UNDP/GEF project

Reducing transboundary degradation in the Kura Ara(k)s river basin

DESK STUDY – ANALYSIS OF TRENDS

in hydropower, agricultural and municipal water use in the Kura Ara(k)s river basin

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Tbilisi, Georgia – Baku, Azerbaijan – Yerevan, Armenia

September 2013

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DESK STUDY 4 ANALYSIS OF TRENDS in hydropower, agricultural and municipal water use in the Kura Ara(k)s river basin

The Desk Study on Analysis of Trends in hydropower, agricultural and municipal water use in the Kura Ara(k)s river basin, prepared in the framework of the UNDP/GEF project “Reducing transboundary degradation in the Kura Ara(k)s river basin” focuses on providing a regional overview of ongoing economic development trends in three key water use sectors in the Kura Ara(k)s river basin – the expansion of large and small hydropower generation, restoring agricultural production, focusing on the irrigation subsector, and developments to improving the municipal water use sector.

The information in this Desk Study presents separate analyses of the three key water use sectors, based on information provided by and discussions with qualified National Experts in the three project countries Armenia, Azerbaijan and Georgia. The integrated impacts of national sectoral development plans on regional water resources in the Kura Ara(k)s river basin are discussed in the final concluding chapter. The collection of information and the country analyses have been coordinated by the appointed UNDP/GEF Kura Ara(k)s project National Coordinators in the project countries.

Information presented in this Desk Study was prepared as input to the appropriate section of the Transboundary Diagnostic Analysis (TDA) prepared by the UNDP/GEF Kura Ara(k)s project. The information will also be used to guide identification of measures for the regional Strategic Action Program (SAP) towards ecosystem based IWRM in the Kura Ara(k)s river basin.

The views presented in this document do not necessarily coincide with or represent the views of the United Nations (UN), the United Nations Development Program (UNDP), the United Nations Office for Project Services (UNOPS), the Global Environment Facility (GEF), or of any organization in any of the project countries Armenia, Azerbaijan, Georgia, but is the sole view of the authors and contributors to this report.

Colophon

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AM	Armenia
AM-MNP	Ministry of Nature Protection of Armenia
AM-NSS	Armenia National Statistical Service
AM-PSRC	Public Services Regulatory Commission of Armenia
ArmStat	National Statistical Service of the Republic of Armenia
AZ	Azerbaijan
AzerStat	State Statistical Committee of the Republic of Azerbaijan
BCM	Billion Cubic Meters
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
FAO	Food and Agricultural Organization, United Nations
FAOSTAT	Statistics Division of the FAO
GDP	Gross Domestic Product
GE	Georgia
GEF	Global Environment Facility
GE-MA	Georgia Ministry of Agriculture
GE-MEnNR	Ministry of Energy and Natural Resources
GE-MEP	Ministry of Environment Protection of Georgia
GE-MEPNR	Ministry of Environment Protection and Natural Resources of Georgia
GE-MRDI	Ministry of Regional Development and Infrastructure of Georgia
GeoStat	National Statistics office of Georgia
GWh	Gigawatt-hour
HPP	Hydropower plant
IAEA	International Atomic Energy Agency
IFI	International Financing Institution
IWRM	Integrated Water Resources Management
JSC	Joint Stock Company
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
KW	Kilowatt
KWh	Kilowatt-hour
MCC	Millennium Challenge Corporation
MCM	Million Cubic Meters
MW	Megawatt
NPP	Nuclear Power Plant
OECD	Organization for Economic Cooperation & Development
PPP	Public-private partnership
SAP	Strategic Action program
SHPP	Small Hydropower Plant
TDA	Transboundary Diagnostic Analysis
TPP	Thermal Power Plant
TWh	Terrawatt hour
UN	United Nations
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
WB	World Bank
WSS	water supply and sanitation
WWTP	Waste water treatment plant

1. INTRODUCTION

This document is the Desk Study on Analysis of Trends in hydropower, agricultural and municipal water use in the Kura Ara(k)s river basin, which describes the challenges of transboundary water resources management in the Kura Ara(k)s river basin resulting from national development trends known to date in important economic water use sectors in the river basin.

The Desk Study is prepared as part of the Transboundary Diagnostic Analysis (TDA) for the UNDP/GEF project "Reducing transboundary degradation in the Kura Ara(k)s river basin. In line with GEF International Waters Best Practices, the TDA provides a detailed baseline description of the situation in the basin, an analysis of the priority transboundary issues, as well as a causal chain analysis for each issue. The information in this document unites available national information from relevant stakeholder authorities and qualified National Experts, the inputs of whom were coordinated by the UNDP/GEF Kura Ara(k)s project National Coordinators in each of Armenia, Azerbaijan and Georgia in 2012 and 2013.

A description of the linkages and the regional socio-development trends in relation to water management, including climate change, extend to new information and analyses within the TDA. In order to define appropriate management responses towards improved ecosystem-based integrated water resources management (IWRM), it is imperative not only to consider the sectoral historical developments that have led to anthropogenic deterioration of the basin ecosystems as observed today, but also to consider the context of intersectoral future socio-economic developments in the basin.

Accordingly, the current report presents an assessment of economic development trends as they impact on water resources use, based on empirical evidence. Future challenges to development and water resources due to both short term and long term development plans are examined for all sectors – hydropower (chapter 2), agriculture (chapter 3) and municipal water use (chapter 4). Integrated implications for water resources in the Kura Ara(k)s basin and riverine ecosystem health with in the countries and across the basin are discussed in chapter 5, with conclusions and recommendations presented in chapter 6.

Both the trend analysis and the scenarios are intended as an initial examination of the development options in line with the water nexus approach, which assesses progress in light of food-energy-water-environmental security. By examining these issues within the scope of the TDA the intention is to draw attention to not only the current and historical causes of the transboundary degradation, but also towards future expansions in sectoral development that if not addressed promptly will threaten to exacerbate these priority transboundary issues and create additional increasingly intractable problems in the basin.

2 HYDROPOWER DEVELOPMENT

The water resources available in three Southern Caucasus countries provide for a significant potential of hydropower development. Accordingly, the governments of Armenia, Azerbaijan and Georgia have adopted strategic and policy documents on hydropower development. Meanwhile, the demand for hydro-generated energy is not the same among the countries. Azerbaijan, as a petroleum-based economy and an arid country is relatively less interested in hydropower development. Yet, developing towards alternative energy sources, there are plans for about 160 small HHPs in addition to a few large ones. The energy policy in Armenia is directed towards the development of medium and small HPPs, planning to construct about 75 stations in total. As Georgia's energy security is more dependent on hydropower development, it envisages the development of medium and large HPPs along with small stations, with currently 36 HPPs planned and a further potentially 83 HPPs identified.

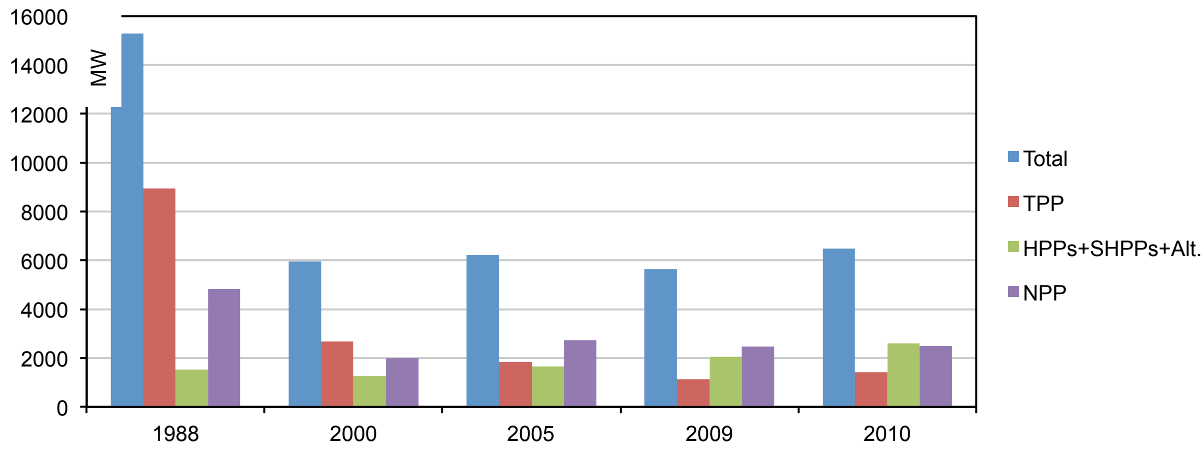
2.1 Armenia

The energy sector in Armenia suffered through a period of reduced availability, due to the economic crisis, the earthquake impacts on the Metsamor NPP, and unreliable gas supply. Since 1996 however the country is able to satisfy its internal needs, despite the overall production being at only 42% of that during the late 1980s. The period of independence also shows a shift from nuclear (-57%) and thermal power (-84%) towards hydropower (+70%) (Figure 2.1.1). In 2011, the total in-country energy production amounted to 7,432.7 GWh, of which about 15% was exported, the remaining 6,351.0 GWh for in-country use (ArmStat, 2012). The NPP remains the largest producer of electricity (39%), followed by large HPPs (33%), TPPs (22%) and small HPPs (6%) (IAEA, 2011).

Before 1990 hydropower generation depended mainly on large HPPs, namely the Hrazdan and Vorotan Cascades, still in operation today, with a total capacity of about 1,000 MW. Construction of small HPPs started after 2000. At present, 129 SHPPs are operational, with a total capacity of 210 MW (table 2.1.1).

The Public Services Regulatory Commission of Armenia (PSRC) has already issued licenses for the construction of another 75 small HPPs with the total capacity of 156 MW (table 2.1.1). Plans exist to further increase the total capacity of SHPPs by another 370 MW by 2025. Also 3 medium HPPs are planned: the Meghri HPP (130 MW, 800 GWh); Shnockh HPP (75 MW, 300 GWh) and Loriberd HPP (57MW, 250 GWh). The potential for hydro-power generation is estimated at 21,800 GWh, including large and medium rivers – 18,600 GWh and small rivers – 3,200 GWh (Armhydroenergyproject JSC, 2008).

Figure 2.1.1 Power generation trends in Armenia between 1988-2010 (in MW).



Source: International Atomic Energy Agency (2011).

Energy development in Armenia is based on a number of strategic programs, including the Energy Sector Development Strategy (2007), formulating its strategic targets and overall direction based on sustainable development principles, taking national security aspects into account.

The National Program on Energy Saving and Renewable Energy (2007) provided for a cross-sectoral assessment of the energy saving and renewable energy potential in Armenia and recommended actions for cost-effective utilization. The assessment included an examination of large and energy intensive enterprises as well as end-use consumption. This allowed revealing trends and making projections for development of the energy sector. According to the Program, future development of the sector is planned through: 1) construction of medium size HPPs (with the capacity of 250-300 MW); 2) construction of additional small HPPs with the total capacity up to 250 MW; 3) rehabilitation of the thermal power plants and construction of modern cogeneration steam-gas power units; 4) continuous enhancement of the safety level of the existing NPP and development of new nuclear units based on modern technologies; 5) investing in renewable energy units, such as: wind (up to 200 MW), solar (up to 1750 KWh/m^2/yr) and geothermal.

Table 2.1.1 Existing and Planned Small HPPs in Armenia.

Location by Marzes (regions)	Existing		Planned	
	№	Capacity (KW)	№	Capacity (KW)
Armavir	4	9,940	3	10,308
Aragatsotn	4	8,098	6	14,932
Ararat	2	3,520	-	-
Gegharkunik	11	13,930	8	25,526
Kotayq	14	13,455	3	3,559
Lori	24	58,100	11	11,622
Shirak	6	15,262	5	9,358
Syunik	33	35,703	19	43,858
Tavush	11	11,478	6	9,484
Vayots-Dzor	19	39,256	14	27,458
Yerevan City	1	750	-	-
Total	**129**	**209,492**	**75**	**156,105**

Source: AM-PSRC (2012).

The Strategic Development Program for the Hydro-energy Sector of AM (2011), based on the National Water Program encourages water resources use for energy production towards ensuring the energy security of the country. It provides a list of perspective SHPPs (<10 MW) as well as the technical-economic justification for the three medium HPPs. It also calls for the rational use of water resources for energy generation, and provides an action plan for safe operation of the HPPs for the Ministry of Energy.

Hydropower developments in Armenia are led by the Ministry of Energy and Natural Resources and Ministry of Economy. Financing for small HPPs largely comes from private sources, while the new unit for NPP is funded through loans, while industrial development is envisioned through private funding. The Meghri HPP (130 MW) is financed by Iran based on a production sharing agreement.

The negative environmental impact of small hydropower stations concerns fish migration for spawning, when special passages for fish or measures to prevent fish injury by turbines are not anticipated during the design of the project. A very damaging impact could be caused by failure to maintain an adequate ecological flow – providing for sufficient volumes and variation according to seasonal ecological needs, as well as by violations of other water usage (discharge) requirements. According to the RA report on Climate Change, the river flow will be reduced by 0.6 BCM (8.5%) by 2030.

