Alazani/Ganikh RiverBasin

Water-Food-Energy -Ecosystems Nexus assessment

Prepared by the Royal Insitute of Technology (KTH, Stockholm)

under the supervision of the UNECE Water Convention secretariat

First draft report for comments by the concerned authorities

19 June 2014

Contents

1 INTRODUCTION: THE NEXUS ASSESSMENT IN THE ALAZANI/GANIKH

1.1 INTERSECTORAL CHALLENGES AND THE NEXUS APPROACH

Population growth, economic development and increased energy and food needs all exert increasing pressure on natural resources. Common development needs have to be met in a sustainable manner, without compromising the functioning of ecosystems. However, energy, land management for agricultural and other purposes and water resources planning commonly take place in isolation, without adequate consideration of what the planned developments require or assume about other sectors, and what implications – positive or negative – they have. Shortcomings in intersectoral coordination are a major challenge both on the national and transboundary levels, in developing countries, transition economies as well as in developed countries.

With predicted increased demands for energy and food in the coming decades, environmental practitioners and policymakers are looking for ways to promote sustainable growth while also ensuring healthy ecosystems and adapting to a changing climate. These mean balancing multiple stakeholder needs.

The "nexus approach" to managing resources aims to enhance water, energy and food security by increasing efficiency, reducing trade-offs, building synergies and improving governance across sectors. The nexus term in the context of water, food and energy refers to these sectors being inseparably linked, so that actions in one area can have impacts on the others, as well as on ecosystems.

In a transboundary setting, friction and potential conflicts may result from tensions between sectoral and national objectives, unintended consequences of resource management and trade-offs between sectors.

1.2 THE NEXUS ASSESSMENT UNDER THE UNECE WATER CONVENTION

The Meeting of the Parties to the United Nations Economic Commission for Europe (UNECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) wished to address the multiple challenges described above. The Parties therefore decided to undertake an assessment of the water-food-energy-ecosystems nexus in a representative set of transboundary basins in the pan-European (UNECE) region and beyond. At the same session of the Meeting of the Parties in 2012, a Task Force on the Water-Food-Energy-Ecosystems Nexus was established to oversee the assessment.

By assessing the situation in transboundary basins jointly and improving the knowledge base, synergies can be achieved and potential solutions identified. The basin assessments to be carried out under the Convention are to support policy development and decision-making.

More specifically, the nexus assessment (UNECE, 2014) has the following broad aims:

- to identify intersectoral synergies that could be further explored and utilized in the different basins
- to determine policy measures and actions that could alleviate negative consequences of the nexus and help to optimize the use of available resources (under future environmental and climate constraints).

The components and the process of the nexus assessment are described in the document "Progress report on the thematic assessment of the water-food-energy-ecosystems nexus"[1]

In response to a call for expressions of interest, some 13 proposals were submitted by countries, joint bodies and other organizations for basins to be considered for assessment.

The Nexus Task Force discussed the assessment approach and scope based on a discussion paper. An assessment methodology was then developed according to that guidance by the Royal Institute of Technology (KTH, Stockholm) in cooperation with the UNECE secretariat.

1.3 WHY THE ALAZANI/GANIKH?

To test in practice the methodology, it was necessary to apply it to a pilot basin.

Taking into account the complexity of the transboundary setting in the different basins, data availability, eligibility for available funding and possibilities for co-funding, the Alazani/Ganykh Basin, shared by Azerbaijan and Georgia, was selected for the piloting.

There are several reasons why a nexus assessment in this basin is opportune:

- Generally good transboundary cooperation between Georgia and Azerbaijan: the two countries have participated in a number of projects, for example on monitoring and assessment

- Major support to water management and related intersectoral coordination in both countries provided by the United Nations Development Programme (UNDP) Global Environment Facility (GEF)-funded project, "Reducing Transboundary Degradation in the Kura Ara(k)s River Basin". That support, notably included an extensive Transboundary Diagnostic Analysis covering the participating countries' part of the Kura Basin,[2] adoption of a Strategic Action Programme to address the identified issues and development of national integrated water resources management plans

- Need for economic development: intersectoral considerations are timely to limit economic externalities and environmental impacts

[1] This document is available at http://www.unece.org/fileadmin/DAM/env/documents/2014/WAT/06Jun_25-26_Geneva/ECE_MP.WAT_WG.1_2014_6_ENG.pdf

[2] In addition to Azerbaijan and Georgia, Armenia participates in the UNDP-GEF Kura project.

- Existing effort to reduce environmental degradation from both sides
- Opportunities from new energy policies and agricultural modernization.

Currently a draft bilateral agreement between Azerbaijan and Georgia on the shared water resources of the Kura River Basin is being negotiated with the support of OSCE and UNECE,[3] with multi-sectoral representation from the countries.

Also in the Alazani/Ganikh Basin, the challenge is to reconcile short-term objectives for socio-economic development and long-term goals relating to the advance of human security – sustained access to sufficient food, water, energy and environmental resources – while taking into account uncertainties and constraints arising from climate variability and change. Using the multi-sectoral nexus approach can support efforts to address this challenge.

1.4 ABOUT THIS DRAFT PILOT ASSESSMENT

The nexus assessment of the Alazani/Ganikh Basin was launched with a basin-level workshop, which was organized from 25 to 27 November 2013 in Kachreti, Georgia, by the UNECE secretariat in cooperation with the UNDP-GEF Kura project and the Ministry of Environmental Protection of Georgia.[4]

The workshop involved representatives of relevant economic sectors (notably agriculture and energy), water and environment administrations, companies and civil society. The statements and presentations made, as well as group work in interactive sessions using visual aids, allowed the identification of the main intersectoral issues and some possible ways to improve the situation.

This pilot assessment draws on the following:

- Discussions and information presented at the workshop
- Replies to two questionnaires, one factual and one perception-based (both distributed at the workshop)
- Documentation from relevant studies and projects or referred to by the workshop participants; the reports and other documents prepared in the UNDP-GEF Kura project were heavily used
- Information provided by national experts as follow-up to the workshop

The draft assessment provides an overview of intersectoral issues, pointing at some issues that would merit more focused study and at some mutually- beneficial opportunities for intersectoral cooperation.. The process demonstrated the value of an integrated assessment, including the importance of considering secondary impacts and some level of concurrent multi-sector or chain assessment, to understand the intersectoral implications of policies and measures. While the transboundary level is a focus here, it is not possible to understand the dynamics between the resources and sectors at the transboundary level without considering the underpinning national level that helps to explain some developments.

---

[3] Responding to requests by Georgia and Azerbaijan to help the negotiation of a bilateral water agreement, OSCE and UNECE launched a project in 2009 in the framework of the Environment and Security Initiative (ENVSEC) to strengthen the transboundary water cooperation between the riparian countries.

[4] The agenda and presentations of the meeting are available from http://www.unece.org/env/water/alazani_ganyh_pilot_project_2013.html.

The nexus assessment has the potential to support an increase in the benefits achieved by different sectors (win-win) by planning developments in an integrated or coordinated fashion. To allow the realization of these benefits, additional analysis would allow the quantification of certain aspects, to be selected on the advice of the country authorities. Future planning efforts would benefit from a continuing exchange of information between sectors and an increase in intersectoral coordination.

This preliminary analysis requires feedback from the sectoral administrations of Azerbaijan and Georgia and other key stakeholders. The feedback will help to validate the results, improve the accuracy of the assessment and elaborate the most relevant aspects, especially those that relate to topical policy developments.

2 GEOGRAPHY OF ALAZANI/GANIKH RIVER BASIN

The Alazani/Ganikh river basin embraces an area of 11,717 km^2. The river itself has a total length of 391 km and an average discharge of around 110 m^3/sec[5]. It has its sources in the Great Caucasus Mountains in Georgia and flows along the Alazani plain (an inter-montainous depression) toward south-east to enter Azerbaijan and discharge in the Mingechevir reservoir. A large part of the river length (282 km) constitutes a natural border between the two countries (UNECE, 2011).

Transboundary surface waters in the Caucasus

0 100 200 300 400 km

Map produced by ZOÏ Environment Network, July 2011

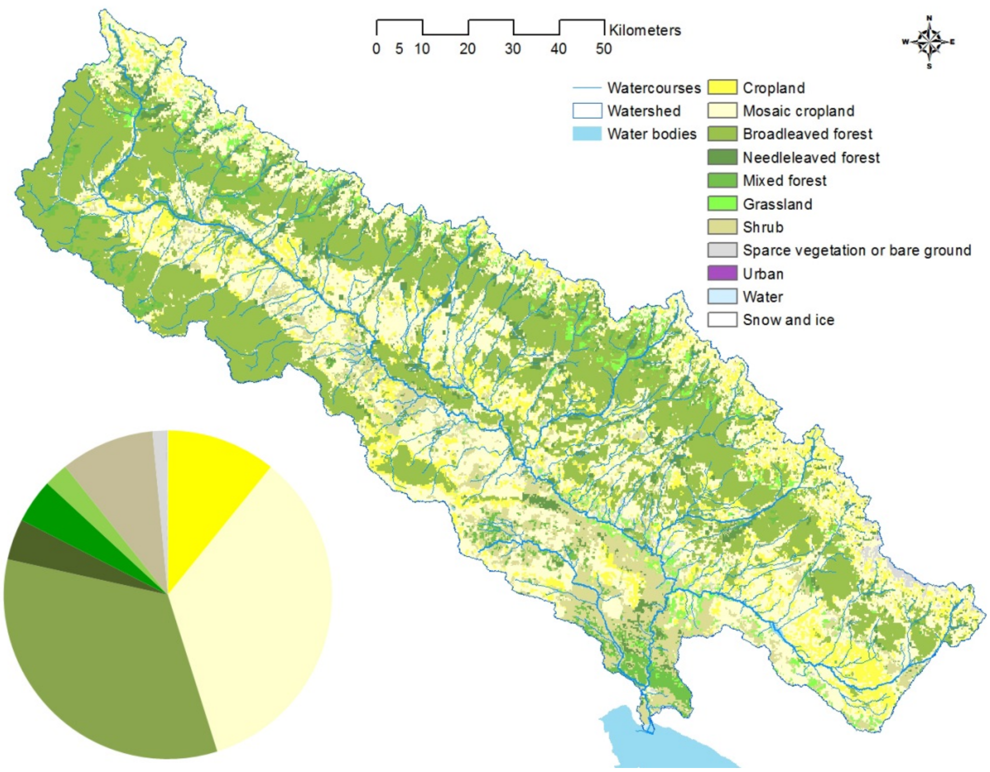
---

[5] Measured at the Ayrichay gauging station in Azerbaijan (located where the river Ayrichay joins the Alazani and the river turns south in the direction of Mingechevir (see figure 2.1)

[redacted]Figure 2.1: ZOI (picture to be substituted (ZOI number 4)) The basin of the Kura River and its tributaries (**UNECE, 2011).**

The geology of the river valley on the Georgian side of the Alazani/Ganikh river basin predominantly consists of loam and pebbles. The end of the Alazani valley is terraced and consistent of conglomerate as well as marl. Conditions are different on the Azerbaijan side where the depression consist of sandstone, chalk and forest loams. The mountainous areas are formed of layers of sedimentary rock (AWC, 2002).

The basin is characterized by an alpine landscape with patches of alpine meadows that shift into a broad-leaf forest dominated by species such as oak, elm and ash growing on the slopes. The floodplain landscape surrounding the meandering river consists of agricultural land, broadleaved dominated forest as well as steppe, bush and semi-desert (AWC, 2002).



[redacted]**Figure 1:** ZOI (picture to be substituted (ZOI number 4)) Land cover in the Alazani/Ganikh River Basin according to a global land cover database **(Bontemps, et al., 2009)**.

The basin is located in a transition area between a sub-tropical continental climate and a humid climate, called the northern sub-tropics. Air intrusions will, due to topography, predominantly come from the south-east making the Alazani/Ganikh River Basin relatively dry. Precipitation varies across the basin with a range of 300-500 mm in Georgia and 500-1400 mm in Azerbaijan (AWC, 2002). The annual average temperature range from 9 to 14^{o}C, with temperatures seldom going below -18 to -23^{o}C and not over the range of 37 to 39^{o}C (Shotadzer & Barnovi, 2011).

Covering the majority of the Alazani/Ganikh river basin is an enclosed transboundary artesian aquifer. The flow rates of the groundwater resources have been estimated to (AWC, 2002):

1) Inflow: 46 m^3/sec, out of which

a) 7.6 m^3/sec from precipitation, and

b) 38.4 m^3/sec from rivers.

2) Outflow: 46 m^3/sec, out of which

a) 29.4 m^3/sec from rivers, and

b) 16.6 m^3/sec through transpiration and evaporation.

According to (AWC, 2002) estimations, surface water and groundwater resources are abundant in the basin. In particular groundwater is a valuable drinking water resource, both due to its availability and its high quality bio-chemical characteristics (AWC, 2002).

According to recent measurements of water quality obtained by sampling and monitoring macro-invertebrates communities along the river, the overall quality of the Alazani/Ganikh is adjudged to be 'good'. (Roncak & Pichugin, 2013) Nevertheless, it was possible to clearly connect human practices (namely untreated municipal wastewater and agricultural discharges, water abstraction and dredging of sand and gravel) with macro-invertebrates communities composition and reduction. .

A key source of pollution is domestic sewage systems. Other, more diffuse sources, include: leakage from agriculture, landfills and urban run-off (CBD, 2010). There are ponds present on both country sides of the Alazani/Ganikh River Basin spread over the agricultural land (34 ponds in Georgia and 15 ponds and one reservoir in Azerbaijan) (Shotadzer & Barnovi, 2011). Summaries of general data are found in Table 1, of renewable water resources in Table 2 and on groundwater balance in Table 3.

Table 1: General data for the Alazani/Ganikh river basin ((UNECE, 2007), (UNECE, 2011)

Country	River length (km)	Sub-basin area (km^2)[6]	Average discharge (m^3/sec)[7]	Basin elevation
Azerbaijan	5	4, 755	110	
Georgia	104	6 ,962		
Total	391 (282 common)	11, 717	110	2.600-2.800 m a.s.l

Table 2: Renewable water resources in the Alazani/Ganikh sub-basin (UNECE, 2011)

Country	Renewable surface water resources (km^3/year)	Renewable groundwater resources (km^3/year)	Total renewable water resources (km^3/year)	Renewable water per capita (m^3/capita/year)
Azerbaijan	3.472	0.0007	3.473	6,150

[6] The exact number may differ somewhat between sources

[7] Measured at the Ayrichay gauging in Azerbaijan

Georgia	1.360	1.24	2.60	7,600

Table 3: Groundwater balance (UNECE, 2011), (AWC, 2002)

Country	Precipitation (mm)	Area (km^2)[8]	Total flow (m^3/sec)	Inflow (m^3/sec)	Infiltration river (m^3/sec)	Infiltration precipitation (m^3/sec)	Discharge evaporation (m^3/sec)	Discharge river (m^3/sec)
Azerbaijan	500-1400	3050	18,9					
Georgia	300-500	980	20,4					
Total	800-1900	4030	39,3	46	38,4	7,6	16,6	29,4

3 INSTITUTIONAL ASSESSMENT

This section focuses on institutions and policies framing the different uses within the Water-Energy-Food and ecosystems Nexus. The different sectors of activity being involved include a great number of institutions, complex regulatory frameworks and many different types of legal provisions.

Conducting an analysis of institutions and on governance mechanisms helps to gain a better understanding of the context in which the different sectors of activity operate. This context is mainly composed of the following elements: varying rivalries between different uses competing for a limited amount of resources, a number of rules dependent on institutions operating at different scales (national, regional, local, etc.), different combinations of actors (such as centralised configurations where the government has an impact or self-organised configuration where actors (often private) have some degree of liberty to negotiate and conclude agreements on resource exchanges).

An analysis of institutions and of governance structures helps to generate understanding of the extent to which conditions are being met in order to achieve an effective integration and/or coordination of different sectors (uses) of resources. This analysis also helps to achieve a better understanding of a system that is often complex and to identify its strengths and weaknesses with a view to addressing intersectoral issues at the local, regional, national and transboundary level of governance.

[This draft assessment is for the time being quite focused on water, and it would be good to improve its coverage e.g. of energy and land regulation.]

3.1 MAPPING OF ACTORS

3.1.1 Georgia

In Georgia, the regulations regarding the Nexus between Water-Energy-Food and Ecosystem relies mainly on four institutional levels.

[8] Alazani-Ayrichay aquifer

- The first level (1) concerns the national level and represents the different Ministries involved in regulating these different uses. Four Ministries can be considered at the top of this architecture: *the Ministry of Environment and Natural Resources Protection (a)*, *the Ministry of Agriculture (b)*, *the Ministry of Energy (c)* and *the Ministry of labour, health and social affairs (d)*.
  The different entities are responsible for the development and implementation of national policies regarding a) the protection of environment (protection of environment, protection of surface waters and groundwaters, soil conservation, etc.), b) regarding the agriculture sector (soil conservation, irrigation plans), c) regarding the energy sector (with the definition of energy sectors programmes for example) and d) regarding public health protection (with the definition of hygienic norms, quality standards regarding air, water, soil, etc., or with the establishment of drinking water quality norms).

- Institutions responsible for the implementation of national policies at the regional level compose the second level (2). Here we identify two Ministries: *the Ministry of regional development and infrastructures* and *the Ministry of economy and sustainable development*.
  These entities operate as links between national policies and their implementation at the regional level. For instance, on the one hand, the *Ministry of regional development and infrastructure*s coordinates the development of water supply and sanitation systems. Its action focuses on the harmonisation of practices and on the homogenous implementation of the national policy defined by different Ministries. On the other hand, the *Ministry of economy and sustainable development* issues construction permits for objects of special importance (such as dams, hydro-technical constructions, etc.).

- The *National Energy and Water Supply Regulatory Commission* constitutes the third level (3) of institutions having an impact on the regulation of the resources. This entity is particular as it is independent from the State Authorities, departments and organizations.
  This level contributes to the implementation of national policies by framing the link with private actors and ensuring the representation of consumers' interests. The Commission is responsible for the definition of rules and conditions regarding the licensing of electricity generation, transmission and distribution, as well as natural gas transportation and distribution and water supply. Moreover, the Commission grants licenses[9] and regulates activities of licensees, importers, exporters, commercial system operators and suppliers within the electricity and gas sectors. The Commission also regulates tariffs in water supply sector. It plays a critical role as it establishes rules in the energy and water supply sectors and arbitrates potential conflicts between regulated entities.

- The fourth and last level (4) is situated at the local level with the involvement of *Local Self-Governments*.
  In 2005, Georgian Government launched the Law on Local Self-Government. The goal of the law is to reinforce the power of citizens to decide on local issues at the municipal level. Consequently

[9] See article 10§1 of the Law on Independent National Regulatory Authorities: 1. An independent regulatory Authority shall have full authority, within its competence to grant licences and permits, to suspend them, to extend their terms, to modify or to revoke them

(and from a Nexus perspective), municipalities are responsible for managing land use, forests and water resources of local importance (article 15). They are responsible for supervising measures for the rational use and protection of resources and must apply Georgian legislation. This strong delegation of competences to the local level shall be materialised through the granting of property rights regarding local forests or local water resources to Local Self-Governments.

