# WATER INFRASTRUCTURE OF KURA RIVER BASIN WITHIN AZERBAIJAN

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**ABSTRACT**

Lack of rainfall or irregular spread (in time and place) of rainfall is the cause of wide spread irrigation using surface water from the Kura and main tributaries. Irrigation water management has significant economic implications in Azerbaijan. The water is therefore mainly collected in reservoirs before piping to the irrigated areas. Water resources of Azerbaijan are very limited. Average annual water deficit in the republic is 4,75 $km^3$. In the recent years, in Azerbaijan, in connection with agrarian reform and especially due to an existing deficit of water resources, about 30-40% of irrigated lands are not used. In this paper an overview of water infrastructure in Azerbaijan is presented.

**Keywords:** reservoirs, irrigation channels, drainage systems, water use.

## Introduction

The Kura-Aras basin is the region of ancient irrigated agriculture. In Mill Steppe in Azerbaijan the traces of large irrigation canal, which was constructed in IV-VI c.c. are well preserved. A lot of traces of ancient irrigation are found in Mugan, where the routes of many irrigation canals are distinctly preserved. The irrigated agriculture in the past century was focused in lower courses of the rivers Shirvan, Karabakh, as well as along the banks Kura and Aras.

Due to the fact that the irrigated lands are located in lowland-arid zone, characterized by hot climate, scanty precipitations (200-300 mm per year) and complexity of soil-climate conditions, receipt of big crop requires regular performance of irrigation-melioration activities, their perfection and increase of their effectiveness.

Irrigation has unavoidable and most often undesirable downstream effects. Annual runoff of the Kura into the Caspian Sea has decreased by about 15-20% when compared to the pre-irrigation period.

**Reservoirs**

The construction of artificial reservoirs was commenced in the first half of the last century. The largest irrigation water reservoir (Mingechevir) was constructed on the river of Kura, in 1953. Irrigation water for fields was withdrawn from downstream pool of the reservoir by two mainstream channels: the Upper-Garabagh channel and Upper-Shirvan channel. Later on, 56 water reservoirs (with capacity over 1 million $m^3$), including 48 water reservoirs in the basin of the Kura River, were put into operation. Among them, there are twenty water reservoirs with the capacity from 1 million $m^3$ up to 10 million $m^3$ (total capacity 94.2 million $m^3$ ); the capacity of eleven reservoirs varies from 10 million $m^3$ up to 100 million $m^3$ (total capacity 258.5 million $m^3$), and the capacity of eight reservoirs is 100 million $m^3$ (total capacity 20.850 million $m^3$).

The existing water reservoirs are located both on rivers (in-channel reservoirs) and outside of rivers (off-river reservoirs), water storage of which is replenished by means of channels diverting water from sources. Nowadays five water reservoirs (Mingechevir, Aras, Shamkir, Yenikend and Sarsang) operate fully for both power generation and irrigation purposes. The first hydroelectric power station and Varvarin reservoir was constructed in 1950-1952. Other reservoirs in the Kura river basin serve the irrigation.

The river of Aras plays an important role in the water supply of the Kura-Aras lowland, especially of Mughan and Salyan steppes (with total areas of 417 thousand ha and 149 thousand ha, respectively).

For the partial elimination of irrigation water shortage in the river of Aras (near Nakhchivan), the hydro system «Aras» was constructed and put into operation (1971) accoding to the treaty between the former USSR and Iran. The total capacity of water reservoir is 1.35 billion $m^3$. At the same time near the village of Goradiz, Fizuli district, the Mil-Mughan water-intaking dam was constructed.

It is necessary to point out that due to occupation of Sarsang reservoir with 560 million $m^3$ capacity by the Armenian Republic, irrigation water supply became impossible on the 100,000 ha of agricultural land that caused irrecoverable losses to the economy of this region. In addition, this water reservoir having the highest (125 m) dam in the republic imposes the threat to the lives of 400 000 inhabitants downstream of the Terter River, because of insufficient maintenance service.

Regulation of river runoff by means of water reservoirs plays an important role for the long-term economic development and rational use of water resources in Azerbaijan.

**Irrigation systems**

The first engineering irrigation channels in Azerbaijan were constructed in the beginning of $20^{th}$ century; water was withdrawn from Aras River. By 1913, 550 thou-

sand hectares of land were irrigated in Azerbaijan. Construction of water supply facilities in the steppes of Mughan, Salyan, Mil and the construction of Mingechevir reservoir with capacity of 16 billion $m^3$ on the river of Kura, hydro systems on the river of Aras, Upper-Garabagh, Upper-Shirvan, Main Mughan mainstream channels, and also land reclamation activities in the Kura-Aras lowland, added to the cultivated land new land areas which was designed for cotton-cultivation. As a result 90% of gross agriculture products are produced on these lands.

At the present, 1.426 million ha out of 4 525 thousand ha of cultivated land are irrigated lands. The complex water economy system operates in Azerbaijan, to supply irrigated lands with irrigation water: wide irrigation network and drainage canals, pump stations redistributing flow, the system of regulated water reservoirs.