The main concern related to hydropower generation is impact on river hydrology, related to maintaining environmental flows for fish and other aquatic organisms and providing longitudinal connectivity for safe fish migration. Additionally, especially SHPPs using the run-of-river approach impact on the water provision to the local community. Currently often while stipulated in water permits, minimum environmental flows are commonly not observed, which causes environmental pressures on a river basin. Better enforcement is needed, during design and operation, based on a well-designed and implemented monitoring system. Also the current methodology on calculating environmental flows needs to be changed, towards taking local hydrological flow conditions, including their seasonality, and their impact on aquatic life into account. According to preliminary estimates by water sector specialists, the water demand for hydropower development will comprise 2.2 BCM, and about 59 MCM/year for the planned new nuclear unit of the NPP.

2.2 Azerbaijan

In 2011, electric energy production in Azerbaijan amounted to 20,294 mln KWh, of which 85% was generated by thermo-electric stations and 13.2% by hydro-electric stations. Currently existing HPPs in Azerbaijan are listed in table 2.2.1.

Good opportunities exist for the further expansion of hydropower generation in Azerbaijan. The Government of Azerbaijan is planning to increase the energy production from renewable sources, including hydropower, by 20% for 2020 (Zerkalo, 17 November 2012). Total annual energy production of potentially small hydropower plants can reach 3.2 TWh (www.economy.gov.az, 26 November 2012). With the support of ADB Baku, 22 potential small hydropower sites have been identified in Azerbaijan. Their envisioned capacities vary from 400 KW to 28 MW, for an overall capacity exceeding 150 MW. Implementation of all projects would require an investment amounting to more than 200 mln US$. Further screening based on technical, economic and environmental assessments resulted in a short-list of 10 SHPPs to be approved by the Ministry of Economy. For 4 SHPPs formal feasibility studies have subsequently been prepared (ADB, 2007), of which 3 are currently under construction: Chinarli (Shamkirchay river), Yukhari Karabakh Channel and Kateck (Katech river), while the Sheki HPP is already operational.

Table 2.2.1 Existing hydropower stations in Azerbaijan.

HPP	River	Capacity (MW)	Annual energy production(GWh)	Water discharge (m^3/s)
Mingechevir	Kura	370	1,355	780
Shamkir	Kura	380	845	850
Varvara	Kura	17	90	360
Yenikend	Kura	150	395	810
Ara(k)s	Ara(k)s	260	80	260
Sarsang	Terter	50	123	67
Vaykhir	Nakhchivanchay	5	12	11
Total		**1,232**	**2,900**	

In addition, it has been planned to build three hydropower stations on Shamkirchay water reservoir which is currently used for irrigation and energy production (AWE JSC, 2010). Installed capacity of the existing HPP on Shamkirchay reservoir is 24.2 MW with annual energy production of 50 GWh. The total volume of the reservoir is 160 MCM, its useful volume – 135 MCM. There are two HPP stations under construction currently. A 25 MW HPP station is being built on the main Mil Irrigation Channel taking its beginning from the Ara(k)s River. The construction is planned to be finished in 2012. In addition, a small, 1 MW HPP station is being built on Goychay River, a left tributary of the Kura River. The construction has to be finished by the end of 2014.

There are ongoing hydropower development projects also in the Islamic Republic of Iran - on the Ara(k)s river the Giz-Galasi water reservoir is being constructed, downstream of Khudafarin, planned to contain 62 MCM for a hydropower capacity of 40 MW, to be completed by the end of 2013. In addition, in 2011 Iran completed the construction of the Khudafarin HPP (200 MW) and reservoir, which is currently being filled to a planned capacity of 1.6 BCM.

As the Nakhchivan Autonomous Republic is not attached to the Azerbaijan's main energy system, the construction of micro, small and medium HPPs was identified as a first priority (www.abemda.az, 26 November 2012).

Industrial water use in the early 1980s in the Kura Ara(k)s basin of Azerbaijan abstracted 1.1 BCM. Of this volume, 32% was used by the Mingechevir TPPs, while 62% was consumed in the Shirvan industrial region, and the remaining 6% in other parts of the basin (The scheme ..., 1982).

2.3 Georgia

Hydropower is the only domestic energy resource available in significant volumes in Georgia. The total hydropower potential in the country is estimated at 80 TWh, of which 27 TWh is considered to be economically viable.

Following independence from the Soviet Union Georgia suffered severe energy crises, as the country largely depended on imported electricity, as the local power generation was low due to deteriorated infrastructure. Since 2000 significant investments have been made, in power generation as well as transmission and distribution networks. Consequently, from a net importer, Georgia has become a net exporter of electricity. Total power generated in Georgia amounted to 10,046 GWh in 2010 (Figure 2.3.1). From this hydropower generation is accountable for 9,368 GWh (93%) and thermal power generation for 679 GWh (7%). Mean annual growth rate in hydropower production from 2004 to 2010 amounted to 6.7% (EBRD, 2012). The share of TPPs has been gradually reduced, currently used for covering peak demands, a consequence of increase gas prices. Currently 51 HPPs are operational, of which 29 located in the Kura basin. Existing HPPs vary in size from large (1,300 MW, Inguri HPP) to very small (<1 MW). The majority of HPPs are run-of-river types with dams not exceeding 10 m., while about 20% of all HPPs consist of larger dams (up to 100 m – Zhinvali HPP) with corresponding reservoirs (table 2.3.1).

Table 2.3.1 Existing and planned HPP stations in the Kura Basin in Georgia.

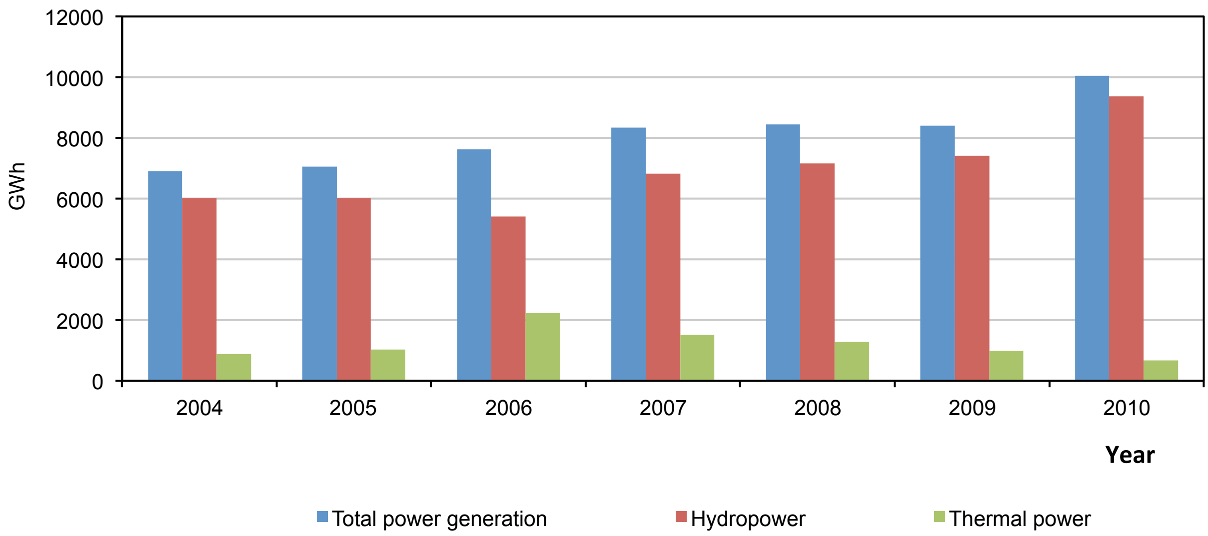
HPP Name	Year	Capacity (MW)	Annual generation (GWh)
EXISTING			
Zahesi	1927	36.8	160
Ortachala	1954	18.0	80
Tetrikhevhesi		12.4	
Khrami-I	1949	112.0	184
Khrami-II	1963	110.0	317
Satskhenisi	1952	14.0	50
Martkofi	1952	3.8	14
Sionhesi		9.1	
Mashavera		0.8	
Algetihesi		1.3	
Dashbashhesi		1.3	
Dmanisihesi		0.5	
Chitakhevi	1949	21.0	110
Kakhareti	1957	2.0	11
Khertvisihesi		0.6	
Paravani HPPs		0.6	
Rustavihesi		1.5	
Tiriponi	1951	3.2	
Igoetihesi		1.1	
Okamihesi		1.6	
Zhinvali	1985	134.0	350.0
Misakcieli		3.0	
Pshavelahesi		0.5	
Alazani	1942	4.8	35.0
Khadori	2004	24.0	100.0
Intsobahesi		1.7	
Chalahesi		1.5	
Kabalhesi		1.5	
Boldodahesi		2.5	
PLANNED/ONGOING			
Alazani 2		6.0	40.0
Khadori 2		5.4	35.1
Shilda	2013	5.3	32.2
Gudauri	2015	7.7	50.6
Mtkvari	2015	43.0	200.0
Paravani	2013	85.8	450.8
Paravani HPP Cascade – Akhalkalaki, Abuli, Arakali	2014	Total – 48.3 (8.8; 22.2; 17.3)	Total 260.2 (48.1; 116.2; 95.9)

Table 2.3.2 Overview of hydropower generation in Georgia.

HPP facility	Georgia			Kura Ara(k)s basin			
	MW	GWh	% *	MW	% **	GWh	% **
Existing	2,483	7,826	40.0	525	21.1	1,411	18.0
Planned/ongoing	2,220	9,432	48.5	201	9.1	1,069	11.3
Prospective	1,802	7,230	45.8	170	9.4	792	11.0

*Sources: EIA reports at www.aarhus.ge; http://hpp.minenergy.gov.ge; www.menr.gov.ge. Notes: * percentage of maximum yearly power generation based on installed capacity; ** percentage of actual capacity (MW) and yearly energy production (GWh) generated in the Kura Ara(k)s basin section within Georgia.*

Figure 2.3.1 Power generation in Georgia in 2004-2010.



Source: National Statistic Service.

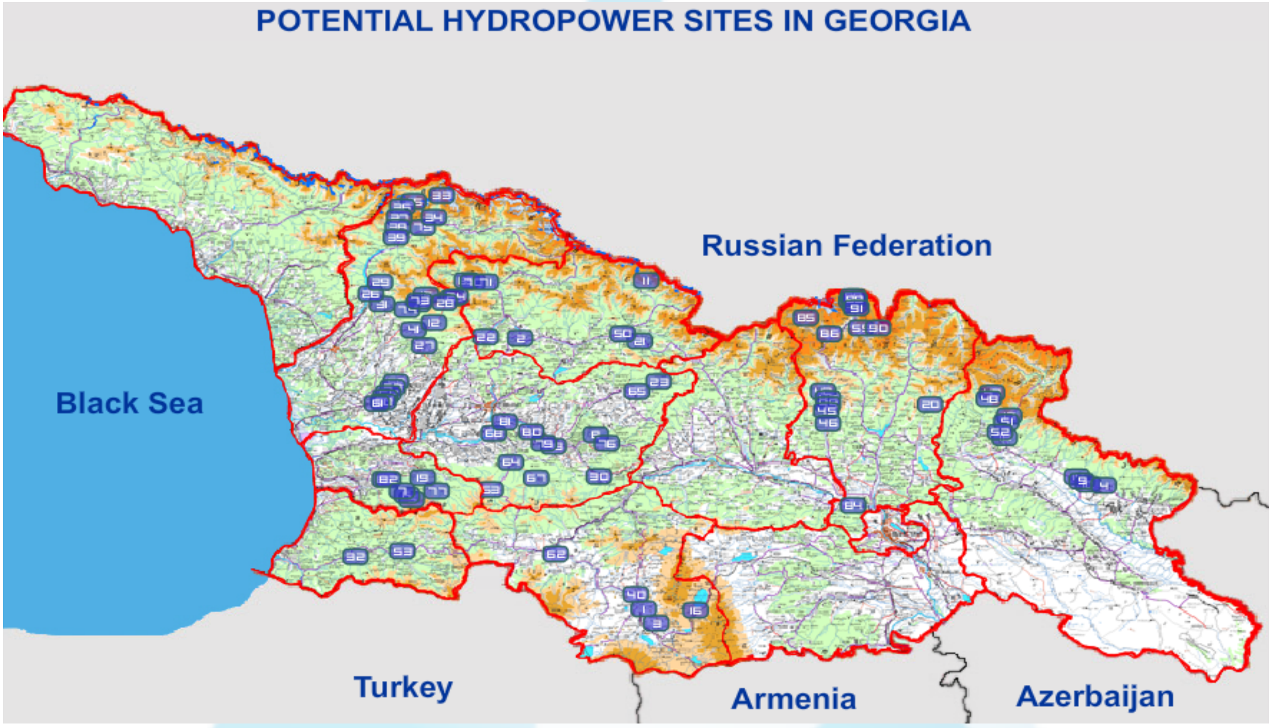
Currently Georgia plans to significantly expand hydropower generation in the near future. Already throughout the country 36 more hydropower development projects are planned of which 9 are to be constructed in the Kura Basin (Table 2.3.1). In addition, long-term prospective locations for HPP stations have been identified, and investment is actively pursued by the government of Georgia. In the Kura basin, 24 HPPs were identified, envisioned to add an additional 170 MW to existing and short-term HPP developments. An overview of all identified potential HPPs in Georgia is presented in figure 2.3.2.