[The relevant Georgian State agencies should be referred to here, e.g. Agency of Protected Areas and National Environmental Agency from the environmental side. Information should be added about the operators, their ownership and supervision: United Irrigation Systems Company of Georgia Ltd and United Water Supply Company of Georgia]

Within the Georgian institutional framework, different kinds of organisations consolidate the links between the different levels (from the national to the local level). Nevertheless, the robustness of the institutional setting still allows some flexibility. For example, the *Independent National Energy and Water Supply Regulatory Commission* allows reinforcing the link between private and public sectors and implementing rooms for negotiations between actors. The subsidiarity between different institutional levels contributes to establish a guiding thread between national level policies and local implementation. The regulatory framework is dense with a high number of policy instruments and actors being involved for the regulation of similar resources. On the one hand, this fact allows a high number of rules especially for resources such as water for example. On the other hand, such a situation may produce counter-productive overlaps and problems of coordination between the different public administrations targeting similar objectives with potentially different kind of policy instruments.

3.1.2 Azerbaijan

The institutional setting regarding Water-Energy-Food and Ecosystems Nexus in Azerbaijan can be described within three levels of institutions.

- The first level (1) regroups the main Ministries being involved in the regulation of resource uses within the nexus. These seven Ministries are considered as key actors.
    - The *Ministry of Ecology and Natural Resources (a)* represents all State agencies responsible for environment protection (for the implementation of the Law on protection of the environment). The mandate of this Ministry is wide and concerns the protection of all natural resources (land, water, forests, ecosystems, etc.).
    - The *Ministry of Emergency situations (b)* is responsible for the protection against natural and man-made disasters. This actor recently saw its responsibilities increased, as the Ministry is now responsible for water management at the national level and supervises the national water Agency.
    - The *Ministry of Agriculture (c)* is a major actor as it is responsible for the implementation of the national agriculture policy.
    - Land use management depends on *State Land and Cartography Committee (d)*. The latter is a governmental Agency and the central executive body responsible for the land cadastre and related monitoring.
    - The fourth involved Ministry is *the Ministry of health (e)*, which sets drinking water standards and leads the monitoring of surface water quality of drinking water.
    - The *Ministry for economic development (f)* is the fifth actor being involved. It includes the Tariff Board, which sets tariffs and fees regarding water. **[Could the Georgian**

authorities please describe what is the nature of the relationship the Ministry and the Tariff Board?]

- Finally, the energy sector's main actor is *the Ministry of Industry and Energy (g)*. The Ministry works mainly and oil and gas, as they are the main energy sources of the country.

- Three companies, which are property of the state of Azerbaijan, compose the second level (2). The first company is the *Azersu Joint Stock Company*, which is responsible for the implementation of national drinking water policy. Its tasks are to manage, supervise and monitor needs for drinking water provision and sanitation, and to determine water use fees in collaboration with the Tariff Board. The second company is the *Amelioration & Water Management Joint Stock Company*. This actor is responsible for the distribution of water to the industries and agriculture sector. Its tasks go nevertheless further as the company also has water protection duties (salinity mitigation measures, flood security measures, preparation of water protection schemes, issuing permits for surface water uses, etc.). The *State Company for alternative and renewable energy sources* is the third public owned company being involved. This actor provides services in the field of alternative and renewable energy sources and is responsible for the development of this field. All these State-owned companies are under the authorities of the Cabinet of Ministries, which currently involves twenty Ministries.

- Water users associations mainly represent the third, more local level of institutions (3). Here, voluntary community farmer associations are responsible for the management of irrigation systems. The new Water Law in Georgia that is about to be reviewed by the Parliament will introduce a basin approach, and with this development, the Alazani-Iori river basin district is expected to emerge in the institutional picture.

The institutional setting from Azerbaijan defines competences in a less linear manner than Georgia. A substantial part of national policies implementation depends on public owned companies. By doing so, the institutional framework seems to delegate a high number of responsibilities to actors linked to the State but not included in public administrations. Thus, the regulation of resources within the Nexus shows decentralisation in the conduct of State's action with responsibilities allocated to semi-public actors.

The Alazani River basin contains eleven administrative districts (seven in Georgia and four in Azerbaijan). The management of the river is carried out within two distinct institutional settings and/or structures of public administration with distinct regulatory frameworks. The figure below (figure 3.1) illustrates the structure of the different actors involved in the management of the Water-Food-Energy-Ecosystem Nexus in both countries. The map describes the actors and the institutional levels on the two sides of the border. The links between the actors depend essentially on public law and indicate a strong control of the central State on the different institutions being involved.

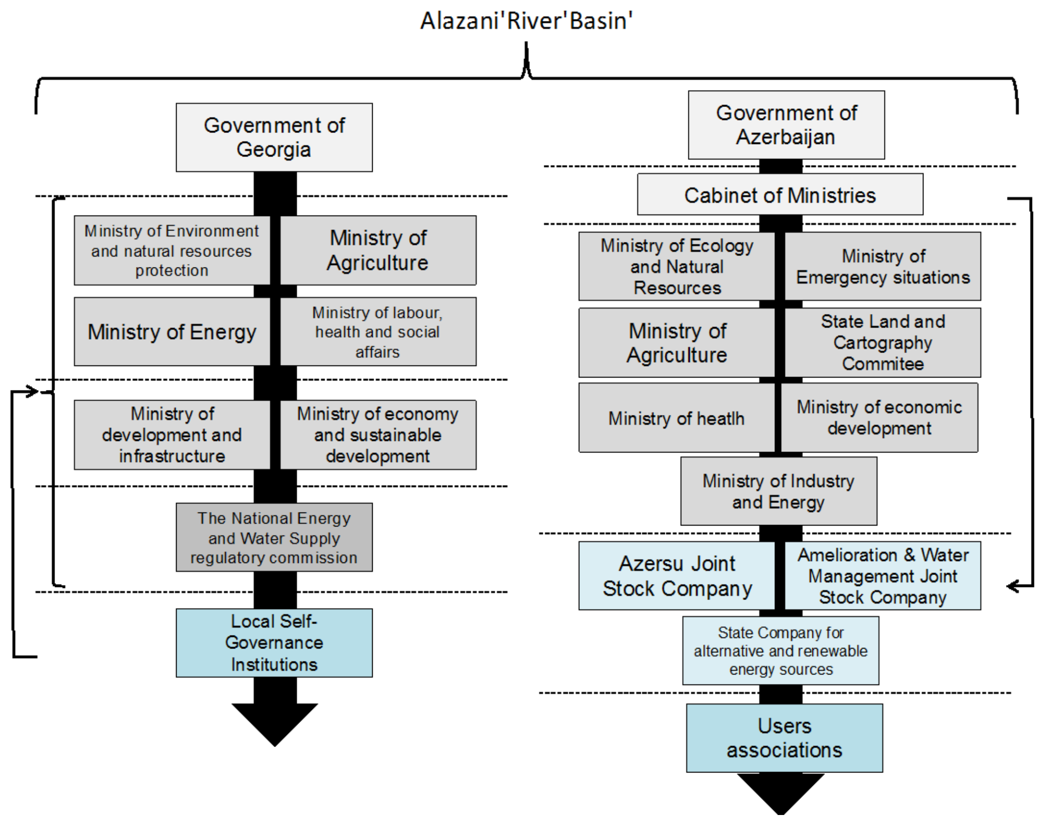


Figure 3. 1. Mapping of actors involved in the Water-Food-Energy-Ecosystem Nexus of Alazani River Basin[10]

3.1.3Transboundary cooperation

The existing mechanisms of cooperation between Georgia and Azerbaijan in the field of environmental protection which are particular relevant to transboundary water resources are the following:

- Agreement between Governments of Georgia and Azerbaijan on Cooperation in the Field of Environmental Protection (signed in Baku, on 18 February 1997)

- Memorandum of Understanding between the Ministry of Environment of Ecology and Natural Resources of Azerbaijan and the Ministry of Environment Protection and Natural Resources of Georgia (signed in Baku on 21 February 2007).

Even though the main obligations of cooperation are defined in the agreements, including e.g. exchange of information on environmental monitoring, responsibility for protection of the basin from pollution and rational use of the water resources, use of clean technologies, there are no clear mechanisms for the implementation of the agreement. Notably, no joint institution like a working group or a commission has been established that would regularly oversee or support the implementation of the agreements.

[10] The two regulatory frameworks are characterized by the strong subsidiarity between the different institutional levels. More precisely, Georgian local self-governance institutions rely to State's Agencies that are part of the different Ministries. In Azerbaijan, the joint stock companies are state owned companies under the authorities of the Cabinet of Ministries.

[This section on transboundary cooperation now only refers to environmental protection and water resources. Relevant information on e.g. energy sector cooperation and trade of agricultural products would be a welcome addition.]

4. SELECTED NATIONAL DEVELOPMENT PLANS

4.1 BRIEF OVERVIEW OF THE SECTORS AND RESOURCES OF RIPARIAN COUNTRIES

This section attempts to capture the selected features of the socio-economy in Azerbaijan and Georgia. Specific interest is in the impact and role of the basin as well as cross sector 'nexus' linkages. A complementary set of indicators is found in the appendixes.

[**Illustration: Sectors/Resources in the two countries to be developed by ZOI based on appendixes**]

4.2 ECONOMIC RELEVANCE OF THE BASIN

Being a sub-basin of the Kura Araks, the Alazani-Ganikh is important for both countries and the Kura. Flowing to Azerbaijan from Georgia, the Kura, provides significant quantities of drinking water to Azerbaijan and it is the main river in Georgia. The Alazan-Agrichay aquifer is the largest groundwater reserve in the region of South Caucasus and the quality if its water is sufficient for drinking. A water transfer system to Baku has recently been constructed to supply the capital with drinking water (UNPD-GEF, 2007). On the Georgian side of the basin, the region of Kakheti is historically and economically important.

Regional strategies and plans for Kakhethi, such as the the Kakheti Development Strategy 2014-2021 that the Ministry of Regional Development and Infrastructure of Georgia recently prepared, indicate that this region is economically very relevant for the country.

Agriculture plays an important role in the basin's economy. Agricultural land accounts for 47.5% of the total land of the basin. Kakheti is a significant region in Georgia with respect to agriculture. It accounts for 38% of the total arable land of the country. The agricultural sector employs 82% of the labour force in Kakheti, which, in turn, highlights its socio-economic role. The cultivation of grapes and wine production in the region deserve particular mention: around 65-70% of Georgia's vineyards are concentrated in Kakheti. And, Georgia's most popular wines are produced in the Alazani valley (Ministry of Regional Development and Infrastructure of Georgia, 2013) (Administration of the Governor in Kakheti Region and Kakheti Regional Development Agency, 2010).

[Need equivelent input from Azerbaijan experts – how important and what is the role of local agriculture]

The basin attracts the interest of tourists, thanks to its natural beauty and the popularity of local food products and wine.

Kakheti in Georgia is famous for its protected territories. Protected territories include Vashlovani, Batsara-Babaneuri and Lagodekhi Vashlovani and Lagodekhi which were created to preserve the unique flora and fauna of the region. Tourism in general and eco-tourism in particular are explicitly suggested in the Kakheti development plan as non-agriculture sectors to prioritized for investment.

On the Azerbaijani side of the basin, in recent years tourism infrastructure has been constructed in all four of its districts. Finally, because of the morphology of the territory in the mountains around the Alazani valley, the area presents good sites for electricity production from hydropower. Small and medium hydropower plants have been constructed in both sides of the basin (and a large potential remains to be exploited – see next section).

Currently, the only large hydropower dam constructed in the region is the Mingechevir, located at the outflow of the Alazani in Azerbaijani territory. Alazani/Ganikh is one of the tributary rivers to the reservoir. The installed capacity of the hydropower plants is 418 MW, which constitutes 39% of the total installed hydropower capacity in Azerbaijan (AzerEnergji, 2013). The water stored in the Mingechevir reservoir is widely used for irrigation. About 1million hectares are being irrigated annually with water withdrawn from it (The World Power Plants, 2014).

Exploring the potential for investing in alternative energy in general in Kakheti is a specific goal for the region, in particular for bio-fuel (Ministry of Regional Development and Infrastructure of Georgia, 2013).

[Need equivelent input from Azerbaijan experts – is biofuel production a key goal?]

4.3 National Policies Influencing the Basin

Selected national policies and measures will potentially influence the economic activities in the basin as well as the allocation of resources. Selected elements of natural resource management, agricultural, energy and environmental protection policies of the governments of Georgia and Azerbaijan are summarized below.

4.3.1Georgia

Georgia is a free market economy. Since its political transformation, the primary roles of the state have become focused on ensuring social welfare and security, overcoming unemployment. Continued economic reforms are expected to create a better market environment and support small and medium enterprises. This is anticipated to stimulate the establishment of a strong middle class.

Under the planned reforms, agricultural production (including crops, livestock and aquiculture[11]) is expected to increase in order to: improve food security; export potential; guarantee employment and increase income levels of the high share of population currently relying on agriculture for living (FAO, 2005) Specifically, the agricultural sector is expected to benefit from loans and grants from the state as well as private investments. These should decrease the need of other types of direct aid. Small and medium farmers will be provided with cash from funds specifically allocated, given the necessary support to create - in the long term - conditions[12] for a higher profitability of the sector.

The tax system is being simplified and made more equitable. The former action is to benefit of entrepreneurs and small and medium businesses (Georgian Government, 2012).

[11] For example see FAO (2005)

[12] These could include, amongst others: expansion of arable land, cropping intensity, yield increases through intensification of production on existing land, through changes of land management practices, modernising and expansion of irrigation systems, improving water use efficiency, etc. All of these efforts will inevitably have an impact on water, land and ecosystems (and demand for energy). Similar changes are underway in Azerbaijan.

In terms of trade, Georgia is committed to expand its role as an exporter, promote free trade with EU, USA and restore relations with the Russian Federation (Georgian Government, 2012).

One national initiative - affecting the region, its agriculture and development - is the continued promotion of private and public-private investments in water supply and sanitation sectors.

Currently, no national strategy formally establishes integrated water resources management but institutional reforms have been planned under the process of National Policy Dialogues on IWRM[13] which started in 2011 (promoted by the UNECE). Three main objectives were established for the process, to be achieved by establishing policy packages:

- Reform institutions and implement the EU Water Framework Directive principles (including the preparation of a National Water Law)
- Setting of targets under the UNECE Protocol on Water and Health
- Strengthening of transboundary water cooperation with Azerbaijan and access the UNECE Water Convention

Water Law dates back to 1997 and is outdated. Within the process of National Policy Dialogue, a new Water Law was developed in 2012-2013. The purpose of the draft law is to ensure the protection of water resources and their rational use considering the interests of the wellbeing of the present and future generations according to the principles of the integrated management of water resources. It is expected that the draft law will be passed to the Parliament for discussions in Summer 2014.

The Parliament of Georgia recently approved the National Forest Policy Document (CENN, ADA AND OBf, 2013). In this document, improvements are proposed for the Forest Code (main law governing the forestry sector) based on sustainable forest use. In particular, it is suggested that separated authorities should be responsible for forest regulation, its management and its supervision.

In terms of electricity generation, Georgia aims to decrease its dependency on fossil fuels by promoting renewable energies. Apart from hydropower, potential exists for geothermal, solar and biomass (Energy Charter, 2012). Hydro generation is expected to increase together with exportation of electricity to neighbouring countries (e.g. Turkey). New investments in hydropower plants aim to benefit from carbon finance schemes, such as the Clean Development Mechanism credits (Energy Charter, 2012). There is a need for nation-wide strategic planning of hydropower resources in order to detect the most suitable rivers and to avoid construction in the areas of high natural or cultural value. Further, for other renewable resources, the Ministry of Energy and Natural Resources is developing a pilot project for a wood-biomass power plant in Mestia, Svaneti region. Wind has strong resource potential in the mountains and on the Black Sea coast. Solar regimes are appropriate for PV generation as well as heating. The Renewable Energy State Program approved by the government in 2008 establishes favourable feed-in tariffs, long-term purchasing agreements and license-free electricity generation for small power plants (up to 10 MW), in line with the program of the government of focusing particularly on small and medium sized hydropower plants (Liu et al., 2014)

[13] More about the NPD on IWRS at http://www.unece.org/env/water/npd.html

Land is currently being degraded for several reasons, including overharvesting of forests for woodfuel. Responding to this, the government is committed to take action to overcome the problems of erosion, desertification and agricultural land loss. Sustainability in agricultural practices and forestry is identified as a priority (Georgian Government, 2012).

Sustainable fisheries will be regulated by the National Biodiversity Strategy and Action Plan for 2014-2020 (currently in draft stage).

Environmental flows in rivers are not regulated at present and as a consequence the common rule for hydropower operations is simply to maintain a river average long-term flow of 10% ((MoENRP, 2013). This common practice is based on the (highly criticized) assumption that 10% is the minimal flow that allows for short-term the survival of rivers habitats. The Ministry of Environment and Natural Resources Protection is committed to introduce new regulations. These will specify the need for having specific environmental flows depending on the river (based on considerations relative to the specific habitats to be protected, specific hydrology and morphology of the river). Draft new Water Law underlines need to maintain environmental flows during any planned water use.

Another priority of the Government is to ensure environment protection standards to comply with EU requirements (strategic assessments of environmental impacts, environmental monitoring, air quality observatories etc. as well as appropriate legislation to ensure compliance of enterprises with modern standards of protection). **[Is this speed out in some document that could be referred to?]**

4.3.2 Azerbaijan

As with Georgia, Azerbaijan continues to open trade to the global and European market. In particular it is strengthening cooperation and moving towards convergence to EU legislation, norms and standards (EU Azerbaijan Action Plan, 2006), (Ministry of Natural Resources of Azerbaijan, 2013).

One of the priority areas of the Azerbaijan-EU Action plan is to "Support balanced and sustained economic development, with a particular focus on diversification of economic activities, development of rural areas, poverty reduction and social/territorial cohesion; promote sustainable development including the protection of the environment" **[By now there is a more recent signed document between the EU and Azerbaijan, right? Related information from Azerbaijani authorities would be welcome.]**

Poverty reduction is one of the pillars of economic development (EU Azerbaijan Action Plan, 2006) and it is specifically addressed in the Poverty Program 2008-2015. Despite the impressive reduction of poverty (halved between 2003 and 2008), the World Bank highlights that access to resources (not only natural but also to services) are still unequally distributed between the rich and poor. (The World Bank, 2013)

The water sanitation and supply (WSS) sector is being improved to reach total coverage water supply and sanitation for the country´s population (EU Azerbaijan Action Plan, 2006). The supply of cities will be achieved with new investments to transport water from groundwater reservoirs to the demand sites (for example, the Alazani-Baku transfer will bring water to the capital from the Alazan-Ayrichay aquifer) (Ministry of Natural Resources of Azerbaijan, 2013). **[Is the groundwater conveyance infrastructure not already completed and operating?]**

Azerbaijan is also committed to establish a coherent national Strategy for Water Resources , currently under development in the framework of the NDPs.

