Mainstreaming Climate Change related activities into the water sector of Azerbaijan

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Water Sector of Azerbaijan

The main problems in the water sector of Azerbaijan are characterized by the presence of broad range of stakeholders and a variety of problem causing issues. These problems are exacerbated by numerous shortcomings and gaps in both drinking water and irrigation water supply. Climate change is exacerbating droughts, floods and other related problems in a country that already lacks water resources.

Despite the implementation of numerous improvement projects, the water sector of the country can still be characterized by a general condition of degraded supply, with high pollution accompanied by excessive water losses in the distribution lines and canals. This is reflected in the increase in per capita water use, which appears very high in Azerbaijan by international standards.

Climate Change Impacts on water resources of Azerbaijan

Water resources of Azerbaijan

Estimates show that internal renewable water resources amount to about 8.12 km3/year (Table 2). Annual surface runoff is estimated at 5.96 km3 and groundwater recharge at 6.51 km3, of which 4.35 km3 constitutes the base flow of the rivers. The estimated incoming surface flow is 25.38 km3/year, of which 11.91 km3 originate from Georgia, 7.50 km3 from the Islamic Republic of Iran and 5.97 km3 from Armenia/Turkey. The total renewable surface water resources (RSWR), including incoming and bordering flows, are therefore estimated at 32.52 km3/year. In the case of the Kura and Araks Rivers, which flow through Turkey, Georgia, Armenia, the Islamic Republic of Iran and Azerbaijan, discussions are under way on a water sharing agreement. The four major river basins in Azerbaijan are:

1. The basin of the Kura and Araks Rivers is the largest basin in the country, forming the largest transboundary river system of the southern Caucasus. It originates in Turkey, and flows through Georgia and Azerbaijan into the Caspian Sea, while the Araks also crosses Armenia and Iran. The total length of the Kura River system is 1 515 km, of which 900 km is located within Azerbaijan. The total annual inflow of the Kura River from Georgia is estimated at 11.91 km3. The total inflow of the main branch of the Araks River and its

tributaries from Armenia and Iran is estimated at 13.47 km3/year, bringing the total inflow into Azerbaijan to an estimated 25.38 km3/year.

2. The Samur River Basin, located in the northeast of the country, forming the border with Russia. The Samur River rises in the Russian Federation and then forms its border with Azerbaijan. Its estimated annual discharge is 2.36 km3, less than half of which is considered to be available for Azerbaijan.
3. The Caspian Sea coastal river basins in the northeast, between the Samur and Kura River Basins.
4. The Caspian Sea coastal river basins in the Lankaran region in the southeast, south of the Kura River Basin.

Table: Azerbaijan's water resources

Renewable freshwater resources	
Precipitation (long-term average)	39 km^3/yr
Internal renewable water resources (long-term average)	8.12 km^3/yr
Total actual renewable water resources	32.5 km^3/yr
Water sources and use	
Water withdrawal (yr 2005)	
Total water withdrawal	12.2 km^3/yr
irrigation + livestock	0.9 km^3/yr
municipalities	0.5 km^3/yr
industry	0.2 km^3/yr
Surface water and groundwater withdrawal	12.2 km^3/yr
Non-conventional sources of water	
Produced wastewater	0.7 km^3/yr
Treated wastewater	0.2 km^3/yr
Reused treated wastewater	0.2 km^3/yr
Irrigation and drainage	
Irrigation potential	3,200,000 ha
Full or partial control irrigation: equipped area (yr 2003)	1,426,000 ha
surface irrig	1,302,000 ha
sprinkler irrig	149,000 ha
localized irrig	2,618 ha
Urban water supply (Baku)	
Baku water supply (from wellfields and reservoirs)	16 m^3/s
Storage / Reservoirs	
total capacity of operating water reservoirs	20.6 km^3
net storage volume	12.4 km^3
total capacity of hydroelectric power station (HPS)	979 MW

Climate change risks on the water sector

Water resources play a major role in the economy of the country. Annually 10,000-12,000 million m3 of water is taken from rivers for agriculture irrigation purposes. The volume and timing of water flowing within the rivers of Azerbaijan has a serious effect on all economic, agricultural and social activities in the country. In order words, any changes in volume of water or shifts in timing will deeply influnece the country's economic and social life.

All studies confirm that climate changes started to cause a reduction in the major rivers and water resources of Azerbaijan. Mainly, reduction is observed in winter rainfall and snow, as well as in spring rainfall. This also led to a decrease in both surface and ground water. According to the analyses after the First and Second National data reductions in river water resources continued.

Climate change influences is expected to stress water resources. Surface water is predicted to decrease by 23% from 2021 to 2050, and water resources are predicted to decrease by 29% from the baseline year (1960-1990) level from 2071 to 2100.

As a result of climate change, the demand for water is expected to increase against the background of a decrease in surface area. This will be primarily due to increased demand for water due to dry and hot weather. For example, very hot weather in the country's main irrigation areas indicates an increase in demand for irrigation water.

For the Azerbaijan two sets of climate changes can be roughly distinguished. The first set represents physical factors, which concern mainly agriculture and whose consequences include crops, land fertility, soil degradation and other related effects. In urbanized territories physical factors may manifest themselves as long-term water shortages and heat waves. The second set mainly includes socio-economic factors such as public health changes, increased frequency of diseases, forced migration etc.

Raising temperatures, combined with changes in rainfall will intensify the frequency and intensity of water shortages in the country. Country reliance on surface water can be dramatically affected as supply from river waters becomes more variable, and more demand is placed on other sources, such as groundwater, storm water and desalinated sea water. Given that climate change is also likely to negatively affect groundwater resources, the role of storm and desalinated waters becomes more important.

Combined with urbanization, climate change will further stress country's agricultural products, making them more vulnerable to pests, disease, and changes in species composition. Along with drier soils, land will experience more frequent and intense fires, erosion resulting in subsequent changes in vegetation, and eventually a reduction in the water supply.

Climate change will also influence water needs. Warmer temperatures will likely increase evaporation rates and extend dry seasons, thereby increasing the amount of water that is needed for the irrigation of many crops, urban landscaping, and environmental water needs. Raising temperatures will also affect household water use, considerably increasing demand in potable water.

The most important economic sectors and social patterns that deeply influenced by volume and timing of water resoruces are given in the next sections.

