TRANSBOUNDARY DIAGNOSTIC ANALYSIS – UPDATE 2013

UNDP/GEF Project
Reducing Transboundary Degradation in the Kura-Ara(k)s River Basin

September 2013 – Baku/ Tbilisi/Yerevan

UNDP
Empowered lives.
Resilient nations.

gef

UNOPS

UNDP/GEF PROJECT

REDUCING TRANSBOUNDARY DEGRADATION IN THE KURA ARA(K)S RIVER BASIN

UPDATED TRANSBOUNDARY DIAGNOSTIC ANALYSIS

Tbilisi, Georgia – Baku, Azerbaijan – Yerevan, Armenia

September 2013

UNDP
Empowered lives.
Resilient nations.

gef

UNOPS

2013 UPDATED TRANSBOUNDARY DIAGNOSTIC ANALYSIS FOR THE KURA RIVER BASIN

The Updated Transboundary Diagnostic Analysis (TDA) for the Kura[1] River Basin focuses on priority environmental issues that are transboundary in nature. The preparation of the Updated TDA involved the assessment of the environmental and socio-economic impacts of transboundary issues, and the identification of institutional, legal and policy issues that need to be addressed. Information presented in the Updated TDA is obtained from publicly accessible sources – publications, statistical services, as well as from national experts in the project countries. While the Kura Ara(k)s river basin also includes Turkey and the Islamic Republic of Iran, the TDA does not provide information on these countries, as they do not participate in the UNDP/GEF Kura Ara(k)s project, under the guidance of which this TDA is prepared.

A comprehensive analysis of transboundary issues provides a factual basis to formulate recommended options for improving the environmental situation and ensuring the sustainable development of the Kura Ara(k)s River Basin. The Updated TDA was produced on the basis of comprehensive studies of the physical and geographical features, water uses, and the socio-economic and environmental situation in the Kura Ara(k)s River Basin with respect to three of the five riparian countries – Armenia, Azerbaijan and Georgia.

The Updated TDA was prepared using the Draft TDA as finalized in 2007 as the baseline.

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

Colophon

Project Title	Reducing transboundary degradation in the Kura Ara(k)s river basin
Financing	Global Environment Facility
Implementing Agency	UNDP United Nations Development Program
Executing Agency	UNOPS United Nations Office for Project Services
Chief Technical Advisor / Project Coordinator	Dr Mary. M. Matthews
Report Editors	Harald J.L. Leummens & Mary M. Matthews
Contributions	Mutallim Abdulhasanov, Gevorg Afyan, Hovik Aghinyan, Adishirin Alakbarov, Marine Arabidze, Nick Arevadze, Matanat Avazova, Helen Bakradze, Lale Bayramova, Medgar Chelidze, Levon Chilingaryan, Astghik Danielyan, Ahmed Abou Elseoud, Nino Gagelidze, Khudaverdi Ganbarov, Vakhtang Geladze, Aram Gevorgyan, David Girgvliani, Karlen Grigoryan, Tamuna Gugushvili, Nino Gvazava, Tim Hannan, Lilith Harutyunyan, Sahib Hasanzade, Brigette Herron, Shamil Huseynov, Farda Imanov, Medea Inashvili, Aida Iskoyan, Vafadar Ismayilov, Reyhana Jafarova, Tigran Kalantaryan, Dima Kavtuashvili, Sahib Khalilov, Inga Kurtskhalia, Harald Leummens, Zaal Lomtadze, Marina Makarova, Ahmed Mammadov, Lyana Mammadova, Mary Matthews, Hamlet Melkonyan, Seyran Minasyan, Ilia Mtskhvetadze, Volodya Narimanyan, Shake Nersisyan, Hovhannes Nikoghosyan, Anar Nuriyev, Teymur Osmanov, Rustam Rajabov, Vilik Sargsyan, Lilit Simonyan, Leyla Tagizadeh, Lusine Taslakyan, Vahagn Tonoyan, Ivane Tsiklauri, Baadur Ukleba, Asif Verdiyev, Rafik Verdiyev, Benik Zakaryan.
Suggested citation	Leummens H.J.L. & M.M. Matthews, 2013. Updated Transboundary Diagnostic Analysis for the Kura Ara(k)s river basin. UNDP/GEF “Reducing transboundary degradation in the Kura Ara(k)s river basin”, Tbilisi-Baku-Yerevan, 2013, 209 pp.

[1] *[1] Other frequently used names for the Kura river include Mtkvari, Kurachay, Cyrus. Other names for the Ara(k)s river include Ara, Aras, Araz, Arax. The standardized use of the names “Kura” and “Ara(k)s” does not reflect any preference or opinion of the authors or contributors on the correct names of these rivers, other than of harmonization.*

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AM	Armenia
AM-EIMC	Armenia Environmental Impact Monitoring Center
AM-MNP	Ministry of Nature Protection of Armenia
ArmStat	National Statistical Service of the Republic of Armenia
AZ	Azerbaijan
AZ-MA	Ministry of Agriculture of Azerbaijan
AZ-MENR	Ministry of Ecology and Natural Resources of Azerbaijan
AZ-NWS	Azerbaijan National Water Strategy
AzerStat	State Statistical Committee of the Republic of Azerbaijan
BAT	Best Available Technology
BCM	Billion cubic meters
BEP	Best Environmental Practice
BMO	Basin Management Organization
BOD	Biological Oxygen Demand
CCA	Causal Chain Analysis
CDM	Clean Development Mechanism
CENN	Caucasus Environmental NGO Network
CERF	Critical Ecosystem Partnership Fund
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DID	District Irrigation Department
DO	Dissolved Oxygen
EBRD	European Bank for Reconstruction and Development
EECCA	Eastern Europe, Caucasus & Central Asia
EIA	Environmental Impact Assessment
ENVSEC	Environment and Security Initiative
EU	European Union
FAO	United Nations Food & Agricultural Organization
FAOSTAT	Statistics Division of the FAO
FHIL	Flood Hazard Intensity Level
FWUA	Federation of Water Users Associations
FSP	Full Sized Project
G-PAC	Policy, Advocacy, and Civil Society Development in Georgia
GCM	Global Circulation Model
GDP	Gross Domestic Product
GDRI	Georgian Development Research Institute

GE	Georgia
GEF	Global Environment Facility
GE-MEn	Ministry of Energy of Georgia
GE-MEnNR	Ministry of Energy and Natural Resources of Georgia
GE-MEPNR	Ministry of Environment Protection and Natural Resources of Georgia
GE-MEP	Ministry of Environment Protection of Georgia
GE-NEA	Georgia National Environmental Agency
GeoStat	National Statistics office of Georgia
GFDRR	Global Facility for Disaster Reduction and Recovery
GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)
GOA	Government of Armenia
GSL	Global Sea Level
GWh	Gigawatt hours
HPP	Hydropower plant
IDP	Internally Displaced Person
IFAD	International Fund for Agricultural Development
IFI	International financial institution
IHP	International Hydrological Program UNESCO
I.R. Iran	Islamic Republic of Iran
IRSWR	Internal Renewable Surface Water Resources
ISARM	Internationally Shared Aquifer Resources Management program
ISF	Irrigation Service Fee
ITC	Faculty of Geo-Information Science and Earth Observation, University of Twente
IUCN	International Union for Conservation of Nature
IW	International Waters
IWRM	Integrated Water Resources Management
IW:LEARN	International Waters: Learning, Education and Resource Network
JSC	Joint Stock Company
KA	Kura Aras
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
LAI	Law on amelioration and Irrigation (Azerbaijan)
LEPL	Legal Entity of Public Law
MAC	Maximum Allowable Concentration
MAD	Maximum Allowable Discharge

MCC	Millennium Challenge Corporation
MCM	Million cubic meters
MEA	Millennium Ecosystem Assessment
Mln	Million
MW	Megawatt
N/A	Not available, or not applicable
NATO	North Atlantic Treaty Organization
NGO	Non-Governmental Organization
NODA	Net Official Development Assistance
NPP	Nuclear Power Plant
OECD	Organization for Economic Cooperation & Development
O&M	Operation & Maintenance
PA	Protected Area
PCCP	Potential Conflict to Cooperation Potential
PDB-B	Project Development Fund- B
PPP	Public Private Partnership
PPP	Purchasing Power Parity
QA/QC	Quality Assurance & Quality Control
RA	Republic of Armenia
RBMP	River Basin Management Plan
ROE	Regional Office for Europe, of the WHO
SAP	Strategic Action program
SEA	Strategic Environmental Assessment
SHPP	Small Hydropower Plant
SIDA	Swedish International Development Co-operation Agency
SNC	Second National Communication
SNCO	State Non-Commercial Organization
SWCIS	State Water Cadaster Information System
TB	Transboundary
TDA	Transboundary Diagnostic Analysis
TDS	Total Dissolved Solids
TPP	Thermal Power Plant
TTT	Technical Task Team
TWh	Terra Watt hours
UN	United Nations
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
WB	World Bank
WFD	Water Framework Directive (EU)
WHO	World Health Organization
WMO	World Meteorological Organization
WPD	Water Policy Dialogue
WQ	Water Quality
WRO	Water Resources Objective
WSA	Water Supply Agency
WSS	Water Supply and Sanitation
WUP	Water Use Permit
WWF	World Wildlife Fund for Nature
WWTP	Waste water treatment plant

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The UNDP/GEF Project “Reducing Transboundary Degradation in the Kura Ara(k)s River Basin” is a Full Sized Project with the participation of Armenia, Azerbaijan and Georgia. The Project is assisting the three Kura Ara(k)s riparian states to 1) identify the principal threats and root causes related to the transboundary water resources of the Kura Ara(k)s river basin and 2) develop and implement a sustainable program of policy, legal and institutional reforms and investments to address these threats. Balancing overuse and conflicting uses of water resources in transboundary surface and groundwater basins is seen as the critical issue in the Kura Ara(k)s basin, and is the principal focus of attention from the very outset of project related activities. The long-term development/environmental goal of the project is the sustainable development of the Kura Ara(k)s river basin enhanced through ecosystem-based Integrated Water Resource Management (IWRM) approaches.

The project objective is to improve the management of the transboundary Kura Ara(k)s river basin through the implementation of a sustainable program of policy, legal and institutional reforms and investment options using the Transboundary Diagnostic Analysis (TDA) and Strategic Action Program (SAP) process. In order to achieve this objective, the project has updated the TDA, and is supporting the development of National IWRM plans that will be the base of the SAP.

In accordance with GEF International Waters Best Practices, the project has undertaken the underlying *Updated Transboundary Diagnostic Analysis*. The objective of this exercise is to work with national and international experts to identify and agree to the main water-related transboundary problems in the river basin, to develop as thorough an understanding of these problems, and through rigorous analysis, determine what actions should be recommended to the partner countries in the region to address these. This *Updated TDA* is the culmination of that process initiated under the Project Development Fund- B (PDF-B) phase of the project that ran from 2005-2007. The PDF-B phase of the project produced the *Preliminary Transboundary Diagnostic Analysis* in 2007. The current *Updated TDA* builds on the foundation set by the earlier version, and expands on the issues raised, focusing on the need to judge the transboundary situation based on empirical evidence beyond strongly held perceptions, and considering the impacts of development trends across the basin which will impact water resources in the future.

The Updated TDA is based on the original four transboundary issues identified and agreed in the early phase of the project, and has been updated based on developments and newly available information within the basin. The four transboundary issues are:

- Variation and reduction in hydrological flows.
- Deterioration of water quality.
- Ecosystem degradation.
- Flooding.

In the 6 years between the UNDP/GEF project’s PDF-B phase and the implementation of the current project there have been significant developments in the Kura Ara(k)s river basin, shaping the water management priorities of the countries. In the framework of the Updated TDA several new desk studies were conducted: (1) Water Quality Hot-spots; (2) Hydrological flow; (3) Climate change impacts on water resources; (4) Socio-economic trend analysis; (5) Gender mainstreaming in water management; and (6) Floodplain forests - Azerbaijan. Thanks to the generosity of other projects, specifically the EU Project “Trans-boundary River Management for the Kura River Basin – Armenia, Georgia, Azerbaijan Phase II and Phase III”, as well as the “UNECE Water Quality Assessment”, information was available which has been useful to this Updated TDA. The findings of these and other projects have been incorporated into the current final Updated TDA, as well as inputs to this draft provided by the Project Steering Committee and National Experts in Armenia, Azerbaijan and Georgia.

The approach used for the *Updated TDA* is in accordance with the Best Practices for TDAs developed under the UNDP/GEF International Waters: Learning, Education and Resource Network project (IW:LEARN), as described in the methodology section. As this is an updated document with a gap of only 6 years, only the major changes in the region impacting on transboundary water issues were addressed, including institutional developments and newly available information, but not all aspects of the Preliminary TDA were repeated.

The description of the basin provides an updated overview of current basin settings. The physical setting reviews the geographic, hydrological, climatic and ecological conditions. The human setting describes populations within the basin, human health and gender issues, as well as the economic setting, providing an update overview of current water-related economic developments in the basin. The institutional setting provides an overview of the national stakeholder organizations involved in the decision-making in the three project countries.

The main transboundary issues are each explored through rigorous analytical review of relevant information by teams of national and international experts collaborating together. The discussion of each of the transboundary issues includes a description of the issue, its transboundary relevance, and the existing perception of the issue as a transboundary problem. This is followed by a presentation of the factual evidence supporting the scope and scale of the issue, and an analysis of gaps in evidence hampering a full and systematic assessment. Subsequently the impacts of the issue are discussed, both to the environment and the socio-economic sectors, while also the "super impacts" that make the issue relevant to decision makers and broader society are introduced. In order to develop recommendations on how to best address these super impacts, and take steps toward improving the transboundary conditions, the causal chain analysis approach is used to identify primary, intermediate and root causes. Additionally, for each transboundary issue, the impact of the cross cutting issue of climate change is discussed, based on a review of predicted climate change for the basin.

For the transboundary issue of **reduction and change in hydrological flow** the main finding is that there is a notable decline in hydrological flows, specifically in the downstream basin and in Armenia, as expressed in five-year annual running means. Additional analysis are conducted as part of the supplemental Desk Study, including the trends in both high and low flows as well as flow variability over the same period. The decline in flow metering stations, especially in Armenia and Georgia, and the lack of reliable data on past and present water abstractions create challenges in assessing the current state and future developments, and will need to be addressed. In addition, the impacts of declining availability, ecosystem degradation and the super impact of conflict over water resources use are discussed in light of the causal chain focusing on climate change, irrational water use, excessive demands on water resources from multiple sectors, lack of reliable information on available resources, and lack of effective integrated planning for water resources management, including at the transboundary level.

The **deterioration of water quality** as a transboundary issue addressed both the national and regional concerns of the need to assess the state of water pollution in a standardized and mutually agreed manner. As the countries of the Kura Ara(k)s basin currently assess water quality using different standards, the EU WFD methodology provides a strong basis towards obtaining improved, comparable empirical evidence throughout the basin. Water quality monitoring information from the countries at the national level provided the key input data to analyze pollution levels along the main Kura and Ara(k)s rivers, as well as selected transboundary tributary basins, included in this Updated TDA. The impacts of deteriorated water quality are ecosystem degradation, decline in human health, and loss of GDP due to impacts on the labor force, by lowering productivity, and costs of pollution, by increasing the need for water treatment. The causes of water quality deterioration are land, air and water discharge of pollution, with climate change reducing the available volumes of water, as such increasing the concentration of pollutants. Intermediate causes include the lack of regulation and enforcement, lack of reliable information for decision-making, and the lack of incentives to reduce pollution. The root cause is a lack of information on the real costs of pollution of waters and the river system.

The issue of **ecosystem degradation** is pervasive throughout the basin and is related to a decline in hydrological flows, deterioration of water quality, conditioned by direct and indirect impacts of a multitude of unsustainable human activities, including climate change. The information that is currently available on ecosystem health is largely outdated and has many gaps, therefore it is difficult to adequately gauge the decline in a rigorous manner. The decline in flora and fauna diversity is marked throughout the basin, although more information to systematically account for these changes and losses is needed. Human development activities cause the loss of ecosystem functions, and as such the capacity of ecosystems to provide services of benefit to humans, including the mitigation of negative impacts. This leads to a subsequent loss of income, or additional replacement costs for the local communities as well as the government, which are the “super impacts”. The causes of ecosystem degradation, in addition to those listed above are: unsustainable use of natural resource; unsustainable land management practices – ecosystem degradation, fragmentation and destruction; a lack of information on ecosystems, their processes, services provided, and the impacts of human activities; and a segmented approach to natural resources management. The root cause is a lack of economic valuation of ecosystem services in the Kura Ara(k)s river basin.

The issue of **flooding** is sporadic but pervasive throughout the Kura Ara(k)s river basin. Flooding is part of the natural water cycle, and contributes to the natural and healthy functioning of ecosystems. However with climate change and increased human populations there has also been an increase in the frequency and severity of these events. The impacts of flooding events are loss of property, loss of life. The super impact is the costs to governments for repairs to infrastructure, compensation, and loss of GDP. The causes of flooding include beyond climate change also aspects of ecosystem degradation from overgrazing and deforestation, as well as increased building and land use activities in flood-prone areas. Additional causes include: focus on reactive flooding responses measures (not proactive) and structural control solutions which commonly lead to increased damages; limited understanding of natural flood cycles within ecological river processes, and the impact of human developments on them; lack of coordination between upstream and downstream communities in impacted areas. The key root cause is outdated flood management practices.

The **cross cutting issue of climate change** is addressed in each of the specific transboundary issue chapters, guided by a review of observed climate change in the recent past and predictions available for the basin until 2100, as described in the National Communications to the UN Framework Convention on Climate Change (UNFCCC). The interpretation of modeling results specific for the Kura Ara(k)s basin region shows that climate change is expected to cause an increase in temperatures, decrease in precipitation, increased glacial melting, increase in evapotranspiration and increase in frequency of severe weather events.

Subsequently an analysis of the **linkages and commonalities between the transboundary issues** assesses the overlaps in both causes and impacts of the issues and shared challenges for each, such as lack of reliable data and lack of prioritization for decision makers. In this way, addressing one challenge can also help to address others.

The linkages chapter is followed by a regional trend analysis that examines the **social and sectoral economic trends envisioned to impact on water management** in the coming 5, 10 and 20 years, within the cross-cutting challenges of climate change. Specific trends analyzed include the increase in population, especially in the lower basin; the sectoral developments planned in agriculture, hydropower and municipal water supply throughout the basin, and the drivers that are shaping these initiatives. In each country, the different sectors in the government are planning to develop economic sectors, which will require the increased use of water resources, increases which may lead to challenges of distribution – between national sectors as well as between upstream and downstream countries - if not managed equitably.

The description of the national socio-economic development trends sets the stage for the **assessment of the transboundary issues**. The observed national trends in hydropower development, municipal water consumption and irrigated agriculture are combined, and their envisioned impact on water resources discussed.

This is followed by a discussion of the **costs and benefits** of defined future scenarios including the “**Business as Usual”** scenario, and the “**Regional Coordination of Water Resources Management**” scenario. These scenarios examine incentives and barriers facing decision makers for each of these. This section provides the foundation for a water Nexus assessment towards improved food, energy, environmental and water security management, by means of an empirical analysis of the trade-offs in available resources for water dependent sectors to ensure long term, basin wide sustainable development.

The Updated TDA is concluded with a set of recommendations based on its findings, categorized by the Agreed Water Resource Objectives (WRO) from the Preliminary 2007 SAP:

WRO I To achieve sustainable utilization of water resources to ensure access to water and preserve ecosystem services

1.1 Achieve improved management of existing quantities of groundwater and surface water resources

- Update hydro-meteorological data collection systems with improved national and transboundary stations including the use of online real time monitoring techniques and established data information exchange mechanism to make information regionally available.
- Develop national and regional conjunctive use strategies for sustainable utilization of surface and groundwater resources based on future trends in water use for different sectors and the potential impacts of climate change, and using updated monitoring information for the groundwater aquifers in line with international BAT for national and transboundary aquifers.
- Assess water demands and sectoral net economic return to GDP per unit of water, applying the most appropriate and staged water nexus approaches to develop, and implement demand management mechanisms to optimize the utilization of available water resources, including allocations to environmental flows in sub-basins for subsequent use on the regional level.
- Provide support for capacity building to improve the sustained implementation of IWRM and ongoing assessments based on the water nexus and economic approaches.

1.2 Achieve reduced losses of water resources

- Adopt modern technologies to improve water use efficiencies in irrigation systems, using incentive structures for farmers based on the public/private partnership approach.
- Improve public awareness and participation in decision making, among farmers, water end-users and other stakeholders, through among others Water User Associations, Basin Management Authorities and gender mainstreaming at local levels.
- Implement demonstration projects on alternative agricultural practices, including no-till rotations and low water use crop varieties, to increase yields and their reliability with public/private partnerships.

WRO II To achieve water quality such that it would ensure access to clean water for present and future generations and sustain ecosystem functions in the Kura-Ara(k)s river Basin

2.1 Improve monitoring programs

- Adopt revised national physicochemical and hydromorphological monitoring programs for both surface and groundwater, including geographical coverage, sampling schedule and parameters measured in line with the EU WFD and international standards.
- Adopt national bio-monitoring programs with shared databases on local taxonomy and water status indicators including environmental flows.
- Improve Quality Assurance & Quality Control in sampling & analytical practices.
- Development of water quality information strategies and tools for improved decision making including improved inter-sectoral information exchange.

2.2 Pollution reduction and prevention

- Assess health risk from water borne diseases for local communities with emphasis on the gender dimension in the water sector, and conduct an economic valuation of the environmental and socio-economic impacts due to water pollution, including losses to GDP.
- Reduce water pollution through development and implementation of integrated river water pollution abatement plans.

- Develop and implement a regional strategy for addressing point and non-point source pollution from contaminated sites and agricultural activities, including demonstration projects for BEP.
- Implement demonstration projects on the use of the best available technologies in pollution prevention and treatment for municipal sources.

2.3 Harmonization of Water Quality Standards

- Adopt harmonized national WQ standards in line with the EU WFD and international best practices.
- Introduce a unified water quality assessment system and harmonize methods and procedures for laboratory analysis for different polluting substances, including inter-laboratory testing.
- Develop a common water quality index and related river basin status assessment criteria.
- Improve data sharing on water quality in regional technical task force(s).

WRO III To achieve and maintain ecosystem status whereby they provide essential environmental and socio-economic services in a sustainable manner in the Kura-Ara(k)s River Basin

3.1 Monitoring and assessment of the status of riverine aquatic ecosystems

- Develop and implement national aquatic and riverine biological and environmental monitoring & assessment programs, interlinked at the regional level, including harmonized data collection, analysis and assessment, to be updated regularly.
- Conduct economic valuation of ecosystem services in support of improved decision making and public awareness.
- Support the mainstreaming of aquatic and riverine ecosystem concerns into sectoral economic development (agriculture, hydropower, forestry etc.), by means of implementation support to National Biodiversity Action plans, intersectoral cooperation and planning, in line with the Water Nexus approach towards improved environmental security.

3.2 Improved sustainable use of natural resources

- Assessment and update of legal and policy mechanisms for the protection of areas of ecological significance to river system health.
- Public awareness raising on the sustainable use of floodplain forest, wetlands, and riverine ecosystems, focusing on ecosystem services provided as well as the protection and use of endemic, migratory and rare flora and fauna species.
- Strengthen EIA and SEA procedures towards a more complete, transparent assessment of development impacts on surface and groundwater, and aquatic and riverine ecosystem services and their values, for use in decision making processes on (sectoral) economic development.
- Conduct demonstration project on opportunities for mainstreaming river system biodiversity conservation and sustainable use of biological resources for economic development and production processes with public/private partnerships.

3.3 Restoration of Riverine Ecosystems

- Assess, update and implement environmental flows in different sub-basins in line with international best practices, including flow assessment & design, legislative support, monitoring and enforcement.
- Implement river restoration plans at critical sites for improved ecosystem services, water supply and safety, to enhance surface and groundwater management in line with environmental security priorities.

WRO IV To achieve mitigation of adverse impacts of flooding on infrastructures, riparian ecosystems and communities

- Conduct a preliminary floods risk assessment for the South Caucasus, including flood hazard and flood risk maps in line with the EU Floods Directive.

- Develop flood risk management plans including early warning systems for national and transboundary areas in line with the EU Floods Directive.
- Strengthen linked crisis response centers for flood hazard mitigation equipped with flood forecasting capacity and response equipment.
- Develop community action plans for flood responses, and train the local communities in most vulnerable areas.
- Conduct demonstration projects to reduce flood severity by developing floodplain buffer zone rehabilitation plans, implemented at key pilot sites.

Additional recommendations:

- Review of the suitability of the Nexus approach towards inter-sectoral, transboundary water management in the Kura Ara(k)s river basin.

Climate Change

- Implementation of climate change adaptation measures towards improved water resources management for food, water, energy and environmental security.
- Improved knowledge and understanding of expected impacts of climate change of relevance to targeted stakeholder groups, towards strengthening sustainable climate change adaptation including annual regional meetings of decision makers and researchers to plan climate change adaptation measures in line with IWRM, and share results of tested mechanisms.
- Implement public awareness measures to highlight local adaptation strategies.

1. INTRODUCTION

The UNDP/GEF Project "Reducing Transboundary Degradation in the Kura Ara(k)s River Basin" is a Full Sized Project (FSP) with the participation of Armenia, Azerbaijan and Georgia. In accordance with GEF International Waters Best Practices, the project has undertaken a "Transboundary Diagnostic Analysis" (TDA). The objective of the TDA is to identify and agree on the main water-related transboundary issues in a river basin, to develop a thorough understanding of these issues, and determine what actions should be taken by the riparian countries to address these. This Updated TDA is the final stage of a process initiated under the Project Development Fund - B (PDF-B) phase of the project, implemented between 2005 and 2007. The Updated TDA is based on the four transboundary issues identified and agreed in the early phase of the project, their status updated based on developments within the basin: (1) Variation and reduction in hydrological flows; (2) Deterioration of water quality; (3) Ecosystem degradation; and (4) Flooding.

In the 6 years between the PDF-B phase and the current implementation phase, significant developments in the basin are shaping the water management priorities of the countries. As part of the Updated TDA, six Desk Studies were conducted: (1) Water Quality Hot-spots; (2) Hydrological flow; (3) Climate change impacts; (4) Socio-economic trend analysis; (5) Gender mainstreaming in water management; and (6) Floodplain forests - Azerbaijan. Thanks to the generosity of other projects, specifically the EU Project: Transboundary River Management for the Kura River Basin – Armenia, Georgia, Azerbaijan Phase II, and Phase III, and the UNECE Water Quality Assessment, information was available of use for this Updated TDA.

