ONLY for Steering Committee Members - pending comments from both countries, and finalisation

DRAFT FOR COMMENTS

UNDP/GEF Kura II project

Water supply and Demand Management

National level assessment Report on

Current and Planned Laws, Regulations and enforcement mechanisms in the Water Sector in Azerbaijan

March 2018

DRAFT FOR COMMENTS

Produced by: Dr. Eng. Hubert Lohr, International Consultant, Water supply and demand management expert

Authors: Dr. Eng. Hubert Lohr, with input from Mr. Shamil Huseynov, Senior Legal and Institutional Expert, Mr. Magsud Babayev, Senior Municipal Water Use Expert, and Mr. Teymur Osmanov, Senior Agriculture water use expert.

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DRAFT FOR COMMENTS

Azerbaijan

National Assessment report:

Physical water supply system for agricultural and municipal sectors with prioritized recommendations

Part II: Azerbaijan

List of Abbreviations and Acronyms

AIOJSC	Amelioration and Irrigation Open Joint Stock Company
ARWC	Apsheron Regional Water Company
AWEJSC	Amelioration and Water Economy Joint Stock Company
BCM	Billion Cubic Meter
FAO	Food and Agricultural Organisation
GNEWSRC	Georgia National Energy and Water Supply Regulatory Commission
GWP	Georgian Water and Power Company
HPP	Hydro Power Plant
JSC	Joint Stock Company
LTD	Limited Company
MCM	Million Cubic Meter
MENR	Ministry of Ecology and Natural Resources
MENR	National Geological Exploration Survey of Ministry of Ecology and Natural Resources
MPD	Minimal permissible discharges
UNDP	United Nations Development Program
UWSCG	United Water Supply Company of Georgia
WHO	World Health Organisation
WUA	Water User Association

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Contents

1 THE KURA RIVER BASIN 2

2 AZERBAIJAN 8

2.1 Geography and climate 8

2.2 Water supply 9

2.3 Irrigation 12

3 SUMMARY 17

4 RECOMMENDATIONS 17

4.1 General recommendations for rational water use 17

4.2 Water resources 20

4.3 Water supply systems 20

4.4 Irrigation 21

5 REFERENCES 23

DRAFT FOR COMMENTS

LIST OF FIGURES

Figure 1: Overview of the Kura river basin 2
Figure 2: Temperature in the Kura River Basin, from (Hannan, Leummens, & Matthews, 2013) 3
Figure 3: Precipitation in the Kura River Basin, modified from (Hannan, Leummens, & Matthews, 2013), precipitation from climate-data.org 3
Figure 4: Runoff map of Azerbaijan taken from (Verdiyev, 2018) 4
Figure 5: Runoff map of Georgai taken from (Beldring, 2017) 4
Figure 6: Surface water flow chart of Kura-Arak River Basin (source: (Hannan, Leummens, & Matthews, 2013), (Verdiyev, 2018)), (FAO, 2018) 5
Figure 7: Inner-annual flow distribution of the Kura River 6
Figure 8: Monthly distribution of temperature and precipitation in Azerbaijan (World Bank, 2017) . 8
Figure 9: Land temperature anomalies 1910 to 2015 for Azerbaijan based on World Bank data (World Bank, 2017) 9
Figure 11: Main features of an irrigation system modified from FAO (Brouwer, Goffeau, & Heibloeam, 1985) 12
Figure 12: Schematic view of water abstraction in Azerbaijan from surface water and groundwater, figures from (Osmanov, T., 2017), (World Bank, 2013), (Verdiyev, 2018) 15

LIST OF TABLES

Table 1: Major reservoirs in Azerbaijan (Verdiyev, 2018) 14

The Kura River Basin

1 THE KURA RIVER BASIN

The Kura/Aras River Basin stretches over five countries, namely Armenia, Azerbaijan, Georgia, Iran and Turkey, and covers an area of 186 600 km². Azerbaijan with an area of 86 600 km² and Georgia (69 700 km²) cover together 88% of the Kura River Basin ((FAO, 2018).

The Kura River, originating in Turkey, forms the main river basin in the South Caucasus with approximately 1500 km length. After 150 km the Kura River reaches the border of Georgia. While flowing east, the river follows the large valley between the Greater Caucasus and Lesser Caucasus mountains. It drains most of the southern Caucasus and the mountain ranges of the extreme northern Middle East.

The largest tributary is the Arak River which has its origin also in Turkey. Along its course to the Kura River, the Arak River constitutes the border between Turkey and Armenia, Armenia and Iran and Iran and Azerbaijan.

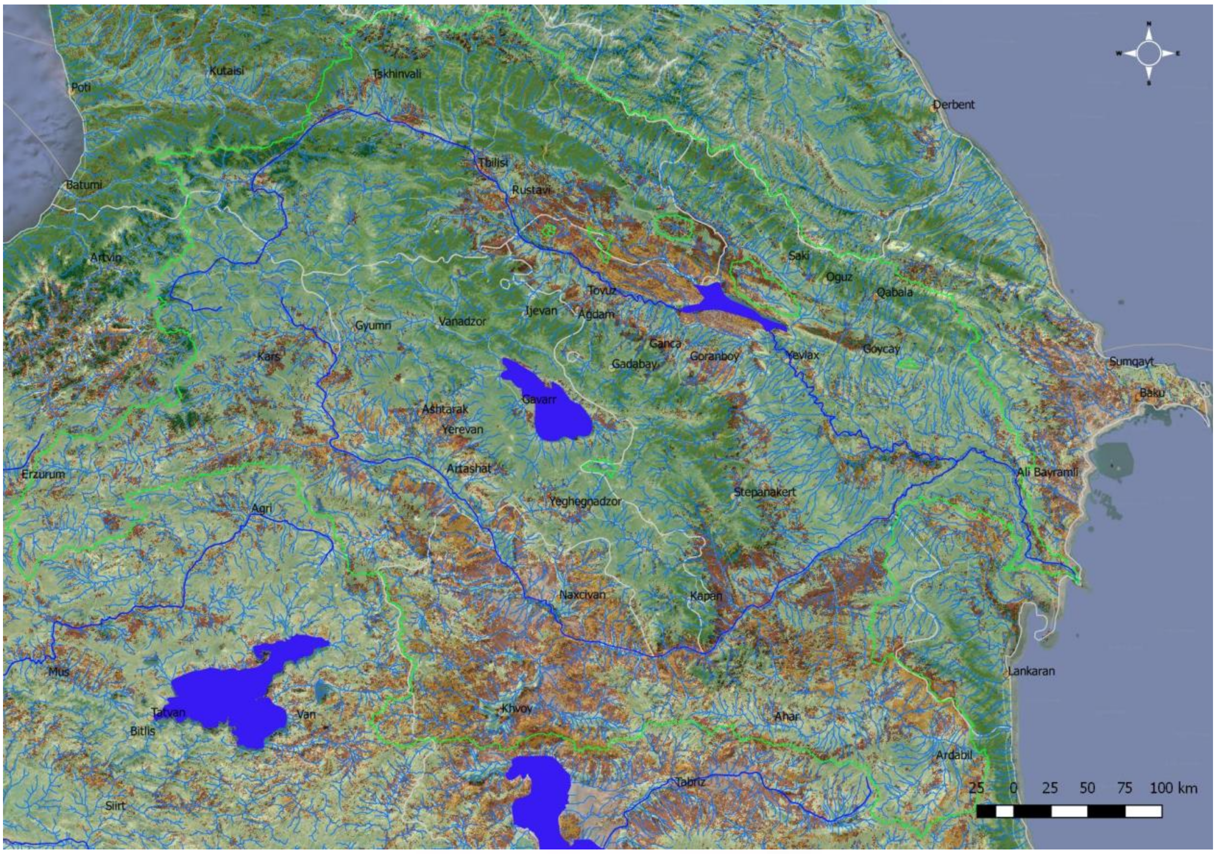


Figure 1: Overview of the Kura river basin

The Kura River Basin is the main transboundary water system in the geopolitically challenging region of the South Caucasus. The participating countries of Azerbaijan and Georgia have undergone significant political and economic transition and are now developing rapidly across a wide range of water dependent sectors (UNDP, 2017).

The UNDP GEF Kura *Project Advancing Integrated Water Resource Management (IWRM) across the Kura river basin through implementation of the transboundary agreed actions and national plans* is implementing a Strategic Action Program for the Kura River Basin in partnership with the Governments of Georgia and Azerbaijan.

The Kura-Arak River Basin lies in the transition between the Temperate Zone and the Subtropical Zone. The average temperature ranges from -1°C to 16°C or according to the Köppen-Geiger classification, zones can be subdivided into humid subtropical (Cfa), cold semi-arid (Bsk) to humid continental (Dfa) climate.