This strategy (not yet formally adopted) concentrates on the following points:

- protection of water resources and aquatic ecosystems
- ensure sustainability and effectiveness in use of water resources while meeting the needs of different water users
- create the legal framework required for the implementation of the strategy
- promote of water saving and cost-recovery
- enhance communication between authorities, regional organizations and citizens
- strengthen capacities in the national and regional level and improve transboundary cooperation[14]

It is expected that in the short term (6 years) the implementation of this strategy will ensure meeting the demand of water for the key sectors in quality and quantity; in the medium term (12 years) it will ensure meeting the demand of the entire population. In the long term (18 years) the water supply system is efficient and water quality responding to both the single sector´s requirements and to environmental protection (Verdiyev, 2012). Alongside the development of the Strategy for Water Resources, the revision of the Water Code may be started soon. A comprehensive assessment of the water balance is also being conducted to have solid basis for discussions on future water use between different sectors.

Azerbaijan seeks to promote transboundary cooperation, not only in terms of monitoring of shared water bodies but also in terms of identifying and implementing projects jointly with other riparian countries, to be developed under international requirements (Verdiyev, 2012).

Land reforms have been implemented since the late 1990s. These aim at achieving a transition to a market-based sector with increased productivity (UNECE, 2011). Subsidies to small farmers in particular play an important role for agricultural development. It has however, been observed that the relatively high amount of money spent in subsidies[15] might have been addressed in alternative ways, to support new investments in infrastructure and to promote specific crops that represent a real competitive advantage for Azerbaijan (UNDP, 2013).

The government is taking specific action to overcome the main obstacles to the sector´s development, including: improving soil quality[16], the rehabilitate of irrigation schemes[17], supporting private investments, expanding financing, creating research centres for agriculture (The World Bank, 2013).

[14] The above list is an adjusted version of (Verdiyev, 2012)

[15] To give an idea, the amount of subsidies reaches 15% in the wheat sector exceeded the 10% allowed by the World Trade Organization.

[16] To address on-going degradation of the agricultural resource base, the Ministry of Agriculture prepared the Republic of Azerbaijan's Agrarian and Industrial Complex Development Strategy (2007-2015) covering measures aimed to improve the ecological soil balance.

[17] Many irrigation and drainage systems, built during the Soviet era, were seriously deteriorated in the past decade due to inadequate funding for maintenance and rehabilitation. This led to significant water losses and irregular and insufficient irrigation water availability, which negatively affected crop yields. Poor irrigation practices and deteriorated collector-drainage and irrigation networks contributed to water logging and secondary salinization. It is estimated that about 42% of the soils is affected by various degrees of salinization. Addressing this is a key objective of current national policy.

5 FUTURE TRENDS

The future state of natural resources in the basin will depend on many factors: national policy and their local implementation, regional plans, transboundary cooperation, environmental footprint of socio-economic activities, climatic conditions, the economic and other incentives that determine their use, protection, extraction and so on. It would take a deep (and arguably necessary) analysis to make an estimate of future consumption of water, ecosystem services, land-use etc. for example, taking all the above into account. For this analysis, we simply report the anticipated trends expressed during the consultation with national authorities and local communities, and use these to initiate the preliminary nexus investigation. (While potentially limited, this provides space to incorporate strong local expertise and provide a common point of departure for the investigation).

5.1 EXPECTED SOCIO-ECONOMIC TRENDS

According to national authorities and local experts from Georgia and Azerbaijan[17], the economic development of the basin will depend largely on two sectors: agriculture and hydropower production. Apart from agro-industry, industry is not expected to be a significant part of the regions development. Tourism is expected to increase as a consequence of the regions natural beauty accompanied with new investments in infrastructure and training local service providers and authorities. (Ministry of Regional Development and Infrastructure of Georgia, 2013; Presidency of Azerbaijan, 2014; Ministry of Economic Development of Azerbaijan, 2008)

As agricultural production has a special place in the regional development agenda, farmers receive generous loans for the provision of modern fertilizers and machinery (in Azerbaijan), farming start-ups (in Georgia) and water (in both countries). Modernizing and expanding irrigation infrastructure to make water more accessible and its use more efficient is a primary concern for both governments. It is not clear if the incentives provided promote broad multi-resource efficiency. This is important, as inefficient use results in flooding, salinity increases and oversizing of, and thus overspending on, supply infrastructure.

Hydropower potential of the basin could attract the interest of private external investors, in both countries. In Georgia and Azerbaijan, hydropower development is largely supported by the government.

At present, rural populations are not expected to increase in the basin. This trend has been perpetuated by urbanization (reducing rural population groups) and the absence of a significant local industrial sector. However, rural household consumption will probably change - creating new stresses and opportunities. More houses are connected to the electricity grid and to water supplies. New water and electricity production, distribution and, in the case of waste, treatment will be required. Should agricultural, agro-industry, hydro-production and tourism boom consumption patterns will be exacerbated by higher per capita use, more input (and outputs), treatment requirement and impact on water flows.

At the same time, growing employment opportunities will change other behavioural aspects may have important (cross sector) nexus impacts. For example, time spend collecting fuel-wood, might have higher payback in the formal economy. People earning money, rather than collecting fuelwood will have increased incomes. Depending on income and fuel prices, this may make commercial fuels both affordable and attractive. That, in turn, will lower deforestation rates.

Environmental protection and legislation has the potential to play an important role in the socio-economic development of the basin. Growth in agriculture and agro-industry expansion will require regulation and ensuring availability of water of adequate quality. This will require controlling aspects of agriculture, agroindustry and tourist service practices, including: waste, water, fertilizer and other management. Growth in tourism will depend on healthy local ecosystems and reversing deforestation. Further, ensuring resilience to flooding events will be important to ensure that all new development activities in the region are sustainable. Thus, special effort will be required to ensure that forests, other natural and artificial infrastructure is appropriately established.

Finally, the future pricing and allocation of resources will strongly affect the manner in they are used in the basin. Efforts to increase economic activities that rely on these resources may inadvertently create cross-sector nexus impacts and encourage wasteful resource use. Subsidies to provide access to resources need to be carefully evaluated in terms of their broader impacts. Some subsidies may have strong multiplier effects. Fuel subsidies may improve household health, but also help preserve forests. Generally, efforts should be made to ensure that they simultaneously promote socio-economic development and economic efficiency. For example, free water provision may be a strong disincentive to invest in efficient water use. Wasteful use will increase cross sector impacts as well as the quantity of supply and treatment infrastructure and required[17]. At present, forests which provide flood control and tourist 'services' are not valued. This creates incentive for them to be over used, for example with fuel-wood harvesting.

[Figure: ZOI Expected trends of economy in the basin]

5.2 Climate change

Increases in temperature have been registered during the past century in both countries (mean annual, mean daily maximum, mean daily minimum). Historical changes in precipitation do not show clear trends of reduction in the entire region (Westphal, et al., 2011), yet future reductions in rainfall are anticipated. The basin demonstrates vulnerability to climate change with projected increase of temperature and decrease of precipitation[17]. These affecting agriculture, sanitation and other water uses with related health impacts. Moreover, climate change will very likely cause decrease of stream flow in the river in the mid-century, especially in late summer and early autumn, resulting in water loss in tributaries of the Alazani/Ganikh (Inashvili, 2013).[17]

Joint action is required to tackle these problems: plans for climate change adaptation at transboundary level (such as rationalizing water use or improving irrigation technologies) require coordination across countries in order to have a real beneficial impact and to avoid negative impact from unilateral action. Similar observation can be made regarding climate change mitigation policies (such as limiting emissions or protecting the forests as carbon sinks) that require large-scale effort.

In terms of emissions, the two countries are not large scale greenhouse gas emitters, are carbon intensive (CO_2 emissions per GDP (see Annex 1)). Their economies rely on highly emitting processes: energy industry and transportation in particular. Azerbaijan is an important fossil fuels producer and exporter and both countries are trade corridors for goods from Asia to Europe (heavy transport).

[Some quantification of local observations or predictions to this section would be helpful additions from the Azerbaijani and Georgian administrations. Some clarification of predictions about flash flooding would also be welcome.]

[redacted][Figure: ZOI (?) Expected impact of climate change]

5.3 RESOURCES AND CONSTRAINTS

Water and energy are necessary to support the expected development in the basin. Land and water ecosystems degradation can threaten the availability and exploitability of these resources. Climate change is projected to impact water, agricultural conditions and ecosystems as well as create increased flood events (with broad impacts).

Table Error! Main Document Only.**: ZOI (table to be translated into visual information (ZOI number 3)) Resources needed, the main uses, the current situation of availability and the future trend**

Resource	Demand	Current situation	Future trend
Water	Irrigation		Extension of irrigated land (planned) – Significant growth (++) Water loss reduction in existing irrigation schemes – Potential to reduce substantially (30% of current use) (-)
	Hydropower	First share in terms of withdrawals (flow requirement to produce electricity)	Small hydro (planned) – Growth (+) Total potential exploited – Significant growth (++) (If future plans include construction of dams – consider losses through evaporation — if significant — and other water uses as well as river flow alteration)
	Municipal use		Increasing living standards and increasing tourism – Growth (+)
	Extraction for consumption out of the basin	Groundwater abstraction for transfer to Baku	Future transfers (+)

Energy	Agriculture		Agriculture intensification (machinery and processes) and agro-industry – Significant growth (++)
	Municipal use and services		Increasing living standard and increasing tourism – Growth (+)
	(Non-agro) Industry	Minor	Stable
	Production for consumption out of the basin		Apart from hydro power (mentioned earlier) potential for bio-fuel production.

Table Error! Main Document Only.**: (ZOI (table to be translated into visual information (ZOI number 1) Resources availability and quality**

Resource	Availability	Quality	Future
Water	Good (There is currently enough water although high losses)	Medium (Depending on the need and on the point of analysis)	Worsening in quality and reduction in availability (Climate change, higher demands, more effluent from agriculture.)

Reforestation efforts – with important ecosystem and productive impacts - focus on large-scale programs. The National Forestry Programme has been developed over 15 years by the Ministry of Environment and Natural Resources, in cooperation with international agencies covering the period

---

Energy	Electricity Good (Reliable) Heating Not good in Georgia (Wood is less and less available and stoves are not efficient) Good in Azerbaijan (Natural gas and kerosene) Transport and industrial processes	Electricity Good (Clean, mainly from hydropower) Heating Not good in Georgia (Wood burning is polluting) Good in Azerbaijan Transport Not good (Mainly inefficient engines: polluting)	Electricity More availability of clean energy and more demand Heating Better if wood is substituted Transport Increasing demand for agricultural processes and transportation
Land for agriculture	Good (Potential agricultural land for expansion)	Not good (Land degradation processes)	Increasing demand for agricultural products
Environmental assets **[An assessment of availability, quality and future outlook needed from the Azeri and Georgian official/stakeholders]**	**?**	?	?

2015-2030. Reforestation will be complemented (and reinforced) by gas provision to households (or other forms of energy) to displace woodfuel (NEC, 2013).

The energy sector will keep on growing to ensure access to energy (such as gas, electricity) to the entire population and to fuel industry, thereby boosting the economy (Energy Charter, 2013). Alternative and renewable sources of energy are going to be promoted and appropriately regulated by the government. The State Agency on Alternative and Renewable Energy Sources (SAARES) has been established in 2009 to develop a national strategy on this for the period 2012-2020 (Energy Charter, 2013).

Aggressive development of small hydro is expected. By 2020 the government expects to build 61 new units (350 MW) (UNIDO, 2013). In general, the expansion of alternative energy sources is an objective stated in the national Action Plan on the improvement of the Ecological Situation (2010-2014). The legal framework to ensure environmental protection is being strengthened (Additional Action Plan on the Improvement of the Ecological Situation for 2011–2014). Further, strengthening resilience to flooding, landslides and other extreme natural events is going is a commitment of the government (through the Ministry of Emergency Situations).

In general, the Action Plan to 2014 includes a large series of broad objectives to improve natural protection, including, among others, inclusion of public and non-governmental organizations in the decision making process on environmental issues, improving awareness and ensuring a multifaceted economy that ensures protection of environment. Sustainable management of land and forest resources use, biodiversity, coastal and marine ecosystems as well as waste are also stated as specific actions in the above mentioned plan.

Commitment to mitigation and adaptation to climate change under the Kyoto Protocol and the UN Framework Convention on Climate Change is included in the National Strategy and Action Plan (EU Azerbaijan Action Plan, 2006).

6. SELECTED TRANSBOUNDARY ISSUES WITH INTERSECTORAL IMPACTS

[**ZOI** visual representation of sectors and their interlinkages (ZOI number 2 to be developed from the initial "loops" from the workshop)]

This chapter describes how different sectors and their chains of activity are physically interlinked. The identification of the sectoral interlinkages in the basin were jointly made during the participatory workshop[18]. During the workshop that included local experts and stakeholders, interlinkages, cross sector impacts and solutions were identified. As the basin is shared, intersectoral impacts discussed below would effectively transboundary cooperative actions.

[18] More information on the workshop at http://www.unece.org/env/water/nexus

6.1 SMALL HYDRO DEVELOPMENT

Both countries plan to expand their hydro power capacity (although at different paces and scales). Of special interest is the expansion, small hydropower[19] in the region surrounding the Alazani/Ganikh. Lending itself to such developments, the tributaries of the Alazani/Ganikh are found in relatively high slopes in an alpine landscape.

Interest in medium, small and micro-hydro technology is due to its: relatively low investment capital; achievable engineering requirements; potential to operate in remote areas (off-grid) - to provide electricity to rural areas; and its limited environmental impact (UNIDO, 2013). The potential for off-grid deployment can help contribute to rural development. As the engineering and manufacturing requirements are well understood, local production, installation and operation are possible.

The development of small hydropower fulfils the bi-national goals of increasing renewable energy sources and reducing greenhouse gas emissions. It also opens potential funding streams through the Clean Development Mechanism (CDM), Nationally Appropriate Mitigation Actions (NAMAs) and would fit within their low carbon growth plans. Incentive programs developed include:

- In Azerbaijan, electricity producers from small hydropower (0.5 to 10 MW) receive subsidies from the state that guarantees the unlimited purchase of the electricity they generate.
- In Georgia, for renewable plants with less than 10 MW of generation capacity (including small hydropower) the program offers long term purchasing agreements, feed-in tariffs and licence-free electricity generation (UNIDO, 2013).

One of opportunity presented by hydropower, when it involves linked reservoir storage, is the use infrastructure for multiple purposes (e.g., for irrigation or drinking water supply, flood control). Integrated uses in the designing phase of a new plant may reveal opportunities to maximize the benefits of such projects. It may also be possible to retrofit existing (or planned) water divisions to include hydro-power production. In such cases, the production of electricity from hydropower as a secondary purpose with no additional impact on the environment might be achieved (as the water used for electricity production is already being used for other purposes).

6.1.1 Possible downstream effects

Small and medium hydro-power plans are likely to dominate new build installations in the tributaries of the Alazani/Ganikh[20].The downstream effects of small and medium[21] hydropower depend on the number, type, design and operation of plants. Although a well-designed small hydropower may have a negligible impact on the environment, a series of small hydropower plants on the same river can have a significant cumulative effect.

With regards to run-of-the-river small hydropower, environmental impact is mainly related to:

---

[19] There is no international definition of small hydropower. In most of the countries in Europe, the term refers to plants with capacities up to some 10 MW.

[20] This assumption derives from consultation with local authorities and see Global Waters (2014).

[21] We note that Stori (11.8 MW) , Stori 2 & 3(13.7MW) and Samquristsqali 2 (22.6MW) are expected to be above the 10MW limit of small hydro.

1. Interruption of river continuity, with consequences on fish migrations up- and down-stream;
2. The alteration of the natural morphology of the river with constructed structures, with consequences on natural flow, sediment regime and consequently riverbed change and to loss of habitats;
3. The land use change due to new infrastructure (plant, transmission lines and other related infrastructure) – especially in remote un-touched areas, this can heavily affect existing habitats.
4. Small hydropower plants operating by diversion may also significantly reduce the remaining flow in the part of the river between the intake and the point where the water is returned. The environmental flow has to be chosen high enough to limit the potential deterioration of the affected ecosystems,

If environmental considerations are well taken into account, the mentioned impacts are however usually locally confined. Potential impacts further upstream of the intake or downstream of the power plant are mainly associated with interruptions of fish migration routes. Considering the importance of fisheries, in the region this should be taken carefully into account: of the 27 species of fish living in the Alazani/Ganikh and its tributaries, 10 have economic importance and are traded inside Georgia (LEGC, 2013).

In small plants, sediments are normally accumulated in a desilter before entering the turbines (mainly to avoid damaging them) and periodically released to empty the desilter and ensure their natural distribution along the river course. This practice should avoid erosion of the river bed downstream.

From a technical point of view, if (predominantly) run-of-the-river plants are to be constructed in the tributaries of the Alazani/Ganikh, most damaging environmental impacts can be avoided. Also, water is not withdrawn permanently but returned to the river after passing through the turbine. The alteration of river continuity, on the other hand, could still represent a source of tension between upstream and downstream users, especially if the number of small plants along the same river becomes considerable.

Environmental flows in rivers to ensure the functioning of riverine ecosystems downstream are not regulated at present. As a consequence the common rule for hydropower operations (in both countries) is to maintain a constant minimum discharge of 10% the average flow (MoENRP, 2013). This is based on the assumption that it is the minimum flow level that allows for survival of river habitats. That assumption is criticized. Determining the minimum flow level of a specific river is a complex task. Ideally it takes into account needs of the ecosystems for water in quantity, quality and time. Effective legislation might require environmental impact assessment and provide clear guidelines[22] and best-practices for building and operations.

[22] Guidelines for sustainable small hydropower development can include: methodologies to select or exclude potential sites for new installations, to monitor and improve existing plants, to selecting best-practice technical solutions for specific plant-types (fish passes, integration of purposes) and so on (ICPDR, 2013). With regards to the Alazani/Ganikh basin and the landscape of its mountains, the consultation of guidelines and best practices from the Alpine countries might provide a variety of useful lessons learned.

6.2 Threats to water quality

An important source of water pollution in the Alazani/Ganikh river basin is domestic sewerage. Industrial wastewater discharges are considerably lower compared to the Soviet period, due the reduced number of enterprises, which typically operate at much lower capacities. **[Which industrial activities are present in the Alazani/Ganikh? Are they mainly related to wine production?]** However, the absence or the obsolescence of wastewater treatment facilities is of concern. Additional sources of pollution include agriculture, urban run-off and leachates from waste disposal sites (Elseud, 2013).

While the Alazani/Ganikh is one of the tributaries of the Kura River and therefore contributes to its pollution, it is not the *only* source: other tributaries of the Kura and the Kura itself are moderately or severely polluted by various human activity.

The Alazani/Ganikh discharges in the Mingechevir reservoir on the Kura and its waters are diluted and re-used (mainly for irrigation and electricity generation) before being discharged into the remainder of the Kura. The pollution load from the Alazani/Ganikh upstream (from Georgia before and then from along the Georgia/Azerbaijan border) is flushed at high velocity after the Mingechevir dam, which helps oxygenation of the water (Elseud, 2013).

6.2.1 Untreated municipal wastewater

Mitigating the impact of the primary polluter - domestic sewerage systems – is a priority for Georgian and Azerbaijani authorities (Elseud, 2013). However, rehabilitating old wastewater treatment facilities and building new ones is hampered by amongst other things, high costs. On the Georgian side, Kakheti region, there are no functioning wastewater treatment plants. Large quantities of wastewater are discharged into the river, untreated. In 2013 the annual amount of municipal wastewater, industrial water and other discharges to rivers reached in total 9.3 million m^3.[23]

[23] Information has been obtained from Local Service Centre of United Water Supply Company of Georgia No comparable data on the Azerbaijani side of the basin.

