impacts.

[2] World Bank (2022): The irrigation operator of the future: A Toolkit

- initiating digitalization, enhanced data monitoring activities to include (i) remote sensing monitoring and modelling of parameters such as crop evapotranspiration, soil moisture, soil salinity, water stress, crop type, and extent monitoring for vegetative growth, and water productivity, water balance modeling, crop modeling, climate modeling, and land monitoring, (ii) river and (canal) flow monitoring providing continuous data at key points in rivers, reservoirs, and at different levels in the irrigation distribution system and canals, (iii) water-environmental monitoring for water quality in rivers, reservoirs, canals, groundwater and sedimentation monitoring, (iv) agro-meteorological monitoring, which is critical for accurate irrigation and water allocation planning, and (v) groundwater monitoring for water levels in aquifers, abstractions and recharge.



Water and Trade
(Water Requirements m3 /ton)

Crop	Average Water Use
Wheat, Barley	1450
Maize	1400
Rice	3450
Veg. Oils (excl. olive)	22000
Fruits	1500
Vegetables	1000
Beef	42500
Milk	6000

Figure 4 Water Cycles and Water for Trade

3.3 Recommendations for improving performance of urban and rural WSS service provision

RWAS delivers services within the realm of reclamation and irrigation. As a public legal entity, it assumes a critical role in the operation of state-owned reclamation and irrigation systems, overseeing water resources facilities such as reservoirs, canals, and pipelines.

UWSSLC is responsible for providing water supply and sanitation and urban drainage to the population living in five large cities (Baku, Ganja, Sumgait, Mingachevir and Shirvan) in Azerbaijan. Each city operates as a distinct department.

It is noteworthy mentioning that, in volumetric terms, irrigation represents about 85 percent of water use in roving volume with about 10 percent for water supply, whereas, in monetary terms, water supply represents about 65 percent of water sector revenue (excluding industry) compared to about 35 percent for irrigation.[3]

3.3.1 Introducing an incentivized performance-based culture

Introducing an incentivized performance-based culture is needed to move towards bottom-up / demand-side oriented approaches instead of continuing with a top-down, supply-side driven approach.

Incentive setting will be based on time-bound targets. Decisions about incentive setting and implementation remain at the discretion of the responsible line agency or ministry in coordination with international financing partners. Incentives can be positive, as in offering rewards for achieving targets, or negative, as in sanctions that will be applied in case of failing to comply with standards. Incentives are understood as motivational drivers for change. Consequently, they can include monetary rewards, but may also include influence from pressure groups among stakeholders claiming, for example, their universal right to access to water and sanitation services through accountability mechanisms.

[3] A price of about USD 20/1000 m³ is probably indicative of the "average" volumetric price charged for irrigation water (or USD 0.02 / m3)
A price of about USD 200/1000 m³ is probably indicative of the "average" volumetric price charged for drinking water (or USD 0.20 / m3)

The primary goal of a newly proposed accountability and incentive system is to distinguish between internal and external factors while ensuring financial sustainability. The key issue is how to design an institutional system that increases transparency and employment efficiency leading to improvement of utility performance. The maturity of a utility's human resource (HR) function is one of the preconditions for accelerating the effectiveness of incentive schemes. Any incentive scheme should be implemented in phases/stages linked to the maturity of the HR functions. A cascading-down approach should be followed to introduce incentive mechanisms in HR.

3.3.2 Implementing a chain of performance-based contractual relationships

The concept of "contractualization"[4] consists of the establishment of a performance-based contractual relationship between entities (internal and external) to create incentive and accountability mechanisms, thereby improving service delivery and increasing efficiency of operations. It consists of a process that involves the creation and the implementation of a chain of performance-based contracts. The process is however conditional on the availability of suitable and experienced personnel. Therefore, different speeds of development among various entities and units may be envisaged.

The "policy, institutional, and regulation" guiding principles that would support the creation of effective incentives, include:[5] (See also Figure 5: Maturity ladder for the urban water sector[6])

- Identifying the key reform drivers.
- Understanding the existing institutional environment in the sector.
- Understanding the political economy of the sector.
- Identifying the intrinsic incentives of key actors.
- Designing institutional interventions that align incentives.
- Providing sufficient capacity support so that the chosen reforms meet the desired objectives.

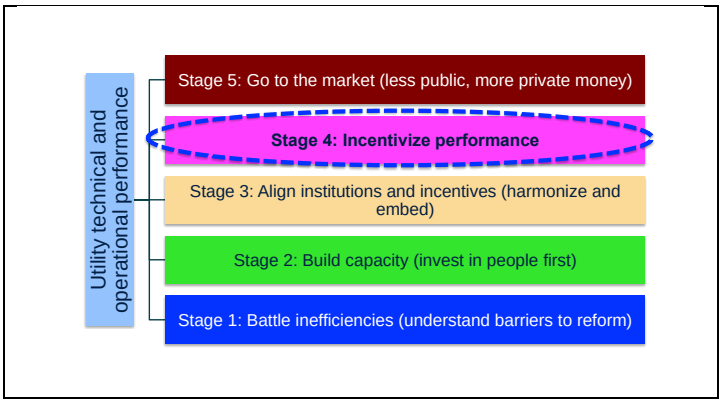


Figure 5: Maturity ladder for the urban water sector

Attributes of a successful implementation of performance-based contracts are:

- Competent and committed leadership.
- Well-planned and owned by the staff.
- Using established benchmarks.
- Effective monitoring and evaluation, and,

[4] Contractualization consists of the establishment of a performance-based contractual relationship between public – and private – entities to empower and create incentive and accountability structures, thereby improving service delivery and increasing efficiency of operations.

[5] Source: Aligning Institutions and Incentives for Sustainable Water Supply and Sanitation Services, Report of the Water Supply and Sanitation Global Solutions Group, Water Global Practice, World Bank, May 2018

[6] Source : Goksu, A. et al. (2019): Reform and Finance for the Urban Water Supply and Sanitation Sector Report Water Global Practice, World Bank, August 2019

- Incentives to support staff efficiency and productivity.

3.3.3 Establishing autonomous cost centers to increase Efficiency and Financial Viability

The main drivers for establishing autonomous cost centers within UWSSLC and RWAs include:

a. Need to improve efficiency (performance), effectiveness (access), and financial sustainability of WSS service provision.
b. The challenge of bridging the infrastructure gap through strategic asset management and finance.
c. Need to improve water sector monitoring and benchmarking.

A stepwise approach is proposed to transform the five cities under UWSSLC into autonomous (legal) cost centers, (a) linking with the HQ through a performance-based contract and time-bound target values of KPIs; and (b) empowering the city-based cost centers for billing and collecting tariff revenues from customers (metered and non-metered). This will enhance accountability internally as well as towards customers.

A framework with bottom-up business planning within UWSSLC is proposed to be developed together with the introduction of the creditworthiness index as an operational KPI.
Some immediate actions are proposed:

(i) Conduct an internal performance benchmarking to assess the CAPEX needs of five cities under UWSSLC, based on geographic, water resources or river basin, financial, demographic, political or service boundaries, and scale.
(ii) Start transforming the five cities under UWSSLC to function as cost centers with internal incentive structures, based on business planning with KPIs.

UWSSLC headquarters would maintain ownership and control over the infrastructure assets, generate economies of scale and efficiency, and facilitate access to low-cost capital, and, pool resources and capacities. The responsibilities of UWSSLC would include:

- Planning and development of new infrastructure, either directly or indirectly.
- Asset management and investment planning for WWS infrastructure.
  - Setting clear criteria for investment prioritization based on sector strategic objectives and cost-effectiveness analysis.
  - Coordinating the process of feasibility study preparation
- Financing investments through government sources and eventually, as it gains credibility, commercial borrowing.
- Managing the relationship with IFIs and donors.

Effective quality and economic regulation require the collection and monitoring of robust, complete and consistent information about the companies' performance, compliance with standards and the costs and investment needs of the industry. Simple benchmarking can be very misleading. A robust information framework is also essential to allow the regulator to monitor and enforce drinking water quality and environmental standards. It is also critical to allow economic regulators to set prices in a way that is consistent with a financially sustainable and affordable industry. (Refer to Section 4.2.1 above)

Consistent financial reporting is critical to assess cost effectiveness. To this end, the introduction of regulatory accounts is essential to remove the discretion allowed under the international accounting standards, for example, on the treatment of depreciation and cost allocation rules. The regulatory accounting framework presents the requirements for the accounting information to be provided annually by the water supply and sewerage service providers using historic accounting. This framework addresses:

- The financial statements and reports of the various service providers.

- The operational analysis of the core and non-core business activities.
- The use of infrastructure renewal accounting.
- The audit requirements for the financial statements.

There is a need to move towards a performance-based financing program to address service provision inefficiencies. Such a financing program will include target-based fund flow from the MoF to ASWRA for the WSS sector, and similarly performance-based financing downwards from ASWRA to the newly established UWSSLC. A prioritization exercise would be needed for result-based investments to deal with the financial gap. CAPEX prioritization should be based on a sound cost-benefit analysis. The following actions or studies are recommended:

- Developing a unitary methodology for analyzing the efficiency of investments to be used at national / local level, including risk-based and results-based analyses.
- Introducing subsidies programs for low-income groups (subsidize access to the network), to support connection fees (especially in rural areas).
- Elaborating a concept paper on the strategy to finance the sector, including specific financial strategy for rural areas.
- Pursuing and leveraging IFI financing, private finance sources, blended finance (MFD: Maximizing finance for development (MFD) and bonds with the inclusion of results-based investments with KPIs. (Figure 6) and principles for improving performance (Figure 7).

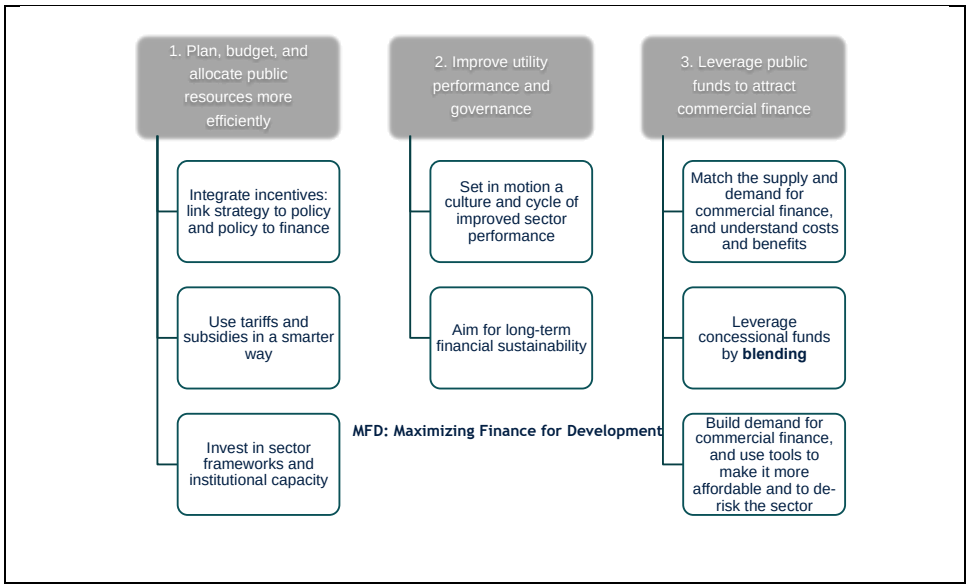


Figure 6: Three components of MFD

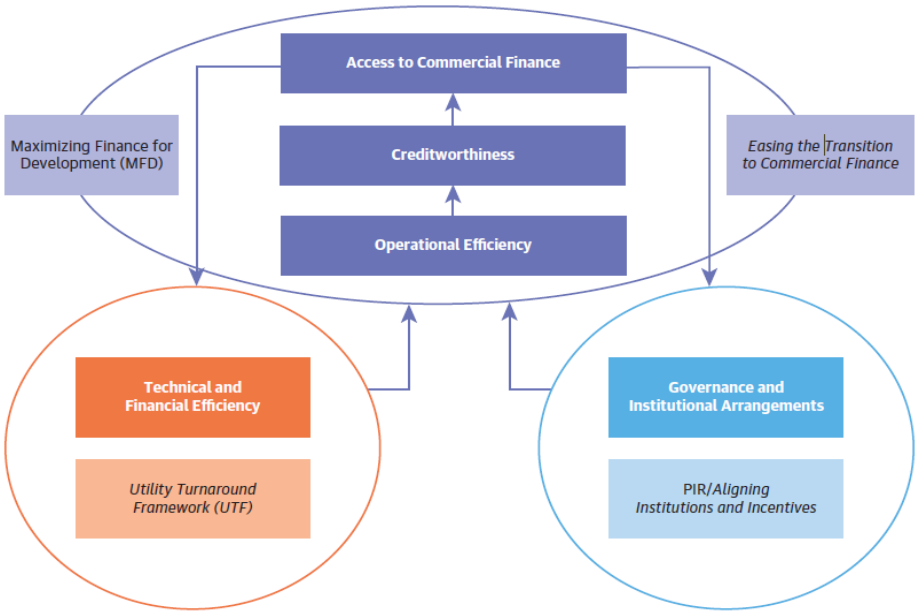


Figure 7 Recommendations from Reform and Finance for the Urban WSS Sector, World Bank, 2019.

3.4 Findings from strategic studies on avenues to promote a more sustainable, inclusive, and resilient water sector

The GoAZ recognizes the need to invest in measures that promote water efficiency, reduce losses, and modernize the institutional and policy landscape to promote a more sustainable, inclusive, and resilient water sector. This will be a prerequisite for future economic and demographic growth in the context of climate change.

Upon request from ASWRA, the following studies were carried out under the auspices and with the support of AZTAF:

1. Non-revenue water reduction and PPP program for Baku,
2. Accountability framework and incentive structures in human resources management.
3. Financial analysis and subsidy flows in urban WSS.

3.4.1 Non-revenue water reduction and performance-based PPP program for Baku

Water scarcity is a critical challenge for Azerbaijan. In such context, the reduction of water losses is a priority. This is becoming even more critical, given the upcoming desalination program. Baku, alike many water utilities globally, is facing challenges associated with climate change and aging water infrastructure. In addition, there's pressure to limit non-revenue water (NRW), including water leakage from drinking water systems. These leaks lead to increased operating expenses, toa high number of major pipeline bursts and to the entry of foreign matter into pipelines, impacting water quality and public health.

Water supply network in Baku is large and characterized as follows:[7]

- Network length (excl. connections) = 10,200 km
- Number of authorized connections = 973,492
- System input volume (SIV) = 364,793,610 m^3/yr
- Billed authorized consumption = 176,879,424 m^3/y (48.5% regarding system input volume)

[7] Based on data provided by AZERSU

- Estimated NRW: 51.5% (estimated at 188M m^3/yr)[8]

Based on the top-down water balance analysis, NRW in Baku service area can be estimated at 51.5%[9] with a margin of error of 5%. Thus NRW in Baku ranges from 50% to 55%.

The Infrastructure Leakage Index (ILI) is estimated between 10 and 11 with a margin of error of 6%. Based on the rating table developed by the World Bank and IWA Water Loss Specialist Group, water supply system in Baku thus belongs to the performance category "C", implying that a leakage reduction program is a high priority.