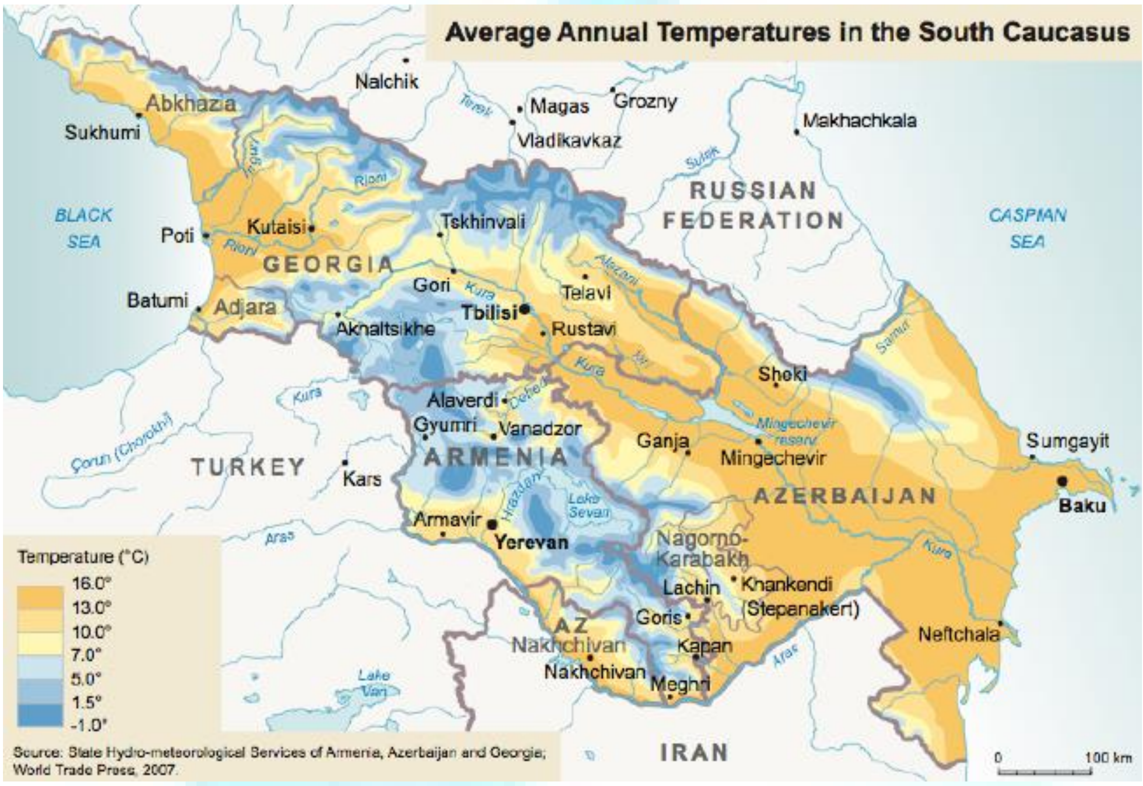


Figure 2: Temperature in the Kura River Basin, from (Hannan, Leummens, & Matthews, 2013)

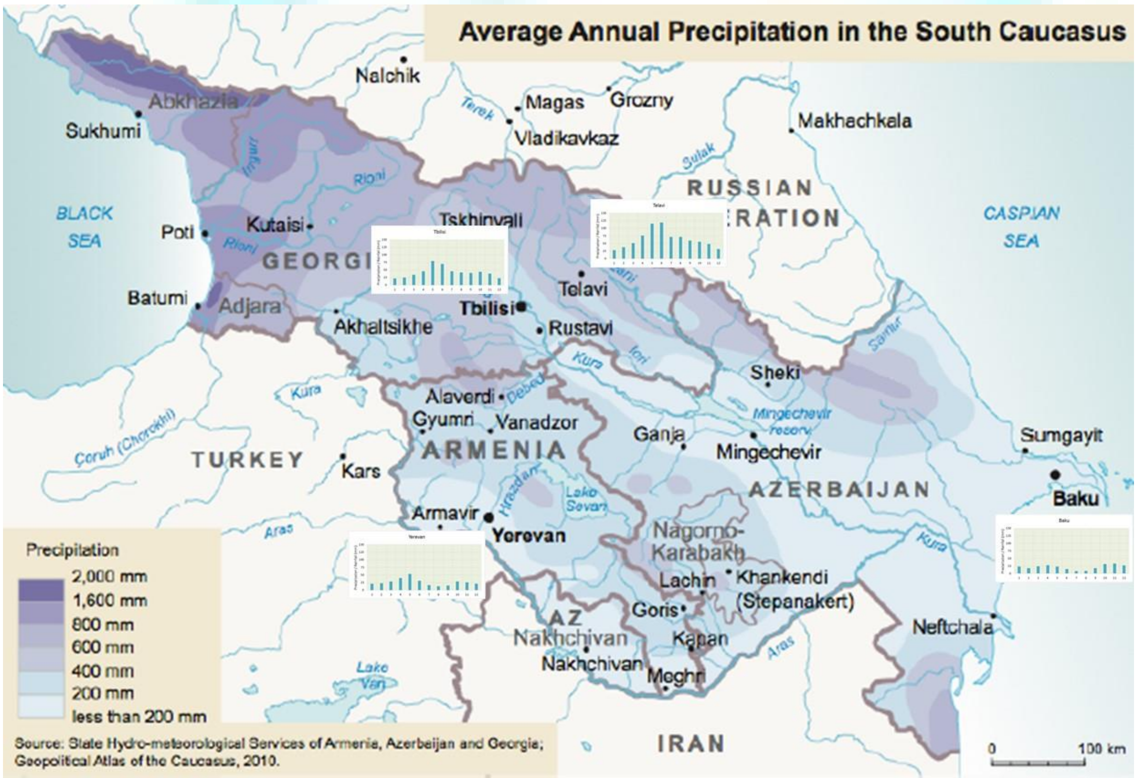


Figure 3: Precipitation in the Kura River Basin, modified from (Hannan, Leummens, & Matthews, 2013), precipitation from climate-data.org

Precipitation in the basin ranges from less than 200 mm up to more than 1600 mm. The distribution is illustrated for Baku, Tbilisi, Yerevan and Telavi.

The runoff in Azerbaijan follows more or less the elevation. The highest yield of runoff occurs in the mountains, while the Kura and Arak lowlands are regions with considerable abstraction and losses.

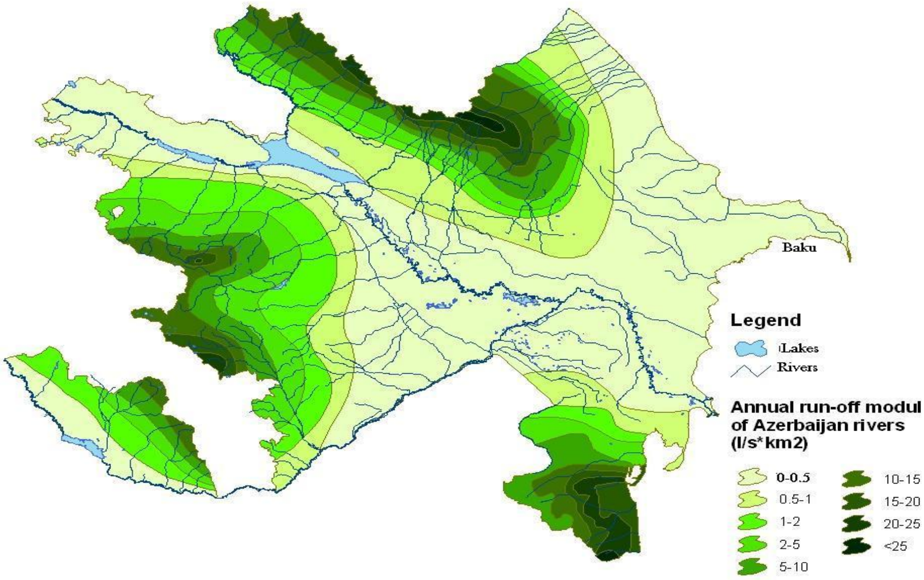


Figure 4: Runoff map of Azerbaijan taken from (Verdiyev, 2018)

The runoff distribution in Georgia was taken from (Beldring, 2017). The figure shows the big differences of the major basins. The western part of Georgia draining into the Black Sea has considerably higher precipitation and runoff compared to the eastern part draining into the Caspian Sea.