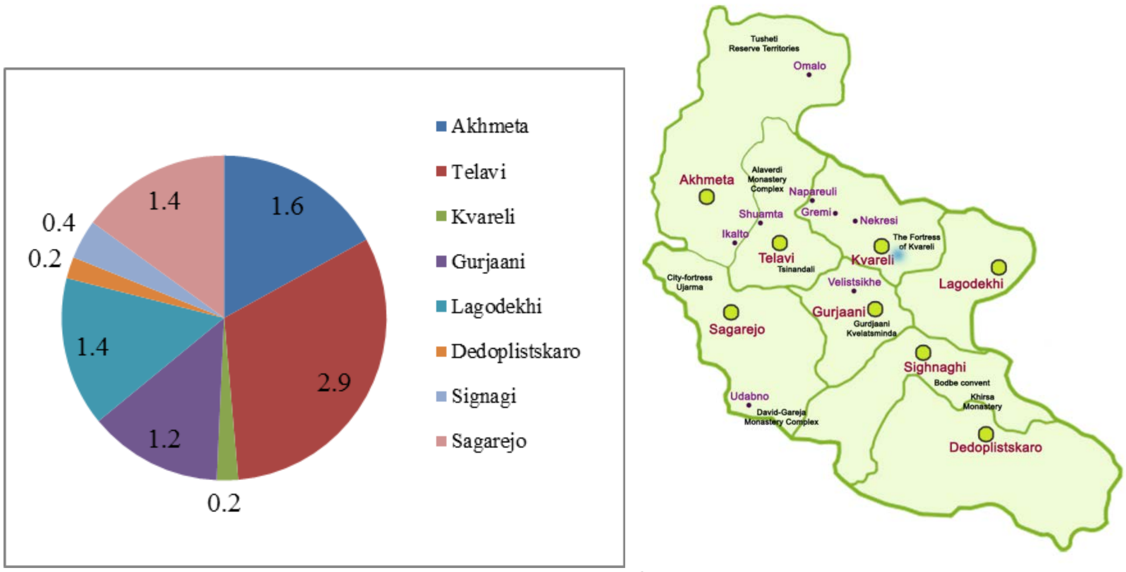


Figure 2: Wastewater per municipality in million m^3 in the Kakheti region, Georgia in 2013 (MoENRP, 2013) [Location of the area in **the basin and in** relation to the river to be shown in further development of the graphics.**]**

6.2.1.1 Possible downstream effects

Discharges of municipal wastewaters increase the amount of nutrients and bacteria in water, and the effects are felt in both countries since the Alazani/Ganikh forms the border.

If the contaminated water of the river is used in villages downstream for drinking and sanitation purpose, the direct effect on the population is the exposure to diseases, especially in the absence of effective pre-treatment.

Further, since nutrients could be beneficially used in agriculture, discharging them into the river wastes a potential resource. In selected instances, wastewater can have positive impact on crop productivity due to its nutrient content and organic matter. However, careful planning and management is required as certain pollutants and may create environmental problems and endanger the health of farmers and product consumers[24] (World Health Organization, 2006). **[Is treated wastewater reused at all in the countries? Would the legislation/regulation allow for that?]**

6.2.2 Agricultural discharges and practices affecting water quality.

Agriculture in the valley of the Alazani/Ganikh is a priority economic sector, both in terms of employment and relevance of the region at national level. About 58% and 76% of the total water withdrawal were directed for agricultural uses in Georgia and Azerbaijan respectively. Further, agricultural land accounts for 47.5% of the total land area in the basin.

---

[24] Note that there are necessarily strict requirements for safe handling of treated wastewater for beneficial uses.

[Question to national experts/authorities or FAO: main crops with some indications about how agriculture is distributed in the basin spatially in general terms – and how it is likely to expand.

Questions to AZ experts: Is there no information on wastewater discharge volumes into the Alazani from AZ? Ideally if something is known about the distribution (by settelment, that would be helpful).]

According to national and local authorities, as the agricultural sector will expand, the modernization of irrigation infrastructure and agricultural practices and support services will continue[25] to be important. At present practice and infrastructure inherited from Soviet times result in excessive water usage for irrigation. The main effects of inefficient use is swamping of large areas and water salinization. (Poor drainage of agricultural fields and the use of certain types of fertilizers contribute to salinization.)

Data on total nitrogen and total phosphorus levels in the Alazani/Ganikh are not available. However there are data on nitrate, nitrite, ammonia, phosphate. As can be seen from the following graph, the concentration of nitrite and nitrate is increasing over the last decade. Ammonium concentrations show a decreasing trend while phosphate levels have grown since 2009.

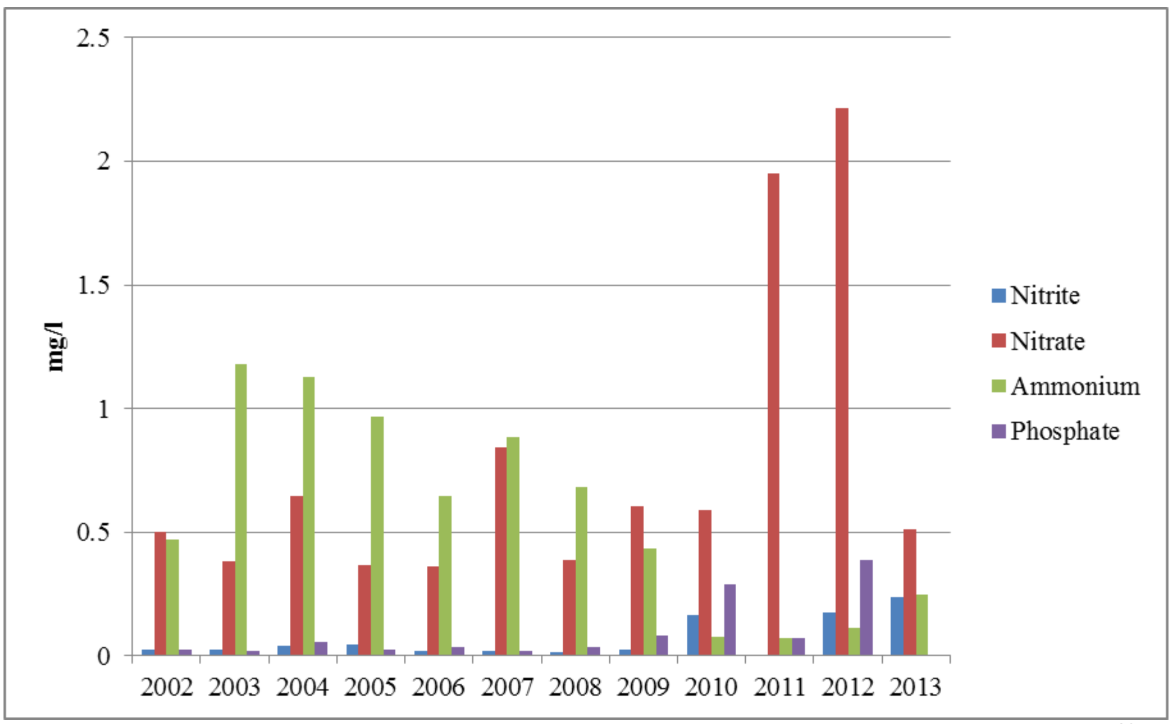


Figure 3: Nitrite, nitrate, ammonium, phosphate for river Alazani/Ganikh – Shaqriani checkpoint[26] (MoENRP, 2013)

Possible downstream effects

[25] Efforts underway are significant. For example in Azerbaijan: Since inception in 2011, more than 400 agricultural machines have been leased to private farms and companies. In addition, cultivation support is provided through subsidised services from state owned Agro Service Centres (http://www.fao.org/docrep/field/009/aq671e/aq671e.pdf ***)

[26] The Shaqriani checkpoint is located 280km from the mouth. The maximum width is 50-60m and maximum depth is 295cm.

In general terms, agricultural discharges contribute to the organic overload of nutrients in the water, leading to algae growth, deoxygenation and fish kills. Agricultural discharges affect other water uses downstream, including water supply and recreational use. The degraded water quality adds to the treatment need before use.

Further, agricultural salinization (caused by over-irrigation and poor drainage) can affect ground water to the extent that it may hamper plant growth and yield. Salinization together with overgrazing and deforestation can affect plant cover and significantly contribute to erosion, desertification in the basin.

6.2.3 Other diffuse sources of pollution.

Contaminated land from illegal and scattered open-air landfills contributes to water pollution by infiltration to groundwater or contact with river flows from the banks. Old sites for the storage of pesticides have caused in the past significant toxic contamination by leaching through the soil, but nowadays they represent a minor problem (Elseud, 2013).

The lack of detailed data about this type of diffuse pollution makes it difficult to determine its actual impact. On the other hand, the very existence of such polluting and uncontrolled hotspots represents a water quality risk that should be investigated.

[Question to local experts: Is floating trash flushed into the stream from the banks and landfills a problem? If present, it might block irrigation channels and maybe affect machinery and other installations.]

6.3 Forest cutting – alteration of hydrological flow downstream

Deforestation is a problem in the Alazani/Ganikh Basin. The main cause is the cutting of trees for wood provision. The situation is particularly pronounced in the upper Alazani in Georgia, where deforestation is predicted to affect erosion. This effect will be exacerbated if climate change is to cause more frequent and intense flooding and subsequent landslides (CENN, 2013).

Deforestation leads to decreased water retention capacity of land. The forest is an important buffer for heavy rain episodes. Without forest buffers, heavy rain leads to a quick increase in the flow of the river. Further, the absence of the buffer alters the hydrological flow of the river - increasing the speed of the propagation of flood peaks in particular.

6.3.1.1 Possible downstream effects

Erosion is a direct result of (amongst other things) deforestation, as soil particles are less easily retained in in the absence of roots. With fast enough flows, particles are captured by runoff and transported to the river. Landslides are an effect of this erosion and so too is downstream water quality - as sediments and mud are transported by the river. Sediment and mud negatively affect the performance and useable life of infrastructure, notably for irrigation and hydropower generation. Further, mudflows can physically damage build structures and wash away crops and topsoil. Finally, as a consequence of hydrological alteration, the riverine habitat would be affected with adverse consequences on fish species and river ecosystems (CENN, 2013).

Georgian and Azerbaijani authorities both have management plans developed regarding restoration of riparian forest within the Alazani/Ganikh River Basin (CBD, 2010) and further efforts are being explored. For instance, a detailed list of reforestation plans, other climate change mitigation and adaptation activities at municipality and basin scales in Georgia are proposed in the 'Integrated Natural Resources Management in Watersheds of Georgia Program' (CENN, 2013), This is a project that provides technical support to the government of Georgia for water and environment related issues.

6.4 Increasing water demand

Agricultural expansion will require more water and continued modernisation of the system. At present drought years are common (FAO, 2014), irrigation is inefficient (Global Waters, 2014) and lack of irrigation limits increased agricultural production[27]. In Kakheti, Georgia irrigation is mainly gravity flow irrigation, pumping irrigation (requiring energy) is currently out of operation but there are reconstruction plans. **[Is there information available about what are the main irrigation techniques used in the Azerbaijani part of the basin?]**

Future water demand will depend on, amongst others: the expansion of irrigated land, the type of crops cultivated, the efficiency and type of irrigation systems, but also the living standards in households, the expansion of industry and agro-industry, the water losses in the pipes.

Water is consumed for agriculture and household consumption and (even though untreated) returned to the river in the form of effluents. Currently, water losses in agriculture significantly contribute to water consumption. According to Georgian experts 35 to 40% of the water withdrawn from the river is lost. (LEGC, 2013). Water requirements in agriculture may increase significantly. This is particularly the case if water management is not more efficient. In 2011 (UNECE, 2011), Georgian authorities predict an increase in water demand from the Alazani up to 10% by 2015.

6.4.1 Downstream effects

Increased upstream water withdrawals might cause lower availability downstream. Depending on the quantity of future withdrawals, this trade-off can create more or less pressure on water resources. Downstream uses that might be affected are irrigation and energy production taking place in the Mingechevir reservoir[28] and power plants. (Both hydropower – for generation - and thermal power generation – for cooling - need water).

6.5 Groundwater use increase and groundwater pollution

Groundwater is also a contributor of irrigation water (UNECE, 2014), though its use for this purpose is limited (LECG, 2013). From the Alazan-Agrichay aquifer underlying the Alazani/Ganikh Basin, Azerbaijan mainly uses groundwater for irrigation (80-85%), and to a lesser degree for drinking water supply (10-15%) or for industry (3-5%) (UNECE 2011).

[27] The Rural Investment Climate Assessment (World Bank, 2012 ***), a survey of 3,000 rural households, found that 49 percent of households, considered the lack of irrigation or drainage as a severe or major constraint to rural investment.

[28] Alazani/Ganikh river annual discharge into Mingechevir reaches 2,5 km^3, while the full volume of Mingechevir reaches 15,73 km^3.

The Alazan-Agrichay aquifer is the largest groundwater resource in South Caucasus. Groundwater resources in the Georgian part of the Alazan-Agrichay valley have been estimated at 26 m^3/s and in the Azerbaijan part more than 70 m^3/s (UNPD-GEF, 2007). The renewable groundwater resources in the Georgian part of the Alazani/Ganikh basin are estimated at 1.24 km^3. **[There are different groundwater resource estimates, which may reflect referring to different areas. The aquifer boundaries and the river basin boundaries apparently do not match.]** Geologically the formation consists of merged alluvial cones of the rivers flowing from the mountainous zone of the Greater Caucasus. (UNECE 2011) There is an upper, unconfined aquifer and a lower artesian aquifer. In very general terms, the Alazan-Agrichay aquifer recharges in Georgia and groundwater flows towards south-east to Azerbaijan. Being under pressure, in Azerbaijan it is easy to extract groundwater through artesian wells. Apart from particular points of the aquifer, water is overall of good quality and it is widely used for drinking water purposes.

The coarse sorted sediments create favourable conditions to groundwater recharge especially in the mountainous part and river provides an important source for recharge. The irrigation has increased recharge from surface water. (UNPD-GEF, 2007) As the groundwater is naturally connected to surface water, pollution and salinization in surface water can significantly affect ground water quality. Similarly, increases in surface water use might affect ground water recharge. Given the large amount of groundwater reserves, this does not seem to be a concern at present – while the effects of climate change are limited (UNPD-GEF, 2007). However, the pressure on groundwater resources does not come only from wells for local consumption (e.g. Televi and Gurjaani in Georgia are supplied from groundwater), but also recently, for large transfers to Baku through the Oguz-Gebala-Baku line (withdrawal flow of 5 m^3/sec).

[Is there at least a schematic diagram available about the structure of the main aquifer(s) in the Alazani Basin?]

6.5.1 Downstream effect

In this case it would be difficult to define “down gradient” effects because groundwater contamination and increased use would impact other users according to the structure, flow conditions and other determining features of the aquifer.

7 POSSIBLE INTER-SECTOR TRANSBOUNDARY SOLUTIONS

[ZOI input: maybe possible to develop a Nexus diagram: now and in the future?]

The following are some examples of actions in one sector that would positively impact other sectors. They originate from the dialogue with and suggestions from stakeholders during the assessment workshop. They do not represent a comprehensive list but rather a series of examples of synergic actions. The purpose is to provide initial indications as to why sector, inter-sector, trans-boundary actions are needed.

For example, one action in the energy sector – often view only within the confines of the energy sector can impact: health (7.3), forests and local impacts - flood control, sedimentation and ecosystem preservation (7.4); And forests and global impacts - carbon dioxide mitigation (7.5). The combined co-benefits that might revealed by adopting a systematic nexus approach significantly increases the benefit to cost ratio of such actions. Further, the action's efficacy would be improved by trans-boundary cooperation and experience sharing.

Note that only insights are discussed in this assessment – in order to motivate why a full multi-sector trans-boundary nexus engagement is needed.

7.1 Investing in water use rationalization and pollution reduction and treatment would significantly help economic development

7.1.1 Energy and water - use and costs

Although water availability is not a pressing issue at present, climate change and future demands could change the situation. A recent study predicted a 9-13% decrease in stream flow between 2035 and 2065 (Inashvili, 2013). At the same time water demands are expected to grow with socio-economic development and agricultural expansion.

The impact of inefficient water use and pollution on the overall economy could be significant in the long term. If more water is used, more water needs to be treated. When water is polluted, activities and uses become limited or further treatment is required. All water treatment requires energy. If there is a shift to cleaner resources (e.g. groundwater resources) more energy is required to pump water. Indirectly, more energy is needed for example to increase fertility in degraded soils, through fertilizers.

While not evaluated here, evidence is mounting that increased water efficiency can lead to large concurrent savings in energy bills (Howells and Rogner, 2014). At the same time, reducing withdrawals would help ensure that enough water remains available in acceptable quality not only for other uses, but for ecosystems preservation and support.

Water losses can be reduced, not only in the distribution network but also in the final use. (For instance, in agriculture low-water-intensity crops might be prioritized over thirsty crops.) Drinking water users (from households to industry and service buildings) could be provided with metering equipment, or low flow appliances. Wherever possible, reuse and recycling of water could be promoted.

The high costs of improving existing infrastructure or building new schemes, systems and practice represents a significant obstacle to their implementation. Part of the problem is that investing in water supply for example, is not a remunerative business: the investment required is not simply paid back by the users, as water has either a very low or no price at all (for example, farmers and electricity producers in Georgia and Azerbaijan benefit of subsidies for the provision of water practically for free (UNECE, 2011), (UNECE, 2010)). Given that water is subsidised, that encourages wasteful use, but also wasteful energy intensive implications. On the other hand, water cannot become an expensive good, as it is needed for practically all human activities and needs[29].

Similar observations are made with respect to water pollution and the high costs of infrastructure and regulation of wastewater discharges (the "polluter pays" principle is practically not applied (UNECE, 2010). The direct and (indirect in the form of energy) costs might not be paid immediately. Eventually

[29] The problem of water pricing is actually a global problem that different countries are facing in different ways, as well as the ownership of water infrastructure from private or public entities.

they will be paid by the economy in terms of poor water quality, lower land and water productivity and higher energy costs.

Integrated solutions[30] that combine needed infrastructure with potentially cost reflective rewards could attract private investments and stimulate efficiency. In order to quantify the potential benefits concurrent, preferably trans-boundary, integrated water, integrated energy (required for treatment), agricultural (irrigation efficiency and cropping), town and economic planning should take place. As the analysis would examine concurrent development in each of these spheres, a strong Nexus approach is required.

7.1.2 Land and ecosystems – economic potential

The economy of a region is heavily influenced by its resources. Agriculture (and agro-industries) is probably the sector in the Alazani/Ganikh valley with the biggest potential to expand - and is expected to do so. Agricultural outputs depend strongly on water, soil availability and quality. Without improvement in agricultural practices, land degradation of current fields will reduce output and productivity and needlessly increase the area of crop land resulting in further deforestation and loss of land of other purposes.