The approach for the Updated TDA is in line with the Best Practices for TDAs developed under the UNDP/GEF International Waters: Learning, Education and Resource Network (IW:LEARN) project, as described in the methodology section in **Chapter 2**. Because the current document is an updated document to the 2007 Preliminary TDA, prepared with a gap of 6 years, only the major changes in the region impacting on transboundary water issues were discussed, including institutional developments and newly available information, but not all aspects of the Preliminary TDA were repeated, such as the Stakeholder Analysis.

Chapter 3 provides an updated baseline description of the Kura Ara(k)s river basin. The physical setting reviews the geographic, hydrologic, climatic and ecological conditions. The human setting described populations within the basin, human health and gender issues, as well as the economic setting, providing an update overview of the current development conditions in the basin. The institutional setting provides an overview of the stakeholders involved in the decision-making in the three project countries.

In **Chapter 4**, the main transboundary issues are explored, following a strict analytical set-up. Each section provides a description of the issue, its transboundary relevance, and the existing perception of the issue as a transboundary problem. This is followed by a discussion of the factual evidence on the scope and scale of the issue, and any gaps in evidence hampering a full and systematic assessment. The impacts of the transboundary issue are discussed, to the environment and the socio-economic sectors, introducing the "super impacts" that make the issue relevant to decision makers and society. The causal chain analysis approach is used to identify primary, intermediate and root causes. For each transboundary issue, the impact of the cross cutting issue of climate change is also discussed, based on a review of climate change predictions for the basin. Each section concludes with recommendations for further steps.

In **Chapter 5** an analysis of the linkages and commonalities between the transboundary issues is presented.

Chapter 6 presents national social and sectoral economic and institutional trends, impacting on water management in the coming 5, 10 and 20 years. Trends include the increase in population, and the development of the agricultural, hydropower and municipal sectors throughout the basin.

In **Chapter 7**, national trends are analyzed in the transboundary context, specifically their impact on water resources in the Kura Ara(k)s basin. The costs-benefits of defined future scenarios "business as usual" and "regional water coordination" are assessed. Scenarios examine incentives and barriers facing decision makers, and conclude with recommendations based on the findings of the TDA, defining the basin for a water Nexus assessment for improved food, energy, environmental and water security.

The recommendations and conclusions of the TDA for action are presented in **Chapter 8**, serving to guide the next steps in developing the Strategic Action Program (SAP) advocated by GEF International Waters.

2. METHODOLOGY

2.1. Background

The GEF IW TDA/SAP "best practice" approach underpins the methodology used in the development of any TDA, including for the Kura Ara(k)s river basin. The TDA methodology consists of the following steps: (1) Identification and initial prioritization of transboundary problems; (2) Gathering and interpreting information on environmental impacts and socio-economic consequences of each problem; (3) Causal chain analysis (CCA), including root causes; and (4) Completion of an analysis of institutions, laws, policies and projected investments. The TDA focuses on transboundary problems without ignoring national concerns and priorities, and identifies information gaps, policy distortions and institutional deficiencies. The analysis is cross-sectoral and examines national economic development plans, civil society (including private sector) awareness and participation, the regulatory and institutional framework and sectoral economic policies and practices.

The Preliminary TDA, prepared during the PDF-B phase of the UNDP/GEF Kura Ara(k)s project, assembled information to describe the perceived transboundary problems, though the collection of empirical evidence was challenging and resulted in the PDF-B Version of the TDA, published in January 2007, remaining incomplete. The current 2013 Updated TDA relies on information that is empirically validated and addresses perceptions that are persistent in the region pertaining to the prioritized transboundary issues. The prioritized issues remain largely the same from the Preliminary TDA. The following section will summarize the methodology of the Preliminary TDA and then introduce the approach of the 2013 Updated TDA. The aim of the 2013 Updated TDA is to refine and update the information in the Preliminary TDA, rather than to conduct a complete revision of the Preliminary TDA. Therefore the Preliminary TDA will remain as an important initial effort of the Project, upon which this current version is based.

2.1.1. Identification of priority transboundary issues 2005-2007

The first step in the Preliminary TDA process was to agree on the transboundary problems. The initial stakeholder consultation in 2005 had highlighted the main problems, but it was important for the TDA Technical Task Team (TTT) to revisit them, agree on whether or not the list was complete, examine their transboundary relevance, determine preliminary priorities and examine the scope of each.

The TTT, made up of 16 experts[2] from the riparian countries brainstormed the list of 23 common GEF transboundary problems in order to determine their relevance and transboundary nature in the context of the Kura Ara(k)s river basin. Subsequently relevant transboundary problems were categorized and ranked by TTT members. The priority issues were identified as:

- Variation and reduction in hydrological flow.
- Deterioration of water quality.
- Degradation of ecosystems.
- Flooding and bank erosion.

2.1.2. National TDA Reviews and Thematic Reports

Selected consultants from the TTT and the project team drafted national TDA Reviews and Thematic Reports. The Thematic Reports included the following topics: Socio-economic situation in the Kura Ara(k)s river basin; Legal and institutional framework for the water sector in Armenia, Azerbaijan, Iran and Georgia; Climate change and evaluation of environmental vulnerability; Biodiversity and ecosystems; Water quality; Assessment of land based sources of pollution; Non rational use of water; Irrigation and drainage; Flooding; Aquifer systems; Impacts on the Caspian Sea; and Causal Loop Diagrams of the Transboundary Problems. Each review and report used a similar structure and the consultants were asked to produce reports that: described the particular problem; identified any gaps in knowledge; identified the environmental impacts and socio-economic consequences; detailed the immediate and underlying causes of the impacts and consequences; and listed proposed options for addressing the identified problem. Consequently, the

2 *A full list of the TTT experts is shown in Appendix 3 of the 2007 Preliminary TDA.*

Thematic Reports constituted the main sources of information for the Preliminary TDA. All the Thematic Reports are presented in the Annexes associated with the Preliminary TDA document, together with other key supporting information (e.g. UNDP/SIDA Reports[3]).

2.1.3. Stakeholder Analysis

The Kura Ara(k)s Stakeholder Analysis from the PDF-B phase involved both qualitative and quantitative surveys of stakeholders in the region. These complimentary analyses provided insights into the concerns, priorities and perceptions of stakeholder groups throughout the region. They also identified where tensions or potential tensions could emerge as a result of different expectations and priorities for water use within the basin. The qualitative study was conducted in Armenia, Azerbaijan, and Georgia during summer 2005. Approximately 150 people were consulted in this process from a wide array of local stakeholders including farmers, housewives, municipal and state government officials, shopkeepers, public healthcare providers, school teachers, local ministry officials, municipal water management officials and others. Subsequently a survey-based Quantitative Stakeholder Analysis was conducted in all four South Caucasus countries among 36 different stakeholder groups. A total of 512 surveys were collected and statistically analyzed for trends among and between groups. The full methodological approach can be found in the Annex 12 of the Preliminary TDA.

2.2. Update methodology

There has been a 6-year time span between the Preliminary TDA and the 2013 Updated TDA. During this period there have been many institutional, socio-economic and informational changes in the Kura Ara(k)s region, while also the approach to the TDA and its place within the decision making process have been refined. The methodology adopted for the Updated TDA seeks to benefit from the new information collected by other projects between 2007 and 2013, to review the socio-economic conditions and baseline data in a new light, and to examine the trends that will impact on transboundary issues in the future and to couch these within the new institutional drivers in the region that are shaping the national and regional approaches to ecosystem management.

At the start of the FSP Phase of the UNDP/GEF Kura Ara(k)s project, autumn 2011, technical TDA Workshops were held with National Experts. In each country, 16 National Experts teamed with project staff to discuss the information in the Preliminary TDA. All participants were asked to review the TDA, identify major gaps and informational inconsistencies. They were also asked to identify sources of additional information to update the TDA. A total of 56 national and international experts reviewed the Preliminary TDA. This Updated TDA reflects the recommendations and approaches advocated in that Gap Analysis. A TDA Team was then assembled from project staff and select national experts to update the Preliminary TDA.

2.2.1. Update of the Preliminary TDA

The project TDA Team agreed on the major transboundary issues identified in the Preliminary TDA with the exception of bank erosion. Bank erosion was an issue that was a high level concern for I.R. Iran as it was believed to influence the country’s territorial integrity with Armenia and Azerbaijan. Ongoing bilateral discussions between I.R. Iran and Armenia as well as I.R. Iran and Azerbaijan are addressing this, and as I.R. Iran is currently not involved in the project, it was decided to drop bank erosion from the Updated TDA.

Additionally, as the countries of the Kura Ara(k)s basin move towards alignment with EU Directives, including the transboundary implications included in the EU Water Framework Directive, and as bilateral agreements emerge, the 2013 Updated TDA has the ability to serve the important function of detailing the baseline conditions to the extent possible, identifying national and regional development plans. Further the 2013 Updated TDA is able to strengthen discussions of climate change impacts, as well as linkages between problems. The TDA recommendations, based on the CCAs and TDA Desk Studies, focus on interventions with the most direct and sustainable impact on the problems, serving to mitigate their negative impacts.

---

3 *UNDP/SIDA refers to reports prepared by the UNDP/SIDA component during the PDF-B Phase of the UNDP/GEF Kura Ara(k)s project.*

A key difference in the approach between the Preliminary TDA and the 2013 Updated TDA is that the 2013 version seeks to differentiate perceptions of the problems from the actual empirical evidence. The existing perceptions are important to understand and to put into context, however, in line with TDA methodology updates, the TDA Team elected to identify where the gaps in empirical information exist so that future efforts may more effectively fill these gaps and seek to address the causes of these. It is critical at a time when budgets and time are both limited that efforts are directed towards understanding and addressing the actual problems based on evidence, rather than seeking to repair perceived problems that may not actually exist.

To strengthen information gathering and analysis, a series of Desk Studies have been conducted, integrating national level data for water quality, hydrology and climate change impacts on water resource management, to support the conclusions reached in each chapter addressing a Transboundary Priority Issue.

The 2013 Updated TDA provides guidance while also examining the roots of perceptions on transboundary issues, available empirical evidence, and identifying gaps in factual information, to update the Causal Chain Analyses, to most effectively support reduction of transboundary degradation in the Kura Ara(k)s basin.

2.2.1.1. Basin description settings as baseline

The Basin description in the Preliminary TDA provided a great deal of information based on perceptions of the authors, based on their expertise and experience. The 2013 Updated TDA similarly relies on the expertise of the drafting team, and additionally on reviewing the materials within the Preliminary TDA as well as newly available information, on the web, through the efforts of related projects, as well as the actual national knowledge, using 16 National Experts in each country as intermediate. The baseline data is intended to provide a snapshot of the physical, socio-economic and institutional setting as of 2012-2013.

2.2.1.2. Update of TDA Priority Issues

For defining Transboundary Priority Issues, the 2013 Updated TDA is founded on the information gathered during the Preliminary TDA. In order to distinguish perception from fact, each section presents the materials according to standard scientific protocols. Each section starts with the description of the problem and its transboundary relevance. The discussion then turns to why there is a perception of this problem and what those perceptions are based upon. People believe what they do for a reason, and often they are correct. However there often is a lack of comparable factual evidence that is able to demonstrate the cause and effect relationship. Therefore, once the perceptions are clarified, the available factual evidence is presented. As the project has not conducted independent studies beyond desk reviews for the 2013 Updated TDA, the team members have relied on evidence collected by other projects, on information presented in publications and as provided by statistics services, and systematically verified these whenever possible. In the event that there are gaps in available data, this has been noted.

2.2.1.3. Causal Chain Analyses

For each transboundary issue the Causal Chain Analysis built on the methodology employed during the Preliminary TDA. The environmental impacts caused by the transboundary issue are discussed, as are the socio-economic impacts. Where possible and relevant, a “super impact” has been identified, to highlight the importance of these impacts in a direct manner to clarify why transboundary issues need to be addressed.

The Causal Chain Analysis also explores the primary, intermediate and root causes of the transboundary issue, focusing on those that are most direct and critical. The CCAs emphasize causes that can effectively be addressed to mitigate the problem as well as the “super impacts”, so that there is a clear motivator for measures towards improvement at the national and regional level. The TDA Team has removed excessive complication from the CCAs to emphasize the most critical and direct mode to address issues problems.

2.2.1.4. Regional development trends

The 2013 Updated TDA also provides an analysis of the anticipated trends that will impact on water resources use and environmental conditions in the basin, including trends in climatic variation, in social and demographic trends and sectoral trends for agriculture, hydropower and municipal water development. The analysis is based on a Desk Study that examines these issues in greater detail. It provides the foundation for the future scenarios of “Business as Usual” and “Regional Coordination of Water Resources Management”, which serve as an initial step towards a more complete Nexus approach for food, energy, environmental and water security, an important assessment tool for decision makers and water managers at all levels.

2.2.1.5. Climate change, linkages and recommendations

The Updated TDA has taken advantage of increased knowledge and understanding of climate change in the region, and addresses the anticipated impacts on the major transboundary issues. As transboundary issues are not isolated, but often overlap and have causal and correlative relationships, the Updated TDA identifies these relationships, to better understand the dynamics and to more effectively target the recommended interventions. The climate change and development scenarios serve to share the recommendations that will be most effective for improvement and sustainable development of the Kura Ara(k)s river basin ecosystems.

The regional recommendations also include a review of interventions which humans currently control (social, economic, institutional) and those which will occur even if all mitigation efforts are employed today at the global level, specifically climate change impacts. In light of these two sets of variables, the recommendations are set into socio-economic and institutional responses to these challenges, as are the risks and incentives for coordination and for non-coordination of actions at the national, regional and international levels.

2.2.2. Additional thematic studies

In line with the Project Document and the TDA Gap Analysis, a series of technical reports have been prepared in order to update the TDA information in support of the national IWRM plans and specifically of the development of the SAP. These reports address the following topics:

- **Climate Change Impacts and Adaption Measures**: Drawing on national, regional and international developments in climate science focusing on climate change scenarios and forecast modeling, the Climate Change Impacts and Adaptation Measures Desk Study examines the anticipated impacts related to transboundary ecosystem management in the Kura Ara(k)s basin.
- **Hydrological Flow**: During the Preliminary TDA there was difficulty in assembling hydrological flow data to accurately reflect what flow data exists, what changes in flow have taken place over the last decades, how future plans will impact the flows, and what steps may be taken to more accurately systematize flow data management across the region. The current Desk Study provides an overview of the state of knowledge, based on national and international sources.
- **Gender Mainstreaming in Water Management:** In 2004 the UNDP/SIDA conducted an initial study on Gender in Water Management in the Kura Ara(k)s river basin. It was agreed during the Gap Analysis that an additional, updated study is warranted that will focus on strategies for improving Gender Mainstreaming into Water Management, as the institutional developments throughout the region provide opportunities to more effectively address this issue.
- **Floodplain Forest Study – Azerbaijan:** In line with the decision of the Project Steering Committee, the TDA Team is conducting a study of floodplain forests for Azerbaijan. The Government of Azerbaijan has plans to restore the forests significantly in the coming decade and this study may provide support in terms of describing the actual state of floodplain forests, their important role in flood management, ecosystem preservation, and support to local livelihoods, especially in the areas between Mingechevir and Gardabani in Georgia.
- **Socio-economic Trend Analysis:** The Preliminary TDA examined socio-economic trends from a historic perspective, but did not address future plans that will impact water management. Within the UNDP/GEF Kura Ara(k)s project the National IWRM Plans will be addressing this at the national level, however for the TDA to be most effective as a guidance document, it will be useful to have the basin wide development plans included in the trend analysis. The summary of this will appear in the final 2013 Updated TDA, but a more detailed report examining the multiple sectors reliant on water resources will provide support for decision making at both the national as well as the regional level.
- **Hot Spots Report on Water Quality:** The issue of transboundary water quality deterioration has been challenging to the region since the collapse of the Soviet Union. In line with the decision of the Project Steering Committee, the Project’s Senior International Expert conducted a desk study, using national level data to identify the major trends in water quality in the basin. The findings of this analysis are presented in the Desk Study as well as summarized in Chapter 4 of the TDA.

2.2.3. List of 2007 Preliminary TDA Thematic Reports

Beglarashvili N.A. & E. Elizbarashvili, 2006. Climate change and evaluation of environmental vulnerability in the Kura Aras basin. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report, 35 pp.

Anonymous, 2006a. Water quality in the Kura-Aras river basin. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report, 45 pp.

Anonymous, 2006b. Assessment of pollution from land-based sources in the Kura Aras river basin. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report, 65 pp.

Anonymous, 2006c. irrigation and drainage. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report, 26 pp.

Anonymous, 2006d. Diagnostic analysis of floods in the Kura-Aras river basin. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report, 19 pp.

Anonymous, 2006e. Groundwater resources of the Kura-Aras river basin". UNDP/GEF TDA Thematic Report, 58 pp.

Anonymous, 2006f. Impacts on Caspian Sea. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report.

Anonymous, 2006g. Causal Loop Diagrams of the Transboundary Problems. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report.

Anonymous, 2006h. Legal and institutional framework for the water sector in Armenia, Azerbaijan, Iran and Georgia. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report.

Anonymous, 2006i. Socio-economic situation in the Kura-Aras River Basin. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report.

Anonymous, 2006j. Non rational use of water. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report.

Tarkhnishvili D., 2006. Biodiversity and ecosystems of the Kura-Aras river basin. UNDP/GEF "Reducing Trans-boundary Degradation of the Kura-Aras River Basin", Preliminary TDA Thematic Report, 32 pp.

3. BASELINE DESCRIPTION OF THE BASIN

3.1. Physical setting

3.1.1. Geographic features

The Kura Ara(k)s river basin is located on the territory of 5 countries: Armenia, Azerbaijan, Georgia, Iran, and Turkey. The basin includes the eastern half of Georgia; about 70% of Azerbaijan, excluding the northeast of the country and the Lenkoran region; the entire area of Armenia; the northwestern part of Iran and northeast Turkey. A map of the Kura Ara(k)s Basin is shown in Figure 3.1.1.1.

The total area of the Kura Ara(k)s basin is assessed as 190,190 km^2, including the closed drainage areas in eastern Azerbaijan – the Mugano-Salyanskaya steppes and the Eastern Shirvan. Table 3.1.1.1 presents the distribution of the Kura Ara(k)s basin in the riparian countries.

Table 3.1.1.1 Territorial structure of the Kura Ara(k)s river basin.

Country	Total country surface in 2010 (km^2)*	Country surface area in basin (km^2)**	% of country	% of basin
Armenia	29,740	29,740	100.0	15.6
Azerbaijan	86,600	60,020	69.3	31.6
Georgia	69,700	34,560	49.6	18.2
Turkey	783,560	28,790	3.7	15.1
Iran	1,745,150	37,080	2.1	19.5
Total	**2,714,750**	**190,190**	**7.0**	**100.0**

*Notes: * Source: World Bank (2012); ** Source: FAO (2009).*

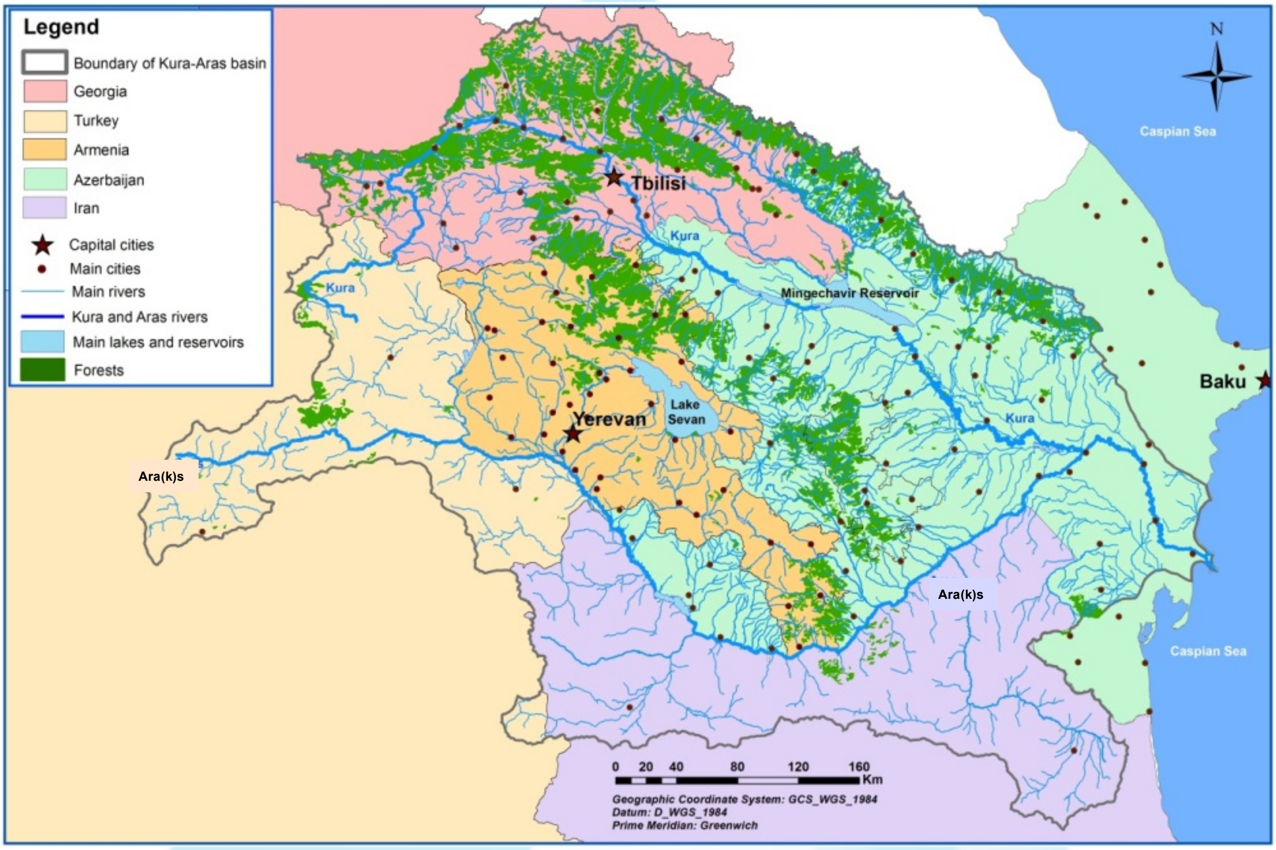
The Kura Ara(k)s basin divides in 4 distinctive regions - the Greater Caucasus mountain range in the north of the basin, the central Transcaucasian Depression with the Kura and lower Ara(k)s river valleys, the southern Lesser Caucasus mountains range, and the south-western highlands (Williams *et al.*, 2006).

The Greater Caucasus mountain range extends over nearly 1,500 km from the Black Sea to the Caspian Sea, and divides into segments - the Western, Central, and Eastern. The Central and Eastern Greater Caucasus form the northern border of the Kura Ara(k)s basin. The highest peaks in the Central Caucasus are the Elbrus (5,642 m) and the Kazbegi (5,033 m) mountains, which include also the largest glaciers. In the Eastern Caucasus the highest peaks are the Tebulosmta (4,493 m) and the Bazar Duzi (4,466 m). In the Lesser Caucasus mountain range absolute elevations are significantly lower – the highest peaks are the Aragats (4,090 m) in Armenia and the Gyamish (3,724 m) in Azerbaijan. To the south-west the Lesser Caucasus range is bordered by the Ara(k)s valley, forming the administrative border between Armenia and Turkey, Azerbaijan and Turkey, Armenia and Iran, as well as Azerbaijan and Iran (Williams *et al.*, 2006).

3.1.2. Geology

The present-day structure of the Caucasus (figure 3.1.2.1) is largely determined by its position between the still converging Eurasian and Africa-Arabian lithospheric plates, within a wide zone of continental collision. The main tectonic units or terrains distinguished include the Scythian (pre-Caucasus) young platform, the fold-thrust mountain belt of the Great Caucasus including zones of the Fore Range, Main Range, and Southern Slope, the Transcaucasian intermountain depression, the Achara-Trialeti and the Talysh fold-thrust mountain belts, the Artvin-Bolnisi rigid massif, the Loki (Bayburt)-Karabakh-Kaphan fold-thrust mountain belt, the Lesser Caucasus ophiolitic suture, the Lesser Caucasian part of the Taurus-Anatolia-Central Iranian platform, and the Ara(k)s intermountain depression at the extreme south of the Caucasus. The youngest structural unit is composed of Neogene–Quaternary continental volcanic formations of the Armenian and Javakheti plateaus (highlands) and extinct volcanoes of the Great Caucasus – Elbrus, Chegem, Keli, and Kazbegi (Adamia *et al.*, 2011).

Figure 3.1.1.1 Geographical map of the Kura Ara(k)s river basin.



Note: Prepared by the UNDP/GEF Kura Ara(k)s project (2012).

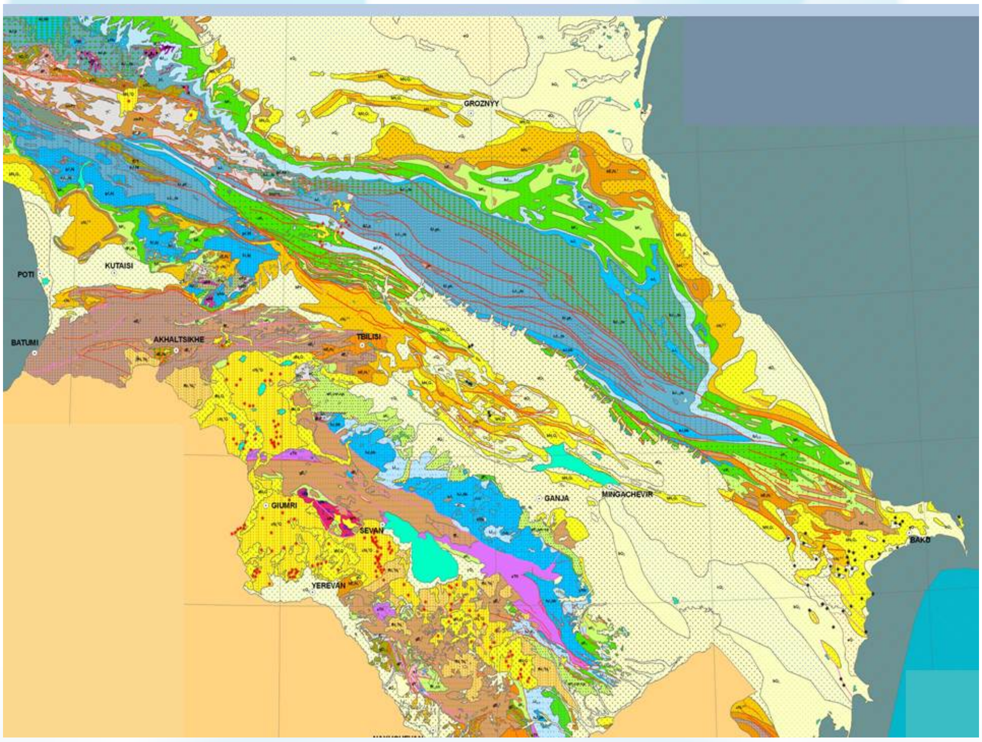
The most recent geological history of the region started during the Late Proterozoic–Early Cenozoic, when the region belonged to the Tethys Ocean and its Eurasian and Africa-Arabian margins. The area was characterized by a system of island arcs, intra-arc rifts, and back-arc basins typical for the pre-collisional stage of the region's evolution (Adamia *et al.*, 2011). The Caucasus Mountains formed ca. 28.5–23.8 mln years ago as the result of tectonic plate collisions between the Arabian plate moving northward and the Eurasian plate. The mountain system forms a continuation of the Himalayas, which are being pressed upwards in a similar collision zone between the Eurasian and Indian plates. The region also reflects some of the same characteristics as the younger mountains of Europe. Structurally the Greater Caucasus represents a great anticline (upfold area) uplifted at the margin of the Alpine geosyncline, subsequently altered by fresh cycles of erosion and uplift. Hard, crystalline, metamorphic rocks such as schists and gneisses, as well as granites that predate the Jurassic Period (i.e., older than 200 mln years), have been exposed at the core of the western sector, while softer, clayey schists and sandstones of Early and Middle Jurassic origin (about 200 to 160 mln years ago) have emerged in the east. From the Late Miocene (c. 9–7 mln years) to the end of the Pleistocene, in the central part of the region, volcanic eruptions in sub-aerial conditions occurred simultaneously with the formation of molasse troughs (figure 3.1.2.2) (Adamia *et al.*, 2011).