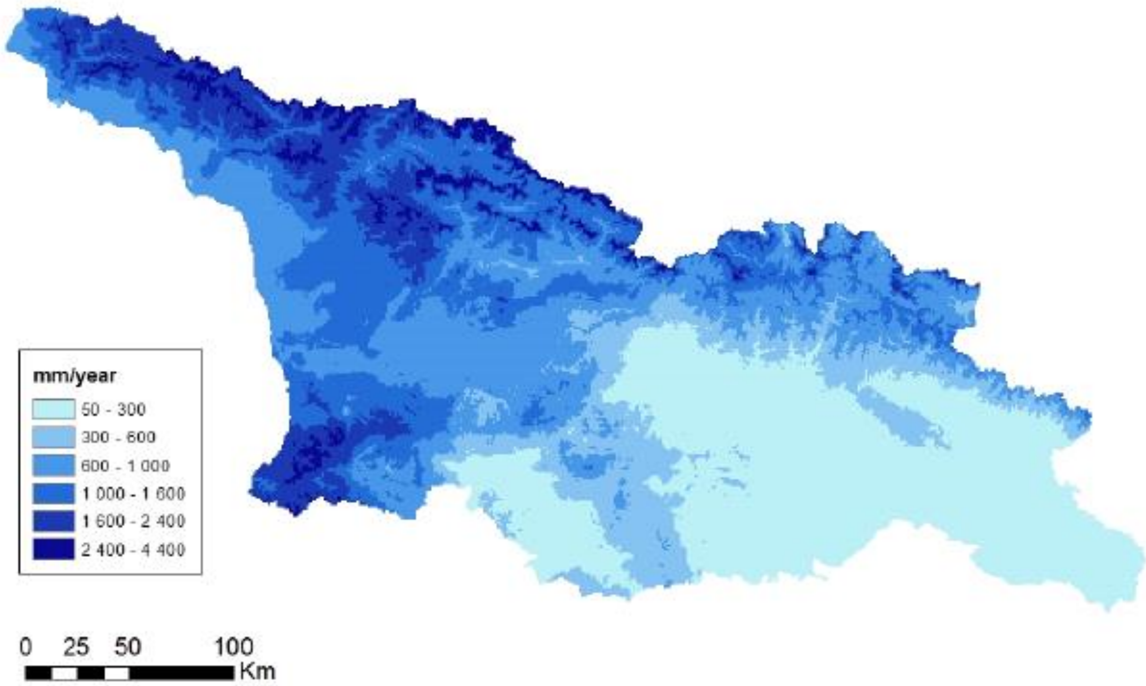


Figure 5: Runoff map of Georgai taken from (Beldring, 2017)

The assessment of available water resources is considerably hampered by substantial gaps regarding data and reliability of data. Figures concerning surface and groundwater resources in Georgia and Azerbaijan result in different water balances depending on the sources used. The sources used were FAO Aquastat, UNICEF Washdata.org, (Hannan, Leummens, & Matthews, 2013), (Vogel, 2017) and internal reports of the Kura II Project provided by national consultants from Georgia and Azerbaijan. Which data source is used for preparing tables or figures is indicated.

Examples of contradicting data is demonstrated by few examples. (Verdiyev, 2017b) claims an increase of water abstraction from 11 to 11.5 BCM whereas (Hannan, Leummens, & Matthews, 2013) indicates an increase from 4 to 6 BCM for the same time period. Although the increase is in the same order, absolute values differ by more than 100%. (Vogel, 2017) indicates a long-term average discharge of the Kura River of 20 BCM at Tbilisi station, 4.5 BCM for the Alazani River and 20 BCM for the Khrami River. Only the figure for the Alazani River is in the same range of other sources while the value for the Kura River seems 100% higher and for the Khrami River 10 times higher, which is probably attributable to mistaken units. Based on all sources, a best estimate about the flow network of the Kura-Aras River Basin is shown in Figure 6.

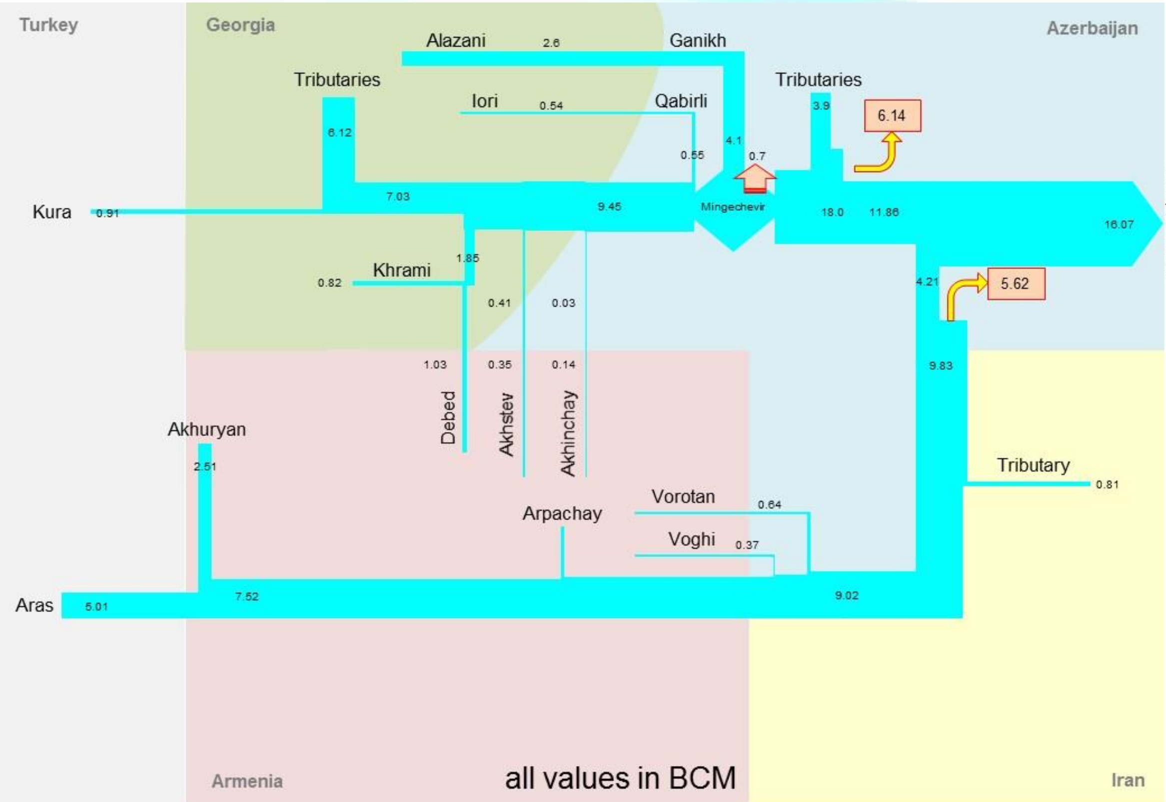


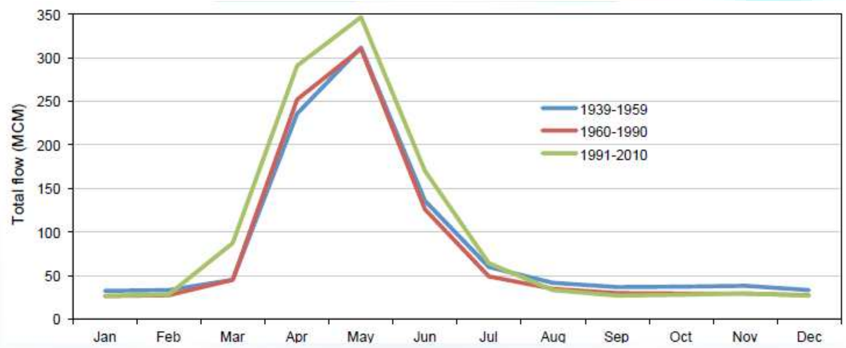
Figure 6: Surface water flow chart of Kura-Aras River Basin (source: (Hannan, Leummens, & Matthews, 2013), (Verdiyev, 2018)), (FAO, 2018)

Figure 6 is schematic flow network of the Kura and Aras River with the contribution of major tributaries. The numbers were taken from (Verdiyev, Conduct an assessment of available ground and surface water in Kura river basin in Azerbaijan, 2018) and (Hannan, Leummens, & Matthews, 2013) and checked against (FAO, 2018). The figures differ but within tolerable margins of ± 1 BCM at the total flow into the Caspian Sea, which is in the range of 10%. FAO data tend to be smaller. All data refer to long-term average, however, the reference period of the figures is not always given and might be inconsistent.