Not only are new investments needed for more water-efficient irrigation, but also good information on best practices, looking into replicating and up-scaling practice proven locally or under comparable conditions. It would be beneficial to develop local and appropriate programs for farmers' education, training and extension services – that are informed by integrated cross sector knowledge.

Tourism is another sector highlighted for expansion across the basin. The particular landscape, biodiversity, mountains, rivers and local products attract nature-seeking tourists. Tourism facilities are already being built and it is anticipated that the trend could continue. An important requirement for tourism in rural areas in contact with nature is a clean, healthy environment.

As the first country to be assessed by the Economics of Ecosystems and Biodiversity (TEEB)[31], Georgia is leading an important global challenge: to assess economic value to ecosystems and their services. Effective insights that help evaluate and internalize ecosystem services into the economy would be useful to help shape resource allocation – and exploit ecosystems for economic growth. Experience sharing may help the region improve clarity in the accounting of natural resources assets and monitoring. Once available, ecosystem evaluation needs to inform (and be informed by) concurrent trans-boundary agricultural, economic, hydro-power, energy planning efforts.

7.2 Hydropower development and Greenhouse gas (GHG) Mitigation and Funding

The Alazani/Ganikh River and some of its tributaries have significant hydro-electric potential. Its existing power plants are listed in Annex 2. At present, the total capacity of hydropower plants reaches

[30] At small scale there are many options for projects on bioenergy (e.g. biogas) for example. Such initiatives are already taking place in rural areas in both Georgia and Azerbaijan and the knowledge regarding particular technologies with potential for replications could be easily shared.

[31] TEEB is a global initiative focused on drawing attention to the economic benefits of biodiversity including the growing cost of biodiversity loss and ecosystem degradation. It presents an approach that can help decision-makers recognize, demonstrate and capture the values of ecosystem services and biodiversity.

38.4MW[32] - roughly a third of the basin's planned potential and 12% of its total potential. However, with each new facility added, GHG emissions are displaced, as alternative sources rely on carbon intensive fossil fuel.

For example, three small hydropower plants were built in the Georgian side of the basin. Khadori was constructed in 2012, Shilda in 2013 and Alazani II is expected to be in operation before the end of 2014. The total installed capacity of the recently constructed plants reaches 16.7MW. Consequently about 51 thousand tonnes CO_2e can be saved annually[33] due to the expansion of hydropower compared to an alternative gas-based system.

Similarly, In the Azerbaijani part of the basin, there are several hydropower plans that are either under construction or under development. Electricity is being provided mainly from the Mingechevir reservoir (UNIDO, 2013), (Matthews & Leummens, 2013).

The total capacity of currently planned hydropower accounts for 117MW, which could potentially decrease the GHG emissions by 263 thousand tonnes CO_2e annually. The total capacity reaches 754 MW (Platts, 2013) which could potentially generate approximately 4000 GWh. If all hydropower potential were technically exploited, about 1.9 million tonnes CO_2e would be avoided. The situation just described is synthetized in Figures 6 and 7.

If a 10 US$ CO_2 subsidy through international mitigation facilities, such as the Clean Development Mechanism or Nationally Appropriate Mitigation Action (NAMA) facilities, significant additional revenues might be gained by hydro expansion. These would reach in the region of 5.7 million US$ if all planned hydropower plants would be operational and 24.3 million US$ if all the potential were technically exploited.

However, if more hydropower is to be developed, strong trans-boundary cooperation, integrated cross-cross sector (water, energy, tourism, agriculture) and environmental interaction and trade-offs would be required. This would necessarily include harmonising development, water infrastructure and flow, energy, GHG mitigation and financial planning in the region – and a detailed Nexus approach.

---

[32] The sources used to identify the existing/planned hydropower plants in the Alazani/Ganikh River basin are (Ministry of Energy of Georgia, 2014), (UNIDO, 2013), (Lazriev & Arabidze, 2008), (ESCO, 2014)

[33] The Lifecycle GHG emission factor for electricity generated by Natural Gas combustion is about 499tCO2e/GWh, while the corresponding factor for hydro based generated electricity is about 26 tCO2/GWh according to the World Nuclear Association report.

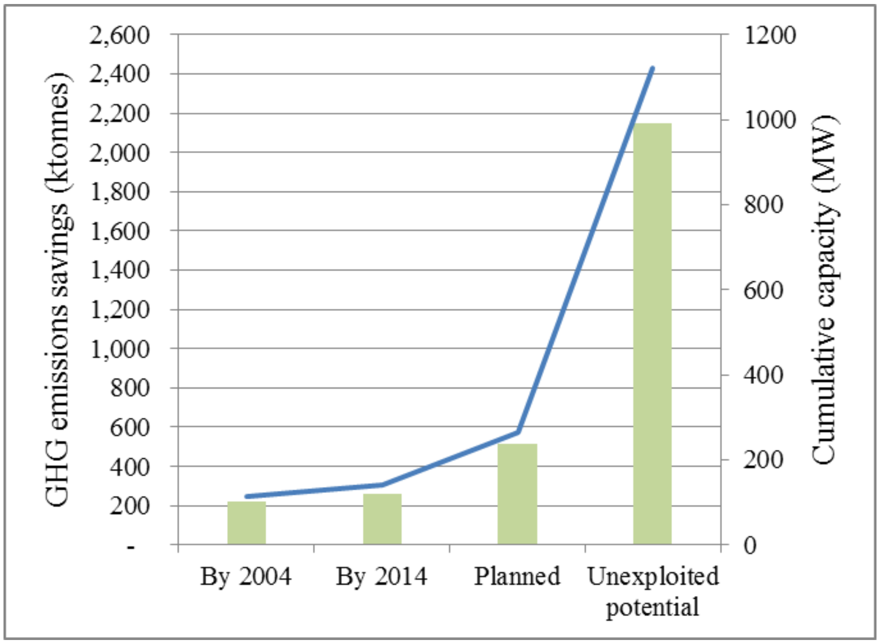


Figure 4: GHG emissions savings with hydropower development

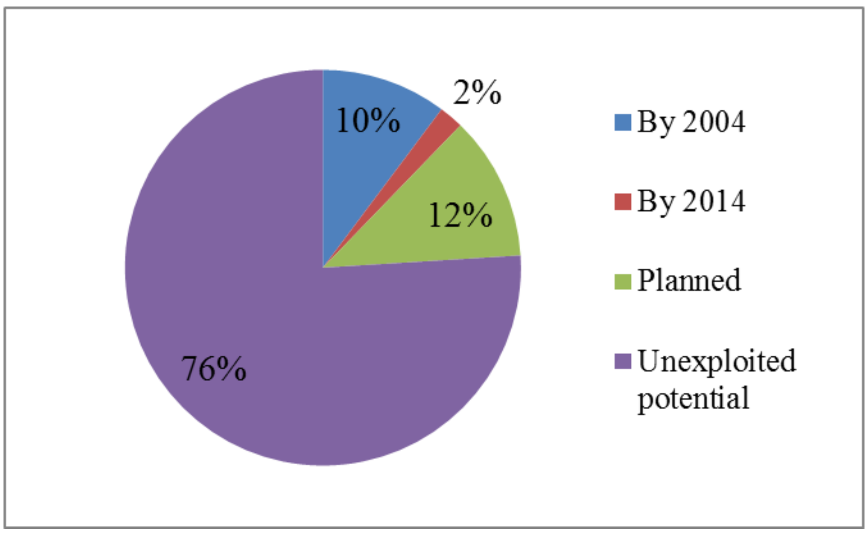


Figure 5: Existing and planned installed hydropower capacity as a share of total potential in the Alazani/Ganikh and tributaries

7.3 AIR QUALITY IMPROVEMENT: WOOD AND FOSSIL FUEL SUBSTITUTION

As with the previous, the next illustrative assessment indicates the need for a nexus approach. That would call for concurrent integrated planning from several sectors that go beyond standard single sector focused 'integrated' planning efforts. We examine a household level 'energy sector' intervention through the lens of health, reforestation and greenhouse gas mitigation.

The burning of firewood emits soot and other air pollutants causing health problems to the population. (Regional pollution – with much lower impact - is also generated by thermal power plants affecting air quality). Wood is harvested in the basin region for heating and cooking purposes. The stoves used are mainly conventional traditional types, resulting in high concentrations of particulate matter and smoke. To illustrate the quantity, in 2012 the firewood burnt in Georgian side of the basin reached 92 thousand m^3, i.e. about 893 tons emitted $PM_{2.5}$[34]. $PM_{2.5}$ smoke is a major cause of respiratory disease – resulting in health impacts, costs and lower productivity.

A deliberate push is being made to displace fuel wood consumption, at the same time due to deforestation woodfuel harvesting is becoming more time consuming. Alternative fuels, such as natural gas and electricity being distributed and utilized (PM emissions are typically low from such fuels.). Particulate matter from natural gas combustion has been estimated to be less to be 4.1 tons in the Georgian side of the region. Table 1 indicates the recent decreases in fuelwood consumption.

Table 1. Share of fuels in the Alazani/Ganikh river basin (Kakheti region) (LEGC, 2013)

Fuel/Year	2009	2010	2011	2012
Firewood	62.7%	57.2%	59.7%	50.4%
Natural Gas	18.5%	21.0%	21.4%	28.0%
Electricity	18.7%	21.8%	18.9%	21.7%

At household level, increasing the rate of substitution of fuel wood is an imperative. Anticipated health savings might well outweigh the cost of increasing the supply of alternatives. (Indicative analyses in other setting have made similar observations (Howells et al 2010)).

Thus integrating health and energy assessments to quantify cross sector benefits would be valuable to help understand how best to allocate health related expenditure.

7.4 Reforestation due to fuelwood substitution

Energy policies to reduce the use of biomass in households normally aim to improve indoor air quality. However, fuelwood harvesting can cause deforestation. Slower (or halted) wood chopping for fuel would help drive forest preservation and reforestation plans.

The experience of wood substitution with gas and other fuels has already shown positive results in Azerbaijan - in particular for forest preservation. National authorities state that illegal logging for fuelwood drastically decreased after the expansion of the gas network to rural areas. In remote areas in the mountains, the fuels promoted were kerosene or other fuels suitable for heating and cooking (Huseinov, 2013).

Unlike Azerbaijan, Georgia has limited natural gas resources. However, there is potential to improve already existing trade from Azerbaijan. (Currently over 80% of Georgia's gas is imported from Azerbaijan.) Similarly, alternative fuels as kerosene, liquid petroleum gas (LPG) and electricity might be promoted.

---

[34]Particulate matter emission for conventional woodstoves is 13.88 kg/ton, while PM emission for Natural gas combustion is121.6kg/106m3 (EPA, 2009)

Improved forestation would result in savings or reductions in locally important services including:

- Flood control
- Sedimentation
- And other local ecosystem preservation

Some of these impacts call for special trans-boundary cooperation. Upstream fuel switching (and therefore reforestation) will impact downstream flooding and sedimentation. Valuing these trade-offs for coordinated action will necessarily involve quantifying the relationships between location and cross sector impacts between the energy sector, forestry and flood plus sediment control. Again, this underlines the need for a well-structured trans-boundary nexus approach.

7.5 Climate change mitigation: reforestation and off-setting

While we consider local ecosystem services in the previous section and health benefits before that, yet another cross sector impact of fuel switching is restoring or preserving a carbon sink. This can be important from an international climate point of view. Climate negotiations, commitments and financing are international processes in which both Georgia and Azerbaijan are involved.

Based on data provided by national experts, about 24,861 ha of forest loss is experienced in the Georgian side of the basin since 2003, i.e. 8.1%[35] of the forest area is decreased mainly due to forest logging and 12.4 thousand tons of CO_2-e are not being captured[36]. Furthermore, 54.6 thousand tons of CO_2-e are being emitted due to firewood burning.[37] So in total 67 thousand tons of CO_2-e are emitted in the atmosphere. The corresponding figure in Azerbaijani side is 2,254 ha or 1.5%[38] forest loss, mainly due to floods. [39]

On the other hand, between 2003 and 2013 reforestation and afforestation measures were carried out in the basin region. In the Georgian side of the basin, a forest gain of 10,153 ha is experienced since 2003, which results in a carbon sequestration increase of about 5 thousand tons per annum. In the Azerbaijani side the corresponding figure reaches 21,611 ha, which results in a carbon sequestration increase of about 10.8 thousand tons per annum.

In accordance to the Azerbaijani Forestry Department's internal projections, by 2020 every year about 1,520 ha of forest area would be planted in the basin region; hence an additional amount of 760 tons of carbon capture would be achieved on an annual basis.[40]

---

[35] Percentage of the forest covered area in Kakheti

[36] The average CO2 capture is 5 tonnes/year/hectare (SICIREC, 2009)

[37] The CO2-equivalent emissions are 0.848 ton CO2-e/ton firewood (Polglase, Paul, & Meyer, 2012)

[38] Percentage of the forest covered area in Azerbaijani side of the basin

[39] There are no data regarding firewood consumption in the Azerbaijani side of the basin.

[40] There are no comparable data for the Georgian side of the basin

Assuming modest carbon prices, annual flows of carbon finance through CDM or NAMAs may exceed hundreds of USD per year. This financing might be used to directly subsidize fuels that displace the use of wood.

8 Conclusions and recommendations

The nexus report provides an overview of the resource management situation in the Alazani/Ganikh Basin, pointing at the linkages between the land, water and energy resources as well as ecosystem services. The information presented suggests how the plans may overlap, support one another or come into competition for resources. The study shows the importance of coordination across sectors and cooperation across borders when managing shared resources to take advantage of synergies. A nexus approach[41] can help to support more sustainable economic growth and to enhance food, energy, water and environmental security.

The approach has the potential to serve as a tool for intersectoral planning and coordination and to strengthen public-private partnerships. This assessment focuses on a selected set of nexus issues and indicative solutions that show the potential utility of a more integrated and detailed study or of integrated actions. Potential actions that may be streamlined into future activities are suggested in the 'way forward' below.

Information exchange between sectors will be beneficial to future planning. Development of transboundary cooperation would allow both countries to better benefit from the different — and complementary — resource bases and coherent actions.

8.1 Recommendations

Sustainable hydropower development. Both countries are developing their hydropower potential (although a different degree). In particular, small hydropower in the tributaries of the Alazani/Ganikh are being targeted. Small hydropower can contribute to rural development, energy security and reduce greenhouse gas emissions. However, not only large plants but also small run-off hydropower plants may have adverse impact on the environment[42] and in turn affect other sectors. Thus *good practices and guidelines* (Athanas & McCormick, 2013) *should be followed when planning the location and technical features* of such plants. Further, impacts on agriculture and aquaculture identified in this assessment should be considered.

Modern fuel supplies. This preliminary nexus analysis reveals that switching household fuels has several significant intersectoral benefits. These include:

- Improved human wellbeing as fuel-wood use (which is common in Georgia) results in high indoor air pollution levels. This damages health and reduces productivity. Further, as fuel-wood collection is a time intensive process, collecting it reduces available time

[41] An extension of integrated resource planning that explicitly and simultaneously considers the development and interaction of several resources (not only water).

[42] Adverse effect of small scale hydropower plants on the environment is mainly related to the alteration of habitat, especially for the fish living in the river. Concerns about the cumulative effects of several small hydro power plants along a river have been also highlighted during the workshop for the Alazani.

for other productive purposes. Net effects are a less productive workforce and higher health bills.

- Reforestation and greenhouse gas (GHG) mitigation. *Substituting wood-fuel by gas and other fuels* has demonstrated positive results in Azerbaijan. In particular this has led to forest preservation. As large quantities of carbon dioxide are captured in forests as they grow, they are a valuable carbon sink. Growing forests reduces the growth in national GHG balances.
- Flood control. *Reforestation in turn provides important regulatory and other ecosystem services*, including flood control, reduction of landslides in the higher reaches and improvement of water quality. *Both countries and related sectors would benefit from afforestation* in Georgia.
- Hydropower and agriculture. Deforestation causes ecosystem degradation and increases sediment load due to intensified erosion. That in turn affects the performance and lifetime of hydropower and irrigation equipment. That is likely to alter hydrological flows with impacts potentially extending to sedimentation of the Mingechevir Reservoir into which the Alazani/Ganikh discharges.

The success of Azerbaijan's gas provision and uptake relies on heavy subsidies and draws from internal resources of natural gas to stimulate significant gas infrastructure development. In mountainous areas where gas infrastructure is not technically or economically viable, other alternative fuels to wood (kerosene in particular) are being made accessible to the local population. There may be the potential to *share experience or extend the gasification (or other fuel provision at accessible prices)* of households through cross-border trade and through the extension of infrastructure for this purpose.

Flood management. Apart from the role of re-forestation, better planning of flood management in the basin is needed. Recent floods have had significant effects on agriculture and other sectors, such as hydropower generation. In the future, if hydropower will be constructed on the tributaries of the river, floods will also mean losses in energy production. Current efforts show that both countries are making significant efforts in this direction. Since the Alazani/Ganikh is a border river, measures require coordination across the border to be effective. By covering also emergency situations (including flooding), the *draft bilateral agreement under negotiation* on Cooperation in the Field of Protection and Sustainable Use of the Water Resources of the Kura River Basin, if it *would support flood management planning and local interventions on infrastructure*, might improve the efficacy of coordinate efforts and investments in infrastructure.

Agricultural and agro-industry development. For both countries the agricultural sector has demonstrable potential for growth. This has several strong benefits, including:

- Poverty reduction and income generation. The region is currently under-developed with high unemployment and low levels of income.
- *Switching fuels from bio-fuel to modern fuel supplies*. As described above, a switch to modern fuel sources has multiple benefits. The switch is a function of having access to a desirable energy form as well as being able to afford it. At present, limited household incomes curb the uptake of cleaner fuels even where infrastructure (access) may exist. Agro industries are labour intensive. Therefore, as employment opportunities increase in the agricultural sector, so too does the affordability of new fuels and their uptake. A

reduction in the reliance on fuelwood is likely to result. That in turn has energy, agricultural and flood-control benefits.

Measures are in place to help accelerate the development of agriculture and agro industries. There is evidence that agriculture is spreading.

Agriculture and agro-industry practice. While agriculture holds great promise, due to its multiple nexus nodes and links with other sectors, adopting appropriate practices is essential. These include:

- *More water-efficient irrigation and processing*. As *reducing water requirements also reduces the energy required to move it around*, a reduction in water translates to a reduction in energy consumption. Studies show that water saving can have significant energy-saving effects (Bartos & Chester, 2014). That in turn – where fossil fuel is used for power generation – reduces GHG emissions.
- *Wastewater treatment and fertilizer control*. Leakage of nutrients and untreated wastewater has several important cross-sector effects. Apart from affecting the health of the basin, such pollution affects aquaculture and has implications for drinking water.
- Deforestation. In many cases extensive and expanding agriculture can result in deforestation. That should be avoided for the multiple reasons mentioned above. This nexus calls for care when trade-offs are made between intensification (which may require high fertilizer loadings), zoning and profit maximization.

With this in mind, it is essential that *policy incentives, economic instruments and other supportive measures are well addressed to support not just development of good practices, but also consider wider nexus impacts*. Thus, incentives should be such that agriculture and related industry are promoted, as well as water and energy efficiency, the limiting of deforestation, the reduction of fertilizer loading, appropriate crop selection, etc.