The structures of the Lesser Caucasus and the Armenian Highland likewise originated from folds uplifted from the Alpine geosyncline. Whereas the western sector of the Lesser Caucasus and the Talysh in the far southeast are formed chiefly of deposits laid down about 50 mln years ago during the downwarp episode of the geosyncline, the central and eastern sectors of the Lesser Caucasus consist of sedimentary strata with areas of intrusive volcanic rock that is at least twice as old. Geologically recent volcanism and contact metamorphism have played everywhere a great role in shaping the landscape. The folded base of the Javakheti Range and of the Armenian Highland, for example, is masked by volcanic debris from eruptions that occurred in the Cenozoic Era, but to the east much older rocks emerge between the middle course of the Ara(k)s river and Lake Sevan. The Kura Ara(k)s lowlands is a structural depression between the anticlines of the Greater and Lesser Caucasus, related to the formation of the Caspian Sea.

Figure 3.1.2.1 Physical map of the Caucasus and adjacent Black Sea-Caspian Sea region.

Source: Adamia et al. 2011.

Figure 3.1.2.2 Geological map of the Caucasus.



Source: *Adamia et al. 2011.* ***Legend:*** *light yellow - Quaternary; yellow – Neogene-Lower Quaternary; light orange – Middle-Upper Miocene; orange – Oligocene-Miocene; light brown – Paleocene-Eocene; light green – Upper Cretaceous; green – Lower Cretaceous; light blue – Middle-Upper Jurassic-Lower Cretaceous; blue – Middle Jurassic; dark blue – Lower-Middle Jurassic; light purple – Triassic; purple – Mesozoic; brown – Permian; grey – Middle-Upper Carboniferous-Permian; yellow green – Cambrian-Triassic; dark purple – Neo-Proterozoic-Paleozoic.*

3.1.3. Hydrogeology

Due to the diversity of natural environments (relief, climate) and geological structure (composition, folding), the hydrogeological conditions controlling the occurrence and flow of groundwater in the South Caucasus are extraordinarily complex (Mkheidze, 2010). The mountainous regions, formed of Mesozoic-Cenozoic rocks, are characterized by significant relief, thick weathering zones, fractured sediments, thin mantles of deluvial/eluvial loam, as well as river valleys and small troughs filled with alluvial and fluvio-glacial sediments. Groundwater is associated with the weathering zone and tectonic dislocations. Groundwater resources mainly originate from precipitation and melt water in glacier zones (Israfilov & Israfilov, 2011).

The Caucasus fold zone includes hydrogeological regions of special types, delineated based on geological structure and water-bearing features of the rocks, including: platform, intermountain, slope and medial artesian basins (porous, fissure-porous and fissure-karstic), hydrogeological massifs as well as volcanogenic basins (porous-fissure groundwater in lava). According to recent principles of hydrogeological zoning, and considering the varied geological and hydrogeological structure of folded zone of the Caucasus, hydrogeological regions of the 1st, 2nd and 3rd hydro-chemical zones and sub-zones are being delineated, in: "Schematic map of Caucasus hydrogeological zoning and hydrochemical zonality" (Mkheidze, 2010).

Table 3.1.3.1 below shows the delineated hydro-geological basins of the South Caucasus countries that are part of the Kura and Ara(k)s river basins, with detailed information on tectonic structure, lithological composition, geomorphology as well as flow rates (UNDP/GEF, 2007). Figure 3.1.3.1 shows that many of the groundwater aquifers in the Kura Ara(k)s basin as transboundary, and as with the majority of surface water, also a large part of the groundwater has the natural tendency to flow from Georgia and Armenia towards Azerbaijan (Alakbarov & Imanov, 2010).

Table 3.1.3.1 Hydro-geological basins in the main geo-structural zones of the South Caucasus.

	Greater Caucasus	Lesser Caucasus	Kura Ara(k)s lowland
Armenia	--	1. Basins of the northern and southern folding and block folding ridges 2. Basin of the central volcanic plateau 3. Ararat basin 4. Sevan basin	--
Azerbaijan	1. Greater Caucasus basin of pore and fracture water 2. Shamakhy-Gobustan Lesser Caucasus basin of pore/stratal and fracture water 3. Apsheron peninsula basin of pore and stratal water 4. Samur-Gusarchay basin of pore and stratal water	1. Lesser Caucasus basin of pore and fracture water 2. Nakhchivan basin of pore and fracture water 3. Talysh basin of pore and fracture water	1. Sheki-Zakatala basin of pore and stratal water 2. Gianja-Kazakh basin of pore and stratal water 3. Karabakh basin of pore and stratal water 4. Mili basin of pore and stratal water 5. Jebrail basin of pore and stratal water 6. Nakhchevan basin of pore and stratal water 7. Shirvan basin of pore and stratal water 8. Mugano-Salyan basin of pore and stratal water 9. Basin of pore and stratal water of Jeyranchel foothills of Neogene origin 10. Ajinoura basin of pore and stratal water
Georgia	1. Kazbegi-Mtatusheti basin of pore and fracture water 2. Mestia-Tianeti basin of – basin of pore and fracture water 3. Fracture water basin of Keli-Kazbegi lava sheets	1. Akhaltsikhe basin of pore and fracture water 2. Tbilisi basin of pore and fracture water 3. Trialeti basin of pore and fracture water 4. Samtskhe-Javakheti basin of pore and fracture water	1. Krtli basin of pore and stratal water 2. Alazani basin of pore and stratal water 3. Iori-Shiraki basin of pore and stratal water 4. Marneuli-Gardabani basin of pore and stratal water

Source: UNDP/GEF (2007).

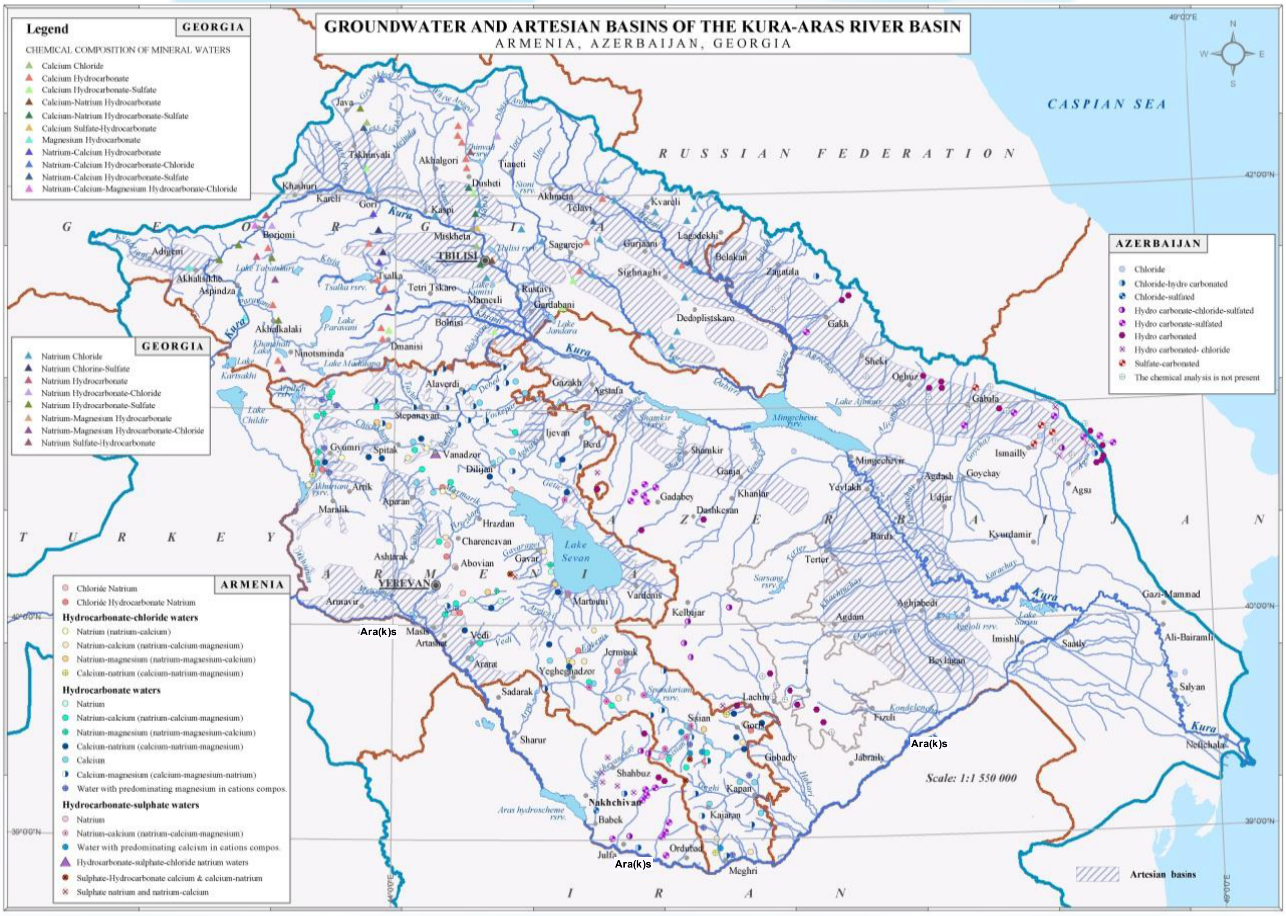
Aquifers of the Greater Caucasus fold zone occur in Georgia and in northern Azerbaijan. These are mostly represented by terrigenous and carbonaceous flysch of the Upper and Lower Cretaceous and Upper Jurassic periods, as well as by shale strata of the Middle and Lower Jurassic. Due to numerous fractures and karsts, limestone and sandstone are highly permeable and saturated with water. Upper Cretaceous and upper Jurassic carbonaceous flysch limestone sediments show the highest flow rates, up to 15-70 l/s, while terrigenous flysch sandstone and shales show low flow rates, 6 l/s to 0.2 l/s respectively (UNDP/GEF, 2007).

High discharge values (5–10 l/s.km^2 and up) are characteristic for the fractured rocks of the volcanic massifs of the Caucasus, whose elevated position creates favorable conditions for groundwater recharge and discharge. The Paleogene-Neogene and Quaternary sandy and clayey deposits of the Kura lowland have smaller groundwater resources: discharge values rarely exceed 0.3–0.5 l/s.km^2 (Zektser & Everett, 2004).

In Georgia, fresh groundwater resources within the Kura catchment total about 22 mln m^3/day (255 m^3/sec), or 8 km^3/year, of which about 50% originates in the Greater Caucasus, 25% in the Lesser Caucasus, and 25% in the Kura depression. Over 70% of the resources are concentrated exclusively in high mountain areas and are difficult to use technically and financially (UNDP/GEF, 2007). In Azerbaijan, the average annual volume of potentially usable fresh and low-mineralized groundwater is about 24 mln m^3/day, or about 10 km^3/year (Alakbarov & Imanov, 2010). In Armenia, the available fresh groundwater resources are assessed at about 11 mln m^3/day (127 m^3/s), or 4 km^3/year. The annual strategic subsurface water resource is estimated as 1,100 mln m^3. Secured usable resources of groundwater from 34 deposits in Armenia total 102.27 m^3/s, used for drinking, irrigation and other economic purposes. These resources are associated with surface waters and their use would respectively reduce the surface runoff (UNDP/GEF, 2007).

In the Greater Caucasus, groundwater aquifers are mainly fresh – from 0.1 to 0.6 g/l, mainly of hydrocarbonate, calcium, sodium-magnesium, and calcium-sodium types, depending on the lithology. In the Lesser Caucasus, mineralization in general is also low, but water types are more differentiated (UNDP/GEF, 2007).

Figure 3.1.3.1 Groundwater aquifers and artesian basins in the Kura Ara(k)s basin.



Source: UNDP/GEF (2007).

Since the second half of the 20th century significant changes in the surface-groundwater balance are observed. The construction of reservoirs on rivers and the expansion of irrigation canals for irrigated agriculture seriously increased the share of river water in the recharging of groundwater. Whereas in natural conditions river water infiltration mostly occurred directly in the riverbed, and remaining water was transited from an area, after the irrigation systems were constructed a significant part of the river water was dispersed over a large areas, thus increasing the share of river water infiltration (UNDP/GEF, 2007).

On the other hand, the thousands of wells drilled into confined aquifers in the Kura Ara(k)s basin also affected unconfined aquifers, due to a redistribution of the groundwater within the subsurface system itself. Both due to direct (over)irrigation as well as due to leakages along irrigation canal, a significant part of the irrigation water infiltrates into the unconfined groundwater. Typically water levels rise closer to the surface, locally causing flooding and swamping of lands. The increased groundwater level below irrigated areas fosters also secondary salinization of arid lands. Together with the water also pollutants, mineral and organic fertilizer components migrate into the groundwater (UNDP/GEF, 2007).

The occurrence of any groundwater pollution is directly related to the pollution status of the major feeding sources, including surface water and soils. Specific data however on the current status of groundwater pollution throughout the basin are not available (UNDP/GEF, 2007). At the same time groundwater resources in the Kura Ara(k)s basin are used by a majority of the population as the main source of drinking water, either centralized or from individual wells and springs.

Although in the past extensive hydro-geological inventories have been carried out, and general descriptions of artesian and confined water-bearing layers are available (*e.g.* UNDP/GEF, 2007; Kharatishvili-Gabesidze, 2011), in general the actual overall volumes, acceptable sustainable use volumes and chemical quality of groundwater resources in the South Caucasus is insufficiently known, and their ecological state is also not fully studied. In Georgia, no groundwater monitoring program is in place at the moment. In Azerbaijan and Armenia monitoring is on-going, although significantly less than during the Soviet Era.

3.1.4. Hydrology

The Kura is the main river in the South Caucasus, its length being 1,515 km. The river originates at a height of 2,740 m in the Kizil Giadak mountain range in north-eastern Turkey. Winding through mountainous regions in Turkey and Georgia, it transverses the Kura Ara(k)s lowlands in Azerbaijan towards its outflow into the Caspian Sea, at -27 m. Global Sea Level (GSL). It is fed by snow (36%), ice melt water from glaciers (14%), underground sources (30%) and rain (20%) (Mammadov & Verdiyev, 2009). The river discharge during the spring flooding period – March/April to June - amounts to 50-60% of the total annual discharge, triggered by intensive snow melt and spring rains (Abbasov & Smakhtin, 2009). About 20-25% of the yearly water volume is discharged during the summer-autumn period, and 20-25% in winter. Key tributaries are:

In Georgia: Paravani/Potskhovistskali (Transboundary TB with Turkey), Liakhvi, Aragvi, Debed-Khrami (TB Armenia).

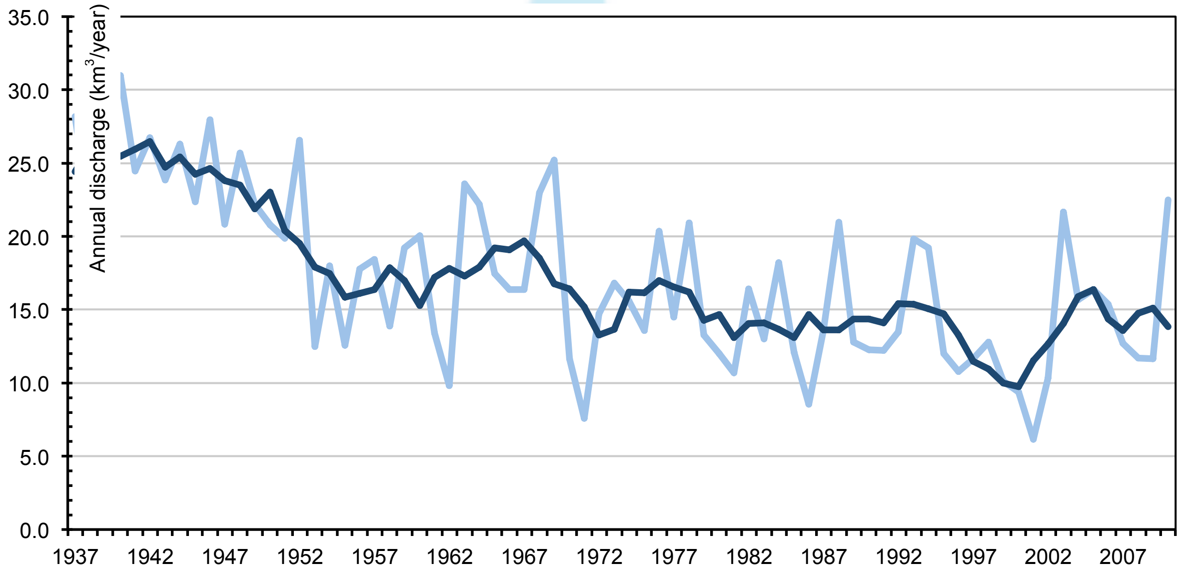
In Azerbaijan: Debed-Khrami (TB from Armenia through Georgia), Iori/Qabirri (TB Georgia), Alazani/Ganikh (TB Georgia), Aghstev/Agstafachay (TB Armenia).

The main tributary of the Kura is the Ara(k)s, originating in the Erzurum Province in eastern Turkey. The Ara(k)s river transverses the Armenian uplands, bordered by the Lesser Caucasus mountain range to the north and the Karadag-Talish mountain range to the south, towards its confluence with the Kura at Sabirabad, Azerbaijan. The length of the Ara(k)s river is approximately 1,070 km. Key tributaries include:

In Armenia: Akhuryan (TB Turkey), Hrazdan, Arpa (TB Azerbaijan), Vorotan/Bazarchay (TB Azerbaijan), Voghji/Okhchu (TB Azerbaijan).

Under natural conditions – before flow regulation and the expansion of water consumption - the average yearly river discharge into the Caspian Sea is assessed to have varied between 25-30 km^3, of which the major portion of about 20 km^3 originated from the riparian states located upstream Azerbaijan, while about 10 km^3 of river flow was generated within the Azerbaijan Republic (Imanov et al., 2009). Figure 3.1.4.1 presents the long-term record of discharge measured at Surra (Azerbaijan), downstream of the confluence of Kura and Ara(k)s rivers. Figure 3.1.4.1 clearly shows the impact of human economic expansion in the mid-20th century – a reduction of annual river discharge in the downstream Kura Ara(k)s river, caused by reservoir construction (with related increased evaporation) and increased water intake, largely for irrigation.

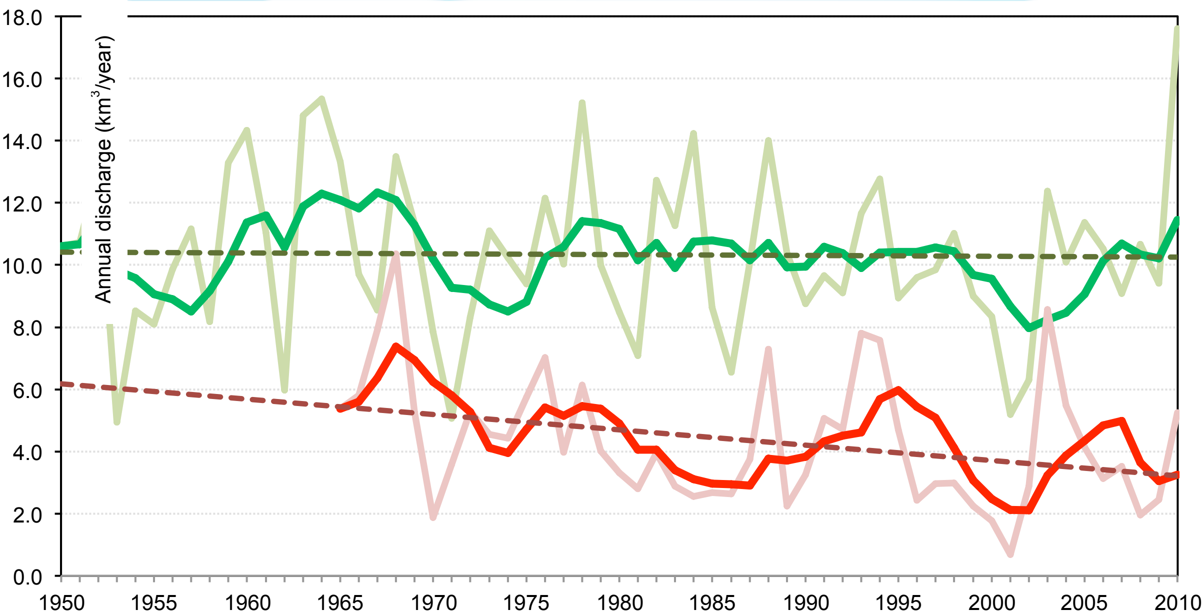
Figure 3.1. ***Annual discharge of the Kura Ara(k)s river in the 20th century at Surra, Azerbaijan.***



Source: Azerbaijan Hydro-meteorological Department, Ministry of Ecology and Natural Resources.

The average yearly discharge of the Kura river upstream of its confluence with the Ara(k)s river for the period 1950-2010 is 10.3 km^3 (hydro-post Zardab, Azerbaijan), while the average yearly discharge for the Ara(k)s River in the period 1965-2010 is 4.3 km^3 (hydro-post Novruzlu, Azerbaijan) (Figure 3.1.4.2). It needs to be taken into account that these flow data are not corrected for annual water intake for consumption, irrigation etc., the total volumes of which are significant – 12 km^3 for Azerbaijan in 2011 (AzerStat, 2012).

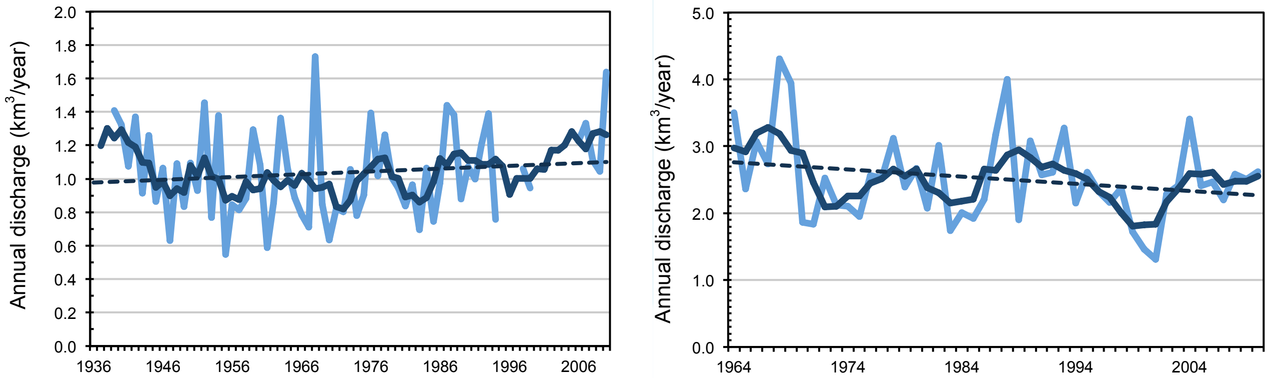
Figure 3.1.4.2 ***Total annual discharge for the Kura and Ara(k)s rivers in Azerbaijan.***



Source: Azerbaijan Hydro-meteorological Department, Ministry of Ecology and Natural Resources. Legend: Kura river at Zardab (Azerbaijan) - green line; Ara(k)s river at Novruzlu (Azerbaijan) - purple line; period – 1950 to 2010; Bold lines – 5 years running mean; light-colored lines – yearly total discharge; dashed lines – linear trend.

Hydrographs times series for the two most upstream monitoring stations in Georgia (Khertvisi) and Armenia (Surmalu) are presented in figure 3.1.4.3.

Figure 3.1.4.3 Total yearly discharge for upstream Kura and Ara(k)s monitoring stations.



Note: Left graph – Kura river at Khertvisi (Georgia); Right graph – Ara(k)s river at Surmalu (Armenia). Sources: Khertvisi – Georgia National Environment Agency, Surmalu - Hydro-meteorological Survey Armenia.

Table 3.1.4.1 Overview of the main lakes in the Kura Ara(k)s river basin.

Name	Surface area (km^2)	Stored volume (x 1,000 m^3)	Origin
Kura river basin			
Azerbaijan *			
Mingechevir reservoir	605.0	15,730,000	Artificial
Lake Sarisu	67.0	60,000	Natural
Lake Ag-gyol	56.2	44,700	Natural
Lake Mehmangyol	35.0		Natural
Shamkir Reservoir	116.0	2,677,000	Artificial
Yenikend Reservoir	23.2	158,000	Artificial
Varvara Reservoir	22.5	60,000	Artificial
Georgia			
Tsalka Reservoir	33.7	312,000	Artificial
Paravani Lake	37.5	90,800	Natural
Jandara Lake	12.5	54,280	Natural
Sioni Reservoir	12.8	325,400	Artificial
Zhinvali Reservoir	11.5	520,000	Artificial
Tabatskuri Lake	14.2	221,000	Natural
Samgori Reservoir (Tbilisi Sea)	11.6	308,000	Natural
Ara(k)s river basin			
Armenia			
Lake Sevan (*2012 estimate*)	1,276.6	37,950,000	Natural
Lake Arpi	22.0	105,000	Artificial
Akhuryan reservoir	41.8	525,000	Artificial
Spanderian reservoir	11.7	257,000	Artificial
Tolors Reservoir	4.7	96,800	Artificial
Azerbaijan			
Khudafarin Reservoir	20.0	1,612,000	Artificial
Aras Su Reservoir	145.0	1,350,000	Artificial
Arpachay Reservoir	6.0	150,000	Artificial

Sources: Azerbaijan – AzerStat; Armenia – Hannan et al. (2013), USAID (2000); Georgia – UNDP-SIDA (2005).