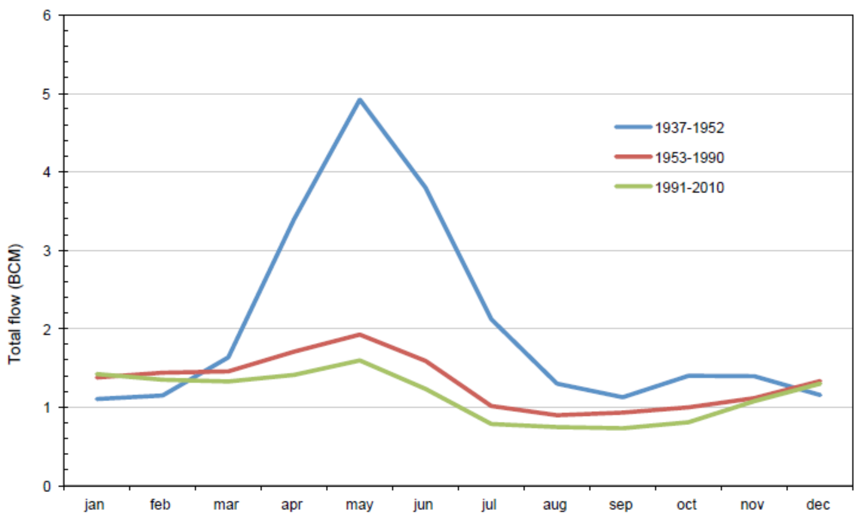
The major problem is related to missing measurements of abstractions at various locations. This is why abstraction was only assigned to two locations in the flow chart at which observations exist. The location downstream the confluence of Kura and Aras refers to the hydro post Surra, upstream the confluence to Zardab station in the Kura River and to Novruzlu station in the Aras River.

Water abstraction are mostly concluded from flow measurements at observation stations or given as total sum without spatial disaggregation.

The inner-annual flow distribution of the Kura River at two locations is shown below. The observation point Surra downstream of the confluence with the Aras River, indicates an anthropogenic impact. The hydrological regime of the Kura River has significantly changed over time. Considerable amounts are diverted into channels for irrigation and large dams leading to a homogeneous flow distribution which does not follow the natural pattern.



Average total monthly discharge for different periods at Khertvisi, Georgia Source: (Hannan, Leummens, & Matthews, 2013)

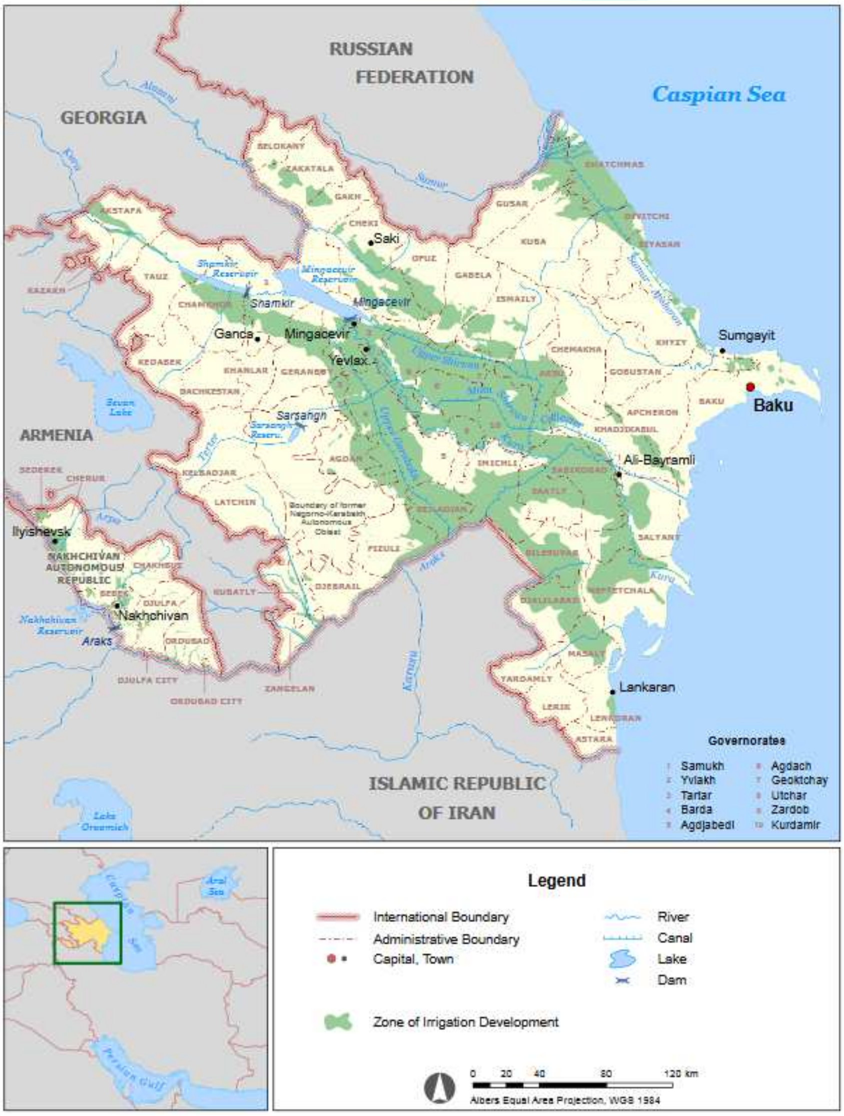


Average total monthly combined discharge for Kura + Aras for different periods at Surra, Georgia Source: (Hannan, Leummens, & Matthews, 2013)

Figure 7: Inner-annual flow distribution of the Kura River

Given the period 1991-2010, the aggregated flow over 12 month at Khertvisi and at the combined Kura + Arak flow corresponds to the calculated flow in the schematic view above.

Azerbaijan



(source: FAO Aquastat, accessed 2018)

2 AZERBAIJAN

2.1 Geography and climate

Azerbaijan is located on the south-eastern slopes of the Caucasus Mountains. It is bordered to the east by the Caspian Sea, to the south by the Islamic Republic of Iran, to the southwest by Turkey, to the west by Armenia, to the northwest by Georgia and to the north by the Russian Federation. The country can be divided into five main physiographic regions:

- the Greater Caucasus mountain range in the north, extending from the Black Sea in the west to the Caspian Sea in the east, over the northern part of Georgia and Azerbaijan and the southern part of the Russian Federation
- the Lesser Caucasus mountain range, south of the Greater Caucasus and covering the south of Georgia and Azerbaijan and the north of Armenia
- the lowlands around the Kura and Aras Rivers
- the Talish Mountains with the adjoining Lankaran lowland in the southeast, along the border with the Islamic Republic of Iran
- the Nakhchivan Autonomous Republic in the southwest

(FAO, 2018)

Long-term average rainfall is given by FAO to 450 mm/year ranging from 200 to 350 mm in Absheron (close to Baku) to 1600 to 1800 mm in the Lenkaran region in the utmost south of Azerbaijan. The all-time high daily precipitation observed is reported to be 334 mm at the Bilieser Station in 1955 (CISBCCI, 2018). The annual average air temperature is approximately 14.6 °C in the Kur-Aras lowlands and 0 °C in the mountains. The absolute minimum temperature observed was –33.0 °C (in Julfa and Ordubad) and absolute maximum temperature of +46.0 °C was again observed in Julfa and Ordubad.

According to (World Bank, Climate Change Knowledge Portal, 2017), annual precipitation in Azerbaijan runs up to 450 mm/a, distributed over the month as illustrated in Figure 8.

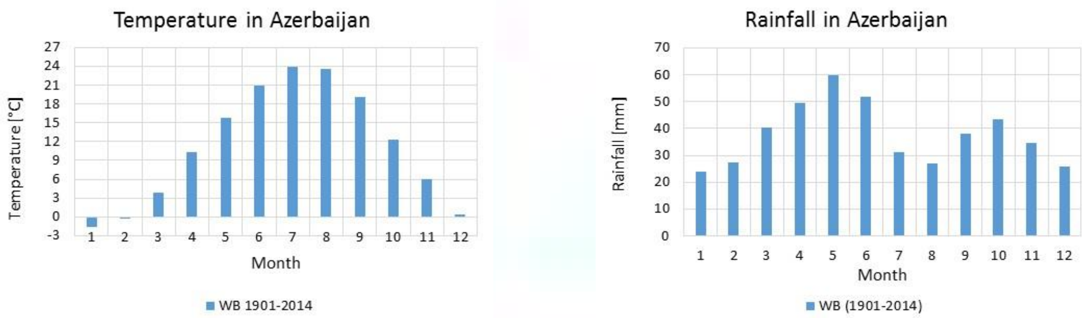


Figure 8: Monthly distribution of temperature and precipitation in Azerbaijan (World Bank, Climate Change Knowledge Portal, 2017)

Azerbaijan has a clear warming tendency. The mean temperature January-December shows a distinct increase and the last 21 years were all above the long-term average based on 1910-2000.