Development of hydropower is based on the Energy Policy, adopted in 2006, one of the objectives of which is effective utilization of national water resources to fully meet internal energy demands. The main directions of the National Energy Policy of Georgia are described as: (1) Energy Efficiency – increasing energy-efficiency in the industrial and municipal sector; (2) Energy security – a) rehabilitation of the old outdated power stations; rehabilitation of the infrastructure connections with energy systems of neighboring countries; rehabilitation of transmission lines; b) construction of new power stations and gradual substitution of imported energy and thermal energy by hydro-energy; construction of new transmission lines.

Table 2.3.3 Prospective HPP stations in the Kura basin in Georgia.

HPP Name	Capacity MW	Annual generation (GWh)	HPP Name	Capacity MW	Annual generation (GWh)
Dzegvi	15.7	82.44	Stori 1	14.0	69.37
Iori	9.7	54.00	Stori 2	11.4	50.52
Ksani 1	4.2	15.23	Stori 3	13.7	60.56
Ksani 2	2.1	9.05	Chelti 1	4.8	25.04
Ksani 3	3.2	11.08	Chelti 2	4.8	25.09
Ksani 4	3.6	12.20	Chela	8.2	34.30
Ksani 5	6.0	22.10	Kvabliani	6.8	28.40
Avani	4.6	18.63	Mushki	2.0	8.02
Duruji	1.7	10.69	Uraveli	4.3	16.47
Samkuristskali 1	4.9	25.70	Uraveli 2	5.1	16.04
Samkuristskali 2	22.6	117.40	Zarzma	4.3	19.80
Stori	11.8	56.78	Poka	0.6	3.07

Figure 2.3.2 Potential hydropower stations in Georgia.



Source: Official webpage of the Ministry of Energy and Natural Resources: http://hpp.minenergy.gov.ge/, last accessed 22 November 2012.

To support the Energy Policy and introduce hydropower development in the country, in 2008 the Government adopted the State Program "Renewable Energy 2008", aiming to support the construction of new renewable energy sources in Georgia by means of attracting investments. The Ministry of Energy and Natural Resources publishes a comprehensive, regularly updated list of potential renewable energy sources, details about their location and technical parameters, as well as application details for investors. At present 83 potential small, medium and large HPPs, largely run-of-river systems, have been identified and are published on the Ministry website (GE-MEnNR, 2012), of which 24 are located in the Kura Basin. The latest envisioned completion date for these projects is 2025.

The hydropower development program is led by the Ministry of Energy and Natural Resources of Georgia. Hydropower projects are mostly privately funded, though in some cases some public funds may be included. International financial institutions (IFI) are significantly involved in funding of hydropower development projects. Involvement of IFIs makes project owners to act better in compliance with international policies and requirements as well as local legal requirements.

While hydro power plants are non-consumptive users, the majority of them will significantly impact on river flow, as typically water is being diverted and/or impounded. Water demands for individual HPPs are conditioned by installed capacity, which is designed based on cost effectiveness principles. Environmental flows still are calculated based on the outdated Soviet approach of a flat minimum environmental flow, currently 10% of mean annual flow, not taking seasonal variation in flow and the dependencies of aquatic ecosystems into account. As hydropower will further develop as planned, providing adequate dynamic environmental flows based on the seasonal needs of the aquatic ecosystems may no longer become feasible, and large parts of the rivers under development may be negatively impacted.

To date there have been non-verified discussions regarding significant hydropower development on the Kura river in Turkey, including diversion of the Kura headwaters towards the Black Sea. Despite attempts at verification, these rumors have not yet borne reliable information.

3. DEVELOPMENT OF AGRICULTURE

The agricultural trends in the Kura Ara(k)s Basin have been marked by a decline in production after the collapse of the Soviet system, as land, livestock and farming equipment was distributed as the collective farms were dismantled. The irrigation channels, especially the smaller tertiary arterial systems became degraded and have not been maintained in many areas of the basin. As a result, while there are now pockets of increasing agricultural activity, the overall agricultural strength of the basin has continued to decline.

Future trends and government plans for the agricultural sector are based on the realization that there are good opportunities to revive agriculture in the region and even to strive to become exporters of agricultural products. The plans to do this will result in increased water use throughout the basin, both as irrigation infrastructure will be updated and improved, and as climate change impacts will require significantly more water for agriculture. Accordingly, based on national level plans and data, the land area used for irrigated agriculture in the Kura Ara(k)s Basin in Armenia, Azerbaijan and Georgia will increase by approximately 40% in the near future, compared to 2010 levels

3.1 Armenia

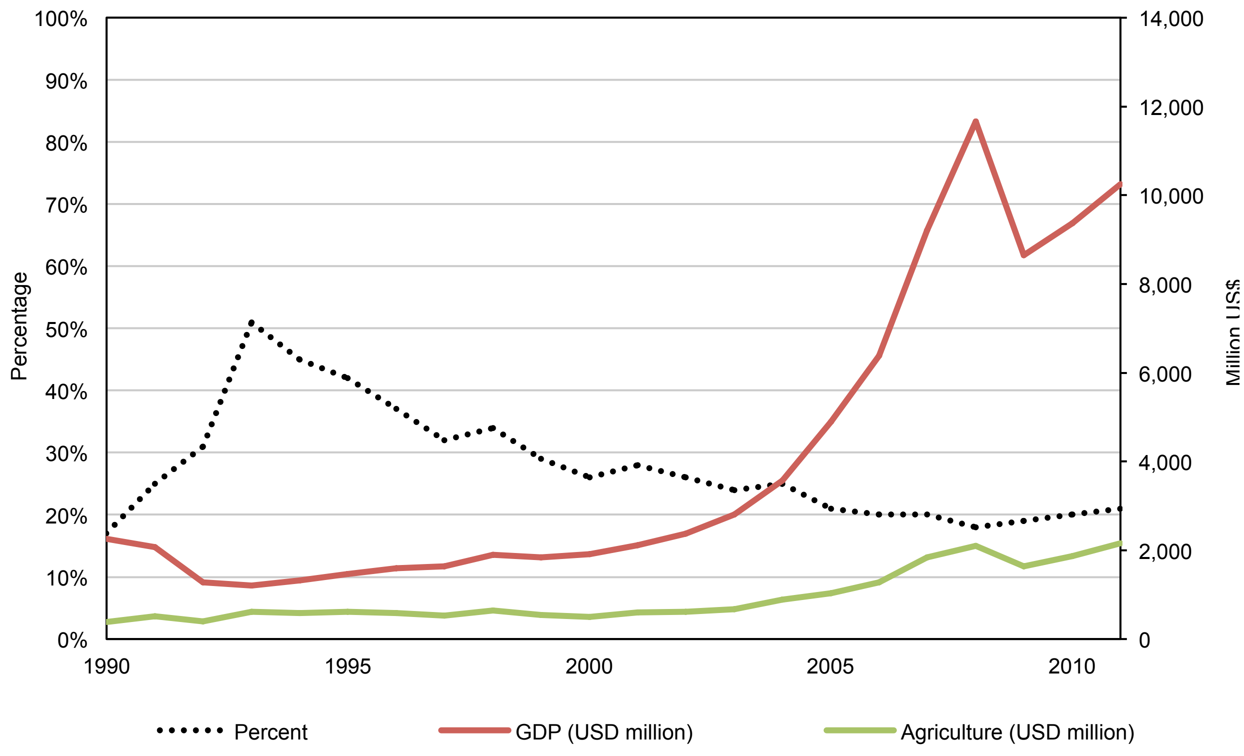
About 70% of Armenia – about 2.1 mln ha, was in 2011 in use for agriculture (AM-NSS, 2012), of which 450,000 ha were used for arable farming, 33,000 for perennial crops, 130,000 ha for haylands, and 1.1 mln as natural pastures. In addition, about 400,000 ha were in use for other agricultural purposes, including fallow lands (ArmStat 2012).

Developments in the agricultural sector during the last 25 years, since 1990, show that the overall production as well as its total value remained largely stable until the early 2000s, while the contribution of agriculture to the country's GDP gradually decreased to 20%, having peaked in the early 1990 at 50% following the disrupture of the industrial sector (Figure 3.1.1). Since 2003, a fast increase in agricultural production was observed, both for arable farming (+100%) as well as livestock farming (+65%). Throughout this period the relative contribution of the main sectors arable and livestock farming remained in balance, 55-65% versus 45-35% respectively (Figure 3.1.2). In arable farming, the largest increase in production was observed in fruits growing (+128%), followed by vegetables (+80%) and cereals (+30%) (Figure 3.1.3).

Following the land reforms in the 1990s and the change to a market economy, currently the agro-food sector in Armenia operates a liberal *market-regulated* economic system, which comprises around 340,000 rural farms, agricultural trade organizations as well as private service providers. Due to the small farm size – on average 1.37 ha, the lack of access to capital, poorly developed rural agricultural needs infrastructure (hardware and consumables, extension services), outdated machinery, as well as poor farming practices the overall productivity in agriculture is low, due to poor seed quality, limited use of fertilizers & pesticides, and high equipment operation & maintenance costs. Accordingly many farmers are unable to make a living from farming, and a significant land area kept fallow (about 35%). Meanwhile the sector involves about 35% of Armenia's active work force, largely in rural areas, where it's the main sector of economy and adequate alternative livelihoods sources are very limited. In livestock farming key problems include poor veterinary practices, lack of a national livestock support system in breeding and animal health care, and poor grazing practices resulting in widespread overgrazing. In both arable and livestock farming access to markets remains a problem, for farmers and customers alike. Meanwhile the government of Armenia contributes only 2% of its annual budget to agriculture (FAO-AM, 2012).

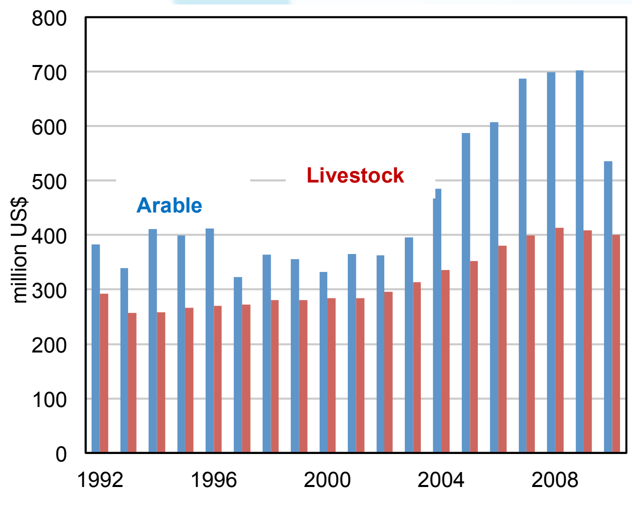
By the end of the 1980s, irrigation in Armenia reached its peak at more than 300,000 ha, highly dependent on regular maintenance and pumping stations with high energy consumption. The irrigation system included more than 70 reservoirs, 3,000 km of primary and secondary canals, 16,000 km of tertiary canals, more than 200 large and medium pumping stations, 500 km of primary and secondary drains, and 2,000 artesian wells. Annually the government was spending more than 170 mln US$ on development and 102 mln US$ on operation.

Figure 3.1.1 Agricultural sector value share in the national GDP.



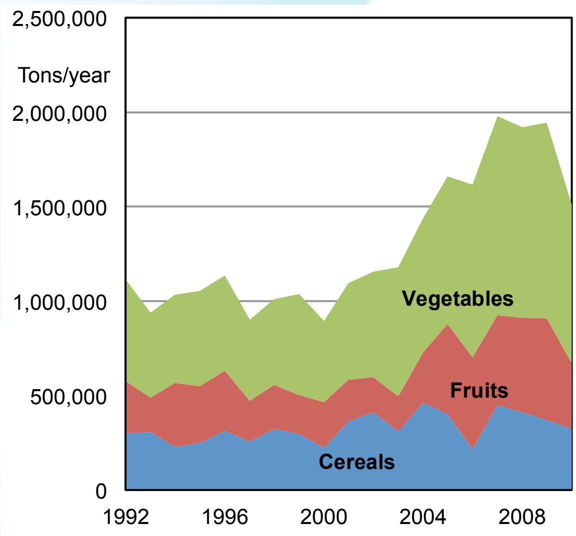
Source: The World Bank, http://data.worldbank.org/indicator/. Notes: Left y-axis refers to % agricultural contribution to the country GDP; left y-axis total value of country GDP and agricultural production in mln US$.

Figure 3.1.2 Development of crop and livestock production values.



Source: FAOSTAT, http://faostat3.fao.org/. Note: values in US$, constant for 2004-2006.

Figure 3.1.3 Crop production in time for major crop groups.



Source: FAOSTAT, http://faostat3.fao.org/.

Following independence, the area under irrigation rapidly declined to a current 150,000 ha (Table 3.1.1). Main causes for the decrease include degradation of water distribution & drainage systems, due to a lack of maintenance, excessive pumping costs, the shift from collective farms to private smallholdership, and bad management of supplier reservoirs, frequently causing water shortages during the vegetation season. Currently the water losses in the conveyance schemes are assessed to be as high as 60%.

Since 2001, sector reforms are being implemented in irrigated agriculture A decentralized management approach has been established, in which Water Users Associations with communities as property holders are responsible for the tertiary infrastructure and division of water, while the state Water Supply Agencies manage reservoirs, primary and secondary infrastructure. Supported by international donors Armenia has invested 250 mln US$ to rehabilitate deteriorated sections and install new gravity irrigation systems.

Table 3.1.1 Development of irrigation in Armenia between 1985 and 2010.