Numerous large and small lakes occur in the Kura Ara(k)s river basin, of natural or anthropogenic origin, the biggest ones of which are listed in table 3.1.4.1. Artificial reservoirs are used mainly for either irrigation or hydro-power generation, or both. Mingechevir reservoir additionally also provides flood control for the downstream Kura river. The largest natural lake in the Kura Ara(k)s basin is Lake Sevan in Armenia, also being the most important water resources "structure", used for irrigation and hydropower generation.

Located in Armenia, Lake Sevan is the largest lake in the Kura Ara(k)s basin, also being the most important water resources 'structure', used for irrigation and hydropower generation. In its natural state it covered 1,416 km^2, storing 58,500 mln m^3. The average annual runoff from rivers in its catchment is 720 mln m^3, while on average an additional 50 mln m^3 enters the lake as subsurface inflow. However, the development of human activities in its basin, mostly in the 1950s, led to a water level decrease of 19 meters, as well as a loss of stored water of 25,500 mln m^3. Despite attempts to restore the lake by means of inter-basin water transfers from the Arpa river since the early 1980s, amounts do not constitute a real resource in itself other than to balance the seasonality of the natural inflows. Nevertheless, the water level has increased by 3.5 m, and in 2012 the Lake Sevan surface area was 1,277 km^2, having a stored volume of 37,950 mln m^3.

In the Kura Ara(k)s region many of the rivers are fed by snow and glacial melt during the late spring and early summer. Research shows that the glaciers are retreating - between 1985 and 2000, glaciers of the region lost 10% of their surface area with more than 90% of the glaciers retreating (Lambrecht *et al*., 2011). Estimates indicate that the glaciers may disappear by 2050, further reducing river flows beyond that expected from increases in temperature and decreases in precipitation alone.

3.1.5. Climate

The climate conditions in the Kura Ara(k)s basin vary both vertically (due to mountainous relief) and horizontally (latitude and longitude). The Greater Caucasus mountain range forms a barrier against the entering of cold air from the north, while prevailing western winds cause warm, moist air from the Black Sea to enter the region. As a result, the climate conditions in the Kura Ara(k)s basin are very heterogeneous, varying from moist temperate in the western foothills via warm temperate in the central areas uplands, wet mountainous, dry subtropical plains to steppe & semi-desert areas in the eastern Caspian coastal zone. The country-averaged mean annual precipitation is 527 mm, 444 mm and 955 mm, respectively in Armenia, Azerbaijan and Georgia, while the country-averaged mean annual temperature is 5.5 °C, 11.5°C and 7.0°C, respectively in Armenia, Azerbaijan and Georgia (Table 3.1.5.1) There is a distinct spring rainfall peak in April – June in all three countries, and a July-August peak in temperature (UNDP/ENVSEC, 2011). According to Vermishev (2010), applying the WMO norms to the standardized period 1961-1990, for Armenia the average annual air temperature is 5.5 °C, while the average annual precipitation is 592 mm.

The climate of Armenia is continental with hot dry summers and cold wet winters, including abrupt daily temperature fluctuations, intensive and abundant solar radiation, and high solar illumination. The average annual air temperature is 5.5°C. The average country temperature in July is 16.7°C, in Ararat Valley varying between 24-26°C. The highest absolute temperature recorded is 43°C. The coldest month is January, with an average temperature of -6.7°C, the absolute lowest temperature recorded being -42°C. The annual precipitation ranges from 1,000 mm in the mountains to <300 mm in the Ararat valley (AM-MNP, 2010).

Climate conditions in Azerbaijan are as varied as in Armenia and Georgia, defined by its topographic heterogeneity within an overall subtropical climatic zone. On average, there are 1900-2900 hours of sunshine annually (approximately 5-8 hours daily sunshine). The annual average air temperature is 14.6°C in the Kura Ara(k)s lowlands and 0°C for high mountain altitudes. In the lowland plains, summers are hot and winters are moderate, while in the mountains the summers are cooler and winter temperatures can reach sub-zero figures. Recorded temperatures have reached a maximum of +46°C, and minimum of -33°C (AZ-NWS, 2011). Humidity tends to be low, although it varies across the country. Annual rainfall on the Absheron peninsular in the west varies between 150-200 mm, whilst in the foothills of the Talysh Mountains in the southeast it averages 1,600-1,700 mm per year. There is less than 400 mm of rainfall each year over 65% of the country. In these semi-desert and dry steppe areas, agriculture is only possible through artificial irrigation (AZ-MENR, 2010a).

In Georgia, climatic differences in the upstream Kura Ara(k)s basin are conditioned by the Likhi ridge, dividing west and east Georgia. To the west the climate varies from humid sub-tropical to permanent ice. The average annual temperature is 14-15ºC, being 6-10ºC and 2-4ºC in the mountainous and high mountainous zones. The average annual precipitation varies between 1,500 and 2,500 mm. The prevalent climate in Eastern Georgia is drier, ranging from arid sub-tropical in the upland plains to alpine in the mountainous regions. The average annual temperature is 11-13ºC in the upland plains and 2-7ºC in the mountains, average annual precipitation ranges from 400-600 mm in the upland plains to 800-1,200 mm in the mountains (GE-MEPNR, 2009a).

Table 3.1.5.1 Country average monthly precipitation and temperature.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av
Country Average Precipitation (1901-2006; mm)													
Armenia	21.5	24.6	41.3	60.0	85.3	73.5	49.7	37.1	36.0	41.3	34.1	22.7	527.1
Azerbaijan	24.9	25.7	40.4	49.8	56.1	50.7	30.2	25.1	37.2	42.5	35.4	25.9	444.0
Georgia	61.2	56.9	63.7	81.1	105.9	112.5	88.9	77.2	81.0	82.3	73.1	70.7	954.6
Country Average Temperature (1901-2006; °C)													
Armenia	-8.6	-6.7	-0.9	6.3	11.5	15.6	19.7	19.6	15.0	8.3	1.5	-5.2	6.3
Azerbaijan	-1.0	0.1	4.3	10.7	16.1	21.2	24.3	23.9	19.3	12.6	6.3	0.8	11.5
Georgia	-5.7	-4.6	0.1	6.9	12.0	15.5	18.6	18.6	14.4	8.7	2.7	-3.1	7.0

Source: UNDP/ENVSEC (2011).

3.1.6. Ecosystems & Biodiversity

Updating the Preliminary TDA showed that information on the actual state of ecosystems and biodiversity is insufficient to fully gauge their status. Many published reports seem to refer to data collected in the pre-1990 Soviet era, if citations are provided at all, and many of them focus either on the Caucasus Biodiversity Hotspot, or the country level, with hardly any information available specifically for the transboundary Kura Ara(k)s river basin. As such, this section presents ecosystems as well as flora and fauna at the country level, defining transboundary implications as feasible, as many of these ecosystems and many of species inhabiting them span beyond national borders.

3.1.6.1. Ecosystems

The major ecosystems of the Kura Ara(k)s basin include glaciers & snowfields, alpine & subalpine meadows, coniferous & broadleaf forests, arid shrub- & wood-lands, steppes, semi-deserts as well as wetlands, including the Kura delta (CERF, 2004; USAID, 2010). These ecosystems harbor a variety of plant and animal species representing a mixture of Mediterranean, Eastern European and Near Eastern floras and faunas, including a high proportion of regional endemics (20-30% in certain taxonomic groups). Main landscapes of the Caucasus Biodiversity Hotspot are shown in figure 3.1.6.1.1.

The large variety of ecosystems found over a relatively small area is due to variations in geology, climate and topography. The lower southern slopes of the Greater Caucasus Range are predominantly covered by broadleaf and coniferous forests, changing into subalpine and alpine meadows, glaciers, and snowfields with increasing elevation. The Transcaucasian Depression is dominated by steppes and arid woodlands in the western Kura Ara(k)s basin, shifting towards semi-deserts and deserts in the east. Relic oaks (*Quercus imeretina, Q. hartwissiana*, *Q. pendunculiflora*) line floodplains and river terraces. The Lesser Caucasus Mountain Chain rises to the south of the Transcaucasian Depression, with broadleaf & coniferous forests, alpine meadows and shrub-lands. The Southern Highlands within the Lesser Caucasus Mountains are characterized by mountain steppe and grasslands, dominated by mixed Eastern Oak (*Quercus macranthera*) woodlands and thorn-cushion steppe vegetation, characterized by species like Golden Milkvetch (*Astragalus aureus*), Horned Sainfoin (*Onobrychis cornuta*), and others (USAID, 2010).

Three main groups of river ecosystems with common hydrographical characteristics can be distinguished: (i) rivers on the southern slopes of the Greater Caucasus fed by glaciers and snow melt, flowing through deep and narrow canyons, and having a considerable hydropower potential; (ii) rivers of the Lesser Caucasus Mountains where surface runoff is comparably negligible, and the river network is less dense, with rivers mainly fed by groundwater springs or water from swampy depressions, characterized by slow flow rates and meandering channels; and (iii) rivers of the Kura Ara(k)s lowland, characterized by an open-spaced river network of steppe watercourses with intensive water diversion for irrigation. Intensive erosion processes and high sediment load are typical for most rivers in the South Caucasian. Mudflows occur in the eastern part of the Southern Caucasian region and in the southwestern part of the Armenian plateau (Yessekin *et al.*, 2006).

The whole of the Kura Ara(k)s basin is part of the Caucasus Biodiversity Hotspot, recognized by Conservation International and the Critical Ecosystem Partnership Fund as one of the 34 critical hotspots in the world (www.biodiversityhotspots.org), Biodiversity Hotspots are typical characterized by a high species richness and endemism while facing serious threats of habitat degradation and loss resulting from human activities.

Forests

Forest ecosystems in the three riparian countries of the Kura Ara(k)s river basin cover about 2,292,600 ha (Figure 3.1.6.1.2). Forests in the Azerbaijan section of Kura Ara(k)s basin cover about 821,200 ha (AZ-MENR 2010a), while the Georgia section of the basin includes 1,128,300 ha (LEPL Agency of Natural Resources - GE-MENR, 2013). The Armenia government states a forest cover of 343,100 ha (ArmStat, 2012). Not all of today's forest is of natural origin, with a certain percentage a result of recent or historical afforestation, predominantly in Armenia (75% of all forests). Forest types predominantly are represented by mountain and foothill natural dry deciduous, broadleaf, and mixed forests (over 80 %) while about only 5-6% of the forests are floodplain forests. The reserve of timber in the mountain forests constitutes 1,000-1,200 m^3/ha in deciduous forests, increasing to 1,800-2,000 m^3/ha in mixed forests (Tarkhnishvili 2006).

Figure 3.1.6.1.1 Main landscape zones in the Caucasus Biodiversity Hotspot.

Source: Williams et al. (2006).

Broadleaf forests dominate in the basin, with typical species including Oriental & Caucasian Hornbeam (*Carpinus orientalis, C. caucasica*), Oriental Beech (*Fagus orientalis*), Sweet Chestnut (*Castanea sativa*), Ash *(Fraxinus excelsior*), Georgian Oak (*Quercus iberica*), Eastern Oak (*Quercus macranthera*), and Caucasian Pine (*Pinus kochiana*). A variety of vascular plant species, many of which are endemic, are found in the forests. Coniferous forests generally occur between 900 to 2,000 m, often on steep slopes, playing an important role in erosion control. Endemic species of Birch (*Betula* spp.) as well as Mountain Ash (*Sorbus caucasigena*), Eastern Oak and Trautvetter's Maple (*Acer trautvetteri*) grow at higher elevations of the Greater Caucasus and northern Lesser Caucasus between 1,800 and 2,500 m. Alpine areas, from 2,500 to 3,000 m, are covered with thickets of relic and endemic Caucasian Rhododendron (*Rhododendron caucasicum*) and with grasslands dominated by herbaceous species, serving as summer pastures for domestic sheep and goat herds. (CERF, 2004; Williams *et al*., 2006; USAID, 2010).

Floodplain forests used to be widespread along the entire valleys of the Kura and Ara(k)s rivers and their major tributaries. The dominating tree species of floodplain forests of the Kura Ara(k)s basin are White Poplar (*Populus alba*), locally - Black Poplar (*Populus nigra*), Ash, willows (*Salix spp.*), Pedunculate Oak (*Quercus pedunculiflora*), and in more humid areas – Alder (*Alnus barbata*). In the undergrowth below the trees typically blackberries (*Rubus* spp.) and scrambling plants such as *Vitis sylvestris* are widely represented (Tarkhnishvili, 2006).

Figure 3.1.6.1.2 Occurrence of forests in the Kura Ara(k)s river basin.

Source: based on Williams et al. (2006).

Steppe & semi-desert

Steppes in the Kura Ara(k)s basin distinguish between highland and lowland plain steppes. At lower altitudes, mountain forests give way to foothill and lowland plain steppes, with tussocks of feather grasses (*Stipa stenophylla, S. capillata, S. lessingiana*), Fescue (*Festuca valesiaca*), Crested Hair-grass (*Koeleria gracilis*), and other species. In non-grazed areas often dry scrubs of Juniper (*Juniper* spp.), Wild Pistachio (*Pistachia mutica*), Almond (*Amygdalus fenzlianum*), Caucasian Pear (*Pyrus caucasicum*), Oriental Apple

(*Malus orientalis*) and other tree species occur, many of which are distant relatives of cultivated species. Highland steppes occur on mountain plateaus with productive chernozem soils, nowadays largely used for arable farming, grazing and haymaking (Williams *et al*., 2006).

Semi-deserts in the eastern Kura Ara(k)s plains are dominated by various species of wormwood (*Artemisia lerchiana*, *A. taurica*, *A. fragrans*). Locally also feather grasses (*Stipa* spp.), Licorice (*Glycyrrhiza glabra*), and Camel's Thistle (*Alhagi pseudoalhagi*) occur. Different species of saltwort (*Salsola dendroides*, *S. ericoides*, *S. nodulosa*) occur on saline soils intermixed with wormwood. Saline semi-deserts are widespread, with Tree-like Saltwort (*Salsosa dendroides*) on slightly saline areas, replaced with increasing salinity by Bluish Saltwort (*Salsosa glauca*) and Small-leaved Seablite (*Suaeda microphylla*), followed by halophytic shrubs (*Halostachys caspica, Kalidium caspicum*, *Halocnemum strobilaceum*) on highly saline soils (Williams *et al*., 2006).

River valley floodplain wetlands

In the central part of the basin, the Kura and Ara(k)s rivers form a broad floodplain, in which historically riparian forests (locally called tugai) lined the riparian zone. Characteristic species include Wing Nut (*Pterocarya pterocarpa)*, Oak (*Quercus robur* subsp. *Pedunculiflora)*) and White Poplar. Most of the natural floodplain area consists of dry steppes with semi-desert vegetation dominated by grass, thorny shrubs and wormwood (*Artemisia* spp.). Artificial reservoirs and natural lakes along the rivers as well as seasonally inundated areas provide significant wetland habitat for migratory and breeding bird populations. Wetland plant communities are dominated by Reed (*Phragmites communis*), Cattail (*Typha angustifolia*) and submerged plants with large biomass providing food for hundreds of thousands of ducks, swans, coots and other resident and migratory bird species, including globally threatened species (USAID, 2010).

3.1.6.2. Flora

The Caucasus Biodiversity Hotspot harbors 7,500 species of vascular plants, about 2,600 (35%) of which are endemic to the region (Zazanashvili & Mallon, 2009). The region shows the highest level of floral endemism in the temperate world, its forests, high mountains, wetlands, steppes and semi-deserts containing more than twice the plant and animal diversity found in adjacent regions of Europe and Asia. (Williams *et al*., 2006). The abundance of relic and endemic plant species in the region is largely due to the absence of glaciation during the last Ice Age, and includes Imeretian and Pontic Oak (*Quercus imeretina, Q. pontica*), Medwedew's Birch (*Betula medwedewii*), Ungern's and Smirow's Rhododendron (*Rhododendron ungernii, R. smirnowii*), Epigea (*Epigaea gaultherioides*), Chestnut-leaf Oak (*Quercus castaneifolia*), Hyrcanic Poplar (*Populus hyrcana*), Danae (*Danaë racemosa*), and others (Williams *et al*., 2006). The floristic zones of the Kura Ara(k)s river basin are shown in figure 3.1.6.2.1.

About 700 species of higher plants are listed in national Red Books of Rare & Endangered Species, including at least 20 kinds of bellflower and 18 kinds of iris. Five species of lichens and 11 species of fungi are also locally endangered. The shrub Tigran's Elder (or Muchlenbergella Overina, *Sambucus tigranii*) is an endemic found sporadically in the Yerevan, Daralagyaz, Aparan, and Shirak floristic regions of Armenia, generally in lower and middle mountain belts on dry rocky and clay soils. It is threatened by habitat loss to development and overgrazing. Tigran's Elder is included in the IUCN Red List as "Vulnerable" (Williams *et al*., 2006), while *Buxus colchica* and *Zelkova carpinifolia* are listed as "Near Threatened" (IUCN, 2011). An updated list of rare vascular species for the Caucasus region is being prepared (Schatz *et al*., 2009).

The wider South Caucasus region is considered a center of origin for a number of globally important food crops. The area is especially noted for fruit and nut trees, and the forests of the Greater and Lesser Caucasus Mountains as well as the Talysh Mountains harbor wild ancestor varieties of apples, persimmons, walnuts, chestnuts, pistachios and many other species that have been domesticated into many different varieties and strains. From an agro-biodiversity standpoint, a number of grains, particularly wheat, have also been developed here, but some are being lost due to changing agricultural practices in the country (USAID, 2010). Besides edible and forage plants species, the flora in the Kura Ara(k)s basin includes also many medicinal, melliferous, oil-bearing and other species of economic value (USAID, 2009a; USAID, 2009b).

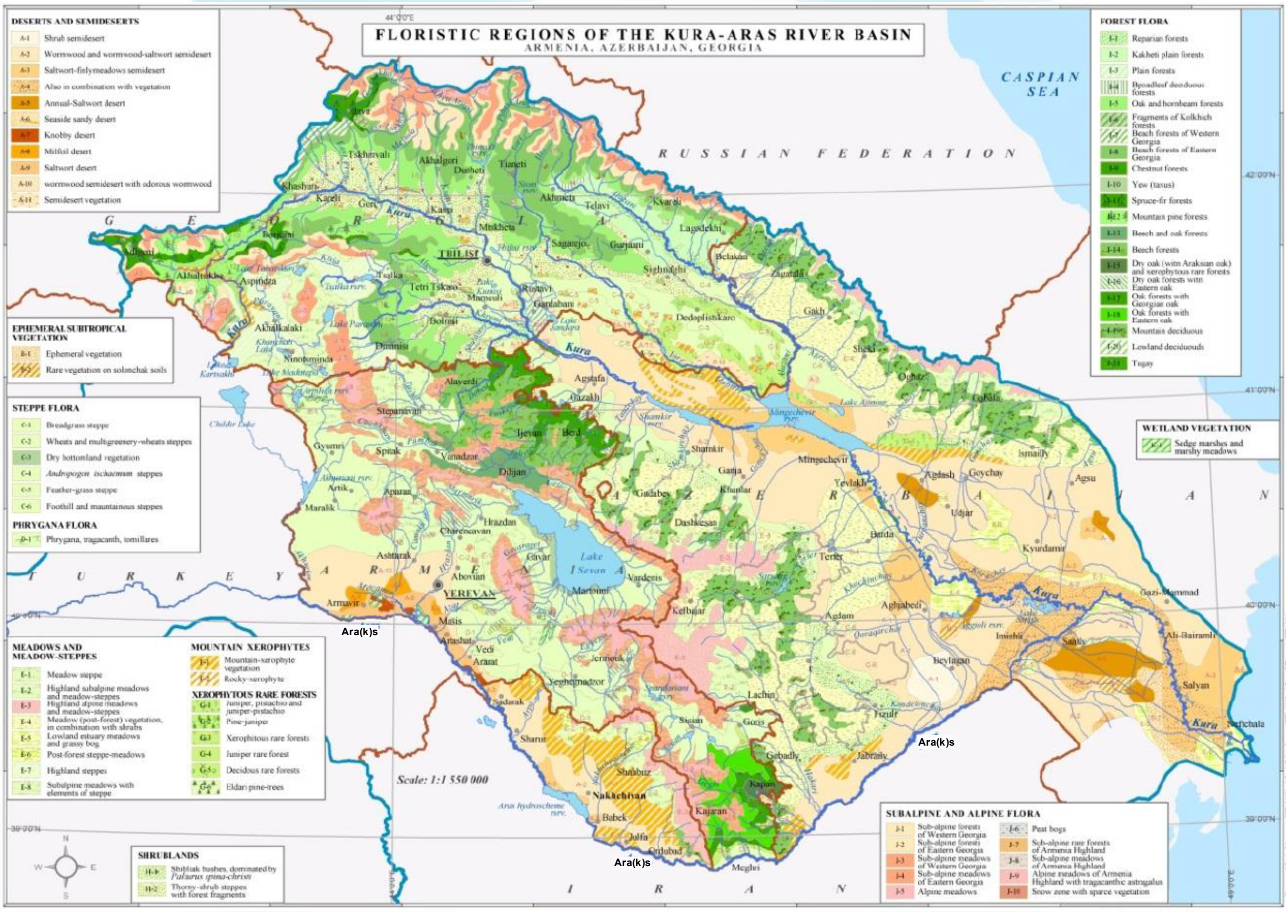
3.1.6.3. Fauna

About 152 mammals inhabit the region - 147 terrestrial and 5 aquatic species - about 20% of which are endemic and several species are threatened (Zazanashvili & Mallon, 2009). Approximately 380 bird species occur in the Caucasus hotspot, of which at least three species are endemic - the Caucasian Snowcock (*Tetraogallus caucasicus*), the Caucasian Black Grouse (*Tetrao mlokosiewiczi*) and the Caucasian Chiffchaff (*Phylloscopus lorenzii*) (GE-MEPNR, 2009a; USAID, 2010). Reptiles are represented by nearly 70 species, about 20 of which are endemic, including 15 species of the Lizard genera *Lacerta* and *Darevskia*. Other key groups include turtles and snakes (USAID, 2010). With 17 species the amphibian diversity is relatively low, only a few species being endemic (www.caucasus-naturefund.org).

The number of animal species classified in any of the 2010 IUCN Red List for Armenia, Azerbaijan and Georgia are presented in table 3.1.6.3.1.

Not protected according to the IUCN Red List but in need of conservation in the South Caucasus are Brown Bear (*Ursus arctos*), of which scientists distinguish 4 subspecies in the region. Among these, two subspecies – *U. arctos syriacus* and *A. arctos lasistanicus* – are considered endangered (www.caucasus-naturefund.org), as are the Caucasian subspecies of Red Deer (*Cervus elaphus maral*), the Eurasian Lynx (*Lynx lynx*), the Gmelin's Mouflon (Argali; *Ovis ammon gmelinii*) as well as the Geoffroy's Bat (*Myotis emarginatus*). In Armenia the Pallas' Cat (*Felis manul*) is among the most threatened mammals (AM-MNP, 2009). Eliava *et al.* (2007) includes an integrated assessment of the current conservation state of important mammal species in Georgia.

Figure 3.1.6.2.1 Main floristic regions in the Kura Ara(k)s river basin.



Source: UNDP/SIDA & Beruchashvili N., Landscape map of the Caucasus (based on Krever et al., 2001).

Table 3.1.6.3.1 Number of threatened and endangered species in different groups.

Animal group	IUCN status				
	Threatened			Near Threatened	Least Concern
	Critically Endangered	Endangered	Vulnerable		
Mammals	--	2	5	13	80
Birds	3	3	8	13	324
Reptiles	2	1	6	5	25
Amphibians	--	--	--	2	7
Fish	5	1	4	1	47
Arthropods			4	4	24
Mollusca	1	1		2	17

Source: www.iucnredlist.org, accessed on 17/02/12.

Two major bird migration routes pass through the region, along the Black Sea coast in the West and the Caspian Sea coast in the East. Especially along the Caspian Sea coast important stop-over sites can be found, supporting seasonally millions of migratory birds on route to breeding and wintering grounds.

The rivers, lakes and wetlands of the Kura Ara(k)s basin, including the Kura delta, attract many water bird species that migrate through or winter here, including the Lesser White-fronted Goose (*Anser erythropus*) and White-headed Duck (*Oxyura leucocephala*), a globally declining species. Azerbaijan holds important populations of a number of southern European species with restricted distributions, such as Ferruginous Duck *(Aythya nyroca)*, and Marbled Teal *(Marmaronetta angustirostris*). Many hawks, vultures and other raptors, including globally endangered species like the Lesser Kestrel (*Falco naumanni*) and the Imperial Eagle (*Aquila heliaca*) also inhabit the forests and steppes. Steppes also serve as wintering areas for Little Bustards (*Otis tetrax*) (USAID, 2010).

The region supports over 200 fish species (USAID, 2010), including anadromous species entering the Kura and Ara(k)s rivers from the Caspian Sea. More than a third of all fish species in the rivers and seas of the hotspot are endemic (www.biodiversityhotspots.org; CERF, 2009).

The Caspian Sea is unique in the world with respect to the occurrence of 6 sturgeon species, all of which are threatened (IUCN, 2011) (Table 3.1.6.3.2). With the exception of a few species of Herring, Sprat and Goby most Caspian Sea fish are also found in the rivers of the Kura Ara(k)s basin. Many of the fish species in the Kura and Ara(k)s rivers are endemics to the Caspian Sea Basin, due to its long period of isolation from other water bodies. In addition to endemic fish species also 12 introduced species occur, of which the Crucian Carp (*Carasius carasius*) has become most common (USAID, 2010).

During the last 50 years a significant decline in the number of sturgeons entering the Kura river from the Caspian has been observed (Caspian Environment Program, 2010). A significant part of the sturgeon spawning grounds in the upstream river sections became inaccessible after the construction of in-stream reservoirs and dams, most notable the Varvara and Mingechevir dams on the Kura and the Bahramtapa dam near Imishly on the Ara(k)s (USAID, 2010). The remaining sturgeon spawning areas in the Kura Ara(k)s river are assessed at 307 ha (Negroni, 2012).

In the three riparian countries of the Kura Ara(k)s basin, over 10,000 invertebrate species were identified, in groups like butterflies, beetles, flies, and wasps & bees, spiders and worms. No clear overview publication was identified yet. Species lists are also considered to be incomplete.