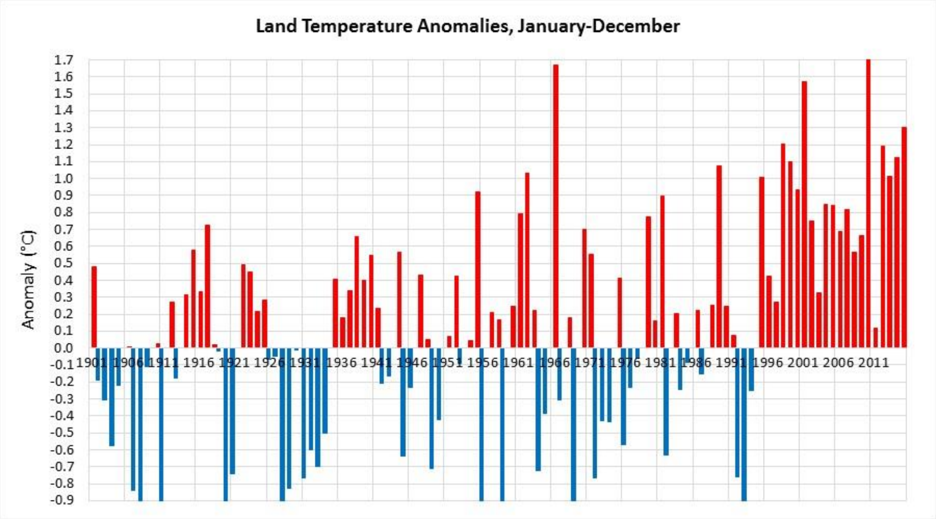
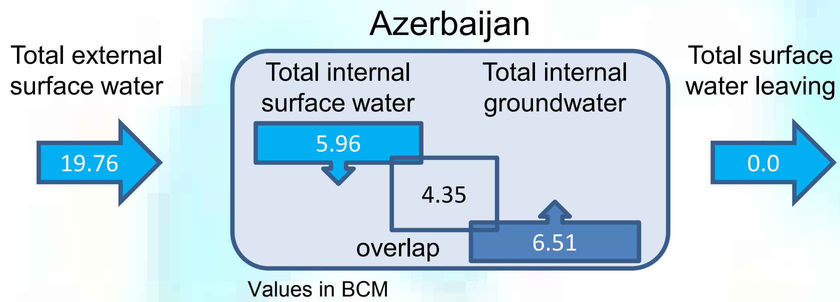


Figure 9: Land temperature anomalies 1910 to 2015 for Azerbaijan based on World Bank data (World Bank, Climate Change Knowledge Portal, 2017)

Internal and external water resources were taken from (FAO, 2018) and illustrated below.



The amount of more than 19.76 BCM (72% or total water resources) outstrips by far the internally produced water resources (28%). According to FAO, Azerbaijan ranks 16 in the world regarding the water dependency ratio.

2.2 Water supply

2.2.1 FAO Aquastat

According to figures from FAO of 2015, Azerbaijan has a total population of 9.8 million of which 53% are urban population and 47% are assigned to rural population.

Based on FAO data, total withdrawal runs up to 12.21 BCM per year, divided into municipal withdrawal 0.5 BCM, industrial withdrawal 2.36 BCM and agricultural withdrawal 9.33 BCM. The last update of the FAO statistics dates back to 2005. In 2010, new numbers were provided to FAO regarding agricultural withdrawal (10.1 BCM) and total withdrawal (11.97 BCM) which means that agriculture sector has increased its water consumption while the total amount has decreased. These figures indicate a water withdrawal per capita and year of 1279 m³.

2.2.2 Drinking water supply and organisation

AZERSU is the responsible entity in Azerbaijan for drinking water supply. They run their own observation points along the Kura River. A 620 km long river stretch is under monitoring of Azersu. Abstraction of water from the Kura River is conducted directly or from bank filtration. On average 19% of the volume of the Kura River is withdrawn. Water treatment will be carried out in 43 facilities, which are currently under construction. Water consumption is estimated to 224 l/day and capita in urban areas and 80-150 l/day and capita in rural areas. There is a strong increasing trend. FAO provides a very simple indicator for national water scarcity based on the renewable freshwater resources per person which is 53% for Azerbaijan.

The largest water pipeline is the Oguz- Gabala 262 km pipeline running along Kura River and providing 432,000 m³ of potable water to Baku. The ultimate challenge is water pollution. This affects drastically costs. Heavy metals and aluminium are found in the Kura River and causes AZERSU to operate Jeyranbatan Surface Water Ultra-Violett Filtration (UF) systems for water purification (Abbasov & Babayev, 2017). The UF plant has a treatment capacity of 570,000 m³ per day (6.6 m³/second) .

AZERSU runs a SCADA system for controlling the water supply network in Baku (Abbasov & Babayev, 2017). This implies that metering is conducted at least to a certain extent. A water supply network model is not yet in place.

In Baku, a pilot project was launched in which metering with smart cards for households and small enterprises were introduced. The area selected was equipped with smart cards and payment for water was controlled. Payments are made in advance to obtain a certain amount of water. If this amount is consumed and further payments are pending, water supply stops automatically. It is envisaged to extend the pilot project for industrial water user.

The AZERSU Joint Stock Company, with the headquarter located in Baku, manages municipal and industrial water supply and sewerage services in Azerbaijan. AZERSU originated from the former Apsheron Regional Water Company (ARWC) and Baku Sewerage Department.

2.2.3 Water supply in Baku

According to AZERSU, over 81% of Baku's population is continuously provided with drinking-water. Ten years ago, the centralized water supply system in the capital covered only 1.56 million people, but now it is used by 2.366 million people. The volume of water supplied from various sources in Baku and the Abpsheron Peninsula increased by 23 per cent – from 564 to 696 million cubic meters. As a result of implementing various projects in 2011-2013, the number of residents provided by uninterrupted water supply increased by 600,000 people, and reached, according to recent data, 1.485 million people ((WHO, 2015).

From 1996 to 2006, the World Bank financed the Baku Urban Water Supply Rehabilitation Project. The project objectives were threefold:

I. To make emergency short term improvements in the water supply system to restore the water supply to Baku, in particular to the poorer elements of the population
II. To improve the water supply system as a whole
III. To provide the basis for longer term planning and recovery

This project was brought about after an earthquake measuring 7 points on the Richter scale hit the region and caused substantial damage to critical components of the water supply system in Baku.

Supported by $5.4 million, water demand management was one core component to reduce water losses and wastage at the household level through a metering and billing program, installation of 15,000 household meters and progressive conversion of billing to a meter -based system. A second component facilitated the consumer education program to create awareness of water conservation needs and practices and encourage reduced water use. Finally, a third key component focused on the household leakage reduction program implemented through the installation of about 180,000 toilet cisterns.

Based on the project review documents (World Bank, 2006), the project's physical targets were apparently achieved. Average hours of service increased from 6 to 12 hours/day, unaccounted for water reduced from a very high 66% to 35% and water quality improved to reach WHO standards. On the other hand, substantial goals for long-term sustainable water use efficiency are rated as modest and achievement were not met, such as (i) metered billing was piloted but not scaled up and (ii) tariff increases enabled ARWC's revenues to cover O&M costs, but not to cover depreciation and debt service.

According to the project documentation about 81.5% of the population in Baku has access to piped water supply. In spite of these high access rates however, the project review states that quality of water supply services is obviously not satisfactory. In spite of several interventions in the sector, supported by various donors, there are still several challenges. One of the key challenges relates to the deterioration in the condition of infrastructure and the reliability and safety of water. Moreover, as a result of age and deferred maintenance, the distribution system is characterized by frequent bursts, high physical losses and intermittent and unreliable water supplies. Physical losses through plumbing in apartment buildings are also high. In addition to supply-side problems, the sector experiences demand-side management problems such as excessive water consumption and wastage.

2.2.4 Problems and constraints

Monitoring and metering

From what is given in the World Bank project review (World Bank, 2006) it seems as if there is still room for improvement regarding the physical state of the water supply network system in Baku. Monitoring and leakage detection are reported as improvable. Apart from the pilot project with metering at household level, no detailed metering is in place. Monitoring of pressure and flow, however, is a prerequisite for successful leakage control.

Water billing and governance

Billing is largely based on arbitrary consumption norms such as for instance for domestic consumers it is 400 litres per capita per day Embarking towards water demand management requires political support and consensus as metering in the water sector entails a dramatic policy shift. The World Bank project concludes that there is an inclination to favour physical works before management related activities. This implies that effort is needed to make sure that technical and institutional issues are addressed.

Cross-sectoral approach

The World Bank states that ARWC – now AZERSU – was well managed and was largely successful implementing the project. Both Government and ARWC were slow decision makers and implementers, contributing to the project's major delays. The project review further suggests paying more attention to address multiple use and water allocation between domestic, industrial and other water using sectors.

Water quality

The fact that AZERSU uses UF Filtration treatment systems strongly indicates the need to enhance water quality as this type of water treatment is expensive and certainly not used if not needed. This issue is most likely not solvable within Azerbaijan as 70% of the water resources come from neighbouring countries. Water pollution is expressed in high operational costs but can extent to long-term threats if heavy metals, aluminium and other substances deposit in sediments, infiltrate soil and accumulate over time.

