UNDP/GEF Kura II project

The cost of water services for public water supply and agriculture in the Kura river basin

A report for the UNDP-GEF Kura II project

Vania Paccagnan

International Consultant

July 2018

Empowered lives.
Resilient nations.

Produced by: Vania Paccagnan

Authors: Vania Paccagnan

Produced for: UNDP/GEF Kura II Project

Financed by: UNDP/GEF

Contents

List of Tables

List of Figures

List of Acronyms

ADB	Asian Development Bank
ATP	Ability-to-Pay
AZN	Azerbaijani Manat
EEA	European Environment Agency
EIB	European Investment Bank
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GEL	Georgian Lari
GNERC	Georgian National Energy and water supply Regulatory Commission
GWP	Georgian Water and Power Ltd
HPP	Hydro Power Plant
IWRM	Integrated Water Resource Management
JSC	Joint Stock Company
O&M	Operation and Maintenance
PWS	Public Water Supply
TOR	Terms of Reference
UNDP	United Nations Development Programme
USD	US Dollar
UWSCG	United Water Supply Company of Georgia
WACC	Weighted Average Cost of Capital
WFD	Water Framework Directive
WSS	Water Supply and Sanitation
WTP	Willingness-to-Pay
WUA	Water User Association

Acknowledgements

The author would like to thank the KURA II project team, in particular Elchin Mamedov and Tamuna Gugushvili, for their support in data collection and translation.

1 Introduction

1.1 Scope of the report

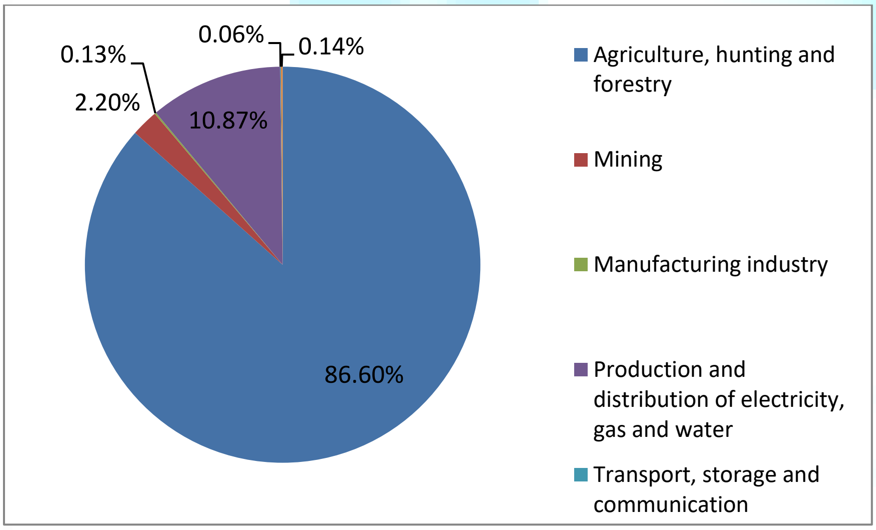
The GEF-UNDP "*Advancing Integrated Water Resource Management (IWRM) across the Kura river basin through implementation of the transboundary agreed actions and national plans*" (Kura II project hereafter) aims to: i) develop a methodology to calculate the Operation and Maintenance (O&M) costs of water services on each sector using water in the Kura river basin; ii) to identify the required data and information needed to apply this methodology; and iii) to estimate these costs for the main water users.

This report considers the full supply cost of water services provision for domestic and commercial (i.e. public water supply, PWS) and agricultural uses. O&M have been estimated, as requested in the TOR. It should be noted that other cost components have been included, namely capital expenditure, to calculate the full cost provision of water in the Kura river basin. Up to our knowledge, this is the first attempt to estimate the full supply cost in this region. Data have been collected directly from supply companies (public water supply providers and national Amelioration companies). Cost of self-supply has not been considered. The final chapter will also estimate O&M and total annual costs of HPP plants.

1.2 Water uses in the Kura river basin

In both countries agriculture is the main water user, followed by PWS (see Figure 1 and Figure 2). The largest volume of water is used in plain areas in Azerbaijan, characterised by dry climate conditions.

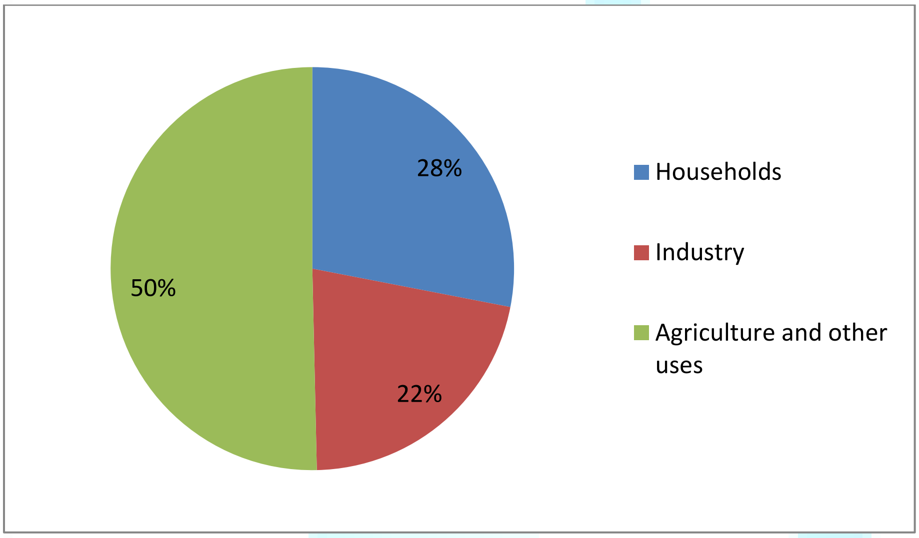
Figure 1 – Share of water abstracted, by main users in Azerbaijan (2016)



Source: Statistical Office website (www.stat.gov.az)

Both countries also have in common the high percentage of water lost in the distribution network, i.e. 3.7 billion m^3 (or 29.43% and of total water abstracted) and 443 million m^3[1], for Azerbaijan and Georgia respectively. In Azerbaijan the policy objective is to reduce water losses to 3 billion m^3 by 2020.

Figure 2 – Share of water abstracted, by main users in Georgia (2016)



Source: Geostat

The main source of water supply is surface water. Groundwater is also used, mainly for drinking water purposes. It constitutes 2% of total withdrawals in Georgia.

Water reuse is already practiced in the Kura river basin. In Azerbaijan water efficiency measures aimed at increasing water recycling and reuse have already been implemented in the industrial sector. In 2016 more than 50% of water needed for industrial purposes came from previously used water. Industrial activities use 24% of total water abstracted.

[1] The data for Georgia only considers the losses in the PWS network. It does not include the water lost in irrigation systems.

2 Methodology to calculate the Operation and Maintenance (O&M) costs of water provision in the Kura river basin

2.1 Introduction

This chapter describes the methodology proposed, along with the data required to carry out an economic assessment of water supply costs. It constitutes the theoretical foundation upon which the subsequent steps of the analysis are built (see chapters 3 and 4).

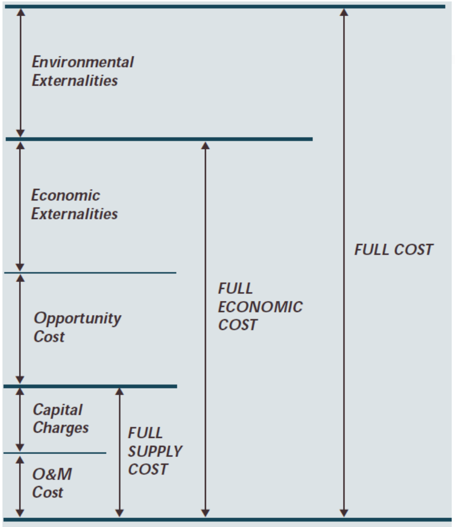
The section is structured as follows. First, the scope of the analysis is clarified (§ 2.2). Then the full cost of water supply is defined (§ 2.3), for all water uses considered, together with data sources and data required (§2.6). Then full cost recovery principle is discussed (§ 2.4) along with ability to pay (§ 2.5). In the concluding part the next steps of the analysis will be explained (§2.7).

2.2 Cost components considered in this report

The methodology spelled out in this chapter built on the approach to full costing suggested by Rogers et al. (2008), where the full cost of water provision is made up of several components (see Figure 3 below), namely:

- The full supply cost of water provision, which is the sum of operation and maintenance (O&M) and capital costs
- The opportunity cost of current water use, defined as the difference between net benefits in the current and future water use and the net benefits of the best alternative use.
- The economic and environmental externalities imposed upon others due to the consumption of water, either because there is not enough water to satisfy competing uses or because water quality is altered and it is not suitable for alternative uses.

Figure 3 – Full cost of water provision



Source: Rogers et al. (2008)

It should be noted that opportunity costs are equivalent to resource costs as defined in the guiding document WATECO (European Commission, 2013) for the WFD, and only arise in situations where alternative uses could generate higher economic values. Environmental externalities are equivalent to environmental costs in the WFD lexicon, as they are defined as the costs deriving from the environmental damage that water use imposes on ecosystems, and economic externalities relate to the costs entailed by environmental quality degradation of aquatic systems.

As the rationale of this work is to understand the full costs of water services provision to assess its current level of cost recovery and exploring financing mechanisms, only the full supply cost of water services provision will be considered. The external costs related to environmental degradation will be covered in another report (Paccagnan, 2018). Opportunity costs will not be assessed, as they related to allocative decisions, which are outside the scope of the Kura II project.

2.3 Defining the full supply cost for water provision

Full supply cost encompasses all the resources required to deliver water to a given use. Consistently with Rogers et al. (2008) and Jagals and Rietveld (N.D.) we refer here to two macro-cost components, capital costs and operation and maintenance costs, defined as in Table 1.

Table 1 – Cost components of water supply services

Cost Component	Definition
Capital Cost	Cost for goods with a life of more than one year • costs for the preparation and construction of the system through to the moment that the system becomes operational • expansion of the system and replacement of major (high-cost) parts
Operation and Maintenance	All expenditures (staff, parts and materials) that are required to keep a system operational and in good condition (maintenance) after its installation is completed

Source: Jagals and Rietveld (N.D.)

Although the components of full supply cost can be clearly defined, their estimation is not straightforward, for two reasons (Massarutto, 2007):

- Cost of water services provision could be affected by inefficiencies in water systems management (monopolistic behaviour by the service provider, poor maintenance or inadequate investments)
- Depreciation and capital costs are dependent upon accounting practices and how asset investment is financed.

Whilst assessing the efficiency of public supply provision in the Kura river basin is outside the scope of this report, some indications can be given by observing the trends in operating costs. So for instance, it is known that reduction of water losses can positively affect the extent of energy costs of water services providers. Anecdotic evidence suggests that investments aimed at reducing water losses in Tbilisi reduced operating costs, by decreasing energy costs by 30%.

Regarding depreciation of assets, besides considering costs that are included in financial statements, depreciation of planned investments should also be considered, according to their useful life. Taking into account future investment costs is necessary to derive an estimate of the prospective, long-run average provision cost, and check whether future costs are affordable for water users.

Capital costs can be estimated by looking at the total construction costs of a project (which is the sum of net construction costs and the contractor surcharge), in case of completed projects, or by considering preliminary studies carried out in the pre-investment phase, for not completed projects. These costs are typically non-recurrent costs, as they are normally one-off expenditures. In order to apportion capital costs to a financial year, useful life of the different water system equipment should be considered. Depreciation is the decline in asset value over a period, typically a year, and it is then calculated by dividing the investment costs by the useful life of the asset. Depreciation periods vary considerably between the components of the system, as shown in Table 2. This spells out the typical useful life for a comprehensive list of water system equipment components.

This method makes it possible to earn back, from annual income, costs incurred on the system during construction and has two advantages: first, it takes into account future running costs of the system, and secondly, it makes possible to collect through tariffs, in case of application of full recovery principle, the share of capital costs that is depreciated in a given period.

O&M include the following components (Jagals and Rietveld, N.D.):

- Operational, i.e. costs for acquiring and administering consumables such as energy, process water and chemicals, as well as disposing of waste.
- Maintenance, i.e. costs for the repair and replacement of parts of installations (e.g. pumps or repairing wells) within the predicted lifetime of the system (otherwise these will be new investment costs)

Table 2 – Typical life expectancies of water system equipment

Component	Life expectancy
Wells and Spring	25 years
Intake structure	35 years
Pumping equipment	10 years
Disinfection equipment	5 years

Hydropneumatic tanks	10 years
Concrete and metal storage tank	30 years
Pipes	35 years
Valves	35 years
Mechanical valves	10 years
Computer equipment/software	5 years
Transformers/wiring	20 years
Motor controls	10 years
Sensors	7 years
Building	30 years
Service Lines	30 years
Hydrants	40 years

Source: EPA 2003

Finally, financial costs have been taken into account. Water and wastewater services projects are among the most capital-intensive amongst infrastructure investment. As noted by Winpenny (2003), the ratio between water asset investment and revenues is much higher in water compared than other water utilities. Therefore, external sources of financing have to be sought, either in the market (through debt) or internally (through equity). The cost of capital (k_c, or WACC, weighted average cost of capital) can then be calculated as a weighted average between the cost of debt, D (i.e. the interest rate paid to borrow the money from the bank, k_d) and the cost of equity, E (i.e. the interest rate paid to investors, k_e), as follows:

$$\text{WACC: } k_c = D/(E+D)\, k_d\, (1-t) + E/(E+D)\, k_e \qquad (1)$$

WACC will vary according to the source of financing. This cost component should be included even if investment in water infrastructure is financed entirely through public money, to consider opportunity cost of capital, i.e. the fact that the money could have been invested elsewhere (Massarutto et al., 2008).

2.4 Full cost recovery

The Water Framework Directive (WFD) establishes that water tariffs should be set to attain an adequate degree of cost recovery (cfr. art.9). As noted by EEA (2013) whilst Member Stated adopted a narrow definition of water services, to consider only the provision of water services and waste water services, the Commission adopted a broader perspective, by including also agriculture and industry, cooling and navigation, and flood protection. In this note we will focus mainly on public water supply (which might include commercial and industry uses) and agriculture, as they are the main uses in the Kura river basin. It should be noted that water tariffs, intended as the fees paid for the provision of water services, are one of the possible instruments, and that different cost components can be covered by different instruments, as highlighted in table 3 below. When discussing full recovery principle, this report will focus on water tariffs for water supply, sewerage and wastewater treatment. Abstraction charges are discussed in the report of environmental degradation (Paccagnan, 2018).

Table 3 – Cost recovery of different pricing mechanisms

Water Service Component	Pricing mechanism	Cost component covered
Water Abstraction	Tax or charge	E&R

	Water trading	
Water supply	Water price/tariff Tax on water use	C&I; O&M
Sewage	Sewage charge	C&I; O&M
Wastewater treatment	Wastewater treatment charge	C&I; O&M
Water discharges	Water pollution charge/tax	E&R

Source: EEA (2013). Note: E&R – Environmental and Resource Costs; C&I – Capital and Investment costs; O&M – Operation and Maintenance

2.5 Ability and willingness to pay

As OECD (2003) suggests, it is useful to distinguish between Ability- and Willingness-to-Pay (ATP and WTP, respectively). When marginal water tariffs are lower than both ATP and WTP then there is not an issue. When these exceed both ATP and WTP some measures should be put in place to make water affordable to all customers. The intermediate case, i.e. when water tariffs lie between WTP and ATP, requires different policy initiatives. This situation normally depends on lack of adequate planning for extreme conditions, such as very hot weather, or upon recent history of low (subsidised) tariffs (OECD; 2003). They recommended to introduce water increase slightly, or to introduce household oriented support to smooth the financial burden (in case of exceptional high water bills). Similarly, introduce frequent billing or bill-smoothing (i.e. through direct debit) could be appropriate measures (OECD, 2003).

The first step of the analysis is to define an affordability threshold. This is normally 3% of disposable income for public water supply is used, although higher thresholds have also been considered (see for example Mack and Wrase, 2017, who adopted a 4.5% threshold for their affordability assessment of US households). The inability to pay might also be detected by looking at collection rates (i.e. % of unpaid bills). However, for agricultural uses low collection rates depend more on lack of willingness to pay rather than by inability to pay (Easter and Liu, 2005).

As several studies have shown, affordability is an issue mainly for low income families. Therefore different affordability indicators need to be computed for different income levels. Considerations on affordability and ability to pay have been included in chapters 3 and 4.

2.6 Data needed and sources of information

2.6.1 Public Water Supply

In order to estimate the full supply cost, the cost components explained above need to be assessed. It should be noted that for public water supply costing should be done at service provider level, and then aggregated at river basin level, in order to assess the level of cost recovery for each provider, and to check whether cross-subsidies between different areas of the country exist.

Financial statements, where produced, are the primary source of information. Table 4 summarises cost and revenue items that can be found in financial statements of joint stock companies.

Table 4 – Cost and revenues items included in financial statements

Component	Item
Service and Production	Water treatment chemicals Electricity consumption Repairs and Maintenance Salaries and employee benefits
Capital	Depreciation
Financial Costs	Interest payments
Revenues	Revenues from water supply Other revenues (interest, subsidies)

Information on previously completed projects could be used to derive cost-functions that can be applied in case no information is available. So for instance, by looking at investment costs for different water treatment plants sizes, a cost/m^3 of treated water can be derived, that can be used in case no financial data are available.

Information on prospective investments can also be collected, to estimate future depreciation costs and financial costs' estimates, and determine in this manner a forward-looking average water provision cost.

2.6.2 Agriculture

In Georgia and Azerbaijan management of irrigation infrastructure is responsibility of two State-owned companies, Georgian Amelioration and Amelioration JSC. The extent of operating costs can therefore be collected directly from these companies. Capital costs can be estimated by considering information on past and prospective projects, by compiling datasets on project investment costs, for different types of interventions. In case data are incomplete or missing, a source of reference can be FAO's dataset on irrigation investment costs. Although it does not contain any irrigation projects located in the Kura region, some reference for costing indicators can be derived by looking at data collected in the NENA region. The average investment cost is USD 1,876/ha. By considering irrigation techniques, average investment costs vary considerably, from 455 USD/ha to 3,560 USD/ha, for spate and sprinkler irrigation respectively (see Table 5). Gravity systems shows lower investment costs than pumped irrigation (672 USD/ha and 3,525 USD/ha, respectively).

Table 5 - Investment costs (2003 US$/ha) for different irrigation techniques in the NENA region

Irrigation Technique	Investment cost
Localized	2 594
Spate	455
Sprinkler	3 560
Surface	2 066
Average	**1 876**

Source: FAOSTAT (2016)

Irrigation technologies are defined by FAO as in table 6.