Agriculture

Currently, more than 90% of the country's agricultural output is taken from irrigated lands. The Agricultural sector of Azerbaijan is highly dependent on irrigation. Most of the territory of Azerbaijan has rather dry climate, and therefore, irrigation very important in the Kura-Aras plain that occupies nearly 40% of the country's territory. Other areas that largely depend on irrigation are Absheron, Nakhichevan, Shaki-Zaqatala and Ganja-Kazakh. All these districts produce important agricultural goods, like wheat, grape, cotton, fruits, and vegetables. More than 80% of agricultural output comes from irrigated crops.

Recently, water shortages in this area are the common issue that face farmers. Droughts with longer durations is linked to rising temperatures and reduced rainfalls in all afore mentioned regions. For example, 2014, 2016 and 2020 droughts have hugely affected on reduced agricultural production. Irrigated crops are accountable for 85 % of total agricultural output, which will also be at risk from projected water shortages, and higher temperatures increased irrigation to maintain yields. Due to climate changes, it is expected that there will be more need for water for agricultural production, which will cause adverse impacts on food security of children. The low output from agricultural activity and harvests will be aggravated by increasing temperatures and increased water stress.

Floods in the country affect lives of 200,000 people on average per year. E.g. in May 2010, more than 240,000 people were affected, with tens of thousands of homes flooded or destroyed and 50,000 hectares of farmland inundated.

The Water Industry

The water industry provides drinking water and wastewater services to residential, commercial, and industrial sectors of the economy. There are almost no natural water sources in densely populated areas of Azerbaijan. This requires flexible and well-developed water management in the country.

Clean drinking water is a challenge for most parts of Azerbaijan. The amount of water per unit area and per capita in Azerbaijan is less than its neighboring Georgia in 7.7 and 8.3 times, and in Armenia in 2.2 and 1.7 times.

The problem of drinking water is expected to worsen due to climate change. This problem has been exacerbated in the last decade by transboundary water withdrawals. As far as I know, more than 70% of Azerbaijan's water resources fall on the Kura and Araz rivers. Both rivers are formed mainly in foreign countries. The increase in the number of reservoirs built by neighboring countries on these rivers in recent decades has sharply reduced the water content of these rivers.

From this point of view, there is a shortage of both drinking and irrigation water in the Kura River in 2020 and in the lower reaches of the Kura.

As a result of the drying up of the Kura River in 2020, serious problems have arisen in the supply of drinking water in many parts of Azerbaijan, mainly in the Salyan and Neftchala regions. It should be noted that the drying of the Kura River was not observed in Azerbaijan until 2020.

The Kura and Araz are claimed to be one of the most turbid in the world, with high turbidity increasing the cost of treatment for drinking water. Sediment flows of these rivers are conspicuous, so that the water quality of the rivers requires large facilities to reduce sediment load near the withdrawal site and conventional treatment to meet drinking water standards. The Kura withdrawal sites were built just after the junction of the Kura and the Araz rivers.

About 80% of the houses in rural areas are not connected to centralized water and sewage networks. Waste water and sewerage systems are only provided in half of the secondary towns. Poor waste water management has created serious hardships in many of the towns, with sewage discharging through ditches into town irrigation systems or nearby streams. The problems are the similar in mountain and lowland areas.

The government has made notable efforts to improve water supply and sewage systems in the country. In 2017 a new water treatment plant for the city of Mingechevir has been built. In 2000, the centralized water supply system in Baku, covered only 1.56 million people, while in 2014 2.366 million people have access to running water. Because of various projects between 2011 and 2013, 600,000 more people have gained access to an uninterrupted water supply. Currently, seventy-eight per cent of urban Baku's population is continuously provided with running water. However, 2014 survey confirms that 90% of Baku families would still prefer to use bottled water, since tap water still does not meet basic quality standards. A considerable part of the Baku population still depends on Kura water. Nearly 25% of the Greater Baku area that has more than 4 million of residents are supplied by water withdrawal facilities located in a downstream part of the Kura river.

Hydropower

Although nearly 10 percent of the country's production is of hydroelectric origin, the use of hydropower potential in the future is not important, and the potential for mitigation in this sector is not large. Accordimg to the Thrid naitonal Ocmunicaiton to UNFCCC , between 2021 and 2050, compared to the baseline years (1960 to 1990), the volume of reservoirs in Azerbaijan is expected to fall by 23% (22.5 km3) and, between 2071 and 2100, reservoir volumes are expected to fall 29% compared to the baseline period.

Currently, hydropower production accounts for only about 10 percent of total energy production. The main hydropower facilities are located on the Kura and Araz rivers. At present, only 20% of the potential of hydropower facilities on these rivers is used. Currently, the amount of water in both the Kura and Araz rivers continues to decline, mainly due to the influence of two roads. The

first factor is the construction of large reservoirs in the upper reaches of these rivers, mainly in Turkey and Georgia. The second effect is the decrease in water content against the background of climate change. Climate change will also increase the demand for water in the river basins, which will further reduce river water and severely damage the hydropower potential.

The hydropower potential of the country's small rivers will also decline due to climate change and increased water intake. For example, the decline in water in the Greater Caucasus rivers, which have faster flow and energy, will be due to both increased demand for water and the effects of climate change.

The total reservoir capacity of Azerbaijan's dams is around 21.54 km^3. Most of this capacity, 21.04 km^3, comes from large dams, of more than 100 million m^3 each. The four largest reservoirs are the Mingacevir and Shamkir on the Kura River, the Araks dam on the Araks River, and the Sarsang on the Terter River, in Armenia. A full overview of the larger dams is provided in Table 3.

