UNDP/GEF Kura II project

Water supply and Demand Management

National Assessment report:

Groundwater and Surface Water Availability in the River Basin

September 2018

Empowered lives.
Resilient nations.

National Assessment report: Groundwater and Surface Water Availability in the River Basin

Part I: Georgia

Document Information

Project	Advancing Integrated Water Resource Management (IWRM) across the Kura river basin through implementation of the transboundary agreed actions and national plans
Project Countries	Azerbaijan and Georgia
Organisation	UNDP GEF Kura II Project
Document	Groundwater and Surface Water Availability in the River Basin
Date	27.09.2018
Consultant	Dr.-Ing. Hubert Lohr, International Consultant, Water supply and demand management expert
Client Representative	Dr. Mary Matthews, Chief Technical Advisor and Regional Project Coordinator; Ahmed Elseoud, Senior Capacity Building Expert
Financing Organisation	UNDP

List of Abbreviations and Acronyms

BCM	Billion Cubic Meter
CC	Climate Change
EIB	European Investment Bank
FAO	Food and Agricultural Organisation
GCM	Global Circulation Models
GNEWSRC	Georgia National Energy and Water Supply Regulatory Commission
GWP	Georgian Water and Power Company
HPP	Hydro Power Plant
IEV	Intrinsic Ecological Value
JSC	Joint Stock Company
LTD	Limited Company
MCM	Million Cubic Meter
MEPA	Ministry of Environment Protection and Agriculture
MPD	Minimal permissible discharges
UNDP	United Nations Development Program
UWSCG	United Water Supply Company of Georgia
WWTP	Wastewater treatment plant

Contents

LIST OF FIGURES

LIST OF TABLES

Water availability in 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 190 190 km². Azerbaijan with a total area of 86 600 km² of which 60 020 km² are within the Kura basin and Georgia with a total area of 69 700 km² of which 34 560 km² are within the Kura basin cover together roughly about 50% of the Kura River Basin.

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 or Aras River which has its origin also in Turkey. Along its course to the Kura River, the Ara(k)s River constitutes the border between Turkey and Armenia, Armenia and Iran and Iran and Azerbaijan.

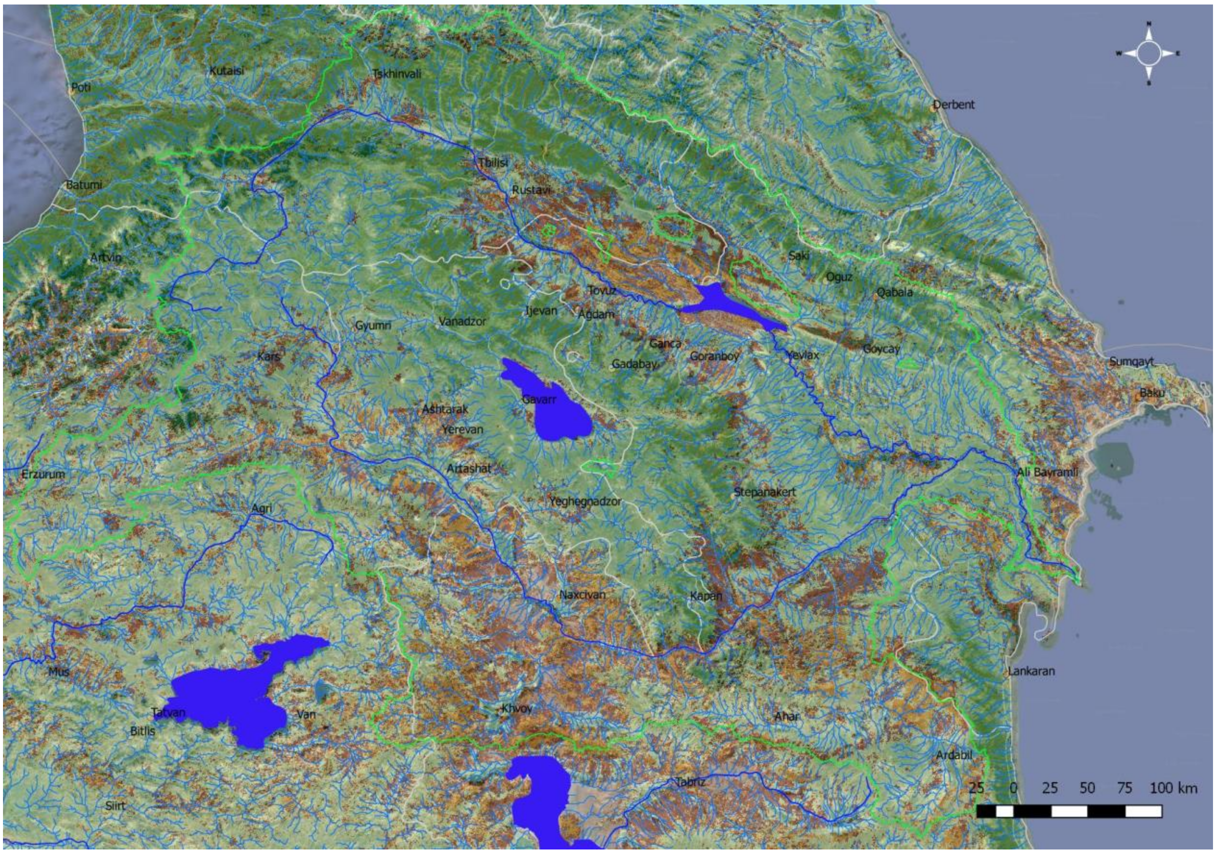


Figure 1: Overview of the Kura River Basin

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.