Drinking water resources. Water will be extracted from groundwater aquifers in the region to satisfy urban demand beyond the basin, notably to supply Baku. *The situation should be constantly monitored* to ensure that the abstraction does not have negative impacts (groundwater depletion) in the long-term.

Water quality. Collaboration between countries to ensure water quality is of primary importance since water resources are directly used by both, in particular by the rural population. Untreated or insufficiently treated wastewaters (and potentially irrigation-return waters, discussed earlier) are the main cause of pollution in the Alazani/Ganikh. Therefore, this collaboration should focus primarily on addressing the scale and type of treatment needed as well as other interventions to *limit low-quality water discharges* (reuse, water efficiency measures). Information and knowledge sharing across countries, as well as appropriate regulatory incentives, can play a primary role to speed up this process. That has several cross-sectoral implications, including on health, aquaculture, tourism, energy use and GHG emissions.

Tourism. The Alazani/Ganikh has potential for tourism (wine and rafting are two examples of tourist attractions), which could significantly benefit the local economy. Such opportunities would be held back without healthy ecosystems, clean water and forests.

The environment is an asset. As the first country to be assessed by The Economics of Ecosystems and Biodiversity (TEEB) initiative, Georgia is leading an important global challenge: to assess the economic value of ecosystems and their services. Such information could eventually provide a basis for schemes that systematically include ecosystem services in decision making. Such *economic ecosystem evaluation could be extended to Azerbaijan* to help develop coherent inputs to planning across those sectors that depend on environmental assets.

Harmonised incentives. Finally, incentives shape the allocation of resources across sectors. *A detailed map of such incentives* should be elaborated and the effects of uncoordinated incentives should be examined. Examples of such effects may include sub-optimally directed subsidies, historical and future water allocation rights and undervalued ecosystem services.

8.2 The Way Forward

The fact that Azerbaijan is reforming its water management policies provides an opportunity through the National Water Strategy to ensure the compatibility of water and water-related policy objectives. The Strategy can improve consistency across policy instruments.

The new Water Law in Georgia that is about to be reviewed by the Parliament will introduce integrated water resources management (IWRM) and a basin approach. The draft law also specifies the coordination of the activities of government bodies in the area of protection and use of waters among the competencies of the water authorities. The work on the legal basis will continue with the development of the by-laws. The anticipated signing of the EU Association Agreement for Georgia as well as Azerbaijan's work in that direction is expected to increase the influence and consideration of EU instruments such as the Water Framework Directive.

Both processes can strengthen outreach to different water-using sectors and intersectoral coordination. The preparation of national IWRM plans in Azerbaijan and Georgia, with the support of the UNDP-GEF Kura project and the EUWI National Policy Dialogues in both countries, and with UNECE and OECD as strategic partners, provides further support in the same direction.

A new Energy Strategy for Georgia is being developed with support from USAID. Such sectoral strategic planning has potential gains from a broad consideration of the implications on the other sectors (and involving the relevant stakeholders) and on ecosystems. Azerbaijan's development plan for the regions will also be critical.

At the transboundary level, the bilateral agreement under negotiation, which cover also the Alazani/Ganikh, has as its basis the "optimal and sustainable use of water resources" as well as "integrated basin management". The draft agreement is foreseen to cover different water uses as well as the protection of water resources, the restoration of ecosystems and the management of the effects of hydrological extremes. With this breadth of issues and the multi-sector representation of authorities envisaged for the planned joint commission, the draft agreement could provide a framework for addressing some of the opportunities benefitting from transboundary cooperation and harmonizing the approaches. Other initiatives such as irrigation/land reclamation projects in the two countries as well as the WWF project on Sustainable Hydropower in the South Caucasus may represent further opportunities.

Both countries are signatories to the Kyoto Protocol and eligible for, amongst others, Clean Development Mechanism (CDM) and Nationally Appropriate Mitigation Action (NAMA) funding streams. Small hydropower development and reforestation programmes would be eligible for carbon finance and supplementary revenue streams. Formal processes might be initiated to investigate this potential.

The UNDP-GEF Kura Project is now finalizing its current phase, and future efforts will focus on the implementation of the Strategic Action Plan (SAP) for the Kura River that will support the improved water resources management in both Azerbaijan and Georgia. It is envisioned that in future phases of the project, in line with GEF 6 strategic objectives, will highlight capacity building for development of integrated management systems in support of the nexus to improve water/food/energy/environment security. The SAP and the next phase of the project will be designed to support the implementation of the bilateral agreement through intersectoral efforts and realization of positive sum benefits for all sectors whenever possible.

References

Alpine Convention, 2011. *Situation Report on Hydropower Generation in the Alpine region focusing on small hydropower.* [Online]
Available at: www.alpconv.org
[Accessed 10 April 2014].

Athanas, A. K. & McCormick, N., 2013. Clean energy that safeguards ecosystems and livelihoods: Integrated assessments to unleash full sustainable potential for renewable energy. *Renewable Energy,* Volume 29, pp. 25-28.

AWC, 2002. *Integrated River Basin Planning Alazani Watershed Technical Report,* s.l.: s.n.

Azerbaijan.com, 2011 (Add this reference in chapter 5). *Development of agriculture and food security.* [Online]
Available at: http://azerbaijans.com/content_1771_en.html
[Accessed 19 June 2014].

AzerEnergji, 2013. *AzerEnergji.* [Online]
Available at:
http://www.azerenerji.gov.az/index.php?option=com_content&view=article&id=91&Itemid=112&lang=en
[Accessed 21 May 2014].

Bartos, M. D. & Chester, M. V., 2014. The Conservation Nexus: Valuing Interdependent Water and Energy Savings in Arizona. *Environmental Science and Technology,* Volume 48, pp. 2139-2149.

Bontemps, S. et al., 2009. *GLOBCOVER ,* Louvain: UCLouvain and ESA Team.

CBD, 2010. *Country Study on Biodiversity of Azerbaijan Republic, 4th national report to Convention of Biological Diversity.* s.l., s.n.

CENN, ADA AND OBf, 2013. *Caucasus Environmental NGO Network.* [Online]
Available at: http://w3.cenn.org/wssl/
[Accessed 22 May 2014].

CENN, 2013. *Integrated natural resources Management in Waterheds of Georgia Program: Assessment of the Vulnerability to Natural Disasters and Climate Change for Upper Alazani Pilot Watershed Area&Plan of Mitigation and Adaptation Measures,* s.l.: s.n.

Edwin D. Ongley, 1996. *Control of Water Pollution from Agriculture - FAO Irrigation and Drainage Paper 55,* s.l.: s.n.

Elseud, A. A., 2013. *Desk study on water quality hotspots in the Kura Araks river basin, UNDP GEF project " Reducing transboundary degradation in the Kura Araks river basin",* Tbilisi-Baku-Yerevan: UNDP.

Energy Charter, 2012. *In depth Review of Energy Efficiency Policies of Georgia,* s.l.: s.n.

Energy Charter, 2013. *In depth Review of Energy Efficiency Policies of Azerbaijan,* s.l.: s.n.

EPA, 2009. *Environmental Protection Agency.* [Online]
Available at: http://www.epa.gov/ttnchie1/ap42/
[Accessed 10 April 2014].

ESCO, 2014. *Electricity Market Operator.* [Online]
Available at: http://www.esco.ge/index.php?article_id=18&clang=1
[Accessed 4 April 2014].

Espoo Convention, 1991 (Add this reference at the end of chapter 4). *Convention on Environmental Impact Assessment in a Transboundary Context.* [Online]
Available at:
http://www.unece.org/fileadmin/DAM/env/eia/documents/legaltexts/Espoo_Convention_authentic_ENG.pdf
[Accessed 19 June 2014].

EU Azerbaijan Action Plan, 2006. *European Union External Action,* s.l.: s.n.

FAO, 2014. Kura-Araks River Basin report. [Online]
Available at: http://www.fao.org/nr/water/aquastat/basins/kura-araks/kura.araks-CP_eng.pdf
[Accessed 19 June 2014].

Georgian Government, 2012. *Government Program for strong, democratic, United Georgia.* [Online]
Available at: http://government.gov.ge/index.php?lang_id=ENG&sec_id=41&info_id=35183
[Accessed 22 May 2014].

Global Waters, 2014. *Integrated Natural Resources Manegement in Watersheds (INRMW) of Georgia Program.* Technical Report2. Rapid Assessment of the Rioni and Alazani-Iori River Basins of Gerogia [Online]
Available at: http://www.globalwaters.net/wp-content/uploads/2012/12/Technical-Report-2-Rioni-Alazani-Iori.pdf
[Accessed 19 June 2014]. (to be changed to Shotadzer, M. & Barnovi, E., 2011)

Global Waters, 2014. *Annex 9 HPPS, Dams and Reservoirs.* [Online]
Available at: www. globalwaters.net/wp-content/uploads/2012/12/Annex-9-to-Tech-Rep-2.-HPPs-dams-reservoirs.pdf
[Accessed 19 June 2014].

Howells et al, 2014. Calabashes for kilowatt hours: Rural energy and market failure. *Energy Policy,* Volume 38, Issue 6, pp. 2729-2738.

Huseinov, S., 2013. *Direct consultation on Natural Resources.* s.l.:s.n.

ICPDR, 2013. *Sustainable Hydropower Development in the Danube Basin,* Sarajevo: ICPDR.

Inashvili, M., 2013. *Climate Change Predictions in the Alazani/Ganikh river basin.* [Online]
Available at: http://www.unece.org/fileadmin/DAM/env/documents/2013/wat/11Nov_25-27_Tbilisi/CC_preditions_on_the_Alazani_Ganih_basin_Medea_Inashvili.pdf
[Accessed 20 May 2014].

K. David et al, 2008. *National Renewable Energy Laboratory.* [Online]
Available at: http://www.nrel.gov/docs/fy08osti/43053.pdf
[Accessed 25 February 2013].

Lazriev, G. & Arabidze, M., 2008. *Ministry of Environment Protection and Natural Resources of Georgia.* [Online]
Available at: http://moe.gov.ge/files/Klimatis%20Cvlileba/Grid_Emission_Factor_Georgia.pdf
[Accessed 4 April 2014].

(LEGC, 2013), Local Expert Group Consultation

Matthews, M. M. & Leummens, H. J., 2013. Desk study-Analysis of trends in hydropower, agricultural and municipal water use in the Kura Ara(k)s river basin.. In: *UNDP/GEF project "Reducing transboundary degradation n the Kura Ara(k)s river basin".* Tbilisi-Baku-Yerevan: s.n., p. 32.

Ministry of Energy of Georgia, 2014. *Potential hydropower sites in Georgia.* [Online]
Available at: http://hpp.minenergy.gov.ge/
[Accessed 4 April 2014].

Ministry of Natural Resources of Azerbaijan, 2013. *Workshop notes.* Kakheti: s.n.

Ministry of Regional Development and Infrastructure, Georgia, 2013. *Kakheti Regional Development Strategy.* Tbilisi: s.n.

MoENRP, 2013. *Ministry of Environment and Natural Resources Protection of Georgia, Direct consultation.* s.l.:s.n.

MoEPNR and UNDP, 2009. *Georgia Second National Communication to the UNFCCC,* s.l.: s.n.

PLATTS 2013 (change to 2012). World Electric Power Plants Database. [Online]
Available at: http://www.platts.com/products/worldelectricpowerplantsdatabase
[Accessed 19 June 2014].

Polglase, P., Paul, K. & Meyer, M., 2012. Comment on "Australian wood heaters currently increase global warming and health costs". *Atmospheric Pollution Research*, 28 April, pp. 258-259.

Presidency of Azerbaijan, 2014. *Azerbaijan 2020. Look into the Future Concept for Development.* [Online]
Available at: http://www. president.az/files/future_en.pdf
[Accessed 19 June 2014].

Shotadzer, M. & Barnovi, E., 2011. *Technical Summary Report: Rapid Assessment of the Rioni and Alazani-Iori River Basins of Georgia,* Florida: USAID.

SICIREC, 2009. *SICIREC.* [Online]
Available at: http://www.sicirec.org/definitions/carbon-capture
[Accessed 20 November 2013].

The World Bank, 2013. *World Bank Azerbaijan Snapshot,* s.l.: The World Bank.

The World Power Plants, 2014. *The World Power Plants.* [Online]
Available at: http://www.industcards.com/hydro-cis.htm
[Accessed 22 May 2014].

UNDP, 2011. *Promotion of Biomass Production and Utilization in Georgia,* s.l.: UNDP.

UNDP, 2013. *Comparative Analysis of Agriculture in the South Caucasus,* s.l.: UNDP.

UNECE, 2007. *Our waters: Joining hands across borders,* New York and Geneva: United Nations publications.

UNECE, 2010. *Second Environmental Performance Review of Georgia,* New York and Geneva: United Nations Publications.

UNECE, 2011. *Second Assessment of transboundary rivers, lakes and groundwaters,* New York and Geneva: United Nations publications.

UNECE, 2011. *Second Environmental Performance Review of Azerbaijan,* New York and Geneva: United Nations publications.

UNECE, 2014
http://www.unece.org/fileadmin/DAM/env/water/publications/assessment/English/H_PartIV_Chapter4_En.pdf (to be changed with UNECE, 2011 *Second Assessment of transboundary rivers, lakes and groundwaters*)

UNIDO, 2013. *World Small Hydropower Development Report.* [Online]
Available at: www.smallhydroworld.org
[Accessed 21 February 2014].

United Water Supply Company of Georgia, 2014. *Information about the water supply in Kakheti, Georgia* [Interview] (February 2014).

UNPD-GEF, 2007. *Groundwater Resources in the Kura Araks River Basin - UNPD-GEF Project Transboundary Degradation in the Kura Arakz River Basin,* s.l.

USAID, 2013. *Energy Analysis of Lower Alazani-Iori Pilot Watershed Area,* s.l.: USAID.

Verdiyev, R., 2012. *National Water Strategy of Azerbaijan Republic.* Geneva: s.n.

Westphal, M. I., Mehtiyev, M. & Tonoyan, V., 2011. *Regional Climate Change Impacts Study for the South Caucasus Region,* Tbilisi: UNDP.

World Health Organization, W., 2006. *Guidelines for the safe use of wastewater, excreta and greywater,* Geneva: WHO.

ANNEX 1 COMPARATIVE REVIEW OF COUNTRIES BASED ON WORLD DEVELOPMENT INDICATORS

The indicators used in this annex are available from World Bank (2014) that are accessible online here: http://wdi.worldbank.org/tables and Aquastat (2009 & 2007)

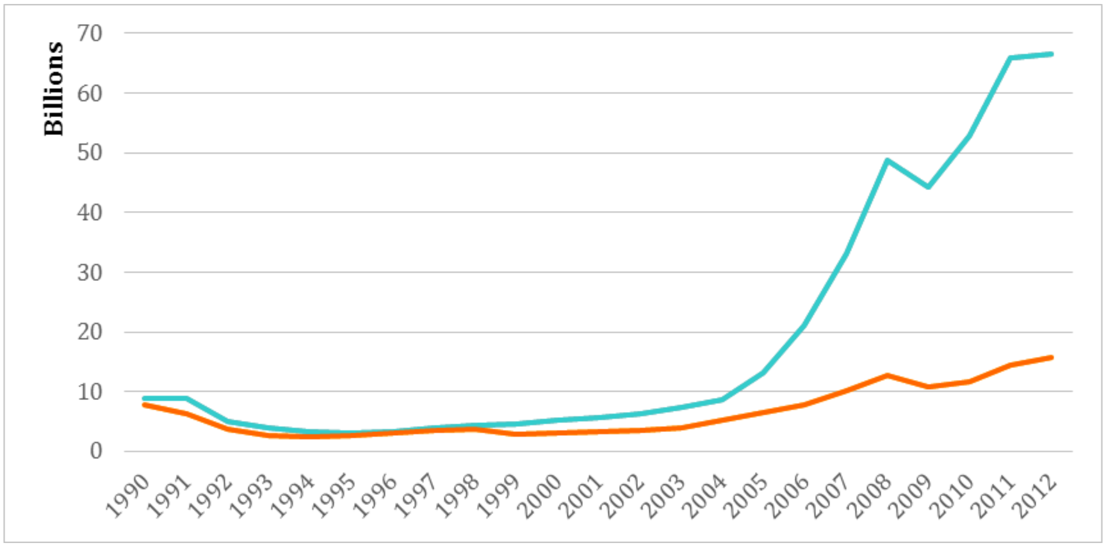


Figure 6 National GDP. Azerbaijan (blue) and Georgia (orange)

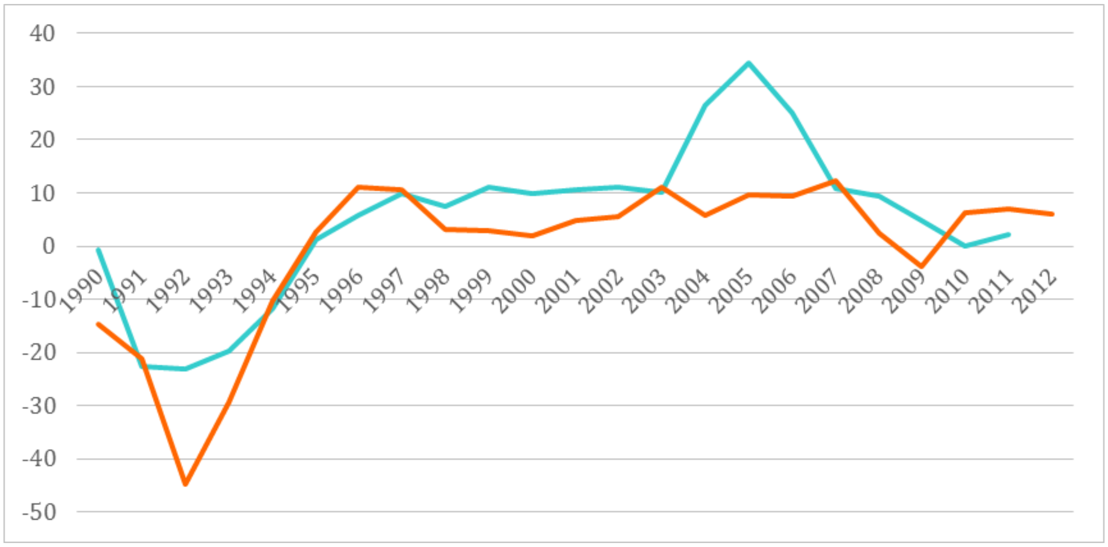


Figure 7 GDP growth (%). Azerbaijan (blue) and Georgia (orange)

Table 4 Selected WDI - Socio-economic indicators

indicator	AZ	GE	unit	year	notes
Socio-economic indicators					
GDP	66.6	15.7	Billion USD	2012	
GDP growth	2.2	6	%	2012	
GDP growth per capita	0.9	5.8	%		
Population	9	4	Million people	2012	
Rural population	46	47	% of total	2012	In AZ is decreasing (49% in 2000); in GE is stable (47% in 1000)
Rural population growth	0.8	-0.1	%	2012	
Population density	112	79	People per sq. km	2012	
Population growth	1.3	0.2	%	2012	
Contribution of natural resources to GDP					
Total natural resources rent	45.1	0.8	% of GDP	2011	
Oil rents	41.9	0.2	% of GDP	2011	
Natural gas rents	3.1	0	% of GDP	2011	
Coal rents	0	0	% of GDP	2011	
Mineral rents	0.1	0.5	% of GDP	2011	
Forest rents	0	0.1	% of GDP		
Population below national poverty line	6	14.8	% of total population	2012	

Employment by sector					
Employment					
In Agriculture	38.7	36.2	% of total	2007	the latest data available for Georgia are from 2007 while for Azebaijan the latest are from 2012. For comparability, I took the data for both countries from 2007
In Industry	12.8	10.4	% of total	2007	(see note above)
In Services	48.5	53.4	% of total	2007	(see note above)

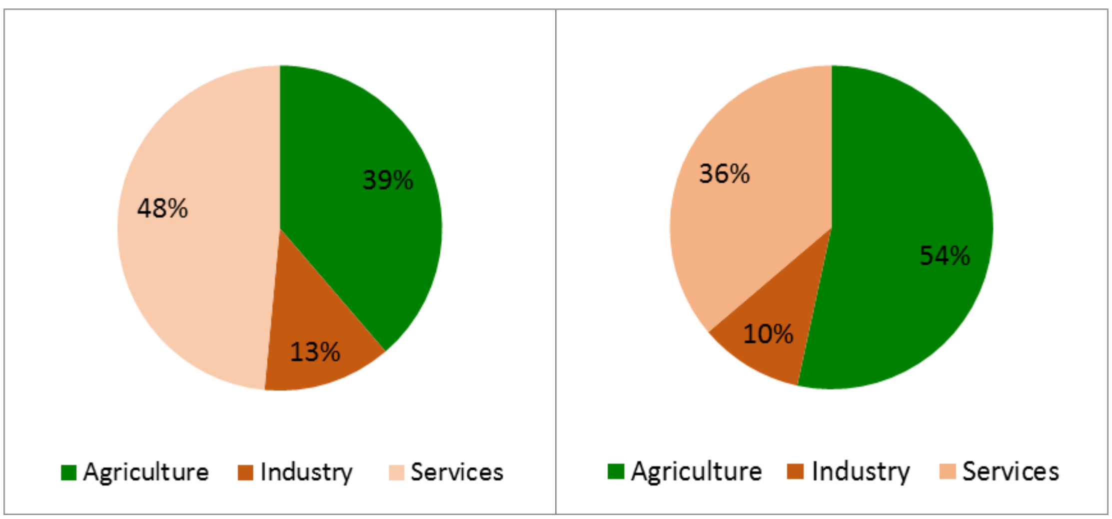


Figure 8 Azerbaijan (left) and Georgia (right) Employment by sector for 2007 (World Bank 2014) (Note that this was the last available year where data were reported consistently by country.