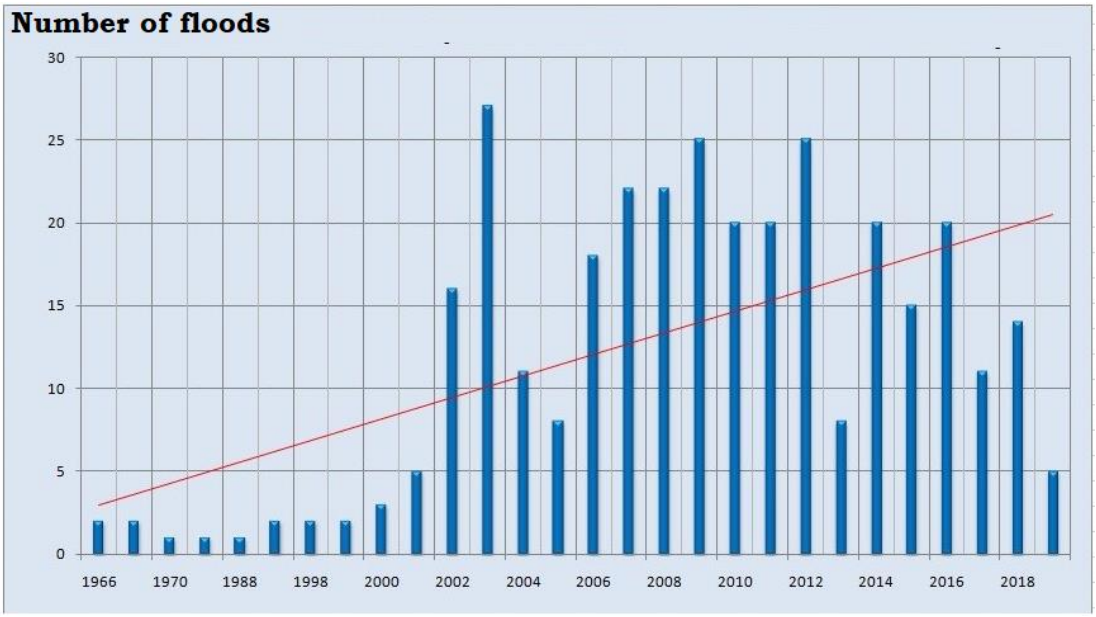
Table: Characteristics of reservoirs that have HPP

#	Water reservoir	Area, km^2	Capacity of reservoir, km^3	Installed capacity of HPP, MW	Maximum Area of irrigated lands, ha
1.	Mingachevir	605	15.73	402	970000
2.	Shamkir	116	2.68	380	46,000
3.	Yenikend	23.2	1.58	150	6000
4.	Varvara	22.5	0.06	16	-
5.	Sarsang	14.2	0.565	50	120000
6.	Araz	145	1.254	22	400000
7.	Bilav		0.1	22	-
8.	Vaykhir		0.1	5	16800

Floods

There are many water-related natural hazards in Azerbaijan. The most common of these natural hazards are floods and droughts. Floods are observed in both small and large rivers in Azerbaijan. Due to the destructive nature of these floods, the strongest are the floods observed in the Kura and Araz rivers. The Kura and Araz always go out of their way and press the Shirvan, Mugan and Mil plains. As a result of the floods, the coastal villages of Salyan, Neftchala, Sabirabad regions and the coastal areas of Shirvan city, located in the coastal zone of the Kura, were flooded. As a result, the above mentioned names of major economic obyektləri dasıyan olunan areas is important respublika, fermer təsərrufatlarına productive areas that are owned, yard-yanı areas and remains the evlər under water, disease and epidemiya sources of hazardous ponds kicik sayılan malyariya source is created.

Floods observed in small rivers occur mainly in the Greater and Lesser Caucasus. The most destructive of these floods are the floods on the southern slope of the Greater Caucasus. Kish, Shin, Girdman, Demiraparan rivers are the main sources of floods. Climate change increases the duration and peak of these floods. Floods in these mountain rivers are mostly in the form of mudflows and debris flows. During these kind of floods, more than 70-80% of the river flow is made of solid materials. Mudflows and debris flows are the transport of solid materials, mud and stones that have been eroded in the basin for a long time, along with water.



Mainstreaming climate changes into the water sector of Azerbaijan

Climate change has different effects for different countries, and therefore adaptation to climate change must take into account the climatic conditions of the countries.

The impact of climate change on the water sector of Azerbaijan, which has a dry climate, will be all-inclusive and wide ranging. This will be reflected not only in the reduction of available water, but also in sharp changes in timing of natural supply. This, in turn, will lead to a further increase in the duration of floods and droughts, a decrease in natural regulation, a violation of the principle of operation of existing water facilities and, consequently, the deterioration of water sector services, including water supply, irrigaiton and sanitaiton.

These extreme natural phenomena are expected to be more severe as a result of climate change, as both floods and droughts are typical for climate-changing countries such as Azerbaijan. In

other words, the adaptation strategy for climate change in Azerbaijan, which will increase the frequency of both floods and droughts, must take into account both "low water" and "high water" options. Intermittent adaptations are necessary to manage with variations happening in between these two extreme states of water availability. By adaptation to climate change, we mean preparing for the extreme events listed above by addressing the vulnerabilities in the water sector. For example, aadaptation to too much water intends to reduce vulnerability from floods, debris and mudflows, while adaptation from low water intends to reduce vulnerability from droughts, water shortages etc. Proactive actions to flood and drought hazards include long-term preparation activities, building of reservoirs, implementing integrated water management etc.

Both floods and droughts may cause serious disturbance in work of water supply facilities and increase vulnerabilities of water users and farmers. Climate Change related hazards that pose serious disasters can be managed though actions of people and communities. Strengthening of water sector management, institutions enable communities and people to cope with various types of climate related hazards easily.
The development process, on the one hand may reduce risk for these kinds of hazards, but on the other hand changes in land use planning, for instance, may increase vulnerability of the water sector.

Climate Change Mainstreaming

Climate change mainstreaming, in the context of climate changes is the practice of supporting communities through risk conscious land planning and development. This means that regular development process takes into consideration all climate related disaster risks, reducing level of an exposure in a particular area. Political desire, correct water management and strong water sector institutions are essential to climate change mainstreaming.

The mainstreaming of climate changes into the water sector should address all the challenges posed by climate change. In Azerbaijan, these problems are primarily water shortages and floods, as well as difficulties that may arise in irrigation and drinking water supply. Overcoming these difficulties and adapting to them is the main goal of mainstreaming. Taking into account these issues, mainstreaming should be mainly aimed at solving the following problems:

1) Implementation of comprehensive structural measures to reduce flood risks in both large and small rivers

2) Implementation of water saving, water loss reduction activities to solve the problems of drinking water and irrigation water supply

The mainstreaming should be integrated into all sectors of economy. The key directions, where mainstreaming must be penetrated are, industry, tourism, agriculture, infrastructure, education, environment, housing and health. Water management, land use planning, gender issues, health issues, climate change adaptation is also main directions for mainstreaming.

Despite the permanent efforts of the government, poverty remains as one of the main root causes of vulnerability for rural population. According to the Second National Communication to UNFCCC, over the last 20 years, manifestation of climate change induced phenomena increase vulnerability even more. In several villages constricted dams and protection walls are gone due to flash floods. This makes basic living conditions in villages below the average country level.