The entire irrigation network of the republic covers 50.8 thousand hectares.The irrigation channels are mainly laid in ground beds (38.3 thousand km). Therefore, the losses due to filtration are so significant. Losses some times reach up to half of total water intake. The implemented agrarian reform changed the land ownership pattern. Therefore, it became very difficult to determine the efficiency of irrigation systems. According to available data, the average efficiency of irrigation systems does not exceed 0.5, and only in single cases it reaches 0.6-0.7..

Continuous operation of outdated water-supply systems, absence of concrete covers on most of irrigation channels (over 90%), as well as the absence of hydrometric posts and other regulating constructions create additional problems for sustainable use of water resources.

As a result of the implementation of agrarian reforms, starting in 1996, state farms, collective farms and other state agricultural enterprises have been replaced by small land owners, in Azerbaijan. The inter-farm irrigation and reclamation systems owned by collective and state farms in past lost the owner and have deteriorated. Taking these circumstances into account, the Government of the Republic decided to hand over all these systems to the Committee of Land Amelioration and Water Economy. The conducted inventory showed that 20-30% of inter-farm channels are incapable of operating as such.

Application of mechanical irrigation (nearby 500 thousand hectares) by means of pump stations from the rivers of Kura and Aras results in many cases, in wasteful agricultural practices. Current irrigation system shortcomings are:

- Insufficient water supply of irrigated lands, due to insufficient regulation of drain, irrigation sources and equipment of water-abstracting constructions;
- Insufficient development of inter-farm diversions of the irrigation network: underdeveloped network and lack of water-meter devices;
- Lack of antifiltration lining on a greater part of main and inter-farm channels and almost on the entire intra-farm irrigation network, causing significant

losses of irrigation water through filtration, and the deterioration of reclamation conditions for irrigated lands;

- Almost total absence of automatics and tele-mechanics on water-abstracting facilities, water distributing units, and irrigating devices;
- Poor spatial planning (by both configuration and relief) of irrigation sites that causes uneven irrigation, washing out of soils, prevents from introducing advanced technical equipment and new irrigation methods;
- Lack of advanced machinery and irrigation technology;
- Low, 0.50, conveyance efficiency of irrigation systems; this causes an inefficient use of available water resources.

The part of these objects is state owned. It is necessary to note that the major part of the constructions is built and put into operation over the period from 1952 to 1964 (for instance, large channels such as Upper-Garabagh, Upper Shirvan, Main Mughan) and, in addition to failing to meet the modern operation requirements, they constrain the further development of irrigated agriculture. 30-40% of water from the channel is lost to filtration and drain because of unlined channels and absence of automated water-regulating constructions.

At the same time, due to unsystematic and non-normalized irrigation of lands, poor construction quality of collector-drainage and irrigation network, and also shortage of budgetary financing, insufficient maintenance and low operation level of inter-farm facilities led to the deterioration of land reclamation conditions and salinization of lands. There is already an emergency situation with salinization of lands in Azerbaijan.

At present, 631 thousand ha (43%) of irrigated lands are subject to various degree salinization, including 140 000 ha of medium-salinated lands and 66 000 ha of highly salinated. Because of high ground water table, 267,000 ha of lands require reclamation.

The objectives and tasks of the reform are reflected in republican laws, other normative and legal acts, privatization program and following laws: «On Essential Principles of Agrarian Reform», «On Reform of State Farms and Collective Farms», «On Land Amelioration and Irrigation», «The Water Code of the Azerbaijan Republic». This plays a positive role in implementation of reforms. It is necessary to note, that the law «On Land Amelioration and Irrigation» defines the legal bases for the activities in the field of land amelioration and irrigation, the rights of ownership on ameliorative and irrigation objects.

Governmental development program on land amelioration and water economy was analyzed and priority objects determined, at the first stage of the works.

Taking into consideration large-scale organizational reform, which is vital for the water economy system, together with reorganization, the careful analysis of

management mechanisms in the sector is also necessary. Such approach will serve as an addition to the physical rehabilitation of the system, implemented with the aid of foreign investors.

**Drainage systems**

The drainage system is constructed on the 610 000 ha irrigated land, which includes 326 000 ha with the closed network and 13 000 ha with curtain drains. Total length of the collector-drainage network is 29.6 thousand km, the length of the collectors -10.8 thousand km; the drainage networks area adds up to 18.8 thousand ha.

The first experimental drainage system in Azerbaijan was constructed in Mughan plain, in 1929. Afterwards, in 1936, they laid the foundation of drainage system on the territory of Mil plain. However up to 1954, the constructed collector-drainage system (CDS) practically was not in operation, because of the absence of transfer pump stations and lack of main collector tracts. Since 1954, ground water is diverted to the Caspian Sea through the Mughan-Salyan discharge (MSD). The Main Shirvan collector entered into this process in 1964, Mil-Garabagh collector (MGC) – in 1966 and Main Mil-Mughan collector (MMMC) – in 1994.