2.3 Irrigation

2.3.1 FAO Aquastat

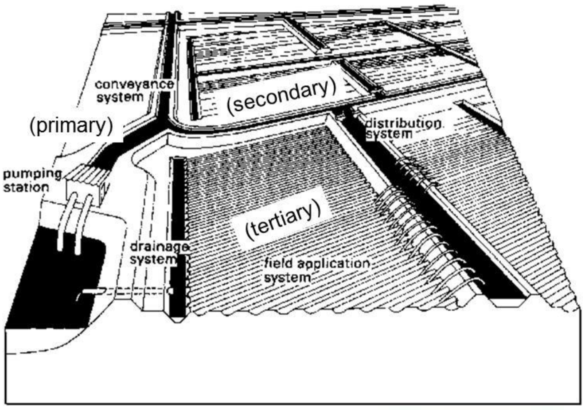
FAO Aquastat states that 1.43 million ha are irrigated in Azerbaijan according to data from 2010. In recent years, the number has slightly increased. Withdrawals due to agriculture are provided as 10.1 BCM per year out of a total withdrawal of 12.5 BCM which results in more than 84% for the agricultural sector. With a population of more than 9.8 million, the withdrawal amounts to of 1297 m³ per capita and year. All figures are last updated in 2016 based on AZSTAT.

The total area for irrigation is subdivided into surface irrigation with 0.618 million ha or 57% and sprinkler irrigation with 0.607 million ha or 43%. The numbers are from 2010. An area of 607 Tsd. ha is 400% higher in comparison to the inventory conducted by the World Bank in 2013. Such an increase within 7 years seems extremely optimistic and stands in contrast to the statement in (World Bank, 2013) that most of the equipment is in a poor state of maintenance and quality.

2.3.2 Irrigation and organisation

In 2013, a review of the irrigation and drainage sector was conducted by order of the World Bank. The study included an inventory of existing facilities, equipment, irrigation techniques as well as the analysis of the financial framework and institutional evolution in Azerbaijan (World Bank, 2013). The following paragraphs stem from this study and are considered as the most up-to-date source regarding irrigation.

The total irrigated area in Azerbaijan was 550,000 ha in 1913 and increased to 1.437 million ha by 2017 (Osmanov, T., 2017). The country has over 51,755 km of irrigation canals, of which 2,184 km are main canals, 8,014 km are off-farm canals and 41,557 km are on-farm canals. Over one-third of the irrigated area or 565,000 ha, are irrigated through 931 pump stations, many of which are located along the Kura and Aras rivers. 349,000 ha are served by electrical pumps, 68,000 ha are irrigated with diesel pumps and 148,000 ha are irrigated from 7,352 sub-artesian wells. Some pumping is used for drainage. There are about 118,000 hydraulic structures of various types around the country.



The main canal (primary) delivers water from a river, reservoir, well etc. to distribution (secondary) canals or inter-farm distributors which, in turn, deliver water to individual farms. On-farm canals or distributors (tertiary) deliver water to fields or irrigated sites.

Figure 10: Main features of an irrigation system modified from FAO (Brouwer, Goffeau, & Heibloeam, 1985)

Drainage is facilitated through 29,640 km of collector-drainage networks, both off-farm and on-farm. These provide drainage for 609,000 ha, which is about 45% of irrigated lands. About 55% of the irrigated area has no drainage systems. About 570,000 ha are served by on-farm drains. Drainage water flows to the Caspian Sea through three main collectors, the Main Mil-Mugan, Main Shirvan and Mugan-Salyan collectors.

Surface or gravity flow irrigation prevails on 65% of the irrigated area and only 35% is lift irrigation. Based on data from 2003, 152,000 ha were irrigated with pressurized irrigation, most of which used sprinklers. As stated above, FAO Aquastat claims 607,000 ha irrigated by means of sprinklers which is 400% more and somewhat questionable.

Approximately 50% of all irrigation and drainage infrastructure is in a state of deterioration and is in urgent need of rehabilitation and/or modernization. Over 450 on-farm systems require rehabilitation serving more than one million ha. Rehabilitation of on-farm systems is the Government's top priority.

Contrary to the amount of large areas under irrigation, only about 25% of irrigated land has adequate access to irrigation water. Providing access to all is estimated to cost $900 million USD and exceeds projected investments for on-farm irrigation.

Rehabilitation and modernization alone will not solve the sector's problems. Given poor drainage, salinization of soils and flooding, there is clearly a need to rehabilitate and expand drainage networks and perform more rigorous operation and maintenance of existing irrigation and drainage systems. Besides that, flood protection and more water storage facilities are considered essential for the future.

Irrigation and drainage is in the responsibility of the Amelioration and Water Economy JSC (Amelioration JSC). In 2006, the Amelioration and Water Economy Open Joint Stock Company (AIOJSC) was established. It originated from the State Amelioration and Irrigation Agency. Its role is essentially providing bulk water supplies to irrigation systems and overseeing the development and management of irrigation and drainage systems in the country. All shares of AIOJSC are state owned.

The AIOJSC has the following responsibilities:

- Provision of water to users
- Use, maintain and protect surface water facilities
- Mobilize financing for development, rehabilitation and management of I&D systems
- Set water tariffs
- Build capacity of staff and WUA
- Regulation of ameliorative condition of irrigated land
- Regulation of use of water supplied by AIOJSC
- Implement or supervise regional amelioration and water management programs
- Preparing forecasts and projects
- Adopting standards, norms and rules for water management
- Developing and regulating Water Users Associations
- Monitoring operations and maintenance of surface water facilities
- Regulating water management and preventing adverse impacts of floods and droughts
- Arranging water protection zones and river bank protection facilities
- Ensuring scientific and technical development about irrigation and drainage.

The AIOJSC provides water to Water User Associations (WUAs) which were established based on the Law on Amelioration and Irrigation adopted in June 1996. WUAs aim to address collectively irrigation water distribution, water payments, settling water disputes and other issues. Despite certain organizational difficulties, as a result of the measures taken, the creation of the Union of Water Users (UWU) in the country has been completed and 479 UWUs covering all irrigated areas have been created (Osmanov & Asadov, 2018).

2.3.3 Reservoirs

There are 138 reservoirs in Azerbaijan, most of which were built for irrigation purposes (Osmanov, T., 2017). 8 water reservoirs with total volume of 640 million m3 are located in the occupied territory of

Azerbaijan and are neither accessible nor utilisable. The multi-reservoir system on the Kura River includes Mingechevir, Shamkir, Yenikend, Varvara Reservoirs, Takhtakorpu and Shamkirchay reservoirs. The Jeyranbatan reservoir supplies Baku and Sumqayit cities with potable water. This reservoir is fed by the Samur-Absheron Canal from border river Samur separating Russia and Azerbaijan in the north. The total amount of water taken from Samur River by this canal is estimated at 0.80 to 0.85 km³.

The total capacity of operating water reservoirs is >22.7 km³, whereas the active storage volume is estimated to 12.4 km³. With a total water surface area of 974 km² and a mean annual evaporation of 1200 mm (Heydar Aliyev Foundation, 2018), mean annual losses from open water surface of reservoirs is estimated to 1.2 BCM.

Table 1: Major reservoirs in Azerbaijan (Verdiyev, 2018)

№	Name	Area, km²	Capacity, km³
1.	Mingechevir	605,0	16,07
2.	Shamkir	116,0	2,68
3.	Yenikend	23,2	1,58
4.	Varvara	22,5	0,06
5.	Araz Water junction	145,0	1.35
6.	Sarsang	14,2	0,57
7.	Jeyranbatan	13,9	0,19
8.	Khanbulanchay	24,6	0,05
9.	Sirab	1,5	0,01
10.	Agstafachay	6,3	0,12
11.	Khachinchay	1,8	0,02
12	Takhtakorpu (2013)	8,71	2,70
13	Shamkirchay (2014)	3.75	1,65
	Total	986.5	27, 05

2.3.4 Efficiency

According to National Geological Exploration Survey of Ministry of Ecology and Natural Resources (MENR) – Complex Hydrogeological and Geological Engineering, Azerbaijan holds approximately 9 km³ of groundwater resources from which a portion of estimated 3-3.5 km³ is abstracted.

Any water abstraction from groundwater undergoes a process of approval. The applicant needs to submit the purpose why it is necessary, project design and plans of water abstraction including design of wells, construction and operation. Based on the water balance calculations, the application is endorsed by the MENR if the abstraction matches their understanding of long-term stability of the aquifer. However, measurements are not checked through monitoring by MENR and control of abstraction lies in the responsibility of the operator.