Table 6 – Definition of irrigation techniques

Irrigation Technique	Definition
Localized	Water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied water as a small discharge to each plant or adjacent to it. It is also called micro- or trickle irrigation.
Spate	Random irrigation using the floodwaters of a normally dry water course or riverbed
Sprinkler	This technique simulates rain, and consists of a pipe network, through which water moves under pressure before being delivered to the crop via sprinkler nozzles.
Surface	These systems are based on the principle of moving water over the land by simple gravity in order to wet it, either partially or completely, before infiltrating. They can be subdivided into furrow, border strip and basin irrigation (including submersion irrigation of rice)

Source: FAOSTAT 2016

Once information on O&M and capital costs is available, depreciation costs can be calculated as in the PWS case, by considering linear depreciation schedules, i.e. by dividing total project costs by the asset useful life. Finally, the cost of capital (i.e. interest costs) can be calculated by looking at the source of financing.

2.7 Steps of the analysis

The methodological approach sketched in the previous paragraphs has been adopted to derive the full cost of water service provision for PWS and agriculture. In particular, we have followed the following steps:

1. Financial statements from service providers in the Kura river basin have been requested
2. Collected data have been analysed, to extract relevant annual costing information at river basin level (when possible, information have been disaggregated at administrative, regional level)
3. Investment costs have also been considered, to derive an indicator of long run average supply cost for different policy measures (USD/m^3 for PWS and USD/ha for agricultural investments)
4. Assumptions on cost of capital (i.e. interest rates) have been made according to the source of financing, as the share between debt and equity was not known.

The remainder of the report is organised as follows. Chapter 3 describes WSS in the Kura river basin for PWS, derives full supply cost and discusses affordability issues. Chapter 4 covers the agricultural sector, by examining investment strategies of the two countries and by deriving full cost estimates for this sector. Chapter 5 briefly touches upon HPP uses. The final chapter will draw some concluding remarks, with regards to application of full recovery principle.

3 Water supply and sanitation in the Kura/Mtkvari river basin

3.1 Georgia

3.1.1 Introduction

Water Supply and Sanitation (WSS) coverage is not complete in Georgia. According to data from National Statistical Office of Georgia, 61% of Georgian population is supplied with potable water (95% in urban centres and 35% in rural areas). Whilst 46.5% of the total population is connected to public sewerage, only 34% receive treatment services[2]. In 2016 total water use per capita amounted at circa 92 m^3 for individuals connected to a public water supply system, and to 133 m^3 for individuals with self-supply (i.e. around 251 l/d and 364l/d, for PWS and self-supply, respectively). In 2017 network losses amounted at 443.4 million m^3 (i.e. circa 63% of water abstracted for PWS purposes). Whilst the volume of water delivered to final customers has decreased from 2015 to 2017, from 279 to 262 million m^3, total withdrawals have increased (from 683 to 705 million m^3), due to the increase in network losses (Geostat).

The total length of water distribution networks in Georgia is about 9,500 km, and the length of wastewater networks and sewers is around 4,000 km. It is estimated that half of these assets are located in the Kura river basin.

3.1.2 Main WSS operators in the Kura River

Out of nine licensees operating in water supply sector in Georgia, 5 companies are under state or municipal ownership, whereas 4 are under private ownership. As highlighted in the map below, from these WSS licensed operators the following 6 operate in the Kura river basin:

- GWP - Georgian Water and Power Ltd., private
- UWSCG – United Water Supply Company of Georgia, public (State)
- MWC - Mtsketa Water, part of GWP Ltd
- Soguri Ltd., private
- MarVWC – Marnueli Water, public (municipalities)
- RWC – Rustavi Water, part of GWP Ltd

Rustavi Water and Mtskheta Water are daughter companies of GWP.

Except from these, there are two other small companies operating in the Kura Basin that does not hold a license so that their tariffs are not regulated by Georgian National Energy and water supply Regulatory Commission (GNERC). These are:

- Kvareli Water, non-commercial legal entity
- Shiraz Eminov, individual entrepreneur

[2] http://www.geostat.ge/index.php?action=news&lang=eng&npid=1160

Figure 4 – WSS management entities in Georgia

Source: GNERC 2017 p. 51

Georgian Water and Power Ltd. (GWP) is a company supplying drinking water to Tbilisi and surrounding villages and sanitation services in the capital. It is privately owned, since it was privatised in 2007. They manage 3,500 km of water mains and one treatment plant in Gardabani (connected with a 30 km connector). Reducing water losses in the network and increasing metering penetration are the main management priorities. Current network losses in Tbilisi amount at 40%. Their reduction will make it possible to reduce energy costs and increase revenues, as the saved electricity can be sold on the market (GWP, pers. comm.). Mtsketa Water and Rustavi Water are part of GWP Ltd. Mtsketa has recently carried out rehabilitation of several central water conduits and simultaneously eliminated all major emergency faults in water supply and sewerage networks. Every month they buy 490,992 m^3 of drinking water from GWP ltd. Rustavi provides WSS services to Rustavi, Gardabani and Marnueli. Most of schedule rehabilitation works in Rustavi have been completed.

United Water Supply Company of Georgia (UWSCG) is a state-owned limited liability entity, completely owned by the state. It was established in 2010 and manages WSS assets, previously owned by municipalities, which remain under public ownership. They provide water supply and sanitation services to 48 urban centres and more than 300 villages throughout the country. No information on the current extend of WSS infrastructure is available. An expert group is currently preparing an inventory of water infrastructure and results should be available by summer 2018 (UWSCG, pers. comm.). Information on asset value will be available in GIS format. It is known that inherited asset status was bad and all assets were written off. Investments rose in the last years, from 8 million GEL in 2010 to 240 million in 2018. Information on investment costs for current and past projects are available on their website (http://water.gov.ge//).

Soguri Ltd is a private company which supplies the municipality of Kaspi and the sorrounding villages with groundwater, through 1.2 km of water mains and a salvage pump tower, rehabilitated in 2008, and a pumping station (which is 25 years old). The current water tariffs ensure full cost recovery of O&M costs.

Marnueli Water Ltd is owned by Marneuli municipality. The company provides water supply services for up to 28 villages in Marneuli municipality. Water is supplied from groundwater sources. 60% of the infrastructure is rehabilitated. Fee collection rates are low. Service costs are mainly covered from the municipality budget.

Kvareli Water supply the municipality of Kvareli and its villages with groundwater and surface water. They manage 324.5 km of water mains, which are on average 20 years old. No wastewater collection and treatment services are in place. Potable water is treated through clorination. Their annual income is circa 10,000 GEL, which is not sufficient to cover their O&M costs. Therefore transfers from municipal budget (circa 250,000 GEL yearly) are necessary to ensure the recovery of O&M expenditures. There are no plans for infrastructure enhancement, although additional maintenance is required following extreme weather events, such as flooding and very cold winters.

Table 7 summarises the main indicators of WSS provision in the Kura river basin in Georgia.

Table 7 – Public water supply indicators in the Kura river basin

WSS Operator	Service area	Service Coverage [3]	Customers	Metering	Water Consumption
GWP Ltd	Tblisi and 12 villages	27.39% water 24.86% Sewerage	Residential 446,200; Non-residential 18,500	23%	250-300 l/p/d for metered customers; 400 l/p/d otherwise
UWSCG	48 urban centres and 318 villages	20.66% water 16.50% Sewerage	306,000 domestic customers and 19,000 commercial	49% of customers are metered (100% commercial)	150 l/p/d for metered customers 500 – 3000 l/p/d for unmetered
Mtskheta Water	Mtskheta	0.17% WSS	2,590 domestic and 90 non-domestic customers	68%	
Marnueli Water	10 villages	0.53% water		49%	
Soguri Ltd	Kaspi	0.01% water	260 domestic and 96 commercial customers	-	
Rustavi Water	Rustavi and 17 villages	3.39% water 3.11% sewerage	54,695	72%	

Source: Own elaborations based on GNERC (2017), WSS operators websites and personal communications

3.1.3 Water tariffs in the Kura basin

Water tariffs differ between households and commercial customers, and metered and unmetered households. Details can be found in Table 2. All operators apply a flat rate, according to actual water consumption (GEL/m^3) for metered customers, or an estimated per capita consumption for non-metered customers. It is worth noting that all non-household customers are currently metered, and hence pay according to their actual water use.

[3] As percentage of total national population

Water tariffs for domestic customers vary from 0.071 GEL/m^3 to 0.423 GEL/m^3 (for metered domestic costumers) and from 0.847 GEL/pp to 2.667 GEL/pp (for unmetered domestic costumers). Customers other than households pay higher tariffs (from 2.652 GEL/m^3 to 4.25 GEL/m^3).

Table 8 – Tariffs for potable water provision in the Kura river basin

Company	Tariff Category	Unit	Tariff Water	Tariff Sewerage	Total WSS tariff
Georgian Water and Power LLC	Household, metered	GEL/m^3	0.182	0.043	0.225
	Household, non metered	GEL per capita per month	2.15	0.517	2.667
	Non-household	GEL/ m^3	2.984	0.759	3.743
United Water Supply Company of Georgia	Household, metered	GEL/ m^3	0.355	0.068	0.423
	Household, non metered	GEL per capita per month	1.704	0.326	2.03
	Non-household	GEL/ m^3	2.86	0.79	3.65
Mtsketa Water	Household, metered	GEL/ m^3	0.152	0.021	0.173
	Household, non metered	GEL per capita per month	1.791	0.245	2.036
	Non-household	GEL/ m^3	3.327	0.386	2.713
Soguri Ltd	Household, metered	GEL/ m^3	0.071		0.071
	Household, non metered	GEL per capita per month	0.847		0.847
	Non-household	GEL/ m^3	4.25		4.25
Marnueli Water	Household, metered	GEL/ m^3	0.333		0.333
	Household, non metered	GEL per capita per month	1.398		1.398
	Non-household	GEL/m3	2.652		2.652
Rustavi Water	Household, metered	GEL/m3	0.315	0.028	0.343
	Household, non metered	GEL per capita per month	1.714	0.151	1.865
	Non-household	GEL/ m^3	2.568	0.157	2.725
Kvareli water	Household	GEL/ m^3	0.50 (GW) 0.67 (SW)	-	0.50 (GW) 0.67 (SW)

Source: Regulatory Commission 2017 and personal communications

3.1.4 Investments in WSS infrastructure

Starting from 2004 provision of WSS services was enhanced through massive investments in infrastructure renewal and upgrade with funding from the state budget and international donors, such as the Asian Development Bank (ADB), the European Investment Bank (EIB) and the World Bank. (Melua, 2015). The rehabilitation of Tbilisi WSS network was completed between 2005 and 2007.

Following the support of the ADB, 546 km of water pipes have been installed or upgraded, giving access to the service to more than 150,000 households (almost 28,000 in rural areas). More than 38,000 households have improved access to sanitation (ABD website). Table 9 summarises the loans that the ADB have financed since 2011, for total investment costs of over 480 million USD. Some of the projects covered areas which fall outside the Kura river basin.

Table 9 – Loans from the ADB for water and sewerage infrastructure projects, million US$

Project Title	Description	Status	Approval Date	Signed Amount
Urban Services Improvement Investment Program -Tranche 6	Financing of water supply and sanitation systems in Marneuli, Bolnisi, and Chiatura. The first component includes construction of: (i) water supply and sewerage systems, including a new sewage treatment plant (STP) in Marneuli; (ii) the sewerage system, including a new STP in Bolnisi; and (iii) the water supply system and a new STP in Chiatura. Project 6 will benefit approximately a population of 37,380 in Marneuli, 9,000 in Bolnisi, and 15,400 in Chiatura. The second component includes project implementation support.	Active	04 Oct 2016	99
Urban Services Improvement Investment Program - Tranche 5	The program is rehabilitating and expanding water and sanitation services and helping utilities' improve their planning and management capabilities. Tranche 5 is financing the construction of sewerage systems in the towns of Zugdidi and Mestia.	Active	29 Sep 2015	90 (75 ADB financed)
Urban Services Improvement Investment Program - Tranche 4	Project 4 will finance the water supply and sanitation (WSS) services in Zugdidi and Poti, respectively, which are two of the seven secondary towns covered by the Urban Services Improvement Investment Program. The first component of the project will support infrastructure investments to rehabilitate, improve, and expand WSS facilities in Zugdidi and Poti, respectively; and benefit approximately 20,600 households in Zugdidi and 13,250 households in Poti by the end of the project period. The second component will include project implementation support and management.		11 Dec 2014	128 (108 ADB financed)
Urban Services Improvement Investment Program – Tranche 3	The project will upgrade the water supply system in Kutaisi and build three reservoirs, two pumping stations, transmission mains, and water distribution network. It will cover work on the water intake, water transmission and distribution system, sewerage system, and wastewater treatment plant in Ureki.	Active	05 Dec 2013	116 (98 ADB financed)
Urban Services Improvement Investment Program – Tranche 2	The project will rehabilitate and expand infrastructure as well as service coverage, and improve the efficiency of the water supply, sewerage, and sanitation systems in the urban centers of Anaklia, Mestia, and Ureki. It will also include institutional development and project implementation support.	Active	23 Nov 2011	40
Urban Services Improvement Investment Program – Tranche 1	The project will rehabilitate, improve, and expand water supply and sanitation infrastructure in six secondary towns. It will also strengthen the capabilities of key water and sanitation provider, United Water Supply Company of Georgia LLC, and develop the capacity of oversight agencies to regulate the sector more effectively.	Active	12 Apr 2011	80

MFF - Urban Services Improvement Investment Program - Facility Concept	The program is improving the infrastructure in order to rehabilitate, improve, and expand services, as well as upgrade the management of supply and sanitation agencies.	Active	30 Mar 2011	250

Source: ADB Website

Loans (for a total amount of over 200 million euros) have also been granted by the EIB since 2010 (see Table 10). The EIB finance projects in Georgia on the basis of an EU mandate for the countries of the Eastern Neighbourhood, the so-called External Lending Mandate (ELM).

Table 10 – Loans from EIB in Georgia for water and wastewater supply (million €)

Project	Description	Signature date	Signed Amount
GWP TBILISI WASTE WATER AND INFRASTRUCTURE	Rehabilitation of Gardabani's wastewater treatment plant; modernisation and development of water supply infrastructure	28/07/2017	21.47
WATER INFRASTRUCTURE MODERNISATION II	Maintain the continuity of the water supply, reduce water leakages in the water supply system and improve water quality across 28 cities in Georgia	20/08/2013	40
WATER INFRASTRUCTURE MODERNISATION	Mainly small scale investment schemes in 28 cities for leakage detection, metering, rehabilitation of the water distribution network, energy efficiency and sewerage system rehabilitation.	15/09/2010	40

Source: EIB Website

The World Bank finance projects in Georgia since 1997. Table 11 summarises the main project indicators. It is worth noting that the total project costs cover also investments in local services other than PWS.

Table 11 - Loans from WB in Georgia for water and wastewater supply (million USS)

Project	Description	Approval Date	Status	Total project cost (WB commitment)
Regional and Municipal infrastructure Development Project	Infrastructure investment in rehabilitation and expansion of municipal services, including PWS	Nov 2, 2010	Closed	120.4 (83.6)
Municipal Development and Decentralisation project 2	Construction rehabilitation and maintenance of public infrastructure and services operated by local government, including PWS	August 1, 2002	Closed	30.90 (19.41)
Municipal Development and Decentralisation project	Institutional development and physical investments in construction rehabilitation and maintenance of public infrastructure and services operated by local government, including PWS	July 15, 1997	Closed	28.10 (20.90)

Source: World Bank Website

The following investments are planned by UWSCG in the next years.

Table 12 – Future interventions planned by UWSCG

	Location	Intervention
1.	Citi of Vale, Samtskhe-Javakheti Region	Water supply systems rehabilitation works
2.	City of Abastumani, Samtskhe-	Water supply and wastewater collection systems rehabilitation

	Javakheti Region	works and wastewater treatment plant construction works
3.	City of Akhaltsikhe, Samtskhe-Javakheti Region	2x800 m3 capacity water reservoir rehabilitation and 2x1000 m3 reservoir construction works
4.	City of Akhaltsikhe, Samtskhe-Javakheti Region	Improvement of water supply systems
5.	Akhaltsikhe Municipality, Samtskhe-Javakheti Region	Rehabilitation of water supply systems
6.	Manglisi, Kvemo Kartli Region	Improvement of water supply systems
7.	Adigeni, Samtskhe-Javakheti Region	Rehabilitation of water supply systems
8.	Bakuriani, Samtskhe-Javakheti Region	Construction of water supply systems
9.	Khashuri, Samtskhe-Javakheti Region	Rehabilitation of water supply and sanitation systems, construction of wastewater treatment facility
10.	Dusheti, Mtskheta-Mtianeti Region	Rehabilitation of wastewater collection systems and construction of wastewater treatment facility
11.	Zhinvali, Mtskheta-Mtianeti Region	Rehabilitation of wastewater collection systems and construction of wastewater treatment facility
12.	Citi of Telavi, Kakheti Region	Full rehabilitation of water supply systems
13.	City of Kvareli, Kakheti Region	Rehabilitation of water supply and wastewater collection systems, construction of wastewater treatment facility
14.	Gardabani municipality (5 villages)	Construction of water supply systems
15.	Pasanauri, Mtskheta-Mtianeti Region	Rehabilitation of water supply and wastewater collection systems, construction of wastewater treatment facility
16.	Bolnisi, Kvemo Kartli Region	Construction of wastewater collection systems
17.	Marneuli, Kvemo Kartli Region	Construction of water supply and wastewater collection systems and wastewater treatment facility
18.	Bakuriani, Samtskhe-Javakheti Region	Rehabilitation/construction of water supply and wastewater collection systems, construction of wastewater treatment facility
19.	Gudauri, Mtskheta-Mtianeti Region	Rehabilitation of water supply and wastewater collection systems, construction of wastewater treatment facility

Total investments planned until 2020 can be found in ADB (2010). Details are provided in Table 13 and have been used to assess capital costs (see next session).

Table 13 – Total investments planned for UWSCG (2011-2020), mln 2010 USD

Segment	2011-15	2016-20	Total
Augmentation	2.5	0.5	3
Treatment	66	14	80
Pumping	5	1	6
Storage	9	2	11
Transmission	236.5	53.5	290
Distribution	311	75	386
Meters	35	8	43
Total - Water Supply	665	154	819
Sewage Treatment	135	39	174
Sewers	414.5	69.5	484
Septic Tanks	56.5	13.5	70
Total - Sanitation	606	122	728
Vehicles and Equipment	14	9	23

Total WSS	**1285**	**285**	**1570**

Source: ADB (2010)

3.1.5 The cost of WSS provision

The cost of WSS provision has been quantified by considering publicly available costing information, published in financial statements or investment plans.