Irrigation parameter	1985	1990	1995	2000	2005	2010
Land area (x 1,000 ha)	310	320	173	n/a	149	152
Water use (mln m^3/yr)	2,730	3,500	1,480	1,090	1,500	1,160

Source: Armenia State Committee for Water Economy (2012), National Experts.

Analyzing the information on the development of the irrigation sector in recent years – decrease in surface area and stable water consumption – it is unclear what was the basis for the rapid increase in agricultural production since 2003, These developments hint at an improved crop production efficiency, which could not be confirmed. Possibilities could include: increasing harvests with equal amounts of water, due to a reduction of losses in the water distribution system (from open canals to pipes), change in irrigation techniques (from sheet & furrow irrigation to drip irrigation, from pumping to gravity irrigation), use of more drought-resistant crop varieties, etc. The issue warrants further investigation, also to conclude on most suitable of possible different approaches applied.

Aquaculture has significantly increased in recent years, with at present, about 350 fish farms registered in the country, using 2,677 ha to annually produce about 5,000 tons, a significant part of which are trout species. An additional estimated 600 tons is directly captured from natural water bodies (FAO-AM country strategy, 2012). Actual water use for aquaculture is estimated at 360-400 MCM annually, mostly in the Ararat valley using groundwater resources.

The overall economic growth during the last decade, increasing consumptive demands of the population, as well as higher demand in the international markets have opened new opportunities for the Armenian agricultural sector. At present food self-sufficiency is 60%: low in wheat (38%), poultry meat (20%), pork (51%) and beef (78%), to almost zero for butter and vegetable oil, while close to self-sufficiency for potatoes, vegetables, fruits, eggs and milk (FAO-AM, 2012).

The 2010-2020 Strategy of Sustainable Development of Armenia's Agriculture identifies the following as major priorities for the development of the country's agro-food sector (FAO-AM, 2012): increase cooperation and diversification of farm management, including the production of high-value products; strengthen the production & processing sales chain, and increase export; develop agricultural support services, including their accessibility; improve effective use of land, water, labor and intellectual resources to increase production; develop a food safety system in line with international standards; develop community infrastructure, including irrigation networks; and increase farm income. Alternatively the Strategy also envisions to develop agro-tourism, organic farming as well as non-agricultural employment in rural areas, and to increase the protection of natural landscapes.

Other strategies which touch upon agricultural development issues include: Poverty Reduction Strategy of Armenia (2007); and the Food Security Concept of the Republic of Armenia (2010). Together these documents confirm the development of sustainable agriculture in Armenia as being of high national priority towards increasing the local production of food, as such increasing national food security as well as the potential for the export of food and agricultural products.

According to these strategies, by 2020 the agricultural output is envisioned to increase by 46% compared to production volumes in 2007-2009, based on arable lands to increase up to 421,000 ha. Key directions include the growing of cereals, fruits, vegetables, and fodder crops, and an extension of cattle breeding.

In response to the main problems in the agricultural sector, currently the Government of Armenia is looking for strategic solutions to make farming profitable, a.o. by encouraging establishment of farm cooperatives, improved marketing support, introduction of crop insurance, provision of trainings & advisory services, subsidies on fertilizers and pesticides etc. As crop production heavily depends on irrigation, plus the predicted severe changes in the climate and gradual deterioration (both quantity and quality) of water resources, growth of the agricultural sector will be possibly only by efficient use of water, including addressing deterioration in quantity (including climate change) and quality (pollution) of water resources.

Armenia’s Strategic Policy and Action Plan for development of the irrigation sector is shaped through various legislative documents and Government Decrees, including the Water Code; Law on Water User's Associations and Federations of WUAs; National Water Program; GOA Decision N:33-N (08/01/2009); GOA Decision N:118-N (14/01/2010); GOA Decision N: 927-N (30/06/2011); GOA Decision N:1055-N (09/08/2012); Program of Measures for the State Committee of Water Systems for the period 2008-2012. The Policy & Action Plan focuses on expanding gravity irrigation systems; rehabilitation of deteriorated water supply and drainage canals, including pumping stations; expansion of reservoirs; promotion of water saving techniques in irrigation. Achievement of these targets largely are envisioned through the recovery of the formerly irrigated lands up to 250,000-300,000 ha with an envisioned annual water consumption of 3.0-3.5 BCM, equal to the assets used in the late 1980s, but providing for a better efficiency, higher overall production, increased food security and sustainable livelihood in farming.

While suitable arable land resources in Armenia are limited, the country is rich in inland water resources, but the potential for fishery and aquaculture is not being exploited. Climate conditions are sufficiently favorable for fish culture in surface waters, and groundwater resources can facilitate a year-round industrial production of different trout and sturgeon species. Fisheries is considered to be especially of interest for rural areas, including foothills and mountains, offering a profitable activity in regions where other types of agriculture meet with unfavorable conditions (Hovhannisyan *et al.*, 2011). Accordingly, the Sustainable Agriculture Development Strategy for 2010-2020 and the Food Security Concept of the Republic of Armenia envision a development of the fish industry, including aquaculture: an expansion of fisheries, improved quality of fish production and processing, and development of a marketing strategy for export. According to data of the Ministry of Agriculture, fish production can be increased to 25,000 tons/year by 2020. According to estimates made by the Head of Commission on Protection of Lake Sevan, accordingly water demand for fisheries is anticipated to increase to 650-700 MCM.

3.2 Azerbaijan

In Azerbaijan, 55% of the country – 4,768,700 ha - land is use for agriculture, including natural pastures and meadows. Arable lands occupy 39.5% of agricultural lands, of which 12% was left fallow in 2011. Arable lands mainly were used for grains (60.1%), fodder crops (24.5%), and vegetables, including potatoes (11.2%) (AzerStat 2012). About 30% of the agricultural land is irrigated – 1,424,400 ha, mainly arable lands, perennial crops and annual grasslands. During land reform after independence in 1991, 1,351 mln ha of land were given to farmers. At present agricultural production is mainly a prerogative of private farmers, producing 94.8% of gross output value, up from 2% in 1990 (AzerStat, 2012), equally divided over plant growing and livestock farming. Commercial enterprises tend to be involved in livestock farming (65% of value produced), especially poultry production. Development of agricultural production is presented in table 3.2.1.

After the collapse of the Soviet Union, agricultural output significantly declined, both in arable cropping as well as livestock farming (Figure 3.2.1), as land, livestock and farming equipment was distributed and the collective farms were dismantled. Figure 3.2.1 shows that by 2003 livestock farming was restored to the 1990 output level, continuing to grow to a 50% increase in production output by 2011. As a result, overgrazing became an increasing problem, also due to the lack of integrated pasture management. Arable farming meanwhile did not manage to restore its previous production output high in 1990, although since 2000 the negative growth has been reversed. One reason is that irrigation channels, especially the tertiary arterial systems having degraded and not been maintained in many areas of the basin since the late 1980s.

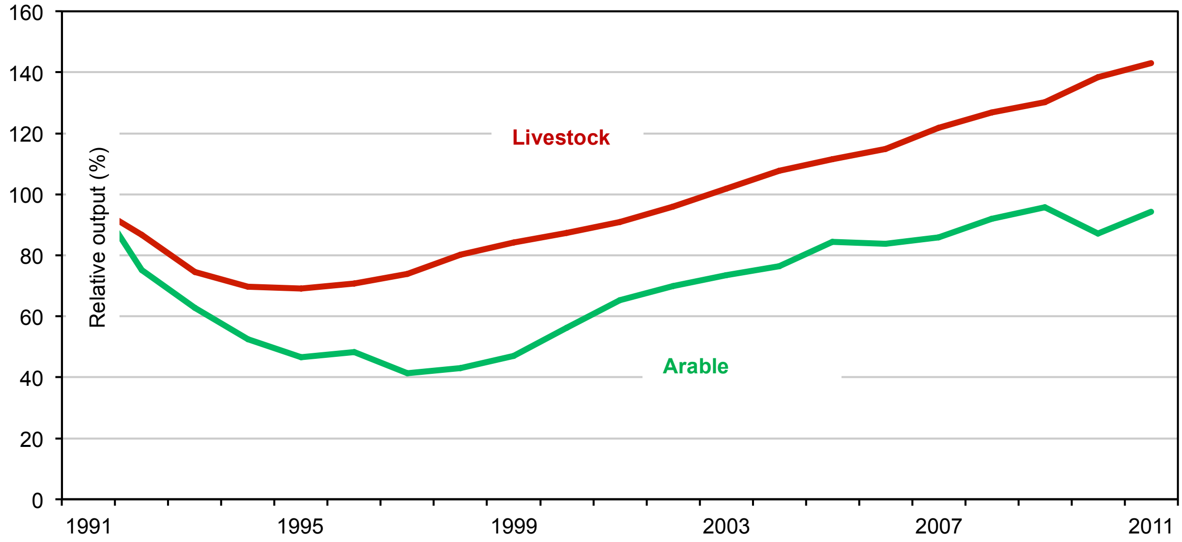
Table 3.2.1 Crop production by type and livestock.

Years	Cereals and dried pulses	Cotton	Tobacco	Potatoes	Vegetables	Watermelons and melons	Cattle and buffaloes	Sheep and goats
			(x 1,000 tons)				(x 1,000 heads)	
1913	485.9	64.0	1.0	37.9	...	...	1,397.0	2,394.0
1928	829.9	55.5	...	91.5	...	...	1,308.0	2,469.0
1940	567.2	154.2	5.4	81.8	63.4	40.4	1,382.0	2,546.9
1970	723.4	335.6	24.6	129.9	409.9	46.9	1,560.3	3,960.6
1991	1,346.4	539.7	57.3	179.9	805.3	61.9	1,831.6	5,418.7
2000	1,540.2	91.5	17.3	469.0	780.8	261.0	1,961.4	5,773.8
2011	2,458.4	66.4	3.6	938.5	1,214.8	478.0	2,646,7	8,491,8

Source: stat.gov.az

Figure 3.2.2 shows that since 1990 the relative contribution from the agricultural sector to the GDP decreased from about 30% in the early 1990s to 6% in 2011, largely due to the significant increase in contribution of the petroleum sector to the GDP. Meanwhile the overall value of agricultural production significantly increased since 2005, exceeding the 1990 level by about 50%. In the intermediate years agriculture suffered from a serious depression, during which annual production fell as low as 35% of the pre-1990 level. Meanwhile about 40% of the country's work force is employed in agriculture, while a larger part engages in subsistence farming. The development of irrigation – in land surface cover and use of water – during the second half of the 20th century in Azerbaijan is presented in table 3.2.2.

Figure 3.2.1 Development of relative annual agricultural output since 1990 (1990=100).



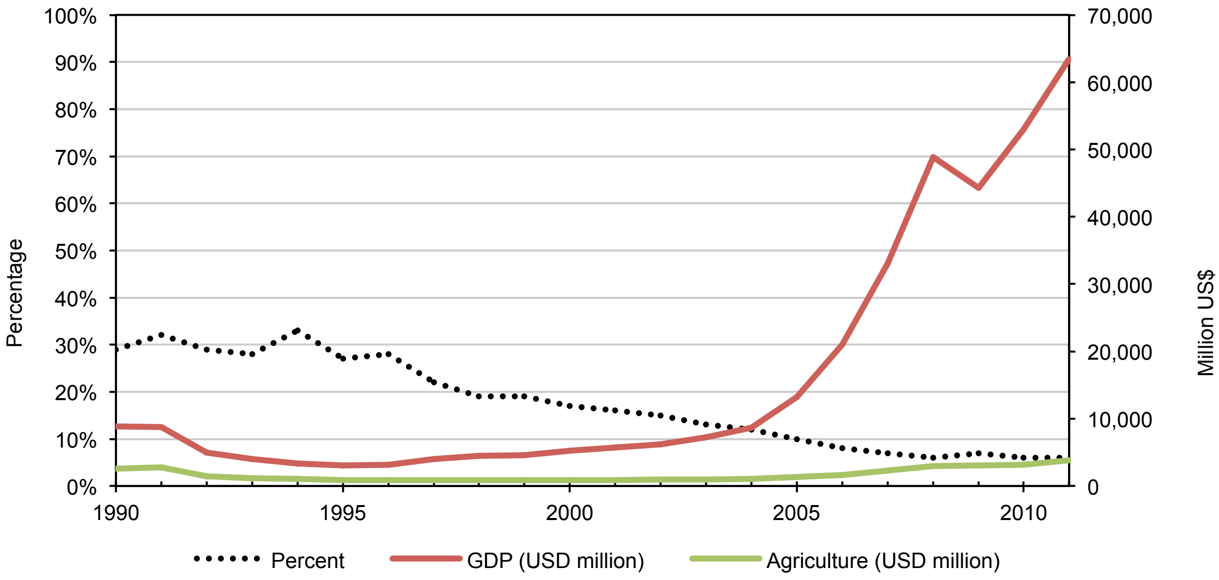
Source: stat.gov.az.

Table 3.2.2 Development of irrigation in Azerbaijan between 1945 and 2010.

Irrigation parameter	1945	1955	1965	1975	1980	1985	1990	1995	2000	2005	2010
Land areas (x 1,000 ha)	685	880	1,040	1,160		1,340	1,423	1,453	1,426	1,433	1,425
Water use (mln m^3/yr)	2,664	2,688	3,450	4,740	6,660	9,132	8,627	7,720	3,819	5,710	5,497

Source: State Statistical Committee of Azerbaijan (Joint Open Company of Irrigation and Water Industry.