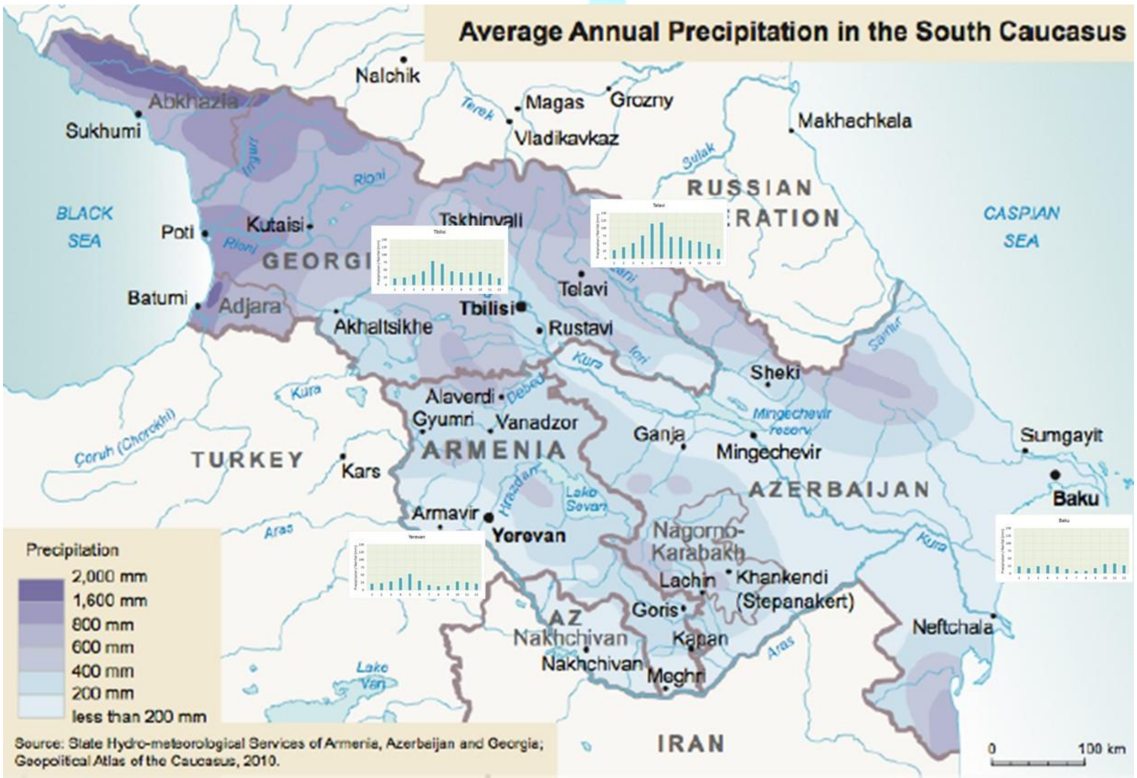


Figure 2: Precipitation in the Kura River Basin, modified from (Hannan, Leummens, & Matthews, 2013), precipitation from climate-data.org

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 Aras lowlands are regions with considerable abstraction and losses.

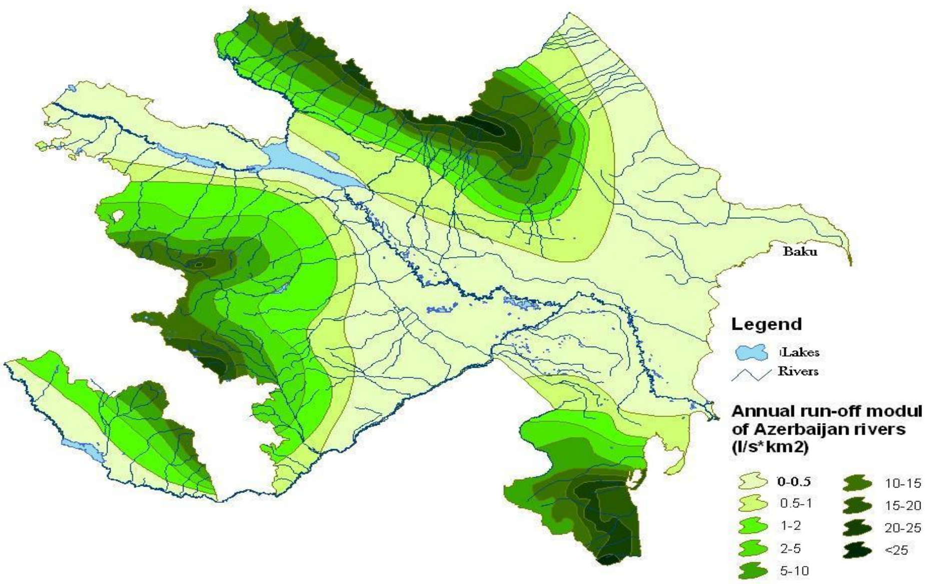


Figure 3: Runoff map of Azerbaijan taken from (Verdiyev, 2018)

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.

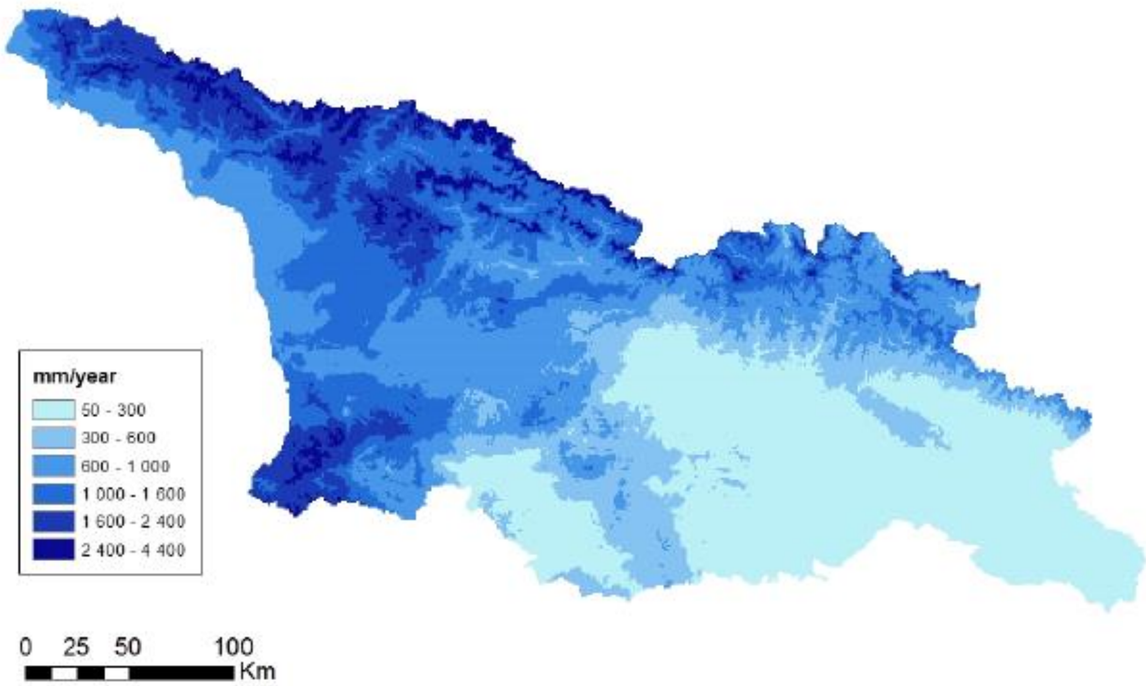


Figure 4: Runoff map of Georgia taken from (Beldring, 2017)

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 were National Statistics of Georgia (GEOSTAT, 2017), 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.

In order to produce a consistent water balance for the Kura River Basin, only data from the Second Assessment of transboundary rivers, lakes and groundwaters (UNECE, 2011) were finally applied to generate Figure 5. This represents the best estimate about the flow network of the Kura-Aras River Basin based on massive effort supported by all governments involved in the Kura River Basin.