Based on the data provided by Azersu, the split between commercial (apparent) and physical (real) losses appears to be in the range 11% to 89% with a margin of error of 7%. This means that commercial losses represent between 15% and 20%, and physical losses between 85% to 80% of overall NRW. Therefore, physical losses are the major cause of NRW in Baku.

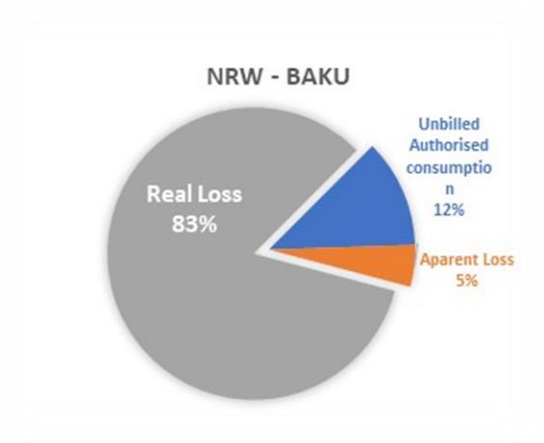


Figure 8: 51.5% NRW for Baku with huge physical losses.

- Real (physical) losses in Baku can be divided into following parts:
  - Leakages on house connections and pipelines with diameter smaller than 50 mm represent 78% of the total amount of real losses
  - Leakages on transmission and/or distribution mains (>50mm) represent 18% of the total amount of real losses
  - Leakages and overflows on utility storage tanks represent 4% of the total amount of real losses

- The estimated total number of leakages in WS Baku is estimated at 11,000, respectively:
  - ≈11,000 leakages on house connections and pipelines (diameter <50 mm),
  - <1,000 leakages on transmission and/or distribution mains (diameter >50mm) and
  - ≈100 leakages and overflows on utility storage tanks.

- Commercial losses originate mainly from meter under-registration (56%), illegal connections (21%), systematic data handling errors (meter reading and billing) (13%), and meter tampering (10%).

An illustrative example of Baku targeting NRW of 30% over a period of 5 years is presented below.

The recommended investments and cost estimates are based on the assessment of the present situation with the objective of reaching the following targets:

- Reduction of NRW from 51.5% to 30%, (avg. 4.5% reduction / year)
- Reduction of physical losses from ILI ≥ 10 to 11 to ILI ≈ 4
- Reduction of commercial losses and unbilled authorized consumption to < 1%.

When it comes to NRW and water loss reduction in Baku, if ILI is reduced from ≈10 to ≈4, the following savings could be achieved:

[8] Water Loss is water that never reaches the customer but affects the operational and treatment costs and can be categorized into two types, *Real Losses and Apparent Losses.* Non-Revenue Water (NRW) is the water that is lost before it reaches the customer and refers to water that is pumped and then lost or unaccounted for. NRW includes both real losses (like leaks) and apparent losses (like metering inaccuracies), as well as authorized unbilled consumption (such as water use by firefighters and religious or social institutions).

[9] The estimate of 51.5% NRW includes 3.5% of technical water which is used by Azersu for internal uses including cleaning of reservoirs etc.

- NRW would be reduced from 51.5% to 30%
- Real (physical) losses would be reduced from 157M m^3/year to 56M m^3/year,

The total budget necessary for achieving NRW reduction target of 30% over a period of 5 years in Baku is estimated at USD 142M.

Rationale for a performance-based Public Private Partnership (PPP) for non-revenue water (NRW) reduction and management in Baku, includes:

- Water scarcity challenge is critical for Azerbaijan and, in such context, of water losses reduction is a priority.
- Given the desalination program for Baku, it is important that leakages be reduced to the economic level (estimated at 20-30%).
- Private sector will bring the much-needed experience and know-how regarding NRW management, among others. The PPP contract would also enable the introduction of blended finance. The next step is the preparation of the business case and the feasibility study for Baku.

3.4.2 Accountability framework and incentive structures in human resources management

The government is restructuring the water sector leading to the creation of separate entities for water supply in the five big cities in the country – the United WSS Large Cities PLE (UWSSLC) – and the Regional Water Amelioration (RWAS) for the small towns and rural areas. This presents an opportunity for the design and implementation of accountability frameworks to foster improvements in service delivery by both entities.

The **opportunities** for UWSSLC and RWAS include:

UWSSLC	RWAS
▪ Sector restructuring presents possibilities of overall systems and process improvements for greater efficiencies in service delivery in the five large cities.	▪ Sector restructuring and the creation of the RWAS presents possibilities of overall systems and process improvements for greater efficiencies in service delivery in the small towns and rural areas.
▪ Specific elements seen in the staffing of the erstwhile Azersu OJSC that will most likely be transferred.	▪ The creation of the most effective institutional structure with clear roles and responsibilities and reporting lines – starting with a clean slate.
▪ Three recently concluded studies by the World Bank that define gaps across NRW management, cost of operations, developing cost centers.	▪ Possibility of introducing systems and processes that have proven to be successful because of the newness of the institution.

UWSSLC has several entry points for the design of accountability frameworks as emerging from some of the recently concluded studies. An accountability framework can be introduced at departmental level and at individual levels, with (i) recognition-based incentive schemes, activity based (e.g. NRW) incentive scheme, and/or (ii) performance-linked pay incentive scheme. The framework will cascade down from top- to lower- level management / staff, hand-in-hand with the transformation into autonomous cost-centers.

Type of Incentive Scheme	How will it help?	Proposed Timeline
Recognition based	▪ A basic scheme linked to satisfaction gained from non-monetary outcomes – generally the first step in institutionalizing an incentive scheme.	Short term (<2 years)

	▪ Easier to implement and focus on recognition for good performance. ▪ Individual and group reward schemes can be implemented. ▪ Employees are recognized for their contributions to overall business goals and rewarded with recognition. ▪ Can be monthly, quarterly, and annual performance recognition.	
Activity based (UWSSLC chooses a specific outcome and designs a scheme around it)	▪ More developed programs that offer monetary rewards to employees or teams for accomplishment of specific, measurable targets. ▪ Rewards may be based on the completion of the activity related to the target or the outcome of such programs.	Medium term (2-4 years)
Variable pay or Performance-linked pay scheme	▪ Most developed reward program that weighs, rates, and monetarily rewards various aspects of an individual's overall performance. ▪ Requires a mature organizational performance management system and a strong HR function. ▪ Requires adequately well-defined and planned business processes and the adoption of technology to manage the process. ▪ Rewards are paid to employees after an objective annual performance assessment. ▪ Pay-out percentage is defined at the start of the year based on business targets.	Long term (>5 years)

Characteristics of different incentive schemes

The entry points for introducing the accountability framework are as follows:

1) **Metering, billing, and collection efficiencies:** Current revenues cover less than half the operating costs and the MoF has invested AZN 8 billion to date to keep erstwhile Azersu solvent. Such a scheme will help in developing an authentic customer base, ensuring that all meters are maintained and monitored, ensuring that correct billing linked to actual consumption is being done, and the revenues of UWSSLC increases. This is a simple and quick framework to design and implement and show results in the short-term.
2) **Connectivity:** A scheme around 'connectivity' will help in creating an updated asset register linked to GIS, with details on quality of infrastructure, customer database with authentic users, improved estimation of O&M costs and their inclusion in the annual budget, and preventative maintenance to manage physical losses and therefore increase revenues.
3) **Wastewater management:** A scheme around 'wastewater management' will contribute to a positive impact on the environment and the potential for reducing stress on water resources through reuse and recycling.
4) **Reduction of non-revenue water:** An accountability scheme around NRW reduction will involve interventions across three broad areas - institutional, engineering/technical, and commercial. A NRW reduction plan requires a dedicated inter-departmental team under the highest leadership meeting frequently to set targets and monitor progress.
5) **Energy efficiency:** Accountability frameworks will contribute to (i) energy use efficiency to promote sustainable use of resources, (ii) carbon neutrality to promote mechanisms to control emission of GHG associated with energy consumption, reducing impact on climate change (iii) energy production and recovery to promote energy recovery practices and energy self-production in wastewater systems (iv) economic and financial sustainability to ensure efficiency in the use of economic resources. This requires a degree of maturity of the system, up-to-date records on infrastructure, the state of the infrastructure, the energy

consumption levels and details at all stages from abstraction of water to treatment of wastewater.

Accountability schemes have been proposed for the **RWAS** aligned to their role as service providers for water and wastewater management as well as sanitation in the small towns and rural areas of Azerbaijan. Small towns are in transition between rural to urban and face specific challenges in service delivery. The type of accountability framework and the associated incentives depend on the service model. The indicators that can be considered are as follows:

1) Indicators related to the level of service provided.
2) Indicators for assessing the degree to which conditions for sustainable WASH service provision are in place. These include institutional/managerial, technical, financial, environmental, and social sustainability. Also referred to as FIETS[10]: Financial, Institutional, Environmental, Technical, Social at different institutional levels.

The proposed roadmap for the incentive scheme for the RWAS is as follows.

Activity	Timeline	Proposed Incentive Scheme
Setting up systems, conducting detailed studies on prevailing practices, etc.	Short-term	
Identifying sub-indicators and ascertaining targets derived from studies conducted and linked to progress of infrastructure development.	Medium-term	Non-monetary recognition of town schemes – the schemes that performed the best in achievement of the agreed national targets for improving services in small towns.
Development of town schemes through clustering of towns and villages, developing 'cost centers'; introducing PPP as well as other types of water management.	Long-term	This will have monetary incentives at regional level that can be cascaded to town scheme level. However, the exact nature cannot be ascertained now.

The prerequisites and challenges that UWSSLC should be mindful of while designing any incentive scheme include:

Pre-Requisites	Challenges
▪ Create a strategic focus and business plan. ▪ Organization restructuring and establishing accountability. ▪ Performance management to create 'objectivity'. ▪ Rewards and incentives scheme design.	▪ Executives are 'risk averse' – most want fixed pay over bonus of higher value. ▪ Complexity and ambiguity destroy value – keep it simple. ▪ Customize a scheme appropriate for the institution – managing the transition to the incentive scheme needs effective change management. ▪ Deciding on what will likely work in the short-term – show quick results to generate interest across departments.

Similarly, for RWAS, the challenges to be mindful of are:

Pre-Requisites	Challenges
▪ Assured supply of piped water. ▪ Assured quality of drinking water as per WHO norms. ▪ Assurance to customers to make the change to piped supply. ▪ Organization structuring and establishing accountability. ▪ Performance management to create 'objectivity'. ▪ Rewards and incentives scheme design.	▪ Customers may be unwilling to make the shift to piped supplies. ▪ The size of the schemes and customer base will be critical for financial viability. ▪ Executives are 'risk averse' – most want fixed pay over bonus of higher value. ▪ Complexity and ambiguity destroy value – keep it simple.

[10] Rijksdient voor Ondernemend Nederland RVO.nl, 2016

	▪ Deciding on what will likely work in the short-term – show quick results to generate interest across departments.

3.4.3 Financial analysis and subsidy flow in urban WSS

The aim of this analysis is to quantify the subsidies which the MoF has provided to Azersu and propose ways of reaching financial balance and reduce dependence to subsidies.

The following subsidies can be identified from Azersu's audited financial statements:

(i) **Low tariffs.** Production cost exceeds revenue as shown in the income statement. There are two main reasons for this situation: (i) more than half of the water is leaking from the mains: to compensate for these losses, Azersu must produce double volume of water compared to what it actually sells to end users; and (ii) tariffs are too low. Because tariffs are ill-regulated, Azersu lacks the discretion to raise prices as needed, unilaterally.

(ii) **Concessional loans.** Banks will not lend to Azersu because of a perception of poor creditworthiness. The company is struggling to pay its bills (days payable outstanding exceeding 250 days). Azersu is dependent upon loans from the Ministry of Finance which are either interest-free or bear concessional rates of interest (1%) far below market rates (estimated to be 14.5% in local currency terms by the Central Bank of Azerbaijan).

(iii) **Equity.** To date, the Ministry of Finance has invested a total of AZN 8 billion in Azersu, with no prospect of earning a reasonable rate of return on capital due to heavy water losses. In the absence of such equity, Azersu would be insolvent.

(iv) **Contributions-in-kind.** The Government of Azerbaijan pays for infrastructure and transfers the assets as a contribution-in-kind to Azersu. Ideally, Azersu should be financing its own investment needs from its revenues.

(v) **Related-party transactions.** The notes to the financial statements also show related-party transactions (including energy sold by Azerishiq) totaling approx. AZN 12 million (2023). Some of these service providers such as Azerishiq may be as heavily subsidized as Azersu, making it difficult to quantify the benefits Azersu may be receiving from transfer pricing arrangements.

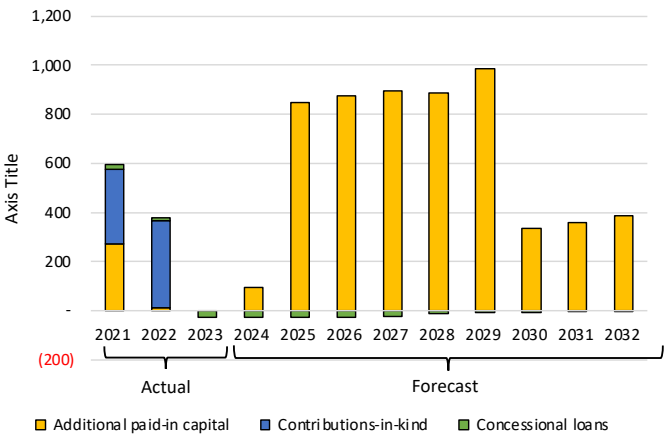


Figure 9: Forecast Subsidies needed from 2023 to 2032, based on Azersu capital investment plan

The Ministry of Finance will need to continue providing Azersu with subsides in the future decade (2023-2032) because Azersu's cannot pay its debt as it falls due, and because of the company's future investment program. Furthermore, from 2025 to 2029, Azersu committed to approximately AZN 800 million (US$450 million) in investment per year, amounting to a total of AZN 5.7 billion (US$2.5 billion), which it cannot finance from its own resources.

Operational Performance Issues

(a) Non-Revenue Water

As already mentioned, just over half of the water that Azersu produces and distributes is being paid for by customers. Reducing these losses would improve Azersu's financial performance as it would reduce energy costs and the need to invest in unnecessary facilities.

(b) Working Capital Management

According to the audited financial statements, Azersu is collecting invoices from its customers (end-users / water consumers) within 36 days (2022). According to the same audited financial statements, Azersu is taking 258 days on average (2022) to pay its suppliers. As a result, Azersu is borrowing heavily from its suppliers. Trade credit being the most expensive form of financing, this situation has a knock-on impact on Azersu's operational performance.