Implementation of the State Program on Poverty Reduction and Sustainable Development in the Republic of Azerbaijan for 2008-2015 resulted in supporting overall economic stability in the country. This ensured economic growth and stability. Many types of private business have been involved to the development process. Agriculture and tourism were the main directions of development. Recently, tourism, food industry and processing of agricultural goods are being represented by several big enterprises. Development of the tourism sector enabled to create new working places in the district and gave prospects for further development. Support of agricultural sector increased income for population, ensuring poverty reduction.

However, these activities did not take into account the future effects of climate change on the water sector and built a water infrastructure using a traditional approach.

Climate risks and identification of potential GHG reduction

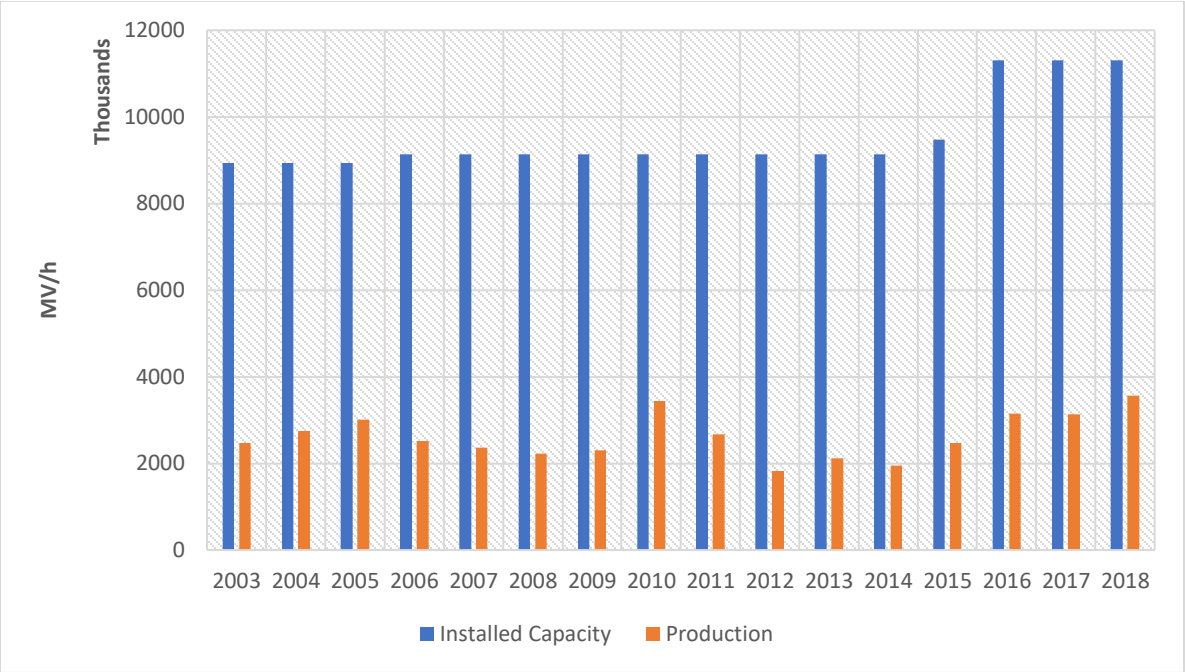
Relative to other renewables, hydropower takes a special place in Azerbaijan's renewable energy budget and has great mitigation potential. At present, only 8% of the energy produced in Azerbaijan is generated by hydropower plants. The energy produced does not coincide with the existing capacity and is much lower than it is.

In 2017 Total installked capacity of all Hydropower was 1 131 MW in 2017, while electricity production was only 358 MW. In other words, only 50% of the total capacity is used to produce electricity in hydropower sector. Biggest hydropower resources are located in Kura and Araz rivers, also rivers directly flowing into the Caspian Sea. Additional hydropower resources are located in the Tartar and Hakari rivers, however, due to military conflict, there resources are not used currently. Seasonal conditions affect hydropower generation, which has fluctuated from a peak of 1 959.3 GWh in 2016 to a low of 1 299.7 GWh in 2014.

Azerbaijan also has a well developed small hydropower generation sector (comprising the Sheki, Mughan, Zeykhur, Gusar, Nyugedi, Chinarly, Balakan, Guba and Zurnabad power plants) with the presence of independent power producers as well as auto producers generating power for consumption in their own facilities.

Figure illustrate difference between installed capacities and real production in the main hydropower generations in Azerbaijan. As sees from the picture these differences are huge and reflect non proper use of hydropower capacity in the country. Productivity is affected with broad range of factors such as

Figure. Comparison of total actual productions and total installed capacity of HPP 2003-2018



The current situation shows that there is a huge gap between existing production capacity and real production. In other words, by reducing this gap, we can make better use of renewable energy sources.

The potential of small hydropower plants in reducing greenhouse gases in the energy sector is huge. Although climate change has negatively affected the energy potential of small rivers, the great potential of small rivers still remains. According to the State Agency for Alternative and Renewable Energy Sources, the energy potential of small rivers in the country is 350 MW.

Structural Adaptation in water sector of Azerbaijan

The water sector of Azerbaijan did not undergo key rehabilitation work since the early 1980s and is in urgent need of complex changes, repair or replacement. Most problems were related to incomplete design, outdated network materials and construction methods, and compounded by insufficient maintenance, repair and rehabilitation. Most engineering studies have concluded that without additional investment, the quality of the water supply will rapidly deteriorate.

Until the early 2000, the Ministry of Amelioration and the Ministry of Energy were in charge of water resources management, while the Ministry of Geology was in charge of groundwater management and the Ministry of Health monitored water quality. At the same time there was not clear division of functional responsibility among these organizations. Since 2000s, the water

sector in Azerbaijan has met with several problems arising from the effects of transition. These problems include both institutional and management concerns, since until 1992, the economy of Azerbaijan had been based on a centralized planning economy, where market mechanisms were very weak or completely absent.

The main legacy of the Soviet and the transition period for the water system can be identified in a general condition of degraded irrigation and drinking water supply, with high pollution accompanied by excessive water losses in the distribution networks. Tariff levels are also insufficient to cover operation, maintenance and replacement costs and lower than international standards. The current system provides little or no incentive for water users to conserve water, reduces water available in other parts of the network, and imposes higher operational costs on the systems.

Old and inefficient irrigation methods in agriculture are also a major factor in large-scale water losses. Although many programs to restore this approach have yielded some results, much remains to be done to address shortcomings in distribution systems and water use.

In order to formulate structural adaptation steps in the water sector, a range of factors need to be considered because existing water infrastructure in Azerbaijan have limitations, such as inflexible and single-purpose architecture and less adaptive operation and management. In addition to these preliminary coping steps, adaptation needs to be systematically seen as a long-term priority as a mechanism, as climate change would have long-lasting and far-reaching impacts.