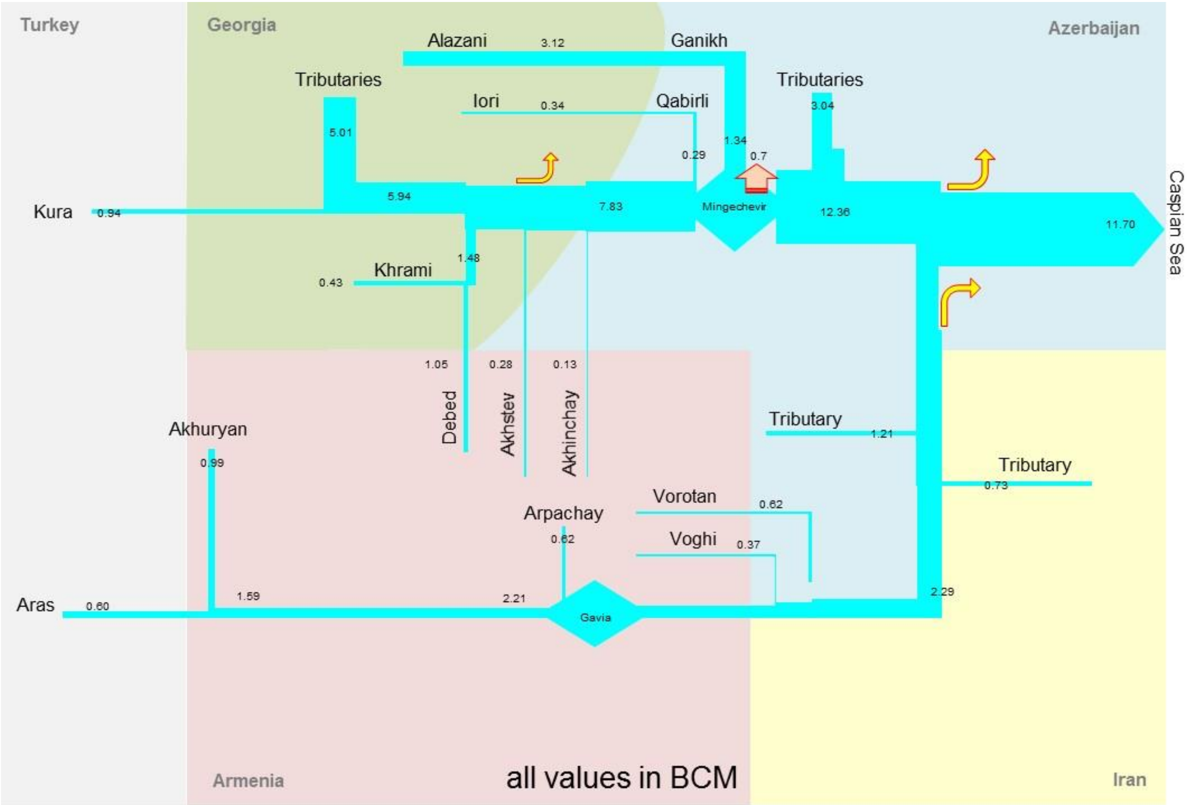


Figure 5: Surface water flow chart of Kura-Aras River Basin (source: (UNECE, 2011)

Figure 5 is schematic flow network of the Kura and Aras River with the contribution of major tributaries. All data refer to long-term average conditions.

2 CURRENT SITUATION (BASELINE)

UNECE has compiled data about renewable water resources in the Kura Basin given as follows.

Table 1: Renewable water resources per capita in the Kura River Basin (UNECE, 2011)

Country	Renewable surface water resources (km3/year)	Renewable groundwater resources (km3/year)	Total renewable water resources (km3/year)	Renewable water resources per capita (m3/capita/year)	Period of observations used for estimating water resources
Azerbaijan	8.704	5.2	13.9	1.913	1953-2008
Georgia	6.438	1.923	8.362	3.144	1935-1990

The figures correspond well with the flow chart in Figure 5.

Concerning water availability, it is meaningful to assess long-term trends and distribution patterns of streamflow. An aggregated analysis capturing surface and groundwater is possible by assessing streamflow along different points along the Kura River. The underlying assumption is that streamflow includes renewable base flow from groundwater aquifers. The further downstream the observation point is the more groundwater aquifers contribute to the streamflow. Another aspect why the analysis focuses on streamflow is the fact that groundwater data are scarce and do not allow an equally profound analysis compared to surface water.

The following analysis was conducted based on annual streamflow data from 1975 to 2010 and monthly distribution patterns at different locations along the Kura River taken from (Hannan, Leummens, & Matthews, 2013). Since repetitive monthly pattern are used the inner-annual distribution might divert from reality but is still within an acceptable confidence interval.

The current situation is referred to as baseline.

The points for the analysis are illustrated in Figure 6.

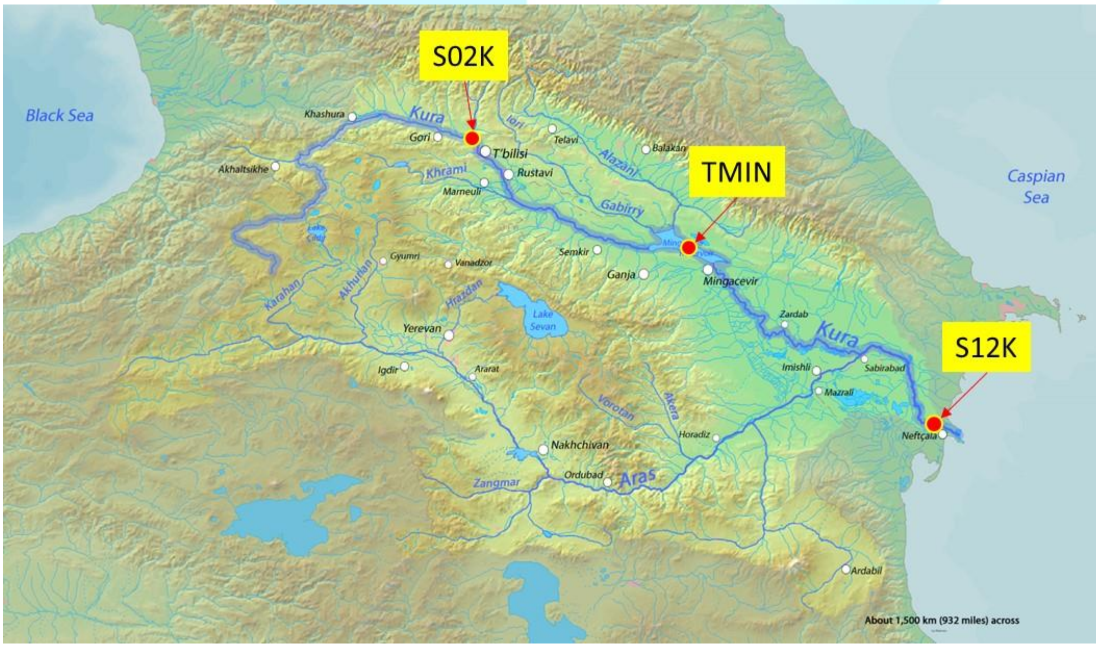
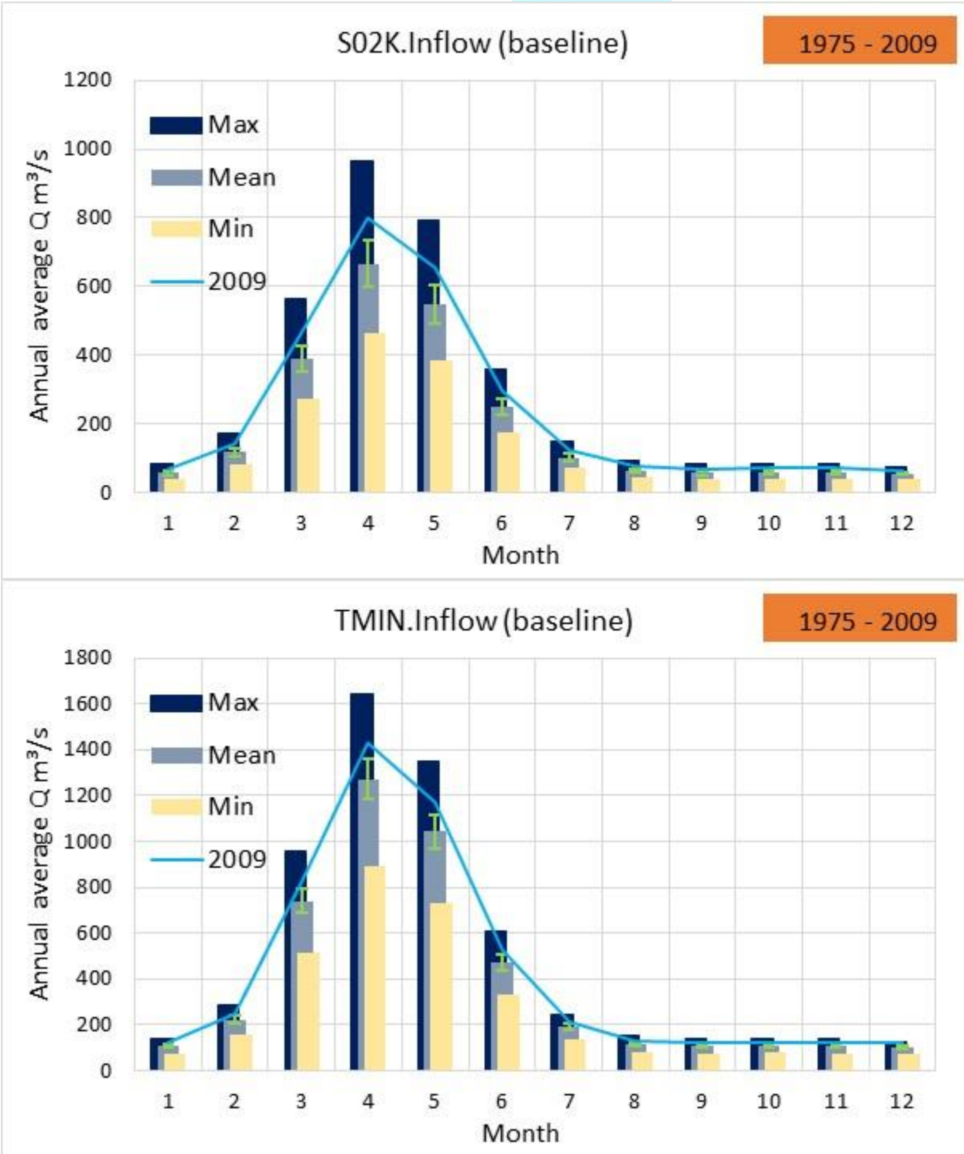