*Table 3.1.6.3.2 Status of endangered Sturgeon species. **

Scientific Name	Common Name	IUCN RED LIST		
		Vulnerable	Endangered	Critically Endangered
Acipenser gueldenstaedtii	Russian sturgeon			X
Acipenser persicus colchicus	Colchic (Persian) sturgeon	X		
Acipenser nudiventris	Bastard (ship) sturgeon			X
Acipenser stellatus	Stellate sturgeon			X
Acipenser ruthenus	Sterlet	X		
Huso huso	Beluga			X

*Notes: * Species selected from WWF (2010); Species status: IUCN Red List version 2011.2, accessed March 2012.*

3.1.6.4. Protected Areas

To support the protection of its biodiversity, the riparian states in the Kura Ara(k)s basin all have established formally Protected Areas, using several distinguished categories. The first protected area in the basin, the Eldar Shami Strict Nature Reserve (IUCN Category I, 20,322 ha), was established in Azerbaijan in 1910 (USAID, 2010). At present there are 95 protected areas in the basin (Table 3.1.6.4.1), covering a total surface area of 1,293,347 ha.

The largest protected areas in the Kura Ara(k)s basin are the Sevan National Park (147,343 ha, including 125,200 ha water surface) in Armenia, the Tusheti National Park (71,482 ha) (GE-MEP 2010) in Georgia, and the Shakhdag National Park (130,508.6 ha) (USAID, 2010) in Azerbaijan, which partly drains directly into the Caspian Sea.

Table 3.1.6.4.1 Overview of Protected Areas in the Kura Ara(k)s river basin.

Country	IUCN category [a] Number and surface area (ha)					Additional	
	I	II	III	IV-VI	Total PA [b]	IBA	Ramsar
Armenia	3 36,104	4 237,621	230 [c]	26 106,892	33 380,617	16 404,790	3 493,511
Azerbaijan [d]	8 103,743	4 203,985		17 313,064	29 620,792	28 361,491	1 500
Georgia	8 74,069	7 148,553	3 224	15 69,092	33 291,938	20 894,068	0

Sources: USAID (2010); USAID (2009a); WWF (2009); AM-MNP (2009); GE-MEP (2010b); Birdlife (2012).

- *a IUCN Protected Area Categories: Ia Strict Nature Reserve; Ib Wilderness Park; II National Park; III Nature Monument; IV Habitat/Species Management Areas; V Protected Landscape/Seascape; VI PA with Sustainable Use of Natural Resources (http://www.iucn.org/about/work/programmes/pa/pa_products/wcpa_categories/)*
- *b Excluding IUCN category III*
- *c Includes 109 geological, 48 hydrogeological, 38 hydrological, 16 natural-historical, and 19 biological nature monuments.*
- *d Source:* www.eco.gov.az .

3.1.7. Literature cited

Abbasov & Smakhtin, 2009. Introducing environmental thresholds into water withdrawal management of mountain streams in the Kura river basin, Azerbaijan. Hydrological Sciences 54(6), December 2009, p 1068 – 1078.

Adamia S., G. Zakariadze, T. Chkhotua, N. Sadradze, N. Sereteli, A. Chabukiani & A. Gventsadze, 2011. Geology of the Caucasus: a review. Turkish Journal of Earth Sciences, Vol. 20, 2011, p. 489-544.

Alakbarov A. & F. Imanov, 2010. Transboundary aquifers of Azerbaijan: current conditions, challenges and mitigation possibilities. In: UNESCO-IHP-ISARM & PCCP Programs 2010. Proceedings of the ISARM 2010 International Conference *“Transboundary Aquifers: Challenges and New Directions”*. Paris.

AM Government, 2011. Government of the Republic of Armenia, Decision N:1450-N on Land Fund and Land Balance of Armenia. 2011. Yerevan, Armenia, 2 pp.

AM-MNP, 2009. Fourth National Report to the United Nations Convention on Biodiversity Conservation: Armenia. Ministry of Nature Protection of Armenia, Yerevan, 78 pp.

AM-MNP, 2010. Second National Communication on Climate Change – a report under the United Nations Framework Convention on Climate Change, Republic of Armenia, Ministry of Nature Protection, Yerevan, Armenia, 2010, 134 pp.

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

AzerStat, 2012. State Statistics Committee of the Republic of Azerbaijan - www.azstat.org

AZ-MENR, 2010a. Fourth National Report to the United Nations Convention on Biodiversity Conservation: Azerbaijan. 167 pp.

AZ-MENR, 2010b. Second National Communication to the United Nations Framework Convention on Climate Change, Ministry of Ecology and Natural Resources of Azerbaijan, Baku, 2010, 85 pp.

AZ-NWS, 2011. Azerbaijan Republic National Water Strategy Draft 2011. Baku, 119 pp.

Birdlife, 2012. www.birdlife.org

CERF, 2004, Caucasus ecosystem profile.

CERF, 2009. CERF footprints across the Caucasus hotspot, 20 pp.

Eliava I, A. Cholokava, E. Kvavadze, G. Bakhtadze & A. Bukhnikashvili, 2007. New data on animal biodiversity of Georgia. Bulletin of the Georgian National Academy of Sciences, 175, No. 2, 2007, p. 115-119.

FAO, 2009. Irrigation in the Middle East region in figures – Aquastat survey 2008. FAO Water Reports No. 34, 2009, 423 pp.

GE-MEPNR, 2009a. Fourth National Report to the United Nations Convention on Biodiversity Conservation: Georgia. Ministry of Environment Protection and Natural Resources of Georgia, 94 pp.

GE-MEP, 2010. National report on the state of the environment of Georgia 2007-2009. Ministry of Environment Protection of Georgia, Tbilisi, Georgia, 213 pp.

Hannan T., Leummens H.J.L. & Matthews M.M., 2013. Desk study – Hydrology. UNDP/GEF project “Reducing transboundary degradation in the Kura Ara(k)s river basin”, Tbilisi-Baku-Yerevan, 2013, 31 pp.

Imanov F., Hasanova N., Humbatova Sh., Ismayilov V., 2009. Hydrological aspects of flood control in Azerbaijan. International Symposium on Floods and Modern Methods of Control Measures. 23-28 September, Tbilisi, Georgia, p.195-201.

Israfilov R.G. & Y.H. Israfilov, 2011. Impact of climate change on groundwater resources: review of a case study in Azerbaijan. In: Baba A., G Tayfur, O Gündüz, K.W.F. Howard, M.J. Friedel & A. Chambel (Eds.), 2011. Climate change and its effect on water resources. Proceedings of the NATO advanced research workshop on effect of climate change on water resources – Issues of national and global security, Izmir, Turkey, 1-4 September 2010, p115-122.

IUCN, 2011. Red list of threatened species, version 2011.2.

Kharatishvili-Gabesidze, 2011. Groundwater resources in Georgia. Waterwiki, 2011, www.waterwiki.net/images/d/da/Georgian_GW_Report_English.doc, accessed 9 September 2012, 27 pp.

Krever V., N. Zazanashvili, H. Jungius, L. Williams & D. Petelin, 2001. Biodiversity of the Caucasus Ecoregion – an analysis of biodiversity and current threats and initial investment portfolio. WWF Baku-Yerevan-Gland-Moscow-Tbilisi, 2001, 132 pp.

Lambracht A., C. Mayer, W. Hagg, V. Popovnin, A. Rezepkin, N. Lomidze & D. Svanadze, 2011. A comparison of glacier melt on debris-covered glaciers in the northern and southern Caucasus. The Cryosphere, 5, 525-538, 2011.

Mammadov R.M. & R. Verdiyev, 2009. Integrated water resources management as basis for flood prevention in the Kura river basin. 13 pp.

Mkheidze B., 2010. Hydro-geological zoning and hydro-geochemical zonality of the Caucasus. International Association of Hydro-geologists, US National Chapter Newsletter Vol. 39, no.2 October 2010.

Negroni G., 2012. Inventory of spawning grounds in the Caspian States – country baseline survey of spawning grounds in Azerbaijan, Iran, Kazakhstan, Russian Federation and Turkmenistan. Draft final report, CASPECO Working Group on Spawning Grounds, UNDP/GEF Caspian Environment Program, January 2012, 93 pp.

Schatz, G., Shulkina, T., Nakhutsrishvili, G., Batsatsashvili, K., Tamanyan, K., Ali-zade, V., Kikodze, D., Geltman and D., Ekin, T., 2009. Coordination and development of plant Red List assessments for the Caucasus biodiversity hotspot. Pp. 188-192. In Zazanashvili, N. and Mallon, D. (Editors) 2009. Status and Protection of Globally Threatened Species in the Caucasus. Tbilisi: CEPF, WWF. Contour Ltd., 232 pp.

Tarkhnishvili D., 2006. Biodiversity and ecosystems of the Kura Aras river basin. TDA Thematic Report, UNDP/GEF "Reducing transboundary degradation of the Kura Aras river basin", 32 pp.

UNDP/ENVSEC, 2011. Regional climate change impact studies for the South Caucasus region. Tbilisi, Georgia, 2011, 62 pp.

UNDP/GEF, 2007. TDA Thematic Report - Groundwater resources of the Kura Aras River Basin. UNDP/GEF RER/03/G41/A/1G/31: Reducing Trans-boundary Degradation of the Kura-Aras River Basin, pp. 58.

UNDP-SIDA, 2005. Preliminary background analysis of the Kura Aras river basin in Georgia. Tbilisi, 2005, 177 pp.

USAID, 2000. Armenian power sector – dam safety conditions and concerns, June 2000, 24 pp.

USAID, 2009a. Biodiversity analysis update for Armenia. 196 pp.

USAID, 2009b. Biodiversity analysis update for Georgia. 89 pp.

USAID, 2010. Biodiversity analysis update for Azerbaijan. 83 pp.

Vermishev M. (Ed.), 2010. Second National Communication on Climate Change. Ministry of Nature Protection of the Republic of Armenia, 2010, 134 pp.

Williams L., N. Zazanashvili, G. Sanadiradze & A. Kandaurov, 2006. An Eco-regional Conservation Plan for the Caucasus, 2nd edition. WWF Caucasus Program Office, May 2006, 225 pp.

World Bank, 2012. http://databank.worldbank.org/data/home.aspx

WWF, 2009. Investment in protected areas of Armenia: present and future. WWF Armenia, 67 pp.

WWF, 2010. Factsheet – Status of Sturgeon populations in the South Caucasus (Azerbaijan and Georgia). WWF Switzerland, 5 pp.

www.biodiversityhotspots.com

www.caucasus-naturefund.org

www.fao.org/nr/water/aquastat/main/index.stm

Yessekin B.K, M.J. Burlibaev, V.P. Bogachev, E.A. Kreuzberg, V.V. Sadomsky & V.I. Sokolov (Eds), 2006. Conserving ecosystems of inland water bodies in Central Asia and the South Caucasus. The Central Asian Regional Ecological Center – Global Water Partnership for Central Asia and Caucasus, Almaty/Tashkent, 2006, 67 pp.

Zazanashvili, N. and Mallon, D. (Eds.), 2009. Status and protection of globally threatened species in the Caucasus. Tbilisi: CEPF, WWF. Contour Ltd., 232 pp.

Zektser I.S.& L.G. Everett, 2004. Groundwater resources of the world and their use. UNESCO IHP-VI, Series on Groundwater No.6, 342 pp.

3.2. Human setting

This chapter presents social and economic baseline information, providing a snapshot of the Kura Ara(k)s river basin in early 2013 for the countries Armenia, Azerbaijan and Georgia. While including unequal parts of these countries, the river basin also is distinguished by different configurations of rural and urban areas, with the countries' large municipal areas and their economic sectors occurring either in- or outside the basin. Therefore information provided in this chapter examines the basin level data where possible, and infers from national level data where basin level data is not available. Where appropriate and available, national statistical data sources were used, supported by selected international databases for reliability and standardization across countries.

The future developments and the historic data will be presented separately in the trend analysis section to more clearly define what and how changes are occurring, including those which will impact on transboundary water resources and their management.

3.2.1. Demography

3.2.1.1. Population of the basin

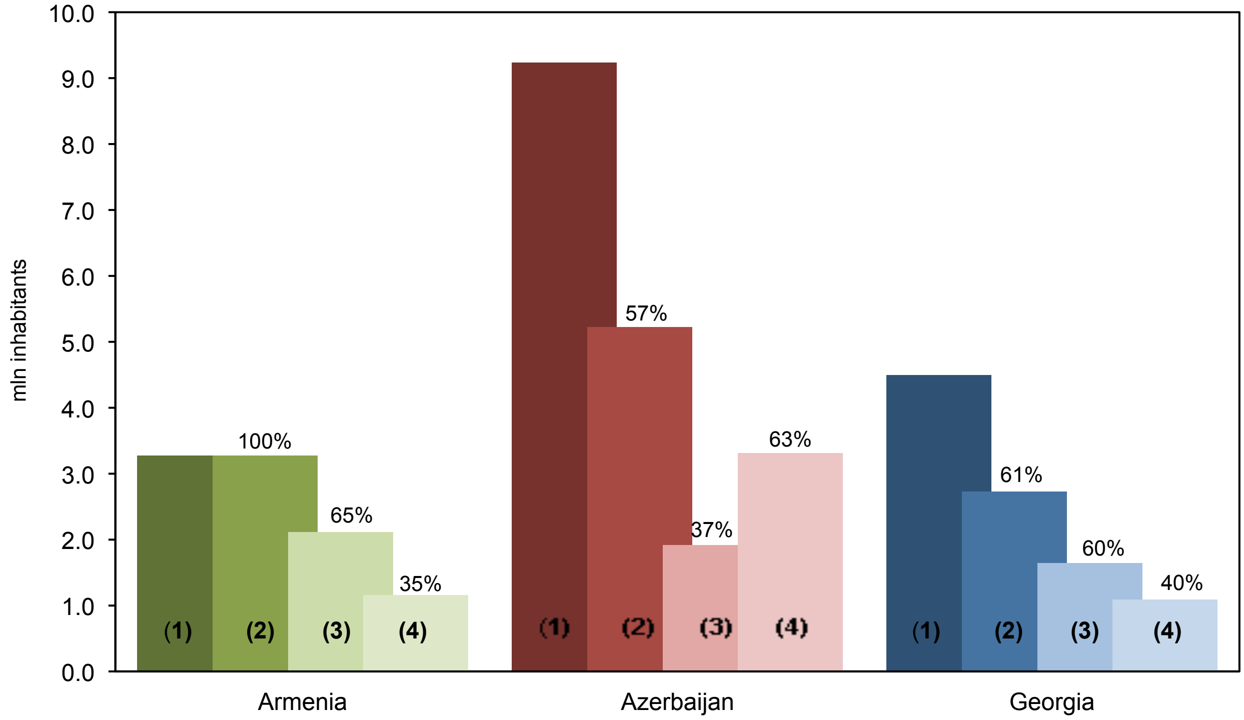
The Kura Ara(k)s river basin includes the whole of Armenia, 69% of Azerbaijan and 50% of Georgia (Table 3.1.1.1). The population distribution differs slightly from the surface area division, due to the specific location of major municipal centers. As such, the basin includes the whole population of Armenia, 57% of the population of Azerbaijan, with Baku located outside the basin, and 61% of the population of Georgia, with Tbilisi located inside the basin. The largest portion of the basin population lives in Azerbaijan (47%) and the smallest in Georgia (24%), with Armenia's population accordingly accounting for 29%. The urban population of Armenia and Georgia is high, as many smaller cities and towns are classified as urban. The majority of the population in the basin therefore still can be considered rural, though population density per square kilometer in the basin is still high - 110 in Armenia, 87 in Azerbaijan and 79 in Georgia. The variation in population density is shown in Table 3.2.1.1.1, Figure 3.2.1.1.1, and Figure 3.2.1.1.2.

Table 3.2.1.1.1 Population of the Kura Ara(k)s river basin in 2011.

	Armenia	Azerbaijan	Georgia	Total/Average
Country level				
Total population	3,274,300	9,235,100	4,497,600	17,007,000
Total rural population	1,159,849	4,346,400	2,105,900	7,612,149
Total urban population	2,114,451	4,888,700	2,391,700	9,394,851
% urban population	64.6	53.1	46.8	55.2
% rural population	35.4	46.9	53.2	44.8
Population density (persons/km^2)	110	107	65	100
Kura Ara(k)s basin level				
Total population	3,274,300	5,222,600	2,729,600	11,226,500
% country population	100.0	56.6	60.6	66.0
% of basin population	29.2	46.5	24.3	100.0
Total rural population	1,159,849	3,311,128	1,088,900	5,559,877
Total urban population	2,114,451	1,911,472	1,640,700	5,666,623
% urban population	64.6	36.6	60.1	50.5
% rural population	35.4	63.4	39.9	49.5
Population density (persons/km^2)	110	87	79	90

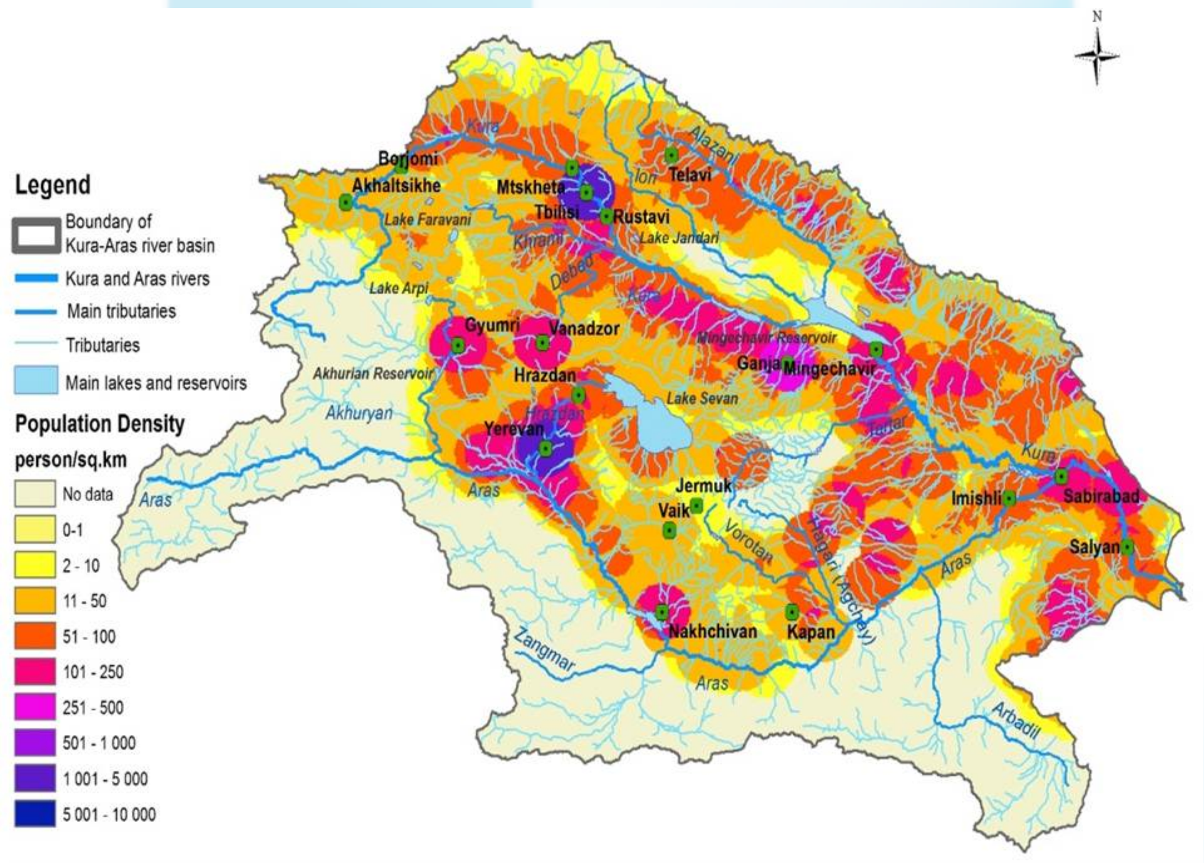
Sources: National Statistical Service of the Republic of Armenia - www.armstat.am; National Statistics Office of Georgia - www.geostat.ge; State Statistical Committee of the Republic of Azerbaijan www.azstat.org; Note: An area is considered urban when the population exceeds 100,000 citizens in municipalities.

Figure 3.2.1.1.1 Population of the Kura Ara(k)s river basin in Armenia, Azerbaijan, Georgia.



Legend: For each country the columns from left to right represent: (1) total population; (2) basin population; (3) urban population; (4) rural population. Source: National Statistics.

Figure 3.2.1.1.2 Population density map of the Kura Ara(k)s river basin.



Map prepared by the UNDP/GEF Kura Ara(k)s project, based on national statistical data.

3.2.1.2. Human health conditions

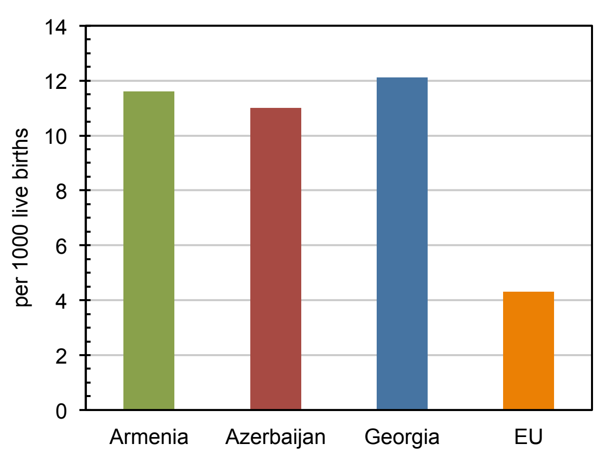
This section presents statistical information on selected parameters related to the human health conditions in the three riparian states Armenia, Azerbaijan and Georgia (Table 3.2.1.2.1). Priority is given to data related to the Kura Ara(k)s basin from publicly available in-country sources at the government statistical services. For parameters that could not be obtained for the basin level, it is assumed that the statistics in human health indicators for the three countries also accurately reflect the condition of the population in the Kura Ara(k)s basin.

A key indicator for human health is the infant mortality rate at birth per 1,000 live births. This indicator provides important information about environmental health, as infants are very susceptible to poor environmental conditions and water borne illnesses (Figure 3.2.1.2.1). For Azerbaijan, infant mortality shows a remarkable difference between urban and rural areas, with mortality in rural areas 3 times lower than in urban areas for the whole country, while even lower in the Kura Ara(k)s basin.

Life expectancy at birth provides another key indicator of the impact of environmental conditions on human populations. This measures the number of years a new borne infant would be expected to live if prevailing patterns of human mortality were to stay the same throughout its life. Environmental conditions are a significant contributor to this, including incidences of cancers, long term exposure to environmental hazards and impacts of overall poor environmental conditions (Figure 3.2.1.2.2).

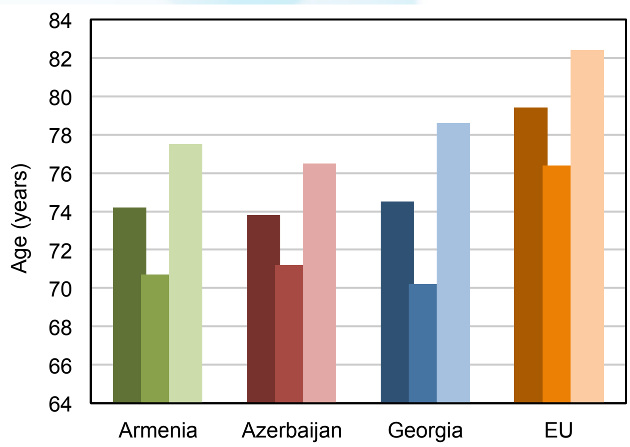
The fertility rate per woman (number of children per woman) is lower in Armenia at 1.5 and Georgia at 1.5 than in Azerbaijan at 2.4 children per women. The mean age of women giving birth to their first child is quite high, with 23.5 years in Armenia, 23.4 years in Azerbaijan, and 24.0 years in Georgia. In the EU the mean age at child birth is 29.8 year (Eurostat, 2012).

Figure 3.2.1.2.1 Infant mortality in 2011.



Source: national statistical data.

Figure 3.2.1.2.2 Life expectancy at birth, 2011.



Source: National Statistical data. Legend: per country columns from left to right –overall average; male population; female population.

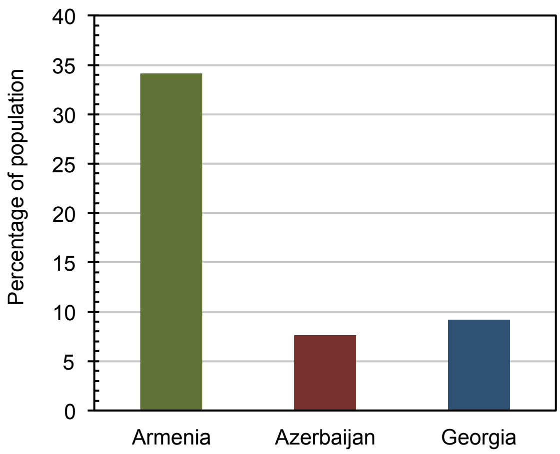
The indicator "% of population below the poverty line" is an important statistic of humans' overall health, but also of the likelihood that populations are able to take necessary steps to ensure clean, safe drinking water supplies, fuel for boiling water, or the means to filter water, issues usually not available to people living below the poverty line. According to the national statistics, the percentage of the population living below the poverty line is the highest in Armenia, while still significant in Azerbaijan and Georgia (Figure 3.2.1.2.3). Meanwhile, the poverty line in US$ - the minimum per capita income to support livelihood - for the three countries is comparable. The poverty of the population also suggests that they are forced to live more directly off the land, scavenging for fuel, food and other resources which may have negative environmental effects on the ecology in the region, especially due to deforestation.

Table 3.2.1.2.1 ***Health statistics for Armenia, Azerbaijan and Georgia in 2011.***

	Armenia		Azerbaijan		Georgia	
Country level	**total**	**‰**	**total**	**‰**	**total**	**‰**
Infant Mortality – overall	507	11.6	1903	11.0	703	12.1
- in urban areas			1536	16.2		
- in rural areas			367	5.9		
- among boys	294	12.7	1047	11.2		
- among girls	213	10.5	856	10.6		
Life expectancy at birth - overall	74.2		73.8		74.5	
- Male	70.7		71.2		70.2	
- Female	77.5		76.5		78.6	
Population below poverty line (%)	34.1		7.6		9.2	
Poverty line (US$/month)	101		136		90	
Kura Ara(k)s level	**total**	**‰**	**total**	**‰**	**total**	**‰**
Infant Mortality – overall	507	11.6	819	8.0		
- in urban areas			551	16.6		
- in rural areas			268	3.9		
- among boys	294	12.7	451	8.3		
- among girls	213	10.5	368	7.8		

Notes: People are defined as poor when available income per adult equivalent is less than poverty line. Sources: National Statistical Service of the Republic of Armenia - www.armstat.am; National Statistics Office of Georgia - www.geostat.ge; State Statistical Committee of the Republic of Azerbaijan www.azstat.org.

Figure 3.2.1.2.3 National poverty in 2011.



Source: National statistical data.

Table 3.2.1.2.4 Poverty statistics in former Soviet states.

Country	Poverty among population %	Year
Belarus	5.4	2009
Kazakhstan	8.2	2009
Kyrgyzstan	33.7	2009
Moldova	21.9	2010
Russia	11.6	2006
Tajikistan	46.7	2009
Turkmenistan	N/A	N/A
Ukraine	2.9	2008
Uzbekistan	18.6	2010

Source: World Bank (2012).