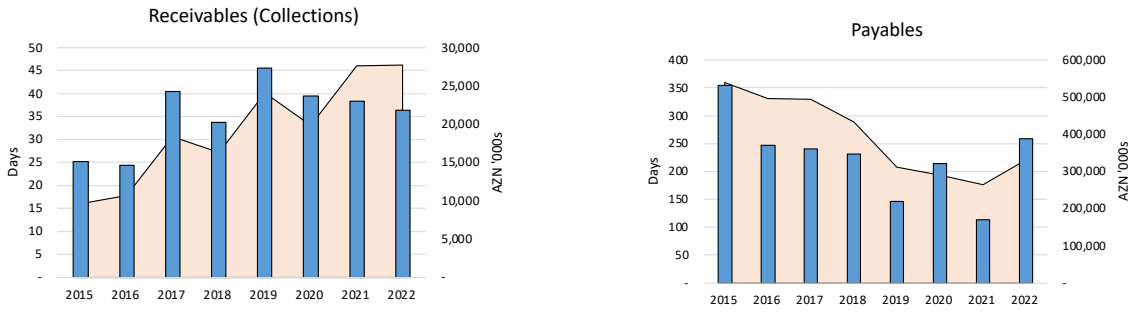


Figure 10: Azersu Receivables and Payables

(c) Cost structure

High operating costs are another source of financial difficulty. The notes to the financial statements include a breakdown of cost of production, administrative expenses, and selling and distribution expenses.

Operating cash flow represents the cash flow, net of operating costs, movements in working capital, and taxes, available to Azersu to invest, service debt and reward its shareholder, the government of Azerbaijan.

Free cash flow is negative, which implies that either Azersu will have to borrow to service its existing debts – the classic 'debt trap' – or it must obtain additional equity injection from its sole shareholder, the Ministry of Finance, to fund its investment program.

(d) Staff productivity

Azersu appears to be over-staffed in comparison to benchmark companies elsewhere in the Commonwealth of Independent States (CIS). With 1,748,832 connections and 14,000 staff, Azersu has 7.68 staff per 1,000 connections. The median staffing level reported by other water utilities in CIS countries is 1.14 staff per 1,000 connections and the average is 2.01 per 1,000 connections. A rationalization of staffing, possibly with government financial support (termination payments, pension liabilities), would help Azersu reduce its cost base.

(e) Labor costs

Labor costs represent about 30% of OPEX, which is lower than most benchmark companies. The median for CIS utilities was 31.6% and the average, 30.8%. Azersu employees are paid 19.5% less than the median employee in Azerbaijan but some 4.5% more than the median worker in "water supply, waste treatment and disposal". Senior management must strike a balance between having sufficient staff to achieve acceptable service levels, attracting high quality personnel, retention of staff (staff loyalty), and cost containment.

Need for Reducing Subsidies. While Azersu has recently achieved O&M cost recovery in 2021, the subsidies cannot be eliminated altogether due to Azersu's heavy investment needs and customer expectations that water be supplied irrespective of their ability to pay. Given its

future investment commitments, there are several ways to reduce Azersu's dependency on subsidies:

(i) Implementing a performance improvement program could reduce subsidies by AZN 1.5 billion over 8 years. Savings can be achieved by raising tariffs, rationalizing staff, and saving energy.

(ii) Reducing non-revenue water from 50% to 30% within 5 years, at an investment cost of $142 million (CAPEX). Back-of-the-envelope calculations suggest that the investment would yield an internal rate of return (IRR) of about 25 % in local currency terms, which compares favorably with the market rate of interest of 14.5% prevailing in Azerbaijan.

(iii) Entering into a management contract, pursuant to which international expertise could be brought in to support Azersu's leadership. One critical area for improvement is quality and timeliness of reporting physical and financial numbers.

As an illustrative example, the breakeven tariffs are considered under two different scenarios: (i) *status quo ante*, where Azersu management does not make any changes in existing business practice, and (ii) where Azeru management will implement *a performance improvement plan* over the next eight years, including a reduction in staff to the industry median, reducing payables to 45 days payable outstanding, expansion of the water distribution network to cover remaining households, reduction in non-revenue water to 30%, and improving access to the sewerage network by 25%. Implementing cost reductions will translate into lower revenue requirements.

Based on a linear trend analysis, drawing upon the preceding nine year's audited financial statements (2014 to 2022), the forward expenses (2023 to 2032) have been projected. The costs taken into account are the operating costs and overheads (excluding depreciation). The overheads consist of wages, foreign exchange gain or loss, and other losses (rent, communication and travel expenses, legal fees, amongst others).

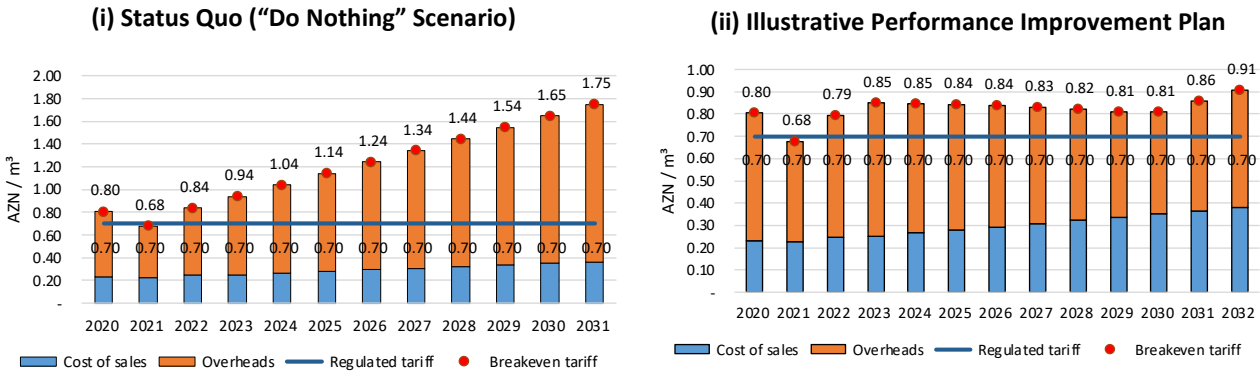


Figure 11: Illustrative Example - status quo scenario compared to PIP scenario.

The illustrative example (Figure 11) shows that with the status quo scenario, it is difficult to reach breakeven tariffs. However, the performance improvement plan will help in recovering most of the operations and maintenance costs, even at the existing tariffs of 0.70 AZN /cum. If the performance improvement plan was made more rigorous and tariffs were increased, Azersu

could potentially achieve breakeven tariffs, covering its operating costs, debt repayment, and fund investments from its own resources.

The illustrative example (Figure 12) shows that implementing a performance improvement program could reduce subsidies by AZN 1.5 billion over 8 years.

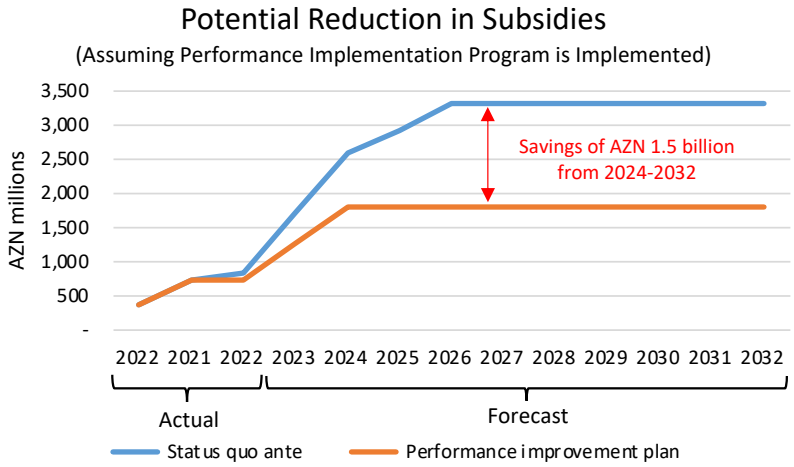


Figure 12: Potential Reduction of Subsidies with Performance Improvement Plan

4 BRIDGING THE ACCESS GAP - WATER SUPPLY AND SANITATION SERVICES FOR RURAL AREAS AND SMALL-TOWNS

Coverage and access to safe drinking water supply and adequate sanitation are lagging behind in rural areas. The WSS access gap is higher in rural areas, as well as in marginal urban areas where poverty is concentrated.

The challenges in rural WSS, which contribute to the root cause of non-sustainability, include:

- Service provision issue: Size and scale of WS infrastructure & fragmentation of operations; Piped drinking water networks are largely unavailable in rural areas: Proportion of rural households with access to "improved water on premises" remains unchanged or even decline.
- Capacity issue: lack of professionalization in service provision and Local Authorities (LA).
- Affordability issue: low income of rural HH and seasonal variability of income.
- Water availability and water demand issues.

While the rationale for the regionalization reform is to facilitate the expansion of access in rural areas—lowering the costs through economies of scale and addressing local capacity shortages—the model may also have an adverse effect. The push to establish financially viable and creditworthy public utilities may result in reducing the incentives for them to expand in poor and rural areas, as doing so reduces their operational performance and financial viability. (See Annex Romania experience)

To improve inclusion, while at the same time safeguarding the achievements in corporatization of public service provision, incentives for regional operators to expand into poor areas must be addressed, possibly by combining commercial financing with budget transfers to compensate for the financial shortfalls, so that expansion does not affect the overall financial viability of utilities.

Local service providers operate poorly performing services with very limited financial resources, and insufficient skills and equipment. At present, many villages outside the main urban centers have an organized water service, which does not depend on Azersu. They present the following characteristics: (i) the network and facilities are in bad conditions, (ii) access to the service is very limited, and its extension requires very large investments, and (iii) revenue from water sales is low, making operation unsustainable.

Regional utilities may not be able to reach remote villages and dispersed rural populations in the medium or long term because a piped centralized networked system may not be feasible, and supported self-supply would be the only viable alternative.[11]

In summary, the key challenges are:

- Integrating rural communities and existing providers into the national governance system to ensure compliance with regulations.
- Ensuring financial and operational sustainability by integrating rural service providers into an effective institutional structure for WSS service providers
- Expanding services to rural areas through innovative financing arrangements.

The following two options may be identified to address the rural WSS access gap:

- Establishing a separate national asset holding company with dedicated focus on rural WSS (RAHC), at national level under ASWRA.
- Local operator models continuing to bring WSS service to remote villages and dispersed rural populations, under various performance based PPCP (Public Private Community Partnership) modalities.

[11] Source: WB-IAWD Program (2018): Beyond Utility Reach? How to Close the Urban-Rural Access Gap? A Review of RWSS in Seven Countries of the Danube Region, May 2018

A separate and dedicated asset holding company for rural WSS may be established, as inspired by the successful experience in Senegal. The key challenge is to enhance rural water supply service delivery and to integrate rural communities and existing domestic providers into the national water sector governance system to ensure compliance with regulations, through performance-based agreements. Linking rural service providers into an effective institutional structure such as a dedicated asset holding company, would contribute to their operational and financial sustainability.

Senegal: Rural versus Urban Asset Holding

Urban Asset Holding Company (SONES)	Rural Asset Holding Company (OFOR)
Public asset holding agencies and contracting authorities, on behalf of Government	
Business plans to maintain an optimal financial balance in the short to medium term, and achieve self-sufficiency in the long term	
Private operators to manage O&M tasks and the renewal of small infrastructure equipment, under an *affermage* (10 year) arrangement	
One large private operator for 66 urban centers (6 million people)	Four private operators to manage 1,500 schemes split into four rural areas/perimeters (7.5 million people)
Responsible for the implementation of its investment program	Implementation of investment program remains responsibility of the Directorate of Water (DH) in the Ministry

Figure 13: The Senegal case: Rural Asset Holding Company

Possible local operator models may include, in case assets are owned by LAs:

- LAs manage WSS as municipal service (as a WSS department).
- LAs hold rural assets in its administrative territory and establish municipal service providers as commercially independent entities.
- LAs delegate the right to use assets to the National Asset Holding Company (NAHC) (or alternatively to the RAHC), which concludes performance-based operations contract with operators.
- LAs conclude performance-based operation contract with nearby municipal service providers, for retail distribution and/or bulk water purchase agreement.

In case assets are owned by Communities/User Organizations/Individuals, the following arrangements may be envisaged:

- *Community Based Organizations (CBOs) – local level*: CBOs performing part of the service functions (e.g. revenue collection), while other functions (e.g. O&M) are delegated to other entities (larger operators).
- *Association of Community Based Organizations (CBOs) – district/regional level*: Several CBOs at local level are forming a larger entity at district level (or even larger areas), hence leading to economies of scale.
- *Community Based Asset Holding Organization (CBAHOs)* – delegation of operation: several CBO(s) may form a CBAHO which is performing the function of asset holder (investment planning/repair/replacement, etc.) and conclude a performance-based operation contract with any appropriate operator, for retail distribution and/or bulk water purchase agreement.

Grouping small-size service providers could provide significant economies of scale, size effect and pooling of resources. Criteria to cluster small-size providers would include the following considerations:

- Geographic, water resources /river basin, financial, demographic, political / service area boundaries, and scale …

- Barriers: dispersed nature of urbanization; small size and unequal financial capacity; initial negative cash flow, varying efficiency level of service provision and variations in performance; lack of technical capacity / trained staff, …
- Financial viability of cluster as a business unit
- Legal and institutional framework, entry & exit conditions
- Governance: similarities and differences between city-wide utilities and regional (clustered) branches

The development of the clustering of service providers based on the concept of RBM, would bring about more efficient water and sanitation infrastructure and services, enhance sustainable water resources management, and improve climate change resilience.

