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Policy Paper

Water-Energy Nexus and Transboundary Water Management as part of Integrated Water Resource Management in Azerbaijan

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Table of Contents

Acronyms and Abbreviations

ACG	– Azeri Chirag Gunashli
ADB	– Asian Development Bank
AWM	– Amelioration and Water Management
Cabmin	– Cabinet of Ministers
CESD	– Center for Economic and Social Development
CSO	– Civil Society Organizations
ENVSEC	– Environment and Security Initiative
EU	– European Union
FAO	– Food and Agriculture Organization
GDP	– Gross Domestic Product
GEF	–Global Environmental Facility
GWP	– Global Water Partnership
HPP	– Hydro Power Plants
ISWF	– International Shared Water Facility
IWRM	– Integrated Water Resource Management
JSC	– Joint Stock Company
MEI	– Ministry of Economics and Industry
MENR	– Ministry of Ecology and Natural Resources
MES	– Ministry of Emergency Situations
MoA	– Ministry of Agriculture
MoH	– Ministry of Health
NATO	– North Atlantic Treaty Organization

OSCE	– Organization for Security and Co-operation in Europe
SOFAZ	– State Oil Fund of the Republic of Azerbaijan
SSC	– State Statistical Committee
SWP	– Swiss Water Partnership
TPP	– Thermal Power Plants
UN	–The United Nations
UNDP	– United Nations Development Program
UNECE	– United Nations Economic Commission for Europe
UNESCO-IHE	– United Nations Educational Scientific and Cultural Organization's Institute for Water Education
USSR	–The Union of Soviet Socialist Republics
WB	– The World Bank
WWC	– World Water Council

Measurements

ha	– hectare (1 ha = 10,000 m^2)
km	– kilometer (1km = 1,000 m)
km^2	– square kilometer (1km^2 = 1,000,000 m^2)
km^3	– cubic kilometer (1km^3 = 1,000,000,000 m^3)
mln	– million
m^3/sec	– cubic meter per second

Executive Summary

The quest for a sustainable and secure supply of fresh water poses a challenge to predominantly semi-arid Azerbaijan. The countryis highly dependent on upstream countries for freshwater resources, making transboundary water management a critical issue for Azerbaijan. Additionally, internal water resource management is complicated and needs to be developed so that the scarce water resources are managed properly and sustainably among various water consuming sectors. The main water intensivesectors are agriculture and energy. Taking into account the fact that energy is the leading component of Azerbaijan'seconomy; this research focuses on the water-energy nexus of the country,in addition to the transboundary and internal regulatory aspects of freshwater resources in Azerbaijan.

This paper is structured as follows: a literature review on water security, various aspects ofwater resource management, the water-energy nexus andtransboundary water managementis followed by a comprehensivereview ofAzerbaijan'sfreshwater capacities. Subsequently, the paper touches upon freshwaterconsumption by various economic sectors (with a specific focus on energy) and the importance of the energy sector in the economic development of the country. Next, it describes the current situation inthe Kura-Aras River Basin and how shared waters affect the water quality in Azerbaijan. Finally, in order to understand internal characteristics of water resource management in Azerbaijan, this paper analyzes institutional regulations and the responsibility matrix of various institutions involved in water resource management.

The comprehensive analysis shows that Azerbaijan is steadily improving its position on the water-energy nexus. However, there are gaps in institutional aspects of water resource management within the country. Additionally, there is an urgent need for cooperation in transboundary water management. Therefore, in order to maintain sustainable development, Azerbaijan needs to develop an integrated water resource management (IWRM) system where various sectors are coordinating with each other on water management, so that one sector is not

prioritized over others. The main purpose of this report is to introduce the current analysis of the country in terms of water resource management and suggest some relevant policy recommendations for the sustainable resource management.

Introduction

Water Security is defined as access to safe and affordable water resources for human needs and ecological health by the Global Water Partnership (GWP), which has been established to achieve a water-secure world by strengthening integrated water resource management (IWRM). IWRM combines water, land and other water-intensive sectors in order to achieve sustainable development. IWRM has different subsections focusing on water resources' relationships with population, agriculture, nature, industry and other users.

The concept of water securityalso highlights the importance oftransboundary water management.Taking into account that almost 60 percent of the world's water resource is shared by basin states, regional and international cooperation iscritical part of IWRM (UN Water 2008). The water-energy nexus isalso considered a part of IWRM, since it implies establishing sustainable economic development and social welfare by achieving good governance of water and energy resources. The water-energy nexus is a recently developed concept like sustainable development, energy efficiency, security of supply and many other approaches that emphasize the interrelated nature of resources.

In the case of Azerbaijan, both transboundary water management and the water-energy nexus are challenging issues. Energy is the second-largest water-consuming sector in Azerbaijan, and is also a leading player in the economic development of the country. However,Azerbaijan suffers from water scarcity and depends on upstream countries, receiving more than half of its freshwater resources from neighboring states. Taking into account Azerbaijan'svulnerabilityin water-related issues, this paper focuses on the country's water-energy nexus and internal institutional and transboundary water

managementissues.This focus highlights the need to develop Azerbaijan's water resource management according to IWRM principles and contributes toachieving water security in the country.The IWRM system facilitates coordinated development and management of water and other related resources in order to achieve water security.

In terms of the water-energy nexus, this report focuses on the fresh water consumption and on primary energy resource extraction and electricity generation in Azerbaijan. Additionally, it discusses the legal and institutional framework of fresh water resource management in Azerbaijan.Regarding transboundary water management, the paper discusses the status of Kura-Aras River Basin, the country's main supply of fresh water. This report also focuses on internal regulations and finds that the development of an IWRM systemwould ensure sustainable economic development and security of supply in both water and energy resources in Azerbaijan. Additionally, cooperation in transboundary water resource management would lead to economic development in the riparian states and support friendly relations among the riparian states and vice versa.

Part One: Water-Energy Nexus and Transboundary Water Management

1.1. Water security defined

Water security is a widely used concept with various interpretations. Depending on the context and discipline, its framework differs; however, it cannot be examined from the technical aspects of thewater sector alone (Zeitoun 2011). Water issues are closely linked with food production, land development and energy issues.A growing world population and changing ways of living also have an impact on water resources consumption for food and energy generation purposes.

From an agricultural point of view, water security means risk management during flood and drought;froma legal perspective,it deals with water allocation rules. UN Water defines water security as a notion“encapsulatingcomplex and interconnected challenges and highlighting water’s centrality for achieving a sense of security, sustainability, development and human well-being, from the local to the international level”. The Global Water Partnership (GWP) defines water security as access to safe and affordable water resources in order to maintainhuman needs and ecological health (2000).

Irrigation and water resources expertBruce Lankford (2013) suggests looking at water security in terms of sufficiency and equity. The indicators of water security in terms of sufficiency are numbers and details like volumetric sufficiency, water quality and flood regulations. However, water security from an equity point of view focuses on the proportions of water allocatedto various sectors and users. Its indicators are water allocation, dynamic apportionment and the efficient usage of water resources (2013) (Appendix I, Table 8, p 42). Additionally, Cook and Bakker, specialists on water security and governance,identify four dimensions of water security:water availability, human vulnerability and hazards, human needs with the emphasis on food security and sustainability(2012).

The water availability and human needs dimensions include both the sufficiency and equity aspects of water security, since the main focus ofthese aspects is on the quantity of water and its availability for different users. The human

vulnerability and hazards aspect is about sufficiency of water resources focusing onprotection against hazards like floods and droughts, and on safe access to water functions and services. According to the GWP, the sustainability aspect of water resources includes variables such as meeting basic needs, securing the food supply, protecting ecosystems, sharing water resources, managing risks, valuing water and governing water wisely (2000). These variables involve elements of both sufficiency and equity; however,the notion of sustainability itself mainly focuses on the equity aspect of water security, meaning that the usage of water resources should be allocated in a way thatprotects water resources for the future generations.In this research water security is defined according to the GWP's definition – an access to the safe and affordable water in order to ensure human needs and ecological health (2000).

The water-energy nexus is an integral part of water security since it discusses access to water resources for human needs and ecological health in the context of increasing energy and water demands. Water and energy are interrelated sectors; enormous amounts of water are used inalmost all energy-generation processes, from primary energy extraction, refining, processing and transportation to electricity generation in hydropower plants (HPP), cooling of thermal power plants (TPP) and emission scrubbing. Additionally, decreasing water supply resulting from drought periods and the competing interestsofvarioussectors might limit electricity generation, oil and gas extraction processes.Conversely the energy sector can negatively impact water quality via waste streams, runoff water from mining operations, produced water from oil and gas extraction, and air emissions that may affect downwind watersheds. Water extraction, treatment and transportation also require energy usage. As can be seen, water and energy are closely interrelated sectors and both are essential for economic development.Therefore, establishing an integrated approach on these sectors would help facilitatesustainable economic development.