3.2.1.3 Gender issues

The Millennium Development Assessment emphasized the clear link between gender equality, poverty alleviation and sustainable development, with women being key actors in many water management systems. However, while largely women carry the responsibilities for domestic water use, their control and inclusion in the higher decision making positions of the water management process remains low in many countries. Despite their important role, women are also often neglected in development plans and projects, although the World Bank found superior project results for projects where gender considerations were integrated into the design and implementation of environmental projects. Especially in communities where women serve as the primary caretakers of children, the elderly and the sick, they are the first to encounter major public health issues. Accordingly, not including women in projects that address water management issues and public health means that these projects might lack essential information on the issues at hand.

The issue of gender within the region was not specifically addressed in the 2007 Preliminary TDA, although a targeted gender study was implemented in 2004 under the framework of the UNDP/SIDA project, included as annex to the Preliminary TDA (UNDP/SIDA, 2005). This report concluded that also in Armenia, Azerbaijan and Georgia women despite being the main users of water resources (especially water for households) their representation and participation in water resources management is very low. Although the rights and freedom of men and women are equally defended by the constitutions of the three Caucasian countries, inequalities between genders in access to water management positions remained and appeared to be supported by the patriarchal model of society present in the region.

As with efforts to improve IWRM and transboundary water management the issue of gender mainstreaming also becomes more critical for the region, inclusion of baseline gender information into the TDA provides a more complete picture of the broader socio-economic aspect of the basin. The baseline statistics on female involvement in the economy are presented in table 3.2.1.3.1 and table 3.2.1.3.2.

The countries of the Kura Ara(k)s river basin are actually quite advanced in many regards of gender balance and gender equality, especially compared to global averages. The percent population that is female is slightly higher than world averages, though in line with the EU situation (table 3.2.1.3.1). As shown in table 3.2.1.2.1, female life expectancy at birth is high, though below EU averages of 82.9 years for females and 77.0 years for males. Also life expectancy is higher than male life expectancy at birth.

Table 3.2.1.3.1 shows that while in all three countries females represent the larger portion of the population, only in Armenia they also dominate in the labor force. The largest difference between genders in employment is observed in Georgia. On the other hand, in Georgia a significantly larger percentage of females, as well as males, is ranked as "economically active", either employed or temporary unemployed Female employment rate in Georgia is significantly lower, more in line with its neighboring countries.

The number of females of the total number of unemployed is the lowest in Georgia, while overall unemployment rates are the lowest in Azerbaijan, and the highest in Armenia, both for males and females. Only in Armenia unemployment rates are comparable to those in the EU, with both Azerbaijan and Georgia showing significantly lower values.

Importantly by comparison with the EU, all three countries have higher percentages of women in the labor force. This suggests that women have a strong standing within the culture and that employment of women is valued, which may be seen as a result of the Soviet economic system as well as culturally determined.

Table 3.2.1.3.1 Gender employment statistics for the Kura Ara(k)s river basin countries Armenia, Azerbaijan and Georgia in 2011, compared to the EU.

	Armenia	Azerbaijan	Georgia	EU [d]
% population female	51.4	50.4	52.3	51.2
% women in labor force	53.1	49.1	46.7	
Female economic activity (employ and un-employ) rate(% of all F) [b]	41.7	48.8	55.8	62.3
Male economic activity rate (% of all M)	43.1	51.4	76.5	75.0
Female/male employment rate (%) [c]	33.5	45.7	48.5 / 63.7	58.5 / 70.1
% female of total unemployed (M+F)	51.8	58.3	40.8	
% male of total unemployed	48.2	41.7	59.2	
Female/Male unemployment rate (of total female/male active labor force)	19.6 / 18.7	6.4 / 4.4	13.1 / 16.7	
Female/male unemployment rate, of total active labor force (M+F)	9.9 / 9.2	3.2 / 2.3	6.1 / 8.9	9.8 / 9.6

Sources: National Statistical Service of the Republic of Armenia - www.armstat.am; National Statistics Office of Georgia - www.geostat.ge; State Statistical Committee of the Republic of Azerbaijan www.azstat.org; [b] % females in active labor force (employed and unemployed) compared to total female population; [a] [c] % of employed females to overall female population; [d] Eurostat http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Table 3.2.1.3.2 Sectoral employment and salary ratio in Armenia, Azerbaijan and Georgia.

Sector	Share of female employment (%)			Female-to-male salary ratio (%)		
	AM	AZ	GE	AM	AZ	GE
Water Supply, Waste Treatment, and Disposal	20.6	35.8	n/a	n/a	69.4	79.1
Professional Scientific and Technical Activities	53.4	41.1	n/a	n/a	46.2	
Human Health and Social Work Activities	85.6	77.6	n/a	41.1	41.1	65.0
Education	83.5	71.0	n/a	68.8	68.8	76.3
Fishing and Fish Breeding						51.7
Agriculture	55.7	23.1	n/a	n/a	111.3	82.4
Forestry and Related Services						

Table 3.2.1.3.2 shows that, on average, women in Armenia, Azerbaijan as well as Georgia have a lower average monthly salary than men across many sectors of employment, even in employment fields that are dominated by women, such as education, health, and social services. The only exemption is the agriculture, forestry & fishing sector in Azerbaijan.

For Azerbaijan, data on employment share and salary ratio in education shows that in the pre-school educational sector females receive a higher average monthly salary than males, which decreases as the level of education increases, compared to the average monthly salary of their male counterpart.

Table 3.2.1.3.3 Occupational involvement and salary ratio of females in education for Azerbaijan.

Share of female employees in education		Average Monthly Salary		
		Male	Female	
	(%)	(Manat)	(Manat)	ratio
Pre-school Education	87.4%	206.1	294.4	1.43
Secondary Education	83.7%	254.9	235.1	0.92
Secondary Technical and Vocation Education	60.8%	176.0	178.1	1.01
Higher Education	55.2%	330.7	295.6	0.89

Table 3.2.1.3.4 Overall and specified gender gap indices.

Index	Armenia	Azerbaijan	Georgia
Gender Gap Index 2012	0.664	0.655	0.669 [a]
Economic Participation and Opportunity			
Wage equality for similar work	0.69	0.71	0.77
Estimated earned income – female to male ratio	0.44	0.52	0.40
Legislators, senior officials, managers - % female / ratio	24 / 0.31	7 / 0.08	34 / 0.51
Professional and technical workers - % female / ratio	65 / 1.88	54 / 1.17	62 / 1.62
Political Empowerment			
Women in parliament - % female / ratio	11 / 0.12	16 / 0.19	7 / 0.07
Women in ministerial positions - % female / ratio	11 / 0.12	3 / 0.03	16 / 0.19
Educational Attainment			
Literacy rate	1.00	1.00	1.00
Enrolment in primary education - % female / ratio	88 / 1.03	84 / 0.99	93 / 0.98
Enrolment in secondary education - % female / ratio	88 / 1.03	78 / 0.97	80 / 0.95
Enrolment in tertiary education - % female / ratio	58 / 1.28	19 / 0.98	31 / 1.25

Notes: [a] ratio assessment - 0.00 = inequality, 1.00 = equality; source: Hausman et al. (2012).

Table 3.2.1.3.4 presents country specific data based on a unified global approach, comparing 135 countries on their gender gap index. The three South Caucasus countries show rather equal results, with Georgia occupying the “highest” position at 85 in the international list, followed by Armenia at 92 and Azerbaijan at 99. Overall values of the gender Gap Index vary between 0.8640 for number 1 highest ranked Iceland and for number 135 lowest ranked 0.5054 for Yemen.

The subcomponent on economic participation and opportunity confirms the earlier conclusion on wage inequality in the South Caucasus countries. Table 3.2.1.3.4 also shows the inequality for females to secure high-ranking jobs, especially in Azerbaijan, though females are over-represented in professional and technical sectors in all three countries.

On professional empowerment, calculated based on women in parliament and women holding ministerial positions, all three countries show a large gender gap compared to other countries, occupying position 109 (Georgia), 113 (Azerbaijan) and 114 (Armenia), out of 135 countries.

On the other hand, educational attainment for females is positive. In all three countries enrollment in primary and secondary education is high, and equal or higher than male enrollment. However, enrollment in tertiary education significantly decreases in Azerbaijan and Georgia, with Armenia showing positive distinction.

Overall the gender statistics show that compared to global averages and even compared to the EU there are significant prospects for women in water management and gender mainstreaming. Further studies are needed to more closely examine prospects for this in the future.

3.2.2. Economic setting

The economic conditions in the Kura Ara(k)s river basin have improved since the Preliminary TDA was drafted in 2007. The global economic downturn in 2008 has in part impacted the region, though not as severely as in other regions of the world, partially due to high levels of international support from the USA and EU, and, in Azerbaijan, due to continuing export of natural resources. This section will examine the overall economic baseline setting, including export/import balances, income and unemployment, and consider the individual sectors of agriculture, industry and services. Also the water uses by sector and overall withdrawals are discussed as economic goods.

3.2.2.1. Economic baseline

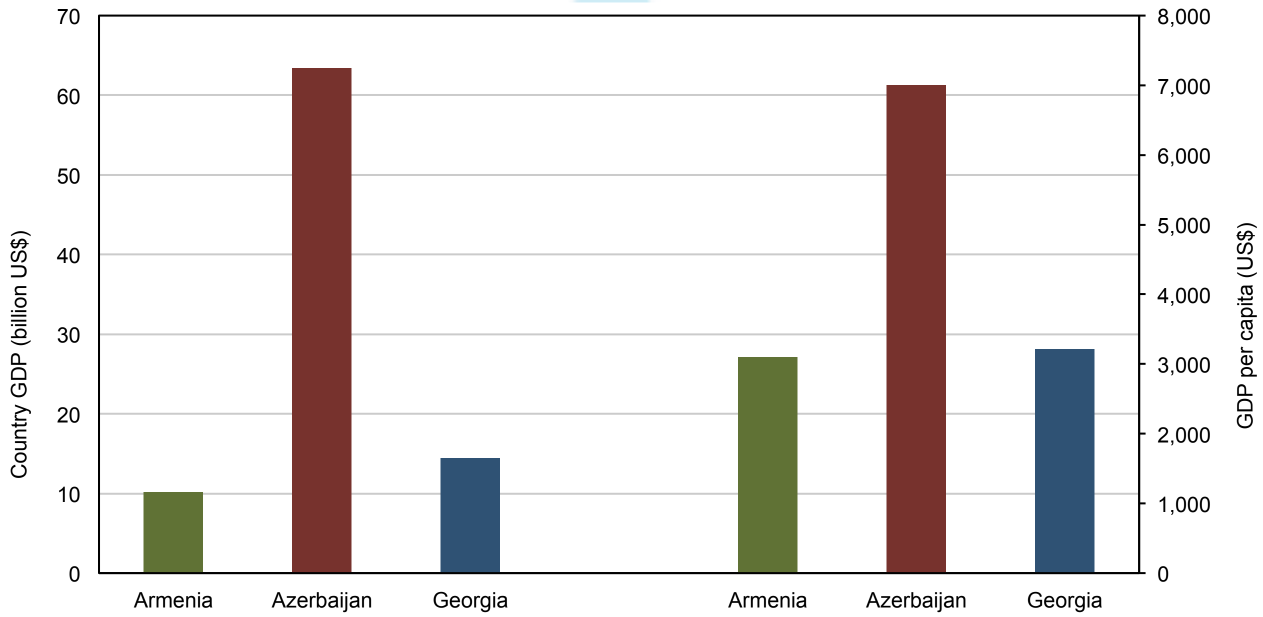
An important consideration to assess the economic baseline for the Kura Ara(k)s river basin countries is variation in income as well as sources of income. The overall economic state of the countries is compared.

In Armenia and Georgia the country Gross Domestic Product (GDP) is significantly lower than in Azerbaijan, where wealth is largely obtained from petroleum resources having entered the global markets via the now functional Baku-Tbilisi-Ceyhan oil pipeline and the natural gas pipeline through Turkey. As global oil markets have been impacted by turbulence in the Middle East and prices for crude oil are increasing, Azerbaijan has benefitted (Table 3.2.2.1.1; Figure 3.2.2.1.1).

While GDP provides an indicator of the entire economy, the GDP per capita provides a picture of the condition of the population. Figure 3.2.2.1.1 also shows the GDP per capita with Purchasing Power Parity (PPP) in current international dollars, for the countries of the Kura Ara(k)s basin and for the European Union. It shows that the GDP per capita in Azerbaijan is more than double those of Armenia and Georgia. It is noted that these values refer to the overall country level - rural populations likely have a much lower GDP per capita. With Baku located outside the basin, GDP per capita in rural areas of Azerbaijan may be more in comparison to those in Armenia and Georgia than reflected in the overall country statistics. In comparison to the EU countries there remains significant differences that all countries are now striving to overcome.

The export-import balance for 2010 (Figure 3.2.2.1.2) also illustrates differences between the countries of the Kura Ara(k)s river basin. Armenia and Georgia are still largely dependent on imports, whereas Azerbaijan is benefitting from the oil sector for exports. This is the standard pattern both for countries that are developing and for petroleum exporting states. In comparison, the EU countries and the global average are nearly on par with equitable balances of exports and imports as a percent of GDP.

Figure 3.2.2.1.1 GDP statistics of Armenia, Azerbaijan and Georgia in 2011 in current US$.



Legend: Left Y-axis – total country GDP; right y-axis – GDP per capita. Source - national statistics.

Table 3.2.2.1.1 Economic baseline statistics for the Kura Ara(k)s river basin countries Armenia, Azerbaijan and Georgia in 2011, compared to the EU.

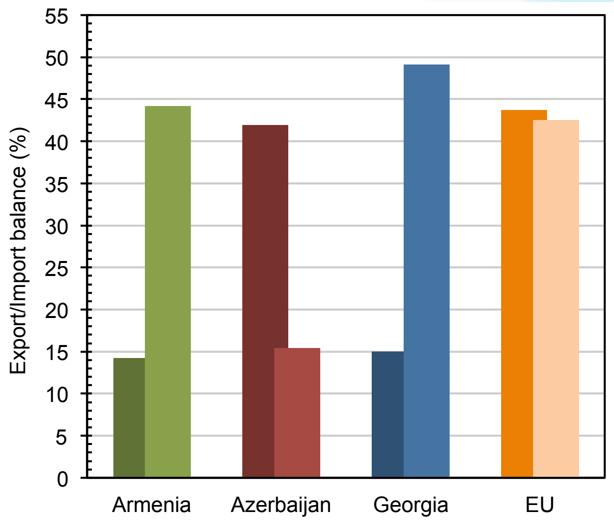
	Armenia	Azerbaijan	Georgia	EU
Gross Domestic Product (GDP)				
Total GDP	$ 10,138.1 mln	$ 63,402.5 mln	$ 14,438.5 mln	€ 13,274,839
GDP per capita	$ 3,101.8	$ 7,003.4	$ 3,215.4	€ 25,200
Per capita income	$ 330.7	$ 4,302.9	$ 4,311.9	
Export/import balance				
- Export, % of GDP	14.2	41.9	15.0	43.7
- Import, % of GDP	44.2	15.4	49.1	42.5
Net Official Development Assistance (NODA) [a]				
- Total	$ 342.82 mln	$ 159.11 mln	$ 625.19 mln	n/a
- Per capita	$ 104.7	$ 17.2	$ 139.0	n/a
Unemployment				
- Overall average (%)	18.4	5.4	15.1	[b] 9.7
- Male (%)	8.9	4.5	16.7	9.6
- Female (%)	9.5	6.4	13.1	9.8
- Urban (%)		5.8	26.5	[c] 8.5
- Rural (%)		5.0	6.5	[c] 11.0
- Aged 20-24 (%) [b]	39.2	14.7	35.6	21.4

Sources: National Statistical Service of the Republic of Armenia - www.armstat.am; National Statistics Office of Georgia - www.geostat.ge; State Statistical Committee of the Republic of Azerbaijan www.azstat.org; [a] World bank (2012) statistics for 2010; [b] Eurostat (2012); [c] Roberta (2012).

Figure 3.2.2.1.3 confirms Georgia being the recipient of the largest amount of net official development assistance (NODA) and aid in the region, surpassing both Armenia and Azerbaijan combined. The distribution of NODA also reflects this trend, with the annual NODA received per capita ranging from just US$ 17 per person in Azerbaijan to US$ 105 per person in Armenia, and almost US$ 139 per person in Georgia (World Bank, 2012). For all three riparian countries the NODA has decreased in recent years.

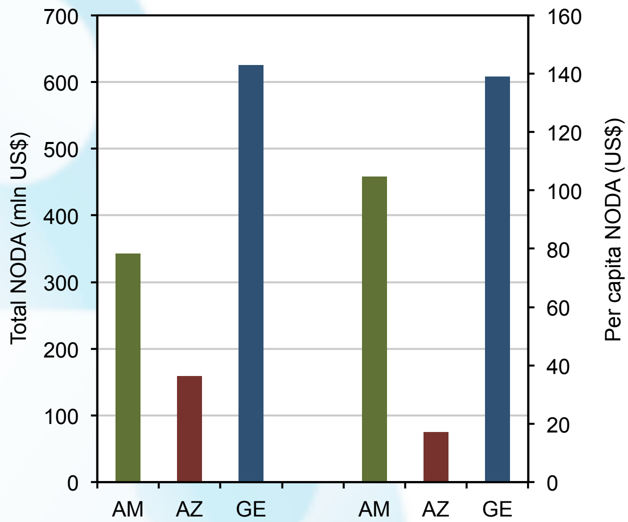
The overall picture of the economic situation in the Kura Ara(k)s river basin must include a snapshot of the economic conditions for individuals. Unemployment rates are 5.4% in Azerbaijan (AzerStat, 2012) and 15.1% (of the active labor force, male and female) in Georgia (GeoStat, 2012), while being 18.4% for Armenia (ArmStat, 2012). The data provided here is official data provided by the countries and discrepancies especially between Azerbaijan compared to Georgia and Armenia may be a statistical artifact due to different measurement criteria. Unemployment rates for the 20-24 years age group are more than double the overall unemployment rate in all three countries (Table 3.2.2.1.1).

Figure 3.2.2.1.2 Export-import balance for 2011.



Source: National statistical data. Legend: per country: left column – export; right column – import.

Figure 3.2.2.1.3 Net official development assistance in 2010.



Source: World Bank 2012. Legend: Left 3 columns – total NODA; right 3 columns – per capita NODA.

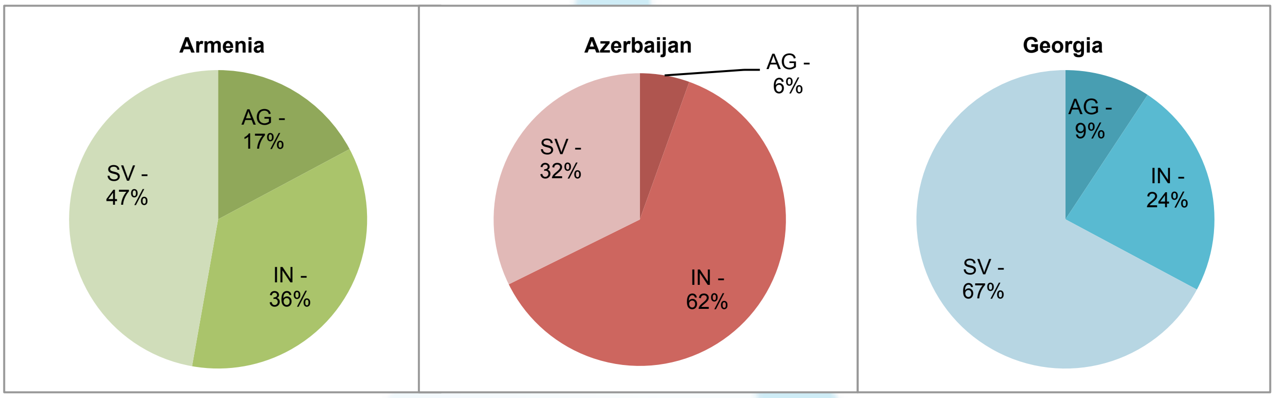
The percentage contribution to the GDP for the sectors agriculture, industry, and services show the significant differences between the economies of the three countries (Figure 3.2.2.1.4). Armenia has the most balanced economy whereas both Georgia and Azerbaijan are more sector-driven. As noted above, Azerbaijan is heavily dependent on industry, the petroleum industry being included in this sector, while Georgia's economy is strongly driven by the service sector (World Bank, 2012).

Compared to the contributions to GDP by sector, the division of employment among the sectors shows a significantly different picture (Figure 3.2.2.1.5). In Armenia, the most balanced of sectoral contribution to the GDP, the percent employment in agriculture is more than double that of agriculture's contribution to the GDP. In comparison, both Azerbaijan and Georgia have six times the percent of employment in agriculture than agriculture's income generation capacity. In both Georgia and Azerbaijan, where the majority of the population is rural, this points to very large discrepancies between income levels of the urban and rural population, as confirmed by the average income per sector in the countries. As discussed above, poverty among rural populations often leads to non-sustainable resource use, and marginalized populations using resources that are vital to ecosystem health.

In Georgia a significant imbalance is observed between the average monthly wages for male and female worker – 743 GEL vs. 427 GEL, with the most notable discrepancies being in the health & social work and retail trade sectors (GeoStat, 2012).

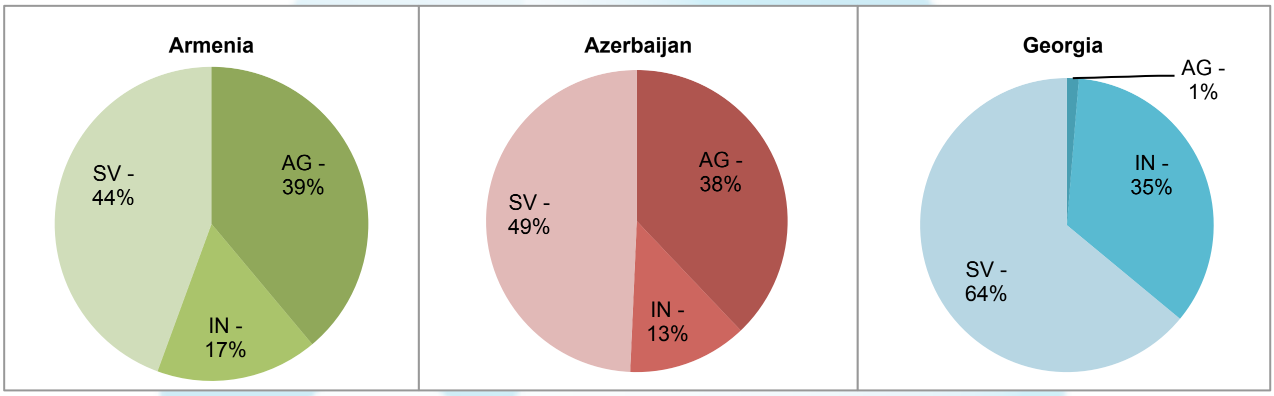
This economic baseline setting provides us with a snapshot of the basin conditions and some of the drivers that are shaping the forces of the economic development. In order to more fully understand the situation, an overview of the economic sectors will provide a more complete picture of the current baseline conditions.

Figure 3.2.2.1.4 Sectoral economic value added to GDP in the Kura Ara(k)s basin countries.



Legend: AG - Agriculture; IN – Industry; SV – Services; unit - % GDP, value added. Source: National statistics.

Figure 3.2.2.1.5 Division of employment in economic sectors in three Kura Ara(k)s basin countries.



Legend: AG – agriculture; IN – industry; SV – services; unit - % total. Source - National statistical data.

Table 3.2.2.1.2 Employment and income statistics per economic sector for the Kura Ara(k)s river basin countries Armenia, Azerbaijan and Georgia in 2011.

Parameter	Armenia			Azerbaijan			Georgia		
	AG	IN	SV	AG	IN	SV	AG	IN	SV
Contribution to GDP (%)	17.2	35.6	47.2	5.5	62.2	32.3	9.3	23.5	67.2
Employment per sector (%)	38.9	16.7	44.4	37.9	12.8	49.3	1.3	34.7	64.0
Average monthly income (local currency)	63,171	151,367	113,718	196.4	684.7	410.0	332	710	706

Sources: National Statistical Service of the Republic of Armenia - www.armstat.am; National Statistics Office of Georgia - www.geostat.ge; State Statistical Committee of the Republic of Azerbaijan www.azstat.org. Note: AG – Agriculture; IN – Industry: SV – Services.

3.2.2.2. The agricultural sector

Throughout the Kura and Ara(k)s river basin agriculture plays an important role for commercial as well as subsistence farming, for employment and for development potential. Agriculture has been practiced for millennia in the basin.

Table 3.2.2.2.1 Agricultural statistics for the countries Armenia, Azerbaijan and Georgia (2011).

Parameter	Armenia	Azerbaijan		Georgia	
		Country	KA basin	Country	KA basin
Total land area (x1,000 ha)	2,974.3	8,660.0	6,002.0	6,970.0	3,456.0
Land under agriculture (1,000 ha)	2,077.0	4,768.7		[a] 3,045.9	595.0
- Arable land	449.2	1,608.2		472.1	318.1
- Perennials	33.0	227.2		100.2	45.7
- Hay lands	128.3	2,665.8		267.1	231.1
- Pastures	1,067.2				
- Other (including fallow lands)	399.3	267.5		311.0	0.0
Irrigated lands (x 1,000 ha)	[b] 154.6	1,424.4		24.0	
Irrigated lands (%)	7.4	29.9		0.1	
Farm type					
- Commercial farms	3.1	5.2		5.2	
- Household farms	96.9	94.8		94.8	
Mineral fertilizer use in commercial farms (x1,000 tons)		20.4		51.7	18.8
Area treated with mineral fertilizer (x 1,000 ha)		54%			
- Annual crops				114.4	38.0
- Perennial crops				23.0	11.8
Average use of mineral fertilizer (kg/ha) [c]	29.2	13.4		43.4	
Organic fertilizer use (x 1,000 tons)				446	
Area treated with organic fertilizer (x 1,000 ha)					
- Annual crops				42.7	
- Perennial crops				20.7	
Average use of organic fertilizer (tons/ha)				7.0	
Area treated with pesticides (x 1,000 ha) [d]					
- Annual crops				57.1	50.1
- Perennial crops				174.6	145.8

Sources: AM-NSS National Statistical Service of the Republic of Armenia - www.armstat.am; National Statistics Office of Georgia - www.geostat.ge; State Statistical Committee of the Republic of Azerbaijan www.azstat.org. [a] - USAID (2011); [b] – AM-MA (2012); [c] – World Bank (2012) for 2009; [d] - Includes fungicides, insecticides, herbicides, rodenticides, fumigants.