Decision-making factors for the assessment and selection of management models for rural and small-town piped water supply schemes include:

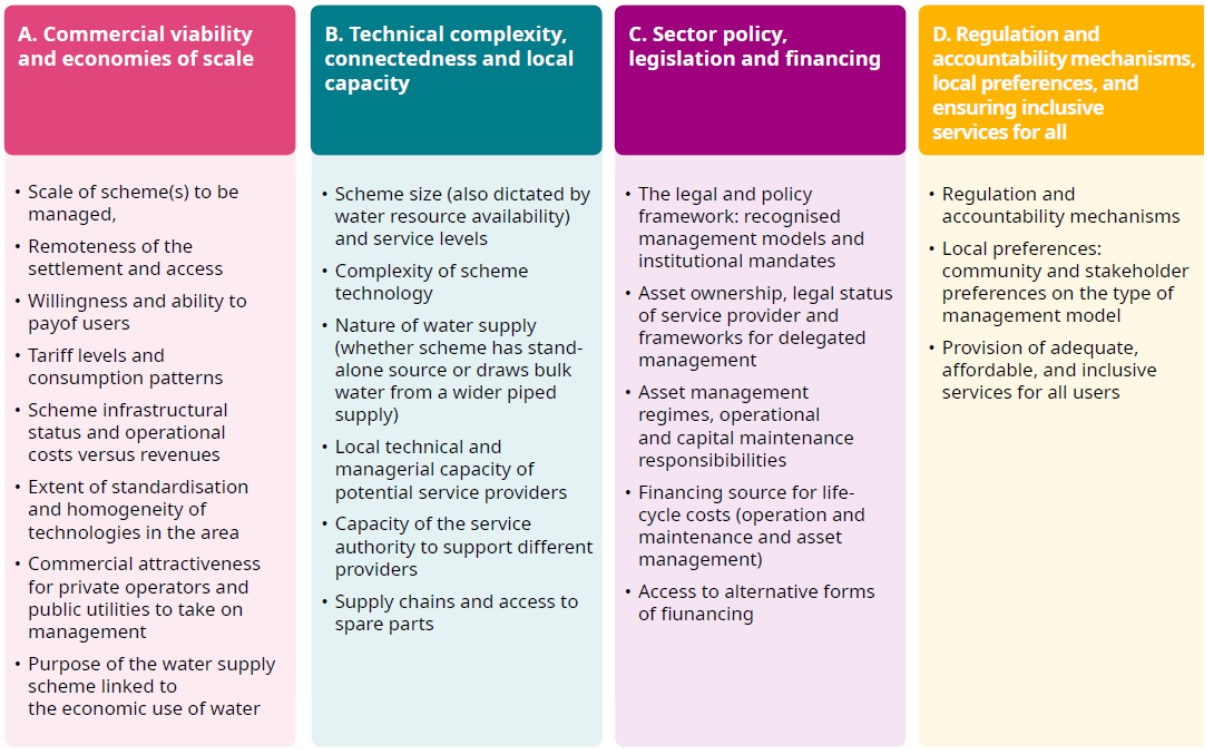
- Commercial viability and economies of scale
- Scope, technical complexity, connectedness, and local capacity
- Financial viability
- Sector policy, legislation, and financing
- Regulation and accountability mechanisms, local preferences, and ensuring inclusive services for all; role of the private sector
- Stakeholder consultation (“reality check”)

Certain management models will require greater likelihood of commercial viability and should be well understood; willingness to pay is complex and needs to be related to tariff levels, consumption patterns and affordability for the poorest. The physical status of a scheme and its operating costs are a critical factor in commercial viability. Opportunities for cooperation include:

- Decentralization
- Suburban localities served by utility of larger town.
- Regionalization (single utility serving whole Rayon; regional/urban service providers expanding to rural areas)
- Local operator models
- Improving self-supply for dispersed populations

Identifying the right management model for any given scheme requires a careful assessment of size, technical complexity, and the availability of provider options in the local area. Selection should avoid an unrealistic expectation that over-burdens (voluntary) low skilled community management entities with complex and demanding technical and managerial tasks with no support. At the other end of the spectrum, private operators will require a minimum level of oversight and accountability from local government or any appropriate regulatory entity.

Table 2 recaps decision-making factors for selecting management models for rural and small-town water supply schemes[12].



When selecting appropriate management models, it is critical to understand the policy and legal framework as well as the status of asset ownership and delegation mandates. The selection of management model should be informed by the flow of financing in the sector and the likelihood that core functions for external support, monitoring, and regulation (amongst others) are to be met. Being clear and realistic about how asset maintenance will be financed has an influence on the selection of management models. CBM is often dependent on uncertain aid transfers or being bailed out by local government on an ad hoc basis to meet such costs.

Table 3 below provides a summary overview of the various issues at stake.

Type of rural area (habitat)	Service provision	Demand for outsourcing / PPP	Sanitation Technology	Finance and Tariffs	Incentives
Sub-urban	Direct local government Public utility provision JS company	Moderate	FSM sewerage	Targeted support for low-income HH	Fiscal incentives for CAPEX PBC
Multi-village schemes (clustered villages)	Association of localities or rural asset holding hiring an operator Strengthening local/regional utility	High	FSM Small WWTPs	Targeted support for low-income HH	Fiscal incentives for CAPEX PBC Strengthening accountability mechanisms

[12] AGUAConsult / WaterAid (2018): Management models for piped water supply services, A decision-making resource for rural and small-towns contexts

Dispersed habitat (remote villages)	CBM Supported self-supply	High	Autonomous sanitation	Grant finance Subsidization	PBC

5 PUBLIC PRIVATE PARTNERSHIPS AS AN OPPORTUNITY TO IMPROVE SERVICES EFFICIENCY

5.1 PPP in water supply and sanitation – overview of service delivery models

PPPs are a strategic option worth considering helping fast-track performance or to develop and manage new water supply sources and systems. The different types of PPP options used in the water and sanitation sector fall into two major categories, depending on whether payment for the service is tied to operational results:

- **Infrastructure provision models**: The Project Finance Initiative (PFI), with green field projects (in case of new infrastructure) and brown field projects (in case of refurbishment of existing infrastructure). PPP options in this category are also known under the generic acronym DB[X] with the Design-Build-Operate (DBO), Build-Operate-Transfer (BOT) and Design-Build-Finance-Operate (DBFO) contracts as the most common ones.
- **Operational and delivery models**: If the private service provider is paid according to operational results and services delivered, the PPP contract is termed as a *Delegation of Public Service* (DPS). Under this heading come the arrangements known as service contract, management contract, lease, *affermage*, and concession.

While private financing can be one of the main attractions of PPPs, it is the efficiency gains and improved service quality and compliance brought by the private sector's management systems and innovative technologies and techniques that make PPPs an attractive mode of delivery in the water and sanitation sector. Efficiency gains would be mostly captured by reduction in non-revenue water (NRW), improvement in billing, collection and labor productivity.

Criteria to assess the structural scenarios are (i) effectiveness: improved access and better quality of service, and, consumer satisfaction, (ii) efficiency: improved financial, commercial and operational performance, (iii) implementability: degree of complexity and cost of transaction, and (iv) potential interest by private sector.

The objectives of a PPP in the water utility sector usually are to:

(i) Enhance service quality.
(ii) Improve operational, commercial, and financial viability.
  - Improve bill collection.
  - Reduce NRW.
  - Improve energy efficiency.
  - Improve staff productivity.
(iii) Transfer skills and potentially technology.
(iv) Transfer (some) risk to private partner.
(v) Increase accountability.
(vi) Serve as a change agent.

The Table 4 below compares management contract, operator contract and lease/*affermage* contract according to various features and ability to balance interests.

Table 4: Comparing PPP options.

	Management Contract	**Operator Contract**	**Lease/*Affermage* Contract**
Scope	The PO manages assets and existing staff in return for a performance-based fee.	The PO operates and maintains network or assets in return for a performance-based fee. The PO typically has greater control	The PO is responsible for operation (technical and commercial) and maintenance. The operator collects the volumetric tariff directly from customers on behalf of the CA.

	Management Contract	Operator Contract	Lease/*Affermage* Contract
		over operations than under a management contract and may also bring in its own staff. In summary one could state that an operator's contract is like a lease/*affermage* contract without commercial risk.	The CA is usually responsible for major rehabilitation and new capital works.
Duration	3-5 years	5-10 year	10-15 years
Prime objective	Improvement of management. Access to technology and expertise.	Improves management and operational efficiency.	Improves management, operational and commercial efficiency. Access to expertise and limited CAPEX. Develops local staff.
Responsibility for overseeing and monitoring contract implementation	Public	Public	Public
Ownership fixed assets	Public	Public	Public
Ownership movable assets	Public	Public/Private	Private
Responsibility for CAPEX	Public	Public	Public Shared in enhanced lease/*affermage*
Responsibility for OPEX	Public	Public/Private	Private
Level of Risk Assumed by Private Sector	Minimal	Minimal/Moderate	Moderate
Operating risk	Public	Public/Private	Private
Commercial risk	Public	Public	Private
Compensation Terms	Fixed fee, preferably with performance incentives	Combination of fixed (lump sum) payment with variable payments (20 to 30 %) as performance incentives. as defined in the contract.	Portion of tariff revenues with performance incentives
Cost recovery and consumer tariffs	PO insulated from consumer tariffs	PO insulated from consumer tariff risk	Tariffs at least need to cover PPP-related cash flows PO does not assume tariff risk
Baseline data availability	Limited requirements given simplicity of contract.	Depends on extent of proposed risk transfer and performance-based remuneration.	High in order to prepare bids and to evaluate performance.
Pros	Often seen as way of introducing private	More politically acceptable than	Is preferred to a management or operating contract because

	Management Contract	Operator Contract	Lease/*Affermage* Contract
	sector/improving operating practices without giving private sector control of assets; Hence more politically acceptable than greater private involvement.	greater private involvement PO takes some risk in asset condition and investment. Greater scope for improved service and efficiency than management contract	of the transfer of the commercial risk (revenues) to the operator, which is believed to create strong incentives to perform. Having the lowest PO price per m3 as bid award criterion, induces a drive for enhancing efficient performance by means of the bidding process itself. Performance incentive structure linked to the volume of water produced, promotes efficient water use.
Cons	• None to very limited repair and renewal obligations. • Limited transfer of risk. • Limited scope to attract private finance.	• Limited repair and renewal obligations. • Less scope for efficiency than affermage/lease. • Limited transfer of risk. • Does not attract private finance.	• The split between CAPEX (public) and OPEX (private) decision-making, often is the cause of serious coordination issues, and may create conflicts of interest between PO and asset owner.
Market interest	Difficult to achieve commercial returns. Steppingstone to enhanced affermage/lease. Often done by consulting firms.	Can be attractive as little end user risk.	• Widely regarded as most attractive model. • PO has more control over in-/outputs. • Successful cases include Senegal, Niger and Cote d'Ivoire

It is recommended to explore and analyze possible PPP alternatives for:

- Distribution network rehabilitation / extension, and the delivery of water supply services in selected towns
- Operation of wastewater treatment plants
- Construction and operation of desalination plant
- Improving access to improved WSS services in rural and peri-urban areas.

A strategy for a successful implementation of the proposed new PPP operating structure and contractual arrangement, customized to Azerbaijan water sector, would need to be developed. The proposed institutional and contractual structure would build on the following considerations:

- Designing a PPP model adapted to local realities.
- Facilitating access to commercial finance to strengthen the financial basis of the private operator.
- Mobilizing public funds to carry out network rehabilitation, extension, and densification.

Given the prevailing local risk and tariff conditions, the following would need to be considered:

- The pathway for private sector engagement in e.g., urban water services need to be mapped out carefully and will have to be progressive. Contractual arrangements should be straightforward and respective roles and accountabilities and oversight mechanisms and responsibilities clearly defined.
- The lack of HR capacity is recognized and thus calls for a gradual approach. While building capacity will be critical, it could only be effective once institutional responsibilities are redefined and leadership and political commitment secured.

5.2 Seminar on PPPs in water supply and sanitation

An interactive seminar on PPP was organized in September 2023, in Baku, and covered the Public Private Partnership (PPP) in water supply and sanitation sector. Some of the leading international operators such as SUEZ, Aqualia, and Aguas de Portugal participated and presented case studies (Ostrava, Tashkent, Tbilisi/Msxeta/Rustavi cities) and models of PPPs being implemented across Europe and Central Asia. The models covered both the service delivery (Ostrava and Tbilisi) and advisory aspects (Tashkent). The operators shared details on contractual arrangements, original and final performance parameters of WSS in referred cities, specific infrastructure details, requirements from client/regulator and necessary institutional / legal / financial pre-requisites for referred PPP contracts. The presentations were followed by a dedicated presentation delivered by the Bank's consultant on desalination technology and latest technological and PPP trends in desalination. A summary of the seminar and key take-aways are in Annex 2 to this report.

5.3 Recommendations: PPP options to foster services efficiency enhancement

A PPP contractual relationship should be built on mutual trust and open communication, beginning with the procurement process, and continuing through the life of the contract.

A phased PPP approach is recommended to minimize risks. Introducing a private sector participation arrangement, e.g., through performance-based contract in selected service areas with new assets – and gradually moving towards a more complex and advanced form of PPP when all preconditions are met – will act as a change agent and contribute to fill the capacity gap of WSS expertise and workforce in the sector. As a strategic measure, this will also help to fast-track service delivery improved performance and strengthen commercial orientation. The experience and lessons learned will lay foundations for future PPP arrangements in the sector, while minimizing the associated risk.

It is recommended to develop a framework to promote "soft" PPPs for initial projects. In the current context of Azerbaijan, the suggested modalities to engage in a PPP arrangement to promote PCE[13] conditions, would hence be:

- A performance-based contract for sustainable NRW reduction and management, and energy efficiency, for Baku city and surrounding urban centers.
- A performance-based contract for UWSSLC and RWAS for efficient commercial management.
- Eventually, a PPP combining the two preceding options in one contracting arrangement.
- Performance-based operating contracts for energy efficient WWTPs[14].

Next steps for a performance based NRW reduction, include:

- Feasibility study and business case report, with potential of results based private sector financing modalities (blended finance)
- Tender documents for PBC
- Tendering process and contract award
- PBC contract implementation

Currently the small towns and rural areas rely mostly on informal self-services and do not have access to professionally managed services. The GoAZ is interested in providing sustainable and climate smart and efficient water supply and wastewater management services in small towns and rural areas through performance-based PPP/DPS[15] contract:

- Selection of pilot area and feasibility study (See Annex 4 checklist)
- Tender documents for PPP/DPS
- Tendering process and contract award
- PPP/DPS contract implementation

[13] PCE: Private Capital Enabling
[14] WWTP: wastewater treatment plant
[15] DPS: Delegation of Public Service

ANNEX 1: INTERACTIVE SEMINAR PPPS IN WSS, BAKU, 27 SEPTEMBER 2023

The seminar on PPPs in the water sector was attended by more than fifty people from a wide range of institutions and representatives of public and private entities. The seminar started with a general background on PPPs, highlighting the main features of successful PPPs: improvement of operational efficiency, accountability, innovation, and focused private investment.

The seminar highlighted PPP experiences in developing countries in the last 20 years.

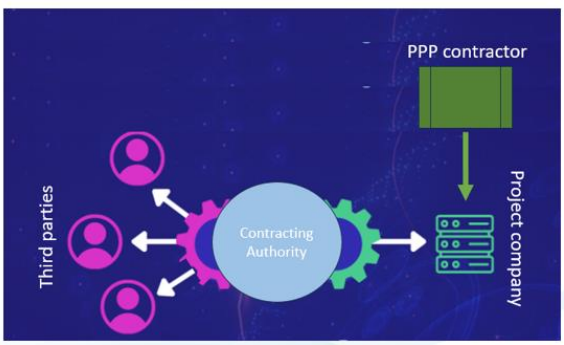
- 1 - Despite difficulties in several countries, water PPP has largely passed the test of time.
- 2 - The positive record on service and efficiency improvements reaffirms the value of PPPs, even though the level of private financing did not match initial expectations. Over time, a more realistic market has developed, with a growing number of private investors from developing countries and with contract designs based on a more pragmatic allocation of risks between partners.
- 3 - What emerges from examining the available empirical evidence is that well-designed partnerships between the public and the private sectors are a valid option to turn around poorly performing water utilities in developing countries.

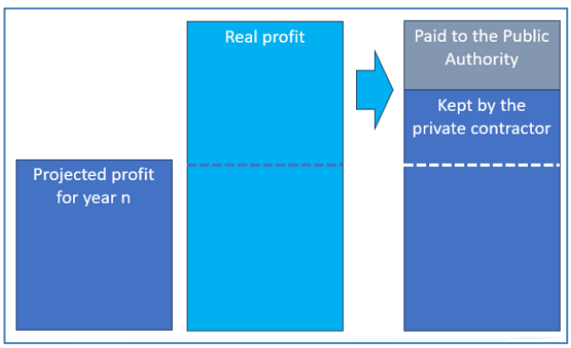
Recent developments in PPPs

The importance of a strong, structured contracting authority was emphasized, capable of overseeing the PPP in all its components, including for example monitoring and information systems, right from its conception.