GDP contribution by sector					
In Agriculture	6	9	% of total	2012	
In Industry	63	23	% of total	2012	

In Services	31	68	% of total	2012	

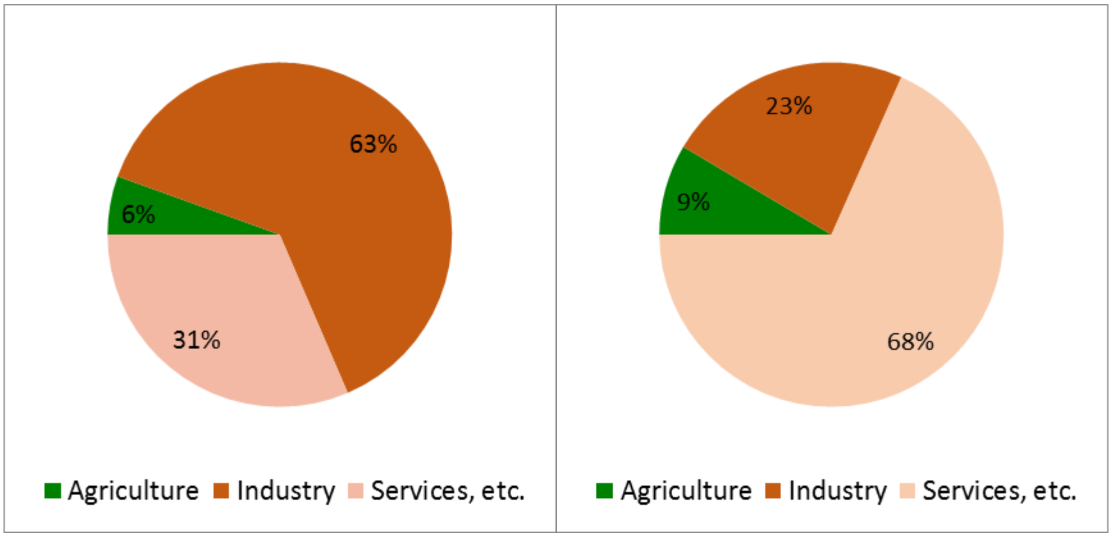


Figure 9 Azerbaijan (left) and Georgia (right) - Value Added To National GDP by sector (as % of GDP) for 2012 (World Bank 2014)

Table 5 Water and energy productivity by sector

Total water productivity					
Total	5.5	8.7	USD / m3	2011	
In Agriculture	0.4	1.3	USD / m3	2011	Calculated with the contribution of agriculture to the total GDP and the amount of water used by the agricultural sector
In Industry	18.1	9.2	USD / m3	2011	(see note above)
In Services/Domestic Use	43	29.9	USD / m3	2011	(see note above)

Energy productivity					
Total	8,72	4,76	Billion USD / Mtoe	2011	
In Agriculture	8,47	9,16	Billion USD / Mtoe	2011	
In Industry	29,63	3,56	Billion USD / Mtoe	2011	
In Services/Domestic Use	3,37	5,00	Billion USD / Mtoe	2011	

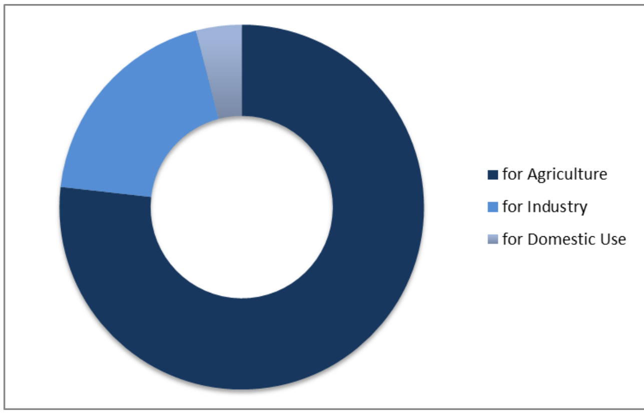
Table 6 Water indicators

Water					
Internal renewable freshwater resources[43]		885	12966	m3 per capita	2011
Annual freshwater withdrawal		12.2	1.8	Billion m3	2011
	as % of internal sources[44]	150.5	3.1	% of internal resources	2011
	for Agriculture	76	58	% of total withdrawal	2011
	for Industry	19	22	% of total withdrawal	2011
	for Domestic Use	4	20	% of total withdrawal	2011

[43] Renewable internal freshwater resources flows refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country. Renewable internal freshwater resources per capita are calculated using the World Bank's population estimates (World Bank 2014)

[44] Withdrawals can exceed 100 percent of total renewable resources where extraction from nonrenewable aquifers or desalination plants is considerable or where there is significant water reuse. (World Bank 2014)

Access to improved water source[45]	80	98	% of population	2011	
	71	96	% of rural	2011	
	88	100	% of urban	2011	



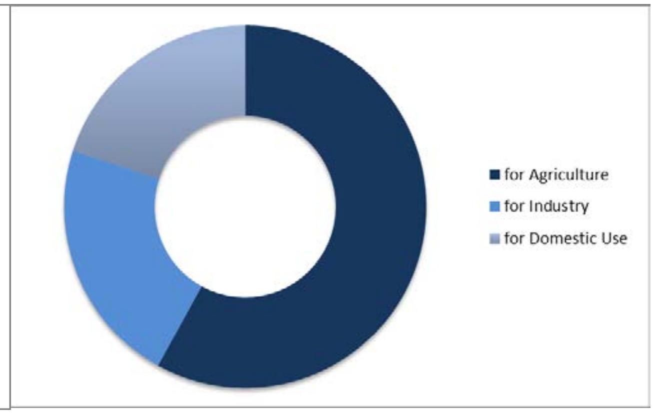


Figure 10 Water use by sector

Access to improved sanitation facilities	93	82	% of population	2011	

Table 7 Land and agriculture indicators

Land and Agriculture					
Land area	87	70	thousands km^2	2012	
Land use					
Forest Area	11.3	39.4	% of total	2011	
Permanent Cropland	2.7	1.7	% of total	2011	Dramatically decreasing in GE (3,9 in 2000)
Arable Land	22.8	6	% of total	2011	Dramatically decreasing in GE (11,4 in

[45] Improved water resource means drinking water (World Bank 2014)

					2000)
Arable land per person	0.21	0.09	ha per person	2011	Half the value of 2000 in GE (0,18)
Total wood resources	148.8	408.0	Million m3	2011	*Note: source National Statistics (Aquatstat, 2009)*
Logging harvest (official)	32 500	789 900	m3/year	2011	*Note: source National Statistics (Aquastat, 2009)*
Logging harvest (illegal)	34 900	NA	m3/year	2011	*Note: source National Statistics* *(Aquastat, 2009)*
Agricultural irrigated land	29.5	21.9	% of total agricultural land	2009-2011	Data for Geirgia is from Aquastat (2007)
Average annual precipitation	447	1 026	mm	2011	
Land under cereal production	1 017.70	170.7	thousands ha	2010-2012	
Fertilizer consumption	10	33.8	kg per hectare of arable land	2009-2011	
Agricultural machinery	148.2	216.9	Tractors per 100 km2 of arable land	2009	

Table 8 Energy indicators

Energy					
Energy production total[46]	60	1.1	thousands metric TOE[3]	2011	
Energy use[47]	12.6	3.5	thousands metric TOE	2011	
Energy use per capita	1 369	790	kg of oil equivalent	2011	
Use of fossil fuels[48]	97.9	72.8	% of total energy use	2011	
Combustible renewable and waste[49]	0.8	8.9	% of total energy use	2011	
Alternative and Nuclear (= Hydropower)[50]	1.8	19.4	% of total energy use	2011	
Energy use growth	-2	-5	%	1990-2011	
Electricity					
Electricity production	20.3	10.2	Billion kWh	2011	
from Coal	0	0	% of total electricity production	2011	
from Natural Gas	85.1	22.5	% of total electricity production	2011	

[46] Energy production refers to forms of primary energy -petroleum, natural gas, solid fuels (coal, lignite, and other derived fuels), and combustible renewables and waste -and primary electricity, all converted into oil equivalents (TOE) (World Bank 2014)

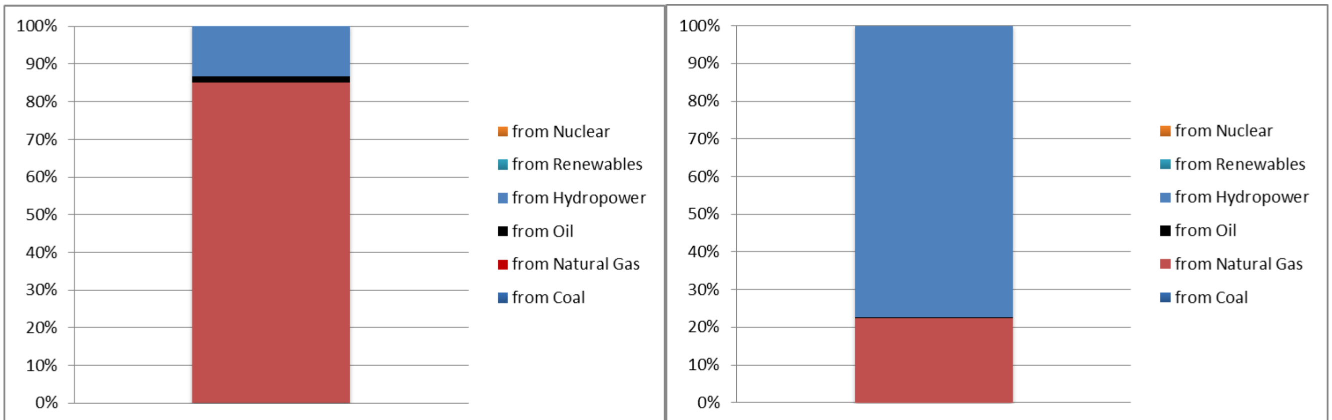
[47] "Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport." (World Bank 2014)

[48] Fossil fuels include coal, oil, petroleum, and natural gas products. (World Bank 2014)

[49] Combustible renewables and waste comprise solid biomass, liquid biomass, biogas, industrial waste, and municipal waste (World Bank 2014)

[50] "Clean energy is non-carbohydrate energy that does not produce carbon dioxide when generated. It includes hydropower and nuclear, geothermal, and solar power, among others". (World Bank 2014) Note that in the case of Georgia and Azerbaijan, this share can be considered to be equal to hydropower only as the other sources are almost not exploited.

from Oil	1.7	0.1	% of total electricity production	2011	
from Hydropower	13.2	77.4	% of total electricity production	2011	



from Renewables	0	0	% of total electricity production	2011	

Figure 11 Electricity production by source

from Nuclear	0	0	% of total electricity production	2011	

Electricity access	NA	NA	% of population		

Table 9 Ecosystems indicators

Ecosystems					
Threatened species (mammals)	7	10	-	2013	
Threatened species	15	11	-	2013	

(birds)					
Threatened species (fishes)	10	9	-	2013	
Threatened species (higher plants)	0	0	-	2013	
Terrestrial protected areas	7.4	3.9	% of total land area	2012	
Marine protected areas	0.4	64.5	% of territorial waters	2012	

Table 10 Emissions indicators

Emissions					
CO2 emissions per unit of GDP[51]	1.6	0.8	kg/2005 USD of GDP	2010	
CO2 emission per capita	5.1	1.4	Metric tons	2010	
Total CO2 emissions	45.9	7	Million Metric tons	Total CO2 emissions	

Table 11 Exposure to climate change indicators

Exposure to climate change					
Land area where elevation is below 5 m	20	1.4	% of land area	2000	
Population living in areas where elevation is below 5 m	29.8	3.3	% of total population	2000	
Population affected by droughts, floods	1.1	0.8	% of total population	2009	

[51] "Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring" (World Bank 2014)

and extreme temperatures			(average annual)		

ANNEX 2 BASIN INDICATORS

The indicators used in this annex are taken from UNECE and Alazani Watershed Consortium and from direct contribution of the Ministry of Environment and Natural Resources Protection of Georgia and Ministry of Ecology and Natural Resources of Azerbaijan, and other sources.

GENERAL BASIN DATA

indicator	AZ	GE	total	unit	year	notes
River (from UNECE, 2011)						
Length	282 (in common) + 5	282 (in common) + 104	391	km		
Sub basin (from UNECE, 2011)						
Sub-basin area	4 755	6 962		km^2		The exact number might differ somewhat between sources
Country´s share	41	59		%		
Withdrawals in the Alazani/Ganyh sub-basin (from UNECE, 2011)						
Total withdrawal	NA	0.632		$\times 10^6$ m3/year	2008	
Agricultural %	NA - Some 9m3/h is pumped from the river for irrigation	0.4				
Domestic %	0.07	0.9				
Industry %	NA	0.2				

Energy %	NA	91.7				
Other %	0.85	6.7				
Alazani-Ayrichay aquifer (from UNECE, 2011)						
Border length	NA	140		km		
Area	3 050	980		km^2		
Thickness: mean, max	NA	150, 320		m		
Main groundwater uses	Used for drinking water (e.g. towns of Telavi and Gurjaani are supplied from groundwater in the alluvium); agriculture.	Irrigation (80–85%) Drinking water supply (10–15%) Industry (3–5%)	Water demand was expected to increase.			
Groundwater management measures	Need to be improved: integrated management, abstraction management, efficiency of use, monitoring, agricultural practices, protection zones, mapping. Need to be applied: treatment of urban and	Need to be improved: control of the use of groundwater resources. Need to be applied: treatment of urban and industrial wastewater, monitoring programmes both quantity and quality, data exchange.	A common monitoring programme seems to be needed. A substantial problem related to groundwater quantity or quality. There is no information about transboundary impacts.			

	industrial wastewater, transboundary institutions, data exchange.					
Groundwater balance for the Alazani-Ayrichay aquifer (AWC, 2002)						
Precipitation	500-1400	300-500	800-1 900	mm		
Area	3 050	980	4 030	km^2		
Total flow	18.9	20.4	39.3	m^3/sec		
Inflow			46	m^3/sec		
Infiltration river			38.4	m^3/sec		
Infiltration precipitation			7.6	m^3/sec		
Discharge evaporation			16.6	m^3/sec		
Discharge river			29.4	m^3/sec		
Renewable water resources in the sub-basin (surface and underground)						
Renewable surface water resources	3 472	1 360		km^3/year		
Renewable groundwater resources	0.0007	1.24		km^3/year		
Total renewable water resources	3 473	2.60		km^3/year		
Renewable water per capita	6 150	7 600		m^3/capita/year		
Wastewater information						
Wastewater						

generated (municipal)						
Wastewater treated						
Primary						
Secondary						
Tertiary						

SPECIFIC DATA (REQUESTED TO THE COUNTRIES REPRESENTATIVES AFTER THE WORKSHOP)

1st storyline (deforestation etc)

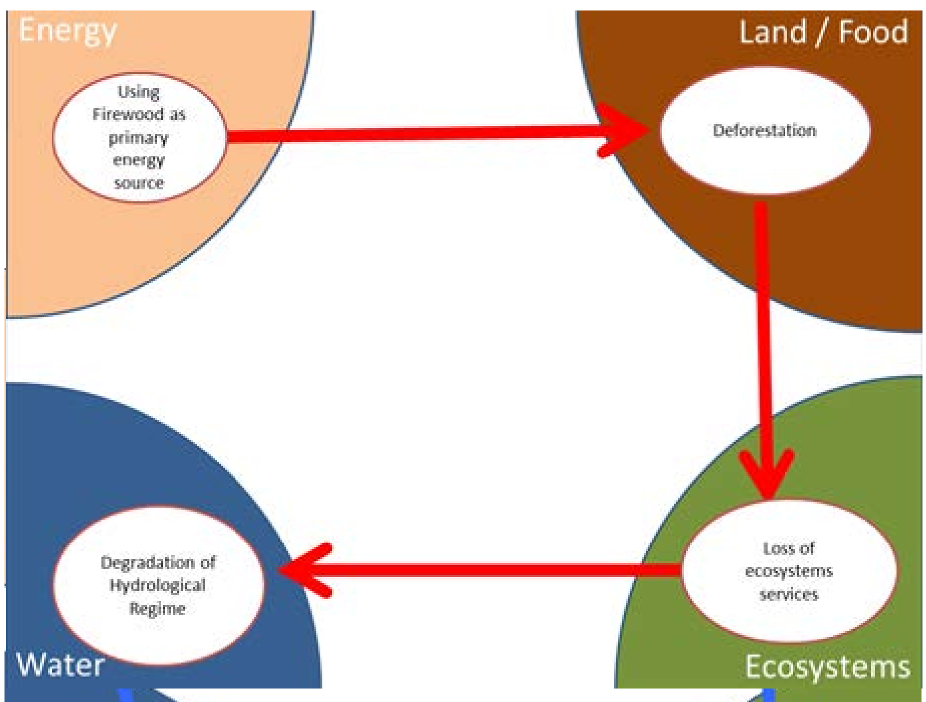


Figure 12 Storyline 1 Interlinked problems

Figure 13 Storyline 1 Interlinked improvements

indicator	AZ	GE	total	unit	year	notes
Firewood use	257513	91970	348484	m^3	2012	Decreasing due to increased natural gas supply and el.
Deforestation	2254	24861	27115	ha	Between 2003-2013	
Land Cover			See below Figure 1			
Water flow		See below Table 1				Groundwater accounts for 40% of the water flow of the Alazani/Ganikh River, rain water for 31% while snow melting for 29%.
Hydropower (existing, planned and potential)	--	--	See below Table 2, Table 3, Table 4, Table 5			
Electrification rate	100	96		%	2013	
Electricity consumption	NA	216.6		GWh	2013	
Gasification rate	82	44		%	2013	In AZ side, 100% in 2015
Natural Gas consumption	NA	33627478		m^3	2013	
Fuel use shares	NA	See below				