The water-energy nexus covers internal aspects of the IWRM system.However, when discussing an integrated approach towards water resources in the context of Azerbaijan, transboundary water management should be taken into account as

an external factor, since Azerbaijan is a downstream country. In the context of conflict prevention and geopolitical relations, water availability and its impacts on livelihoodsarealso considered as part of water security. In general, water conflicts are the results of increasing water demands and scarce water resources. However, conflicts over shared rivers among riparian states do not necessarily occur due to water scarcity; they might also happen as a result of the mismanagement of these resources (Houdret, et. al. 2010). In this regard, transboundary water management is a crucial aspect of water security, since water does not recognize borders of international law and thus needs cooperative management.

Houdret has identified water quality, water quantity and timing of flow asamong the main factors that must be taken into account while discussing water conflicts(2008). Additionally, in terms of transboundary water management, the political aspects make the issue more sensitive.Therefore,transboundarywater resource management should not only cover technicalissues, but rather should present a holistic approach that takes into account various interest groups and conflict-sensitive issues in addition to technical issues.

1.2. The Water-Energy Nexus and Transboundary Water Management as part of Integrated Water Resource Management

The integrated water resource management(IWRM) concept highlights the interrelated nature of various economic and social activities that demand water resources and suggestsachieving sustainable economic development and social welfare by establishing coordinated use and management of water, land, and other related resources. The main focus of IWRM is to prevent the unregulated use of water resources and establish a stable system thatcoordinates the water management of different sectors so that one sector is not being given priority at the expense of others. IWRM has different subsections focusing on water resources' relationships withpopulation, agriculture, nature, industry and other users. Depending on the country and region, various aspects of IWRM such as

water-population, water-agriculture or water-industryshould be concentrated on while developing this system.

In the case of Azerbaijan, the major issues impeding IWRM are competing interests between the agriculture and energy sectors,as well astransboundary water management (Table 5, p 26) (SSC 2014c).As such, this paper willnext discussthe impacts of the water-energy nexuson the economic development of Azerbaijan, present an overview of the country's water resources, and analyze the national institutional framework of water resource management. Additionally, considering Azerbaijan's vulnerability to transboundary water issues, this paper will focus on the status of the Kura-Aras river basin as part of transboundary water management. The discussion will be followed by policy recommendations aimed at improving Azerbaijan's water resource management.

1.2.1. Why Water-Energy Nexus?

Because of increasing water demand for energy and irrigation, the amount of water in Azerbaijan's reservoirs might not be sufficient to meet needs. On the one hand, the lack of water resources for TPP cooling processes and HPPs might lead to electricity shortages. Therefore, demand for high water reservoirs that would ensure the generation of more electricity in order to answer the population's needs. On the other hand, a shortage of water supply for irrigation purposes might result in extreme food shortages, since irrigation is the main crop production method in Azerbaijan (AWM 2015a). Additionally, about half of Azerbaijan's crop production is cash, like grapes, cotton and tobacco, not food (FAO 2011). These circumstances create overlapping interest among various water-related institutions.Meeting demand requires that additional economic and environmental costs be incurred in the construction of new water reservoirs. Alternatively, establishing IWRM system, which facilitates coordinated water resource management and ensures that one sector's interests is not prioritized over others.

Azerbaijan has been focusing on diversifying its economy byattempting to decrease its dependency on fossil fuels and by introducingenergy efficiency and

renewable energy sources in the country. For example, the 2020 development strategy of Azerbaijan envisions achieving 20 percent of the electricity demand of the country from alternative and renewable energy sources, which is 9.7 percent of the current energy market of Azerbaijan (Presidential Decree 2012). At the same time, the development concept for 2020 highlights the importance of environmental protection, the efficient usage of natural resources and environmentally sustainable economic development.Within the water-energy nexus, efficient water use in the country's energy sector is one of the primary means by which Azerbaijan can take steps towards achieving its 2020 strategic goals.

Increasing demand for water and energy highlights the importance of effective management and supply chains for water resources. Although water is an integral element of energy resource development and utilization processes, it has recently been acknowledged internationally, thatthe efficient usage of water and energy resources via an integrative approach could foster sustainable economic development and ensuresecurity of supply. However, despite the close linkages between energy and water resources, the interconnections between these sectors are underexplored in many countries, including Azerbaijan.

1.2.2. Why Transboundary Water Management?

Another crucial aspect ofIWRM istransboundary water management. This is an important issuewith Azerbaijan's neighboring states. The Kura-Aras River Basin, which starts from Turkey and is shared by Armenia, Azerbaijan, Iran and Georgia with total size about 188,000 km^2, is the main fresh water source for Azerbaijan (MENR 2015e). In cooperating on transboundary water management, the riparian states should implement measures for water quality and flood prevention, and should ensure that water resources are allocated and apportioned equitably, as Lankford suggests.Taking into account that more than2/3 of Azerbaijan's fresh water resources come from outside of the country, along with ensuring efficient water usage in the country, there should also be an integrated water management system developed with its neighboring countries.

However, there is not any multilateral treaty on Kura-Aras river basinamong all theriparian states, nor among the South Caucasus states that heavily depend on freshwater from the basin. There are bilateral treaties between Azerbaijan-Georgia and Armenia-Georgia, however they do not establish a holistic framework for transboundary water management in the South Caucasus. Currently, the projects carried out by international and donor organizations in this regard are mainly capacity-building projects. However,these have primarily been only pilot projects, since each country has a complicated internal water resource management system.

Part Two: The Case of Azerbaijan

2.1. The water resources of Azerbaijan

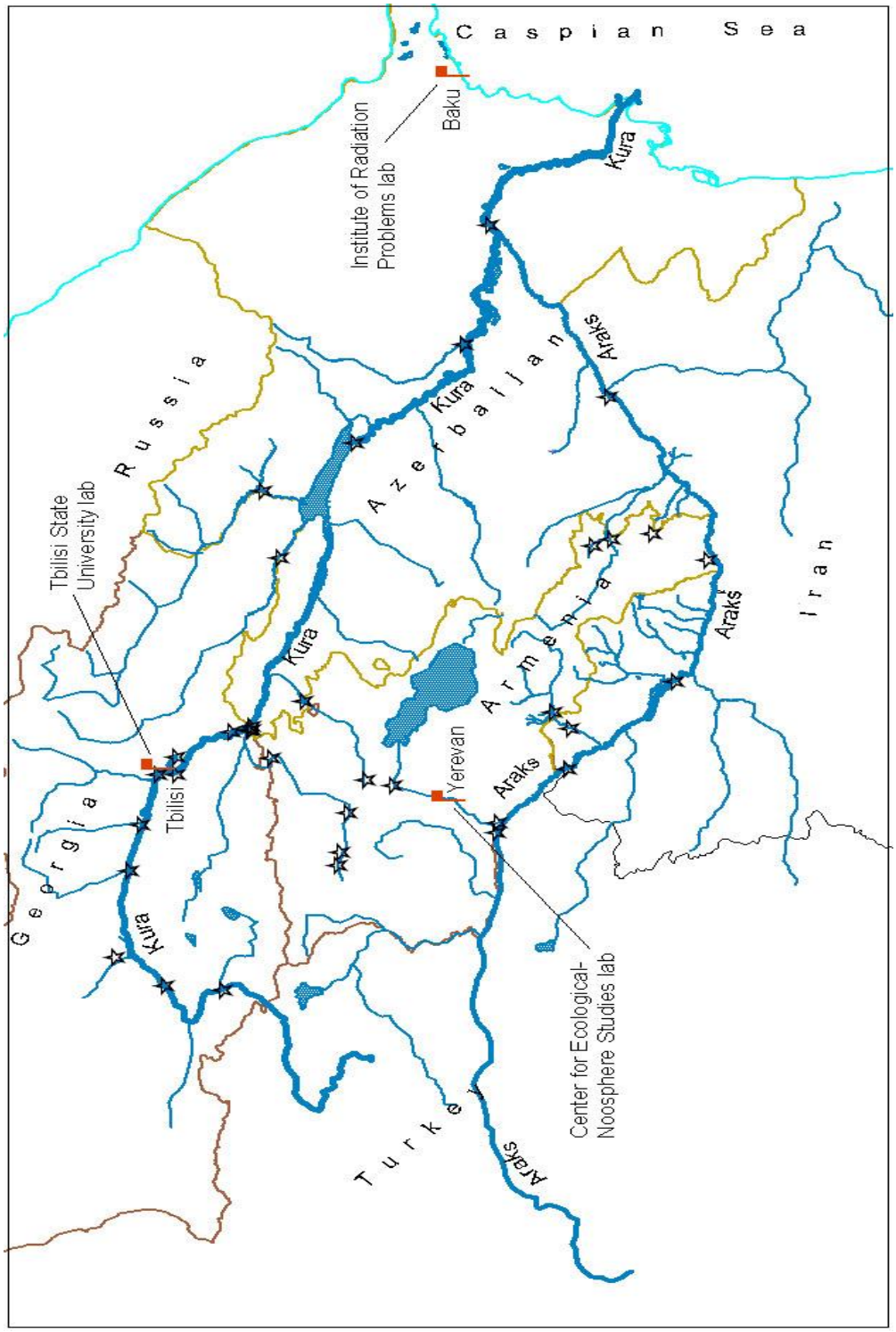
Azerbaijan's overall renewable fresh water resources are 31-32km^3. During drought periods,the total renewable water resourcesdecrease by 20-21 km^3. Estimatedsurface water resources equal 27 km$^{3.}$ A significant amount of this, 19-20.6 km^3, comes from transboundary rivers, whereas only 7.81-10.6 km^3 of surface water comes from rivers originating within Azerbaijan (AWM JSC 2015b; MENR 2015g).