The presentation went through several features which have emerged from recent experience. The need to address issues in PPP contracts such as information systems, branding, project company executing the contract and reversibility was highlighted.

PPPs are increasingly performance-based. The relevance of defining KPIs reflecting the key objectives of the Contracting Authority and of defining regulatory mechanisms to cap operator's profit to its performance was stressed. It is recommended to set for each KPI a time-bound target value with a transparent calculation of the remuneration of the operator.





The role of information systems in today's operation was emphasized. Private operators can help significantly in digitalization of operations, which generates technical and financial efficiencies. This includes information systems for automatic data workflows, mobile apps for

operating staff, sensors to detect network failures, voice assistants for customer care and artificial intelligence for data interpretation.

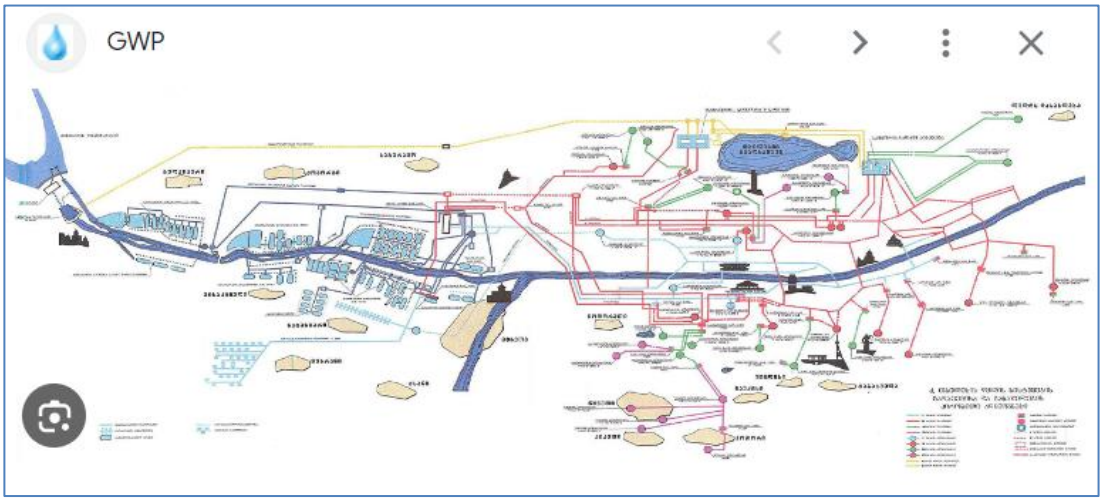
The capacity of PPPs to attract private finance was discussed. Requiring too high private finance (debt or equity) can also reduce competition. It is thus rather recommended to tailor private financing to high technology equipment, such as for example: non-revenue water sensors, high tech equipment, information system, smart metering, etc.

A recent operations contract in Lille (France), with a population of 1 million inhabitants, was presented. It implements many of the above features, with a mechanism incentivizing the private operator to reduce water consumption and reduce raw water abstraction in context of improving climate resilience.

Three case studies were then presented, illustrating the wide variety of PPPs.

The Tbilisi case study (divestiture)

The case of Tbilisi and 3 other cities in Georgia for the provision of water and wastewater was presented. In 2022, the private operator Aqualia acquired 80% of GGU – a company that owns and operates the end-to-end water cycle infrastructure in the Georgian capital, Tbilisi, and other cities, serving 1.4 million inhabitants. Infrastructure at stake include a dam and a reservoir, with a capacity of 520 Hm3, 7 Drinking Water Treatment Plants (DWTP), 1 large Wastewater Treatment Plant (WWTP), 4,300 km of distribution networks and 1,700 km of sewerage network. GGU also owns and operates important renewable energy generation assets with an installed capacity of 240 MW in 9 mainly hydroelectric plants, 4 of them associated with the water cycle assets (150 MW), which were acquired by Aqualia.



GGU/Aqualia could issue USD 250 million green bonds, which will be used in the coming years to finance new investments.

The provision of water and wastewater services is regulated by the Georgian National Energy and Water Supply Regulatory Commission (GNERC). The regulatory system aims to attract investment in the utilities sector, ensuring that investors recover their capital and the costs of the operation with adequate returns based on WACC calculation.

The Ostrava case study (joint stock / lease contract)

Two different examples (Ostrava and Tashkent) were presented of a partnership between a Municipality and a water operator SUEZ to improve the management and the performance of water and sanitation companies in Eastern Europe and Central Asia. These examples

demonstrate the needed adaptation of the business models according to the level of maturity of the water and sanitation companies, the level of water and sanitation tariffs and the political willingness to delegate or not the operation of such systems.

The 30 years lease operation contract for the provision of water and wastewater service to a population of about 300,000, in place since 1992, during the last 30 years in Ostrava, Czech Republic, was presented. The contract will be extended for another 10 years.

Suez, the Operator, brought strong improvements in the operation as reflected by the much-improved values of the 11 KPI monitoring the performance of the operator. For example, Non-Revenue Water could be reduced from 70 % to less than 8 %, water quality could be improved to meet the national standards and bad debts from customers could be reduced to less than 1% of sales. Smart metering was implemented throughout the whole city and has contributed to get a very high customer satisfaction level, estimated to be now at 97 %. Also new technologies like, for example, ice pigging to clean pipes, were introduced by Suez.

The average tariff is about 3.60 €/m3 and the annual turnover is about EUR 52 million, out of which EUR 12.6 million was paid in 2022 to the city as the lease fee. This money is entirely used by the City for CAPEX, and represents about 80 % of the CAPEX, the remaining 20% being financed by the Municipality. Profits of the company are shared by its shareholders, the Municipality of Ostrava and SUEZ.

The Tashkent case study (management contract)

The co-management contract recently signed in Tashkent was also presented. Through this 7-year contract, Suez, the contractor, provides assistance to the Water Utility to modernize the operation, make it more efficient and improve the level of service.

An investment plan of EUR 142 million will be implemented. It includes the creation of an intelligent center for real time monitoring of the operation, a Non-Revenue Water reduction initiative, a water quality program, and various actions to improve technical and financial efficiency. The financing will fully come from different concessional and commercial loans, as the very low tariff of about EUR 0.08/m3 does not generate cash for such CAPEX.

Several targets to improve operation efficiency have been set, especially targeting a strong improvement in bill collection and a 12% less withdrawal from water resources. The importance of clearly defined objectives and the selection of the right modalities when going for a PPP, was stressed. PPPs are tools to increase efficiency and level of service and are not an end in themselves.

Many models may be applicable in the region. The best model corresponds to a work of co-creation between the local authorities and the private operators, which must be based on trust, technical and financial competence, and common willingness to achieve ambitious goals for the well-being of the population. The need to incorporate sustainability features in PPPs contracts – including asset maintenance - and to ensure transparency was also highlighted.

It was concluded that there is a need to improve common understanding of PPP modalities and implementation features, and to have a close look which PPPs would be able to best fit the needs identified by the Azerbaijan government.

Key take-aways

- The term “privatization” is very controversial at best and has been misused often to describe the process of private sector participation (PSP) or public-private partnership (PPP). Privatization (or divestiture) is only one of the options of PSP or PPP.
- A PPP can be an instrument and an agent of change in facilitating reform. The pathway for private sector engagement in WSS however need to be mapped out carefully and will have to be progressive. Contractual arrangements should be straightforward and respective roles and accountabilities and oversight mechanism and responsibilities clearly defined. One should seek to start simply, leaving the door open for introducing gradually more complex and novel features.
- The range of options for engaging the private sector depends upon the level of control and risk the government wishes to retain, share or cede. All the different types of PPP options

used in the water and sanitation sector fall into two major categories, depending on whether payment for the service is tied to operational results:

- **Infrastructure provision models**: The Project Finance Initiative (PFI) with green field projects in case of new infrastructure and brown field projects in case of refurbishment of existing infrastructure. PPP options in this category are also known under the generic acronym DB[X] with the Design-Build-Operate (DBO), Build-Operate-Transfer (BOT) and Design-Build-Finance-Operate (DBFO) contracts as the most common.
- **Operational and delivery models**: If the private service provider is paid according to operational results and services delivered, the PPP contract is termed a *Delegation of a Public Service* (DPS). Under this heading come the arrangements known as service contract, management contract, lease, *affermage*, and concession.

- A major shift in PPP contracting in recent years has been the extensive use of KPIs for firmer and more transparent control by the public entities, in what are called performance-based (output-based) PPPs. One of the important drivers of value creation in a PPP project is output specification that defines the desired outcomes, without specifying the actions required to achieve them. Specifying inputs reduces the risk of performance for the private sector.
- The private sector is concerned about the financial viability of the entity and the project while the public sector must also consider the socio-economic impact and consequential priorities. The Private Sector cannot be responsible or be engaged for indirect or economic benefits.
- While private financing can be one of the main attractions of PPPs, it is the efficiency gains and improved service quality and compliance brought by the private sector's management systems and innovative technologies and techniques that make PPPs an attractive mode of delivery in the water and sanitation sector. Efficiency gains are mostly captured by reduction in NRW, improvement in billing and bill collection and labor productivity.
- Choose the right solution & PPP option for the right challenge, and options can build upon each other; there is no ideal or unique PPP set-up. A sequential engagement sometimes is needed, from input–based (contract of means) to output–based (contract of results).
- PPPs cannot work irrespective of the enabling environment; however, this is a necessary but not sufficient condition for a successful PPP. A PPP is an instrument, a means to an end - It is the process by which the objectives of the reform are achieved, that matters!
- Leveraging of public funds for revenue earning investment becomes a guiding principle and needs to be actively explored. Blended or hybrid financing with benefits of financial resource diversification, is a valuable approach to reduce the cost of borrowing and the consequential risks as it becomes more affordable.
- Successful PPP infrastructure projects have in common: (i) strong underlying business case; (ii) strong financing and robust contractual structure; and (iii) sustainable funding sources. Critical success factors are risk assessment, value for money, affordability, and robustness of cash flows.
- An effective PPP takes time to prepare and implement, especially in forms that involve private financing. No matter the PPP option, an operator can only succeed if given the control on the means to achieve performance targets. The importance of the initial PPP concept stage, for making the business case, cannot be overemphasized. Risk identification is a process started in the preparation of the business case as it is at the heart of any PPP project. The risk analysis and management process must be systematic and structured, with good knowledge and insight of project context. Detailed preparation is expensive, and a pre-feasibility study should be used as an eliminator. The goal for this initial concept stage is to scope out the PPP concept just enough so that major stakeholders can have informed opinions about PPP.

- Creditworthiness is critical for the financing of PPPs. Creditworthiness requires a paradigm change in utility corporate governance, consisting of shifting from being a government department to an entity that is managed as a business. The ability to ring-fence revenues from water sales is key in attracting commercial financing and PPPs.
- Emerging features in PPP contracts are (i) open book operations, and (ii) profit-sharing for incentivizing overall performance.
- The key importance of communication of the objectives pursued with PPP, should be recognized, and this from the early stages.

ANNEX 2: PILOT PPP FOR RURAL AND SMALL-TOWN WSS CHECKLIST

Check list for water supply and wastewater PPP for rural areas and small towns.

1. **Profile**
   - Size and scale of WS infrastructure / commercial viability and economies of scale
   - Proportion of rural households with access to “improved water on premises” / technical complexity, connectedness
   - Water availability (groundwater / surface water) and water demand
   - Sanitation (autonomous, sewers, other?)
   - Habitat characteristic (remoteness, dispersed)

2. **Local capacity**
   - Local professional capacity for service provision; lack of technical skills?

3. **Finance**
   - Affordability: Tariff? Metering?
   - Billing and bill collection? Revenue from water sales?
   - Financial viability of village / multi-village as a business unit? Unequal financial capacity?
   - Initial negative cash flow, varying efficiencies of service provision and variations in performance?
   - How asset maintenance will be financed: dependency on aid transfers or being bailed out by local government on an ad hoc basis to meet such costs?

4. **Institutional**
   - Ownership of assets (village/municipality, community (CBO), user organization/association, individual).
   - Legal and institutional framework, delegation mandate/contracting authority.
   - Level of oversight and accountability from local government or any appropriate regulatory entity.

5. **Stakeholders**
   - Stakeholder consultation and interest for improving services (“reality check”)?
   - Local preferences and ensuring inclusive services for all.
   - Role of the private sector?

(iii) Informing country-wide sustainable water resource management based on mapping of reservoirs and water accounting systems.

EXECUTIVE SUMMARY

Part B of this report seeks to show the importance of data-driven decision-making in water resources management and planning.[16] The Water Accounting Tool (WAT) aims to improve the understanding of irrigation dynamics in Azerbaijan by using advanced remote sensing technology. It evaluates irrigation performance across the country, and provides valuable insights regarding irrigated areas, major crop types, evapotranspiration rates, and biomass and yields. The tool also assesses irrigation efficiency and water consumption, highlighting areas with potential for water savings. The WAT findings emphasized an important irrigation water deficit, leaving some irrigable lands with no water, and high irrigation inefficiencies, in addition to highly variable irrigation efficiency at regional level. It illustrates the potential for water-saving measures, such as the substitution of irrigation-intensive crops, and the need for ground-truthing data to improve the reliability of remote sensing analysis. Overall, this component underscores the importance of informed decision-making and the use of innovative tools, such as the WAT, to address water scarcity and climate change challenges.

This part of the report also outlines the findings of the Water Evaluation and Planning (WEAP) model implementation in Azerbaijan, with a focus on the Upper Karabakh canal area. A case study was conducted to assess the potential of WEAP as a water modeling tool for the country to inform water resources management and planning to enhance water security.

The WEAP model for Azerbaijan was developed using publicly available data, historical water consumption, reservoir storage volumes, measured streamflow, land cover, and past and projected climate data. The model focuses on estimating current and future water availability, assessing vulnerability to uncertain factors such as climate change and upstream development, and on evaluating investment options for upgrading irrigation infrastructure or expanding double-cropping areas. The vulnerability assessment considered climate scenarios and the potential impact of increased withdrawals in upstream countries on water security in Azerbaijan. The model also provides management strategy scenarios, including improving irrigation efficiency and expanding double-cropping, and their potential impact on water resources. The findings of the WEAP model indicate that improving irrigation efficiency could alleviate water stress deriving from climate change, and expanding double-cropping could increase irrigation needs but be offset by efficiency improvements. These findings highlight the contribution of the WEAP model in assessing the impacts and benefits of strategic actions to improve water security in Azerbaijan.

The assessment provides recommendations for policy and operational improvements in the irrigation and drainage sector, emphasizing the need for rehabilitation and modernization of irrigation schemes and for the development of a comprehensive strategic plan for water resource management in the irrigation sector. This study also underscores the key role of water storage infrastructure for Azerbaijan economy and water security, and that better operational rules and allocation strategies could improve water productivity. It stresses the importance of capacity building in water agencies to effectively utilize the WEAP model and WAT for policy formulation and planning of water allocation and investments countrywide. Overall, the assessment provides valuable insights into the potential of the WEAP model and WAT as tools for water resources management and planning in Azerbaijan and offers valuable recommendations for improving water security in the country.