Figure 6: Selected points for the analysis along the Kura River

Three points were selected. S02K represents the upper part and receives flow from the sub-catchments in the northern Caucasus Mountains and upstream the confluence with the Khrami River. TMIN is the total inflow into the Mingechevir reservoir the catchments of the Khrami, Debed, Akhstev, Akhincay, Iori/Qabirli and Ganikh/Alazani rivers. S12K is the mouth of the Kura River and represents the flow which discharges into the Caspian Sea.

The monthly distribution with long-term mean, min and max values is given in Figure 7.



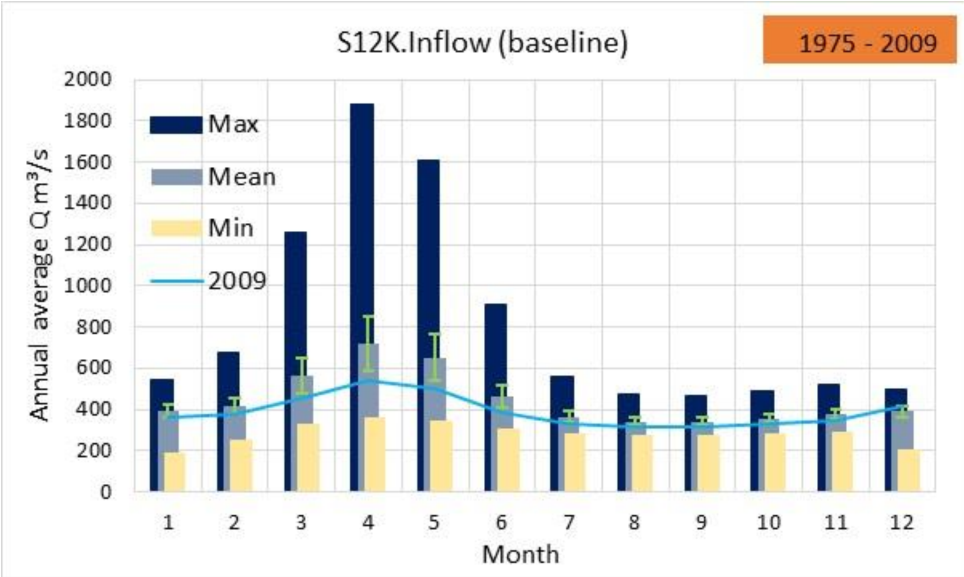
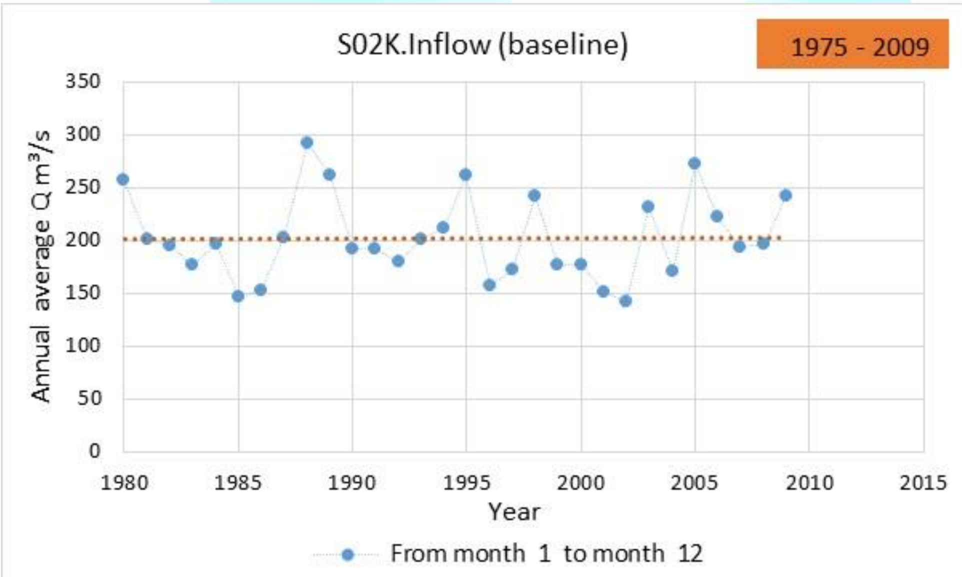


Figure 7: Long-term mean, min and max monthly discharge illustrated with the year 2009

The effect of the Mingechevir reservoir is clearly visible, smoothing downstream mean and min values. However, max values still occur during high flow conditions.

A trend analysis explains what the future would be like if past conditions were to continue and extrapolation was possible.