In Armenia, about 70% of the country is agricultural lands, including arable & perennial crops, hay-lands as well as natural pastures (Table 3.2.2.2.1; Figure 3.2.2.2.1). Arable lands cover 21.6% of all agricultural lands, of which 36.2% was left fallow in 2011 (ArmStat, 2012). In Armenia, of all agricultural lands, 7.4% is irrigated, or 156,400 ha (Harutyunyan, 2012). Arable lands were mainly used for cereals (55.0%), forage crops (23.2%), potato (10.0%) and vegetables (8.7%). As for Georgia and Azerbaijan, agriculture in Armenia is dominated by household farming, providing 96.9% of the gross agricultural output in 2011 (ArmStat, 2012). Commercial farmers are largely involved in livestock farming (95.5%), predominantly poultry.

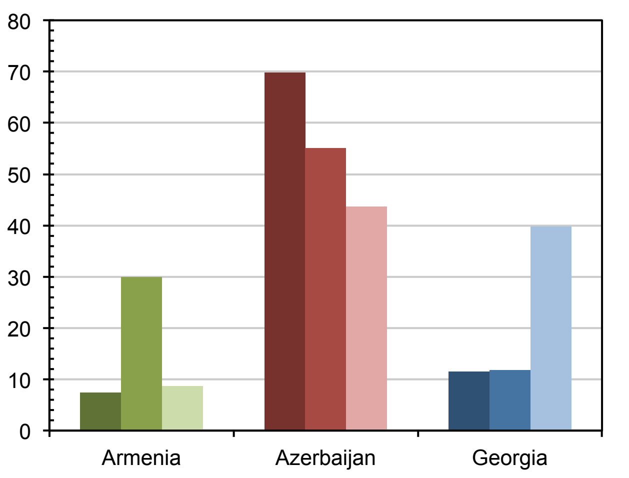
In Azerbaijan, 55% of the country is in use for agriculture, including natural pastures and meadows. Arable lands occupy 39.5% of agricultural lands, of which 12% was left fallow in 2011. Arable lands in production mainly were used for grains (60.1%), fodder crops (24.5%), vegetables (11.2%, including potatoes) (AzerStat, 2012). About 30% of the agricultural land is irrigated, mainly arable lands, perennial crops and annual grasslands. As for Georgia, today private farmers, peasant farmers and households produce the majority of agricultural products – 94.8% of gross value, up from 2% in 1990 (AzerStat, 2012), equally divided over plant growing and livestock farming. Commercial enterprises tend to be more involved in livestock farming (65% of value produced), especially poultry production.

In Georgia, 43.7% of the country is considered agricultural, including natural pasture-lands and meadows, or 3,045,900 ha (USAID, 2011). In 2011, however, only 1/3 of the nation's arable land is in active use, or 281,000 ha, of which about 180,000 ha are located in the Kura basin (GeoStat, 2012), a continuing decrease since the 2005 census (Table 3.2.2.2.1), while the rest accounts for natural grazing lands, about 1.8 mln ha (USAID, 2011). The Georgian Ministry of Agriculture for 2011 estimates the total area under irrigation in Georgia at 24,000 ha, down from 386,000 ha in 1988. Irrigated lands are largely located in eastern Georgia, in the Kura Ara(k)s river basin. Main sown crops include grain & leguminous crops (68%) and potatoes (16%) (GeoStat, 2012). Livestock numbers stabilized around 42% of the pre-independence numbers (USAID, 2011) – 1.1 mln heads of cattle, 105,000 pigs, 630,000 sheep and goats, 6.4 mln heads of poultry. Agriculture in Georgia is dominated by family holdings, with only 2.7% of sown areas managed by commercial enterprises, mainly wheat and oats, while for permanent crops – fruits, grapes, citrus – their contribution drops to 0.8%, except for tea (45%) (GeoStat, 2012). In livestock farming this division is comparable, with commercial enterprises mainly being involved in poultry production (about 30%) (GeoStat, 2012). Of all farmers, 80% produces for self-consumption. Meanwhile the farming population is aging, with 75% of farms operated by persons older than 45, and 36% by persons older than 65 (GeoStat, 2007).

Compared to the productivity in lead countries for selected products in the world, agricultural productivity is sub-optimal in Armenia and Azerbaijan, and poor in Georgia. Reasons for the poor state of agriculture include low degree of entrepreneurship, lack of cooperative development, little public investment, aging rural population, limited extension service, limited formal educational opportunities, and the low use of fertilizers and pesticides (USAID, 2011).

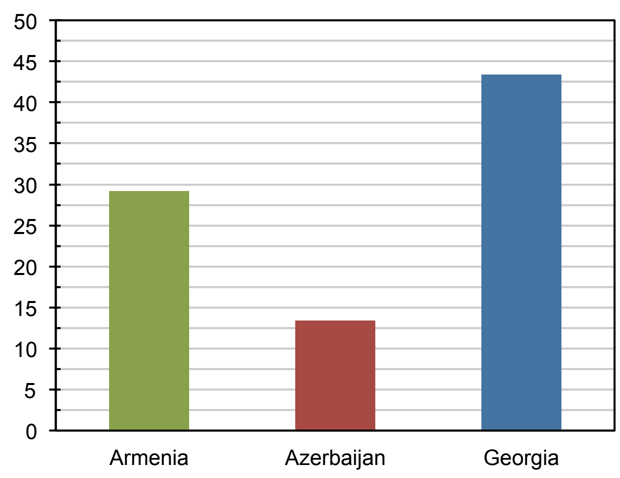
In the agricultural sector, the use of agrochemicals is an acknowledged contributor to water quality and ecosystem degradation. Fertilizer use in the basin is low compared to the 2009 EU and world average, assessed at 131 and 122 kg/h respectively (World Bank, 2012). Meanwhile, fertilizer use in Georgia is three-fold the amount of Azerbaijan, while exceeding the use in Armenia with 50% (Figure 3.2.2.2.2; Table 3.2.2.2.1). The use of fertilizer has impacts that include contributing to eutrophication, algae blooms and damaging sensitive species that are susceptible to nutrient richness. This measure does not include organic fertilizers or manures spread on fields.

Figure 3.2.2.3.1 Land use patterns in 2011.



Source: National statistical data. Legend: country columns from left to right – Irrigated agriculture; Total agriculture; Forest cover; units - percentage of total land.

Figure 3.2.2.3.2 Fertilizer consumption in 2009 in kg/ha on arable land.



Source: World Bank (2012).

Forestry

In 2011, forests in Armenia covered 343,100 ha, or 11.5% of the country (Table 3.2.2.2.2) (ArmStat, 2012). However, forestry experts indicate that the total cover may be as low as 240,000 ha, a result of legal and illegal logging since 1990. In 2011, total logging equaled 50,500 m^3 (ArmStat, 2012), up from allowable cuts in 2010 of 35,000 m^3 (Urutyan & Zohrabyan, 2011). Meanwhile, in 2010 the absolute minimum demand for stacked fuel wood amounted to 457,000 m^3, down from 562,000 m^3 in 2003. These figures hint at the ongoing, albeit decreasing, extensive illegal logging practices in Armenia. Demand is mainly created by the absence of alternative energy sources for rural households, despite the ongoing gasification in the country (Urutyan & Zohrabyan, 2011).

In 2011, forest in Azerbaijan cover 1,021,000 ha, or 11.8% of the country (AzerStat, 2012), of which an assessed 821,200 ha are located in the Kura Ara(k)s river basin (AZ-MENR, 2010), as such covering about 13% of the Kura Ara(k)s basin surface in Azerbaijan. For 2011, total wood resources are assessed at 148.8 mln m^3 (AzerStat, 2012). Officially licensed logging in 2011 was limited to 32,500 m^3 (AzerStat, 2012), while illegal logging in 2010 was assessed at 34,900 m^3, based on the registration of violations (AZ-MENR, 2012).

In Georgia, in 2010 forests covered 2,772,500 ha, or 39.8% of the country (FAO, 2010). The largest part – 98% - occurs in mountain areas, while only 2% occurs in upland plains, while the largest majority of all forests are of natural origin. Geographically the majority of the forests occur in western Georgia. Forest cover types include coniferous forests (16.0%), broadleaf forests (83.6%), hardwood forests (70.5%) and lightwood forests (10.9%) (GE-MENR, 2012). Logging in 2010 equaled about 697,000 m^3 (GeoStat, 2010). In 2009, registered and prosecuted violations valued almost 40,000 m^3, of which about 30,000 m^3 in the Kura basin, which is believed to be only a fraction of total violations of logging regulations. Reforestation in 2010 was completed on 1,700 ha, largely (1,110 ha) by means of planting and sowing (GeoStat, 2012).

Table 3.2.2.2.2 Forestry statistics for the countries Armenia, Azerbaijan and Georgia in 2011.

Forestry	Armenia	Azerbaijan	Georgia
Area covered by forests (ha)	343,100	1,021,000	2,772,500
Area covered by forests (%)	11.5	11.8	39.8
Total wood resources (mln m^3)		148.8	[a] 408.0
Logging harvest (official) (m^3/yr)	50,500	32,500	798,900
Logging harvest (illegal) (m^3/yr) [b]	630,000	34,900	

Sources: National Statistical Service of the Republic of Armenia - www.armstat.am; National Statistics Office of Georgia - www.geostat.ge; State Statistical Committee of the Republic of Azerbaijan www.azstat.org. [a] – Ministry of Energy & Natural Resources of Georgia (2010); b – Illegal-logging.info, 2012.

In general, forest remain on slopes and in elevated areas, while nearly all of the low-lying areas have been deforested for agricultural purposes, including the eastern Georgia Kura and Alazani river valleys (USAID, 2012) as well as central Armenia Ararat valley and the Kura Ara(k)s lowlands in Azerbaijan. After acquiring independence in the 1990s, the transition to a market economy, along with a significant reduction in the gross domestic product, increasing poverty & unemployment as well as energy deficits inflicted serious damage to the South Caucasus forest ecosystems. The end of wood imports from Russia and a rise in cheap exports, as well as the domestic logging for fuel-wood and the ineffective control of all these activities resulted in an unsystematic development of the timber industry, unsustainable subsistence logging, and overall significant degradation in the composition and quality of the forests.

3.2.2.3. The industrial and service sectors

The industrial sector in the Kura Ara(k)s river basin provides a significant portion of income to each of the countries, as noted above. However, at the national level, it is disproportionate in terms of employment. The industries vary significantly between the countries.

In Armenia, of all industrial activities, contributing 35.6% to the GDP (see table 3.2.2.1.2), manufacturing is the dominant sector, providing for 64.6% of all industrial output in 2011. Mining (17.0%) and electricity, gas, steam and air conditioning supply (16.6%) are of secondary importance, while water supply, sewerage, waste management and remediation activities (1.8%) are of minor importance. Manufacturing is dominated by the production of food products and beverages (50.2%), the manufacturing of basic metals (24.9%) and non-metallic mineral products (7.3%). All other manufacturing activities are of minor importance, with the exception of the production of rubber & plastics (2.9%) and tobacco (2.5%). Almost half of the country's industrial production is realized in Yerevan (42.4%), with other important regions being Syunik (17.9%), Kotayk (10.5%), Ararat (8.1%) and Lori (7.3%) (ArmStat, 2012).

In Armenia, in-country energy production in 2011 was 7,432.7 GWh. As Georgia, Armenia is a net energy exporter, about 15% of the total production, while the remaining – 6,351.0 GWh – is used in the country. The production of electricity is equally divided over the NPP, HPPs, and TPPs.

HPPs in Armenia produce 33% of the country's yearly needs, equal to about 2,450 GWh. Meanwhile the potential hydro-power resources of Armenia are estimated at 21,800 GWh, including large and medium rivers – 18,600 GWh and small rivers – 3,200 GWh (Armhydroenergyproject JSC, 2008). In order to increase the portion of electricity generated by hydropower, in preparation of a future decommissioning of the nuclear power station, a significant expansion of HPPs is envisioned. In November 2012 the construction of the Meghri HPP (130 MW; 800 GWh) was initiated on the Ara(k)s River. Additionally the Government of Armenia is conducting negotiations with the World Bank on financing the feasibility studies and construction of two other large HPPs - Shnogh HPP (75 MW; 300 GWh) on the Debed River; and Loriberd HPP (66 MW; 200 GWh) on the Dzoraget River. In 2011, in total 115 small HPPs (SHPP) were operational, with an installed capacity of about 158 MW, producing about 520 GWh electricity. Meanwhile, licenses for another 88 SHPPs (total 177 MW; 637 GWh) were issued, while the further expansion with 108 SHPPs (134 MW) is under consideration (Ministry of Energy & Natural Resources of Armenia, 2012).

The industrial sector in Azerbaijan, contributing 62.2% to the GDP as noted above, is represented by the oil & gas, energy, chemistry, mechanical engineering, metallurgy, food industry, and light industry. The sector is dominated by the oil & gas sector, providing for 80.5% of industry's contribution to the GDP in 2011, while the manufacturing of refined petroleum products provides another 7.4% to the GDP. In 2011, the petroleum industry produced 45.6 mln tons of oil and 25,728 mln m^3 of gas. Other manufacturing industries contributing only slightly to the GDP include food products & beverages, construction materials, chemicals, and machinery & equipment. Manufacturing enterprises other than refined petroleum products contribute 6.9% to the GDP. The production, distribution and supply of energy, gas and steam provides for another 4.7%, while water supply, waste water treatment and disposal contributes 0.5% (AzerStat, 2012).

In 2011, electric energy production in Azerbaijan amounted to 20,294 mln KWh, of which 85% was generated by thermo-electric stations and 13.2% - 2,679 GWh/year - by hydro-electric stations. Other important natural resources extracted in Azerbaijan include building materials (sand, gravel, stones – 5 mln tons), and salt (21,000 tons) (AzerStat, 2012).

The industry sector in Georgia is dominated by manufacturing enterprises (76.8%), mainly involved in the production of food products and beverages (39.3% of manufacturing), basic metals (21.8%), non-metallic mineral products (9.0%) and chemicals & chemical products (8.9%). The electricity, gas and water supply sector contributes 18% to the industrial output. In contrast to Azerbaijan, mining and quarrying represent only a minor contributor to the total industrial output (5.3%), 50% of which is related to mining of metal ores (GeoStat, 2012). Overall, 75% of industrial production of Georgia is concentrated in the Kura Ara(k)s basin, with the Tbilisi region as center.

In 2009-2010, total electricity generated – 85% from hydropower, 15% from thermal & import - of Georgia amounted to 9,300 GWh, exceeded internal demand by 15%, exported to neighboring countries Armenia, Azerbaijan, Russia and Turkey (GE-MEn, 2010).

Table 3.2.2.3.1 presents the current features of hydropower generation in Georgia. Currently installed hydropower has a capacity of 2,483 MW, generating 7,826 GWh per year, by 51 hydropower plant (HPP) complexes, varying in size from large (3,800 MW, Inguri HPP) to very small (<1 MW). The majority of HPPs are run-of-river types with dams not exceeding 10 m., while about 20% of all HPPs consist of larger dams (up to 100 m – Zhinvali HPP) with corresponding reservoirs. The electricity production in recent years in existing HPPs is on average 40% of installed capacity, typically determined by the river water availability in different seasons. Types of existing HPPs include large dams, medium-high dams with reservoirs and run-of-river pipelines, and run-of-river complexes with dam overflows. Only about 20% of all hydropower energy is generated in the Georgian section of the Kura Ara(k)s basin. The total hydropower potential of rivers in Georgia is assessed at 50,000 GWh/year, offering opportunities to completely supply the internal demand as well as to provide significantly to the export market (GE-MEnNR, 2012).

Table 3.2.2.3.1 Overview of hydropower generation in Georgia.

HPP facility	Georgia			Kura Ara(k)s basin			
	MW	GWh	% *	MW	% **	GWh	% **
Existing	2483	7826	40.0	525	21.1	1411	18.0
Planned/ongoing	2220	9432	48.5	201	9.1	1069	11.3
Perspective	1802	7230	45.8	170	9.4	792	11.0

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

In the services sector, generally the environmental impacts are less significant. The tourism industry, support for industries, agriculture support, banking, and municipal development are included as “services”. This sector is significant for both GDP and employment in all three countries in the basin. It should be noted that the services sector in Azerbaijan is largely concentrated in Baku, outside of the basin.

3.2.2.4. Water use

One key set of indicators that has important economic and environmental consequences is water withdrawals. Below, the country statistics are presented on water withdrawals and water consumption, inferring information on total losses. Also the water use per sector of economy is discussed. Table 3.2.2.4.1 presents a summary overview of quantitative data, obtained largely from the national statistics office in each of the countries.

Overall, Table 3.2.2.4.1 shows that in Armenia and Azerbaijan an about equally significant part of fresh water withdrawal is used for agricultural purposes. However, in absolute volumes, agricultural water withdrawals in Azerbaijan significantly outpace both Armenia and Georgia, largely related to more arid conditions in the country as well as the far larger area of land under irrigation. In Georgia meanwhile the largest volume of water withdrawal is used for drinking water supply, both in percentages and well as in absolute volume, compared to Armenia and Azerbaijan (Figure 3.2.2.4.1; Figure 3.2.2.4.2).

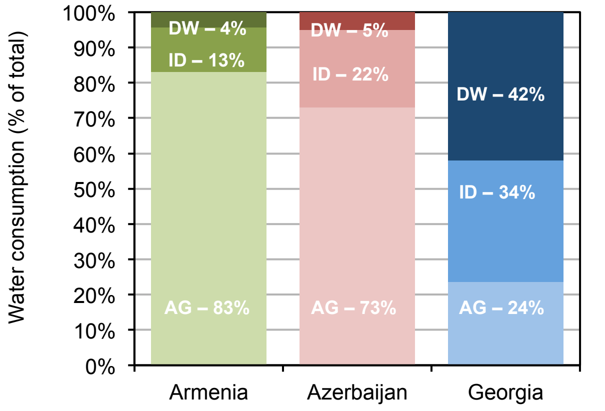
Table 3.2.2.4.1 Water abstraction & consumption, Armenia, Azerbaijan and Georgia, 2011.

	Armenia		Azerbaijan		Georgia	
	(mln m^3)	(%)	(mln m^3)	(%)	(mln m^3)	(%)
Total abstraction	2,438.3	100.0	11,779.2 (10,208.4)	100.0	2,012.3	100.0
- of which groundwater	1,002.8	41.1	n/a		381.1	18.9
Total consumption, of which:	1,738.1	100.0	8,001.8 (6,460.9)	100.0	1,044.7 (884.2) [a]	100.0
- Agriculture, fishery, forest	1,444.5	83.1	5,746.1 (4,966.8)	73.0	247.7 (216.3)	23.7
- Industry	218.8	12.6	1,760.3 (1,295.4)	22.0	357.9 (303.0)	34.3
- Drinking water	74.8	4.3	396.7 (174.2)	5.0	439.2 (364.9)	42.0
Estimate losses	700.2	28.7	3777.4	32.1	967.6	48.1
Water consumption per capita (m^3/year)	530.8		866.5 (1,237.1)		232.3 (323.9)	

Notes: [a] - in brackets water use in the Kura Ara(k)s basin section of the country. Sources: ArmStat (2012); AzerStat (2012); GE-MEP (2012).

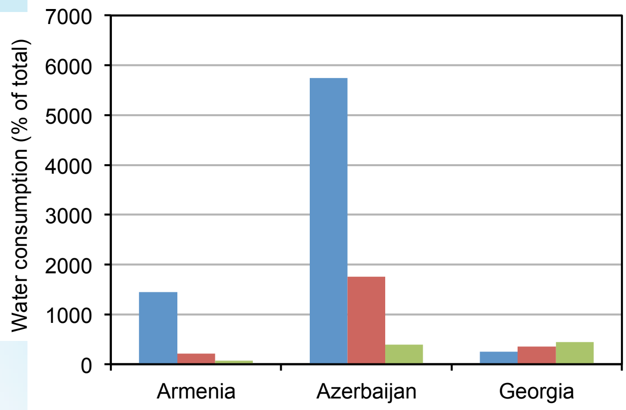
Table 3.2.2.4.1 also shows that Georgia consumes far less water overall per capita, largely due to higher precipitation, which makes rain fed agriculture possible. The increased value of consumption per capita for the Kura Ara(k)s basin in Georgia over the country average serves to confirm that irrigation is predominant in eastern Georgia, having a significantly dryer climate that the western part of the country.

Figure 3.2.2.4.1 Country relative water use by sector in 2011.



Legend: DW – Municipal withdrawal; IN – Industrial withdrawal; AG – Agricultural withdrawal. Source – National statistical data.

Figure 3.2.2.4.2 Total country sectoral water consumption in 2011.



Legend: country columns from left to right – Agriculture; Industry; Communal water consumption. Source – National statistical data.

Water abstraction & consumption

In **Armenia**, total water abstraction from water resources in 2011 amounted to 2,438.3 mln m^3, of which 1,002.8 mln m^3 (41.1%) obtained from underground sources. Total consumption reached 1,738.1 mln m^3, divided over the sectors agriculture , fish breeding & forestry – 1,444.5 mln m^3 (83.1%), industrial & communal use – 218.8 mln m^3 (12.6%) and drinking – 74.8 mln m^3 (4.3%) (ArmStat, 2012). As such, estimated losses amount to 700.2 mln m^3, or 28.7% of total abstraction.

Water abstraction in **Azerbaijan** in 2011 totaled to 11,779.2 mln m^3, of which 10,208.4 mln m^3 (86.7%) were collected inside the Kura Ara(k)s basin (AzerStat, 2012). Meanwhile, total water consumption in the country in 2011 amounted to 8,001.8 mln m^3, divided over the sectors irrigation & agriculture – 5,746.1 mln m^3 (71.8%), industry & manufacturing – 1,760.3 mln m^3 (22.0%) and municipal & drinking purposes – 396.7 mln m^3 (4.9%).

As not all the country is located in the Kura Ara(k)s basin, the corresponding water use inside the basin in 2011 was: irrigation & agriculture – 4,966.8 mln m^3 (86.4% of all irrigation water), industry & manufacturing – 1,295.4 mln m^3 (73.6% of all manufacturing water) and municipal & drinking purposes – 174.2 mln m^3 (43.9% of all municipal water), to a total of 6,460.9 mln m^3, or 80.7% of all water use in Azerbaijan (AzerStat, 2012).

The data show that part of the water collected in the Kura Ara(k)s basin is “exported” to parts of the country outside the basin, 6% of all intake, or 706.8 mln m^3. The statistics per administrative district distinguish between net water providers and net users, identifying the major water intake locations Mingechevir, Imishly and Yevlakh. Accordingly, the water losses in the country and the Kura Ara(k)s basin amount to 3,767.4 mln m^3 (32.0%) and 3,308.8 mln m^3 (32.4%) respectively (AzerStat, 2012).

Total water abstraction in **Georgia** in 2011 reached 2,012.3 mln m^3, of which 381.1 mln m^3 from groundwater sources (GE-MENRP, 2013). Water consumption in the country totaled 1,044.7 mln m^3, divided over the sectors agriculture, fisheries & forestry – 247.7 mln m^3 (23.7%), industry – 357.9 mln m^3 (34.3%) and municipal & drinking purposes – 439.2 mln m^3 (42.0%). An additional 20,557.9 mln m^3 are abstracted for use in the hydropower sector (GE-MENRP, 2013). Losses amount to 967.6 mln m^3, as such assessed at 48.1%.

Consumption in the Kura Ara(k)s basin part in Georgia in 2011 reached 884.2 mln m^3, divided over the sectors agriculture, fisheries & forestry – 216.3 mln m^3 (24.5%), industry – 303.0 mln m^3 (34.3%) and municipal & drinking purposes – 364.9 mln m^3 (41.3%). An additional 5,381.8 mln m^3 is considered non-consumptively used by the hydropower sector (GE-MENRP, 2013). Comparing the country and basin data, it is also clear that irrigation exclusively takes place inside the Kura Ara(k)s section in Georgia

Irrigation

In **Armenia**, in total 1,444.5 mln m^3 of water is supplied to 156,400 ha of irrigated lands, or an overall provision of 9,236 m^3/ha. Obviously additional losses in addition to those presented above apply, the unit value too high according to international standards. In irrigation, distribution losses are typical large, assessed to be 40% (OECD, 2012) up to 60% (UNDP/GEF, 2013 – Desk Study on Socio-economic Trends). As such the actual water provision to agricultural fields more likely is in the order of magnitude of 3,500-5,500 m^3/ha. In **Azerbaijan**, irrigation water in the amount of 5,746.1 mln m^3 is supplied to a total of 1,424.4 mln ha, equal to 4,034 m^3 per ha (AzerStat, 2012). In **Georgia**, the total amount of irrigation water – 114.9 mln m^3 - is supplied to 24,000 ha, a per hectare use of 4,787.5 m^3 (GE-MEP, 2012).

Payment systems for irrigation water differ in the three countries. In Armenia payments are calculated per m^3 of water consumed, only occasionally according to the number of hectares irrigated. In Azerbaijan, payments, installed by the Tariff Council in accordance with Resolution №06 dated 12 April 2006, amount to 50 cents per 1000 m3 for arable land irrigation, and 40 cents per hectare for irrigated pastures. In Georgia and Azerbaijan the payment is calculated according to surface area irrigated. Revenues from irrigation water tariffs amount to 54% of operation and maintenance costs (O&M) in Armenia, while in Azerbaijan revenues cover only 1.8% of O&M costs. Cost recovery typically is lower than for drinking water and wastewater services as a result of very low irrigation water tariffs applied in all countries, significantly lower than tariffs applied to domestic consumption (OECD, 2012). Meanwhile, the quality of irrigation services is rather poor, with high conveyance losses and uncertain and unreliable water supplies (OECD, 2012).

Communal water use

Based on the most recent data available from the national statistics on population figures in the three basin countries as well as their sections part of the Kura Ara(k)s river basin, as presented above, the average daily water supply to the population was calculated:

Armenia:	Country & Kura Ara(k)s population – 63 l/inhabitant/day.
Azerbaijan	Country population – 118 l/inhabitant/day.
	Kura Ara(k)s basin population – 91 l/inhabitant/day.
	Note: National statistical data present daily water supply per inhabitant at the country level on average at 68 liters, varying according to location - for urban areas 164.9 liters, for rural areas 17.5 liters per inhabitant per (AzerStat, 2012).
Georgia:	Country population – 255 l/inhabitant/day.
	Kura Ara(k)s basin population – 349 l/inhabitant/day.

Water intake in the Kura Ara(k)s basin for Baku currently is 242.8 mln m^3 per year (7.7 m^3/s), of which 126.1 mln m^3 reaches Baku (57.1%). Unclear whether the remaining water is lost, or that water is also diverted to other users along the trajectory (AZ-NWS, 2011).