[16] Detailed information about methodology, results and recommendations can be found in the report produced for Activity III "Towards preserving Azerbaijan's scarce water assets and corresponding supporting reports produced for the WAT and WEAP models.

INTRODUCTION

Component 3 of Support to improving water security in Azerbaijan Advisory Services and Analytics under AZTAF supports the development of two analytical tools for better informing policy and investment decisions on water allocation and efficiency under climate uncertainties and associated risks. The development of these tools is a priority as per the recommendations of the 2020 Water Security Diagnostic prepared by the Bank in close consultation with the government and water practitioners[17]. It builds on World Bank-supported studies on Azerbaijan's water sector, in particular, the Review of World Bank engagement in the Irrigation and Drainage Sector in Azerbaijan of February 2013,[18] the Azerbaijan Water Security Diagnostic Report of August 2020, and the Azerbaijan Country Climate and Development Report (CCDR) of November 2023.[19] More importantly, these tools are part of the priority support areas identified during discussions with the GoAZ counterparts.

The component 3 is structured into two tasks. Task 1 consists of developing a water accounting tool using remote sensing information to benchmark performance of irrigation schemes in the country. Task 2 aims to pilot a water resources modeling tool to showcase its potential and inform water resources management and investment planning. Task 2 applies the Water Evaluation and Planning (WEAP) model to the Upper Karabakh canal area and the associated Mingachevir Dam.

[17] Azerbaijan Water Security Diagnostic Report (unpublished), August 2020
[18] Review of World Bank engagement in the Irrigation and Drainage Sector in Azerbaijan, February 2013
[19] Azerbaijan. Country Climate and Development Report, November 2023

1 WATER RESOURCES MANAGMENT IN AZERBAIJAN

Azerbaijan economy heavily relies on agriculture which is the largest water user in the country. Azerbaijan has a population of 10.32 million (2022), of which 23 percent (2.4 million) reside in its capital city Baku. Agriculture has been historically one of the major contributors to the economy and a crucial sector for food security and livelihoods particularly in rural areas. It is the second sector in terms of exports and the most important in terms of employment. Between 80-90 percent of agricultural production derives from irrigated agriculture due to the dry climate, making the agriculture sector the largest water user in the country. Investments to improve agricultural productivity will be an important element for economic diversification given the limited oil and gas reserves.

Azerbaijan relies extensively on transboundary water inflows due to its geographical and climatic conditions. A total of about 32 km^3 of renewable freshwater – including surface and groundwater - is available on average per year, but only around 8 km^3 are estimated to be produced within Azerbaijani's territory. The largest share (78 percent) of Azerbaijan's runoff enters through transboundary Kura and Araz Rivers from the three neighboring states[20]: Georgia, Iran, and Armenia.[21] Future water availability to meet demand growth will depend on abstractions in neighboring countries, on the impacts of climate change on runoff in river basins, and on the actions taken by riparian countries to adapt to those impacts. The renewable groundwater resources are estimated at approximately 6.5 km^3, of which about 67 percent contribute to the baseflow of rivers (Ahmadov, 2020)[22].

Water availability is on the decline due to increasing upstream demand and climate change impacts. Imanov et al (2023) reports that over the past three decades, the water resources of the Kura River and its main transboundary tributaries have decreased by 16.0–55.2%, mainly due to the construction of new reservoirs and an increase in water withdrawals for irrigation and other sectors in countries located in the basin. A sharp manifestation of water scarcity in the Kura basin in recent years (2011–2021) underlines the significant reduction in atmospheric precipitation, primarily in the form of snow, in the context of climate change. 2014 was one of the driest years of recent times. During this drought period, the decrease in the river flow in the downstream section of the Kura River reached critical levels, causing serious problems not only for irrigation of drylands, but also for drinking water supply.[23] Water levels in the Mingachevir reservoir dropped, with much reduced water levels downstream in the Kura River's lower reaches, leading to a reversal of flow direction and seawater intrusion as far as 30 km inland. Water resilience needs to be substantially strengthened to address future impacts of climate change and inadequate storage, which otherwise will fuel potential conflicts among water users.

A vast water storage infrastructure allows to manage a highly variable water availability. Azerbaijan features bi-modal rainfall, with a notable rainy season in the spring (April to June) and less notable rainy season in the fall (September to November). Rainfall also differs spatially, with highest rainfall in the north-western area and the extreme south-east, and lowest rainfall within the lower KuraAras plains (largest irrigated land) and the Caspian Sea coastal area near Baku. Dams are the backbone of Azerbaijan's development as storage provides

[20] Rzayev 2017 (cited in CCDR)

[21] However, these values differ from other sources, such as the FAO reported values and those reported in the Draft Water Strategy.

[22] Ahmadov. 2020. Water resources management to achieve sustainable development in Azerbaijan. Sustainable Futures, Volume 2, 2020, 100030, ISSN 2666-1888, https://www.sciencedirect.com/science/article/pii/S266618882030023X

[23] Imanov F., Aliyeva I., Nagiyev S., Leummens H. (2023). Changes in the annual flow of the Kura River. Czasopismo Geograficzne, 94(1): 39–52 . https://depot.ceon.pl/bitstream/handle/123456789/22564/czageo-94-02.pdf?sequence=1&isAllowed=y

water for irrigation, hydropower, domestic uses, and recreational activities. In total, 142 reservoirs of various sizes were built in Azerbaijan to increase water resources availability (Khalilov, 2003; Ahmadzade & Hashimov, 2016). Azerbaijan has the largest volume of water storage in South Caucasus, amounting to about 21 km3 (corresponding to around 80% of total dams storage in the region). At the same time, the storage is imbalanced with 80% of the total capacity stemming from six large reservoirs representing more than 100 million m3 (Mingachevir, Shamkir, Araz, Sarsang, Yenikend and Agstafachay, as indicated in Table 1), and 20% scattered over 130 smaller reservoirs. The GoAZ is advancing on increasing water storage in the country, through projects like the 'Khudafarin' and 'Qiz Qalasi' dams, jointly with Iran[24]. Ther GoAZ is also planning construction of more dams along with a water resource masterplan as part of the upcoming national water strategy.

Nevertheless, storage capacity is declining as dams are aging and underperforming. According to a recent study (Perera et al, 2022), 24 percent of storage volume is lost due to sedimentation in Azerbaijan. These losses could reach 34 percent by 2050 due to climate change.[25] Furthermore, dam managers face difficulties in predicting the inflow into the reservoirs and do not necessarily know the pattern of the downstream demand. In addition, dam safety inspections and monitoring do not follow the acceptable international standards.

Name	River	Year	Height (m)	Capacity (million m3)	Main use*
Mingachevir	Kura	1953	80	15730	I, W, F, H, N, R
Shamkir	Kura	1983	70	2677	I, W, F, H
Araz	Araz	1971	40	1350	I, W, F, H
Sarsang	Terter	1976	125	565	I, F, H
Yenikend [26]	Kura	2003	27.5	158	I, H
Agstafachay	Agstafachay	1969	53	120	I, F
Ayrichay	Ayrichay	1986	23	81	I, F
Xachinchay	Xachinchay	1964	38	23	I, F
Total				20,704	

* *I = irrigation; H = Hydropower, W = water supply; F = Flood protection; N = Navigation; R = Recreation*

Table 1. Large dams in the Kura-Araz River basin in Azerbaijan. (Produced by authors based on FAO, 2009[27], and Wikipedia)

The rehabilitation and modernization of irrigation schemes are crucial to improving water productivity. Around 1,500,000 hectares are irrigated in Azerbaijan, amounting to around 50 percent of the total agricultural land. Irrigation is mostly performed through large schemes inherited from the Soviet era, located in the downstream and dry parts of the Kura River basin. The water losses from irrigation and drainage systems are high (estimated at around 2–3 billion m3 per year[28]), and yet are barely quantified due to lack of metering devices. Even though official statistics indicate about 26 percent of losses, higher values were reported in conversations with stakeholders and in the draft water strategy for total losses (around 50%), considering also on-farm losses. State fee for irrigation water is only 0.5 AZN per 1000 cum, which is low and does not provide any incentive to save water. Only half of the irrigated area has drains, and most on-farm infrastructure comprises earth canals.

[24] https://caspiannews.com/news-detail/iran-azerbaijan-resume-construction-of-joint-hydropower-plants-2021-2-24-53/
[25] Perera, D.; Williams, S.; Smakhtin, V. Present and Future Losses of Storage in Large Reservoirs Due to Sedimentation: A Country-Wise Global Assessment. *Sustainability* **2023**, *15*, 219. https://doi.org/10.3390/su15010219
[26] Information extracted from Wikipedia: https://en.wikipedia.org/wiki/Yenikend_reservoir
[27] FAO. 2009. Transboundary River Basin Overview – Kura Araks. https://www.fao.org/3/ca2130en/CA2130EN.pdf
[28] https://www.sciencedirect.com/science/article/pii/S266618882030023X

Furthermore, service delivery for the irrigation sector needs substantial improvement. The recently established Regional Water Amelioration Service (RWAS) under the recently established State Agency for Water Resources (ASWRA) is responsible for the operation and management of irrigation systems, including reservoirs and other major water infrastructures such as long conveyance canals that connect resources in reservoirs and irrigation schemes. The RWAS plays a pivotal role in the performance of the irrigation sector as provider of bulk water to Water User Association in charge of operating irrigation schemes. Similarly, the Water Users Associations (WUAs), which are responsible for on-farm irrigation services, need more capacity, equipment, and financing to operate complex hydraulic systems. There is a total of 373 WUAs in Azerbaijan, most of which are small and inefficient. Tariff collection in small WUAs is often pending for more than a year, thus generating low income streams. The irrigation sector suffers from a lack of regulation of WUA's activities, particularly a lack of adequate incentives to foster efficient use of irrigation water by small and medium size farms. Overall, the country needs to develop alternative models and regulatory frameworks regarding WUAs' roles and responsibilities. The Israeli engineering firm Mekorot is currently finalizing an irrigation masterplan in collaboration with the ASWRA, which will inform future actions and investments in the sector.

Even though Azerbaijan is currently advancing on improving information systems, more efforts are needed to better inform water resources management and planning. In order to scale up the data base, the GoAZ is trying to expand the modern equipment for monitoring and measuring streamflow and meteorological parameters introduced by a recent UNDP project on a pilot basis. The GoAZ is developing the "Electronic water management information system" (denominated ESTIS in Azeri), under the umbrella of the Ministry of Ecology and Natural Resources and funded by the Cabinet of Ministers according to a recent decree[29]. Likewise, the official statistical database AZSTAT[30] has been recently launched with data of demographics, economic sectors including agriculture, and water use. However, in Azerbaijan, there is currently no standard for water accounting practices to better understand and monitor water consumption from different users. Access to data still remains a challenge, sometimes with costs associated. The draft water strategy highlights the importance of information systems to improve the performance of existing water infrastructure and inform infrastructure investment planning.

[29] https://e-qanun.az/framework/46872
[30] https://www.azstat.gov.az/webmap/?lang=en

2 THE WATER ACCOUNTING TOOL

Enhancing the understanding of irrigation service delivery performance and identifying factors that may contribute to low performance is crucial for making informed decisions and facilitating investments aimed at improving water management and efficiency, both on and off the farm. However, there is a persistent inadequate availability and access to data and information regarding water, land, and crop performance. This limitation hinders the development of the necessary insights and the ability to carry out diagnostic and operational assessments of irrigation performance.

The Water Accounting Tool (WAT) introduces a Digital Water Accounting System for Azerbaijan based on remote sensing technology to improve the understanding of irrigation dynamics, providing valuable insights that can be used for informed decision-making in agricultural and water resource management. The WAT conducts a comprehensive evaluation of irrigation performance across Azerbaijan, relying on advanced high-resolution remote sensing technology and products. Remote sensing technology offers a unique opportunity to obtain a country-scale overview of irrigation efficiency in Azerbaijan, a task that field methods alone could never achieve due to the vast scale and the complexity of assessing crop irrigation water use across such a large area. The WAT provides users access to acreages according to crop types, irrigated lands, estimation of crop yield, water use statistics, and high-resolution maps. This system enables data visualization and analysis at various spatial scales, thus supporting policymakers, water authorities, and stakeholders in making informed decisions to optimize irrigation systems and achieve sustainable water use in the irrigation sector. This chapter includes a summary of the methodology deployed and main results and conclusions. A detailed report can be found in Annex 1.

Methodology

This WAT study relies on advanced high-resolution remote sensing technology and products to address these data gaps and comprehensively evaluate irrigation performance across Azerbaijan. Remote sensing provides a well-established alternative to supplement the data collected on water, land, and agriculture from ground-based methods. Remote sensing (RS) and advanced data analytics offer a strong alternative to conventional methods for data collection and provide the opportunity for developing reliable, robust, and transparent platforms for large-scale land, agriculture and water monitoring (Karimi, et. al., 2013). The WAT study utilizes remote sensing techniques to achieve the following objectives: (i) map irrigated areas, (ii) identify major crop types, (iii) estimate evapotranspiration rates, and (iv) evaluate biomass and yields. These assessments are performed at a spatial resolution of 10 to 30 meters and monthly or annual intervals, enabling a nation-wide detailed analysis of irrigation system performance over six years (2017-2022). By combining these layers of information, a comprehensive understanding of irrigation dynamics can be obtained.

The assessment of irrigation performance considered 10 indicators calculated at the district or region level. For ease of interpretation and benchmarking of irrigation systems, each indicator is assigned a score ranging from 1 to 10, using a combination of local and international best practices. This scoring system establishes a target level (score 10) and a critical level (score 1) for each indicator. The calculation of indicators was conducted annually

from 2017 to 2022, and the resulting scores are averaged to obtain a single score for each economic region[31] or per district.

This exercise enables stakeholders and decision-makers, such as water committees, to assess key indicators associated with cost-effective and fair access to irrigation water, efficient utilization of water resources, and availability of water for irrigation purposes. Such assessments helped identifying current issues and informing future interventions aimed at enhancing the performance of the irrigation sector, particularly in light of growing uncertainties surrounding water availability patterns due to the adverse impacts of climate change.

Results

The WAT study highlights an important deficit in irrigation water. Based on the WAT results, the estimated annual average irrigated land in Azerbaijan is 1.02 million hectares while the average irrigable area is 1.54 million hectares, signaling that around 34 percent of the crop areas are not being irrigated. Karabakh economic region is the largest consumer of irrigation water use, and maps of irrigated lands reveals a significant concentration of irrigation downstream of the Mingachevir reservoir, in the regions of Karabakh, Mil-Mughan and Central Aran. In terms of water consumption, irrigated crops in Azerbaijan consume between 1,560 and 2,630 million m3 of irrigation water each year, with an average rate of 2,330 million m3 per year over the study period. According to the State Statistical Committee of the Republic of Azerbaijan (AZSTAT), the total volume of water received for the same period was[32], on average, 7,030 million m3, potentially indicating a total water loss of around 67 percent at the national level.

Remote sensing analysis shows that orchards are the most irrigation-intensive crop class in Azerbaijan, consuming on average 4,400 m^3/ha. Cotton and fodder crops consume an average of 3,250 m^3/ha, while irrigated grains (wheat or barley) consume an average of 1,320 m^3/ha. It is important to note that these values are annual averages over a six-year observation period and across the entire country. The actual water consumption of each crop class may vary depending on the specific location and climate conditions. For example, orchards in the arid regions of Azerbaijan may require more water than orchards in the more humid regions. However, the irrigation status of orchards cannot be unambiguously identified with remote sensing. Hence, ground-truthing data would allow improving the interpretation and assessment.