The fresh water resources of Azerbaijan come from the following sources:

- The water resources of *rivers* are 28.1-30.3 km^3, out of which 19-21 km^{3}come from transboundary and/orborder rivers and 8-11 km^{3}from local ones.
- Freshwater resources of *lakes* are 0.9 km^{3}with 395km^{2}catchment area.
- Azerbaijan also has very limited *groundwater* resourcesof less than 0.1 km^3.

Since Azerbaijan suffers from scarce water resources, reservoirs also play an important role in the water supply system of the country. The total capacity of the *reservoirs* is 21.5 km^{3}and working capacity is 12.4 km^{3}with a 694 km^{2}catchment area(AWM JSC 2015b).

Map 1. The river network in Azerbaijan



Source: http://www.nato.int/science/pictures/2005/b-eastern_eur-map.jpg

2.1.1. Rivers

Azerbaijan's river network includes more than 8,300 rivers. Onlythe Kura and Aras, each being longer than 500 km, are large rivers. The Kura and Arasare boththransboundary rivers, and the primary freshwater sources in Azerbaijan.The Kuraflows from Turkey throughGeorgia.The Aras, the second largest river of Azerbaijan,also originatesin Turkey,flowing alongTurkish-Armenian, Iranian-Armenianand Iranian-Azerbaijanborders and joining the Kura River in Azerbaijan.
It is worth mentioning that the main large and middle-sized rivers are either trans-boundary or border ones, and only four local rivers –Pirsaat, Hakarichay, Tartarchay, and Kurakchay– are listed as middle-sized rivers. Additionally, local rivers are mainly mountainous ones. Therefore, their water capacity changes depending on the season, causing droughts and floods in the nearby regions.
In general, all rivers belong to the Caspian Sea Basin. Depending on the convergence,they are classified as follows:

- The Kura-Aras River Basin (including the right and left tributaries of Kura River containing 7.5-7.8 km^3 of freshwater)
- The Samur River Basin
- The Caspian Sea Basin (rivers directly converging to the Caspian Sea)
- Caspian Sea South Basin.

The below table shows the large and medium size rivers of Azerbaijan, and indicates their type, length, and catchment area, as well as the height of source and mouth. As shown in the Table 1, thetransboundary and border rivers are the main contributors to the river network in Azerbaijan.

Table 1. The list of large and middle sized rivers in Azerbaijan

	Rivers	Basin	Type	Length (km)	Catchment area (km^2)	Height (m) Source	Mouth
1	Kura	Caspian Sea (south)	Transboundary	1,515	188,000	2,740	-28
2	Aras	Kura - Aras	Border	1,072	101,900	2,990	-11
3	Ganikh (Alazan)	Kura-Aras (Mingachevir Lake)	Transboundary	413	16,920	2,560	75
4	Khrami	Kura - Aras	Transboundary	220	8,340	2,422	255
5	Samur	Caspian Sea (north)	Border	216	4,430	3,600	-28
6	Tartar	Kura - Aras	Local	200	2,150	3,120	3
7	Pirsaat	Caspian Sea (south)	Local	199	2,280	2,400	-11
8	Sumgait	Caspian Sea (north)	Local	198	1,751	2,000	-28
9	Turyanchay	Kura-Aras	Local	180	1,840	3,680	-4
10	Bazarchay (Bargushad)	Kura - Aras	Transboundary	178	2,711	3,040	270
11	Bolgarchay	Caspian Sea (south)	Border	168	2,170	1,710	-17
12	Garasu (Shirvan)	Kura - Aras (Hajigabul lake)	Transboundary	134	8,920	-1	-19
13	Ayrichay	Kura-Aras (Ganikh)	Local	134	1,810	3,200	135
14	Gabirri (Iori)	Kura-Aras(Mingachevir Lake)	Transboundary	134	4,840	2,560	51
15	Aghstaphachay	Kura – Aras	Transboundary	133	2,586	3,000	210
16	Kurakchay	Kura – Aras	Local	126	2,080	3,100	18
17	Arpachay	Kura – Aras	Transboundary	126	2,630	2,985	780
18	Khachinchay	Kura – Aras	Local	119	657	2,100	10
19	Gargarchay	Kura - Aras (White Lake)	Local	115	1,490	2,080	-0.5
20	Vilashchay	Caspian Sea (south)	Local	115	935	2,203	-28
21	Goychay	Kura-Aras (Garasu river)	Local	115	1,770	1,980	-1
22	Gusarchay	Caspian Sea (north)	Local	113	694	3,780	-28

23	Gudyalchay	Caspian Sea (north)	Local	108	799	3,000	-28

Source: MENR 2015e

2.1.2. Lakes

There are 450 *lakes* in Azerbaijan coveringan overall area of 395 km^2. Only 9 of these lakes are larger than 10 mln m^3.The largest freshwater lake in the country is Sarisu, located in the Kura-Aras Lowland. Tufangol, the biggest mountainous lake,has a volume of 0.11 mln m^3,and islocated at an elevation of 3,277m.

Table 2. The list of the large lakes in Azerbaijan

	Lake	**Location**	**Catchment Area (km^2)**	**Volume (mln m^3)**
1	Sarisu	Kura-Aras Lowland	66.7	59.1
2	Jandargol	Georgia Borderline	10.6	51.0
3	Aghgol	Kura-Aras Lowland	56.2	44.7
4	BoyukShor	Absheron Peninsula	16.2	27.5
5	BoyukAlagol	Karabakh Volcanic Plateau	5.1	24.3
6	Goygol	Kurakchay Basin	0.79	24.0
7	Hajigabul	Kura-Aras Lowland	8.4	12.1
8	AshigGara	Hakarichay Basin	1.76	10.2
9	Aghzibirchala	Davachi Region	13.8	10.0
10	Garachug	Nakhchivanchay Basin	0.45	2.53

Source: MENR 2015c

Freshwater lakes are primarily used for fisheries, drinking water supply, irrigation and recreation purposes. The biggest freshwater lake of Azerbaijan,Sarisu, is located between the Kura and Aras rivers. In order to prevent household wastewater from flowing into the lake, there is a dam in the north and hydrological discharge equipment in the east parts of the lake.However the oilfield waters from Muradkhanli oil bed have polluted the south part of SarisuLake.

Aside from freshwater lakes, there are also more than 200 saline lakes in Azerbaijan, located in the Absheron peninsula. The main saline lakes are Boyukshor, Girmizigol, Masazir, Yasamal 1, Kurdakhani, Bulbula and Khojasan. The Boyukshor is the largest among the saline lakes; its catchment area is 1300 ha and capacity is 45 km^3. However, the lake has been heavily contaminated byoilfield waters, household and industrial wastewaters, andtheBalakhani landfill, which was previously located nearby. Boyukshor Lake is currentlyin the process of remediation, beingcarried out by TamizShahar JSC as part of the decree “Protection, utilization and improvement the ecological situation of Boyukshor Lake”, signed by the President of the Republic of Azerbaijan in December, 2013. The first phase of the rehabilitation, which includedtreatment of a 300 ha area in the east part of the lake, was completed in June 2015.