Figure 3.2.2 Agricultural sector value share in the national GDP (Azerbaijan).



Source: The World Bank, http://data.worldbank.org/indicator/

Despite the recent growth, productivity in agriculture in Azerbaijan remains low, with only about 50% of the potential opportunities being utilized. The main reasons are: insufficient & outdated machinery; lack of fertilizers, pesticides & herbicides; lack of maintenance in irrigation systems; insufficient water resources; depletion of soil fertility; poor seed quality and animal breeding; insufficient processing industry; lack of new technologies; lack of awareness; low level of communication and extension networks; climate change; social problems in rural areas; lack of organizational & productive structures; poor financial and credit support; etc.

To address these issues the Government of Azerbaijan has adopted a number of state programs and strategies. The State Program on Social and Economic Development of the Regions of the Republic of Azerbaijan continues to being implemented since 2004. According to this Program the Azerbaijan Amelioration and Water Management JSC is obliged by 2015:

- To prepare and implement an integrated management plan of water resources.
- To carry out renovation works in order to improve water supply to winter pastures.
- To streamline the structure of scientific research and design institutions in amelioration and the water industry, establish a united institute and strengthen its material and technical basis.
- To create protection zones around water facilities and strengthen control over their use.

The Amelioration and Water Management JSC also developed 10-year implementation plans to increase & improve the land surface under irrigation. The plans include the construction of 13 reservoirs (capacity 1,017 MCM), irrigation canals (418 km). As a result it is envisioned to restore 275,000 ha of existing irrigation fields - water supply as well as drainage, and to install new irrigation systems on 350,000 ha. An envisioned 89 km of dykes will be constructed. While estimates on water use were not available, it is likely that the river flow into the Caspian Sea will notably decrease, as according to this plan, water demand will increase by 15-25%.

The Agrarian Policy of Azerbaijan defined the main strategic goals as: to achieve sustainable economic development; to eliminate poverty; to provide food security; and, to restore the ecological balance.

The Ministry of Agriculture continues implementing the Agrarian and Industrial Complex Development Strategy (2007-2015), including measures to improve soil conditions: a national program to improve soil fertility; creation of a cadaster system for agricultural lands; mechanisms for the sustainable use of pastures; land inventory and mapping of soil salinization; reclamation of salinized and waterlogged soils; anti-erosion programs for mountainous and lowland regions; legislative improvement on land protection, rehabilitation, and use; strengthening phyto-sanitary services; and developing standards for fertilizer and pesticide production, transportation, use, and storage (World Bank 2007).

Example results of the State Program on Reliable Supply of Population with Food in the Republic of Azerbaijan (2008-2015) included: 92,498.8 tons of mineral fertilizers were sold with 50% discount to producers of agricultural products in 2010; in 2011 the State Agency of Agricultural Credits under the Ministry of Agriculture provided 20.95 mln US$ to 204,000 agricultural entrepreneurs from 39 Districts; annually 2.6 mln US$ will be gathered from the lease of summer and winter pastures. These funds are planned to be invested in land and irrigation improvement, as well as electric transmission lines for pastures.

The national programs are supported by irrigation and drainage infrastructure improvement and rehabilitation projects financed by the Azerbaijan Government in cooperation with international partners: Rehabilitation and Completion of Irrigation and Drainage Infrastructure Project (World Bank); Irrigation Distribution System and Management Improvement Project (World Bank); Irrigation Rehabilitation, particularly Khanarkh Canal (Islamic Development Bank); and Rehabilitation of Hydraulic and Irrigation Facilities and Water Supply in Aghdam, Fizuli, and Terter (UNDP and UN High Commissioner on Refugees). Benefits from these projects include reduction of irrigation water losses as well as soil salinity and waterlogging problems. The World Bank projects include strengthening institutional capacity (e.g., development of water user associations).

3.3 Georgia

Agricultural land in Georgia constitutes about 3 mln ha, or 43% for the country, of which 40% is suitable for arable farming, the remaining natural meadows and pastures for grazing (GE-MA, 2012). Main crops include grains & leguminous crops (68%) and potatoes (16%) (GeoStat, 2012). Following land reforms in the 1990s, about 1 mln ha has been privatized (USAID, 2011), handed out for free to the rural community - on average 1.25 ha per household in villages and small cities and 5 ha pastures in mountainous areas. As such, the sector is dominated by family holdings, with only 2.7% of sown areas managed by commercial enterprises, mainly wheat and oats, while for permanent crops – fruits, grapes, citrus – their contribution drops to 0.8%, except for tea (45%) (GeoStat, 2012). In livestock farming commercial enterprises mainly are involved in poultry production (about 30%) (GeoStat, 2012). Of all farmers, 80% produces for self-consumption.

Table 3.3.1 Development of irrigation in Georgia between 1945 and 2010.

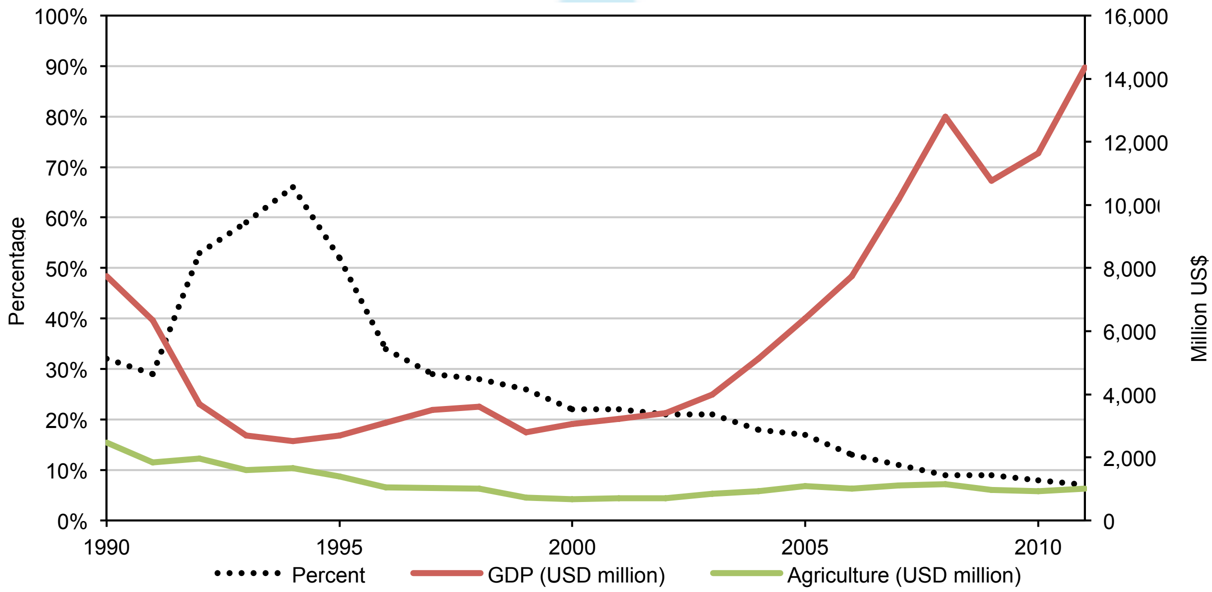
Irrigation parameter	1945	1955	1965	1975	1980	1985	1990	1995	2000	2005	2010
Land use (x 1000 ha)	201	265	306	283		345		350	160	30	24
Water use (mln m^3/yr)					1,566		1,354	1,445	208	87	59

Source: Ministry of Environment Protection (2012 inquiries), UNDP/GEF (2007), State statistics Committee of Georgia (2012 inquiries), Irrigation Water Supply Company (personal communication).

During the Soviet period, agriculture was a key sector of Georgia’s economy, exporting vegetables, fruits and subtropical cultures to the Soviet Republics (G-PAC, 2010). Accordingly, the contribution of agriculture, including arable crops, livestock, forestry, hunting and fishing, to the GDP was high, 32% in 1990. While the share of agriculture to the GDP surged in the early 1990s, this represented a relative increase, due to worse conditions in other sectors of the economy, as the total annual production value continued to decrease until the 2000s. Since 1994 the share of agriculture to the GDP decreased, via 22% in 2000 to 9% in 2011 (GE-MEPNR, 2008) (Figure 3.3.1). Data on irrigation expansion and decrease are presented in table .3.3.1.

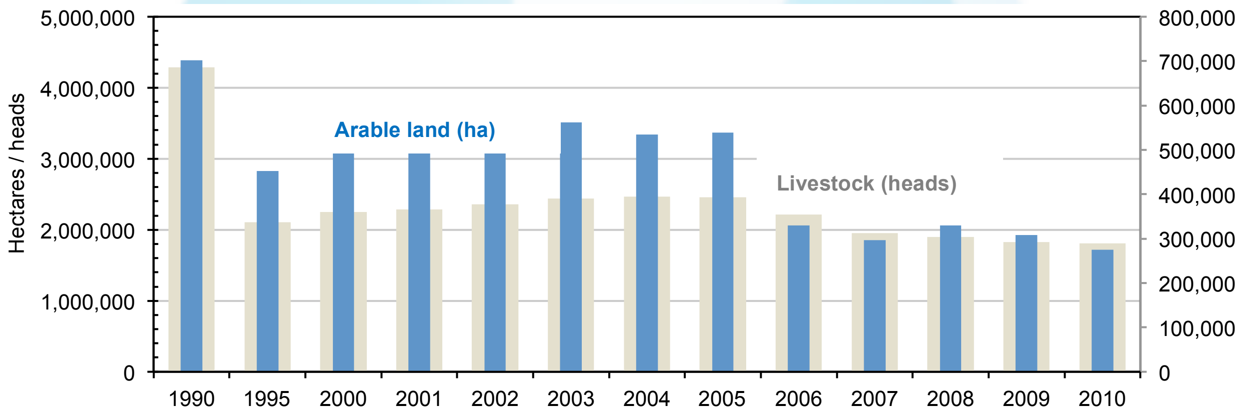
Sown areas declined by nearly 35% in the years immediately after independence, and livestock numbers (cattle, pigs, sheep) by 50%. Sown areas rose between 1995 and 2000, and then started to decline again. In 2010 the sown area constituted 40% of the 1990 level (Figure 3.3.2). In 2011 the irrigated area in Georgia amounted to 24,000 ha, down from 386,000 ha in 1988, largely located in the dryer eastern part of Georgia, in the Kura river basin. The decline in livestock after 1990 was followed by an expansion until 2004 but then moved into another phase of decline. In 2010 livestock numbers constitute 42% of the pre-independence level, at 1.1 mln heads of cattle, 105,000 pigs, 630,000 sheep and goats, 6.4 mln heads of poultry. Livestock herds were affected by an outbreak of African swine fever in 2007, and increased exports to the Middle East and neighboring countries (USAID, 2011). In current prices however, the agricultural sector shows periodic fluctuations, with relatively overall increase since the mid-1990s (figure 3.3.3).

Figure 3.3.1 Agricultural sector value share in the national GDP in Georgia.



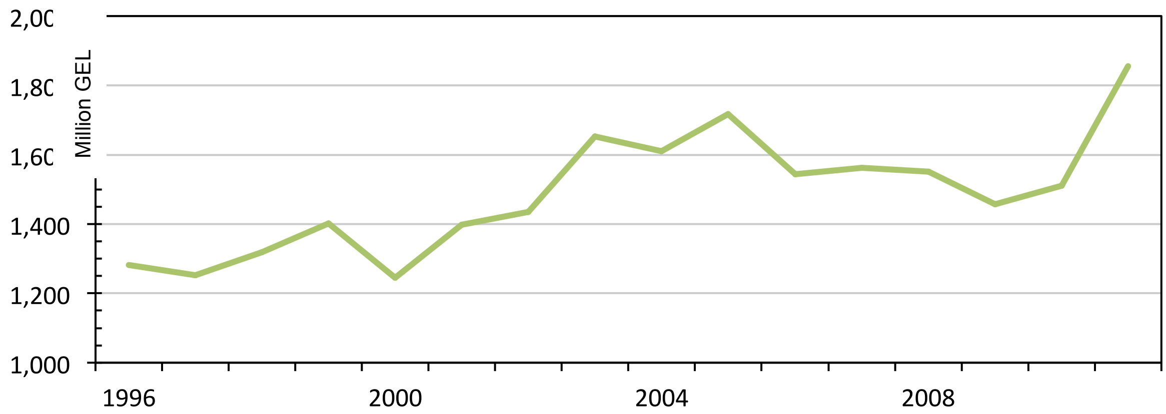
Source: The World Bank, http://data.worldbank.org/indicator/

Figure 3.3.2 Land cultivation and livestock in 1990-2010 in Georgia.



Source: USAID (2011).

Figure .3.3.3 Agriculture contribution to GDP at current prices.