Results show that the irrigation system efficiency in Azerbaijan is low with only 37%[33] at the national level, and highly variable, ranging between 20-50%in most regions. This estimated irrigation efficiency reflects a scenario where both conveyance efficiency and field efficiency are around 60%. Significant water losses may occur during conveyance which are due to high leakage and seepage from aging infrastructure. A conveyance efficiency of 60% is deemed reasonable for extensive canal systems, although it is notably lower than the 73% reported by AZSTAT. This difference might suggest the presence of additional losses at the farm level that are not captured in official statistics, thereby influencing the overall efficiency.

[31] There are 14 economic regions in Azerbaijan, politically defined in the Decree "On the new division of economic regions in the Republic of Azerbaijan", signed on July 7, 2021.

[32] Irrigation water use data are available in the State Statistical Committee of the Republic of Azerbaijan (AZSTAT) database as “Irrigation and water supply of agriculture by economic regions and administrative units”.

[33] Guba-Khachmaz and Sheki-Zagatala economic regions, primarily due to the prevalence of orchards and the associated uncertainties regarding their irrigation status. AZTAT data suggest that the identified fraction of irrigated land used in the country for orchards (2 percent) needs to be considered. Scheme command areas would be required to better account for irrigation water use in orchards.

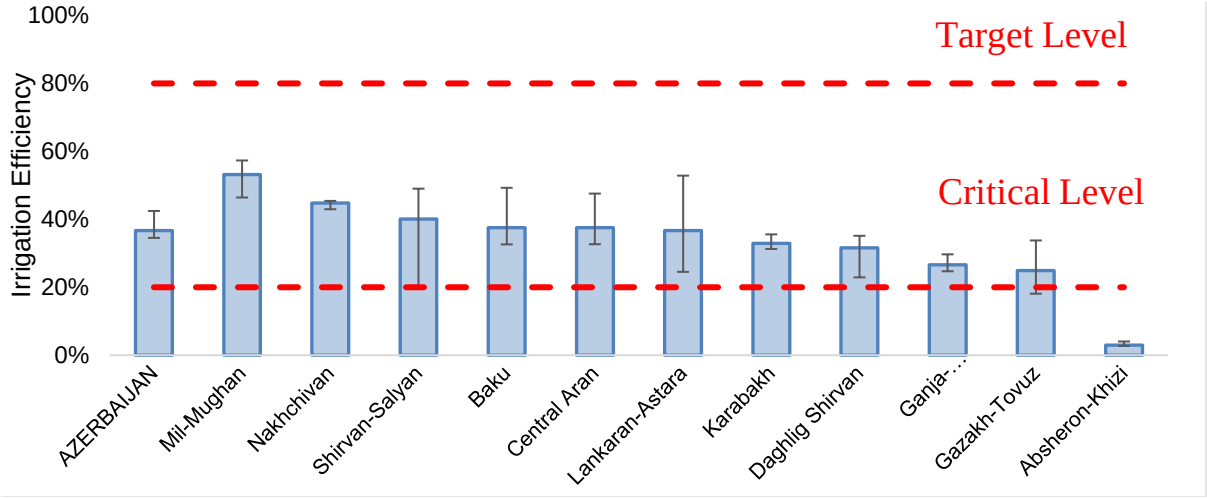


Figure 1. Average irrigation efficiency per economic region. The error bars show the full range of annual values. Critical and target levels represent global values for measuring irrigation service delivery performance.

The WAT provides estimates on irrigated areas, and evapotranspiration (ET) at the district level, showing variations in irrigation efficiency and the potential for improvement in the Upper Karabakh canal area**.** The WAT generated information about the irrigated area, precipitation, and ET for the four districts considered to be part of the Upper Karabakh canal area (Agjabedi, Barda, Yevlakh, and Beylagan).

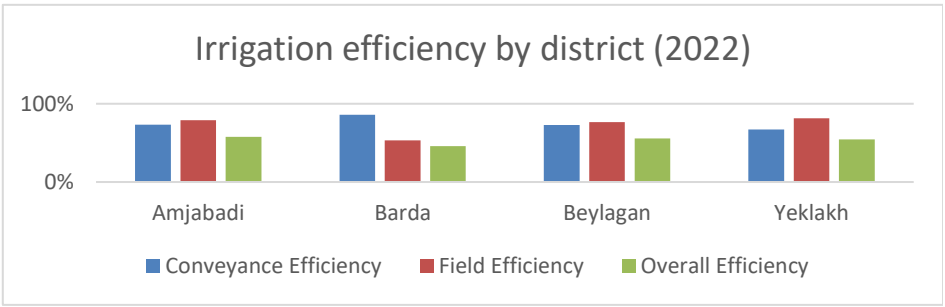


Figure 2. Irrigation water demand and irrigation efficiency at the district level in the Upper Karabakh canal area for the year 2022. (Results from the Water Accounting Tool and data provided by the GoAZ).

Nearly all districts in Azerbaijan have shares of cropped areas that are facing water shortage during the crop growing season**.** These shares vary between 15% and 30% on average, even within the same economic region (e.g., Guba-Kbachmaz). Variations within the same economic region show that water shortage is not only caused by climatic factors.

Azerbaijan's average annual water-saving potential is estimated at 960 cubic meters per hectare (m3/ha). Hence farmers could reduce their crop water use without yield loss. The highest water saving potential were found for districts in Gazak-Tovuz and Karabakh. By capitalizing on these irrigation schemes, potential irrigated areas in Azerbaijan could be expanded and/or water stress could be reduced at the tail end of canals. This highlights the opportunity for actual water savings, which could reduce net irrigation water consumption by up to 40 percent country-wide if measures to cut over-use irrigation water are introduced at scale.

Substitution of irrigation-intensive crops could also contribute to water-saving**.** The most common irrigated crop classes are grain crops (wheat or barley) and fodder crops, accounting for about 35% of the irrigated area, followed by cotton (11 percent). Only 9 percent of the total irrigated cropped area is used for double cropping. The irrigation water demand for wheat &

barley is at least 50% lower compared to fodder crops or cotton. Therefore, for each hectare of fodder or cotton replaced by grain crops, one additional hectare of land can be irrigated.

Further ground truthing with georeferenced field data and incorporating training data will help improve the reliability of these estimates and improve the results of the remote sensing analysis. It is also important to note that the remote sensing data shows a larger inter-annual variability of the cropped area compared to the one reported by AZTAT. This highlights the need to investigate the quality of both methods, in spite of the good agreement between multi-annual average values.

The CropMapper-Azerbaijan is a visualization tool produced to provide users with information on crop acreages and crop water use. The CropMapper-Azerbaijan is a Google Earth Engine Application (Gorelick, et al., 2017) configured to operate in Azerbaijan at the country and subnational levels. It allows access, visualization, summarizing and downloading crop-disaggregated annual maps of irrigated areas. The App also provides access to crucial aggregate statistics, such as cropped area and water consumed, for a selected year and area of interest. Users can display high-resolution maps of crop types, irrigated area, evapotranspiration and biomass production. The current version provides access to data from the years of analysis of the present study (2017-2022). Future versions of the app may be updated to operationally provide access to new crop data at the end of each agricultural year. The app version can be accessed via the weblink:https://hydrosolutions.users.earthengine.app/view/cropmapper-aze-v1. Figure 2 illustrates the CropMapper-Azerbaijan.

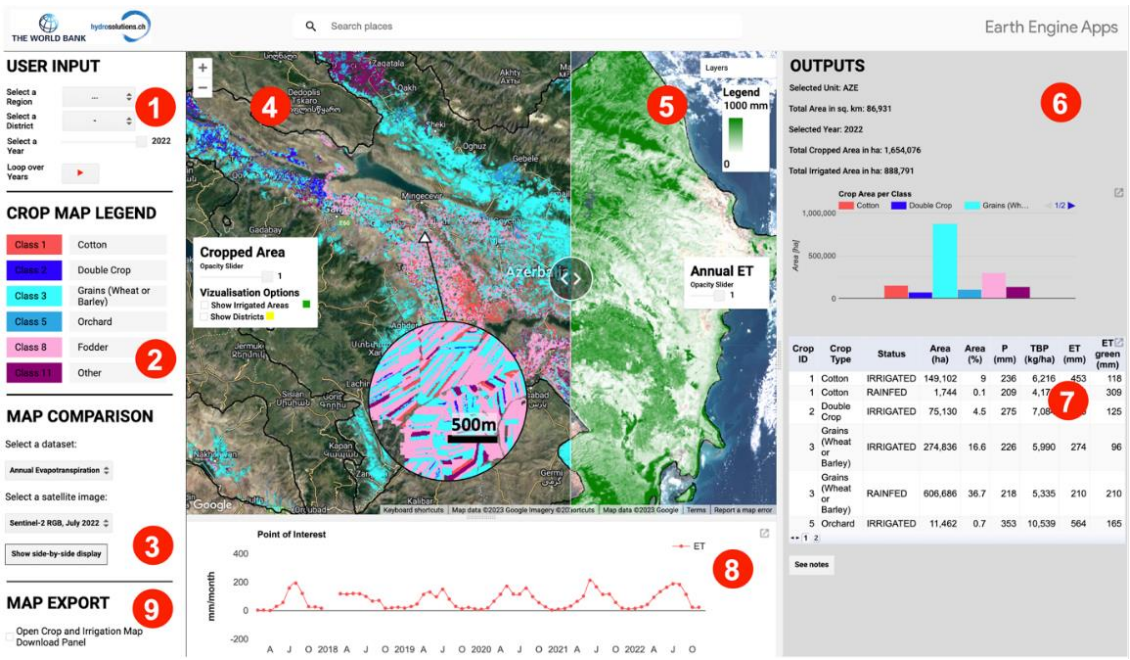


Figure 3. Screenshot of the cropmapper-azerbaijan web application. (1) User input and selection panel, (2) Crop map legend showing color coded crop list, (3) Map comparison selection panel, (4) Interactive map window with crop-disaggregated crop map shown in the left part and a user-selected dataset shown on the right side (5). (6) shows the output panels with a cropped area bar chart for the chosen domain and a table containing a crop-specific water balance (7). The users can click on points of interest to obtain time-series charts of selected variables (8). All data can be exported as georeferenced maps.

3 WATER EVALUATION AND PLANNING (WEAP) MODEL

As highlighted in the draft water strategy and evidenced by research, the availability of relevant data and adequate methods and tools are critical for both IWRM and investment planning. The modelling would help in assessing the needs for new infrastructure and its integration into the existing infrastructure. The Water Evaluation and Planning (WEAP) tool is widely used to evaluate uncertainties around water resources management and security. The tool provides a flexible framework for simulating both supplies and demands that can be developed at a level of detail that matches available data. Simple WEAP models are often a starting point for more detailed analyses that may include other tools and/or refine the existing WEAP model to include a higher level of granularity in key areas identified in the first phase of analysis. During the mission held in May 2023, it was agreed between the World Bank and the GoAz to apply the WEAP model in Azerbaijan.

The WEAP model is commonly used to conduct vulnerability assessments – in which different uncertainties[34] are evaluated to estimate their potential impact on water supplies and demands – as well as scenarios exploration, where various water management strategies are assessed to measure their effectiveness towards enhancing water security[35]. The overall objective of this study is to showcase the applicability of WEAP in Azerbaijan to assess its potential as a water modeling tool for the country to inform water resources management and planning to enhance water security. In particular, this study examines WEAP's ability to perform the following within the study area:

- Estimate current and future water availability under different climate projections.
- Assess the vulnerability of the existing water management system to uncertain factors, such as climate change and upstream development.
- Assess investment options for upgrading existing irrigation infrastructure or expanding double-cropping areas.

The WEAP model developed for this study, herein called Upper Karabakh Canal Water Model (UKCWM), focuses on the Upper Karabakh canal area, the country's largest irrigation artery. The UKCWM is based on the mapping of hydrologic systems, key reservoirs and related infrastructure (main canals, main irrigation scheme), and can contribute to prioritizing investments in reservoirs and infrastructure improvements.

The UKCWM was developed primarily using publicly available data, including historical water consumption, reservoir storage volumes, measured streamflow, land cover, and past and projected climate data, as well as some data provided by local stakeholders (i.e. GIS data and physical capacities for key infrastructure). Since no map on the irrigation schemes was accessed, the UKCWM assumes that all irrigated lands estimated by the WAT for the districts of Agjabedi, Barda, Beylagan, and Yevlakh are irrigated by the Upper Karabakh canal. The UKCWM was calibrated to ensure that surface water flows simulated approximate observed flows at a few locations. The model includes a range of climate projections and produces results demonstrating how varying demands and irrigation efficiencies might impact surface water inflows to Mingachevir reservoir, reservoir storage, and crop production.

[34] Where uncertainties are defined as exogenous factors beyond our control that influence the performance of the water management system. These factors can introduce unpredictability and risk into decision-making and planning because they are not subject to direct management or manipulation.

[35] Where Water Security is defined as water of adequate quantity and quality to support all social and economic needs and to protect against water-related risks such as drought and flood.

To conduct an analysis for the study area, UKCWM considers the entire area of the Kura and Araz river basins. The cropped areas within the Karabakh canal study area were estimated using results produced by the WAT for the period 2017-2022. These estimates indicate that the irrigated area within the four districts served by the Karabakh canal ranges between 195,000 and 260,000 hectares. It identifies irrigated and rainfed areas of five different crop types – i.e. grains, fodder, cotton, double cropped, and other. Estimated planting and harvesting dates at the field level for each year between 2017-2022 were adjusted according to stakeholder's feedback.

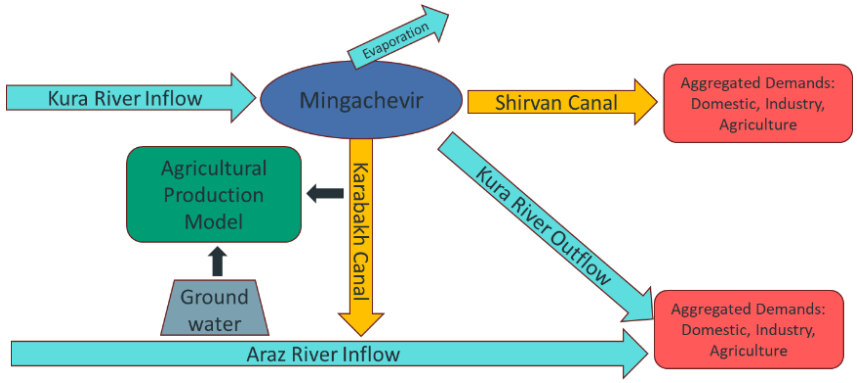


Figure 4. Conceptualization of the Upper Karabakh Canal Water Model (UKCWM).