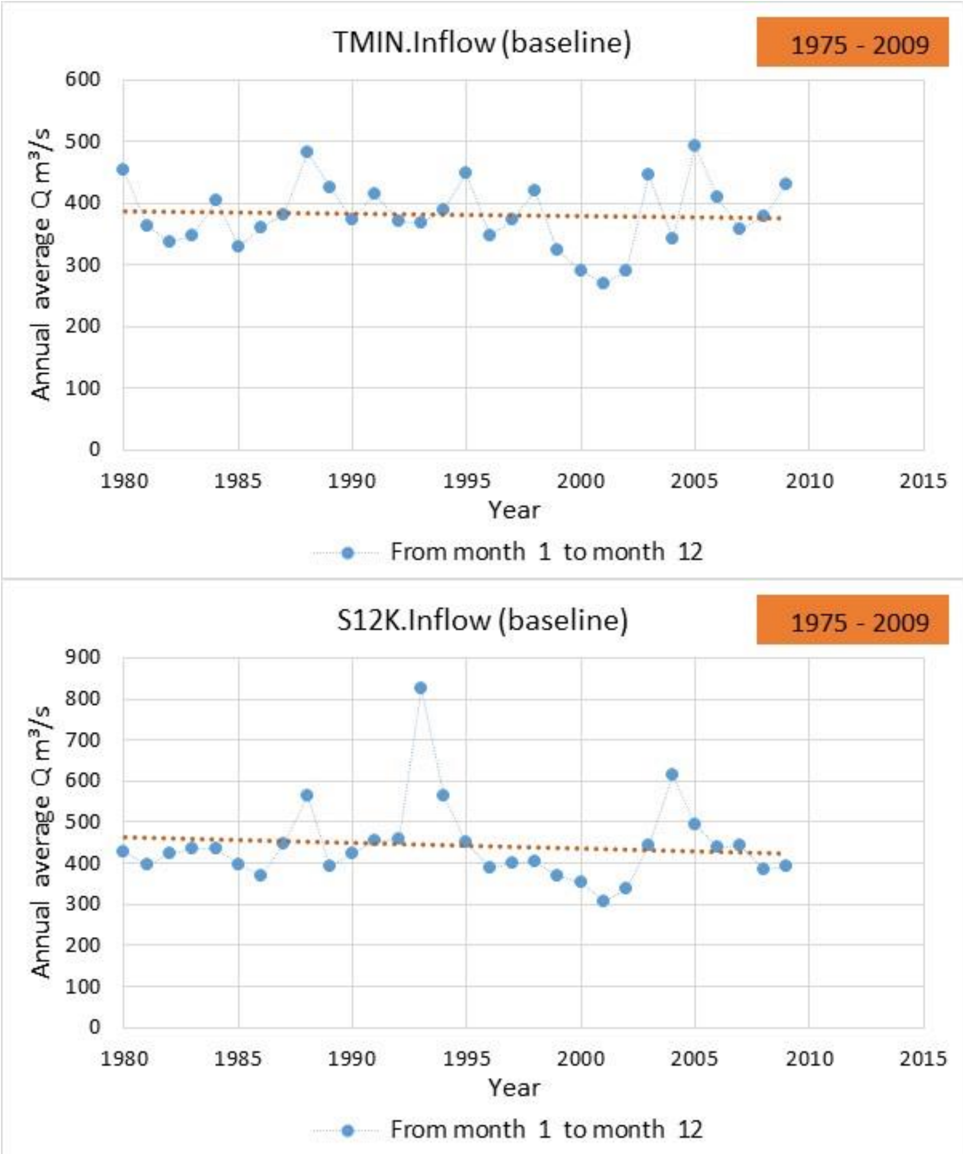


Figure 8: Trend analysis for annual streamflow 1975 – 2010

There is no trend visible in the upper part of the Kura River while a trend seems to exist at the confluence. Such a trend is among others also mentioned in (Verdiyev, 2017b). Analysing the anomaly or derivation from the long-term average shows that the trend mainly stems from exceptionally dry years end of the 90s and the beginning of this century.