Girmizigol, Masazir, Kurdakhani, Bulbula and Khojasan lakes are also polluted with industrial and household wastewaters. As a result of the prevention of household wastewater flow to the Yasamal 1 Lake and remediation measures,the ecological situation of the Yasamal 1 has been improving (MENR 2015d).

2.1.3. Reservoirs

Because Azerbaijan’s climate is mainly semi-desert and dry steppe, the country has limited water resources. Additionally, the main rivers are mountainous with a tendency to flood. Therefore, in order to regulate river flows and provide sufficient water supplyto users such as households, agriculture, electricity generation and

various industries,*water reservoirs*are widely usedin the country.Moreover, since Azerbaijan receivesthe majority of its freshwater resources from upstream countries, it is extremely vulnerable to the quality, quantity and timing of water coming from them.

There are around 140 reservoirs in Azerbaijan,and 62 of them are larger than 1 km^3. These reservoirs have been established both on the rivers and at the riverbed edges covering fertile soil and Tugay forests.

The Mingachevir Water Reservoir is the largest reservoir in Azerbaijan with 15,730 mln m^3 volume. It islocated on the Samukh Lowland and filled by the Ganikh, Gabirri and Kura Rivers. The UpperShirvanand UpperGarabakhChannels originate from the Mingachevir Reservoir and are utilized in the irrigation of the Mil-Mugan and Shirvan Lowlands. Apart from irrigation and electricity generation, the reservoirs are also used for fisheries, recreationand household consumption. In addition to Mingachevir, there are the Varavara, Shamkir and Yenikandreservoirs on the Kura River. These reservoirs are utilized both in irrigation and electricity generation processes. There is alsothe Aras Reservoir in Nakhchivan, the Javanshir in Agsu, the Agstafa and Jogaz in Gazakh, theNohurgishlag in Gabala, the AshigBayramli in Ismayilli, the Khanbulan Reservoirs in Lankaranregionsandthe Sarsang Reservoir on the Tartar River (MENR 2015f).

The Aras Reservoir (or ArasWater Junction) is the second-largest water reservoir in Azerbaijan with a volume of 1,150 mln m^3. It is utilized by Azerbaijan and Iran. The jointly-built reservoir is used both for energy generation and irrigation purposes. It provides 400,000 ha of irrigated lands with water.

The Agstafa Reservoir has 120 mln m^3 volume and provides water for the irrigation of 135,000 ha area in Gazakh, Agstafa, Tovuz and Shamkir regions. The Agstafa River is polluted by sewage waters from Armenia, which adversely affects the water and the irrigation quality of the nearby region.

The Sarsang Reservoir, with a capacity of 560 mln m^3,is located on the Tartar River, Aghdara region and currently is under occupation. This reservoir used to

provide a 100,000 ha area (Tartar, Aghdara, Barda, Goranboy, Yevlakh, Agjabadi) with irrigation water.Since the reservoir area is currently under occupation, the quality, quantity and timing of the water flow from the reservoir keep changing and causing trouble for the residents and industries in this region. According to the MES, the reservoir needs technical maintenance since it has been outdated for more than a decade, which is dangerous for the 400,000people living in the lower reaches of the Sarsang Reservoir(APA News Agency 2014; Sarsang 2014).

Table 3. The list of main water reservoirs in Azerbaijan

	Reservoirs	Catchment Area (km^2)	Capacity ($mlnm^3$)
1	Mingachevir	605.0	15,730
2	Shamkir	116.0	2,677
3	Aras Water Junction	145.0	1,350
4	Sarsang	14.2	560
5	Jeyranbatan	13.9	186
6	Yenikend	23.2	158
7	Agstafachay	6.3	120
8	Varvara	22.5	60
9	Khanbulanchay	24.6	52
10	Khachinchay	1.8	23
11	Sirab	1.5	12
	Total	**974.0**	**20,928**

Source: MENR 2015f

2.1.4. Groundwater resources

Mainly groundwater resources are located in the Kura-Aras Lowlands andGreater and Lesser Caucasus Mountains and majority of them are transboundary ones.The foothill areas are rich with *groundwater resources* suitable for drinking water and other purposes, which are fed with ice and glaciers, river water and groundwater flows.

Table 4. The list of drinking and mineralized groundwater resources

	Location	The confirmed capacity (thsnd m^3)
1.	Ganja – Gazakh Foothill	4,218.6
2.	Karabakh – Mil Foothill	2,231.5
3.	Shaki Zagatala Foothill	2,000.0
4.	Samur – Davachi Foothill	1 686
5.	Nakhchivan Foothill	902.2
6.	Shirvan Foothill	517.7
7.	Jabrayil Foothill	234,6
8.	Lankaran Foothill	86
9.	Mughan – Salyan Foothill	76
10.	Lesser Caucasus (Mountainous part)	74.6
11.	Nakhchivan Mountainous Area	24.3
12.	Shamakhi-Gobustan Region	9.8
13.	Absheron Peninsula	0.3
	Total	**12,079.4**

Source: MENR 2015b

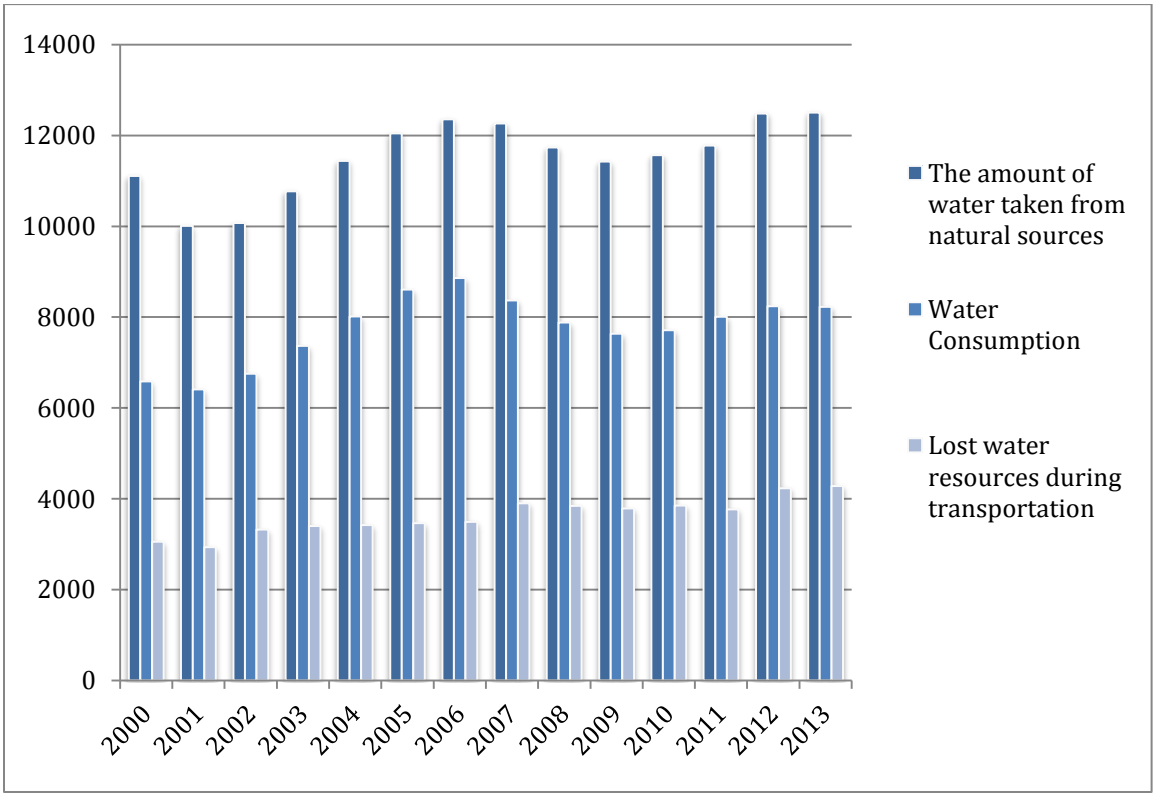
Although there are reservoirs and artesian wells in Azerbaijan, due to scarce and unequal location, the water supply differs from region to region. For instance, theAbsheron and Kura-Aras Lowlands are the most poorly supplied with water resources. Therefore, the efficient and coordinated management of water resources is a challenge, which needs to be addressed properly.