O&M costs can be inferred by looking at the financial statement of GWP (EY, 2016), which are available on GWP website up to 2015. Table 14 summarises O&M costs of GWP in 2015 and 2014.

Table 14 – O&M Costs of GWP (thousand GEL)

	2015	2014	Variation
Salaries and other employee benefits	17,669	16,388	7.82%
Electricity and transmission costs	14,792	13,676	8.16%
Raw materials, fuel and other consumables	4,446	5,400	-17.67%
Maintenance expenditure	4,023	4,216	-4.58%
General and administrative expenses	2,659	2,518	5.60%
Taxes other than income tax	2,845	4,040	-29.58%
Professional fees	2,091	987	111.85%
Reversal of allowance/(allowance) for impairment of trade receivables	- 169	5,197	-103.25%
Charge for provision	168	6,549	-97.43%
Other income	- 630	-1,070	-41.12%
Other operating expenses	6,024	7,123	-15.43%
Total operating costs	53,918	65,024	-17.08%

Source: GWP website

The total O&M costs of UWSCG are over 20 million GEL, split by region as highlighted in Table 15.

Table 15 – UWSCG's O&M costs in the Kura river basin, 2017 (thousand GEL)

Regions	O&M Costs
Shida Kartli	2,332
Kakheti	3,020
Samtskhe-Javakheti	10,076
Kvemo Kartli	2,787
Mtskheta Mtianeti	1,968
TOTAL	20,183

Source: UWSCG

Therefore total current O&M costs of WSS services for the Kura river basin are estimated in the order of **74 million GEL/year**, that is **0.64 GEL/m^3 (0.26 USD/m^3)**[4]. Capital costs have been estimated by looking at recent investments in the WSS sectors, as reported in planning documents and donor websites (ABD, 2010; EIB, 2017). In order to assess depreciation costs, we consider investment costs carried out from 2010 to 2020. We apportion total investment costs to the Kura river basin according

[4] These results are obtained by considering financial data from GWP and UWSCG, as we do not have financial information from minor providers. Given the limited service coverage, we deem that these estimates would not be affected by including smaller WSS operators.

to the population served (i.e. 0.56% of total population). The annual capital costs are circa **104 million GEL (42 million USD)**. By considering an asset useful life of 30 years and the total amount of water delivered annually, the unit depreciation costs are estimated in **0.89 GEL/m^3 (0.36 USD/m^3)**. By considering current investment in new WSS infrastructure, unit WSS provision costs are therefore estimated at **1.53 GEL/m^3 (0.62 USD/m^3)**. This would increase to **2.31 GEL/m^3** if we include also the cost of capital (estimated by considering a 3% interest rate).

3.1.6 Application of Full Cost Recovery principle

GWP is a private company and operates in profit. Therefore their costs are fully recovered from tariff revenues. Their degree of O&M cost recovery is and 184% (by including financial and depreciation costs reported in their financial statement the affordability index drops to 117%).

This percentage is 91% for UWSCG, which shows regional variability of their degree of O&M cost recovery (see Table 16), suggesting that cross-subsidies among different areas of the Kura river basin are in place.

Table 16 – Degree of cost recovery for UWSCG, 2017

Regions	%
Shida Kartli	141%
Kakheti	87%
Samtskhe-Javakheti	34%
Kvemo Kartli	207%
Mtskheta Mtianeti	171%
Average	**91%**

Source: UWSCG

Once the full cost of WSS provision is taken into account, current tariff covers between a fifth and a third of total WSS provision costs.

3.1.7 Ability and Willingness to Pay

An affordability assessment can be conducted by considering two indicators for ability to pay, i.e. average household income and incomes of poor households, and by comparing them with average water bill per household: the share of income spent on water bills for different income levels will give an indication of the current degree of affordability of water services in the Kura river basin. In this respect, the affordability threshold used varies between 2.5 and 5% (in this study we will consider 3% as the affordability threshold). Fankhauser and Tepic (2005) highlighted that in Georgia water bills amounted at 0.2 per cent of total household expenditure (0.6 by considering the bottom income decile). By assuming and indicative FCR tariff set at 1 USD/m^3, they also estimated that in 2007 the water bills would be 8.7% of total expenditure for bottom decile households, once the full cost of water services provision has been taken into account.

According to the National Statistical Office, 20.6% of Georgian population lives below the poverty line in 2016[5]. The poverty line is here defined as relative poverty, i.e. the share of population living under 60% of median consumption. The World Bank (2016) use a different poverty threshold, i.e. 2.5

[5] http://www.geostat.ge/index.php?action=page&p_id=188&lang=eng

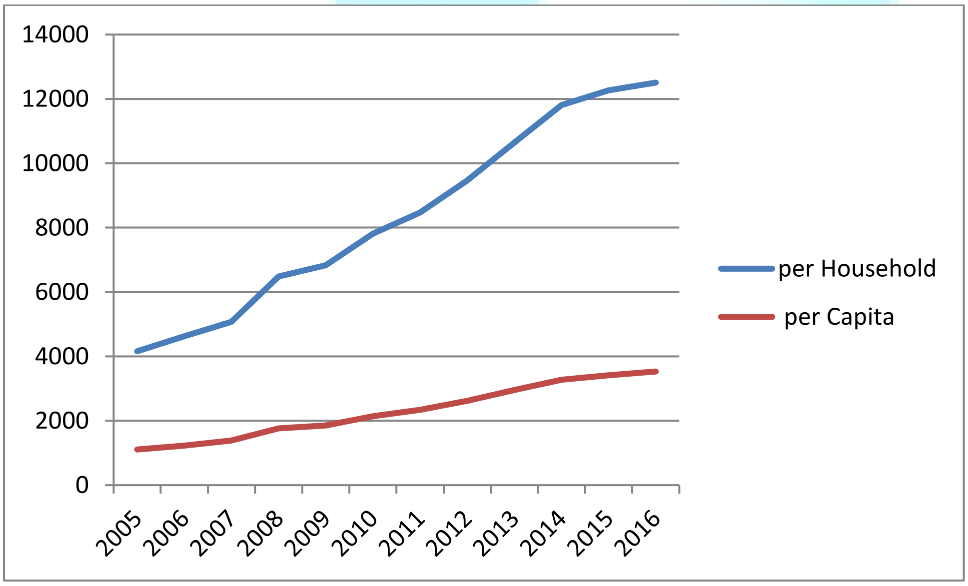
USD/day (2005 PPP). By using this indicator, they estimate that almost a third (32%) of Georgian population lived with less than USD 2.5/day in 2014. The poverty rate varies considerably from region to region, as shown in figure 5 below. According to these figures, in the Kura river basin the Shida Kartli region shows the highest poverty rate (51.9% of population was living with less than 2.5 $/day in 2014), followed by Mtskheta-Mtianeti region (49.3%). They noted also that whilst since 2010 the poverty rate is decreasing (due to positive trends in labour earnings, agriculture income and social transfer) it remains high compared to countries with similar level of GDP per capita.

Figure 5 – Poverty headcount by regions ($2.5/day 2005 PPP) in 2014

Source: World Bank (2016)

Figure 6 summarises the average yearly income per capita and household since 2005, both showing an increasing trend. In particular, both per capita and household incomes have more than tripled between 2005 and 2016.

Figure 6 – Yearly per household and per capita incomes, GEL



Source: National Statistics Office of Georgia

By considering urban and rural incomes per capita, it is worth noting that the urban income increased more rapidly than the rural one. Per capita urban income increased by 326% between 2006 and 2016, whilst in rural areas the 2016 per capita income is 2.53 times the one in 2006. By considering an average monthly household water consumption[6] of circa 25 m^3, the average household bill is in the ranges indicated in Table 17.

Table 17 – Average household water bill (GEL/month)

	Metered	Unmetered
Min	1.79	2.80
Max	10.67	8.80

Source: Own calculations

By considering these hypothetical water bills, the affordability threshold can be computed, by dividing the household water bill by income levels. Two affordability indicators are presented below, for single-income families and for low-income families. These do not vary considerably, and show that current water tariffs are affordable even for the poorest families, but the percentage of income spent on water bills is very close to the affordability threshold (or slightly above when considering the highest tariffs applied). As the highest variable tariffs are lower than the sustainable level identified in this study, we conclude that even a small increase would not be affordable for poorest households.

Table 18 - Affordability of current tariff structure

	Single-Income family		Bottom-Income family	
	Metered	Unmetered	Metered	Unmetered
Min	0.61%	0.95%	0.72%	1.12%
Max	3.63%	2.99%	4.27%	3.52%

Source: Own calculations

3.2 Azerbaijan

3.2.1 Introduction

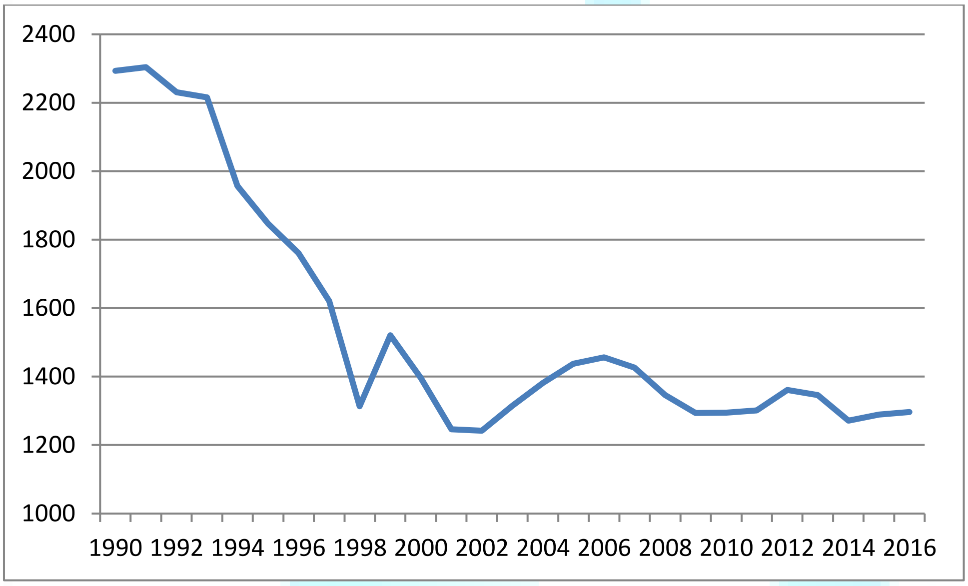
Access to water and sanitation services (WSS) in Azerbaijan has improved considerably in recent years, due to ambitious investments in this sector. As an example, Baku population is now served with continuous water supply, whilst in 2005 only 1.5 million people had access to centralised WSS. Expenditure in WSS was 0.3% of GDP in 2012 (WHO, 2015). Moreover, investments are planned rural areas, which will give access to drinking water to an additional 600,000 people. The objective is to reach 100% coverage by 2025. Future challenges include serving a growing population, which is expected to increase to 15 million in 2030, and tackling climate change.

[6] This has been calculated by considering per capita water consumption and average household size (Geostat).

3.2.2 Water use and service coverage

According to data from the State Statistical Committee, water use per capita has decreased since early '90s, as shown in Figure 7. In 2017 per capita abstraction amounted at 1,297 m^3 (circa 355 litres per capita per day).

Figure 7 – Per capita water abstraction (m^3), 1990-2016



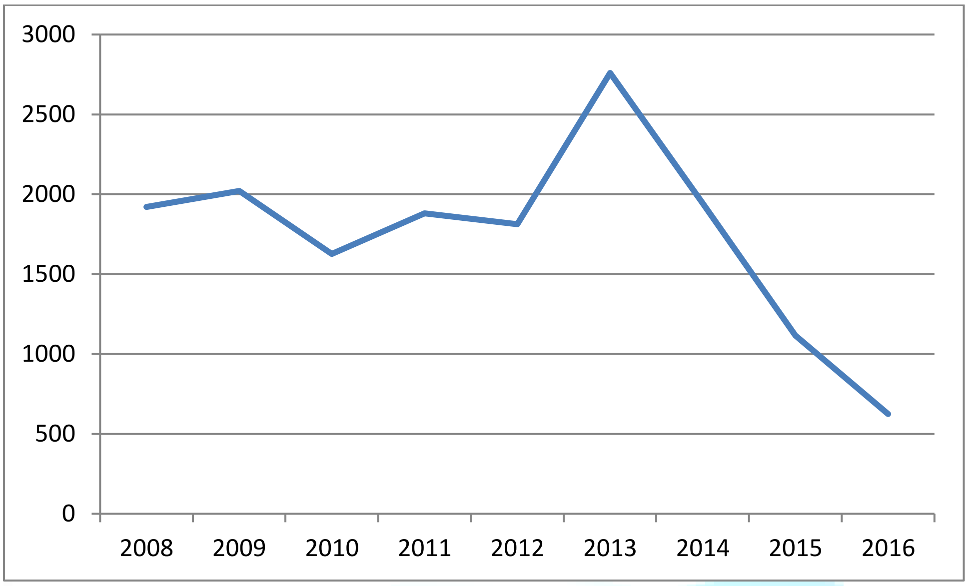
Source: State Statistical Committee

Domestic water use accounts for only 3% of water consumed. Regarding WSS service coverage, in 2017 88% of population had access to potable water supply. As regards to sewerage collection, in 2009 only 31 % of the population was connected to a sewerage network. In 2017 this percentage has increased to 55-60% on average, with coverage in big cities reaching 100% (Azersu, pers. comm.).

The distribution network is inefficient, as 3,680 million of m^3 are lost during transportation (i.e. 29% of total water abstracted). The production and distribution of electricity, gas and water has losses for almost 310 million m^3, i.e. 23% of distributed water for PWS purposes.

Data on total investment in new assets and maintenance expenditure for protection of natural resources are published annually by the State Statistical Committee from 2000. As shown in Figure 8 repair and maintenance of fixed assets peaked in 2013, totalling almost 2.8 million AZN and then decreased considerably in the following years, to 625 thousand AZN in 2016. In 2016 60% of the budget for environmental protection in Azerbaijan was allocated to repair and maintenance for water resources protection. Unfortunately the publicly available statistics do not make it possible to distinguish between investment carried out in PWS and agriculture.

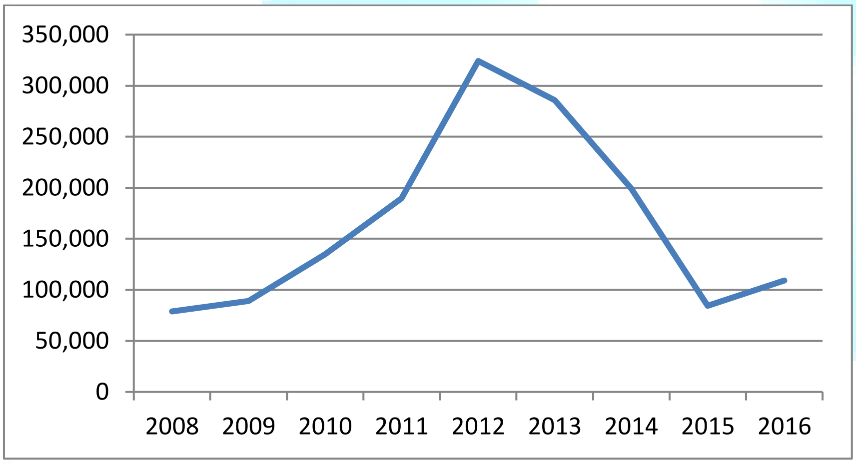
Figure 8 – Total maintenance expenditure for protection of water resources (thousand AZN)



Source: State Statistical Committee (Table 13.6)

By considering capital expenditure, since 2008 almost 1.5 billion AZN have been spent on capital investments on water resources protection, as shown in Figure 9.

Figure 9 – Capital investment for protection of water resources and their rational use (thousand AZN)



Source: State Statistical Committee (Table 13.7)

3.2.3 Azersu JSC

Azersu JSC is the state owned provider for WSS in Azerbaijan. The company was established in 2004 as a state-owned enterprise. They provide water and waste water services across the country, to both households and commercial entities. The group comprises eight subsidiaries, which possess their own share capital. In January 2017, the number of customers was split across regions as follows (Azersu website):

- “Sukanal” Departments of Baku: 737,140
- “United Sukanal” LLC: 340,514

- “Sumgayit Sukanal” Department: 91,677
- “Absheron Sukanal” Department: 71,100
- "Mingachevir Sukanal" Department: 25,559
- "Shirvan Sukanal" Department: 17,231
- “Shaki Sukanal” SJSC: 9,833
- “Ganja Sukanal” SJSC: 61,729

Therefore, 394,000 (i.e. 91.2%) of total customers (total subscribers are circa 432,000) are located in the Kura river basin. It should be noted that, although Baku and its surroundings are not part of the basin, they are included in the analysis as they receive water from the Kura. Table 19 summarises the infrastructure managed by Azersu and the sources of potable water supply. Details are split at regional level. The main water sources for potable water supply are:

- The Kura river itself provides potable water. In the Absheron peninsula, all water of Kur River is treated from silt in radial and horizontal sedimentations and then screens is chlorinated. The water treatment system has been rehabilitated with support from the WB and the EBRD.
- Jeyranbatan Reservoir
- Oguz- Gabala groundwater is transferred to Baku through a 262.5 km long pipeline, completed in 2010. Its cost, circa 780million AZN (459 million US$), was financed through the Oil Fund.