At the on-farm level 72% of the estimated total canal length is earthen, only 10% is lined.

The rough scheme about water fluxes in Azerbaijan is depicted below.

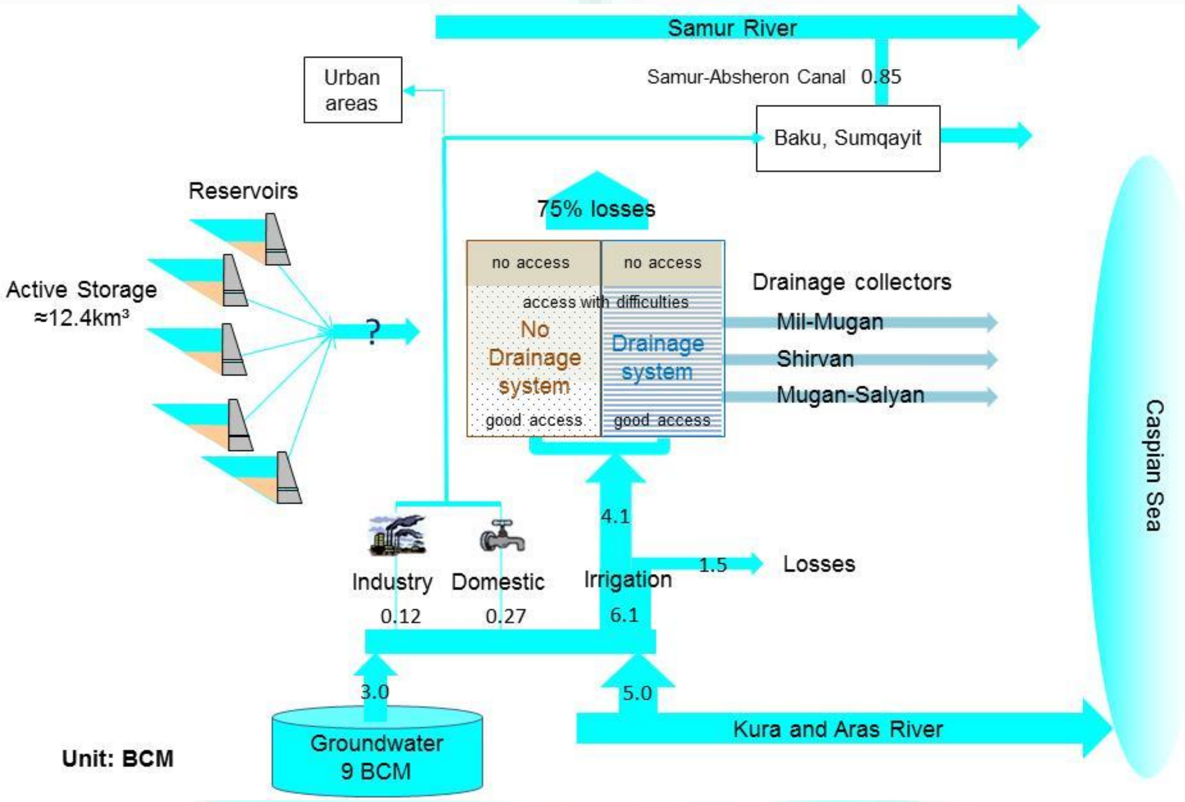


Figure 11: Schematic view of water abstraction in Azerbaijan from surface water and groundwater, figures from (Osmanov, T., 2017), (World Bank, 2013), (Verdiyev, 2018)

Water abstraction given in Figure 11 from various sources does not correspond with total water abstraction in Figure 6 which is based on water resources data. A possible reason is that abstraction refers only to Kura River but this is not mentioned in the reports used.

Regarding irrigation, losses occur at two levels: water transport in the main and distribution canals (1.5 BCM according to (Osmanov, T., 2017)) and losses of approximately 35-40% (Osmanov, T., 2017) and (Osmanov, 2018) in the field distribution system. The amount of water that is drained from the irrigation areas is not documented.

2.3.5 Problems and constraints

Hydrological hazards

The country exposure to hydrological extremes like floods or droughts is high. The occurrence of both conditions may increase in intensity and frequency due to climate change in the future. Azerbaijan intends to build more storage reservoirs over the next decade to contain flooding and at the same time to prepare for drought situations (World Bank, 2013) and (Asadov & Osmanov, 2017).

Locations for reservoirs and irrigation sites do not correspond so that considerable distances for water transport have to be covered. This calls for proper design and maintenance of the conveyance system and coordinated operation of reservoirs. AWEJSC is well aware of this problem and envisages a step-by step lining of canals changing earth into concrete canals.

Water demand

The amount of water delivered by Amelioration is demanded by Water User Associations (WUA). Farmers make estimates of their water needs and hand the data over to Amelioration. The scientific institute, under the umbrella of the Amelioration Department, roughly conducts cross-checks of the demand. The decision what to plant, when and how is beyond the responsibility of the Amelioration department and is solely determined by the WUA.

This implies that WUA will always demand enough water to compensate their low water use efficiency. This creates no inventive to save water and enhance efficiency as long as water is delivered.

Drainage of on-farm land

On low-lying land along the Kura and Aras Rivers, on-farm drains are very large and require machinery beyond the capacity of WUAs to purchase. As cleaning of these drains is essential, AIOJSC is committed to support WUAs by doing maintenance of on-farm drains. However, this eats up a lot of resources of AIOJSC (World Bank, 2013).

Equipment

Azerbaijan faces a massive need for rehabilitation and modernization of its irrigation and drainage infrastructure. At least 50% of drainage infrastructure needs restorative cleaning and rehabilitation. This includes main, secondary and on-farm canals, gates, chutes, drop structures, hydro-posts, and so on (World Bank, 2013).

Salinization

Salinity is a serious problem in Azerbaijan. Between 2005 and 2009 Azerbaijani research institutes found that area of slightly salinized land is about 406,000 ha. The area of moderately salinized is 292,000 ha, while the area of strongly salinized land runs up to 480,000 ha and very strongly salinized land to 320,000 ha respectively. 800,000 ha are more than 50% of the area which is currently considered as irrigation area in Azerbaijan. Interestingly, salinization is not recognised as a problem according to the Hydrogeological and Engineering Geology Expedition of the National Geological Exploration Service (Bakhtiyar, Karimov, & Mammadov, 2017). Soil and groundwater salinization was confirmed for the low lying areas of the Kura river basin with the consequence that groundwater abstraction is not possible there. This was stated, however, as an unavoidable fact rather than a mounting issue.

According to (World Bank, 2013) the two main causes of salinization are the relatively high elevation of the Caspian Sea, which restricts drainage from the Kura-Aras plain. Too much irrigation water raises the groundwater table and with poor drainage salts are not well leached from the soils. Also, the common clay content of soils promotes salinity due to the low permeability and restricted effect of rainfall on leaching soils.

3 SUMMARY

Azerbaijan lacks sufficient water resources which originate within the country. 70% of freshwater comes from neighbouring countries. Azerbaijan ranks 16 in the list of water dependent countries in the world.

Azerbaijan runs a hydrological monitoring network from which information about water levels, discharge and groundwater resources can be calculated. On the other hand, computing a consistent water balance is difficult due to inhomogeneous information and data.

Water abstraction takes place from groundwater and from major rivers such as Kura and Aras, supported by a number of reservoirs. The largest reservoir is located at the Kura River and is one major component of Azerbaijan's water supply.

Concerning the water supply sector, the technical progress outstrips the institutional as water provision is technically implemented, partly with high-end technology, but at the same time adequate tariffs and billing structures for cost-coverage seem to be insufficient. Thus, any technical progress like metering must be accompanied by institutional and legislative steps to enable efforts towards water demand management.

Irrigation plays an important role in Azerbaijan. The vast majority of water is abstracted for irrigation purposes. Azerbaijan faces the situation that water runoff originates far away from irrigation areas and makes water transport necessary. Losses are significant in the irrigation sector. Losses during water transport account for approximately 1/3 and losses in the distribution system account for 2/3 of the total sum of losses. This is partly attributable to poor equipment and a lack of incentives to use water efficiently.

As a consequence of floods and droughts in the past, Azerbaijan embarks on new reservoirs for flood protection and water supply. It is paramount to enhance coordinated operation of reservoirs in combination with an improved management of irrigation within the WUAs. Uncoordinated crop and demand patterns together with uncoordinated reservoir operation would certainly counter the investment of new reservoirs.

4 RECOMMENDATIONS

A first list of possible topics in respect to ration al water use is given in Section 4.1 followed by specific recommendations for different sectors.