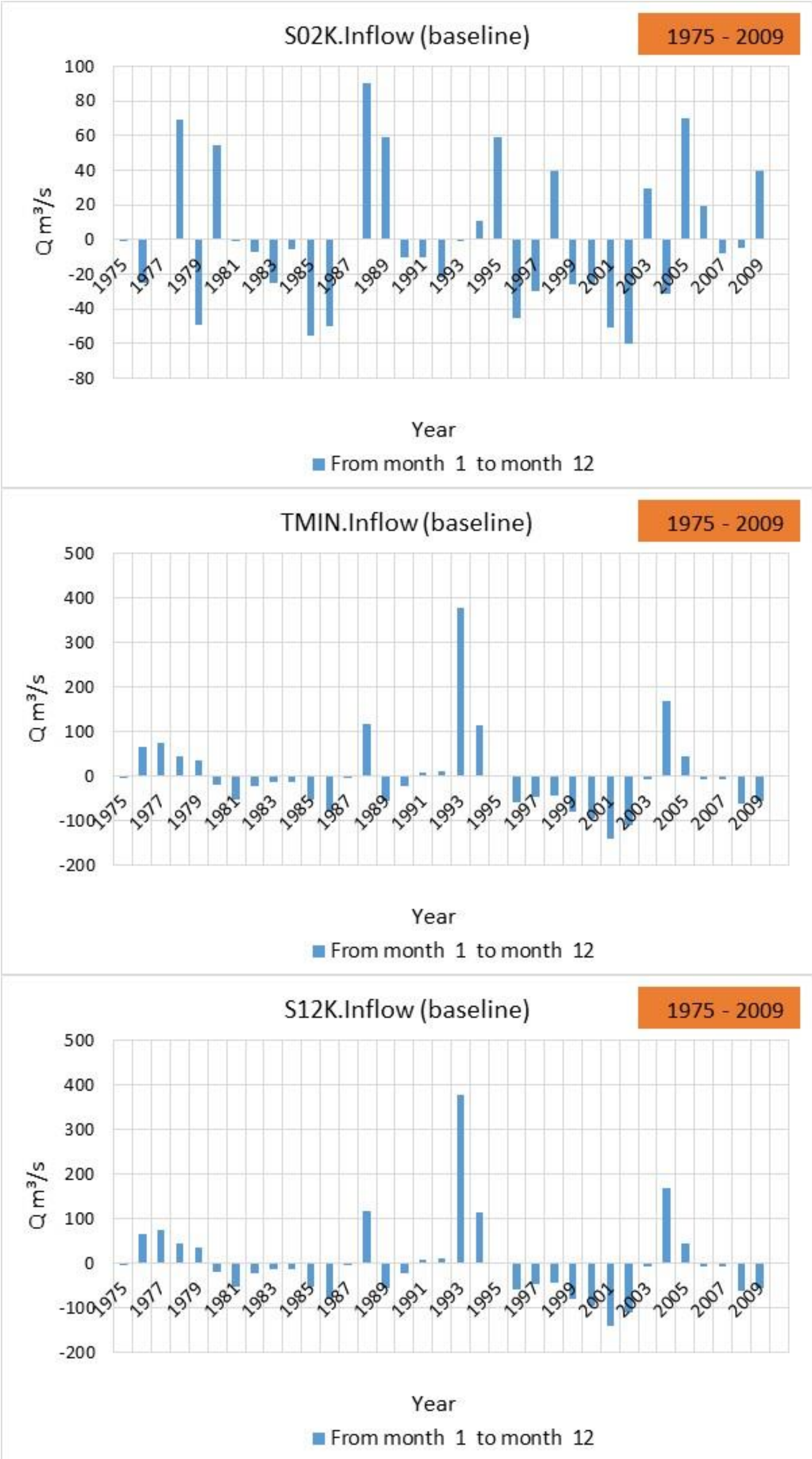


Figure 9: Anomaly of annual streamflow 1975 – 2010

3 CLIMATE CHANGE IMPACTS ON WATER AVAILABILITY

The Regional Climate Change Impacts Study for the South Caucasus Region ((UNDP, 2011) was conducted in 2011 and assessed the Kura River Basin according to likely effects of climate change. A team of international and national experts from Armenia, Georgia and Azerbaijan supported by relevant Ministries of each country worked together on behalf of UNDP and assessed the effect of climate change on available water resources. 65 meteorological stations were analysed, results of different emission scenarios from global circulation models (GCM) were obtained, downscaled and analysed.

The report highlights that climate change is already occurring in the South Caucasus. On the country-average scale, Armenia, Azerbaijan and Georgia all show statistically increasing trends in mean annual temperature, mean daily minimum temperature and mean daily maximum temperature over the last century. The evidence for trends in annual precipitation is less convincing, although there are stations in Armenia and Azerbaijan that have experienced precipitation declines. In Georgia, there are no decreasing trends in annual precipitation, but two stations in the southwestern part of the country show increasing trends in precipitation. Almost all the meteorological stations have recorded increases in the duration of warm spells – either consecutive days above 25 ºC or consecutive nights higher than 20 ºC. There is no strong evidence that the maximum duration between rainy days is changing in the South Caucasus.

Evaluating results of emission scenarios, all GCM are in accord that the mean annual temperature will increase significantly by the end of the century (A2 emission scenario): 1.8 ºC-5.2 ºC and 3.5 ºC-4.9 ºC, in western and eastern Georgia, respectively; 4 ºC - 5.1 ºC in Armenia; and 3 ºC-6 ºC in Azerbaijan. However, results for precipitation are less homogeneous. Only one GCM shows an increase of precipitation while but all other models applied for the region reveal a decline in precipitation for all three countries: 20 – 31% in Armenia, 5- 23% in Azerbaijan, and 0 – 24% in Georgia by the end of the century (A2 emissions scenario). In view of already occurring dryer conditions, there is more evidence that the South Caucasus will continue to become drier this century.

What this means for water availability was further analysed in (UNDP, 2011). Three transboundary river basins in the South Caucasus were assessed: Alazani (Ganikh), Khrami-Debed and the Aghstev River Basins. Due to projected declining precipitation and increasing temperatures, by the end of the century, streamflow is projected to decline dramatically: 26 - 35%, 45 – 65%, and 59 – 72% in the Alazani (Ganikh), Khrami-Debed and Aghstev Basins, respectively. If this becomes reality within the next 30 to 70 years, there is a dramatic change of the water resources in the countries.

In the light of this assessment one scenario was developed and evaluated, a 25% reduction of streamflow equally distributed over the Kura River Basin.

Although a 25% reduction is the lowest impact according to (UNDP, 2011), the effect is huge and disproportional.

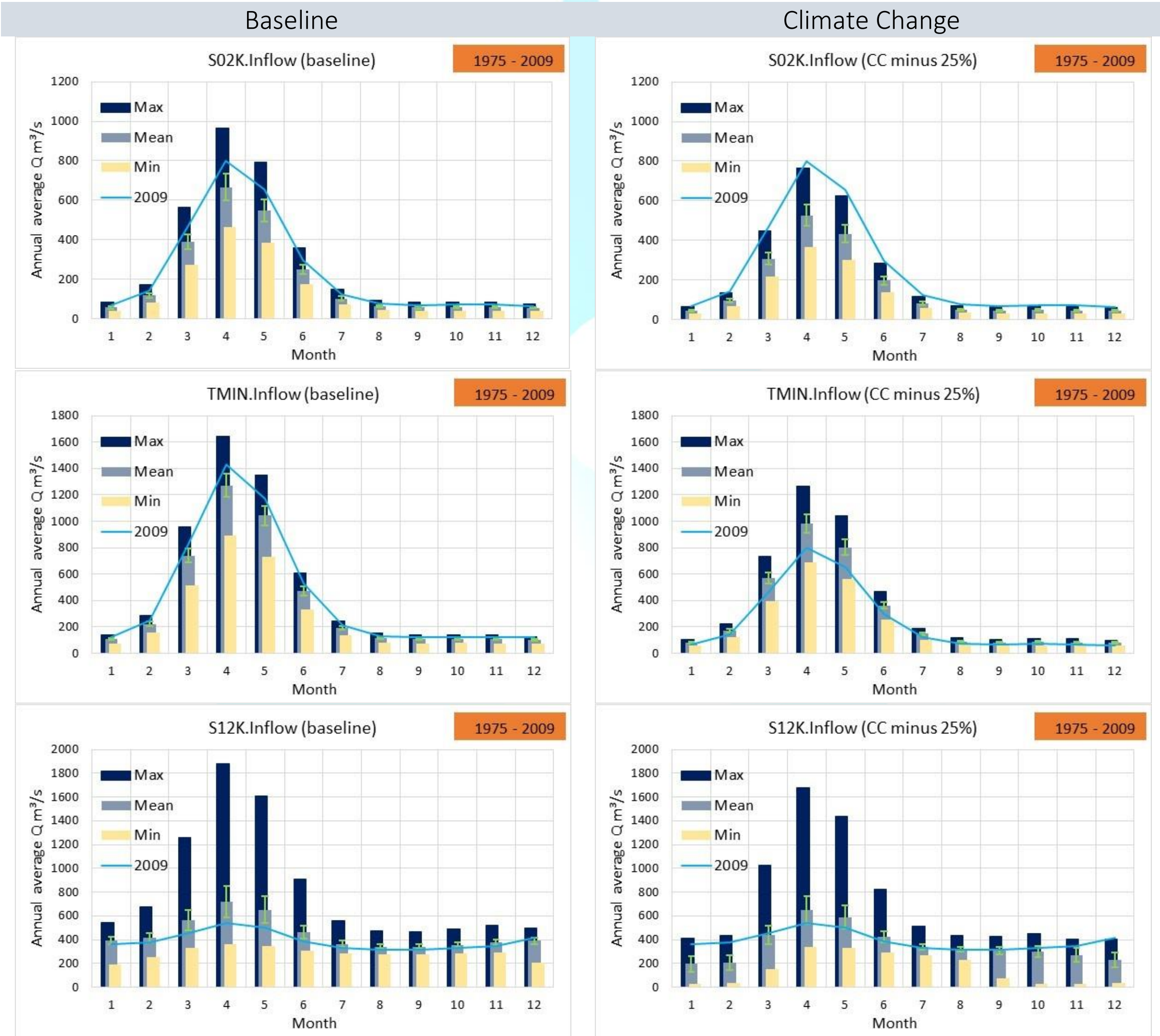


Figure 10: Comparison of baseline and CC scenario A (long-term mean, min and max)

Uncontrolled streamflow will drop dramatically and it is questionable if low flow conditions remain at the level indicated because of the simplified approach used. The figure seem to reveal that floods are not a problem anymore. This is wrong as monthly means simply level out effects of extreme flood conditions. In other words, preparedness for drought and flood conditions is essential.