The main structural adaptations in Azerbaijan are to protect against extreme water-related events. These extreme events are characterized by both high and low water. Too much water means floods, and too little water means droughts and water shortages. A key harmonization strategy should reduce disparities between these extremes and serve to achieve better water management.

In this regard, structural adaptations should be understood as increasing the preparedness of the infrastructure for events such as floods and droughts in the water sector.

Infrastructure preparation for floods consists mainly of improving dams, bridges and roads around the river. At the same time, relocating or increasing the protection of houses built around rivers and in dangerous areas should be one of the main measures to be taken.

The table provides information on structural adjustments, their purpose and responsible organizations related to floods and water shortages in the water sector of Azerbaijan (table).

Table. Structural Adaptation measures in a water sector of Azerbaijan

Climate Change impacts	**Specific measures**	**Adaptation functions and/or co-benefits**	**Places that are very important to implement**	**Responsible organizations**
Increased flood risk	Construction of Early warning systems			
Increased flood risk	Strengthening dams around rivers İncreasing water holding capacity of reservoirs Reforestation in basins İmprovment of roads Flood risk zonings	Prevention of floods İncreasing water carrying capacity of river channels	Small rivers of Great Caucasus (Kish, Shin, Damiraparanchay, Goyçay, Girdman, Ağsu rivers)	MoES Azmelioration Local government Local municipialities
Increased flood risk	Designing retention areas	Release of flood water during floods	Kura and Araz river downstream areas	MoES
Increased flood risk	Construction of buildings away from flood prone places	Flood risk reduction	Flood prone areas	Local municipialities Urban and rural residents
Increased drought risks	Construction of infrastructure to reduce water losses in irrigation Making paved canals in irrigation network	Adaptation to droughts and water shortages	Central Aran of Azerbaijan, al irrigated areas	Azmelioration
Drinking water shortage		Prevention of water losses in water supply network		Azersu Local Municipialities
Drinking water shortage		Application of water-saving techniques at home	Cities and villages of Azerbaijan	Local communities Urban and rural residents

		Vacuum and pressure assisted toilets Water saving shower heads		Business representatives
	Contraction of sea water desalination stations	Non-conventional water source		Local communities Local municipialities Azersu

Non-structural Adaptation in water sector of Azerbaijan

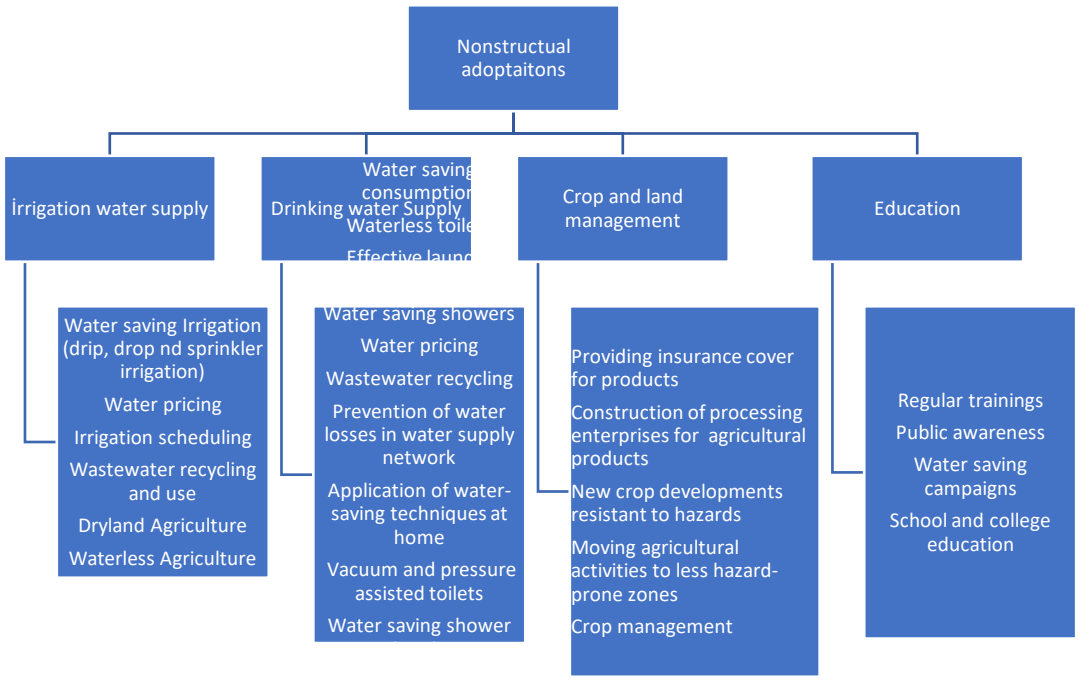
Unlike structural adaptation, non-structural adaptation does not involve any construction or infrastructure work, but rather improves management within the existing infrastructure.

Non-structural adaptation targets water demand and supply by management adjustments of water users and improve water control systems. These possibilities constitute a range of non-traditional elements as shown in Table which include investing in water users in water management, water pricing, water allocation, water scheduling, water restriction, water marketing and recycling of water. Nonstructural adaptations may comparatively be cost effective than structural adaptations. However, putting non-structural and structural adaptations against each other is not the right approach. On the contrary, the simultaneous application of both approaches gives better results in adapting to climate change. Such approaches should apply to both the drinking water and irrigation sectors.

The role of secondary and higher education in increasing public literacy and adapting society to climate change is also great. The integration of climate change into the school curriculum and the holding of additional classes on effective management of the environment and water resources in universities are among such activities.

The following diagram shows the main directions of non-structural adaptation to climate change in the water sector.

Figure. Non-structural adaptations in irrigation and drinking water supply



In Azerbaijan, where irrigation covers more than 80 percent of food production, the widest and most comprehensive activities should be carried out in the agricultural sector. Possible harmonization measures in agriculture cover a wide range and are shown in the table below.