2.2. Water-Energy Nexus in Azerbaijan

2.2.1. Water Consumption

According to the State Statistical Committee (SSC) freshwater consumption in Azerbaijan reached to its maximum level in 2013; 12,509 mln m^3 freshwater has been withdrawn from the natural sources, which is 774 mln m^3 more than 2008's records. As seen in Figure 1, water consumption fluctuates over time, mainly due to seasonal changes; however, water loss keeps increasing as a result of poor water resource management (2014c).

Figure 1. Water Consumption



Source: SSC 2014c

The main water-intensive sector in Azerbaijan is agriculture,which accounted for up to 73 percent of overall freshwater consumption in 2014. The second-mostintensive sector in freshwater usage isthe energy sector. The SSC reports that in 2014 1,803mln m^3 of freshwater resources, almost 22 percent of total freshwater consumption in Azerbaijan for that year wasutilizedfor the generation of electricity, natural gas and water supply (2015b).

Table 5. The freshwater withdrawal based on economic activity in Azerbaijan, 2014

	Water taken from natural water resources (mln m^3)	Water consumption	Water loss during transportation	Wastewater	Treated wastewater
Agriculture, fisheries and forestry	10,844.6	5,928	3,637.8	4,087.2	0.6
Mining industry	222.5	222.5	0.1	227.6	7.6
Manufacturing industry	17.2	48.8	1.0	13.7	7.2
Electricity generation, natural gas and water supply and consumption	1,022.1	1,803.2	365.6	656.2	62.6
Transportation, storage and communication	9.9	55.1	2.4	12.3	9.1

Other sectors	6.7	57.7	0.8	360.7	178.2
Overall	**12,123.0**	**8,115.3**	**4,007.7**	**5,357.7**	**265.3**

Source: SSC 2015b

Apart from the electricity-generation subsection, the energy sector is also involved with other industries. For instance, the mining industry includes the energy sector, viaoil and gas extraction; the manufacturing industry is related to the energy sector via oil refinery and the production of chemical compounds used in the energy sector; and the transportation and storage subsections include oil and gas containers.

Asseen from Table 5, the third-most water intensive industry is mining.The leading mining sector in Azerbaijan is sandstone mining, which is not as water-intensive as the oil extraction industry; however it requires overwhelming amounts of water for dust-control purposes (Please See Appendix II for more, p 43).Additionally, since the sum of water consumption in the mining and manufacturing industries and the transportation sector in 2014 was 4 percent. If roughly calculated,it can be concluded that fresh water usage in energy sector was roughly 23-24 percent of overall fresh water consumption in 2014 (SSC 2015b).Water consumption in electricity, natural gas and water supplywas greater in 2014 than it had been in previous years, equaling 27-28 percent (2,175 mln m^3) in 2012 and 26-27 percent (2,060 mln m^3) in 2013 (SSC 2015b).

Although large amountsof saline water are used for oil and natural gas extraction and petroleum refining processes, the SSC does not report salt-water withdrawals in oil and natural gas production processes. This makes it difficult to conclude the overall amount of water resources (both saline and fresh) consumed by the whole energy sector, the main driverof Azerbaijan’s economic development.

2.2.2.Energy sector's input in economic development

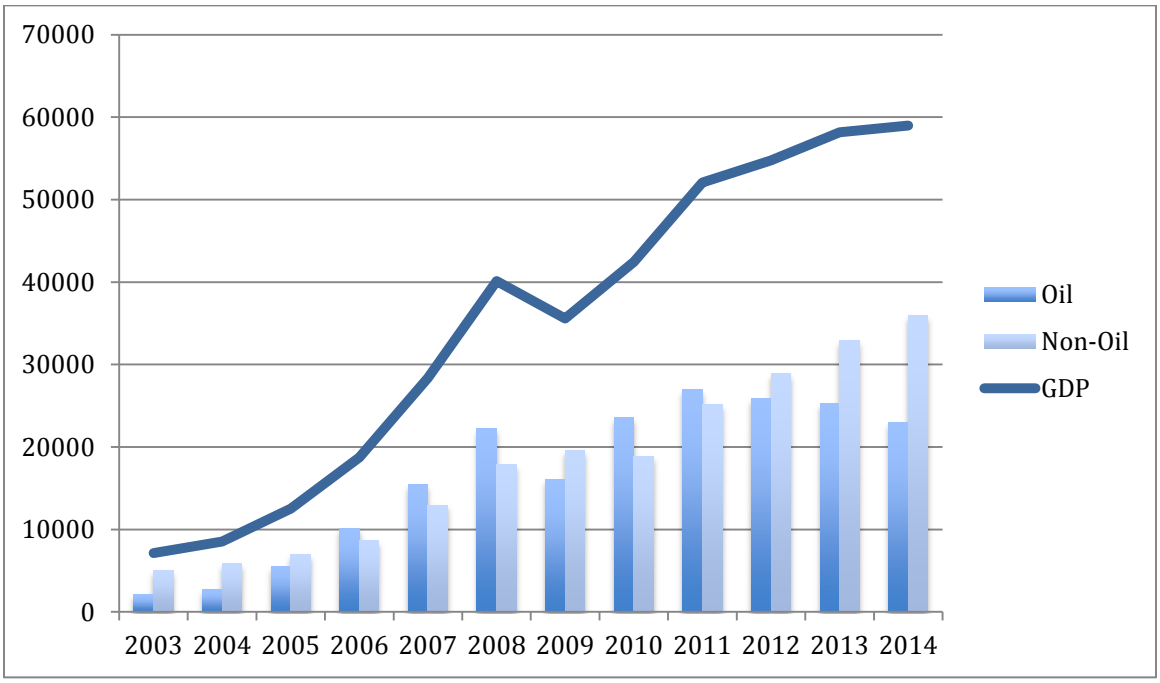
According to the SSC, in 2014 the oil sector's share in the GDP of the country was 39 percent (Figure 2) (2015c). In previous years, the oil sector'scontribution to the GDP of the country has fluctuated between 30-55 percent.Azerbaijan has been one of the fastest-growingeconomies in the world, mainly due to its extensive oil and gas exports in the 2000s. The research done by the Center for Economic and Social Development (CESD) shows that Azerbaijan's fossil fuel export revenues contributed 95 percent of the state's overall export revenues in 2013. Moreover, taking into account the direct transfers from the State Oil Fund of the Republic of Azerbaijan (SOFAZ) and tax revenues from the oil sector, 66 percent of the state budget revenues are coming from the energy sector (2014).Although the energy sector plays an important role in the economic development of Azerbaijan, non-oil sectors such as construction, banking and real estate also contributed to the observed, double-digit economic growth during 2000-2008.

As of 2009 the economic development of the country has stagnated,influenced by the world financial crisis;however, there has still been gradual development during recent years as a result of economic diversification policies, which have lead to development in agriculture, tourism and other spheres of the country's economy. At the same time, advancement in oil and gas recovery techniques resulted in increased national energy production. In fact, the primary production of all energy products has tripled from 2000 to 2013 (Please See Figure 2) (SSC 2015a). According to the 2015 Energy Yearbook by the SSC, crude oil production has increased by 217 percent, natural gas by 230 percent and renewables by 90 percent in 2013 in comparison with 2000's indicators.

Additionally, apart from oil and natural gas extraction, refinery and production processes, electricity generation is quite a water-intensive sector as well. Electricity generation has increased by 25 percent from 2000 to 2013 (Please See Figure 3, p 30) (SSC 2015a). At the same time, the growing economy also boosts water production and consumption. Freshwater consumption has increased by 25 percent since 2000 as electricity generation has grown (Please

See Figure 3) (SSC 2014c). Additionally, the Asian Development Bank (ADB) projects that oil production in Azerbaijan will go up by 20 percent; however, natural gas production will increase by 254 percent by 2035 in comparison with 2010 production volumes (2013). All these increases also mean increasing demand in water supply.