The vulnerability assessment focused on the potential impact of climate projections and increased withdrawals in upstream countries. The WEAP model has the ability to automatically link to over 100 CMIP6 climate projections[36]. To capture the potential future range of precipitation and temperature projections, six models (three hot and dry, and three wet and warm) were selected, in consultation with stakeholders and consistent with the recent World Bank's Country Climate and Development Report (CCDR) conducted for Azerbaijan (World Bank Group, 2023). The six scenarios selected and the average changes in precipitation and temperature projected by these models for the 2021-2040 and the 2041-2060 time periods are summarized in Table 2. These data also indicate a persistent rise in average annual temperature, with most projections suggesting a height of 1 to 1.5 degrees Celsius for 2020-2040 and an increase of 1.6 to 2.6 degrees for 2040-2060. Overall, the average of these data suggests a slight increase in precipitation over the historical period. The impact of climate change on the Mingachevir carryover capacity, unmet water demand and agricultural production shocks are assessed.

Table 2. Summary of CMIP6 data used in the UKCWM study

CMIP6 scenario	Future period	Change in recipitation	Change in temperature
KACE-1-0-G SSP370 (HotDry1)	2021-2040	-6%	0.7
	2041-2060	-5%	2.3
TaiESM1 SSP370 (HotDry2)	2021-2040	-4%	1.1
	2041-2060	-4%	2.1
UKESM1-0-LL SSP370 (HotDry3)	2021-2040	-7%	2.2
	2041-2060	-8%	2.9
MRI-ESM2-0 SSP585 (WetWarm1)	2021-2040	+4%	1.4
	2041-2060	+7%	2.4
CMCC-ESM2 SSP370 (WetWarm2)	2021-2040	+6%	0.8
	2041-2060	+8%	1.7
TaiESM1 SSP245 (WetWarm3)	2021-2040	+8%	1.0

[36] CMIP6, or the Coupled Model Intercomparison Project Phase 6, is a collaborative effort within the climate science community to compare and assess global climate models. Launched by the World Climate Research Programme (WCRP), CMIP6 involves multiple climate modeling centers worldwide. The project aims to improve our understanding of the Earth's climate system, enhance the reliability of climate projections, and provide valuable insights for policymakers. Researchers use CMIP6 to simulate various aspects of the climate, such as temperature, precipitation, and atmospheric composition, enabling comprehensive analyses of potential future climate scenarios.

	2041-2060	+7%	1.6

The other key uncertain factor that potentially threatens water security in Azerbaijan is an increase in withdrawals by upstream countries. The level of annual withdrawals from the Kura and Araz river by these countries is unclear and the degree to which these withdrawals will change in the future is also highly uncertain. For this study, the UKCWM assumes that the share of water use is split proportionally across irrigated areas in each country, amounting to a total of approximately 10 billion cubic meters currently withdrawn by upstream countries, and a little more than 2.6 billion cubic meters withdrawn from the Kura River before it reaches Azerbaijan. The scenario “High Upstream Demand” assumes that this level of withdrawal increases by 50 percent between 2020 and 2040 and remains at this higher level until 2060.

This study considered two management strategies discussed with stakeholders. The first one focuses on efficiency improvements within the irrigated areas receiving water from the Upper Karabakh canal. The other one focuses on expanding the areas under irrigation by converting areas growing only winter wheat to growing a combination of winter wheat and summer crop.

The “Irrigation efficiency” scenario assesses the benefit from improving the overall irrigation efficiency from 50% to 75% in the Upper Karabakh canal. Discussions with stakeholders confirmed the reported estimates of current water losses of fifty percent (AZSTAT, 2022) for irrigation systems in the Upper Karabakh canal area. This includes losses due to inefficient conveyance structures and outdated irrigation technologies (i.e. on-farm losses). The analysis considered a new scenario within the UKCWM, called “Irrigation efficiency”, that assumed that cropped areas remain fixed at 2022 levels in the Upper Karabakh canal area (227,000 hectares) and that water losses would be reduced by half by the year 2030 and remain at 25 percent thereafter until 2060. No changes of irrigated areas or irrigation efficiency are considered for the rest of the areas in the KCWAM. The assessment includes a comparison of the irrigation efficiency under the reference climate (assuming the historical temperature and precipitation) and the six climate projections selected.

The “Double cropping” scenario assesses the impact of increasing the land under double cropping, currently representing around 6 percent of total irrigated lands in the Upper Karabakh canal area. This involved the assessment of the impact of converting some portion of the lands currently growing only winter wheat to double cropping. In this scenario, half of these areas are converted to a double cropping regime in which winter wheat is followed by a summer crop (i.e. watermelon) that is also irrigated. The conversion occurs linearly between the years 2021 and 2040, after which the crops were held constant. The conversion to double cropping adds about 17,440 hectares to the area irrigated in summer months. This increases the irrigation requirements by about 117 million cubic meters per year, or 13 percent.

Results

The UKCWM, a robust water model was developed for the Upper Karabakh canal area and primarily relied on publicly available data (namely the official statistical database AZSTAT). Data generated by the Water Accounting Tool (WAT), particularly related to irrigation efficiency, irrigated areas and crop-types served as input data for the UKCWM to address some data gaps, complementing with validation and inputs provided by Azerbaijan’s representatives from government agencies. Future efforts should refine the UKCWM with hydrological data and agricultural ground-truthing to validate water losses, crop water use rates, and irrigation technologies.

Climate change may cause a reduction of inflows into Mingachevir dam. The vulnerability assessment considered a set of climate scenarios that looked at the dry and wet ends of CMIP6 projections. These projections indicate that the total water supply in the future could be significantly different than what was observed historically, with the dry climate scenarios suggesting decreased inflows into Mingachevir reservoir of 20 to 35 percent, while the wet scenarios suggest no significant difference from the historical period.

Climate projections suggest that agricultural water requirements may be substantially higher due to increasing temperatures, with dry climates increasing irrigation water demand by 13 to 25 percent and wet climates increasing demand by 2 to 11 percent. The combination of the higher irrigation requirements and the decreased river flows suggest that Mingachevir reservoir could be chronically stressed under the driest scenarios. However, wetter scenarios indicate that inflows could be high enough to offset the increased demands.

The water supply situation in Azerbaijan could be further stressed if withdrawals increase in upstream countries, which is a key concern for water managers in Azerbaijan. The analysis indicated that a fifty percent increase in withdrawals from the Kura River upstream of Azerbaijan could decrease inflows into Mingachevir by 8 percent. When combined with dry climate projections, this poses a significant threat to water security.

Improving irrigation efficiency could alleviate water stress due to climate change. To address the challenges expected with possible decreasing water supplies due to climate change and increased water withdrawals, UKCWM assessed the potential benefits of a management strategy that focused on improving the overall irrigation efficiency within the Upper Karabakh area. This included reducing losses from the Upper Karabakh canal and increasing on-field irrigation efficiency so that the overall water losses are cut by half compared to their current levels that sit around 50%. This strategy indicates that, in the absence of climate change, delivery reliability and water productivity could be significantly improved within the Upper Karabakh canal area. When climate projections were also included, it was observed that the water productivity under dry projections produced similar results to the historical scenario, because efficiency improvements offset increases in irrigation requirements. When looking at the water supply situation beyond the Upper Karabakh canal area, UKCWM suggested that efficiency enhancements in the Upper Karabakh canal area could have a slight positive impact by increasing storage in Mingachevir and water deliveries elsewhere in Azerbaijan by 1 to 3 percent.

Improving irrigation efficiency could enable the potential expansion of double-cropping. To address a stated desire to expand irrigation within the Upper Karabakh canal area, a second scenario was considered in which half of the land currently growing winter wheat is converted to growing both winter wheat and a summer crop, which adds over 17,000 ha of irrigated land to the summer irrigation season. This expansion increases the irrigation requirement in the order of 13 percent. However, this increase is completely offset when implemented in combination with improvements in irrigation efficiency.

In general, UKCWM provides a valuable screening tool for exploring the potential impact of future uncertainties and testing the effectiveness of potential or existing management strategies and investment interventions. However, the findings in this study reflect a limited analysis of how the model can be used to address the gap between water supplies and demands. The climate scenarios represent the bookends of all climate projections. A more comprehensive analysis should broaden the scope of these projections to include more

moderate levels of future precipitation and temperature. Additionally, it is also recommended that the vulnerability assessment could be expanded to include high, low, and medium population projections (from UN World Population Prospects 2022) and a more rigorous assessment of potential decreases in the Kura River flow due to increased upstream water demand.

The scenario analysis presents a starting point for further investigation into improving the allocation of water from Mingachevir reservoir and other water supplies in Azerbaijan. While this study focused on improving system performance by adjusting water management in the area around the Upper Karabakh canal, this study evidenced the potential of the WEAP modeling tool to contribute to informing water resources management and investment planning in Azerbaijan. Future efforts could focus on enhancing the model by refining the set of rules governing the operation of Mingachevir reservoir and increase the resolution of water demand in other areas receiving water from Mingachevir. This could follow the approach already applied under this study.

4 RECOMMENDATIONS

The WAT and WEAP models have been successfully implemented as prototype desk-level applications with global datasets for strategic planning and monitoring water efficiency in Azerbaijan but require calibration with field data for policy and operational recommendations. The implementation of the WAT and the WEAP model was successful as a prototype desk-level application with global data sets and limited availability of official data from Azerbaijan. Their practical application should be most helpful for collaborative strategic planning and monitoring water efficiency and specific water allocation issues.

The WAT and WEAP models contribute to responding to the need for country-wide water resource assessments using advanced technology and hydro-economic modeling. With non-stationary hydrology due to anthropogenic climate stress, the Water Security Diagnostic Report 2020 (World Bank, unpublished) underlined the need for country-wide water resource assessments using advanced earth observation technology and hydro-economic modeling, as implemented under this study. However, hydrometeorological information from local stations was not obtained, and it is crucial to calibrate results and validate recommendations. Future efforts should focus on calibrating these tools with field observations and ground-truthing data. Otherwise, their usefulness to support specific policy and provide operational recommendations will remain limited.

Technical capacity building of local practitioners and within Azerbaijan's water agencies is necessary to fully exploit the functionalities of the WAT and WEAP models. Discussions with officials in Azerbaijan shed light on the institutional need to adopt tools to better inform water resources planning and management. Earth observational and digital operationalization using the Google Earth Engine are widely applied by water agencies, water users, and water practitioners in countries like Mexico and Spain, and the potential for much more significant benefits to improve water and soil management and agriculture productivity is increasing with AI-supported machine learning upgrades.

The WAT reveals that the overall efficiency of water allocated to agriculture is 37 percent country-wide, with considerable variability and losses due to leakage and seepage from aging infrastructure. Results show that system-level irrigation efficiency in Azerbaijan is low with only 37 percent[37] at the national level, and highly variable, ranging between 20-50 percent in most regions. This estimated irrigation efficiency reflects a scenario where both conveyance efficiency and field efficiency are around 60%. Significant water losses may occur during conveyance which are due to high leakage and seepage from aging infrastructure and substandard maintenance of irrigation and drainage channels. A conveyance efficiency of 60% is reasonable for extensive canal systems, although it is notably lower than the 73% reported by AZSTAT. This difference might suggest the presence of additional losses at the farm level that are not captured in official statistics, thereby influencing the overall efficiency. In general, there are significant variations in water productivity and water shortages among different districts.

The WEAP model assessments anticipate the impact of climate change on water availability in Azerbaijan. Climate change may lead to reduced inflows into Mingachevir dam, with climate scenarios projecting a decrease of 20 to 35 percent under dry conditions, while wet scenarios

[37] Guba-Khachmaz and Sheki-Zagatala economic regions, primarily due to the prevalence of orchards and the associated uncertainties regarding their irrigation status. AZSTAT data suggest that the identified fraction of irrigated land used in the country for orchards (2 percent) needs to be considered. Scheme command areas would be required to better account for irrigation water use in orchards.

show no significant change from historical patterns. Agricultural water requirements are expected to increase due to rising temperatures, with dry climates potentially increasing irrigation water demand by 13 to 25 percent and wet climates by 2 to 11 percent, which could stress Mingachevir reservoir under the driest scenarios. Water supply in Azerbaijan could be further stressed by increased withdrawals in upstream countries, with a potential 8 percent decrease in inflows into Mingachevir if upstream withdrawals increase by fifty percent. Improving irrigation efficiency within the Upper Karabakh canal area could mitigate water stress from climate change and increased withdrawals, potentially improving delivery reliability and water productivity. The UKCWM model serves as a valuable tool for exploring the impact of future uncertainties and testing the effectiveness of management strategies and investment interventions, though the study suggests a need for broader climate scenario analysis and consideration of population projections and upstream water demand.

The WEAP model provides the opportunity to assess the impacts and benefits from implementing strategic actions, such as those recommended by the World Bank CCDR for Azerbaijan (2023). The World Bank CCDR for Azerbaijan (2023) concluded that an expansion of irrigation could place additional pressure on the country's water resources and might require increased water storage infrastructure capacity. Instead, it argues that increasing water efficiency is critical to meeting future water demand. There are significant discrepancies in water inflow data from different sources, which complicates water allocation decisions and the operation of large water reservoirs, especially considering Azerbaijan's dependency on transboundary flows.

Based on these elements, some key recommendations were formulated:

Policies: The top priority for the government in the irrigation and drainage (I&D) sector should be the rehabilitation and modernization of irrigation schemes both on-farm and off-farm. It is a precondition for subsequent management improvements. Azerbaijan should adopt a policy to reduce the future need for rehabilitation through improved maintenance at a satisfactory standard.

The I&D sector needs a comprehensive strategic plan or master plan that provides a multi-criteria prioritization, justification, methodology, and analysis of all investments proposed and specific modalities for implementation. At present, a world-class company is preparing an irrigation strategy, however, no information was shared with the World Bank team. The recommendations of this strategy will be crucial to guide the application of the WAT and WEAP models.

Operational aspects: The WAT and the WEAP model could be valuable tools to improve the country's planning and management of water resources. Still, it requires capacity building in water agencies in Azerbaijan for these models to become practical tools that inform policy formulations and planning of water allocation and investments countrywide. The establishment of an inter-ministerial team under ASWRA could be explored as a mean to integrate modeling tools as part of decision-making related to water resource planning and management. However, considering that the institutional framework of the water sector is under reform, an assessment on technical capacities within relevant institutions would be needed to make a more informed decision and develop a roadmap with clear responsibilities and roles, and recommendations on staffing, equipment and procedural changes as appropriate.

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7. Mr. Vugar Majidli, Head of the Department of Finance for Economic Sectors, MoF
8. Mr. Mehman Rzayev, Advisor Water, Minister of Economy, Member of Water Commission
9. Mr. Riad Akhundzada, Head, Strategy, International Cooperation and Science Department, ASWRA
10. Mr. Etibar Mammadov, Deputy Chairman, Azersu
11. Mr. Bahadur Kengerli, Head of Planning and Design Department, Azersu
12. Mr. Fuad Tahmazov, Head, Project Management division Azersu
13. Mr. Ferhad Heyderov, Head, Regional Department, Azersu
14. Mr. Eldeniz Sheydayev, Head Sukanal, Azersu
15. Mr. Elman Alaskarov, Specialist, Azercosmos
16. Mr. Rasul Rahmanov, Consultant, Ministry of Ecology and Natural Resource
17. Mr. Emin Musayev, Consultant, Ministry of Ecology and Natural Resource