Table 19 – Service provided by Azersu JSC

Region	Residential Areas	Customers	Water Source	No. Water Reservoir	Km water pipes	Km Sewerage
Absheron	16 (1 urban)	49,448 D: 48,704; ND: 794	Jeyranbatan	13	81.7	147.9
Aghdam	29 (17 settlements) (12 villages)	9,816 ND-25	Sub artesian (N125)	17	40.7	NA
Aghdash	2 (1 urban, 1 village)	2,645 NP-82	Artesian (63) İrrigation ditch (105)	3	57.2	18
Agdjabadi	47 (1 urban) (46 villages)	5,324 NP-81	Subartisian -59 Artesian – 44	2	234	13.5
Agstafa	1 urban	2,068 NP-61	Subartisian-10	2	61.8	NA
Agsu	28 (1 urban) (27 villages)	2,753 P-2,690; NP-63	Subartesian -38 Artesian- 6	7	131	NA
Astara	5 settlements	495 NP-34	Astarachay river	7	40.7	NA
Balakan	1 urban 1 settlement	2,006	Subartesian-10 Artesian – 14 Siltikçay, Balakançay, Humbulçay	3	87.7	NA
Barda	8 settlements (1 urban)	13,454 NP-315	Subartesian-177 Artesian - 114	2	176.9	NA
Baylagan	8 settlements	3,894	Sunartesian -45 Artesian - 41	38	388.3	11.4
Bilasuvar	7 settlements (1 urban)	5,682	Water canal - 1	3	116.4	NA
Jabrail	11 settlements	4,483	Subartesian - 14	17	155.3	NA
Dashkesan	1 settlements	7,640	Mineral Springs	3	65.3	23.9
Fizuli	34 settlements	13,980	Subartesian-42	35	330.1	7.7
Ganja	1 urban, 2 settlements	57,872 NP-882	Subartesian- 180	33	525	298.6
Gadabay	1 urban	6,125	Mineral spring	2	21.5	NA
Goranboy	5 settlements	3,864	Subartesian – 21	8	163.5	NA

	(2 urban)					
Goychay	23 settlements (1 urban)	5,699	Subartesian -33 Artesian -29	11	459.1	298.6
Goygol	6 settlements (1 urban)	6,135	Subartesian -2	7	252.4	25.1
Hajigabul	12 settlements (1 urban)	7,135	Kura main water canal	4	25.5	NA
Khocali	4 settlements	1,259	Garachay	10	36.9	NA
Khochavand	10 settlements	2,325	Subartesian-66	3	27.6	NA
Imishli	1 settlement 1 urban	3,274	Subartesian - 24	21	308.8	13.8
Ismayilli	1 urban	2,697	Subartesian -6	6	31	30
Kurdamir	5 settlements (1 urban)	2,713	Mineral spring	3	60.4	7.5
Gakh	4 settlements (1 urban)	3,898	Subartesian – 9 Artesian -70	4	144.5	NA
Gazakh	3 settlements (1 urban)	4,274	Subartesian-8	8	65	31
Gabala	1 settlement 1 urban	2,865	Subartesian -6	7	161.8	14
Lachin	1 settlement	3,253 NP-5	Subartesian-18	3	211.8	NA
Mingachevir	1 urban	24,235 NP-825	Mingachevir reservoir -1 Garabag canal -1	11	199.9	133
Naftalan	1 urban	2,146 NP-34	Subartesian -12	5	47.0	15.4
Neftchala	7 settlements 1 urban	4,834 NP-90	Kura River	5	99.0	18.6
Oguz	14 settlements 1 urban	3,673 NP-123	Subartesian – 7 Artesian – 11 Mineral springs	11	234.6	NA

Saatly	3 settlements 1 urban	2,355 NP-152	Water canal, Araz River	19	420.4	NA
Sabirabad	6 settlements 1 urban	5,067 NP-172	Kura River	46	825.4	14.8
Salyan	1 urban	3,333 NP-107	Kura River	18	71.4	22.6
Shamakhi	20 settlements 1 urban	2,920 NP-73	Subartesian – 3 Mineral spring, Pirsaatchay River	14	265.8	35.6
Shirvan	1 urban	14,641 NP-442	Kura River	2	66.5	22ç5
Shaki	9 settlements 1 urban	12,299 NP- 195	Subartesian -67 Artesian – 424	2	944.6	36
Shamkir	7 settlements 1 urban	4,611 NP-128	Subartesian -105	7	303	NA
Tartar	1 urban	5,530	Subartesian - 23	2	47.0	NA
Tovuz	13 settlements 1 urban	5,525 NP-101	Subartesian – 7 Zayamchay River, Tovuzchay River	7	404.5	17.2
Uchar	1 urban	2,698 NP- 87	Subartesian-9	10	34.8	NA
Zagatala	20 settlements 1 urban	11,784 NP-163	Subartesian-39 Artesian -112 Carcay, Talacay, Silibancay rivers	26	310.7	26.6
Zardab	2 settlements 1 urban	1,769 NP- 45	Kura River	3	21.9	NA
Yevlakh	5 settlements 1 urban	11,387 NP-174	Subartrsian – 62 Artesian – 86 Kura River	2	83.5	15.8

Source: Azersu website

3.2.4 Water tariffs, metering and water efficiency

The Tariff Council is in charge of approving tariffs for Azersu JSC. They propose a water tariff, but the final decision is taken by Cabinet of Ministers. The marginal tariff is currently set up by considering only O&M costs, on social considerations ground. Capital costs are not included as they are subsidised by the Government.

Legislation is being amended. As a consequence, a cost-plus formula could be applied in future, possibly from 2018. Water tariffs have been increased in May 2016. Current applied water tariffs are as follows:

- for big cities:
  - Metered: 0.35 AZN/m^3 water and 0.15 AZN/ m^3 sewerage
  - Unmetered: 2.5 AZN /capita (i.e. 0.50M/ m^3 * 5 m^3, i.e. the monthly estimated consumption).
- for small cities: 0.45 AZN / m^3 (i.e. 0.30 AZN for potable water and 0.15 AZN for sewerage).

Water tariff for industrial users is 1 AZN/m^3 for water and 1 AZN/m^3 for sewerage. Water tariff for food industry is 8 AZN/m^3. Currently industry recycled 55% of its treated wastewater, the target is 80%.

In 2017 66.9% of domestic customers and 82% of commercial customers were metered. Water metering (with a pre-paid card system) measures only actual consumption, not the time of consumption. Water meter readings are carried out monthly. Details on the rate of penetration in the different regions are given in Table 20. The objective is to reach a complete (100%) coverage by 2035.

Table 20 – Metering penetration (%)

Department	Household	Non Household
“Sukanal” Departments of Baku	79	88.4
“United Sukanal” LLC	50.2	54.4
“Sumgayit Sukanal” Department	73.2	91.9
“Absheron Sukanal” Department	70.2	89.9
"Mingachevir Sukanal" Department	40.1	80.1
"Shirvan Sukanal" Department	39.6	86.1
“Ganja Sukanal” SJSC	26.8	83.4

Source: Azersu

According to the State Statistical Committee the average household size in Azerbaijan is 4.43. Therefore, the average monthly water bill for a household supplied with unmetered water is estimated in circa **11 AZN**.

3.2.5 Investments in WSS infrastructure

By considering the funding from central budget and loans granted by international donors to Azersu in recent years (Table 21), almost 1.5 billion AZN (840 million USD) have been invested in WSS new assets from 2014 to 2016. It is worth noting that the contribution of loans from international organisation has increased considerably during these three years, from 12% of total investment costs in 2014 to 66% in 2016.

Table 21 – Funding on water supply and sewerage systems in Azerbaijan (2014-2016), mln AZN

Year	Total	From the budget	Loans from international organizations
2016	520.8	177.7	343.1
2015	508.9	345.4	163.5
2014	390.4	342.6	47.8

Source: Azersu

In order to cover capital costs, Azersu JSC receives financial support from the Government. The State Treasury has an account which is used to finance construction projects and funded by the Government. Subject to State Treasury approval, funds are transferred to Azersu and can then be spent. Azersu treat these contributions as a Government investment within the Group equity. As at 31 December 2016 total Government investments amounted at 3,271 million AZN (EY, 2017).

Operations are also financed through loans, received from local banks, central government or international donors (see Table 22). Most of these loans (almost 90%) are long-term loans with interest rates either null of below 3%.

Table 22 – Interest-bearing loans and borrowings (thousands AZN)

Borrower	Amount
Government loans financed by International financial Institutions	167,434
Loans from the Ministry of Finance	38,939
Loans from local banks	215,556
Total	421,929

Source: Azersu JSC 2016 Financial Statement

3.2.6 The full cost of WSS provision

The O&M costs of WSS provision costs can be inferred by looking at the financial statements of Azersu JSC (EY, 2017), which are available on Azersu JSC website since 2010. Table 23 summarises O&M costs of Azersu in 2016 and 2015.

As the publicly available information is not disaggregated at regional level, we apportion total (group) costs according to the customers served. Therefore total O&M costs of WSS services for the Kura river basin are estimated in circa **163 million AZN,** which correspond to a unit cost of **0.58 AZN/m^3**.

In order to assess depreciation costs, we consider investment costs carried out in the last three years (see table 3), and apportion total investment costs to the Kura river basin according to the population served (i.e. 91.2%). Therefore total investment costs in water and sewerage systems in the last three years amounted at circa **1,295 million AZN** (i.e. 767 million USD, of which over 60% comes from State budget, the remaining from loans by International Organisations). By considering an asset useful life of 30 years and the total amount of water delivered in the last three years, the unit depreciation costs are estimated in **0.1178 AZN/m^3**.

Table 23 – O&M costs for Azersu, thousands of AZN

Cost Category	2016	2015	Variation
Salaries and other employee benefits/əmək haqqı və işçilərin digər gəılirləri	79717	74169	7%
Electricity and transmission costs/Elektrik və nəql xərcləri	33641	32053	5%
Raw materials, fuel and other consumables/Xammal, yanacaq və digər isteklak malları	12793	17477	-27%
Maintenance expenditure/Xidmətrər xərcləri	3638	11698	-69%
General and administrative expenses/Ümumi və administarive xərclər	15321	28476	-46%
Taxes other than income tax/Vergilər və gəlir vergilərindən başqa	5130	3453	49%
Insurance expenses/ Sığorta xərcləri	890	533	67%
Reversal of allowance/(allowance) for impairment of trade receivables/Ödənişin bərpası	16568	6311	163%
Charge for provision and liabilities/Təminat və öhdəlilərə görə ödəniş	185	418	-56%
Other operating expenses/ digər xərcləri	5279	9058	-42%
Total operating costs/Ümumi əməliyyat xərcləri	***173162***	***183646***	-6%

Source: EY (2017)

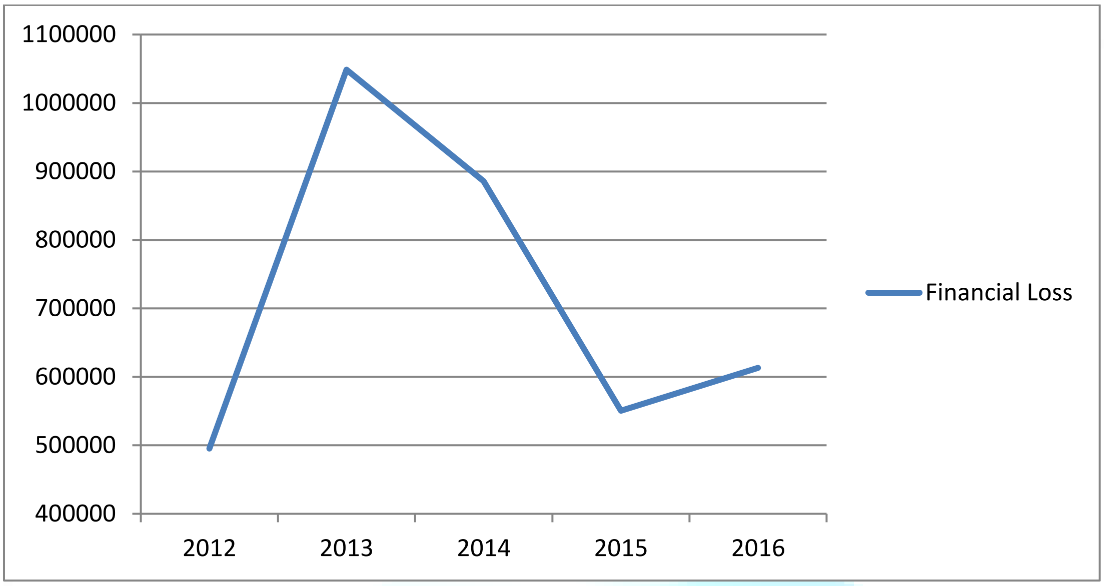
The cost of capital can be deduced by considering the interests paid on current loans. These vary between null and 2.45% for loans from international organisations or banks, and 8% from local banks. By applying an interest rate of 3% it is estimated that the unit cost of capital would amount at **0.0451 AZN/m^3**.

It is therefore estimated that **total provision costs**, including current investment in new WSS infrastructure, **are circa 0.74 AZN/m^3 (0.44 USD/m^3).** It should be noted that this result should be considered as a conservative estimate, as we had investment data only for recent investments, and no info at all for prospective ones. For old investment, we included in the analysis the depreciation costs monetised in the financial statement. Moreover, once new interventions are put in place, O&M costs might increase with respect to the current level.

3.2.7 Application of Full Cost Recovery principle

Current tariff levels do not make it possible to finance WSS provision only through tariffs. The following table summarises the financial results of the last five years, showing that the company operates in loss. It is worth noting that since 2013 the extent of financial losses has been reduced, with the exception of last year, when the exchange risk influenced the financial results of the group. In 2016 their financial loss amounted at more than 600 million AZN (circa 360 million USD).

Figure 10 – Financial losses of Azersu JSC (thousands of AZN)



Source: Azersu JSC Financial Statements

According to Azersu JSC 2016 financial statement, revenues from sale of WSS cover only **92%** of total operating costs. Once we take into account current depreciation and financial costs, then the share of cost covered through tariffs decreases to **82%**[7]. This percentage will decrease further, once the planned investments are completed, as the depreciation costs will increase.

We estimate that, by depreciating recent investments according to the useful life and by adding the cost of capital, the share of total cost recovered by current revenues is around **55%**. This percentage would increase to 59% with an improvement in operational efficiency (that is, with a cost reduction of 10%). The introduction of the full cost recovery principle (FCR) would require that current water tariff are set at the level derived in previous paragraph.

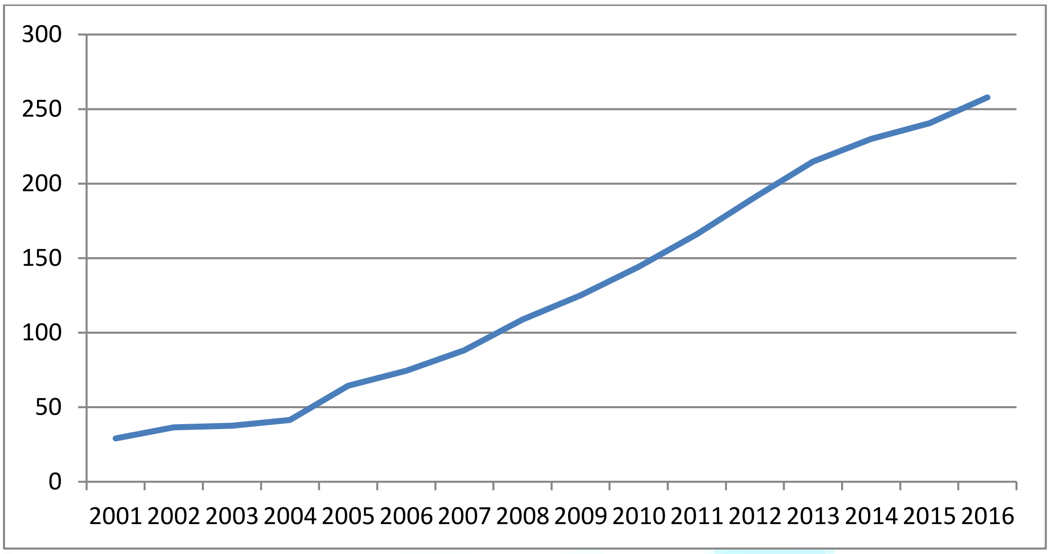
3.2.8 Affordability of water and wastewater services

An affordability assessment developed by Fankhauser and Tepic (2005) highlighted that in Azerbaijan water bills amounted at 1.1 per cent of total household expenditure (0.6 by considering the bottom income decile). By assuming and indicative FCR tariff set at 1 USD/m^3, they also estimated that in 2007 the water bills would be 8.5% of total expenditure for bottom decile households, once the full cost of water services provision has been taken into account.

Since 2001 income per capita has increased steadily, as shown in Figure 11. In 2016 per capita monthly income amounted at circa 258 AZN (USD 152). By considering an average size single-income household, the unmetered water bill would amount at 11 AZN per month, i.e. **4.27%** of the average monthly income.

[7] This percentage does not consider impairment of assets.

Figure 11 –Monthly income per capita, AZN



Source: State Statistical Committee

The average metered water bill for a household can be estimated by considering the water tariffs currently applied and the average individual water consumption. Estimated water bills according to household size are reported in Table 24.

Table 24 – Average monthly household bill for metered water and wastewater services, according to household size (AZN) - 2016

Household Size	Big Cities	Small Cities
2	10.80	9.72
3	16.20	14.58
4	21.60	19.44
5	26.99	24.30
6	32.39	29.15
7	37.79	34.01

Source: Own elaboration on data from State Statistical Committee

By considering the water bill paid by an average size single-income household, current water bills are **9.3%** of monthly income in big cities and **8.3%** in small ones.

According to the State Statistics Committee, in 2016 5.9% of population lived below poverty line (defined as relative poverty, i.e. the share of population living under 60% of median consumption). In 2016 that was 148.5 AZN per capita per month. Information on income deciles is also available from the State Statistical Committee, see Table 25.

By considering the bottom decile, current metered water bills would amount at **15%** and **14%** of total income, in big and small cities respectively. For unmetered water bills this percentage is **7%**. Current water bills are therefore unaffordable for poor households or for single-income families. As current tariffs do not guarantee the application of FCR principle on equity grounds, it will be necessary to consider alternative support means for disadvantaged families.

Table 25 – Income deciles, 2016 – per capita per month

Decile	AZN	USD
1	158	93
2	185	109
3	201	118
4	215	127
5	230	135
6	246	145
7	266	156
8	292	172
9	333	196
10	452	266

Source: State Statistical Committee

3.3 Conclusions

Up to our knowledge the present study is the first comprehensive assessment of total (O&M and capital) costs related to water and wastewater services provision in the Kura/Mtkvari river in Georgia and Azerbaijan.

For Georgia, our results are high level estimates of the total and unit WSS provision cost at river basin level (O&M costs are also presented disaggregated at regional scale). Moreover, we considered future investment costs by looking at planning documents, therefore simulated total provision costs might slightly differ from the actual level of investment, once programmes are implemented. We deem that these figures do not underestimate full WSS provision costs. For Azerbaijan, due to limited data availability it was only possible to derive high level estimates of total provision costs at river basin level, as no detailed information is available at regional scale. Moreover, we had no details on future investment costs and therefore simulate total costs on the basis of current level of investment only. This might actually underestimate the full WSS provision costs.

An analysis of the current level of cost recovery was carried out. For the Georgian side of the Kura river basin, we considered O&M costs as reported by water companies in their financial statements (or as provided directly), and derived capital costs by considered (planned) investments in water assets carried out in the last ten years. Results of the analysis indicate that in Georgia the current level of cost recovery is almost full, when only O&M costs are considered, and varies between 20-30%, when total costs are included. In Azerbaijan the current level of cost recovery varies between 92% (when only O&M costs are considered) and 55% (when total costs are included). . Our findings are consistent with previous studies. For example, OECD-EUWI (2012) found that water tariffs do not cover O&M costs (level of cost recovery was 71% and 75% for Azerbaijan and Georgia, respectively).

A very high level macro-affordability assessment was also developed. For Georgia, the data analysed confirmed that currently WSS is affordable to poor households (falling in the bottom income decile) and for single-income households, but even a small tariff increase might result unsustainable. In

Azerbaijan the data analysed confirmed that currently WSS is not affordable to poor households (falling in the bottom income decile) and for single-income households.