The situation occurs less drastically downstream the Mingechevir reservoir. The answer is that the relatively consistent level at point S12K is achieved at the expense of the reservoir level.

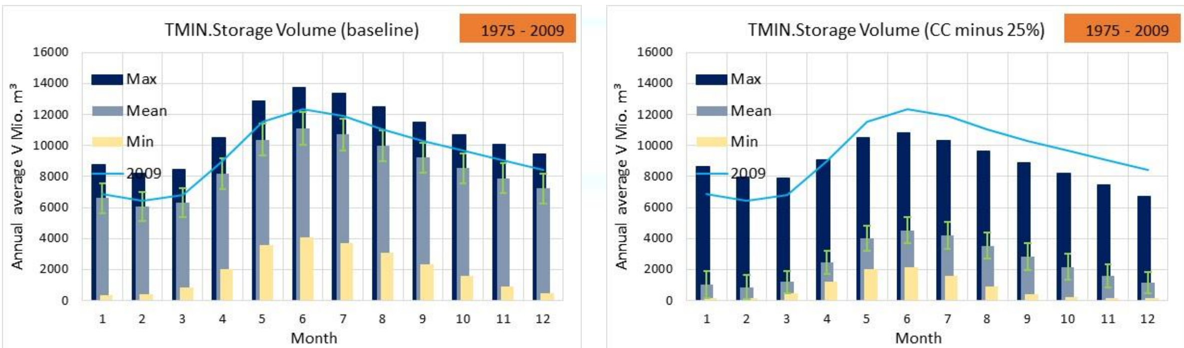


Figure 11: Comparison of baseline and CC scenario A (storage volume – Mingechevir reservoir)

The decrease of the storage volume means a reduction of security of supply.

Figure 12: Comparison of trends for annual streamflow (baseline – CC)

Apart from the fact that streamflow drops by 25%, it is interesting that the trend exacerbates downstream the reservoir. The reason is that the reservoir more frequently reaches its minimum operation level and cannot fulfil the required low flow augmentation.

4 FUTURE DEVELOPMENTS IN THE COUNTRIES

4.1 Population

The National Statistics Office of Georgia has published the main results of the 2014 General Population Census (Geostat, 2016). There is a declining trend in the overall population in Georgia and at the same time a significant migration from rural areas to cities, mainly Tbilisi.

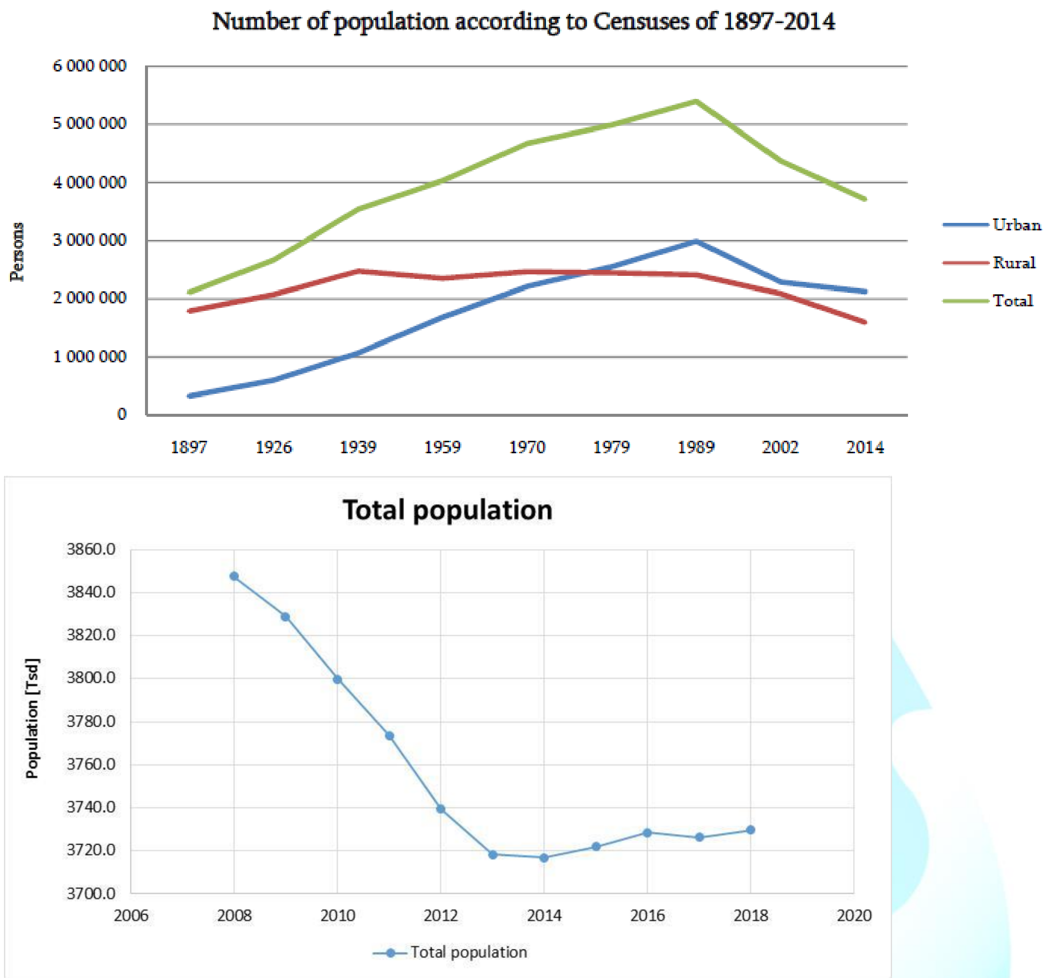


Figure 13: Population in Georgia 1897 to 2018 taken from (Geostat, 2016) and (Geostat, 2018).

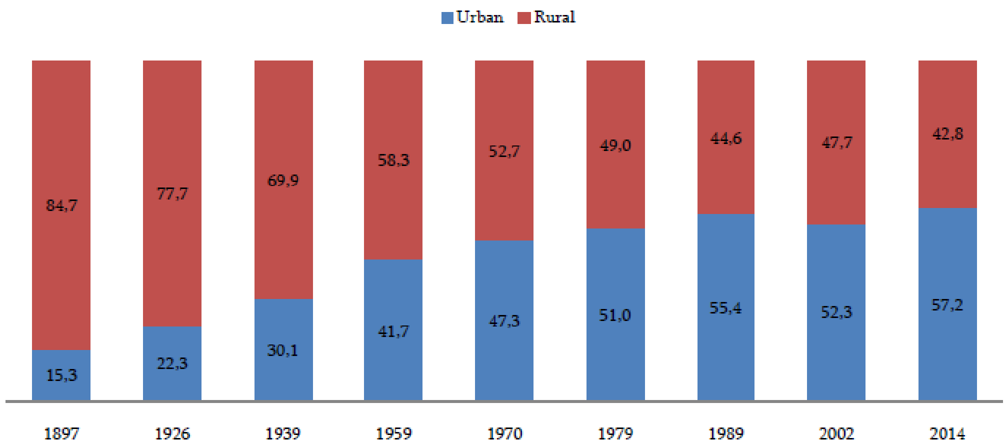


Figure 14: Distribution of urban/rural population (Geostat, 2016).