Figure 2. The share of oil revenues in GDP in 2003-2014, Azerbaijan



Source: SSC 2015c

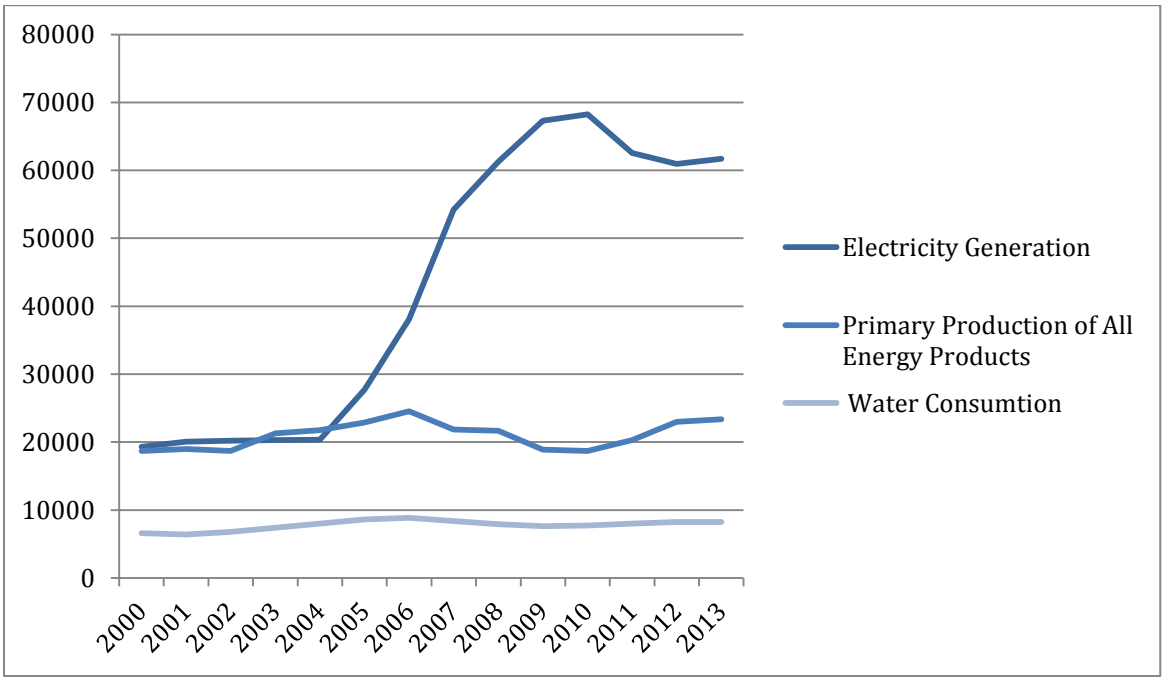
As seen from the Figure2,until 2011, the oil industry's contribution increased along with GDP growth. Obviously, the amount of energyproduced and exported is influenced by many political and economic factors, such as world energy prices, and international political conditions.From a purely technical point of view, water injection or hydraulic fracturing is an integral part of the oil and natural gas extraction processes. Azerbaijan produces oil and natural gas in conventional ways, which are not as water intensive as shale oil and gas production, since conventional methods use water injection but not hydraulic fracturing.

2.2.3. The use of water in the energy sector

Regardless of which technique is used, oil and gas productionrequires enormous amounts of water to increase the pressure in the well and extract fossil fuels, which isalso usually accompanied by the production of water as a by-product. The produced water consists of formation water and water that has been previously injected into the well, in order to stimulate oil and gas extraction. Any type of water can be used in the water injection processes in order to increase production. However, the produced water should be effectively managed in order to be able to re-inject the water and protect the environment from water polluted with fossil fuels.

According to the Sustainability Report prepared by BP, almost 98 percent of water produced from the Azeri-Chirag-Gunashli (ACG) and Shah Deniz fields were treated and used for reinjection purposes in 2013 (2014). Taking into account that produced water is increasing annually, BP envisages improving its capability for handling produced water quality. In fact, the amount of produced water has more than doubled in 2013 compared to the previous year: the amount of produced water was equal to 2,017,897 tons in 2012 and 4,489,658 tons in 2013. Additionally, BP increased its hazardous water recycling by 10 times in 2013in comparison with 2012 results andthe improvement of water managementin those fields is one of the stated priorities of BP (2014). Thus, although there are not any publicly available statistics on how much saline water has been injected into the wells since 1994 and on whether there is any correlationbetween overall water usage andthe amount of produced fossil fuels and economic development, in order to assess the water-energy nexus of the country, this report shows that there is an improvement in the water resource management and further development is envisioned. However, it should be highlighted that there is no other publicly available statistics on the amount of water used in the energy production, therefore, the research is limited on BP’s report.

Figure 3. Comparison of water-energy production and consumption



Source: (SSC 2014c; SSC 2015a)

Depending on location, water availability, technology, and the type of energy facilities, the amount of water injected may vary.Since there is lack of data on how much water (both fresh and saline) has been consumed for the energy sector, it is complicated to checkhow closely these sectors are interdependent; however,Figure 3 shows thatthe fluctuations in primary energy production and water consumption are occurring approximately in the same period (SSC 2014c; SSC 2015a). Obviously, Azerbaijan's energy infrastructure heavily depends on water, and this causes concern about the availability of water as we look towards future demands on limited water resources.

Additionally, along with economic development and increasing demands for energy and water resources, there is also a gradual increase in population. Azerbaijan's population is growing steadily: up to 1.3 percent annually (WB, 2014) (Appendix III, p 44). Population growth and economic and industrial developments are expected to crucially increase energy and water demands for

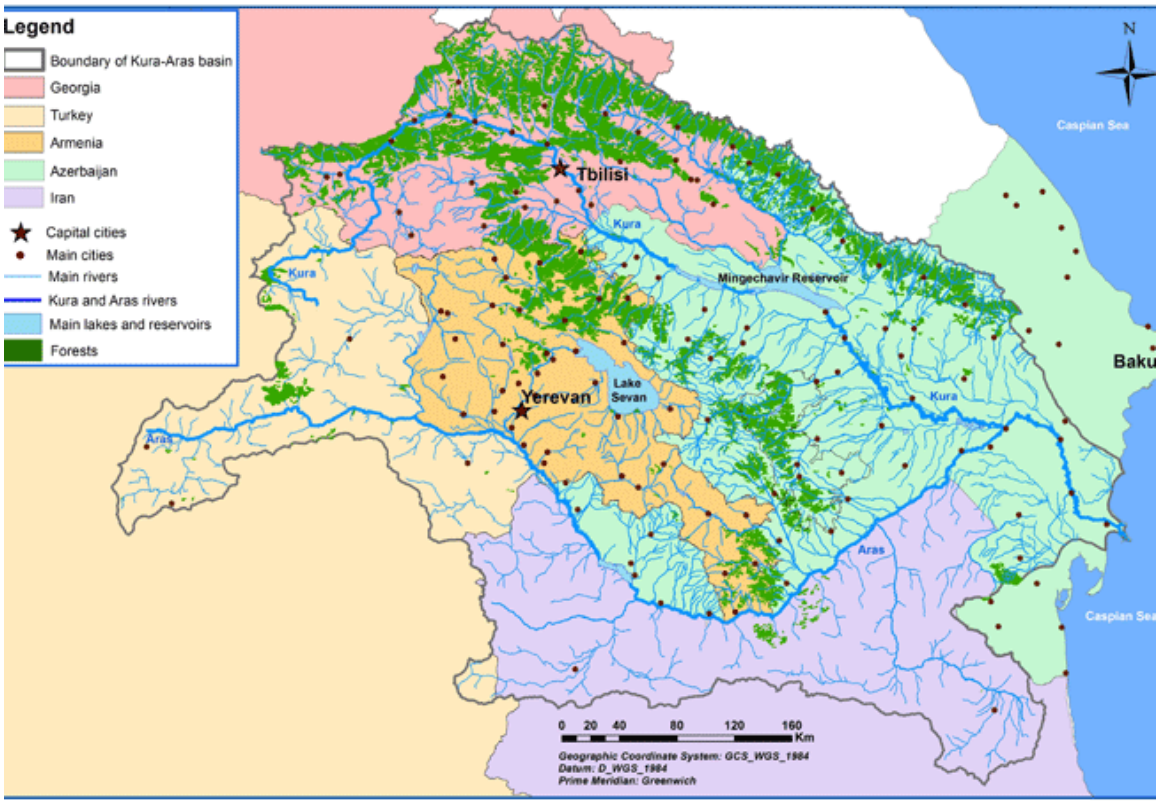
electric power generation, fossil fuel production and transportation. Therefore, taking into account the close interrelations of thewater and energy sectors, it would be better to have an integrated approach towards water resource management in order to ensure sustainable development in the country.

2.3. Transboundary water management in theSouth Caucasus

Azerbaijan faces several challenges regarding its fresh water resources. First of all,70-72 percent of its freshwater capacity originates outside of the country, which makes Azerbaijan vulnerable to the quality, quantity and timing of water flow from upstream states. Secondly, as the majority of the rivers in Azerbaijan are mountainous ones, the amount of water flow changes seasonally as well. Additionally, since reservoirs are the main water-supplying units in the country, any influence such as low quality or changing amount of water directly impacts all water-related sectors. Therefore, the polluted water flow coming from neighboring countries negatively affects agriculture, drinking water and other water-intensive industries, and requires regional cooperation on transboundary river management.