Table. Nonstructural adaptation activities in agricultural sector of Azerbaijan

Specific measures	**Adaptation functions and/or co-benefits**	**Areas to be implemented**	**Available agricultural products**	**Responsible organizations**
Rainfed agriculture	No need in irrigation. Relies on rainwater	Medium and high mountainous areas	Grapes, tomatoes, pumpkins, beans, and other summer crops.	MoA Azmelioration Local communities Farmers
Dryland/waterless Agriculture	No need in irrigation. Relies on rainwater	Foothills and medium mountain areas	winter wheat, maize, beans, sunflowers, grapes, lavandula	MoA Azmelioration Local communities Farmers
Waterless Agriculture	No need in irrigation	All mountain areas	,	
Water Efficient irrigation (Drip, drop, sprinkler etc.)	Water use reduction	All irrigated lands	All agricultural goods	MoA
Recycled water use	Water saving	All irrigated lands	All agricultural goods	MoA
Collector-Drainage water use	Non-conventional water source	Central Aran	Salt tolerant agricultural plants	MoA

Water desalination	Non-conventional water source	Coastal areas and areas close to drainage collectors	All agricultural plants	Local farmers, MoA, local municipialities
Rainwater Harvesting	Non-conventional water source	All areas	All agricultural plants	Local farmers, MoA, local municipialities

Integrated Water Management

Manistreaming of climate changes into the water sector requires successful coordination of stakeholders in water management. Stakeholders in irrigation water, drinking water, flood management, and hydropower production may often have difficulty coordinating with each other. For example, full supply in one sector can cause problems in another. From this point of view, the situation in Azerbaijan is more complicated and there is a serious need for integrated use of water resources. Integrated use is an approach that takes into account the interests of all parties and requires close coordination between the parties.

In Azerbaijan, integrated water management assumes a special significance for three orders of reasons. First, the availability and management of water resources are critical because of natural conditions: low precipitation levels, high evaporation, a complex intermingling of water sources of several types and origins. Second, demographic pressure is especially high due to explosive urban growth, but also to continuing importance of agricultural and industrial activities, all heavy users of water and all to a large extent responsible for increasing pollution. Third, water resources have been mainly developed in the past to accommodate the increasing population and economic activity, with no attention to environmental deterioration, climate changes and recreational uses of water.

Integrated Water Management planning offers a framework for water managers to address water-related challenges and provide for future needs. Formally, IWM provides reliable water supplies at lowest reasonable cost and with highest benefits for economic development, environmental quality and other societal objectives. IWM also consider right and needs of all types of water users providing equal, need based and fair water supply for all of them. A proper IWM approach can not only take into account the risks associated with climate change, but also provide a better management of these risks. In this case, using all possible options, the distribution and allocation of water is carried out in such a way as to save water and ensure its efficient use.

Several water users can be identified in a water sector for water use in Azerbaijan, with various types of needs and requirements. They may be ranked according to the importance and needs, quality and quantity of water supply:

1. Residential water users. They include households, hospitals, offices and the enterprises of food industry, where water is required for baking, drinking and washing purposes. Public health closely depends on water used by these types of consumers and therefore, high quality

of water is required. Suppliers are required to maintain consumers with highest quality of water that meet international health standards and without interruption. Currently, nearly 10 million of consumers who need 24 hours of water supply 7 days a week.Industrial water users.

2. The growing economy of Azerbaijan requires increasing amounts of industrial water, mainly for cooling and washing. While industrial water need not to be of high quality, some technical standards should be met. Recycled wastewater with average quality can be a good source for industrial water users.
3. Recreational water users. Recreational resources users include individuals, hotels, resorts, sanatoriums, and rest homes. In 2019 nearly 2 million of tourists attended aforementioned places all over Azerbaijan. Top destinations include Baku, Gabala, Sheki, Guba, Lenkoran and Goygol cities.
4. Agricultural water users. Agricultural water users are mostly farmers and are one of the most important categories of water stakeholders in Azerbaijan. The water is being used mostly for irrigation. In addition to water taken directly from water sources, agricultural water users also have access to treated wastewater and relatively saline collector-drainage water.

Current water related institutional situation

The stakeholders involved in the water resources management in the territory of the Republic of Azerbaijan include state, non-state, and local self-governing institutions.

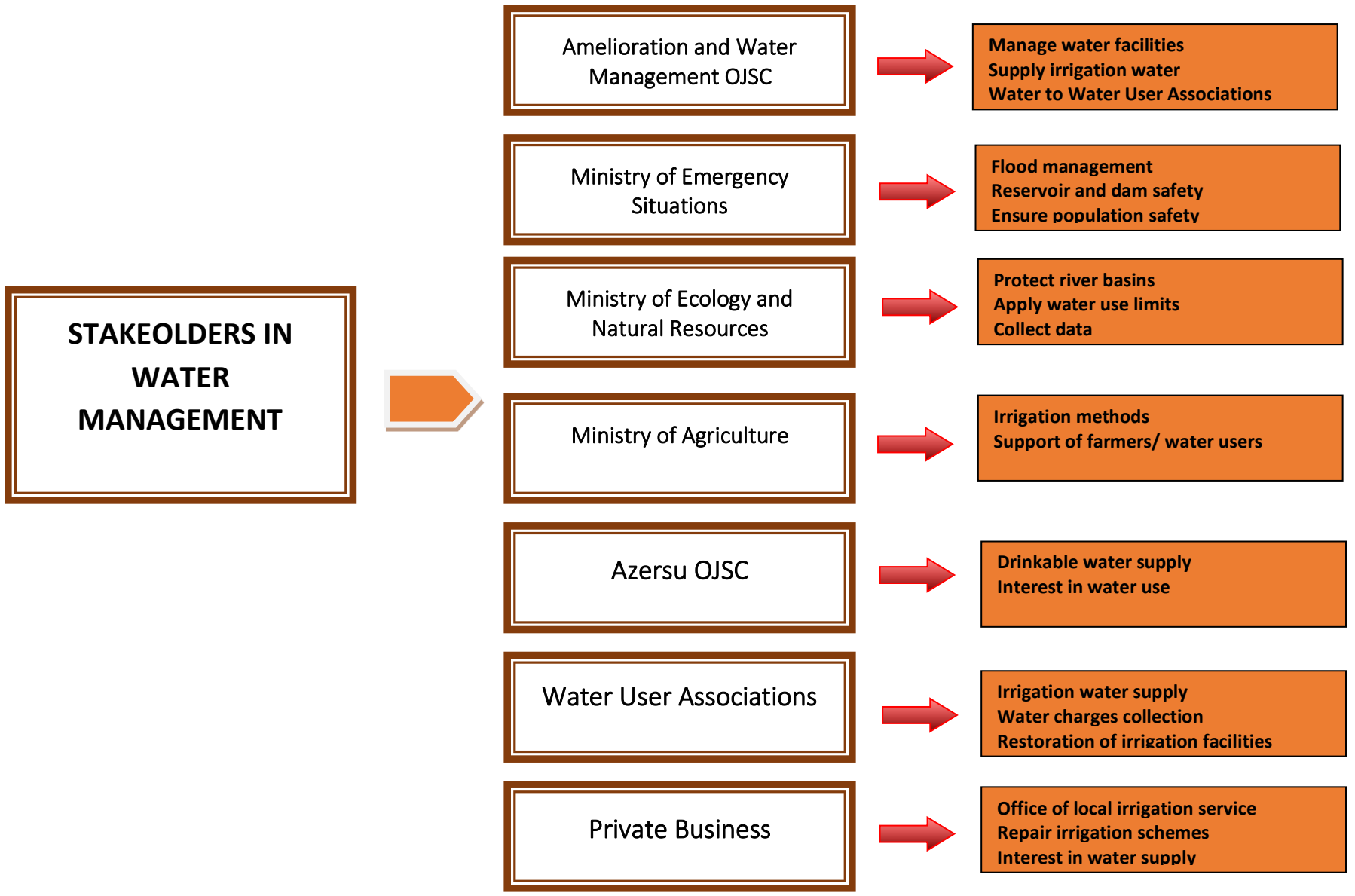
The institutional situation in Azerbaijan is characterized by independently operating ministries and entities that form a group of water related stakeholders with very limited coordination, mostly on an as-needed basis only. These include:

- Azersu Open Join Stock Company
- Amelioration and Water Management Open Join Stock Company
- Ministry of Agriculture
- Ministry of Ecology and Natural Resources
- Ministry of Emergency Situations with its State Agency for Water Resources Management
- Azerenergy OJSC
- Municipalities
- Water User Associations/Farmers
- Private Business Water Users

Highest water demands exist for irrigation water with the timing of the demand overlapping, but not sufficiently being covered by the high river flow season as the high-water season ends in early July. Further high demand is for hydropower water with year-round need for discharge to drive the turbines. Due to the variable nature of the runoff, conflicts may arise not only between

hydropower demand and irrigation demand as direct large competitors over the water resource but also between irrigation and other water users. E.g. in years of low flow Azerenergy may be concerned of insufficient reservoir filling if water is diverted for irrigation. A constant conflict further arises between the hydropower demand for filled reservoirs and the flood protection demand for empty reservoirs and respective space for flood water retention.

The diversity in the activities of the organizations is aimed at supplementing one another's work. Each organization fulfils different functions, although a similarity is observed in their operations. The following chart provides a brief summary of the key stakeholders in the use of water in the Republic of Azerbaijan and their work.


STAKEOLDERS IN WATER MANAGEMENT
Amelioration and Water Management OJSC
Manage water facilities
Supply irrigation water
Water to Water User Associations
Ministry of Emergency Situations
Flood management
Reservoir and dam safety
Ensure population safety
Ministry of Ecology and Natural Resources
Protect river basins
Apply water use limits
Collect data
Ministry of Agriculture
Irrigation methods
Support of farmers/ water users
Azersu OJSC
Drinkable water supply
Interest in water use
Water User Associations
Irrigation water supply
Water charges collection
Restoration of irrigation facilities
Private Business
Office of local irrigation service
Repair irrigation schemes
Interest in water supply

Amelioration and Water Economy Open Joint Stock Company

Amelioration and Water Management Open Joint Stock Company (Amelioration) is the key state institution responsible for provision of water supply to the agricultural bodies and amelioration of lands. Except large water reservoirs, all the existing irrigation schemes, distribution channels, collector-drainage networks in the country are in the management of this institution. The institution also deals with irrigation schemes that are under construction now. In most regions, the departments responsible for irrigation channels and collector-drainage networks operate separately. The organizational structure of Amelioration is quite complicated and sometime parallelism is observed in the operation of its departments. The Irrigation Systems and Mechanical Irrigation Offices (ISMIO) deal with the provision of farmers with water supply. The ISMIOs ensure delivery of water received from main channels and other water resources to the Water User Associations. Sub-artesian Wells Operation Offices (SWOO) raise the ground water to earth surface with mechanical method for farming areas, and deals with the operation, repair and restoration of sub-artesian wells and electricity and mechanical equipment. The water supply of winter pastures is dealt with by the Winter Pastures Water Supply Systems Operation Offices. The work f the collector-drainage systems is controlled by Melioration Offices. The structure of Amelioration is not based on area principle. Only mechanical irrigation offices operate in most regions.

Ministry of Ecology and Natural Resources

The Ministry of Ecology and Natural Resources (MENR) is the central body of executive power that realizes the state policy on the protection of environment, organizing of the use of nature, efficient use and restoration of surface and ground water resources, the observation and forecasting of hydrometeorological processes in the Republic of Azerbaijan. The rules on protection of water bodies, prevention of their contamination, pollution and exhaustion, as well as improvement of water quality and regime are established by MENR.

MENR is also in charge of protection of forest resources, their efficient use, restoration of fallen forests, establishment of new forest strips.

With the goal to keep the water bodies in line with ecological requirements, prevent the pollution of water bodies, as well as maintain the environment settled by animal and plants world, MENR determines water protection zones and water protecting wood strips, applies acceptable norm of harmful impact on water bodies, and determines the ecological water discharges below water reservoirs.

MENR implements permanent environmental monitoring on the water bodies to protect water bodies. The permanent hydrological observations aimed at studying the regime of water bodies

are also implemented by National Hydrometeorology Department of the MENR. At the same time, MENR can also determine ecological flows to prevent too much water intake. Most of the environmental data are collected and archived by this institution.

Azersu Open Joint Stock Company

Azersu Open Joint Stock Company (Azersu) is an only company in Azerbaijan that is in charge of providing drinkable water and sewage services in Azerbaijan. Azersu is also the only institution that implements state policy and strategy in the field of potable water supply. Azersu deals with withdrawal of water from the water sources, its processing, transportation and sale and treatment of wastewater. It deals with design, construction and operation of water treatment facilities, reservoirs, pumping stations, water pipelines, sewage collectors, and provides maintenance. This institution currently provides water supply to 1,171,065 subscribers with drinkable water. 1,132,575 of this represent population, and 38,490 - non-population consumers. The balance of the institution includes water lines with a length of 17,265 km, and sewage and rainwater lines with a length of 3,050 km. This organization has rather large budget and resources.

Ministry of Agriculture

The Ministry of Agriculture of the Republic of Azerbaijan is a body of executive power that forms and implements state policy in the field of agriculture. The Ministry also provides practical assistance to local executive structures in conducting agrarian reforms. This institution has exclusive authorities in organizing of breeder, quarantine and sanitary measures.