Source: Geostat - http://geostat.ge/index.php?action=page&p_id=119&lang=eng; World Bank, http://data.worldbank.org/indicator/

Development in the agricultural sector largely reflected the political and economic developments in Georgia since 1990. Land privatization resulted in agricultural holdings being extremely small: the 2004 Agricultural Census showed that household land typically consisted of 2-3 land plots of about 0.45 ha each. Land plots of less than 5 ha constitute 98.4% of all farms, while only farms with a land area exceeding 5 ha are considered to be commercially viable (GDRI, 2012). As such the majority of farms in Georgia is subsistence farming oriented. Accordingly, also only 1/3 of arable lands are in rotation, about 300,000 ha. This is caused by non-existence of a land market, lack of financial and technical resources, including fertilizers and pesticides, and deterioration of irrigation and drainage system, as well as outmigration from rural areas to the cities, as farmers are unable to earn a living from farming (GDRI, 2012). Notably, 75% of the farmers is older than 45 years, of which 36 is older than 65 (GeoStat, 2007), while the agricultural productivity is among the lowest compared to surrounding countries for most crops except for garlic, beans and hazelnuts. Also the strains with the Russian Federation, including embargoes against Georgian imports, have significantly impacted the agricultural export sector. In addition, water and wind erosion, environmentally degrading agricultural practices and other anthropogenic and natural processes have led to an almost 35% degradation of farmland (GE-MEPNR, 2008). The overall result of these developments was that during 2003-2011 the import of agricultural products increased by 5.7 while the export increased by only 2.6. As a result, the growing demand for agricultural products is satisfied mainly by import (GDRI, 2012).

Nevertheless, the agricultural sector remains as one of the most significant sources of income of population of Georgia and one of the key contributing factors for eliminating poverty in the rural areas. Over 55% of the active labor force derives the majority of their income from the agricultural sector (GeoStat, 2012). Recently the government therefore is giving renewed attention to the development of the agricultural sector. While discussions are ongoing to make Georgia a net exporter of grains and cereals within the next 20 years, and the Strategy of Agriculture Development of Georgia for 2012-2022 has been drafted, still no officially approved document is available. The new government meanwhile has announced its priorities for reforms in agriculture to include economical strengthening of the rural areas, increased incomes and living standards of farmers by means of modernization of the sector, differentiation of agricultural services, increased competitiveness of the agricultural sector etc. which should significantly increase agricultural production, reduce import, towards a better self-sufficiency for agricultural products in the country (Georgian Dream, 2012).

The Agriculture Development Fund was established the objectives of which include a support program for smallholder farmers; promotion of rural agricultural corporations; development of infrastructure; provision of low interest rate credits; provision of co-funding for food processing enterprises; provision of agricultural insurance etc. Already 400 mln US$ has been mobilized, of which 100 mln US$ will support 640,000 smallholder farmers. Additional support of 40 mln € is envisioned to be provided by the EU, towards increased food production and reduce rural poverty by supporting the implementation of the national sector strategy and strengthening small farmers' organizations (Agro-Georgia, 2012).

Recently a trend of farm land consolidation is being observed, with the size of private commercial agricultural holdings having doubled to an average size of 10 ha (USAID, 2011). Since the early 2000s the Georgian government also invested in irrigation & drainage infrastructure rehabilitation programs. The total area suitable for irrigation is estimated at 725,000 ha (FAO Aquastat, 2012), of which 500,000 ha were already adapted in the early 1980s, systems which are largely deteriorated at present. The main source of water for irrigation is river diversion. The Ministry of Agriculture aims to enhance irrigation areas from 25,500 ha to 200,000 ha in next 3-6 years. The plan will refurbish primary and secondary canals, install efficient methods of irrigation systems, including drip irrigation. For this, state funding is planned to increase by 32 mln US$ in 2013. Rehabilitation of 10 irrigation channels is ongoing in 6 municipalities in the Kura Basin (Marneuli, Gardabani, Mtskheta, Sagarejo, Kareli and Kaspi). Two other irrigation & drainage improvement projects are planned to start in 2013, financed by the International Fund for Agricultural Development (IFAD; 15 mln US$) and the World Bank (50 mln US$).

The expansion of irrigated land area will increase water consumption, estimated to double from the current intake. This will have a significant impact on available water resources, both in the country as well as in downstream Azerbaijan, the more so as temperatures rise, increasing crop water demands in the already dryer part of the country best suitable for grain production. In addition, the planned expansion will be challenging because of problems with wind erosion, soil salinity and decline in soil nutrients due to historically poor agricultural practices, as well as potential impacts from water pollution.

4. MUNICIPAL WATER USE DEVELOPMENT

Information on actual municipal water use volumes in the three countries as a whole as well as for the Kura Ara(k)s basin sections was presented in TDA chapter 3-2. In summary, for 2011 the total abstraction for drinking water purposes in the Kura Ara(k)s basin sections of the 3 countries was 613.9 MCM, which, taken the total population of the basin into account – 11,226,500 inhabitants, amounts to an overall drinking water use per inhabitant of 54.7 m^3/year, or 150 liter/day.

Based on the example scenarios designed in chapter 6-2 of the TDA - the modeled increase in population by 2050, 23% in the conservative scenario using the average growth in population for the period 2000-2010, 31% when using the average for 2005-2010 - provides for an assessment of the increase in consumptive water use to of 730 MCM to 780 MCM. As the current water distribution system has major shortcomings, giving rise to significant leakages, and considering the envisioned future improvements to reduce losses, it may be likely that the overall abstraction for consumptive use may not increase as much as the simplified scenario analysis shows.

4.1 Armenia

Throughout the 1990s, the water supply and sanitation (WSS) sector in Armenia suffered from (1) poor infrastructure – deteriorated existing WSS infrastructure, with all WWTPs either out of order or providing insufficient treatment, even at the mechanical level, and no disinfection or sludge treatment; (2) Poor service – irregular water supply was the standard, and access to piped water did not mean access to good quality water, as confirmed by an increase in outbursts of acute intestinal water related infections; (3) lack of financial means – low household income hampered payment for services, while the energy crisis increases prices for service providers (OECD, 2004).

Institutional, legislative and regulatory reforms were initiated in 2001, aimed at rehabilitation of the collapsed water supply system, and the implementation of efficient national water policies in line with the broad public management reforms in the country (Towards Performance Based…, 2009). Despite the delays in adoption of needed legislation, over the past decade, the access, reliability and quality of drinking water and infrastructure has improved. Public-private partnerships (PPPs) were established, and subsequent decentralization of responsibilities, privatization, and separation of regulatory, standard setting and operational functions enabled private sector involvement and the application of commercial principles. Currently about 2 mln inhabitants of Armenia are served by five water and wastewater utilities under PPP arrangements, the remaining 560 villages outside these utility areas served by individual municipal arrangements.

As a result, in many regions of the country water supply has become significantly more reliable and continuous. Water meters have been installed for the vast majority of PPP subscribers, positively impacting on water saving. These improvements have been achieved through improved operations by the PPP operators and effective implementation of the investment programs financed by the state and International Financial Institutions (WB, KfW, ADB, EBRD, USAID). Overall investment in the sector until present amounted to 300 mln US$ (ADB, 2012).

However, there are still many challenges to overcome. Infrastructure conditions remain very poor - on average 81% of the water is lost before reaching the subscribers. The water tariff, a main source of revenue for PPPs, is too low to cover routine operation and maintenance costs, while inadequate customer service do not justify an increase of tariffs. In addition, there are still significant disparities between urban and rural areas in terms of coverage and quality of services. There is a need for major investments to rehabilitate poor infrastructure and further expand water services; to reduce excessive amounts of unaccounted water; and to continue institutional and financial capacity building.

In wastewater treatment conditions are worse. None of the 20 WWTPs operating during Soviet times is currently in operation, except for the Yerevan "Aeration" WWTP, providing only partial, mechanical treatment. Positive development trends, however, include the renovation of the “Aeration” WWTP by the government, and the recent construction of WWTPs in the towns of Gavar, Martuni and Vardenis, part of the valuable Lake Sevan basin. Also new drinking water treatment facilities have been constructed in Sevan City, for groundwater, and Dilijan, abstracting water from the Aghstev River.

A number of government decrees have been adopted recently aiming to achieve further improvements:

- The Government Decree on a phased program for the implementation of short, medium and long-term measures for developing the water sector, including drinking water, until 2021 (2009).
- The Decree on defining measures to apply modern technologies to reduce losses, to improve water quantity & quality monitoring, to reduce & prevent pollution, to recycle water, and manage data (2010).
- The Decree on assessment of water demand in the domestic drinking water supply sector, to be applied by the basin management organizations in the country (2011).

These programs define the sectoral strategy for the short, mid and long term perspective, directed at increasing water use efficiency through reduction of water losses (both technical and management).

4.2 Azerbaijan

Water withdrawal for drinking water supply are minor compared to water use in irrigation – 397 MCM compared to 11.8 BCM, as such the sector is not expected to have a significant impact on the river ecosystems (www.azstatgov.az).

The Government of Azerbaijan has adopted several National Plans to provide safe drinking water and sanitation measures to the community: (1) the State Program of Social Development of Regions (2008-2015); and (2) the State Program of Poverty Reduction and Sustainable Development in the Republic of Azerbaijan (2008-2015). The Plans aim at providing the country population with potable water through reliable water supply systems by the end of 2015. The plans are integrated with plans to adjust mountain rivers, construct multiple use reservoirs, including irrigation, improve drinking water supply, aquaculture and tourism in coming 10-20 years (www.economy.gov.az). Furthermore, the Presidential Decree #3 of November 2003 requires the Cabinet of Ministers to undertake measures for the elimination of socio-economic problems related to food and water supply, decreasing poverty, and to apply the norms of the European Social Charter on providing 24 hour access to water.

The Government of Azerbaijan requested international assistance to improve the availability, quality, reliability, and sustainability of water supply and sanitation services in all provincial cities in Azerbaijan. Specifically, the project aims to improve water distribution systems in order to reduce/avoid leakages; to ensure safe collection and treatment of domestic and industrial wastewater; to ensure compliance of water supply facilities, sewer systems and WWTPs with the international and/or Azeri standards; to ensure affordable water supply and sanitation tariffs for consumers; and to ensure minimum level impact on the environment caused by the water supply and sanitation systems.

Feasibility studies, EIAs and construction works are currently ongoing in all provincial cities in the Kura Ara(k)s basin except several regions in the eastern Azerbaijan. Specifically, feasibility studies are ongoing in Saatli, Sabirabad; EIAs - in Shirvan Neftchala and Salyan; and construction works - in Ganja and Sheki. For each city the water sources have been identified individually, e.g. the Kura river is the source for Shirvan, Salyan and Neftchala, the Cogas water reservoir and Agstafachay River - for Gazakh and Agstafachay, groundwater - for Barda, Gobustan and Terter, the Mingechevir reservoir – for Mingechevir and Yevlakh, the Shamkirchay reservoir (under construction)- for Ganja, Goranboy, Samukh and Shamkir (www.azersu.az). To improve drinking water supply for the population living along the banks of the Kura and Ara(k)s rivers, the construction of local treatment facilities for cleaning the source water is ongoing. Currently 178 of such installations have been installed already, providing more than 400,000 people with drinking water, in 221 villages in 20 districts. Every inhabitant gets about 30 liters of safe drinking water per day (www.eco.gov.az).

As all old WWTPs constructed in the 1970s and 1980s are no longer operational, new WWTPs are designed for 29 cities, or under construction in 21 cities, as such covering all cities in the Kura Ara(k)s basin in Azerbaijan to be linked to the WWTP network by 2015. Remaining settlements will be connected to this network until 2030. As there are no national standards for WWTPs, including the limit effluent values, all newly constructed plants are meant to meet international standards. A certain amount of the treated wastewater will be reused for the irrigation of agricultural land and parks (AWE JSC, 2010).

4.3 Georgia.

Due to the poor technical state of the existing water supply system, almost in all regions in Georgia access to safe drinking water is still a problem. At present drinking water treatment facilities are often technically unfit, and lack adequate supplies of filter materials, installations and chemical reagents. While it was assessed that more than 60% of the water distribution infrastructure needed to be replaced, no major rehabilitation works were carried out in the period between 1987 and 2004. Surveys done between 2000 and 2002 confirmed that the quality of drinking water failed to meet the state standards, causing threats of intestinal infection and epidemic outbreaks (ECBSea, 2009). Despite the relatively high coverage of the centralized water supply, varying from almost 100% in the 3 biggest cities to 64-82% in 17 other cities and towns, about 30% of the population outside Tbilisi receive water for less than 12 hours per day, many people living on upper floors do not receive water at all due to low pressures, and water often contains sediments, inappropriate smell and color (OECD, 2008). In addition, while on average 70% of the population is connected to sewage water collection systems, all WWTPs established during the Soviet period are currently out of order or provide only primary treatment. As a result, untreated municipal wastewater is a major polluter of surface waters in Georgia (GE-MEPNR, 2010).

Starting from 2004 the optimization of drinking water resources management was started, funded from the state budget with support from international donors. Extensive reconstruction-rehabilitation works had been carried out in Tbilisi in the period of 2005-2007. Most central water supply pipelines have been rehabilitated and all major drinking water quality monitoring laboratories have been refurbished and equipped with modern computerized systems (ECBSea, 2009). Currently Tbilisi is provided with an up-to-date high-quality water supply service ensuring delivery of good quality drinking water without significant interruptions 24 hours a day to 400, 000 customers, of which about 2000 are public and state organizations, about 15,000 commercial enterprises and the rest are in the residential sector (GEO-Cities, 2011).