All elaborations were carried out in an excel spreadsheet and the analysis can be easily replicated once new information becomes available. Future directions of research could be:

- update total WSS provision cost analysis, by including actually implemented future investments and by deriving a sustainable water tariff (i.e. that covering the full cost of WSS provision)
- disaggregate total cost analysis at regional (sub-basin) level, by considering O&M costs and investment, as long as socio-economic characteristics
- carry out a more detailed affordability assessment by considering family income information and derive an estimate of water bill per household according to family size (by applying the sustainable tariff), and the relative affordability threshold.

4 The economics of water use for irrigation in the Kura/ Mtkvari river basin

4.1 Introduction

As part of the Kura II project, an economic assessment of agricultural water uses in the Kura has been completed. This chapter considers the economics of agricultural water use in the Kura river basin.

Whilst the two countries face different demographic, socio-economic and climatic conditions, they both share common challenges of rehabilitating old irrigation infrastructure, modernizing their agriculture and attaining a more sustainable water management informed by IWRM principles, including financial viability through cost recovery. For missing information, international literature has been referred to.

This work builds on previous studies and current strategy documents for the two countries, and available data from national statistical offices, or the national Amelioration Agencies, by adopting the costing approach explained in chapter 2.

This chapter is organised in two sections, §2 for Georgia and §3 for Azerbaijan. For each country, a short review of the current management situation is described (para 1), and key economic issues highlighted. Then, a characterization of water use for irrigation is undertaken (para 2), by looking at published statistics. In the following paragraph a description of the irrigation system is provided, and an economic assessment of current irrigation infrastructure is carried out. Investment and operating costs are estimated (para 5), and compared with current tariff revenues (para 4). Other sources of financing will be investigated, and affordability assessment will be carried out (para 5). The concluding section will discuss policy implications and future research needs.

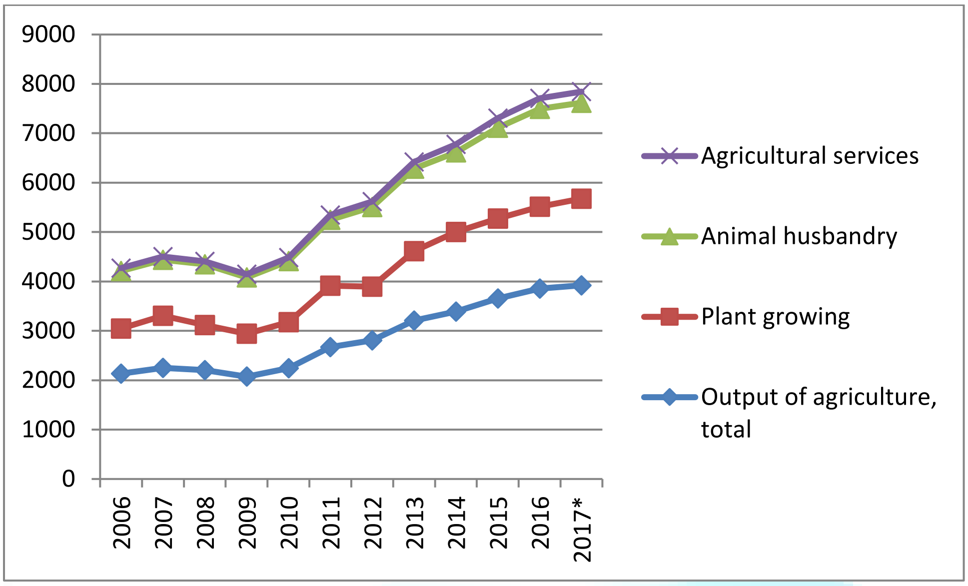
4.2 Agricultural water use in Georgia

4.2.1 Current water use in agriculture

In 2015 agriculture accounted for 41% of total water use in the country, 43.1% of population employed and 8.2% of GDP (2017, Geostat website). In 2017 total agricultural output was 3.922 billion GEL, of which 1.755 billion come from plant growing. All agricultural activities show a positive trend since 2009 (see Figure 12).

By considering the Kura (Mtkvari in Georgian) river basin area, less than 17% of total water intake is used for agriculture (more than a quarter is lost in transportation).

Figure 12 – Output of agriculture, million GEL (data for 2017 are preliminary)



Source: Geostat website

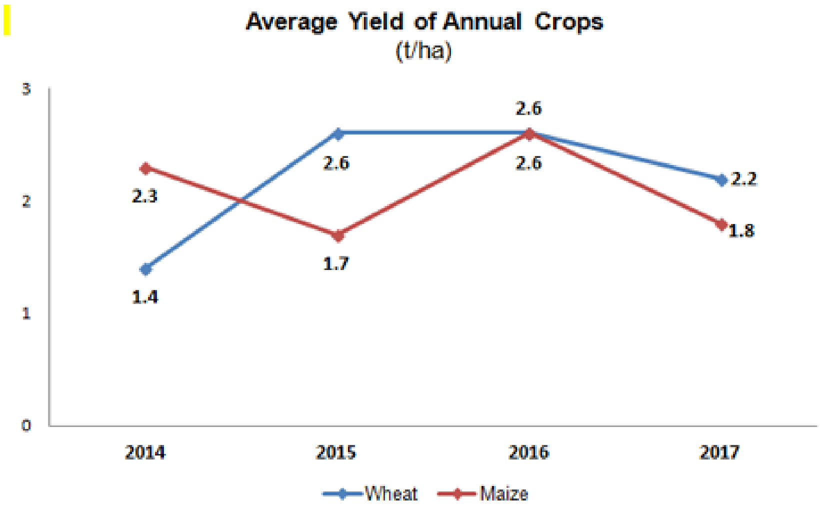
Table 26 – Water Use in the Kura river basin in Georgia, 2016 (m³ and % on total water intake)

Water intake	For irrigation	For HPPs	For ponds	For enterprises	Discharge	Losses
2,038,949	341,192	838,439*	8,592	5,377	329,585	515,764
100 %	16.73 %	41.12 %	0.42 %	0.26 %	16.16 %	25.31 %

Source: Ukleba (2017)

Cereals (i.e. maize, wheat and barley) are the main annual crops grown in Georgia, whilst perennial crops include grapes, apples and pears, hazelnut and walnut, citrus fruits and stone fruits. As highlighted in the Irrigation Strategy (Ministry of Agriculture and Georgian Amelioration, 2017), yields of annual crops are very low compared to neighbouring countries, with maize and wheat currently achieving only 2.2 ton/ha and 1.8 ton/ha respectively (see Figure 13). The Strategy also notes (p. 23) that yields of major crops, (including maize, beans, oilseeds, vegetables, fruits and vineyard grapes which currently depend on rainfall) will increase with rehabilitation of irrigation infrastructure.

Figure 13 – Average Yield of Annual Crops

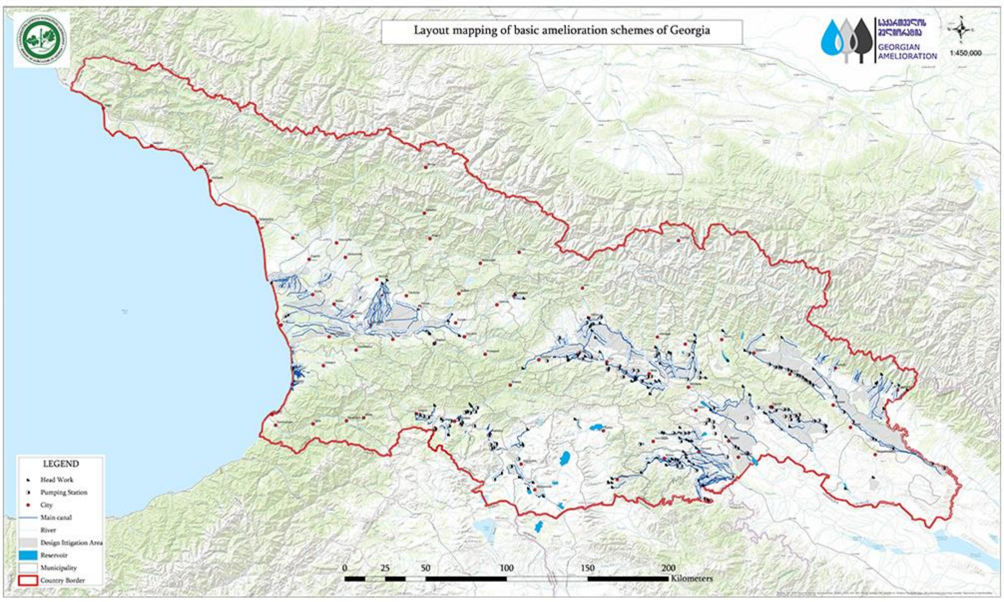


Source: Geostat website

4.2.2 Status of irrigation infrastructure

Irrigated area in Georgia has declined considerably since the 1990s, due to institutional weaknesses, mismanagement and under-investment following the collapse of Soviet Union which led to deterioration of existing assets. As a consequence of aging infrastructure, production has fallen by 44%. Productivity of agricultural land has also worsened, as crop yields are much lower than those of neighbouring countries. As shown in Figure 14, the majority of irrigation schemes lay in the eastern part of the country, along the Kura and its tributaries.

Figure 14 – Amelioration schemes in Georgia



Source: Georgian Amelioration website

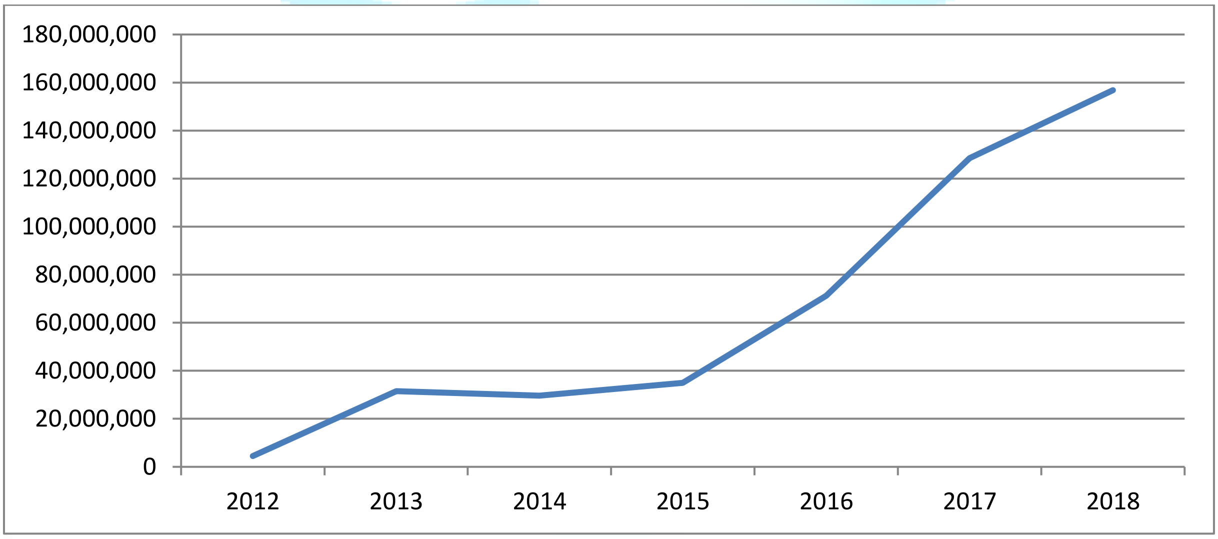
With regards to the Kura/Mtkvari river basin, out of 33 reservoirs, only 10 are operative. There are also 94 gravity irrigation systems, covering 231,354 ha of project irrigation areas. Moreover 63 mechanical pumping stations serve 41,266 ha of irrigation areas. Despite a current feasible irrigation area of 160,000 ha only 49,000 ha were actually irrigated in 2016 (Ukleba, 2017), up from 43,000 ha irrigated in 2012. Currently 114,300 ha are irrigated according to the Irrigation Strategy.

A programme of rehabilitation started in 2012, aimed to rehabilitate existing irrigation infrastructure. According to the Irrigation Strategy, by 2025 278,000 hectares of irrigable land will be restored, producing an increase in water demand of 500% (from 150 million mc to 900 million mc). Another 105,000 hectares will be drained, from the current 35,900 ha. These interventions are expected to increase current irrigation productivity. Besides rebuilding its ageing infrastructure, the country is also facing the challenge of reorganizing the irrigation services for farmers. This report considers economic issues related to the rehabilitation programme only, and will not analyse the economic and financial implications of the irrigation sector reforms.

The Strategy for Agricultural Development 2015-2020 (Ministry of Agriculture, 2015) lists a set of infrastructure interventions like: construction and rehabilitation of water reservoirs for irrigation purposes; rehabilitation of irrigation infrastructure and specific headworks and rehabilitation of drainage infrastructure and primary channels. Other measures include better optimal allocation of water resources and improvement of the tariff system.

Georgian Amelioration Ltd. is supported by the international donor organizations (World Bank, IFAD, ORIO, etc.) for major rehabilitation works. Since 2012 125 irrigation and drainage projects have been implemented in the Kura river basin in Georgia (13 are still in progress and are expected to be completed by 2020). Total project costs exceed 450 million GEL (circa 170 million USD). More than 150 million GEL are planned to be invested in 2018 only, see Figure 15.

Figure 15 – Total investment costs in irrigation and drainage projects in the Kura river basin (2012-2018), GEL



Source: Own elaborations on data from Georgian Amelioration

Table 27 summarises investment carried out in the Kura river basin since 2012, by administrative regions.

Table 27 – Total investment costs in irrigation and drainage, per region (GEL)

Region	2012	2013	2014	2015	2016	2017	2018
Shida Kartli	1,243,088	4,107,165	10,373,500	10,456,369	21,610,000	34,728,593	31,016,010
Mtskheta-Mtianeti		7,796,705	5,832,532	3,945,355	4,646,925		
Kvemo Kartli	1,136,993	16,825,647	6,344,971	12,746,636	25,275,037	69,977,972	91,414,912
Kakheti	2,101,360	898,971	3,226,289	3,974,646	18,013,630	22,387,584	33,586,750
Samtskhe-Javakheti		1,894,500	3,853,745	3,851,000	1,686,393	1,400,985	800,000
Total	4,481,441	31,522,988	29,631,037	34,974,006	71,231,985	128,495,134	156,817,672

Source: Own elaborations on data from Georgian Amelioration

4.2.3 Tariff setting and current cost recovery

The current tariff of GEL 75 (USD 28) per hectare per year is not based on actual consumption (it does not even consider the number of times that water is supply) and the type of crops irrigated. Therefore it does not provide any incentives to increase water efficiency. Nor it is designed to apply full cost recovery principle, as it is set at a low level, for social considerations (i.e. low farmers' income and their need of social protection). Estimates of current level of cost recovery vary between 13% (Georgian Irrigation Strategy 2016-2025) to 22% (OECD, 2016) of O&M costs only. Nonetheless, collection rates improved in the last few years (from 63% in 2013 to 88% in 2016).

A study from OECD (2016) concluded that the "absence of an official tariff setting methodology based on economic cost parameters is a major shortfall in the current irrigation management model" (p. 39). In this respect, the economic literature (Tsur et al., 2004; Dono et al., 2012) suggests to apply a two-part tariff, with a flat rate component, dependent on the irrigated area, and a variable one, dependent on the type of crop and irrigation technique. The justification of this tariff structure is twofold:

- first, the cost structure of irrigation services requires to set tariffs at average costs, AC, to achieve full cost recovery (as for irrigation water systems MC < AC, marginal cost pricing does not guarantee cost recovery)
- secondly, as pricing at average cost does not provide any incentives to water savings, a variable components should be introduced, which takes into account the actual water consumed. This will make it possible to achieve economic efficiency, which requires to set prices equal to marginal costs, MC.

These principles are confirmed by the Irrigation Strategy 2017-2025, when it states that the "bulk water tariff will consist of two parts – one fixed and one variable. The fixed portion will be based on the area of agricultural land within the local unit boundaries, as specified in the operating license awarded to GA by the regulator. The variable portion of the tariff will be based on the volume of water delivered to each local water retailer, whether a WUO, a municipality, or a corporate farm, at rates specified in the contract." (p. 10)

It should be noted that a water fee entirely based on a volumetric tariff structure is not recommended for irrigation uses on the ground that provision costs are determined by the extent of the area covered by the irrigation services, more than the volumes delivered (Dono et al., 2012).

Moreover, currently the distribution network is not equipped with water gauges, and hence measuring the water actually provided is impossible at the moment. Ukleba (2017) notes that in future new meter gates will be arranged for all-tier distributing channels. Until these works are completed, information on irrigated crops and number of water applications could be used as a proxy of the volumes delivered.

Current collection rate is high, but below 100%. In 2013 the collection rate was only 63% (OECD; 2016), but it increased to 88% in 2016, which implies that the actual collected tariff is circa 66 GEL/ha/y (24 USD/ha/y). Table 28 summarises expected and actual income generated by tariffs in 2016, by regions.

Table 28 – Revenues and collection rate, by region (2016), GEL

Region	Due	Paid	Collection rate
Kakheti	1,623,272	1,642,848	101%
Kvemo Kartli	2,769,069	2,373,465	86%
Shida Kartli	1,124,704	847,659	75%
Total	**5,517,045**	**4,863,972**	**88%**

Source: Georgian Amelioration

Finally, operation and maintenance costs incurred in 2016 are summarised in Table 29, by regions.

Table 29 – Operation and Maintenance costs, 2016, GEL

Region	Maintenance	Operation	Total
Kakheti	468,008	146,651	614,787
Kvemo Kartli	693,535	107,492	801,027
Shida Kartli	713,899	114,063	827,962
Total	**1,875,442**	**368,206**	**2,243,776**

Source: Georgian Amelioration

Additional 77,561 GEL were spent in 2016 to carry out interventions that were due in previous years. In total Georgian Amelioration spent almost 3 million GEL for O&M cost in 2016.

By considering the total irrigated area, the 2016 unit O&M cost is therefore circa **60 GEL/ha**. This result is much lower than figures derived in previous studies. Estimates by OECD (2016) show that O&M costs for gravity irrigation systems vary in the range 200 - 250 GEL/ha (74 – 92 USD/ha). By considering electricity costs for pumping stations, these can raise to 300 GEL/ha (110 USD/ha).

4.2.4 Estimation of Full Cost

Capital costs can be estimated by considering investments since 2012, and prospective investments. Data from Georgian Amelioration indicate for each implemented project, the total project costs and the related irrigated area. The following tables summarise the average construction cost for irrigation and drainage projects, according to location and type of intervention.