4.1 General recommendations for rational water use

Topic	Remarks	Prerequisite	Plan
Direct measures			
Water audit and balancing	Water audit and balancing provides a comprehensive appraisal of the availability, distribution, utilization and the extent of losses in a system. Such an assessment is extremely useful in resource assessment, policy formulation and decision-making particularly on future investments in infrastructure.	Data compilation	Short-term
Development of a database	One of the critical bottlenecks in implementing water demand management strategies is the lack of updated data on various aspects of water	Inventory of the supply system	Short-term

Topic	Remarks	Prerequisite	Plan
management system using GIS	supply. It is imperative to couple strategies such as metering with an effective data acquisition, compilation and processing system to use it as an aid for decision making.		
Metering	Measurements of the quantity of water in and out of the system at supply mains.	none	Short-term
	Measurements of inlet/outlet of storage tanks and different pressure zones	None	Mid-term
	Household level	none	Long-term
Active and passive leakage control	Leakage management refers to monitoring the flows into supply areas in order to measure leakage and prioritize leak detection activities. Active leakage control means site visits and is closely linked with GPS leakage tracking. Modelling to obtain reference conditions should accompany the activity to increase efficiency of leakage identification. Passive leakage control includes complaints management, record keeping and requires allocation of staff to response to complaints.	Supply network modelling	Mid- to long-term
Asset management programme	Asset management program involves developing a time bound plan for retrofitting and replacement of existing infrastructure.	Inventory of the supply system	Short-term
Pressure management	The undulating topography results in very high pressure at certain points and low pressures in other areas. Pressure management is a key aspects to ensure adequate service levels, minimize leakages and ensure long term sustainability of the infrastructure.	Metering; Supply network modelling	Long-term

Topic	Remarks	Prerequisite	Plan
Indirect measures			
Water supply network modelling	EPANET is a first-class software free of charge for modelling water supply systems. It is possible to model flow, pressure, water quality and it can easily be used for leakage control. It is also possible to study the impact of pressure management. Pressure management carried out in an automated way can help a lot in reducing losses. Modelling alone does not help increase water use efficiency but increases understanding and is a prerequisite for other measures aiming at water use efficiency.	Inventory of the supply system	Mid-term
Water tariff change	Incentives at all levels of users are needed to achieve a better water use efficiency.	Metering	Long--term

Topic	Remarks	Prerequisite	Plan
	Accompanied by individual metering, a new tariff structure, also suggested in (World Bank, 2006) seems necessary. This requires a shift in the policy and affects legislation and is thus considered as a long-term measure. Concepts of new tariff scenarios could be: • Actual consumption with fixed price per m³ • Variable price per m³ depending on consumption		
GPS leakage tracking	Screening of urban areas in a structured way to track visible leakages. There are two options: • Screening of the supply network • Public participation by an mobile-phone app Each leakage point, private or in the network, is tracked with GPS coordinates and picture and uploaded into a GIS system. Based on the findings countermeasures can be streamlined in form of incentives: • Campaigns for financial support for households if rehabilitation is verifiably done or new systems are installed within a given period • Combining the cadastre system with the GPS points to single out the households and address them individually • Advertise with the leakage point maps in newspapers, TV and invite households to contribute to a SAVE OUR NATURE or SAVE OUR WATER campaign	App development or utilisation of existing apps	Short-term to mid-term
Area related accounting	Costs for wastewater could be charged in relation to impermeable and polluted areas for industry first and later for private households. Areas like parking places, paved places, car repair, roofs, which are not considered or listed as permeable generate more runoff and pollution than permeable surfaces. The database for supporting the assessment can be developed based on aerial images and the cadastre system. This is standard in Germany.	Aerial or satellite images; Surface pollution relationship; Key for cost allocation	Mid-term
Combined emission and immission principle	Any discharge is evaluated according to its amount per year and its impact on the receiving river. A fee structure is applied which fines heavy polluters.	Desired water quality standards; Monitoring	Mid-term
Cumulative impact approach	Discharge permissions are endorsed based on cumulative impacts. Cumulative impacts are considered for both temporal and spatial aspects.	Monitoring; Modelling	Mid-term
Topic	Remarks	Prerequisite	Plan
Measures with respect to water allocation planning			

Topic	Remarks	Prerequisite	Plan
Water availability with satellite data	Use of satellite data for snow observation for medium to long-range forecasts of available water.	none	Short-term

4.2 Water resources

No	Topic	Description	Indicators
1	Water balance model	Water balance model is an appropriate approach to account for the availability, distribution, utilization of water resources. Such an assessment is extremely useful in resource assessment, policy formulation and decision-making particularly on future investments in water infrastructure and long-sighted planning. It provides the framework for water withdrawals and sector policies regarding water supply and in particular irrigation. It would also enable to allow for cost-effectiveness calculations with new reservoirs and to show how much investment is due to water losses.	• Responsible institution identified • Water balance model for Kura River and major tributaries established • Number of observation points included • Method developed to integrate unobserved catchments • Number of abstraction points included • Number of people trained
2	Monitoring	Data are probably recorded but not homogeneously structured and accessible. It is recommended to establish a format for unambiguous data management. Such a format could be a hydrological year book comprising flow in rivers, releases at reservoirs and water abstraction for both surface and groundwater.	• Hydrologic Year Book format established
		A hydrological year book in the CSV format is suitable to be published on a website. It is recommended to make this the official access point providing most relevant water resources data.	• Website established • Download CSV format enabled

4.3 Water supply systems

No	Topic	Description	Indicators
1	Monitoring	Measurements of the quantity of water in and out of the system at supply mains.	• Number of water meters installed and in operation
		Measurements of inlet/outlet of storage tanks and different pressure zones	• Number of water meters installed and in operation
		Household level	• Number of household water meters installed and in operation • Measurements from household water meters collected
2	Data management	A consistent data management for keeping all observed data is required. This is best implemented by a database with import and export functionality. The export must be tailor-made in order to drive a simulation model	• Database established • Import of observations in operation • Export of time series established
3	Water demand	Current water demand patterns (24h hours, weekly, monthly) subdivided into private households, industry, others is a prerequisite	• Patterns gathered • Patterns verified by water metering

No	Topic	Description	Indicators
		for planning and establishing a hydraulic network model (see below).	
		Water demand projections are essential for planning. This should be done in close collaboration with urban and land use management departments.	• Projections assessed for different time periods
4	Modelling	Modelling of the water supply system of Baku has manifold advantages: it requires an inventory of the system which is often very helpful for other reasons like asset management, for maintenance programmes etc. With a model established, leakage control and planning programmes are enabled.	• Model software selected (recommended: EPANET) • Parameter and input collected • Number and length of pipes integrated in the model • Length of pipes integrated in the model • Calibration run based on water metering verified
	Operational mode	Once a model is in place, it could be coupled with near-real time observations. This is the prerequisite to run such a model in operational mode. This, in turn, facilitates leakage control and is the way forward to achieve pressure management.	• Hardware and software environment determined • Formats for import / Export features conceived and designed • Number of observation points which are coupled with the model • Work flow established

4.4 Irrigation

No	Topic	Description	Indicators
1	Drainage	Drainage should be made compulsory to avoid the increase of salinization. As of now, the area not utilisable for irrigation is large. Soil of good quality is an asset and once irreversibly destroyed is lost forever. Therefore, support and incentives to promote drainage is important. At the same time, drainage standards should be developed to avoid inhomogeneous situations in the country and to facilitate approval, construction and control.	• Standards established • Regulations for approval formulated and endorsed • Control mechanisms established • Amount of irrigation field with new drainage
2	Coordination of crop patterns and WUA capacity building	A harmonised concept about crop patterns and water demand could lift the water stress during the dry months. At the same time, distributing water demand over time reduces the hydraulic capacity required, and thus generates savings due to smaller infrastructure and reduces losses.	• Inventory of current crop patterns in the country • Incentive strategy developed to promote certain crops • Number of WUAs introduced
		WUAs capacity in terms of using technical equipment and irrigation practice needs enhancement. Yield can be improved and water can be saved if demand is met accurately. How to measure demand and equipment to measure demand is piloted to develop a showcase for replication. c	• Number of training conducted • Number of equipment provided • Measurements conducted • Demonstration meetings carried out

No	Topic	Description	Indicators
		Measurements of the flow within the distribution system of an irrigation scheme	• Equipment for observations are selected • Number of equipment and observation points in operation
3	Maintenance	A maintenance plan including staffing and financing is an objective for AWEJSC and for WUAs.	• Length of channels maintained • Maintenance program set up • Request management established • Financial plan worked out • Agreements settled
4	Water management	Appropriate communication and clear responsibilities are key for improving efficiency. Farmer's compliance in terms of efficiency is obligatory. A flat rate in providing water, if any, should be abolished and replaced by a tariff structure which uses the amount of water used.	• Information meetings held • Economic analysis conducted • Price and willingness to pay evaluated • Tariff structure suggested • Tariff structures endorsed • Tariff structure introduced

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