		Table 6				
Reforestation rate	21611	10163	31774	ha	Between 2003 and 2013	

2nd storyline (water use)

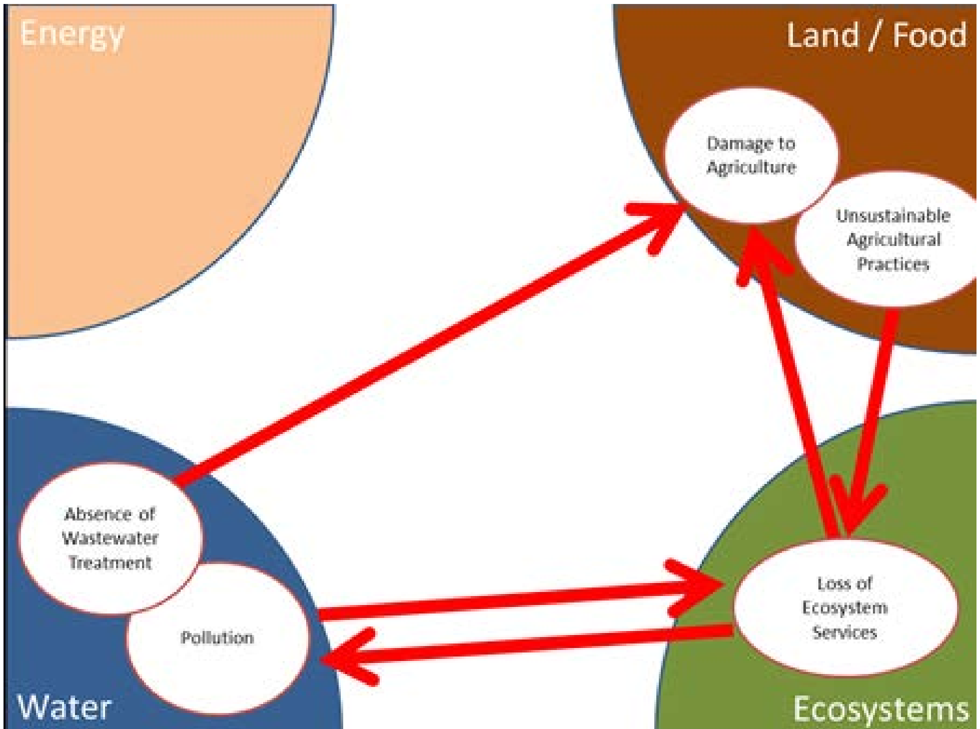


Figure 14 Storyline 2 Interlinked problems

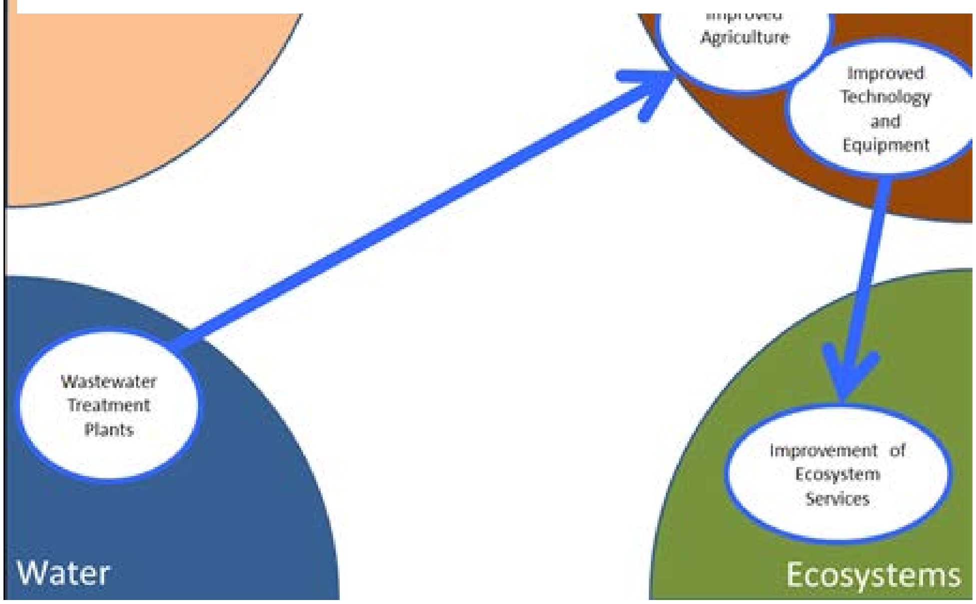


Figure 15Storyline 2 Interlinked improvements

indicator	AZ	GE	total	unit	year	notes
Water Pollution	NA	See below Table 7, Table 8, Table 9, Figure 2				
Arable land	NA	196237		ha	2013	
Irrigated area	NA	55871		ha	2013	Gravity flow irrigation/ in addition 12500 ha in 2014 due to technical maintenance of pumping stations
Irrigation capacity	NA	49000		m^3/h	2013	
Area of crops	NA	74500		ha	2012	Declined since 2008 (114400 ha)
Red listed species			See below Table 11			
Priority Biomes			See below Table 12			
Wastewater produced	NA	See below Table 10				
Wastewater treatment plants (planned)	NA	6500		m^3/day	2014-2015	
Wine industry development	NA	6		Million bottles	2012	Increased from 3,2 million in

						2009

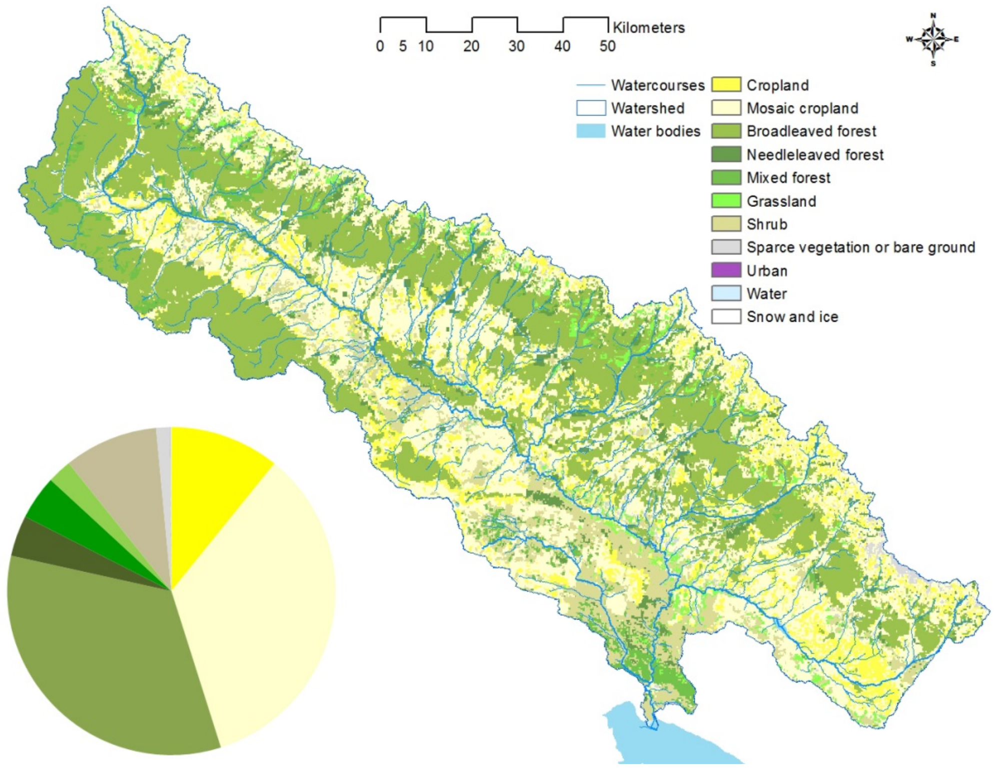


Figure 16: Land cover in the Alazani/Ganikh River Basin according to a global land cover database (Bontemps 2011)

Table 12: River Alazani/Ganikh – Shaqriani hydrological checkpoint. Average monthly and average annual discharge (m3/sec) (Also included in CENN, 2013)

	1932-1960	**1961-1990**	**1991-2013**
1	19,53846154	18,42172414	25,03652174
2	21,79230769	20,02758621	25,13565217
3	32,08846154	34,61724138	36,11304348
4	70,57307692	68,31724138	78,5
5	98,61923077	86,40689655	97,55217391
6	85,32307692	73,72758621	81,44782609
7	53,03846154	50,77931034	52,60956522
8	36,83846154	37,21448276	35,88695652
9	40,31153846	34,54310345	36,84347826
10	42,87307692	33,63793103	38,15217391

11	36,20769231	29,54482759	35,36086957
12	24,112	23,16896552	27,62826087
YEAR	45,2536	42,49655172	47,53043478

Table 13: Existing hydropower plants in Alazani/Ganikh river basin (Also included in Shotadze & Barnovi 2011)

Name	Country	Capacity (MW)	Year of Commissioning
Chalahesi	Georgia	1.5	2001
Intsobahesi	Georgia	1.65	1993
Alazanhesi	Georgia	4.8	1942
Kabalhesi	Georgia	1.5	1953
Napareulhesi	Georgia	2.5	Under re-construction
Khadorhesi	Georgia	24	2004
Sheki	Azerbaijan	1.6	1929
Balakan	Azerbaijan	0.8	1954
TOTAL		**38.35**	

Table 14: Recently constructed hydropower plants in Alazani/Ganikh river basin (Also included in Shotadze & Barnovi 2011)

Name	River	Region	Capacity (MW)	Average annual output (GWh)	Capacity factor
Khadori 2	Alazani	Kakheti	5.4	35.1	74%
Shilda	Chelti	Kakheti	5.28	32.22	70%
Alazani II	Alazani	Kakheti	6	40	76%
Ismailly 1	Geychay	Azerbaijan	1.6	6.3	45%
Balkan 1		Azerbaijan	1.5	10	76%
TOTAL			**19.78**	**123.62**	

Table 15: Planned hydropower plants in Alazani/Ganikh river basin (Also included in Shotadze & Barnovi 2011)

Name of HPP	River	Region	Installed capacity, (MW)	Average annual output, GWh	Capacity Factor
Avani	Avanis khevi	Kakheti	4.6	18.6	46%
Chelti 1	Chelti	Kakheti	4.8	25	59%
Chelti 2	Chelti	Kakheti	4.8	25.09	60%
Duruji	Duruji	Kakheti	1.74	10.7	70%
Stori	Stori	Kakheti	11.8	56.8	55%
Stori 1	Stori	Kakheti	14	69.4	57%
Stori 2	Stori	Kakheti	11.4	50.5	51%
Stori 3	Stori	Kakheti	13.7	60.6	50%
Samquristsqali 1	Samkuristsqali	Kakheti	4.88	25.7	60%
Samquristsqali 2	Samkuristsqali	Kakheti	22.6	117.4	59%
Ismailly 2	Geychay	Azerbaijan	3.2	12.6	45%
Mukhas 1	Dashaghil	Azerbaijan	1.5	10	76%
Mukhas 2	Dashaghil	Azerbaijan	1.5	10	76%
Alicanchay		Azerbaijan	5.85	20.3	40%
Ayricay		Azerbaijan	0.62	3.1	57%
Turyanchay		Azerbaijan	10	40.6	46%
TOTAL			**116.99**	**556.39**	

Table 16: Hydropower potential in the Alazani/Ganikh river basin (Also included in Shotadze & Barnovi 2011)

River Name	River or water reservoir where the river flows into (right, left)	Capacity (MW)
Alazani	Kura/Mtkvari (left)	258.8
Samkuristskali	Azalani (left)	71.6

Ilto	Azalani (right)	33.6
Stori	Azalani (left)	66.8
Usakhelo	Stori (right)	28.3
Lopota	Azalani (left)	34.1
Turdo	Azalani (right)	17.7
Intsoba	Azalani (left)	18.5
Chelti	Azalani (left)	35.4
Kisiskhevi	Azalani (left)	7.1
Duruji	Azalani (left)	29.9
Bursa	Azalani (left)	10
Cheremiskhevi	Azalani (left)	5.2
Sharokhevi	Azalani (left)	26.6
Avaniskhevi	Sharokhevi (right)	23.7
Kabali	Azalani (left)	47.7
Apeni (Areshi)	Kabali (right)	5.5
Chartliskhevi	Azalani (left)	18.4
Shromiskhevi	Azalani (right)	14.8
TOTAL		**754**

Table 17: Share of fuels in the Alazani/Ganikh river basin (Kakheti region)

Fuel/Year	2009	2010	2011	2012
Firewood	62.7%	57.2%	59.7%	50.4%
Natural Gas	18.5%	21.0%	21.4%	28.0%
Electricity	18.7%	21.8%	18.9%	21.7%

Table 18: Water pollution Shaqriani checkpoint (Also included in CENN,2013)

Sampling Date	Nitrite	Nitrate	Ammonium	Phosphate

	mg/l	mg/l	mg/l	mg/l
2002	0,022	0,5	0,47	0,025
2003	0,022	0,38	1,18	0,02
2004	0,0377	0,644	1,126	0,0545
2005	0,04525	0,3675	0,96625	0,021875
2006	0,0212857	0,35857	0,645714286	0,03428571
2007	0,0175333	0,84444	0,884444444	0,0206
2008	0,0127333	0,38533	0,679416667	0,03345455
2009	0,0249167	0,60467	0,434916667	0,0815
2010	0,1634545	0,59109	0,073790909	0,28966667
2011	0,001	1,949	0,069	0,069
2012	0,17525	2,21425	0,11275	0,38775
2013	0,2361667	0,51243	0,24625	0,001

Table 19: Toxicity levels in Shaqriani checkpoint (Also included in CENN, 2013)

Sampling Date	**BOD5**
	mg/l
2003	0,83
2004	1,624
2005	1,46875
2006	1,918333
2007	1,143333
2008	1,291667
2009	1,644167
2010	1,072
2011	1,5
2012	2,4125

2013	1,191429

Table 20: Temperature of the river in Shaqriani checkpoint as recorded in May of each year (Also included in CENN,2013)

		Sampling Date	**Temperature.** °C
May	2004	27,05	12
May	2005	25,05	14,7
May	2006	22,05	19
May	2007	10,05	12,7
May	2008	19,05	17
May	2009	28,05	10
May	2010	24,05	14,7
May	2012	5,05	17,2
May	2013	8,05	13,5

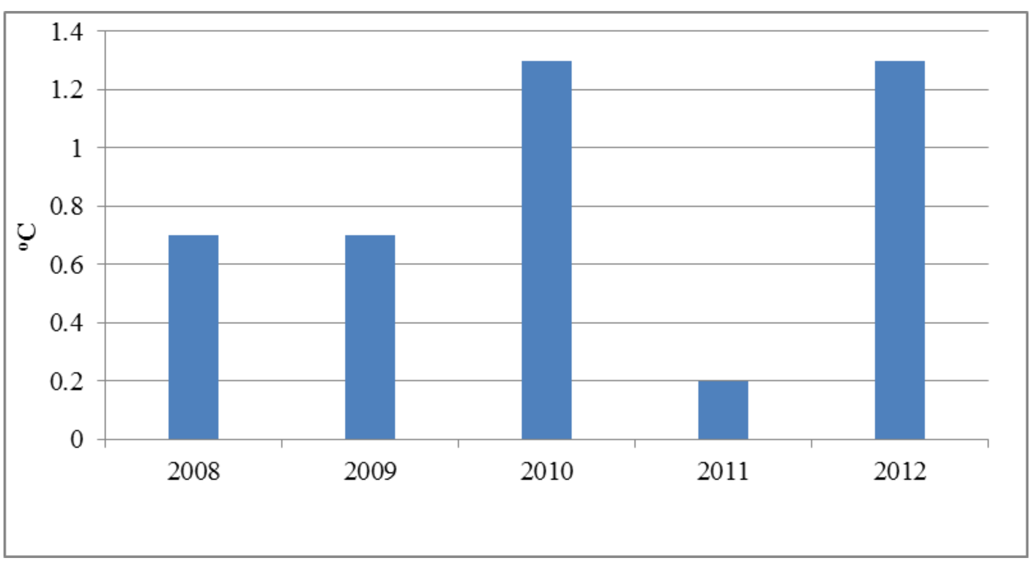


Figure 17: Temperature anomaly in the Alazani/Ganikh river basin (Azerbaijan)

Table 21: Wastewater (Also included in INRMW, 2013)

Municipality	m3/year
Akhmeta	1584375
Telavi	2948063
Kvareli	197456
Gurjaani	1242360
Lagodekhi	1388743
Dedoplistskaro	199812
Signagi	364852
Sagarejo	1398052
Total Kakheti	9323713

Table 22: Red listed species within the Alazani/Ganikh River basin according to IUCN (2014)

Birds	**Aegypius monachus L.**
	Aquila heliaca Savigny
	Gypaetus barbatus L.
	Marmaronetta angustirostris
	Otis tarda L.
	Tetrao mlokosiewiczi Taczanowski
	Tetrax tetrax L.
	Phalacrocorax pygmeus Pallas
Reptiles	Emys orbicularis L.
	Eremias arguta Pallas
	Vipera ursini Bonaparte
	Vipera lebetina L.
	Vipera dinniki Nikolsky
	Testudo graeca L.
Amphibians	Hyla arborea L.

	Triturus vittatus Jenyns
Small mammals	Miniopterus schreibersii Kuhl
	Myotis emarginatus Geoffry
	Myoxus glis Blasivs
	Nyctalus leisleri Kuhl
	Sciurus anomalus Gmelin
Large mammals	Capra cylindricornis Blyth
	Capra aegagrus Erxleben
	Cervus elaphus L.
	Hyaena hyaena L.
	Lutra lutra Linnaeus
	Vormela peregusna Guldenstaedt
	Rupicapra rupicapra L.
	Panthera pardus L.
	Ursus arctos L.

Table 23: Priority biomes

The Caucasus Ecoregion has four priority biomes, of which three would be relevant for the Alazani/Ganikh River Basin; the forest biome, covering 18,5% of the whole Caucasus Ecoregion but as much as 42% of the Alazani/Ganikh River Basin, the freshwater and wetland biome (8,5% of the Caucasus Ecoregion), and the high mountain biome (17% of Caucasus Ecoregion).