Table 30 – Average Irrigation and drainage investment cost (GEL/ha and USD/ha), per region

Region	GEL/ha	USD/ha

Kakheti	1363	502
Kvemo Kartli	2160	796
Mtskheta-Mtianeti	1986	732
Samtskhe-Javakheti	2001	737
Shida Kartli	4014	1479
Average	**2480**	**914**

Source: Own elaborations on Georgian Amelioration data

The average cost per hectare of drainage systems (only in the Kakheti region) is 1073 GEL/ha. Therefore, average investment cost per hectare in the Kura river basin is 2480 GEL/ha (USD 914/ha). These estimates are circa a half of FAOSTAT (2016). This can be explained with the average size of rehabilitation scheme, above 1,500 ha/scheme. Average investment costs were also derived according to intervention type (see Table 31 – Average Irrigation and drainage investment cost (GEL/ha and USD/ha), per type of interventions

By considering the useful life of the irrigation and drainage networks, the average depreciation costs shown in Table 32 are estimated.

Table 31 – Average Irrigation and drainage investment cost (GEL/ha and USD/ha), per type of interventions

Type of Intervention	GEL/ha	USD/ha
channel	1944	716
Channel and headwork	2796	1030
drainage	1058	390
Headwork only	954	352
pumping station	6220	2292
reservoir	5033	1855
Average	**2480**	**914**

Source: Own elaborations on Georgian Amelioration data

Table 32 – Depreciation cost for I&D investment (GEL/ha/year and USD/ha/year), per type of intervention

Types of intervention	GEL/ha/year	USD/ha/year
channel	65	24
channel, headwork	93	34
drainage	35	13
headwork	64	23
pumping station	415	153
reservoir	50	19
Average Kura river	**120**	**44**

Source: Own elaborations on Georgian Amelioration data

By adding estimated depreciation costs and the cost of capital to O&M costs the long-run average cost of supply is estimated at **230 GEL/ha/year (circa 85 USD/ha/year)**, i.e. current provision costs are three times current water tariffs.

4.2.5 Ability to pay

The Irrigation Strategy calculates the gross margins for rainfed and irrigated crops, for small (< 3 ha) and medium-large farms (> 3 ha), by considering the crop budgets for 10 annual crops. The difference in gross margins is highlighted in Table 33, which shows that increases in gross margins are greater for medium-large farms, than for small farms, except for wheat, maize and grasses. This seems to suggest that a reorganisation of the farming system, towards an increase of the average farm size, might increase the effectiveness of irrigation policies for most crops.

By considering these differences in crop patterns and by estimating changing crop patterns under an increase in irrigated land scenario, the irrigation strategy concludes that there are likely to be significant gross margin increases due to irrigation infrastructure rehabilitation (GEL 700 and GEL 6,720, for marginal/small farms and for medium/large farms respectively). All farms will benefit from an improvement of irrigation techniques (with increases in gross margins between 33% and 113%).

Table 33 – Absolute and relative difference in gross margins between irrigated and rainfed crops (GEL/ha and %)

Crop	Medium Large Farm		Marginal/Small Farm	
	GEL/ha	%	GEL/ha	%
Wheat	266	75%	287	64%
Maize	264	51%	327	55%
Haricot Bean	479	56%	428	53%
Potatoes	2829	113%	2154	66%
Vegetables	2829	68%	1777	48%
Grasses	324	59%	331	104%
Orchard crops	1529	42%	1280	33%
Vineyard grapes	1602	73%	987	40%

Source: Own elaborations on IS data

This analysis indicates that whilst the ability to pay varies according to the size of the farm, with bigger farms being able to afford higher water fees, all farms with improved irrigation schemes have higher gross margins and therefore a greater ability to pay.

It is worth noting that the figures in Table 33 might be interpreted as the maximum ability to pay of farmers, i.e. the maximum they can afford, in the Kura river basin in Georgia for improvements in irrigation techniques. Their maximum willingness to pay might be lower though. Any change of water irrigation fees should take these figures into consideration. By considering our estimates of long term average total provision costs, it can be argued that although the application of the full cost recovery principle is feasible in future, impacts on farm profitability should be assessed carefully.

4.2.6 Future adaptation options in agriculture

A study from the World Bank (2014) assessed the impact of climate change on agricultural production, by considering three climate change scenarios (high impact, medium impact, and low impact). As can be seen from Table 4034, in Eastern lowlands all main crops will be negatively affected, with the exception of pasture. Climate change is expected to positively impact crop yields in Eastern mountainous areas, with the exception of grapes and potatoes.

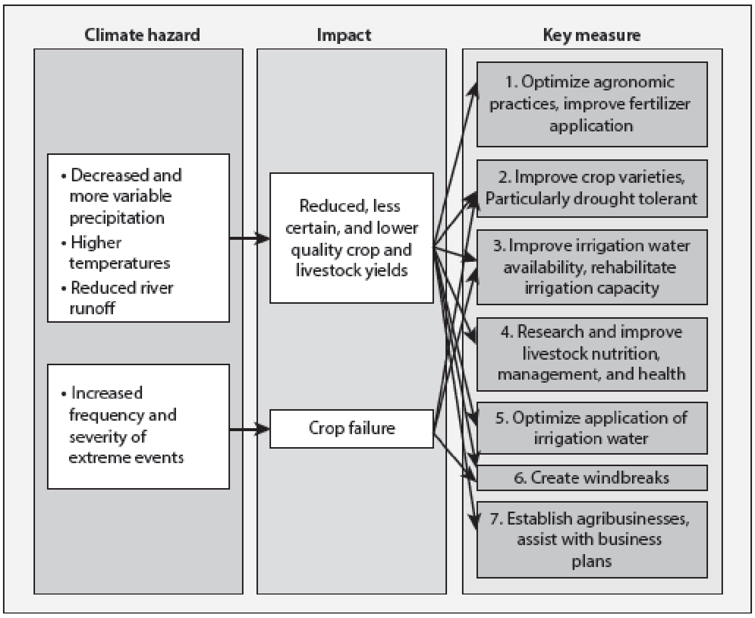
Table 34 – Effect of climate change on crop yields in 2040 under the medium impact scenario in Georgia

Irrigated/rainfed	Crop	Eastern Lowlands (%)	Eastern Mountainous (%)	Western Lowlands (%)	Western Mountainous (%)
Irrigated	Corn	−4	48	−4	−3
	Grapes	−5	−5	−5	−5
	Mandarin	−5	N/A	−5	N/A
	Potato	−5	−5	−5	−5
	Tomato	−6	76	−5	−5
	Wheat	−5	69	−5	−5
Rainfed	Corn	−4	48	−4	−3
	Grapes	−6	−5	−5	−5
	Mandarin	−5	N/A	−5	N/A
	Pasture	26	87	20	44
	Potato	−10	−14	−6	−7
	Tomato	−11	55	−9	−11
	Wheat	−5	69	−5	−5

Source: World Bank (2014)

Based on economic modelling of a long list of adaptation options, the study recommends the following strategies to increase resilience and adaptive capacity to climate change (see Figure 16).

Figure 16 – Measures to increase adaptive capacity in Georgia in the agricultural sector, and their link with anticipated climate hazards and impacts.



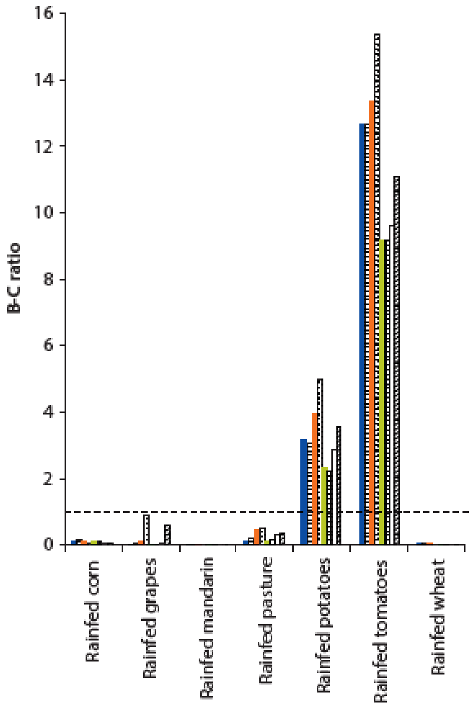
Source: World Bank (2014)

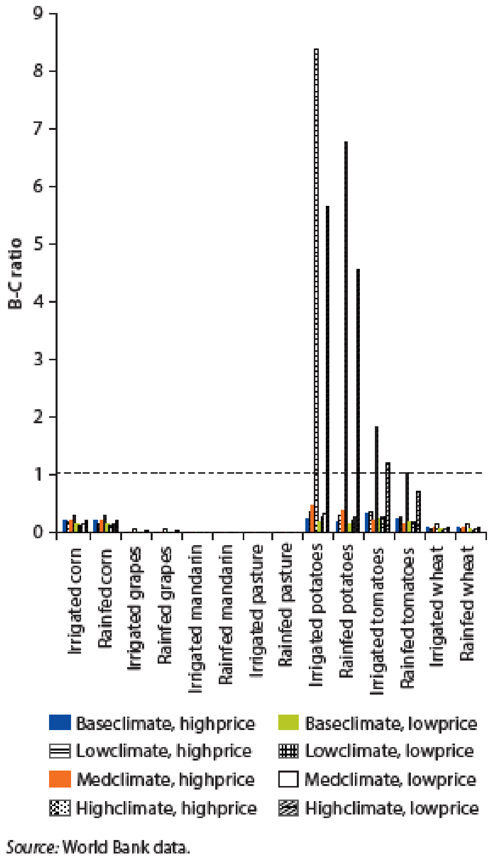
Then an economic assessment was conducted on the main adaptation options. The results can be summarised as follows (World Bank, 2014):

- Investment in new irrigation infrastructure is justifiable from an economic point of view (i.e. BCR>1) only for rainfed potatoes and tomatoes

- BCRs for rehabilitated infrastructure are higher, but investment is cost-beneficial only for rainfed potatoes and tomatoes (Figure 17). The same conclusions can be drawn for optimisation of water application and investment in drainage infrastructure.

Figure 17 – CBA for rehabilitated irrigation infrastructure (left) and optimised application of irrigation water (right) in Eastern Georgia





Source: World Bank (2014)

4.3 Agricultural water use in Azerbaijan

4.3.1 Current water use

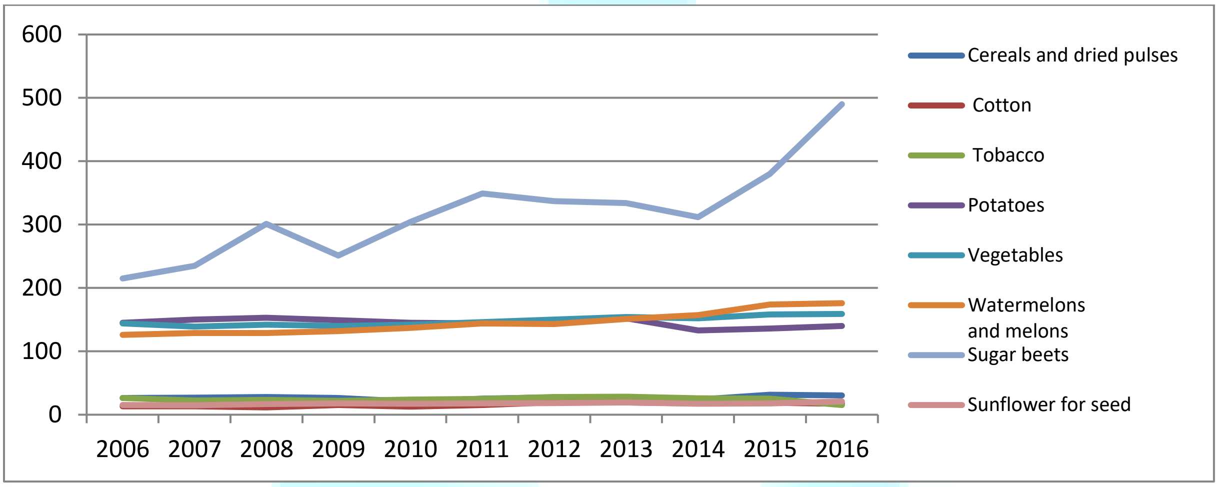
Due to climatic conditions, irrigation is essential for agricultural production. In 2016 agriculture accounted for 6% of total GDP, and 36.3% of employed population.

Total arable land in Azerbaijan is 3.2 million ha. Between 2000 and 2017 the total sown area increased by 44% to 1,437 thousand ha, of which 1,404 thousand ha were irrigated. Potential irrigated land amount at circa 1.6 million hectares.

Whilst the available water resources are generally sufficient in mid-wet years, it should be noted that for circa 120 thousand hectares (circa 8% of irrigated land) the water supplied was not sufficient to meet demand in dry-years. If we consider that it is anticipated that 1.6 million hectares will be irrigated in the future, the water demand for irrigation purposes is expected to increase.

Most of irrigated land, that is 84%, is sown with seasonal crops, and the remaining 16% for permanent crops. As in Georgia, agricultural yields are low. For cereal and dried pulses, in the last ten years these vary between 2 and 3.1 t/ha. Apart for sugar beet, whose yield has more than doubled from 2006 to 2016, yields did not increase in the last 10 years, as shown in Figure 18.

Figure 18 – Yields of agricultural products, all farms (2006-2016), 100kg/ha



Source: State Statistical Committee

The most important crops are wheat, cotton, potatoes, vegetables, tobacco, melon, sugar beet, sunflowers and fruit trees. Table 35 reports the total regional production in the Kura river basin for main crops.

Table 35 – Total production, tons (2016), by region

	Cereals and dried purses 2.103	Cotton 2.113	Potatoes 2.117	Tobacco 2.114	Sugar Beet 2.115	Vegetables 2.118	Water Melons 2.134
Baku	-	-	134	-	-	12,812	103
Ganja-Gazakh	277,945	4,334	454,219	24.4	76,564	218,435	20,732
Sheki-Zagatala	486,526	-	57,599	3,529.5	-	91,798	19,629
Aran	1,099,963	79,671	79,599	5.0	153,261	353,530	347,871
Yukhari Garabagh	260,058	3,747	17,225	-	82,300	72,220	12,670
Kelbajar-Lachin	5,536	-	1	-	-	21	1,229
Daghlig Shirvan	305,544	1,031	16,326	3.4	-	17,287	4,226
TOTAL	**2,435,572**	**88,783**	**625,103**	**3,529.5**	**229,825**	**340,353**	**393,790**

Source: State Statistical Committee

4.3.2 Strategic policy directions

In December 2016, the Government launched a Strategic Roadmap for the development of the national economy in eleven key sectors, to be implemented between 2017 and 2020. These strategy documents set medium- and long-term goals for reforms and sustained development. A Strategic Roadmap for agriculture and agricultural products processing sector was approved by the President of Azerbaijan in 2016. Nine strategic objectives are set to create a favourable environment for increasing competitiveness of agriculture and sustainability of agricultural products processing sector. These strategic objectives address the following issues:

- strengthen sustainability of food security;
- increase production potential of agricultural products along the value chain;
- develop agricultural markets and facilitate access to relevant resources, including finance;
- enhance scientific research and education in the field of agriculture and develop an information-consulting services system;
- develop market infrastructure and facilitate access of producers to the market;
- form mechanisms of sustainable utilization of natural resources;
- improve business climate in the agrarian field; and
- enhance welfare in rural areas.

In addition, a number of the state programmes in the agriculture sector were approved by the President of Azerbaijan, whose main strategic objectives are summarised in Table 36.

Table 36 – Strategic policy objectives, as defined by the State Programmes for agricultural sectors

State Programme	Implementation period	Strategic Objectives
Socio-economic development of the regions	2014-2018	The main objective of the State Programme on Socio-Economic Development of Regions of the Republic of Azerbaijan is the continuation of activities aimed at the development of the non-oil sector, diversification of economy, rapid development of regions, in particular, further improvement of infrastructure and social services related to rural development.
Development of viticulture	2012-2022	The purpose of the State Program is to provide the population with a better supply of fresh and quality table grapes, to improve the supply of wine and grape processing facilities, and to stimulate the development of viniculture to increase the export of wine and grape products.
Development of cotton growing	2017-2022	The purpose of the State Program is to meet the demand for cotton products in the country, to improve the raw material supply of cotton processing enterprises, to develop the processing industry, to increase the export of cotton products, to strengthen the state support for cotton growing and to stimulate the development of this field to increase the employment level in rural areas.
Development of citrus fruit growing	2018-2025	The purpose of the State Program is to stimulate the development of citrus fruits in order to meet the demand for citrus fruits in the country, to increase the export of produced products and increase the employment level and financial wellbeing of the rural population.
Development of tea growing	2018-2027	The purpose of the State Program is to meet the demand for dry tea in the country mainly through local products, improving the raw material supply of tea processing enterprises, improving the processing industry, increasing the export of tea products and raising the employment level of the rural population.
Development of rice-growing	2018-2025	The purpose of the State Program is to stimulate the development of paddy field in the country to meet the population's demand for rice, to replace imports, to develop the paddy industry and increase the employment level of the rural population.
Development of silkworm breeding and sericulture	2018-2025	The objective of the State Program is to achieve the sustainable development of silkworm breeding, to improve the quality of raw material processing industry, to increase the quality and volume of produced products, to create new economic entities, to increase the export potential of silk products and to increase employment.

Source: Ministry of Agriculture Website

4.3.3 Extension and conditions of irrigation infrastructure

Land that can be used for agriculture is mainly located in plain-arid zones characterized by hot climate and less rainfalls. Irrigation infrastructure is of vital importance for Azerbaijani agriculture.

Irrigation systems and infrastructures of state importance include 138 water reservoirs with a total storage capacity of 22.0 billion m^3, 20 headworks, 53,905 km of irrigation canal, 33,015 collector-drainage networks, more than 136,000 various hydraulic structures, 1,028 pumping stations, 8,561 sub-artesian wells, more than 2,178 km retaining walls against floods and torrents. Other water management systems and structures of state importance supply water to 1,025 thousand ha winter pastures are being operated. As reservoirs are not located in the proximity of irrigated land, long-distance conveyance is necessary, in order to provide water for agricultural uses. The main channel characteristics are summarised in Table 37.

Table 37 – Main channels under Amelioration JSC responsibility

N	Name of canals	Year of commissioning	Length km	Water discharge capacity, m3/sec.	Service area, thousand ha	Feeding source
1	Upper Garabagh canal	1958	172	113	90	Mingechevir water resevoir, Kura River
2	Upper Shirvan canal	1958	123	78	100	Mingechevir water reservoir, Kura River
3	Main Mil canal	1976	37.2	80	120	Araz River
4	Samur-Abşeron canal	1940	183.3	55	90	Samur River
5	Main Muğan canal	1960	34	65	65	Araz River

Source: Amelioration JSC

It should be noted that the Shirvan canal will be substituted by a new channel, the Yukhari Shirvan (200 km long), which, once completed will serve an additional 111 thousand hectares of land. It is estimated that after completion of this work, water demand will increase by 2 billion m^3.