Technical condition of the collectors in Northern Mughan, Salyan plain, Garabagh plain is satisfactory. The collectors of Shirvan plain, Southern Mughan and partially of Mil plain are in unsatisfactory condition.

In 1964, the Mil-Garabagh collector, with the discharge of 25 $m^3/s$, was connected to the Main Shirvan Collector (MSC). Over the operation period of MSC was found that discharge rate is twice higher than designed capacity. As a result, the collector is overloaded; the water level rises above its predicted level. This causes floods quite frequently.

As a whole and as it exists, MSC neither diverts drainage waters to the Caspian Sea, nor meets the development requirements of irrigated agriculture in the republic. Therefore, it is necessary to implement the complete reconstruction of MSC along its whole length.

Currently, Mil-Garabagh collector, 1957-1964, is overloaded; the pipe canal over the river of Kura does not provide the estimated flow. Therefore, it is necessary to complete reconstruction of the collector along its whole length and connect it with Main Mil-Mughan collector. Probable cost of the reconstruction of this collector is 18 million USD.

In separate parts of primary drains are observed occurance of line clogging and backwaters. Separate sites of various collectors are silted. Insufficient capacity and technical equipment of collector-drainage network, currently provides neither full drainage of reclaimed lands, nor the collection and diversion of drainage waters.

**Water Use in Agriculture**

The irrigated lands over 1970-1993 were constantly expanding in the republic and the basin. Since 1994 on, reduction of irrigated land areas is observed, due to the overall crisis in agriculture of Azerbaijan. As a result, part of these lands was taken out of cultivation (this was mainly caused by salinization). However, since 1997 owing to the internal reserves, recovery of agricultural production is observed. At present water consumption in Agriculture makes up to 3 418 million m3 annually.

In Azerbaijan traditionally are cultivated Water-intensive crops. Irrigation water supply per one hectare lags behind due to water deficiency therefore, only two, instead of 6-7 irrigations are frequently performed.

In the Kura-Aras basin of Azerbaijan the main portion in the total volume of water, used for irrigation, is presented by surface waters. The increase of usage of surface as well as ground waters (1976-1985) was caused by the development of agricultural production, construction of agro-industrial complexes, etc. Beginning from 1992, in tong term dynamics of overall water usage the sharp decrease of its volume is observed. It was connected with general crisis in agriculture. Since 1999 the water usage became stabilized due to the revival of agriculture.

It must be also noted that during last years use of groundwater for irrigation is out of control.

The ground waters of the republic used for irrigation are high quality, pollution protected; their resources depend much less on annual water content (harvest), they can be withdrawn immediately near to consumer. The fresh and slightly mineralized ground water resources in the republic account over 5.2 $km^3$.

Agriculture is the main consumer of ground water: over 6,000 water wells (5-7 million $m^3$/day) are used in agriculture.

At the moment, it is not possible to provide complete list of organizations and departments actually consuming ground waters in the republic. But, for example, ground water consumed for irrigation, household use, and also, for industry in 1985 made 6.5 million $m^3$/day. The consumption rate increased in 1990 up to 7.6 million $m^3$/day. The underground water output for irrigation increases twice, during drought.

The most important consumers of ground water for irrigation purposes are the districts located in Ganja-Gazakh and Garabagh and Mil artesian basins, among them are Fizuli, Aghdam, Geranboy, Shamkir, Aghjabedi, Barda, and Khanlar districts.

The extended droughts over the recent decades have led to the exhaustion of water resources, intensification of erosion and desertification of a significant part of dry lands, while the obsolete irrigating systems have led to inefficient water consumption, because of which, irrigated lands became partly salted. Finally, the in-

comes of recently formed and gradually developing farms considerably decreased. Serious problems arose, as far as the provision of the country's population with food is concerned.

In conclusion, the deficiency of water resources in Azerbaijan and the Kura-Aras basin and the transition to new economic relations bring up many economic and environmental issues. The most important issues are, as follows: increase of efficiency of land and water use, creation of rational structure of cultivated land, selection of most optimal irrigation scheme for agricultural crops, provision of production resources. The solution can be found based on the economic-mathematical modeling, since it allows considering alternative ways of effective utilization of these resources in the basin.

**Conclusion:** Azerbaijan has enough developed water infrastructure in Kura river basin. It's necessary to do the following primary actions:

- the maintenance of reservoirs and irrigation-drainage network in operating condition and uninterrupted water supply to irrigated lands for extensive watering of all agricultural crops, and also drain of collector-drainage waters to the Caspian Sea.
- the reduction of water deficiency by concrete lining of irrigation canals and pipeline constructions, since 90% of the canals were constructed on earthwork bed; introduction of progressive methods and technologies of watering; revision of the watering rates of agricultural crops; also, use of returned water, including collector–drainage water;
- the prevention of soil salinization in the lowland irrigated zone, by the construction of collector-drainage systems, ameliorative actions, combating sedimentation and overgrowing of irrigation and collector-drainage systems and improve operation of these systems;

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