There is currently nomutual agreement among the states of the Kura-Aras river basin on water resource management in the basin. As a result, the basin is polluted with oil and oil products, phenols, surface-active synthetic substances, heavy metals, pesticides and different kinds of organic substances, causing degradation in the ecosystem of the basin. Another challenge of not having a common legal framework for transboundary river management is flooding. Lack of cooperation in terms of information sharing andlack of an established mutual management framework negatively affects downstream countries in particular (MENR 2015a;UNDP/GEF2007).

Map 2. The Kura-Aras River Basin



Source: Epress 2013

Intensive usage of Kura waters begins in Georgia, with fourteen irrigation canalsnear the city of Tashis-Kara. The Gabirri and Ganikh Rivers are also intensively used for irrigation and electricity generation purposes. Because of its use in irrigation, the Gabirri River generallydoes not reach the Mingachevir Reservoir. Additionally, the GanikhRiver is utilized for the Samgori, Sioni and Khrami HPPs. Due to all these reasons, although the natural flow of the Kura River is 853m^3/sec, only 580m^3/sec reaches the Caspian Sea (Gashgay 2013). Moreover, according to the MENR, the ArasRiver is more contaminated than the Kura. The household and industrial wastewaters fromHrazdan, Charensavan, Abovyan and Yerevan are discharged into the HrazdanRiver, one of the tributes of the Aras River. The Aras is also severely contaminated as a result of industrial wastes discharged into the riverfrom the Gafan, Gajaran and Sastakert mines.It is worth noting that all reservoirs on the Aghstafachay, Hasansu, Akhinja, Tovuz,

Bazarchay and Arpa rivers are located on Armenian territory, making Azerbaijan vulnerable to floods, droughts and water contamination (MENR 2015a).

During the Soviet period, the USSR signed agreements with Turkey and the Islamic Republic of Iran on the equal division of the all water resources, and water regulation among the South Caucasus states was an internal,centralized procedure. However,while all three post-Soviet countries have established their own water codes since the collapse of the USSR, they have neither developed these water codes in cooperation as a regional legal framework, nor signed any agreement on collaborative river management.Several agreements have been signed between Azerbaijan-Georgia and Armenia-Georgia on river basin management.Additionally, a number of projects have been undertaken with support from the EU, NATO, UNECE, OSCE and UNDP, both independently and within the ENVSEC project, having Georgia both as a participant and mediator country; however, there is still a need for more intense cooperation.

2.4. Institutional Structure of Water Resource Management in Azerbaijan

The main legal document on water resource management,the Water Code,identifies the local governments and municipalities of the Republic of Azerbaijan and the official representatives of water bodies, who have obtainedalicense from the local government, as responsible for the usage and protection of water resources(1997).According to article 16 of the Water Code, the main principles of water resource management are:

- Ensuring economic development and environmental protection;
- Providing the population with quality water;
- Adaptation of the watershed principle to the territorial structure;
- Separatingwater quality protection functions from water for farm and amelioration(irrigation) processes.

Moreover, article 12 of theWater Codeidentifies the local executive governments of the Republic of Azerbaijan as responsible for preparing the comprehensive

framework on water resource management and protection for each economic region of Azerbaijan (1997).

2.4.1. Obligations of the state

In terms of water resource management and protection, the state has the following obligations identified in the Water Code:

- Defining the state policy on water resource management and protection;
- Implementing investment policy in water resource management and protection;
- Approving, implementing and monitoring state programs on the usage and protection of water bodies;
- Determining the regulationsfor monitoring, registering and reporting on water resources;
- Determining and implementing regulations on water resource management;
- Defining the procedures for granting special usage licensesto water body users;
- Setting the regulationsfor defining protected areas and water usage regime;
- Identifying financial terms, such as fees and ways of paying them for the purposes of the restoration and protection of water bodies;
- Approving standards, norms and regulations on water resource management and protection;
- Providing official, ecological state expertise on the activities that might have negative impact on the water bodies;
- Forbidding and limiting the activities of equipment and institutions that negatively affect the quality of the water resources in Azerbaijan;
- Identifying the sanitation and protection zones of specially protected water bodies and drinking water sources;
- Preparing and implementing projects in order to prevent floods and their negative consequences;

- Fulfilling other responsibilities related to water resources mentioned in Azerbaijan's legislation.

2.4.2. Responsible state institutions

The Water Code gives a general understanding about the state's responsibilities and principles in water resource management in Azerbaijan, without going into details of which institutionsare dealing with specific issues of water management.In this regard, the N 206 decree of the Cabinet of Ministers (Cabmin) approved some regulations on water resource management legislation on 15 October1998, elucidating each institution's responsibilities and obligations related to water resource management. The main institutions in water resource management are: the Ministry of Ecology and Natural Resources (MENR); Amelioration and Water Management JSC (AWM); and the Ministry of Emergency Situations (MES). Additionally, the Ministry of Health (MoH), Ministry of Agriculture (MoA), State Veterinary Service under theauspices of the MoA, State Hydrometeorology Committee, Azersu JSC, local governments and other relevant institutions participate in the development of standards, norms and regulations.

The decree of the Cabmin on "Approving some regulations regarding water legislation" provides detailed information about the responsibilities of these state institutions.

The Ministry of Ecology and Natural Resources (MENR), the main governmental agency in environmental issues, isresponsible for:

- Theconservation of theenvironment, including the Caspian sea area belonging to Azerbaijan;
- The organization ofefficient management and restoration of natural resources;
- The observation and forecasting of hydro-meteorological processes and establishment of environmental strategies on the usage of natural resources;

- The protection from pollution the environment and natural resources.

In terms of institutional regulations, it is responsible for:

- Thestandardizationof monitoring and usage norms of *groundwater resources* in cooperation with the MES, MEI, MoA, AWM JSC, MoH and other relevant institutions;
- The development, together with the MES, MoH, MoA and AWM JSC, of ecological, technical, hydrogeological, hydrological and metrological standards, norms and regulations on the usage and protection of water bodies, which standards are then approved by the Cabmin.

The Amelioration and Water Management (AWM) JSC is responsible for:

- Providing irrigation and amelioration services;
- Ensuring water quality and the proportional distribution of water resources for irrigation and amelioration purposes;
- Providingthe socio-economic development plan foramelioration and water resource management,providingforecasts of the water related issues for the upcoming years;
- Participatingin projects and in the development of standards, norms and regulations related to water resource managementissues;
- Regulating all water reservoirs, channels and dams
- Enforcing the standardization of *surface water* resources in coordination with the MES, MEI, MoH, MENR, State Veterinary Service under the MoA and Azerenerji JSC.

The Ministry of Emergency Situations (MES) is responsible for:

- Protecting populationduring emergency situations caused by natural and/or human-made disasters, including floods, and providing security for water bodies;
- Cooperating closely with the MENR on standardization of the processes for developing standards, norms and regulations for groundwater resources, as well as for ecological, technical, hydrogeological, hydrological, meteorological purposes.

Sanitation and hygiene standards, norms and regulations for the usage and protection of water bodies are developed by *Ministry of Health (MoH)* together with the MES, MoA, AWM JSC, State Control Committee on the Usage of Ecology and Nature, State Hydrometeorology Committee and other relevant institutions approved by the Cabmin of the Republic of Azerbaijan.*Azersu JSC* is a centralized institution providing drinking water and wastewater treatment services in the country. AzersuJSC participates in all processes associated with drinking water management, from water treatment, transportation and sale to the technical maintenance of water reservoirs, pumps, channels and sewage systems.

Table 6. Institutional matrix

Function	Water resources	Water supply	Irrigation
Regulation	MENR, MES, MoH, AWM	MENR, MoH, AWM, SCC, Azersu JSC	MENR, AWM, MoA
Information, monitoring, health	MENR, MES, MoH	SCC, Azersu JSC, MENR, MoH	AWM, MENR, MoA
Operation and research	MENR, AWM, Azersu JSC, SCC, MEI	SCC, Azersu JSC	AWM, MEI, MoA

As seen from the responsibilities matrix, too many entities are involved in the regulation process, sometimes causing overlap or gaps in water resource management. For instance, the MENR deals with groundwater and the AWM is responsible for surface waters.However, groundwater and surface water resources are interrelated, causing gaps in the management of the overall fresh water resources of Azerbaijan.Another example is the MES. The MES is responsible for flood management, but it is unclear as to whether it can step inafter the flood has happened or before in order to take preventive measures.