The development of water and sewerage systems has become one of the main high priorities at all levels in the country, as such extensive rehabilitation projects are also ongoing in the regions in Georgia (Task Force for Regional Development in Georgia, 2009). Development and improvement for municipal infrastructure, including water supply and sanitation systems is one of the objectives of the State Strategy for Regional Development of Georgia for 2010-2017. Specifically, the Strategy aims at creation of a favorable environment for investments in the sector; rehabilitation and construction of the water supply/sanitation infrastructure; ensuring access to safe drinking water and sanitation; improving water metering; reducing water loss; improving cost recovery etc. IN 2009 about 120 mln US$ were allocated for the rehabilitation and development of the drinking water systems, and an additional 35 mln US$ for the sewerage network (Task Force for Regional Development in Georgia, 2009). There has been increased involvement of also donor organizations in supporting rehabilitation of the water supply and sewerage sectors in Georgia in recent years. Among them is recently completed project of US Millennium Challenge Corporation (MCC) which through the Georgian Municipal Development Fund supported the US$ 57.7 mln Regional Infrastructure Development Project to improve municipal water and sewerage services in five cities throughout Georgia including cities of Borjomi and Bakuriani located in the Kura Basin.

Following the MCC, there have been many more municipal water development projects that are financed through the Municipal Development Fund of the Ministry of Regional Development and Infrastructure of Georgia (GE-MRDI), towards supplying all municipalities of Georgia with water on a daily basis. The project envisages replacing and/or repairing water supply system pipes, existing reservoirs and head works. The Municipal Development Fund actively directs donor funds towards municipal water development, from multilateral and bilateral donors including the EU, ADB and WB, as well as USAID, GIZ, and KfW. Within the Kura Basin, rehabilitation works of water supply systems are ongoing in more than 10 cities and villages.

5. OVERALL REGIONAL INTERPRETATION

The socio-economic trend analysis for the TDA combined with the expanded information collected in the Desk Studies for Climate Change, Hydrology and Water Quality, has provided an array of updated information. The interpretation of this towards the assessment of future impacts of developments on water resources at the basin level is based on the best available data at this time, spring 2013, from national and international sources. It is expected that as more refined data will become available, more detailed analyses and assessments of future impacts can take place. The findings presented below focus on impacts of hydropower expansion, municipal water development, and irrigation expansion. The data looks at current plans based on the trend analysis as well as on potential development in the basin. The potential development is based on estimates from national sources on the maximum potential sectoral development for each county.

5.1 Hydropower generation

As described above for each individual country and the Kura Ara(k)s basin area within the country, the hydropower sector is envisioned to expand significantly in the nearest future. Table 5.1 presents an overview of all short- and long-term development plans defined by the responsible sectoral authorities in the countries Armenia, Azerbaijan and Georgia.

Table 5.1 Overview of hydropower development plans in the South Caucasus.

Sector HPP generation	Armenia	Azerbaijan	Georgia ***	Total
Current installed (MW)	1,201	1,232	525	2,958
Licensed/under construction (MW)	418	150	201	769
Short-term total (MW) *	1,619	1,382	726	3,727
Short-term planned increase (%)	34.8	12.2	38.3	26.0
Country contribution to total short-term regional increase (%)	54.3	19.5	26.1	100.0
Long-term planned - increase ** (MW)	370	175	170	715
Long-term planned - total (MW)	1,989	1,557	896	4,442
Relative increase - long-term national (%)	65.6	26.4	70.7	50.2
Country contribution to total long-term regional increase (%)	51.7	24.5	23.8	100.0
Country contribution to overall short & long-term regional increase (%)	53.1	21.9	25.0	100.0

*Notes: * short term total includes currently operational HPPs and those which are licensed for construction or currently under construction; ** potential HPP development based on assessed feasibility within the basin; *** only HPP development in Georgia's Kura Ara(k)s basin section is included.*

Based on table 5.1 the following conclusions can be drawn on regional hydropower development in the Kura Ara(k)s river basin until 2025:

- The currently installed hydropower capacity in the Kura Ara(k)s basin is 2,958 MW.
- Approved & licensed plans or ongoing construction works on expanding the hydropower capacity in the basin amount to in total 769 MW, a 26% increase compared to the current capacity.
- The largest absolute short term increase in MW capacity is planned in Armenia, increasing by 418 MW, compared to 201 MW in Georgia and 150 MW in Azerbaijan.
- At country-level the relative short-term envisioned increase in hydropower capacity is the largest in Georgia (38.3%) followed by Armenia (34.8%) and Azerbaijan (12.2%). The relative contribution of the individual countries to the overall short-term regional increase shows that Armenia contributes relatively more (54.4%) than Georgia (26.1%) or Azerbaijan (19.5%).

- Existing long-term plans envision an additional expansion of hydropower generating capacity of 715 MW, equal to an additional 19.2% increase on top of existing and ongoing short-term developments. Accordingly, by 2025 the total hydropower capacity in the Kura Ara(k)s basin is envisioned to increase by 50.2% compared to currently installed capacity. This potential increase will include 769 MW in short term ongoing activities and 715 MW in long-term plans.
- The largest overall relative increase in hydropower capacity is envisioned to occur in the Georgian section of the Kura Ara(k)s basin, planning to increase its current capacity of 525 MW to 897 MW, an increase of 70.7%. Armenia closely follows with 65.6%, and Azerbaijan plans an extension of 26.4%.
- Meanwhile the largest absolute long-term increase is planned in Armenia – 788 MW, followed by Georgia (371 MW) and Azerbaijan (325 MW).
- The largest contribution to the overall short- and long-term expansion of hydropower in the Kura Ara(k)s basin comes from Armenia (53.1%), followed by Georgia (25.0%) and Azerbaijan (21.9%).
- Most plans focus on installing small and medium-sides HPPs, based on the run-of-river approach. Although this approach does not use large dams and reservoirs, the environmental impacts still can be significant if proper environmental flows are not maintained. Potential impacts include a longitudinal disruption of flow and sediments, decrease or destruction of river biodiversity, including fish, both in quantity and quality, and a resulting loss of ecosystem functions. Also the geomorphological characteristics of rivers may be affected, due to the redirection of river water away from its current path.
- Installing run-of-river HPPs may affect the water availability to other water users along the piped pathway, including municipal, agriculture and industrial users.
- Potential HPP development in upstream areas may significantly impact on the return on investment for HPPs in downstream areas, if not planned and managed in a coordinated manner. This includes potential impacts on current developments including the Iranian/Armenian shared HPP at Meghri.
- A shared view exists on climate change as an ongoing process in the South Caucasus. An increase in temperature together with a decrease in precipitation is envisioned to cause an overall reduction in river flow. While forecasts are based on generalized, regional models, the heterogeneous topography and relief of the South Caucasus region will provide for significant more spatial variation in actual climate change at any specific location. This will have significantly consequences for any tributary's capacity to generate hydropower, reliable assessments of which are currently unavailable as no suitable hydrological flow forecast models exist.
- In the event that larger scale HPPs are developed, additional issues of reservoir filling & release schedules, seasonal energy requirements, and seasonal needs for irrigation as well as downstream ecosystems must be taken into consideration. The failure to coordinate this can have significant impacts on food security, water security and environmental security within the basin.
- Impacts of hydropower development are not only transboundary but national as well. These include:
    - While the largest hydropower development is planned in Armenia, also other water uses development plans exist, including the further increase of water levels in Lake Sevan (by 2025: +3.5 m; +6 BCM), the increase in irrigated lands (+200%). These will also impact on available water resources, to be more acutely felt nationally, in addition to their transboundary impact.
    - In Azerbaijan, any increase in hydropower generation in upstream areas may impact on the seasonal availability of water resources to cover irrigation needs, increasing due to the planned expansion as well as climate change impacts. Meanwhile, the development of irrigation together with climate change may impact on opportunities to generate hydropower in downstream areas.
    - In Georgia, any expansion of hydropower in the Kura basin may impact on the amount of water available for an envisioned expansion of irrigation, especially in the Alazani basin where commercial irrigated vegetable production already exists and is projected to expand.
- Additional studies should be undertaken to take energy transmission potential, type of hydropower being used, impacts on environmental flows and potential for coordination between sectors within and between countries into account, to maximize the positive impacts and minimize the negative impacts of hydropower development.

5.2 Municipal water use

As described above, there are opportunities for improving and expanding municipal water supply in the individual countries of the Kura Ara(k)s basin. While limited specific information is available for this sector, a preliminary assessment of the joint impacts of envisioned development plans for the Kura basin has been undertaken.

Table 5.2 Water consumption by sector in three South Caucasus countries in 2011.

	Armenia	Azerbaijan	Georgia	Total Basin
Total consumption (mln m^3)	1,015.9	6,460.9	1,044.7	8,521.5
agriculture, fisheries, forests (mln m^3)	722.3	4,966.8	247.7	5,936.8
Industry (mln m^3)	218.8	1,295.4	357.9	1,872.1
municipal drinking water (mln m^3)	74.8	174.2	439.2	688.2
export for municipal water use (mln m^3) *		706.8		706.8
agriculture as percent of consumption in country (mln m^3)	71.1	76.9	23.7	69.8
industry as percent of consumption in country (mln m^3)	21.5	20.1	34.3	22.0
municipal water withdrawals as percent of consumption in country (mln m^3)	7.4	13.6	42.0	8.2

*Notes: * "export for municipal water use" is the amount of water withdrawn from the Kura Ara(k)s basin for use in the municipal areas of Baku.*

From the features on sectoral water consumption, presented in table 5.2, one can observe:

- The highest consumer of national water by far is agriculture, using almost 77% in Azerbaijan, 71.1% in Armenia, and 23.7% in Georgia. Overall, agriculture in the Kura Ara(k)s basin accounts for 69.8% of all water consumption. Any expansion of the sector (see below) therefore will have important impacts on both water quantity and water quality. Volumetric water use in agriculture depends on irrigation method applied, crops varieties grown with specific crop water requirements and drought tolerance, cultivation methods, soil types, as well as the efficiency of water transportation in the distribution system. Water quality depends on the chemical composition of agricultural discharges into the surface and groundwater. Via agricultural drainage or seepage water potentially land-based sources of pollution, including harmful agrochemicals, salts and other contaminants may enter the rivers.
- Industrial water consumption has increased only in Azerbaijan since the collapse of the Soviet Union. In both Armenia and Georgia the industrial sectors and related water use have declined, but as economies are recovering, it is likely that there will be an increase in industrial water use. The current data shows that 21.5% of consumption in Armenia, 20.1% in Azerbaijan, and 34.3% in Georgia is used in industrial processes, with the overall basin level consumption at 22.0%.
- Increased rates of industrial water use have significant potential to negatively impact on water quality, if insufficient attention is paid to minimizing pollution outflows. This becomes the more important as water resources are forecasted to become more limited, reducing the rivers' capacity to dilute pollutants entering the system.
- Municipal water consumption is relatively low in Armenia, at only 7.4% of total consumption. In Azerbaijan, where significant water resources are redirected to surplus Baku's available resources, municipal water use amounts to 13.6% of total abstraction, of which roughly one fifth is withdrawn for use inside the Kura Ara(k)s basin. In Georgia, where consumption overall is much lower as there is less need for irrigated agriculture, municipal water use accounts for 42.0% of total water withdrawals. Accordingly, for the Kura Ara(k)s basin municipal water use accounts for 8.2% of water consumption to date.
- Municipal water use is expected to increase significantly in the near future, related to an ongoing increase in population numbers, increased welfare levels of the population, as well as the expansion of municipal water supply services and wastewater treatment capacities in the three basin countries. The rate of increase in municipal water supply should not exceed the rate of strengthening wastewater treatment capacities, both in volume as well as geographical coverage. This is a common feature in municipal water development, because less investment is required to improve water supply services

compared to the sanitation services. The availability of municipal water services without proper sanitation services will increase overall consumption, which in turn will increase the volume of polluted sewage wastewater released directly into rivers and waterways, if expanding the wastewater treatment capacity is lagging behind. This will have a serious impact on water quality, especially also in light of declining water resources as a result of climate change.

- Specific developments of importance at the national level include:
  - In Armenia, the impacts of expanded hydropower, see above, and increased agriculture, discussed below, will have impacts on water availability for industrial and municipal water use, both annual volumes as well as seasonal availability. Also, the quality of water within the country could jeopardize human health, if wastewater treatment facilities for municipal and industrial water are not updated, and polluted water is used downstream for agriculture, or if agricultural drainage water is used for either municipal or industrial purposes.
  - For Azerbaijan the water consumption from surface water sources in the Kura Ara(k)s basin is much higher than either Armenia or Georgia. Main factors include the larger population, the more arid climate and the higher dependency on river water as the major source for water consumption. A significant portion of the water abstracted for consumption meanwhile is “exported” outside the Kura Ara(k)s basin, to support consumptive needs in the Baku area. Accordingly, the availability of water of sufficient quantity and quality will be a concern at the national level, especially if growth rates in industrial, municipal and agricultural uses will continue, taking the forecasted impacts of climate towards more scarcity of water in the region into account. The inter-basin transfer of water for municipal use to Baku will likely increase as the population in Baku continues to grow, a trend observed also within the Kura Ara(k)s basin of Azerbaijan. As the most downstream country, the most arid one, and the most dependent on the Kura Ara(k)s as the main source of water, Azerbaijan may face water scarcity that has the potential to create significant water insecurity and food insecurity if not addressed through inter-sectoral and transboundary coordination.
  - For Georgia, the total water consumption is much lower than either Azerbaijan or Armenia, due to its climatic and geographical features. The municipal water consumption is less of an immediate concern within Georgia, with supplies largely originating from groundwater sources, however wastewater disposal must be considered for downstream impacts, including impacts on communities in eastern-most Georgia. For example, an increase in water consumption in the Iori basin, where water scarcity is already an issue during dry seasons, would create challenges for an increased outflow of polluted wastewater into decreasing water volumes. This has potentially significant negative impacts on ecosystems as well as the health of Georgian citizens, as well as on transboundary relations.