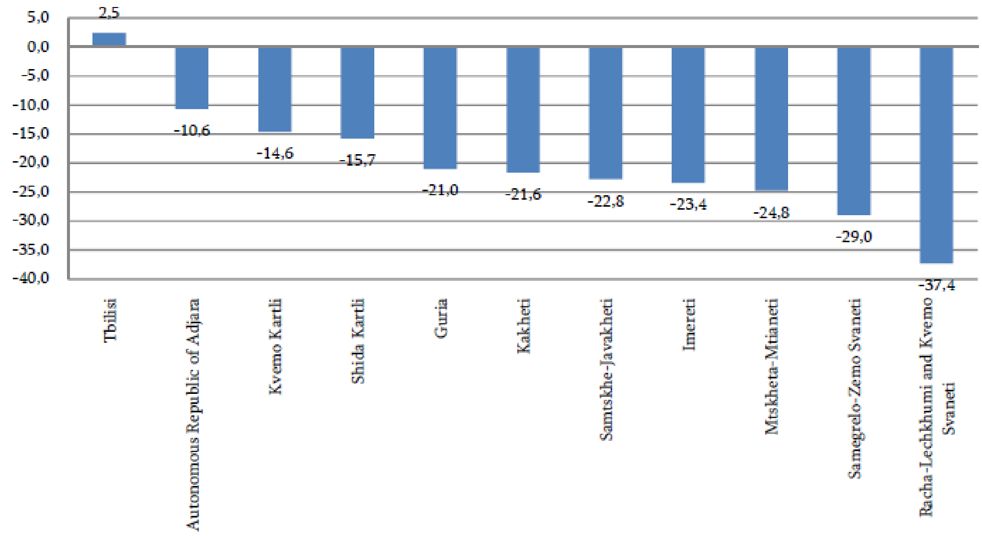


Figure 15: Increase/decrease of number of population for selected regions compared to 2002 Census (%)(Geostat, 2016).

At first glance, the decline of the population in Georgia seems to bring a reduction of water consumption and might release pressure on water resources. Unfortunately, just the opposite hold true. In fact, the undoubtedly trend of urbanisation in Georgia will increase the pressure on water resources mainly because of two reasons:

1. Water consumption in urban areas, e.g. Tbilisi, is by a factor of 3 to 5 higher compared to rural areas.
2. Water use and even more importantly, waste water discharges concentrate on certain locations and will lead to a drastic drop of the water quality in receiving rivers and adjacent groundwater aquifers.

4.2 Agriculture

The strategy of Georgian Amelioration, supported by the World Bank and other donors, is to counter the decline of the agricultural sector in the country. Investments into new technology, development of new irrigation areas and reservoirs accompanied by incentives and new water fees are considered to turn the negative trend into a bright future of the agricultural sector. Even under very positive assumptions concerning water use efficiency, it is strongly recommended to thoroughly analyse the feasibility of development plans in the light of changes of water availability under climate change. It is of utmost importance that isolated sectoral thinking is avoided in favour of integrated and joint planning hand in hand with the water sector and to embark on integrated water resources management principles.

(UNDP, 2011) provides valuable information on future crop water and irrigation requirements. Water requirements were projected for main crops in three important agricultural regions in the South Caucasus, namely the Ararat Valley (Armenia), the Belakan region (Azerbaijan), and the Dedoplistskaro region (Georgia). In the Ararat Valley, by the end of the century, crop water requirements (CWR) for winter wheat and vegetables are projected to increase 19 – 22% and 19 – 23%, respectively, compared to 1967 – 1982, while irrigation water requirement (IWR) is projected to increase 35% - 36% and 38% - 42% for winter wheat and vegetables, respectively.

The increase in water requirements is a consequence of decreasing precipitation and increasing temperatures with higher evapotranspiration. Even maintaining existing irrigation facilities will require significantly more water in the future. A shift to drought-tolerant crops, efficient use of modern irrigation techniques, nature-based erosion protection measures to keep soil fertility as high as possible are proposed in (UNDP, 2011).

4.3 Industry

Industry is in Georgia not yet a big water consumer and will play a minor role in view of water availability. However, climate change induced effects must be considered if investors are attracted by means of low taxes and low water fees.

4.4 Mining

Certain activities related to mining need water, be it as direct consumers of water for production processes or be it to have sufficient streamflow to limit concentrations of toxic and/or unwanted substances when waste water is discharged into rivers. The problem of emitting waste water and keeping a good standard of water quality has increasingly become an issue in Europe and in other parts of the world. The level mining companies are affected depends on how water quality standards are enforced and environmental laws are mandatory. The EU WFD, for example, owns high water quality standards and if and when Georgia is to adopt the EU WFD, mining companies or more generally, all emitters of waste water, are advised to pre-empt restrictions by foresighted investments in advanced water treatment technology.

4.5 Hydropower and Energy generation

A reduced availability of flow has detrimental effects on hydropower generation. A 25% drop of streamflow will reduce the operating time of turbines disproportionally as a 25% reduction is beyond the assumptions when turbines were designed, so that minimum operating levels will often be undershot. Recent developments of hydropower dams in the country should take likely changes in streamflow regimes into account by flexible designs and turbines with a flat efficiency curve and a wide range between the maximum capacity and minimum flow.

Conventional power plants relying on water for their cooling system or if they release water with high temperatures into rivers will face more production stops compared to the past.

4.6 Summary

UNDP to Georgia writes, that the sectors and regions most vulnerable to water stress and climate change in Georgia have been identified. Apart from the Black Sea coastline, which was identified as the most vulnerable system having a strategic importance for the rehabilitation of the country's economy and development of foreign trade, the second important vulnerable system in Georgia is agriculture, where special attention is paid to wheat in Eastern Georgia. Also, in spite of a currently sufficient supply of water resources, appropriate attention must be paid to increase the efficiency of water utilization.

Based on the climate change assessment conducted on behalf of UNDP in 2011 ((UNDP, 2011) and hydrological modelling performed for this report, a likely 25% reduction of streamflow can lead to a 50% drop of storage volume in reservoirs as exemplarily demonstrated for the Mingechevir reservoir. The drop is caused due to the attempt to keep downstream requirement at the current level.

As a result, the security of supply will drop and reservoir operation might become more challenging. The need for seasonal forecasts will rise. Integrated planning and strong collaboration between different sectors will be a must.

Furthermore, a reduction of streamflow will certainly decrease the quality of surface water if the current standard of waste water treatment in still in place in the future.

Reduced streamflow will lead to more groundwater abstraction, most likely beyond the annual recharge level, which will be reduced as well.

As such, water use efficiency will become one pillar for development or – if not in place – a major obstacle for development. Consequently, water use efficiency should be promoted and enforced at all levels.