Therefore, it is necessary to improve local legislation and the institutional framework in order to support effective water resource planning and management.

Conclusion

Azerbaijan has limited freshwater resources andtransboundaryrivers are the major sources of freshwater in the country. However, there is no regional legislative framework designed to regulate water flow and make the downstream countries better-insured water quality and quantity. At the same time, the presence of competing users within Azerbaijan necessitates the development of anIWRM system within the country and, if possible, adapting the model to be part of a regional cooperation framework. The main competing sectors are the agriculture and energy sectors; both are crucial for the economic development and social welfare of the country. Taking into account that Azerbaijan has scarce and unequally distributed water resources– 70 percent of all renewable fresh water resources come from neighboring countries – Azerbaijan needs to develop an integrated approach towards water resource management on the local, regional and international levels in order to achieve economic expansion by developing both the agriculture and energy sectors. The chart below summarizes the main challenges that Azerbaijan faces in thewater-energy nexus, and ininternal and transboundary water resource management issues.

Table 7. Major problems in the water management system of Azerbaijan

General Water Issues	Challenges
Water Energy Nexus of the National Economy	1. Lack of publicly available data on the amount of water withdrawal and consumption for the energy sector. 2. Lack of publicly available data on wastewater and produced water treatment in the energy sector. 3. The above-mentioned points make research, analysis and development of water-energy nexus policy difficult.
Water ResourceManagement	1. Legislative weaknesses of the existing legal database. 2. Absence of the concept of water conservation and of principles for its implementation. 3. Lack of adequate organizational structure. The responsibility matrix of water related institutions,is complicated. 4. Lack of a clear economic basis in order to establish differentiated charges for various water consumption purposes.
Transboundary River Management	1. Absence of a mutual agreement among the riparian states on transboundary river management makes downstream countries vulnerable to water pollution, floods, riverbank erosion and other problems related with the basin.

Recommendations

Since this report discusses the water-energy nexus, national institutional framework of water resource management and transboundary water management issues, this section includes internal regulatory, financial and technology-oriented, as well as water-energy and transboundary water management-related recommendations.

Internal Regulations

- Strengthen the legal framework on water resource management.
- Establish an institution dealing with all dimensions of water resource management, such as a Ministry of (Environment and) Water Resources, taking into account the experiences of countries that have already developed such institutions.
- Establish independent and affiliated research centers with the above-mentioned institution, in order to conduct research on international best practices in water management issues and prepare policy recommendations, taking into account local characteristics, like water availability in each region, theeffects of seasonal changes on water reservoirs, etc.
- Maintain and monitor the effective implementation of the aforementioned policy recommendations.
- Support research activities to design sustainable business models that reward flexibility, low-carbon energy sources and energy efficiency in complex and highly interconnected energy systems. Promote their implementation and share lessons learned from these studies.
- Continue work on a cooperation framework among the riparian states.
- Make water management a participatory process by involving various stakeholders such as the local population, industry representatives and policy makers in the decision-making process.
- Establish mutual cooperation in collecting and sharing regional data about transboundary rivers.

- Promote the use of existing or emerging technologies that exploit the potential for more efficient, cost-effective, sustainable, and local closed-loop solutions.

Financial

- Ensure that water is recognized as an economic good, taking into account affordability and equity criteria.
- Take into account that access to quality water is a basic human right, make sure that all industries pay the real cost of the water, apart from households.
- Promote the most efficient use of low-carbon and renewable energy sources that requires minimum amount of water and complementary of energy efficiency and renewable energy policies.
- Facilitate investment in the modernization and improvement of the operation of the existing,environmentally friendly energy sector through financial incentives.
- Ensure that market conditions promote the realcost of fuel, electricity and heat generation to promote the efficient use of energy.
- Coordinate the development of regional and national strategic infrastructure deployment plans with developers of smart business models for energy networks.
- Define joint measures to minimize costs, capture energy-saving opportunities and support the prioritization of energy efficiency measures.

Technology-oriented solutions

- Provide on-site industrial water reuse and recycling for water-intensive industries.
- Utilize produced water in a beneficial way; re-injection might be one of the options.

- Develop long-term stability for energy policies and market regulations to secure and attract investments in efficient electricity and heat generation and distribution technologies.
- Ensure that the grid connection standards attract less water intensive energy sectors such as solar and wind energy companies to invest in Azerbaijan, as the country has huge potential in these energy sources.

Water-Energy Nexus

- Undertake a systematic assessment of win-win policies on energy and water demands, analyzing how the population and industries use energy and water in Azerbaijan.
- Develop strategic national and regional heating and cooling plans based on a mapping of demand and source points to identify cost-effective opportunities for co-generation development, and restoration or expansion of co-generation capacity.
- Identify the impacts of water policies and regulations on energy supplies and demands.
- Identify the impacts of energy policies and regulations on water demands, supplies and availability.
- Develop water-energy nexus goals integrating the analysis on each economic region in Azerbaijan.
- Conduct comprehensive analysis ofregional development planning to ensure that it accurately takes into account the energy–water nexus (including links to land use, agriculture, transportation and industrial policy, international trade, etc.).
- Study the effects of policies aimed at climate mitigation and adaptation on the energy and water sectors, and, specifically, on the energy–water nexus.
- Study how Azerbaijan can reduce itsenergy and water footprints through technological innovations, altered processes, alternative suppliers and awareness-raising initiatives.

- Consider ecosystem services that can be used as drivers for the more sustainable use of water resources.
- Consider the internalization of environmental and social costs of water resource management.
- Develop an approach to placeenergy–water considerations in the context of the climate change and carbon agenda.
- Ensure that each energy extraction, generation, production, and transportation entity regularly reports its water consumption in energy-related processes to the SSC and shares publicly.
- Identify existing international, technical solutions that successfully achieve energy efficiency in water generation; for instance, powering desalination plants with wind power or using solar panels on rooftops. The key to this project is the need to establish the feasibility and efficacy of such plants against a range of criteria (cost, transferability between locations, resilience to climate impacts, etc.).

Transboundary Water Management

- Promote the importance of transboundary water management as an international public good among the riparian states.
- Develop practical awareness of the UN Convention on the Law for Non-Navigational Uses of International Watercourses and other international conventions on shared waters in each co-riparian state's decision-making bodies.
- Establish an International Shared Waters Facility (ISWF), which would serve both to arbitrate between the riparian states and to facilitate financial arrangements for the existing and upcoming initiatives in cooperation with various international organizations such as WB, UNDP and initiatives like GWP, SWP and WWC.
- Support regional economic groups interested in transboundary water management.

- Cooperate with civil society organizations (CSO) on confidence building and conflict prevention in terms of transboundary water management.
- Support the CSOs financially in order to engage them in processes of regional institutions and trust-building processes, representing the local institutions' and population's views.

Appendix I

Table 8. Definitions and measures of water sufficiency and equity/justice

Main axis	Indicator	Details	Example units
Sufficiency	Volumetric sufficiency	Exact or relative measures of per capita water availability	Cubic meters per capita
	Water quality	Exact or relative measures of water quality (e.g., pollution, turbidity, salinity, oxygen), or measures of client satisfaction in urban areas	Classes (high, good, mod, poor, bad)
	Flood protection	Risk map of protection from flooding (distance-depth for example)	Depth, extent, risk of event (e.g., return period)
Equity/ justice	Water allocation/ equity	Bulk water allocation between sectors; measures might include difference from expected or variation measures such as the Christiansen coefficient of variation	Exact % rations relative from expectation or history; measures of difference
	Dynamic apportionment	Scarcity allocation during drought or when levels of supply change dramatically and dynamically; low flow ratios and access measures during drought might apply	Percent coverage of minimum requirement; measures of difference
	Productivity/ efficiency	The specific production from units of water and/or land/labor using carefully accounted denominators of withdrawal and/or consumption	Unitless efficiency; economic or biophysical productivity

Source: Lankford 2013

Appendix II

Table 9. The subsections of mining industry

	2005	2009	2010	2011	2012	2013
Stone, sand gravel, salt and other products	177	229	227	204	200	208
Extraction of crude petroleum	31	35	27	28	28	29
Metal ores	3	3	3	3	3	3
Mining support service activities	32	47	54	54	58	78
Overall mining industry	**243**	**314**	**311**	**289**	**289**	**318**

Source: SSC 2014a

Appendix III

Figure 4. Population growth

Source: SSC 2014b

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