Out of the 53,905 km canals, 2,353 km are main canals, 8,935 km are off-farms canals, 12.677 km are in-farm canals and 29,130 km are field canals. One third of irrigated land (637,000 ha) is served by 1,028 pumping stations, most of which is located around the Kura river (Osmanov, 2018). Out of the 33,015 km drainage collector network, 22,030 km are initial drains, 6,683 km are interfarm collectors, 331 km are intrafarm collectors, and 971 km are main collectors (Osmanov, 2018). In 2017 the gravity systems covered 0.8 million ha of irrigated land (56%), whilst the rest is mechanically irrigated. Energy costs amount at 110 AZN million (Osmanov, 2018).

The high losses in agricultural irrigation systems are explained by the channel characteristics, with 75% of irrigation channels being earth channels. The losses in the network are also responsible for the rise of groundwater level, and the consequent salinity problem.

The 2016 National Water Strategy notes that “while general irrigation infrastructure has been developed intensively, especially secondary and third level irrigation channels have been degraded due to lack of maintenance” (p.9). A World Bank report (2013) notes that 50% of irrigation infrastructure is in poor state, and requires urgent rehabilitation. They estimate that 900 million USD are necessary to rehabilitate the irrigation network (World Bank, 2013). This figure is a fifth of the estimates included in the 2016 National Water Strategy, which concludes that over 5 billion USD will be needed to implement the Strategy.

According the State Program on Amelioration and Water Resources in the Republic of Azerbaijan for the period 2016-2020 the following actions are envisaged:

- Construction of 8 new water reservoirs with total capacity of 539.5 million m^3
- Construction of new irrigation channels with 355 km length
- Put 255,900 ha hectare new irrigation lands into use
- Improve conditions of 373,000 hectare of irrigated land
- Construction of new irrigation and collector-drainage network in 271,000 hectare
- Construction of protective dams with length of 991.7 km
- Construction of protective dams on mountainous rivers (95 km)

Investments in irrigation and drainage have risen sharply since 2006. The 2016 National Water Strategy also spells out non-investment measures, such as the optimisation of agricultural systems and the development of cultivation practices to shift towards less demanding crops.

4.3.4 Tariff setting and current cost recovery

The Tariff council is in charge of approving tariffs proposed by Amelioration JSC. The marginal tariff is set up by considering maintenance and capital costs, along with social considerations.

Since 1997 water for irrigation is paid 0.5 AZN/1000 m^3 (this is the quote for bulk water supply to the WUAs, which then charge a little part for their management costs, around 2 AZN/1000 m^3). The World Bank (2013) estimates that the tariff level necessary to cover off-farm irrigation costs is AZN 5-10/1000 mc, for bulk water supply, and 10-17 AZN/1000mc, for retail distribution. This implies that, in order to ensure cost recovery of O&M costs only, current water tariffs for agricultural uses should increase 5-10 times.

4.3.5 Full cost estimation

It was not possible to conduct an in-depth estimation of total water provision costs for the agricultural sector, due to lack of information on O&M and capital costs on specific investments.

Some information on capital expenditure can be derived from the State Budget, which specifies the resources devoted to agriculture, forestry, fisheries, hunting and the protection of the environment. In 2018 these were 3.1% of total budget, i.e. 656.3 million AZN (+26.8% from previous year).

In 2018 total expenditures for agricultural activities from the state budget are split in:

- 342.3 million ANZ (including 248.9 million AZN for the amelioration and irrigation systems),
- Expenses for veterinary activity accounted for 25.4 million AZN,
- 13.1 million AZN was spent on forestry,
- 2.9 million AZN, for fisheries and hunting activities.

The expenditures envisaged for the protection of environment and biodiversity conservation and implementation of other environmental measures are 15.9 million AZN, whilst hydro-meteorology activities are estimated to be 7.8 million AZN.

Additional expenditures related to agriculture activities (but not to infrastructure projects) are:

- 199.2 million AZN expenditure for the provision of food security in Azerbaijan

- 20.2 million AZN for insurance of agricultural properties and funding of other measures

An additional 30 million AZN was ring-fenced to the implementation of the state programs on the development of cotton and tobacco growing in Azerbaijan.

The World Bank (2013) estimate that the average investment cost for rehabilitating the irrigation and drainage network is 460-900 USD/ha. O&M costs are estimated at **40-50 USD per hectare**. By adding estimated depreciation costs and O&M costs the long-run average cost of supply is estimated in the range of **55-80 USD/ha/year**. This range should be considered as a reference value to set water tariffs, if full cost recovery principle is applied.

Besides centralised irrigation network, also in-farms networks should be modernised, to improve water use efficiency. The North-East Development Project financed by the World Bank reported that the renovation of on-farm canals has reduced water losses from 50 per cent to 29 per cent of conveyed water, the current practices of furrow and flood irrigation are irrational and there is scope for further improving water-use efficiency. Considered the higher upfront costs, estimated in **2000 USD/ha** (Elchin Mamedov, pers. comm.) the investment cost are subsidized by the Government of Azerbaijan, promoting the investments in water-efficient technologies such as drip, sprinkler, when appropriate for orchard and vegetable crops (IFAD, 2013).

4.3.6 Ability to pay

The ability to pay can be assessed by looking at the gross margins for different crops. Statistics on prices and costs are published, at national and regional level, for the following crops: grain and leguminous, raw cotton, sugar beet, tobacco, green tea leaf, potato, vegetables (open land), market-garden crops, fruit and berry and grape. By considering economic data for the main crops cultivated in the Kura river basin and the crop yield, the following gross margins per crop type per hectare can be derived, see Table 38.

Table 38 – Gross margins according to crop type, AZN/ha, 2016

Crop	Agricultural Enterprises	Private farms enterprises
Grain and leguminous	253	288
Row cotton	142	326
Sugar beet	6012	4900
Tobacco	-	1046
Green tea leaf	109	-
Potato	7125	4211
Vegetable	469	2655
Fruit and berry	457	1900
Grape	124	815

Source: Own elaborations on data from State Statistical Committee

In order to make gross margins comparable with current water tariffs (defined per hectare), the average water use per hectare should be considered. No statistics exist on water use according to irrigated crops, hence we refer to the irrigation requirements used by World Bank (2013), as shown in Table 39, to have an estimate of average use per hectare.

Table 39 – Irrigation requirements for main crops and estimated water tariff per hectare (AZN/ha)

Crop	Irrigation Requirement (mc/ha)	Water tariff (AZN/ha) - Low	Water tariff (AZN/ha) - High
Barley and Wheat	3,000 – 3,500	1.5	1.75
Beets	5,000 – 6,000	2.5	3
Corn	4,000 – 4,500	2	2.25
Cotton	4,500 – 5,000	2.25	2.5
Alfalfa	7,000 – 8,000	3.5	4
Grapes	2,000 – 2,500	1	1.25
Tobacco	4,000 – 4,500	2	2.25
Vegetables	4,000 – 5,000	2	2.5

Source: World Bank (2013) and own elaborations

With this information, an indicative tariff per hectare can be estimated (see Table 39): that varies from 1 to 4 AZN/ha, according to irrigated crop. If we compare it with the gross margins estimated in Table 38, current water bills for irrigation purposes are between 0.04% and 1.8% of farmers' gross margins. A uniform water tariff, defined according to water use or irrigated land only, would penalise low value crops. It would be preferable therefore to charge water for irrigation according to the actual water use or irrigated crop, to take into account the different ability to pay of different farm types.

4.3.7 Future adaptation options in agriculture

A study from the World Bank (2014) assessed the impact of climate change on agricultural production, by considering three climate change scenarios (high impact, medium impact, and low impact). As can be seen from Table 40, all main crops will be negatively affected, with the exception of pasture and corn (only in high rainfall areas). Grape production in irrigated areas will be most impacted, with a decrease of 16% in current yields, followed by cotton (-13%) and potatoes.

Table 40 – Effect of climate change on crop yields in 2040 under the medium impact scenario

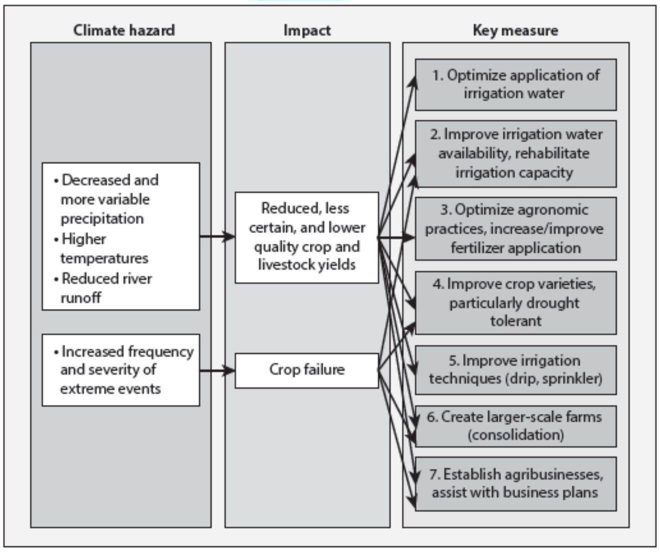
		Deviations from the current crop yields			
Agricultural system	*Crop*	*High Rainfall (%)*	*Irrigated (%)*	*Low Rainfall (%)*	*Subtropical (%)*
Irrigated	Alfalfa	−7	−7	−6	−2
	Corn	−6	−7	−6	−6
	Cotton	−1	−3	−4	−5
	Grapes	−5	−5	−5	−5
	Potato	−7	−9	−5	−6
	Wheat	−5	−5	−5	−5
Rainfed	Alfalfa	−6	−8	−6	−8
	Corn	2	−7	−7	−6
	Cotton	−13	−13	−13	−10
	Grapes	−7	−16	−5	−6
	Pasture	11	5	6	11
	Potato	−12	−13	−14	−11
	Wheat	−5	−6	−5	−5

Source: World Bank, 2014

The same study estimates an unmet water demand in the range of 700-900 million cubic meters for the whole country. In the eastern lower Kura river basin, modelling projects an irrigation deficit of 76.7% (meaning that each farm will receive less than a fourth of the water needed for irrigation).

Based on economic modelling of a long list of adaptation options, the study recommends the following strategies to increase resilience and adaptive capacity to climate change (see Figure 19).

Figure 19 – Measures to increase adaptive capacity in Azerbaijan in the agricultural sector, and their link with anticipated climate hazards and impacts.



Source: World Bank, 2014

Then an economic assessment was conducted on the main adaptation options. The results can be summarised as follows (World Bank, 2014):

- Investment in rehabilitated infrastructure shows BCRs between 4 and 11 for cotton and potatoes for all climate change scenarios. Regarding grapes, depending on the climate change scenario considered, the BCR varies between 0.5 and 3
- Increasing efficiency in water used for irrigation is highly cost-beneficial for potatoes (BCRs are between 8 and 85) in all climate change scenarios considered, whilst for alfalfa and cotton the benefits are circa twice the implementation costs. For all other crops it is not economically justifiable, with the exception of cotton in the very high impact climate change scenario
- Investment in drainage are cost-beneficial in all climate change scenarios considered only for cotton and potatoes, whilst for other crops these are not justifiable on economic grounds (B:C>1 in all climate change scenarios)
- Optimising crop varieties show a B:C in the range 10-60 for all crops (i.e. benefits are up between 10-60 times higher than the costs), but alfalfa and pasture, (where BCR is smaller than 1)
- Similarly, optimising fertiliser use show very high BCR for all crops (range is 10-48), except alfalfa, corn and pasture.

4.4 Conclusions and further research

This study builds on previous research and available data to estimate the total irrigation costs in the Kura river basin. A high level figure (cost/ha) has been derived for Georgia, using original data, and for Azerbaijan, using existing literature.

Our analysis shows that current water tariffs do not make it possible to cover the full cost of water provision: current irrigation tariffs covers a third of total provision cost in Georgia and even a smaller fraction in Azerbaijan. Application of the user pays principle should take into consideration the ability of farmers to pay, which varies according to the size of the farm, with bigger farms being able to afford higher water fees, and the crops being cultivated.

These results were derived by using macro-statistical data. A more detailed analysis, carried out at micro-scale, by considering land use and water use patterns, would provide estimates of actual gross margins by region and give an indication of the ability to pay per crop type.

Further research should also be conducted on the impacts of using more efficient irrigation techniques and the related impacts on crops productivity.

5 Hydroelectric generation in the Kura river basin

5.1 Introduction

The Caucasus region is a strategic link between Europe, the Middle East, and Asia, in terms of transport and energy infrastructure. Many of the countries in this region are seeking to increase green energy production. Hydropower generation is expected to increase worldwide. In the Kura river basin, both countries plan to increase hydropower generation capacity.

In recent years, Georgia has been seeking to increase electricity production from Hydro Power Plants (HPPs) to increase local production and become potentially an energy exporter. Similarly, Azerbaijan has been pursuing an energy strategy that focuses on diversification from the fossil fuels and increase of energy production through HPP and other renewable sources.

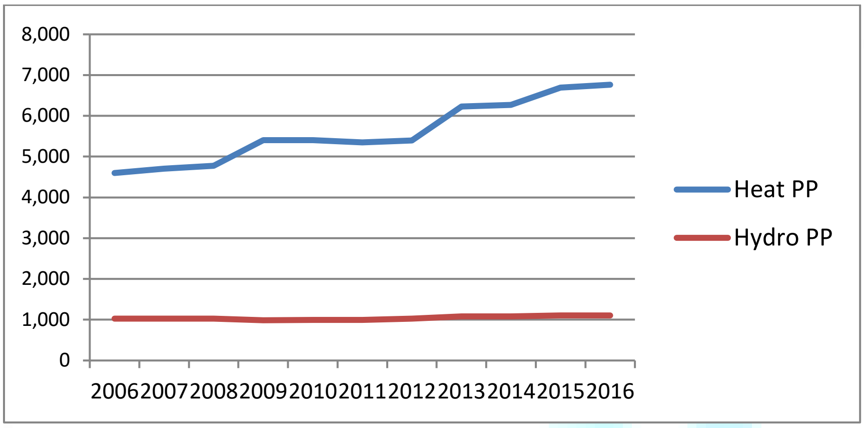
This chapter aims to analyse the hydroelectric production in the Kura river basin. It is structured as follows. In section 2 an overview of electricity production in the two countries is provided. Then in section 3 the water tariffs paid by HPP are described, and the policy suggestions given by economic literature recalled. In section 4 the cost of hydroelectric production is characterized, by referring to cost estimates derived in international literature. Finally, some suggestions for research in the next phase are given.

5.2 Electricity production in the Kura river basin

5.2.1 Hydroelectricity generation in Azerbaijan

In Azerbaijan, total capacity of electricity generation system has reached 7,869 MW in 2016. The increase in generation capacity over the previous decade has been driven by heat power plants, as the installed capacity of HPP has remained pretty much the same, around 1 GW, i.e. 14% of total installed capacity (see figure 1).

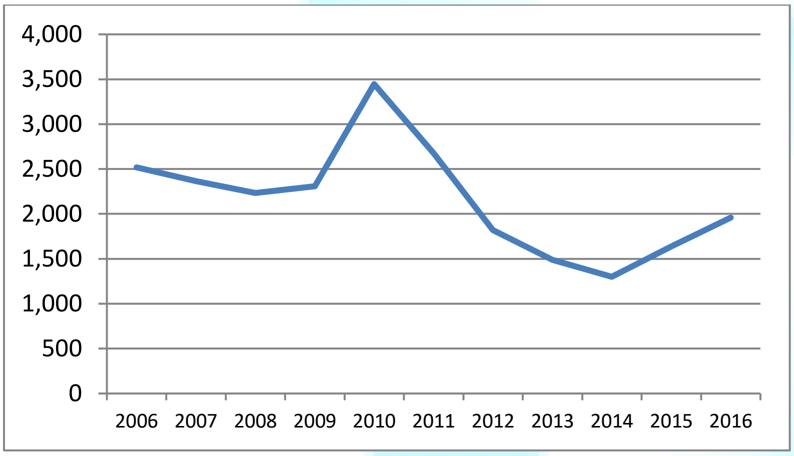
Figure 20 – Total capacity, heat and hydro power plants (MW)



Source: State Statistical Committee

Total electricity generated amounted at 25 TWh in 2016. Figure 22 describes the evolution of energy generated from HPP since 2006. The share of HPP generation on total electricity produced peaked in 2010 (18%), but then decreased to 8% in 2016.

Figure 21 – Electricity generated from HPP (GWh)



Source: State Statistical Committee

Azerbaijan plans to increase the share of renewable energy sources to 20 percent by 2020: total potential capacity of renewable energy sources in Azerbaijan exceeds 12,000 MW. Solar accounts for most of this potential at 5,000 MW, while wind accounts for 4,500 MW, biomass for 1,500 MW, geothermal energy for 800 MW, and small hydro for 350 MW[8]. The HPP generation potential in Azerbaijan is estimated at 40 TWh, but feasible potential is 16 TWh[9]. In 2016 the construction of three small HPP was completed, with a total installed capacity of 5.5 MW[10]. There are 22 HPP in Azerbaijan (the characteristics of biggest ones are summarised in Table 41). Potential of wind energy is yet to be exploited, particularly in the southeast, around the Caspian coast.

[8] https://www.azernews.az/analysis/81686.html
[9] https://www.azernews.az/business/95486.html
[10] Ismayilli-2, Astara-1 and Oguz have the capacity of 1.6, 0.3, and 3.6 megawatt, respectively.

Table 41 – Main HPP in Azerbaijan

Power Plant	Capacity (MW)	River
Mingachevir	424	Kura
Shamkir	380	Kura
Yenikan	150	Kura
Fizuli	25	Bash Mil canal
Shamkirchay	25	Kura
Varvara	16.5	Kura
Araz	44	
Bilav	22	
Arpachay	20.5	
Ordubad	36	

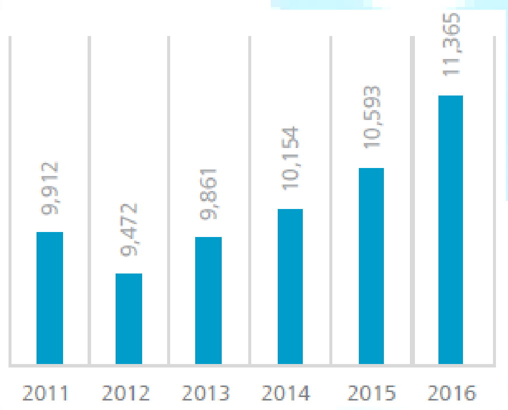
Source: Azerenergj

The electricity production is sufficient to cover domestic demand, with the surplus being exported to neighboring countries. Azerenerji is the state power engineering enterprise carrying out of energy production and distribution. Is it entirely owned by the State.