The Ministry is an institution that might also be interested in the application of modern irrigation methods to increase the productivity. It cooperates with international organizations in different spheres. Its partners include UN's Food and Agriculture Organization, UN's International Fund for Agricultural Development, USAID, International Centre for Bio saline Agriculture (ICBA) and multiple organizations. These organizations work closely with farmers through the Ministry and provide different types of assistance in correct growing measures. For example, ICBA has implemented several successful projects on planting in saline lands.

Except a few exclusions, the Ministry of Agriculture has no notable activity in application of modern irrigation technologies in a dry country such as Azerbaijan, whereas proper irrigation is the key factor that enhances productivity and maintains productive lands.

The irrigation is the key component underlying the basis of productivity in vegetation. Correct irrigation allows to use water efficiently, prevents salinization and considerably increases productivity. In this view, a close cooperation can be built with the Ministry of Agriculture (MA).

Ministry of Emergency Situations

The Ministry of Emergency Situations (MoES) is entitled to reduce the risks of water-related natural disasters, flood and flash floods, landslides, avalanche, drought, forest fires, to manage them during emergency situations and apply emergency zone when necessary.

Currently, MES only controls the work of large water bodies and takes measures to prevent possible natural disasters. Mingachevir water reservoir, Shamkir water reservoir and other large water facilities have been attached to the balance of MoES. However, no water body located at this area is in the balance of the M0ES. All amelioration and water economy facilities are planned to be attached to the balance of the MES State Agency for Water Resources in future.

Water User Associations

Water User Associations (WUA have been established in accordance with the law of the Republic of Azerbaijan on Amelioration and Irrigation. The main goals of these associations include the following: ensure efficient use of irrigation schemes; collect water charges; solve disputes erupting among the users.

After collecting the water fees from farmers, the WUAs transfer little part of them to Amelioration, and the rest of the funds are spent to treat local irrigation ditches and channels and build new irrigation ditches. In a number of regions, some problems emerge in the operation of the WUAs due to the fact that farmers are not willing to pay water charges. In a number of cases, WUA employees face challenges in proper management of these funds as well. Sometimes the budget of WUAs lacks transparency.

It should be noted that the farmers are not sufficiently aware of the goals of these associations. Even WUAs' coordinating employees are sometimes unaware of the goals of this institution. Although WUA members are elected by water users, these elections assume perfunctory nature in most cases.

The key problem of WUAs in the region is that they do not have sufficient material and technical base. Unlike ISMIOs, these institutions do not receive state support and their budget is formed by a little part of collected water charges. Therefore, the WUAs cannot sufficiently meet the interests of water users.

Local Municipalities

State-owned water economy facilities of local importance that are located in the municipal lands, are under the ownership of the municipalities. The use and management of these facilities is governed by the law of the Republic of Azerbaijan on water economy of municipalities. According

to this law, the municipalities can create water economy enterprises to operate water economy facilities that are in their balance. The treatment of irrigation systems that are in the balance of municipalities, the maintenance of the collector-drainage networks are also in the responsibility of the municipalities. Besides, the municipalities can organize the management of the water bodies that are under their ownership, and develop different action plans to ensure protection of water bodies. For example, the municipalities can determine water intake points in the water bodies, establish special ban zones and create water protecting wood strips.

The budget of municipalities is underlain by local taxes and they are not able to receive considerable amount of funds from state budget. Serious problems emerge when local taxpayers are weak. The weakness of the budget of municipalities reduces their financial strength and therefore they fail to effectively manage the water bodies in their balance. Therefore, the municipalities play no role in the management of irrigation systems that are in the municipal areas. The water budgets of municipalities and communities are formed thanks to non-periodical collections of funds. That is, necessary money to solve any problem is voluntarily collected by community members.

The Law of the Republic of Azerbaijan on the Water Economy of Municipalities allows the municipalities to create small irrigation offices in their territories. These small irrigation offices might make it possible to solve water economy problems of farmers located at the lands with municipal ownership, or those that are in the territory of municipality from administrative viewpoint. Although the current WUAs are in close touch with AWE, it would be better if they closely cooperate with municipal structures. The adjustment of the operation of WUAs with municipalities might have a positive impact on the settlement of gender problems and election of WUA representatives.

Small farmers

Small farmers represent the most sensitive and vulnerable layer among the water users. According to various data, the area of the lands of small farmers, vary between 1-6 ha. The main layer that needs assistance in irrigation work is the small farms, and the measures taken together with other institutions are aimed at providing assistance to small farmers. The main work of the local executive structures is to provide state support to farmers. For example, the executive structures of villages operate together with the Ministry of Agriculture in granting state subsidies to farmers, cheap fuel sale, delivery of fertilizer and providing other services.

WUAs are originally created at the initiatives of farmers and elected by association members. But the farmers have no direct impact on the operation of WUAs.

Recommendations on mainstreaming climate into the water sector

Climate change is expected to have a significant negative impact on Azerbaijan's water sector and the country's drinking and irrigation water supply. These effects will primarily lead to an increase in water-related natural hazards and a shortage of irrigation and drinking water. Given current infrastructure and institutional framework, it can be concluded that these dangerous events can lead to natural disasters. This requires comprehensive and large-scale activities in the water sector, which can include:

1. The climate changes issues should be included into the legal framework
2. Significant steps should be taken to improve institutional governance in the water sector, and appropriate structural and non-structural adaptation strategies should be developed.
3. As a structural adaptation, the water infrastructure must be rebuilt and made ready to deal with impending natural hazards.
4. The water infrastructure needs to be upgraded to prepare for flood management
5. Given the expected shortage of water, water losses in both drinking and irrigation water supply should be prevented.
6. Water saving technologies both in irrigation and drinking water use should be implemented
7. Both structural and non-structural updates should be made to allow the application of new irrigation methods in agriculture.
8. Multilateral activities should be implemented to save water in large cities and settlements.
9. Cultivation of agricultural crops with low water demand should be started
10. Management changes should be made to increase the efficiency of both irrigation and drinking water supply.
11. Action plans should be developed and implemented to ensure the transition to integrated water management
12. The most important activities need to be undertaken to increase awareness of climate change, both at the community level and in the education sector.
13. Hydropower potential of existing Hydropower dams is several times more than actual production. Hydropower potential of Hydropower plants should be used properly and would increase contribution of hydropower to the energy sector
14. Small hydropower dams should be used in mountain rivers. This would increase potential of Hydropower sector.

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