5.2 Agricultural water use

The developments described for the agricultural sector during the last two decades, as well as the national development plans in the countries were described above. A quantitative overview of the current expansion plans for irrigated agriculture is presented in table 5.3, including an assessment of the impact of agricultural water use on river flow.

Combining the best available information on actual water use in agriculture, national irrigation development plans, and averaged transboundary river flows, one is able to detect significant impacts to the water resources of the Kura Ara(k)s basin. These include:

- Each basin country is planning for a significant increase in irrigation.
  - In Armenia, where significant international investments are being made in restoring and improving irrigated agriculture, the plans are to increase from 154,000 ha to 454,000 ha within 15 years. This is equal to a relative increase of 195%, for which an additional 1.41 BCM needs to be abstracted from the country’s rivers. Accordingly the outflow from Armenia’s rivers to downstream Azerbaijan and Iran reduces by 17.8% to an average 6.5 BCM. While some irrigation water may return to the river system, either through groundwater seepage or via drainage canals, information on this issue is not readily available. As noted above, irrigation development in Armenia may significantly decrease water resources availability – total and seasonal - for downstream HPPs.

- In Azerbaijan, highly dependent on irrigation for farming and food security, current plans anticipate a 25% (350,000 ha) expansion of irrigated lands, increasing the annual water consumption in agriculture by 1.22 BCM. The result would be an 8.6% decline in river outflow from Azerbaijan into the Caspian Sea. This will likely impact fisheries and ecosystem health, especially taking into account that also river flow will decrease due to expanding upstream abstraction as well as climate change, anticipated to be significant in the lower Kura basin.

Table 5.3 ***Overview of current and future agricultural water use in relation to river flows across national borders.***

	Armenia	Azerbaijan	Georgia	Total Basin
Irrigated agriculture land area				
Current (ha)	154,000	1,425,000	24,000	1,603,000
Planned (ha)	300,000	350,000	200,000	850,000
Total (ha)	454,000	1,775,000	224,000	2,453,000
Increase (%)	195	25	784	53
Land potentially suitable for irrigation (ha)	660,000	3,200,000	725,000	4,585,000
Irrigation Water consumption				
2011 water use in irrigation (BCM)	[a] 0.72	4.97	0.12	5.81
Additional estimated increase in irrigation water consumption (BCM)	1.41	1.22	0.96	3.59
Planned total (BCM)	2.13	6.19	1.08	9.40
Potential water use for irrigation (BCM) [b]	3.10	11.15	3.46	17.71
National Water Inflow-Outflow				
Total National Inflow (BCM)	2.51	19.15	2.08	
Total National IRSWR (BCM)	5.42	7.20	9.37	
Total National Outflow (BCM)	7.93	14.26	11.45	
Envisioned country river outflow taking planned irrigation expansion into account (BCM)	6.52	13.04	10.77	
Change in river outflow due to planned national level irrigation (%)	-17,8	-8.6	-5.9	
Envisioned river outflows to downstream based on potential water use for irrigation [c]	4.83	3.11	9.00	

Notes: [a] – based on recorded water abstractions corrected for estimated losses averaged at 50%; [b] – indicative figures for actual use at field level, without taking losses in distribution channels into account, based on FAO statistics (2012) for maximum area potentially suitable for irrigation. [c] assuming that water for irrigation is only abstracted from surface water sources.

- In Georgia a drastic expansion in irrigation of 784% is envisioned, which will significantly increase water use to 0.96 BCM. Although the percent change to the total outflow from Georgia into Azerbaijan is limited to 5.9%, locally on tributaries the impact may be larger. For example, if a significant expansion in irrigation is planned in the Alazani and Iori tributary basins, the only mechanism to ensure sufficient water supplies may be to rely on inter-basin transfers from the main Kura basin within Georgia.

- The envisioned 8.6% decrease in river flow from Azerbaijan into the Caspian Sea will be exacerbated by planned increased irrigation abstractions in upstream countries, of 1.41 BCM in Armenia and 0.96 BCM in Georgia, to an overall 3.59 BCM. As such the outflow to the Caspian Sea is envisioned to reduce overall by 25.1%.

- According to FAO (2012) all three countries have a far larger land area suitable for irrigation than currently being used, or plan on using in the nearby future. If all suitable lands would be brought in use for irrigation, the total volume of water assessed to be needed increases to 17.71 BCM. This would indicate that no more water will flow from the Kura river into the Caspian Sea, if the countries continue to manage and utilize water with the same efficiency as today. Accordingly, this should stimulate the basin countries to take urgent measures on improving the water use efficiency across the basin, and reduce losses in all sectors, as well as on realistic planning for future developments in the agricultural sector. The countries should also take measures to improve water quality and reduce pollution loads from other water use sectors. This will allow expanding the reuse of drainage water in agriculture, to partly meet the future increasing demands for water.
- It should be noted that the figures presented are based on assessed actual water use at the farm level, and as such do not take losses in the irrigation distribution system into account. Considering that the percentage losses is considered to be in the order of magnitude of 30-40%, the actual abstraction volume to satisfy planned irrigation needs would be 6-7 BCM. Accordingly the relative reduction in flow to the Caspian Sea would reduce by 40-50%, based on unchanged irrigation approaches.
- However, the project countries are aware of the importance of reducing losses throughout the water management sector, towards improving economic productivity, and making the best use of limited resources. An observed trend in agricultural developments in Georgia includes the in-migration of commercial farmers from South Africa and other countries, bringing BAT knowledge of farming in semi-arid areas, including operational management of commercial farming, knowledge that will help in initiating modernization of farm approaches, including the reduction of water losses in irrigation.
- The numbers presented above do not provide fully accurate information on changes in water use in the irrigation sector, as the actual abstractions will also depend improvements in water use efficiency There are potential gains from applying less water intensive irrigation and agricultural methods, including improved distribution canal efficiency, drip irrigation, sprinkler irrigation, no-till farming, drought-tolerant crops, and natural soil enhancement techniques. The current analysis indicates the level of impact in water resources to be expected in relation to investments in irrigated agriculture.
- Data on river flow volumes presented do not take any forecasted alterations in flows due to climate change into account, which are expected to be significant at the basin level but still unknown for specific tributary basins.

6. CONCLUSIONS AND RECOMMENDATIONS

While the data on available surface water resources, actual water abstraction and development plans provide a general insight in water resources expectations for the future, gaps remain that need to be addressed to obtain a complete profile of water trends in the basin. These gaps in knowledge include:

- Data on the envisioned increase in municipal water withdrawal, in relation to population increase, increased welfare, improved water supply services, etc.
- Information on potential alteration in flows resulting from hydropower uses, including loss of opportunity in other sectors, e.g. irrigation, due to the prioritization of energy production.
- Overview of strategic reservoirs planned for construction throughout the basin.
- Accurate data on the impact of development plans on water quality: increased pollutants' concentrations due to declining water flow, use of agrochemicals, expansion of urbanization and industrialization, and specific land-based sources of pollutants.
- An assessment of increasing costs for water treatment, to make water viable for municipal, agricultural and industrial purposes, as well as ecosystems.
- Links between water development plans and the state of aquatic ecosystems, including recharge rates of surface and groundwater, loss of ecosystem services, loss of species, reduced species populations.
- Information on developments in Turkey or I.R. Iran, where water-related development activities are known to be ongoing and planned, in irrigation, hydropower, etc., and populations are also increasing. For the sustainable integrated planning of water resources use in the Kura Ara(k)s basin, these developments should be included in future studies.

The above analysis assumed, for reasons of convenience, that surface water in the river basin is the sole source of water to meet the future expansion in water demands in all sectors. This however is not actually the case, since also groundwater resources are and can being used, but without better monitoring and information analysis on potential availability and recharge rates, no assessment is possible. The countries should invest in studying the potentially available volumes of groundwater, and analyzing the economy of utilizing groundwater to substitute part of the increasing surface water demands.

Overall there is the need for the development of a conjunctive use strategy of both surface and groundwater resources at the national levels to be integrated at the transboundary Kura Ara(k)s river basin level. The conjunctive water resources use strategy is envisioned to be based on the following principles:

- Complete and reliable assessment of dynamic water volumes available from groundwater and surface water sources, based on the sustainability principles.
- Comprehensive knowledge on forecasted changes in water resources availability due to climate changes, based on detailed spatio-temporal modeling and assessment of reliability.
- Upstream dependence and downstream responsibility of each country.
- Integration of sectoral water use plans.
- Accepting responsibility for maintaining current and future environmental sustainability, provision of ecosystem services.

LITERATURE CITED

ADB Asian Development Bank, 2008. Technical Assistance Consultant's Report, Azerbaijan Renewable Energy Development Project., 2007

ADB, 2012. http://www2.adb.org/Documents/RRPs/ARM/45299/45299-001-arm-dc.pdf

Agro-Georgia, 2012. EU Support to Agriculture in Georgia, 31 October 2012

AM-NSS, 2012. National Statistical Service of the Republic of Armenia, 2012. www.armstat.am

Armhydroenergyproject JSC, 2008. The update of the existing scheme for small hydropower stations of the Republic of Armenia. Renewable Energy Project GEF-TF-056211, Renewable Resources and Energy Efficiency Fund of Armenia, Yerevan 2008, 440 pp.

ArmStat, 2012. Statistical Yearbook of Armenia - 2011. National Statistical Service of the Republic of Armenia, Yerevan 2012, 624 pp.

AWE JSC Amelioration and Water Economy, 2010. National Water Supply and Water Sanitation Project for Shemkir rayon, Feasibility Study Report, 2010

AzerStat, 2012. Statistical Yearbook of Azerbaijan, 2012. State Statistical Committee of the Republic of Azerbaijan, Baku, 2012.

AzerStat, 2012. The environment in Azerbaijan - forestry, fishing and hunting farms. Statistical Yearbook, Baku - 2012. p. 95

EBRD, 2012. Small Hydropower in Georgia and Armenia, Paravani HPP, Draft Strategic Environmental and Social Assessment.

ECBSea, 2009. Water Sector Convergence Plan of Georgia. EU project Environmental Collaboration for the Black Sea, 2009

FAO-AM, 2012. FAO – Republic of Armenia, 2012. Country program Framework 2012-2015. Yerevan, Armenia, 34 pp.

G-PAC, 2012. Policy, Advocacy and Civil Society Development in Georgia. USAID Georgia, Transformation of the Agricultural Sector in Georgia.

GDRI, 2012. Economic and Social Development, Development of Agriculture. Georgian Development Research Institute, http://www.slideshare.net/gdri_ge/ss-13964705, 2012

GE-MEP, 2011. Reports on Water Use in Georgia for 2000-2010 http://aarhus.ge/index.php?page=118&lang=eng, 2011, Ministry of Environment Protection of Georgia.

GE-MEPNR, 2008. Ministry of Environment Protection of Georgia (MEP). National Assessment Report for Sustainable Development, 2008

GE-MEPNR, 2010. National Environmental Action Plan of Georgia 2011-2015, Ministry of Environment Protection of Georgia (MEP), 2010

GEO-Cities, 2011. Tbilisi: An integrated environmental assessment of state and trends for Georgia's capital city, 2011

Georgian Dream, 2012. Pre-election program. http://gd.ge/, Ministry of Agriculture of Georgia (MA), Strategy of Agriculture Development of Georgia 2012-2022, 2012.

GeoStat, 2007. First National Agricultural Census of Georgia. National Statistics Office of Georgia. www.geostat.ge.

GeoStat, 2012. Statistical Yearbook of Georgia, 2011. National Statistics Service of Georgia, Tbilisi, 2012, 280 pp.

Hovhannisyan A., T. Alexanyan, T. Moth-Poulsen & A. Woynarovich, 2011. Review of fisheries and aquaculture development potentials in armenia. FAO Fisheries and Aquaculture Circular No. 1055/2, Rome, 2011, 59 pp.

IAEA, 2011. Armenia Country overview. International Atomic Energy Agency, 2011

OECD, 2004. Financing Strategy for Urban Wastewater Collection and Treatment infrastructure in Armenia. Final Report, 2004.

OECD, 2008. Financing Strategy for the Urban Water Supply and Sanitation Sector in Georgia, 2008

Task Force for Regional Development in Georgia. Regional Development in Georgia – Diagnostic Report, 2009

The scheme of development and distribution of productive forces of Azerbaijan SSR in the period up to 2000. Volume III. Applications, page 78. Baku 1982

Towards Performance Based Utility Sector in Armenia: Case of Drinking Water Supply Services. Caucasus Research Resources Center. 2009.

USAID, 2011. Analytical foundations assessment – agriculture (rural productivity) sector assessment, 161 pp.

World Bank, 2007. Integrating Environment into Agriculture and Forestry Progress and Prospects in Eastern Europe and Central Asia Volume II Azerbaijan Country Review

Zerkala Newspaper, 17 November 2012