5.2.2 Hydroelectricity generation in Georgia

In Georgia, total generated electricity increased since 2012 (see Figure 22). More than 80% of electricity produced in 2016, or 9,329 GWh, came from HPP (Geostat website). The remaining is produced with natural gas. Georgia had installed more than 70 operational hydropower stations[11]. Another 38 are planned. The 1300-MW Enguri HPP is the most important electricity generation facility in Georgia, with its annual generation of 3.1-3.3 TWh. It provides yearly 35-40% of total generation in the system.

Figure 22 – Generated electricity (GWh)



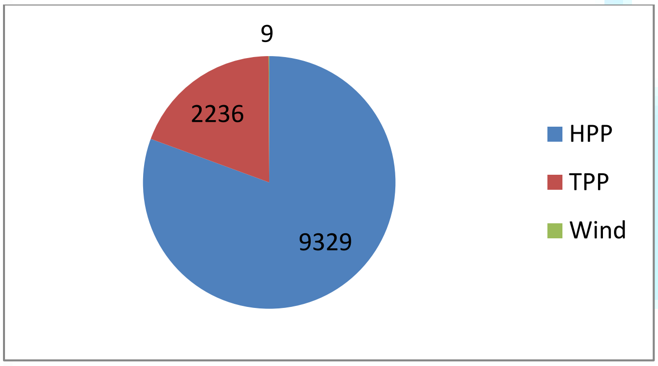
Source: Energy Community (2017)

There are 18 power generating companies in Georgia (GNERC, 2017). Most of them operate hydro power plants (HPPs) with only five thermal power stations (TPPs) with total installed capacity of around 924 MW (Energy Community, 2017). HPPs have limited storage capacities and consequently

[11] https://www.hydropower.org/country-profiles/georgia

energy generation is dependent on river flows, with peaks during the spring-summer period (Energy Community, 2017).

Figure 23 – Generated electricity by source (GWh) - 2016



Source: GNERC, 2017

Table 42 summarises info on main operators and the HPP they owns and manage.

Table 42 – Power generating companies in Georgia

	Enterprise	Power Plant	Owner	Type	capacity (MW)
1	"Engurhesi" Ltd	Engurhesi	State	HPP	1,300
2	JSC "Energo-pro Georgia"		Private		590
		Shaori-Dzevula cascade		HPP	119
		Lajanurhesi		HPP	114
		Airturbina ("Gpower" Ltd)		TPP	110
		Gumati cascade		HPP	70
		Rionhesi		HPP	50
		Mtkvari cascade		HPP	39
		Zahesi (JSC "Zahesi")		HPP	37
		Iori Cascade		HPP	27
		Atshesi		HPP	18
		Chkhori (JSC "Zahesi")		HPP	6
		Kinskisha (JSC "Zahesi")		HPP	1
3	"Mtkvari Energy" Ltd	Gardabani Energy Block #9	Private	TPP	300
4	"International Energy Corporation of Georgia" Ltd	Tbilsresi; others	Private	TPP, HPPs	308
5	"Gardabani Thermal Power Plant " Ltd	Gardabani Thermal Power Plant	State	TPP	231
6	"Vardnili Hydroplant Cascade" Ltd	Vardnilhesi	State	HPP	220
7	"Vartsikhe 2005" Ltd	Vartsikhehesi	Private	HPP	184
8	"Georgian Water and Power" Ltd	Zhinvalhesi; others	Private	HPP	146
9	JSC "Khramhes-1"	Khrami-1	Private	HPP	113
10	JSC "Khramhes-2"	Khrami-2	Private	HPP	110
11	"Georgia-Urban Enerji" Ltd	Paravanhesi	Private	HPP	87
12	"Eastern Energy Corporation" Ltd	Khadorhesi	Private	HPP	24
13	"Energy" Ltd	Larsihesi; Shidahesi	Private	HPP	24
14	"Saknakhshiri (GIG Group) " Ltd	Tkibuli Thermal Power Plant	Private	TPP	13
	Other (with installed capacity below 13 MW)				91
	Total				3,740

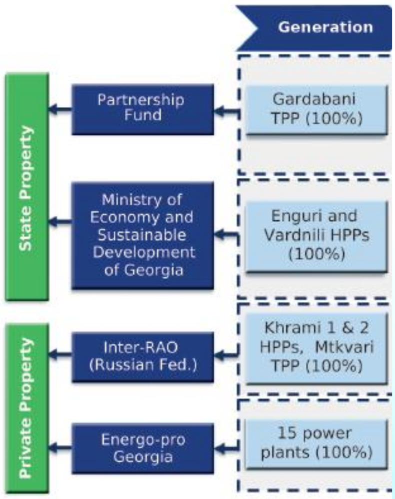
Source: KPMG

HPP electricity generation is carried out by private and public companies, see Figure 25. The main operators are:

- The major power generating company of Georgia is Engurhesi Ltd. It is a 100% state-owned company responsible for operation of Enguri hydro power plant, which has one of the highest and unique (271.5 m height) arch dam in the world. Its rehabilitation costed circa EUR 33 million in 2017, covered by an EBRD loan.
- Vardnili Hydroplant Cascade Ltd. is the second state-owned operator, which owns and manages the Vardnilhesi HPP.

- JSC Energo Pro Georgia is private operator, daughter company of ENERGO-PRO Group, comprising electricity generation and distribution utilities in Czech Republic, Bulgaria, Georgia and Turkey, and owning and managing 15 hydro power plants and 1 gas-turbine power plant in Georgia[12]. JSC ENERGO-PRO Georgia carried out 50.4 mln GEL investment in 2016 and 65 mln GEL in 2017
- Georgian Water and Power LLC owns hydroelectric power stations generating electricity for own consumption and for sale to electricity market.

Figure 24 – Ownership of electricity sector in Georgia



Source: GNERC (2016)

5.3 Water fees paid by hydropower generators

Hydropower generators do not pay a service fee, as public water supply customers (either domestic or commercial) and farmers (for irrigation purposes). In both countries they pay an abstraction fee.

In Georgia the Law on Fees for Natural Resources Use establishes that HPP should pay 0.01% of the "base fee" for surface water, i.e. **0.01% of 0.01 GEL/m^3.** The abstraction fee is paid by any water license/permit holder. This is what is formally defined by the law. But in fact, as specific licenses and permits on water abstraction from surface water bodies have been abolished, there is no enforcement mechanism and fees for surface water generally are not paid.

In Azerbaijan at the moment HPPs are exempt from paying abstraction fees.

Therefore, in both countries water abstraction fees are either not applied at all or do not consider the environmental impacts (i.e. externalities) entailed by hydroelectricity generation.

Charging for non-consumptive water used, i.e. HPPs, is recommended to take into account external effects. Although HPPs do not produce carbon emissions as they generate electricity, like other

[12] http://www.energo-pro.ge/about/owners-group/

alternative energy sources, they still are carbon emitters in form of embedded carbon in hydropower assets or when plants are rotten in water (and emit methane). Moreover, they entail other environmental impacts linked to the water reservoirs level, which has an impact on fish population, and the amount of water left for downstream users.

The introduction of an environmental tax has been discussed in the economic literature (Pontoni et al., 2016), which argues that properly designed environmental taxation would stimulate environmentally friendly production, without hindering operators' profitability.

5.4 Cost of electricity generation by HPPs

1.1 Investment and O&M Costs for HPPs

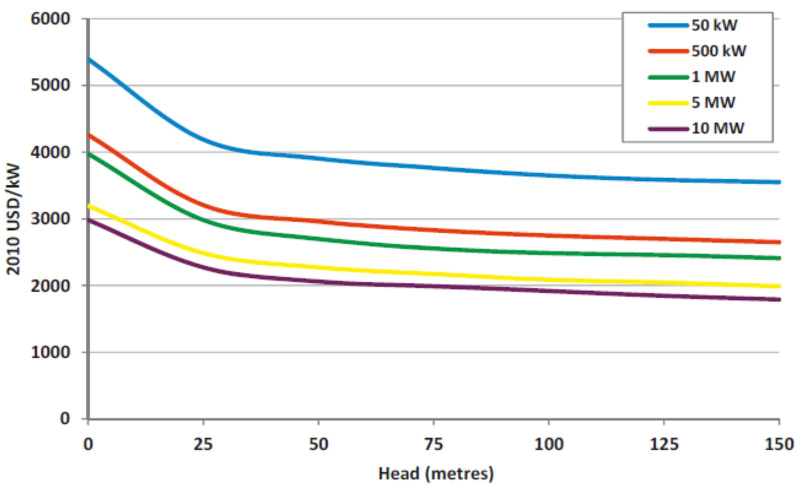
Hydropower plants have a long useful life, in the range of 40 to 80 years (IRENA; 2012)[13]. HPP also show long lead-in times, due to significant feasibility, planning, design and civil engineering works required. The two main cost components are:

- Civil works (dam and reservoir construction; tunnelling and canal construction; powerhouse construction; etc.) related to construction of HPP;
- Cost related to electro-mechanical equipment.

Total investment costs vary considerably from project to project, depending on the site characteristics, cost of local labour and materials. The total installed costs for large-scale hydropower projects typically range from a low of USD 1,100/KW to around USD 3,850/KW (IRENA, 2012)[14]. Small HPPs show higher unit costs, which depend on the installed capacity, as shown in the following Figure 25.

[13] For large hydropower plants, economic lifetimes are at least 40 years, (80-year lifetimes is the upper bound). For small-scale hydropower plants, the typical lifetime is 40 years but in some cases can be less.
[14] Estimates provided by IRENA (2012) have been updated to 2017 prices. GDP Deflator used was 1.1.

Figure 25 – Total investment costs as a function of installed capacity and turbine head



Source: IRENA (2012), p. 19

Annual O&M costs are often estimated as a percentage of the investment cost per kW per year. Typical values range from 1 % to 4 %. Ecofys et al. (2011) indicated that O&M costs averaged circa USD 50/kW/year for large-scale hydropower projects and around USD 57/kW/year for small-scale hydropower plants.

1.2 Estimating costs for the Kura river basin

In order to estimate total generation costs for the HPPs located in the Kura river basin we considered all plants (big and small HPP) and applied the unit costs described in the previous paragraph. We used estimates derived from the literature as no information on actual costs is available (either because financial statements are not publicly available or because they do not indicate the costs related to hydropower generation).

Total investment costs are assessed by considering IRENA's unit costs and annual depreciation are calculated by considering an asset life of 60 years. O&M are estimated at 3% of total investment costs. Results are shown in Table 43.

Table 43 – Estimated Investment, O&M and Total Annual Costs for HPP generation, Kura river basin, 2017 (thousand USD)

	Georgia		Azerbaijan		Total	
	Low	High	Low	High	Low	High
Investment Cost	3,347,784	11,095,120	1,298,246	4,465,866	4,646,029	15,560,986
O&M	100,434	332,854	77,895	267,952	178,328	600,806
Total Annual Costs	**223,186**	**739,675**	**125,497**	**431,700**	**348,683**	**1,171,375**

Source: Own elaborations

5.5 Conclusions and further research

In this report we estimated the investment and O&M of HPPs in the Kura river basin. Our results indicate that total annual costs are in the range 350-1,170 thousand USD.

Future directions for research could be:

- to investigate what are the implications for water resources in terms of expansion of current HPP capacity;
- to explore possibilities for better shared reservoir management;
- to carry out an assessment of future water demand for hydroelectric production, by considering planned investments in HPP in the two countries. Effects of climate change should also be considered.

Conclusions

This report describes a methodology to assess the provision costs of water services for each sector using water resources in the Kura river basin. It does not only refer to O&M costs, but also to capital expenditures to rehabilitate the distribution networks. In respect to the classification developed by Rogers et al. (2008) this analysis then assesses full supply costs. The main focus of this report has been PWS and agriculture, as they are the two main water users in the Kura river basin, where massive investment programmes have been initiated in recent years.

We collected primary data from water service providers or Amelioration companies, or referred to relevant literature when costing information was not available. We estimated full supply cost for PWS and agriculture, by considering O&M costs and capital expenditure, annualised following a linear depreciation method. For HPP, only general costing estimates were derived, as this sector does not pay a fee for water service provision, but supply costs are incorporated in investment costs incurred to build energy generation plants.

Our estimates indicate that current water tariffs do no cover full supply cost, and that both PWS and agriculture are subsidised by central government, even for the O&M component. Cross-subsidies are present, either amongst different user categories (i.e. households and commercial customers) or amongst regions. Our findings are consistent with previous studies.

The application of full cost recovery principle is hindered by users' ability to pay. Despite the fact that current water tariffs are set at a very low level for social considerations, for both PWS and agriculture in both countries, poor households in Azerbaijan already spent a high share of their income on water services. In Georgia currently water tariffs are affordable, but any water tariff increase should take into consideration the impact on households' income.

Besides using financial instruments other policy means have been used to incentivise more efficient water use, particularly for agricultural water use. Support to farmers in form of awareness raising and education campaigns play also a role in ensuring that more sustainable agricultural practices are introduced, not just to use water more efficiently, but also to reduce impacts on the natural environment.

This report does not consider external costs. A separate report (Paccagnan, 2008) has been drafted to cover the costs of environmental degradation, where the external cost component is discussed, along with financial instruments that can be used to internalise it.

References

ABD, 2010, Georgia: Developing an Urban Water Supply and Sanitation Sector Strategy and Regulatory Framework for Georgia. Output 1 - Strategic Investment Plan. Final report. [Accessed 12 February 2018]

Dono G., Giraldo L., Severini S., 2012, The cost of Irrigation Water, *Water Resources Management,* Vol. 26(7): 1865-77.

Easter K-W- and Liu Y., 2005, Cost Recovery and Water Pricing for Irrigation and Drainage Projects. Agriculture and Rural Development Discussion Paper 26. The World Bank. Available at: http://siteresources.worldbank.org/INTARD/Resources/Cost_Recovery_final.pdf

Ecofys, Fraunhofer ISI, TU Vienna EEG and Ernst and Young, 2011, Financing Renewable Energy in the European Energy Market: Final Report. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/2011_financing_renewable.pdf

EEA, 2013, Assessment of cost recovery through pricing of water. Technical Report 16/2013. Available at: https://www.eea.europa.eu/publications/assessment-of-full-cost-recovery

European Commision, 2013, Economics and the environment: the implementation challenge of the 21 Water Framework Directive, WATECO: a guidance document. Brussels.

EY, 2017, Azersu JSC – Consolidated financial statement 2016. [Accessed 13.12.2017]

EY, 2016, Georgian Water and Power LLC. Financial Statements.

Fankhauser S. and S. Tepic, 2005, Can poor consumers pay for energy and water? An affordability analysis for transition countries. EBRD Working Paper no. 92. [Accessed 15 December 2017]

FAOSTAT, 2016. Investment costs in irrigation database. Website accessed on 22.11.2017 http://www.fao.org/nr/water/aquastat/sets/index.stm

IFAD, 2013, Review Republic of Azerbaijan North-East Development Project. Project performance assessment. Available at: https://webapps.ifad.org/members/ec/79/docs/EC-2013-79-W-P-4.pdf [Accessed 23.07.2018]

Irena, 2012, Hydropower. Irena Working Paper 3/5. Available at: www.irena.org/Publications

Jagals P. and Rietveld L., N.D., Estimating costs of small scale water supply interventions, Available at http://www.who.int/water_sanitation_health/economic/chapter7.pdf

Mack E.A. and S. Wrase, 2017, A Burgeoning Crisis? A Nationwide Assessment of the Geography of Water Affordability in the United States. PLoS One. 2017; 12(1): e0169488. Available on line at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5226794/

Massarutto, A., 2007, 'Water pricing and full cost recovery of water services: economic incentive or instrument of public finance?' *Water Policy, 9*(6), 591–613.

Massarutto A., V. Paccagnan ed E. Linares, 2008, "Private management and public finance in the water industry: a marriage of convenience?", *Water Resources Research*, Vol. 44, W12425, doi:10.1029/2007WR006443

Melua D., 2015, Municipal water and wastewater sector in Georgia. A report to NISPA and SlovakAid. [Accessed 12 February 2018]

Ministry of Agriculture, 2015, Strategy for Agricultural Development in Georgia 2015-2020.

Ministry of Agriculture and Georgian Amelioration, 2017, Irrigation Strategy for Georgia 2017-2015.

OECD and EPIRB, 2016, Facilitating The Reform Of Economic Instruments For Water Management In Georgia. Final report. Available at: https://www.oecd.org/env/outreach/GE%20Econ%20Insts_OECD_EPIRB.pdf

OECD-EUWI (2012), Strengthening the economic and financial dimension of integrated water resources management in Azerbaijan, Georgia and Armenia - Final report ENV/EPOC/EAP(2012)10. Available at [Accessed 24.07.2018]: https://www.oecd.org/env/outreach/Kura%20EIs%20TWC.pdf

OECD, 2003, Social Issues in the Provision and Pricing of Water Services. OECD Publications, Paris.

Osmanov T., 2018, Assessment of condition of irrigation network infrastructure, and recommendations for the approximate volume of annual water losses in irrigation networks and for the reduction of these losses. A report to the Kura II Project.

Paccagnan V., 2018, *Estimating the Costs of Water Degradation in the Kura River Basin*. A report prepared for the Kura II UNDP-GEF project.

Pontoni F., Vecchiato D., Marangon F., Tempesta T., Troiano S., 2016, Choice Experiments and Environmental Taxation: an application to the Italian hydropower sector. *Economics and Policy of the Energy and the Environment*. Issue 3.

Rogers P., R. Baathia and A. Huber, 1998, Water as a social and economic good. How to put the principle into practice. Global Water Partnership TAC Background paper no. 2

Ukleba B., 2017, Report on Irrigation Infrastructure. Report for the KURA II project.

USEPA, 2003, Taking Stock Of Your Water System A Simple Asset Inventory For Very Small Drinking Water Systems.

WHO, 2015, Azerbaijan. Glaas Un-Water Global Analysis and Assessment of Sanitation and drinking water. Geneva. [Accessed 18.01.2018]

Winpenny, 2003, Financing Water for All. Camdessus Report on Financing Water Infrastructure. https://www.oecd.org/greengrowth/21556665.pdf

World Bank, 2016, Georgia Poverty Assessment - Fiscal Year 2016. [Accessed December 2017]

World Bank, 2014, Reducing the vulnerability to Azerbaijan's Agricultural System to climate change. A World Bank Study. Available at: https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-0184-6

World Bank, 2014, Reducing the vulnerability to Georgia's Agricultural System to climate change. A World Bank Study. Available at: https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-0184-6

World Bank, 2013, Review of World Bank engagement in the Irrigation and Drainage Sector in Azerbaijan. Available at:

http://documents.worldbank.org/curated/en/745171468009938367/Review-of-World-Bank-engagement-in-the-irrigation-and-drainage-sector-in-Azerbaijan