Payment for water services rated at 0.35-0.45 US\$/m^3 in Armenia and Azerbaijan, whereas in Georgia rates amount to 0.12 US\$/m^3 for Tbilisi and 0.25 US\$/m^3 for other cities. The general trend for these water tariffs is an increase, resulting from the rehabilitation of existing water infrastructure and the building of wastewater treatment plants (OECD, 2012). The water tariffs currently in place allow only for a partial recovery of O&M costs of water services, estimated at 71%, 75% and 93% in Azerbaijan, Georgia and Armenia, respectively (OECD, 2012), despite collection rate being rather high - about 75% in Azerbaijan, about 99% in Armenia in 2011 (OECD, 2012).

In **Armenia** the overall average % of people connected to water supply amounts to 59.2%, served by three main supplier companies. This includes Yerevan and its vicinities where close to 100% is connected. In

Armenia's rural areas, 560 villages are served by arrangements that vary by each individual community. In **Azerbaijan** the drinking water supply to the population in the Kura Ara(k)s basin is improved by installing local treatment facilities for treating river water. Currently 178 facilities having been installed already, providing more than 400,000 people with drinking water, in 221 villages of 20 districts. The target is to provide every inhabitant with 30 liters of safe drinking water per day (www.eco.gov.az). In the **Georgian** part of the Kura basin, overall 56% of the population is connected to the water supply system, including Tbilisi where 100% of the population is covered. Accordingly, in rural areas in Georgia only 23% of the population is provided with centralized water.

In the three countries the water supply infrastructure is in a poor condition. In Georgia, water losses are estimated to be 40-60%, varying between cities, while Armenia also reported high conveyance loss figures – the five drinking water supply companies reported losses up to 81.6% in 2011 (OECD, 2012). While no information was available for Azerbaijan, in Baku water losses amount to only 5-6% (OECD, 2012), after recent significant rehabilitations. For the rest of the country, however, anecdotic information confirms water loss rates as high as in the neighboring countries.

Waste water

In **Armenia**, total waste water discharges in 2011 amounted to 750 mln m^3, of which 388 mln m^3 (51.8%) was clean without treatment applied, 115 mln m^3 (15.3%) was insufficiently treated, and 247 mln m^3 (32.9%) was polluted and untreated (ArmStat, 2012).

Payments for water use in Armenia in 2011 amounted to about 440,000 US$, or 3.5% of overall payments for natural resources (ArmStat, 2012). Revenues from environmental charges are fed into the state budget (OECD, 2012). Expenditures on water resources protection and effective use comprised 45.5% of the overall expenditures for environmental protection in 2011 (ArmStat, 2012).

Total waste water discharge in **Azerbaijan** in 2011 amounted to 5,093.8 mln m^3 for the country, and to 4,356.2 mln m^3 for the Kura Ara(k)s basin (AzerStat, 2012). Revenues from environmental pollution enter into the Environmental Protection Fund of Azerbaijan (OECD, 2012).

In **Georgia**, total waste water discharges in 2010 amounted to 175 mln m^3, of which 37 mln m^3 (21.2%) was clean without treatment applied, 41 mln m^3 (23.4%) was treated according to standards, and 97 mln m^3 (55.4%) was polluted (GeoStat, 2012). At present, pollution fees are applied only in Armenia and Azerbaijan, the fees being abolished in Georgia in 2005 (OECD, 2012).

Current abstraction and pollution fees do not provide incentives for users to reduce pressures on water resources, as charges are significantly too low and have limited influence on users' behavior. Also the level of enforcement of generally low (OECD, 2012).

In the three countries, waste water treatment facilities are either absent or in a dire state. In **Armenia**, only the waste water treatment plant (WWTP) in Yerevan performs partial mechanic treatment, while none of the other 20 formerly existing WWTPs is in operation. In **Azerbaijan**, all WWTPs constructed in the period 1970-1980 no longer are in operation. At present, in 21 cities in the Kura Ara(k)s river basin new WWTP are being constructed, while another 29 are in the design phase, ultimately envisioned to provide for wastewater treatment in all cities in the Kura Ara(k)s basin in Azerbaijan. In **Georgia** all old wastewater treatment plants from the Soviet period at present are out of operation. Only one WWTP – in Gardabani, receiving waste water from Tbilisi and Rustavi - is in operation, but performs only mechanic treatment. The WWTP discharges the partially untreated wastewater into the Kura river, close to the border with Azerbaijan (OECD, 2012).

Throughout the Kura Ara(k)s basin, on average, only 70% of the urban population is connected to sewerage collecting systems, while rural households are rarely connected to sewerage networks (OECD, 2012).

3.2.3. Literature cited

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

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

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

AZ-MENR, 2010. Country study on biodiversity of Azerbaijan Republic - Fourth National Report to Convention on Biodiversity Conservation. Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, Baku, Azerbaijan, 167 pp.

AZ-MENR, 2012. Ministry of Ecology and Natural Resources of the Republic of Azerbaijan - www.eco.gov.az

AZ-NWS, 2011. Azerbaijan Republic National Water Strategy. Baku, 2011, 119 pp.

Eurostat, 2012. http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database, accessed 16 October 2012

FAO, 2010. Global forest resources assessment 2010 – Country report Georgia. Forestry Department, FAO, FRA2010/075, Rome, 2010, 45 pp.

FAO, 2012. *AQUASTAT - FAOs Information System on Water and Agriculture*. March 2012. http://www.fao.org/nr/water/aquastat/main/index.stm.

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

Geostat, 2010. Agriculture of Georgia – statistical publication. National Statistics Office of Georgia, Tbilisi, 2010, 85 pp.

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

Harutyunyan L., 2012. UNDP/GEF Kura Ara(k)s Project National Expert on IWRM for Armenia – expert opinion.

Hausman R., L.D. Tyson & S. Zahidi, 2012. The Global Gender Gap Report 2012. World Economic Forum, Geneva, Switzerland, 381 pp.

Illegal-logging.Info, 2012. www.illegal-logging.info

Ministry of Energy & Natural Resources of Armenia, 2012. http://www.minenergy.am/

GE-MEn Ministry of Energy of Georgia, 2010. Overview presentation – Energy sector of Georgia, Tbilisi, 12 pp. www.menr.gov.ge

GE MEnNR, 2012. Ministry of Energy and Natural Resources of Georgia, www.menr.gov.ge

GE MEP, 2012. Ministry of Environment Protection of Georgia, water use in Georgia between 2000-2010. Available in Georgian at http://aarhus.ge/index.php?page=118&lang=eng

GE-MENRP, 2013. Ministry of Environment and Natural Resources Protection of Georgia, statistical data on water abstraction and water consumption for 2011.

National Statistics Office of Georgia, 2012. www.geostat.ge

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

OECD, 2012. Strengthening the economic and financial dimension of integrated water resources management in Armenia, Azerbaijan and Georgia – case study on the Kura river basin. Task force for the implementation of the environmental action program for Central and Eastern Europe, Caucasus and Central Asia, annual meeting, 24-25 September 2012, Oslo, Norway, 45 pp.

Roberta M., 2012. Measuring differences in urban-rural development: the case of unemployment. Theoretical and Empirical Researches in Urban Management, Vol. 7 Issue 3, August 2012, p 44-52.

State Statistical Committee of the Republic of Azerbaijan, 2012. www.azstat.org

UNDP/SIDA, 2005. Task Report – Gender issues in water resources management in the Kura Aras river basin, 31 pp.

UNECE, 2009. *UNECE Countries in Figures -2009 UNECE* . February 2009 (accessed March 2012) http://www.unece.org/stats/profiles2009.html.

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

Urutyan V. & T. Zohrabyan, 2011. Assessment of the economic and social impact of unsustainable forest practices and illegal logging on rural population of Armenia. ICARE International Center for Agricultural Resources and Education Foundation, Yerevan, 78 pp.

World Bank, 2012. *The World Bank Data Indicators.* March 2012 (accessed March 2012). http://data.worldbank.org/indicator?display=default.

3.3. Institutional setting

3.3.1. Armenia

The Ministry of Nature Protection (MNP) has overall responsibility for the protection, sustainable use and management of natural resources, including atmospheric air, water, land, underground resources, flora and fauna, protected areas, as well as for the improvement of the environment in the Republic of Armenia. The MNP's authority includes overseeing the development and implementation of the national environmental and natural resources policies and strategies, environmental standards and guidelines, as well as environmental compliance. The Ministry implements these functions through its departments and divisions, subordinate bodies and state non-commercial organizations (SNCOs).

The Water Policy Division (MNP-WPD) of the MNP is responsible for the formulation of the National Water Policy as well as strategic programs for the protection and sustainable use of water resources, and for the monitoring of their implementation.

The Water Resources Management Agency (MNP-WRMA) of the MNP is the key institution responsible for the implementation of water resources management and protection policies as well as strategic programs that are being formulated by the MNP-WPD. This includes, but is not limited to, the coordination of the development and implementation of the National Water Policy and the National Water Program, including the development and implementation of legal acts that provide for their implementation; the assessment and classification of water resources by their use; the development and implementation of water basin management plans; the regulation of water use and management of competing water uses by means of estimating water availability and ensuring water use efficiency through the permitting and planning processes, for groundwater as well as surface water; participation in the development of all types of water quality standards and control of implementation of legal requirements, in cooperation with the other MNP subdivisions as well as the Ministry of Health and Ministry of Agriculture; maintenance of the State Water Cadaster and State Water Cadaster Information System (SWCIS) based on own data as well as information provided by other stakeholder institutions, and provision of information to government and public stakeholders, etc. Under the MNP-WRMA, six Basin Management Organizations (BMO) – Northern, Akhuryan, Ararat, Sevan, Hrazdan and Southern were established, each of which includes 2 to 4 of the major river basins in Armenia. The MNP-WRMA is transferring some functions to the BMOs as part of the process to decentralize the management of water resources, but this is an ongoing process due to budgetary limitations and insufficient technical capacity.

The Basin Management Organizations (BMO), established under the MNP-WRMA are responsible for achieving the goals and objectives of IWRM - more efficient and targeted integrated management and protection of water resources - in their respective basin area. BMOs operate in accordance with agreed basin management plans, the Water Code, and the National Water Policy. In fulfilling the goals of the National Water Program, BMOs are legally required to fulfill the following functions: Develop and implement Water Basin Management Plans, integrating sector and public interests; Develop draft prospective/long-term projects for the management, use - water supply quantities and supply regime - and protection of water resources, taking basin peculiarities and specific problems into account; Serve as the link between the MNP-WRMA and the basin community; Support water users in the application for obtaining Water Use Permits (WUP) – procedures, data requirements, documentation; Register applications and submit them to the MNP-WRMA, register issued permits and control the implementation of WUP conditions; Address issues of community concern regarding water management and protection within the scope of their authority, or act as intermediate according to the Armenian legislation; Inform the communities about the National Water Policy, National Water Program and parts of Water Basin Management Plans; Subject to approval by the MNP-WRMA, prepare water extraction plans - quantities and regimes; Execute control on water use – measuring devises, volumes & regime according to licenses, and their compliance with water protection zones; Periodically conduct qualitative and quantitative analyses of waste water discharges by means of specialized laboratories. The BMOs submit reports on executed activities to the MNP-WRMA on a regular basis.

The Environmental Impact Monitoring Center (MNP-EIMC) SNCO of the MNP is responsible for monitoring of atmospheric air quality, surface water quality and soil pollution. The water quality monitoring system in the country has been established in 1964. After 1992 the extent of water quality monitoring activities was significantly decreased. Since 2007 the MNP-EIMC has expanded its activities again to currently collecting 1,200 samples from 131 observation points - 39 large and medium size rivers, 6 water reservoirs and Lake Sevan - annually throughout the country (6-12 samples from each observation point). Samples are analyzed for up to 48 parameters, including nutrients, heavy metals, and pesticides. The MNP-EIMC maintains a database containing primary information on the quality of surface water. This local database is not linked to any website. The MNP-EIMC submits summary data to the MNP-WRMA for inclusion in the SWCIS. The MNP-EIMC also develops forecasts and publishes information (monthly and annual bulletins, maps, booklets, brochures, etc.) on surface water quality. Collected information is used by the MNP-EIMC to assess the overall chemical status of the surface water resources and monitor pollution trends, as well as to classify surface water resources into categories based on their suitability for various types of use - fisheries, drinking, irrigation, technical, etc.

Due to the economic crisis and insufficient funding, some activities included in the Action Program for Environmental Monitoring for 2007-2011, including the efforts of the MNP-EIMC to introduce WFD compliant aquatic biological monitoring is still incomplete, despite necessary equipment for aquatic biological monitoring having been provided within the framework of the EU Project on Transboundary Management of Kura River - Phase II, Armenia, Azerbaijan and Georgia. This equipment will allow defining about 20 biological monitoring parameters, which would form the basis for calculating the index of biological quality of rivers. Currently aquatic biological monitoring has been initiated only in selected pilot river basins, as a part donor supported projects.

The Hydrogeological Monitoring Center (MNP-HMC) SNCO of the MNP is responsible for the monitoring of groundwater resources. Although periodic observations of groundwater wells and springs have been conducted since 1950s, between 1990s and 2005 all monitoring was suspended, although nearly 96% of Armenia's drinking water is provided from groundwater sources. Between 2006 and 2008, the MNP-HMC re-introduced groundwater monitoring on a limited number of locations. Since 2009 the MNP-HMC's hydrogeological monitoring network includes 70 sampling points, 24 wells and 46 springs, throughout the 6 basin management areas of Armenia, with key monitoring parameters including discharge, level (pressure) and temperature. Based on monitoring results, the MNP-HMC evaluates the main patterns of fresh groundwater formation in Armenia, assesses their quantitative and qualitative properties, and recommends measures for more efficient use and protection of groundwater resources in the country. MNP-HMC prepares annual summary reports based on monitoring results which are presented to the MNP.

The State Environmental Inspectorate (MNP-SEI) of the MNP is responsible for compliance assurance and enforcement of water and environmental legislation. Through its 11 regional offices, the MNP-SEI supervises the implementation of norms and requirements of water resources use and protection by water users, including water intake from surface and groundwater bodies as well as the pollution load in wastewater discharges (excluding radioactive materials), where appropriate in accordance with water use permits issued by the MNP-WRMA. The MNP-SEI is equipped with laboratories, which are however in poor condition. The MNP-SEI is also responsible for maintenance of the database containing information from inspections and water users on actual water withdrawals, return flows and their quality. Any fines levied enter the State Budget, as Armenia has no special targeted water fund. The MNP-SEI submits work plans and performance reports to the MNP.

The State Environmental Expertise (MNP-SEE) SNCO of the MNR is responsible for conducting assessments of concepts, specific projects and other types of development activities, in accordance with the Law on Environmental Impact Assessment (EIA) and ratified international agreements. The MNP-SEE issues expert conclusions on environmental assessments for final approval by the Minister of Nature Protection.

The Information-Analytical Center (MNP-IAC) SNCO of the MNP is responsible for collecting and processing of information, as well as for the compilation and maintenance of a database with statistical information received mainly from the separate agencies of the MNP. The MNP-IAC provides data and information from the database to government institutions, non-governmental organizations and the public in accordance with the order and procedures defined by legislation. The MNP-IAC may also implement entrepreneurial activities, including publication of environmental books, booklets, maps, posters, catalogues, notifications, etc.

The Ministry of Emergency Situations (MES) was established in 2008 and is responsible for the three priorities for emergency mitigation, preparedness, and response/recovery: (i) develop a program for risk assessment and emergency preparedness; (ii) respond to and aid recovery from emergencies; (iii) coordinate a government-wide policy on risk mitigation. The MES coordinates the development of joint, multi-agency emergency management policies to support these priorities.

The State Hydro-meteorological and Monitoring Service (MES-SHMS) of the MES is the authorized agency for monitoring surface water quantity, as part of the regular monitoring of meteorological and hydrological conditions. Collected information is used to prepare projections on unfavorable hydro-meteorological phenomena such as floods, storms, extreme increase/decrease of atmospheric temperature, thunderstorms, dust storms, heavy precipitation, hail, avalanches, droughts, and others. The Service also develops weather, hydrological and agro-meteorological projections. The MES-SHMS currently operates a monitoring network of 7 hydrological stations which collect information from a total of 92 observation points throughout the country. An important aspect of the MES-SHMS is mass-media public disclosure of projections of extreme events, also provided to the government, ministries, and agencies. Meteorological observations are made eight times per day at 46 meteorological stations. Due to limited resources, at present the MES-SHMS's hydrological monitoring includes only water level, flow, water and air temperature at all observation points, as well as precipitation at 10 of these points. The MES-SHMS maintains an electronic database and prepares annual reference books based on obtained monitoring data. The reference books are submitted to the MNP-WRMA for use in assessing WUP requests. The MES-SHMS also provides summary data to the MNP-WRMA for inclusion in the SWCIS.

The Armenian Rescue Service (MES-ARS) is the primary organization responsible for emergency situations and civil defense, including water-related disasters, such as flooding, mudflows, inundations etc. It carries out prevention, mitigation and liquidation of possible consequences of emergency situations, executes functions of civil defense, protection of the population and economic objects in emergency situations. It maintains public awareness, trains responders, plans for natural disaster responses, and coordinates emergency response and recovery. The MES-ARS staff includes firefighters, rescuers, and trainers; it supports 8 departments, 5 sections, and detached and regional subdivisions.

The Ministry of Territorial Administration (MTA)

The State Committee of Water Systems (MTA-SCWS) of the MTA is the authorized body responsible for the operational management of state owned drinking water supply, irrigation water supply, drainage structures, as well as wastewater collection, treatment and disposal facilities. It is also responsible for operating the Vorotan-Arpa-Sevan tunnel, the issuing of contracts and agreements on third party management, the operation and maintenance of water systems, as well as the transfer of authority for the operation of irrigation systems to **Water Users Associations (WUA)** and **Federations of Water Users Associations (FWUA).** The MTA-SCWS oversees the improvement of water services to the consumers and the implementation of further reforms in water infrastructure development and service delivery. The MTA-SCWS prepares annual reports on all activities in the fields of drinking water supply, wastewater treatment, irrigation water supply and management of water infrastructure (reservoirs and other hydro-technical structures). The annual reports also provide information on the performance indicators of 5 drinking water supply companies, 3 water supply agencies, and 1 drainage network operating company, as well as the WUAs in the country, including a financial-economic analysis. The MTA-SCWS maintains a website with the summaries of above mentioned information, annual progress and assessment reports.

Water supply companies, five in total, are private companies which are operating based on Public Private Partnerships (PPP) contracts. The PPPs allow the government to retain ownership of assets, ensuring capital injection and technical expertise through private sector involvement in the water supply system. The 5 operators provide water supply and wastewater services in all 49 cities in the country as well as 306 communities. The remaining 560 communities have local water supply systems not under these 5 contracts.

WUAs and FWUAs. The establishment and operation of the WUAs and FWUAs is regulated by the Law on WUAs and FWUAs adopted in 2002. WUAs are public organizations established by farmers, responsible for water distribution among member and non-member farmers. Irrigation infrastructure has been transferred (free of charge) to the WUAs for a period of 25 years. The transfer agreement regulates the rights and responsibilities of the WUAs for operating and maintaining these systems. WUAs are nonprofit organizations.

The highest governing body is the Assembly of Representatives of Farmers, which approves the annual budgets, the members of the Governing Council, as well as operational plans and development strategies of the WUA. Currently 44 WUAs are operating in the country, supplying water to almost 90% of irrigated lands.

The FWUAs are unions established by WUAs and are designed to take over responsibility for the operation and maintenance of the main canals, reservoirs, big pumping stations which supply water to more than one WUA, as by Law a WUA cannot supply water to another WUA. No FWUA has been established until now, mainly due to WUAs not being ready. The Law envisages transferring the main infrastructure to the FWUAs for a 50 years operational period. FWUAs would be managed by the WUAs.

Water Supply Agencies (WSA) are currently responsible for operating the main irrigation network (main canals, big reservoirs, large pumping stations) which supplies water to more than one WUA. As mentioned above, FWUAs should be established by WUAs to take over the functions of the WSAs. The ultimate goal is full elimination or minimization the role of the WSAs.

The State Drainage System Operating Company (SDSOC) "Melioratsia" is responsible for the operation and maintenance of the main drainage network of the Ararat Valley, including primary collectors, secondary and tertiary drains, bridges, culverts, siphons and other structures. The maintenance includes periodical cleaning of the collectors and drains, activities which are outsourced and are monitored by "Melioratsia". Annually "Melioratsia" prepares maps of groundwater levels which demonstrate the dynamic changes and overall drainage conditions in the Ararat Valley.

The Ministry of Energy and Natural Resources (MEnNR) is responsible for the development and implementation of the national policy and strategy in the energy sector, including the hydropower sub-sector, as well as the integrated management and use of underground resources. It develops, implements and supervises policies and programs on energy efficiency, the effective production & use of local energy potential and alternative sources of energy, and ensures the energy security of Armenia. The Ministry does not issue any type of permit/license – WUPs are issued by the MNP-WRMA while licenses for construction and/or operation of hydropower facilities are issued by the Public Service Regulatory Commission (PSRC).

> **The Republican Geological Fund of the Geological Agency (MEnNR-GA-RGF)** of the MEnNR is responsible for the inventory and assessment of availability groundwater resources. It maintains an archive with data and information on groundwater resources, which is provided to interested stakeholders, i.e. the MNP and the MNP-WRMA, other government institutions as well as citizens, to be used in the water use permitting process.

The Ministry of Agriculture (MA) is the state authorized body responsible for the development of the agricultural policy and strategies, including land amelioration, irrigation and drainage. The MA is also responsible for developing irrigation standards and regimes for agricultural crops, as well as developing and implementing flood and drought protection measures. **ArmForest** SNCO of the MA is responsible for the implementation of measures targeted at the protection and restoration of Armenia's forests.

The Ministry of Finance (MF) is responsible for conducting inspections in the sphere of water systems and environment, coordinates loans and grants from international financial organizations and donors. Based on inputs from government institutions, the MF submits the State Budget of Armenia for approval to the Government of Armenia (GOA) and the National Assembly. Following its approval the MF also monitors the implementation of the State Budget.

The Public Service Regulatory Commission (PSRC) of Armenia is responsible for regulating the Public Utility Sector, comprised of (i) the energy sector, including electric energy, heat supply and gas supply systems; (ii) the water sector, including drinking water, irrigation water for the WSAs and technical water supply, drainage and wastewater treatment; and (iii) the telecommunication (electronic communication) sector. The PSRC sets the regulated tariffs for water supply and wastewater services proposed by the water utility companies according to the tariff methodology established. It also issues licenses/system use permits for respective services based on the procedure established by legislation, including licenses for construction and/or operation of hydropower facilities. It also approves model contracts between the public utility companies and users.

The National Water Council (NWC) is a high level inter-sectoral advisory body chaired by the Prime Minister, which by means of cross-sectoral high level participation discusses and provides guidance on the National Water Policy, the National Water Program, as well as other issues related to management in the water sector. Under the NWC the **Dispute Resolution Commission** is established, which by means of mediation resolves disputes that relate to water use permits.

The Ministry of Health (MH), through its **State Hygiene and Anti-Epidemiological Inspection (MH-SHAEI)**, is responsible for safeguarding the sanitary/epidemiological safety of the population. It develops and supervises the implementation of sanitary/epidemiological regulations and standards, including those for the drinking water sector. By means of inspections the MH-SHAEI controls the quality of water sources used for drinking purposes. Through its branches in Yerevan and its suburbs and the Marzes of Armenia, the MH-SHAEI collects regular samples from drinking water sources and the water supply network for bacteriological and chemical analysis. Data from inspections is maintained in the electronic database, which is not available online. The MH-SHAEI provides summary information to the MNP-WRMA for inclusion in the SWCIS.

There are other Councils/Commissions, established under the President and Prime Minister of the Republic of Armenia, which are involved in water governance. These are: the National Council on Sustainable Development, and the Scientific-Technical Council under the Prime Minister, the National Security Council, the Public Council with its Committee on Agriculture and Environment, and the Commission on Lake Sevan Issues under the President of Armenia.

The State Water Cadaster (SWC) was established by Government decision in 2004, defining the order of registration of documents and the provision of information. This decision authorizes the MNP-WRMA to consolidate and maintain all water resources and water systems information in an official repository. The MNP-WRMA stores annual data and information received in an established digital format from all participating agencies – the State Water Cadaster Information System (SWCIS). The SWCIS integrates data on water resources quantity and quality, watersheds, extractions from river beds, biological resources, water users, water use permits and water system use permits. Table 3.3.1.1. presents stakeholder institutions of the SWCIS, and the type of data/information they provide.

Table 3.3.1.1 Stakeholder Institutions of the SWCIS.

Stakeholder Institution	Available Data
Water Resources Management Agency, MNP (state authorized body for SWC)	Water use and wastewater discharge data (WUPs)
Environmental Impact Monitoring Center, MNP	Surface water quality data
State Environmental Inspectorate, MNP	Actual water use and wastewater discharge data
Hydrogeological Monitoring Center, MNP	Groundwater quality and quantity data
Armenian State Hydro-meteorological and Monitoring Service, Ministry of Emergency Situations	Surface water quantity data
Republican Geological Fund of the Geological Agency, Ministry of Energy and Natural Resources	Inventory of groundwater resources
State Committee of Water Systems under the Ministry of Territorial Administration	Water systems used by the drinking water supply, irrigation water intake, drainage structures, operating organizations and WUAs
State Hygiene and Anti-Epidemiological Inspection, Ministry of Health	Drinking water quality monitoring, water monitoring of open reservoirs, violations of sanitary norms

Conclusions

Despite legal and institutional reforms in Armenia's water sector since 2000, still challenges exist for the implementation of a decentralized integrated management system of water resources in full compliance with the requirements of the EU WFD. Currently the Water Policy Dialogue (WPD) meetings, chaired by the MNP-WRMA, serve to bring the various authorities together to discuss water governance challenges and potential solutions as a team. The Steering Committee of the WPD includes representatives from key sectors, and functions as a strong inter-sectoral coordinating body.

Considerations for improvements towards fully operationalizing the implementation of IWRM in Armenia are:

- **Coordination.** Coordination and cooperation at the national as well as on the river basin level is weak, between various sectoral state institutions, as well as between agencies within any ministry. Although government decrees regulating aspects of cooperation between agencies largely are in place, supervision and enforcement are overall lacking. Also, sectoral development programs in related fields like agriculture, energy etc. are developed without proper consideration of priorities and objectives of other stakeholders involved in water management. Political and sectoral demands dominate over the principles of integrated sustainable water resources management defined by Armenian legislation.
- **Data collection & information management.** Despite improvements in recent years, limited financial and human resources hamper the collection of sufficient data covering the spatial-temporal and parameter extent necessary for informed decision making, for groundwater, surface water as well as related thematic fields. Monitoring networks were minimized following Armenia's independence. Today, salaries are too low to attract and keep capable staff, and financing is insufficient to maintain or update technical resources – hardware and software – to meet modern requirements. New practices cannot be introduced, lacking possibilities for hardware purchase, staff training, methodology development, even when international donor support is provided, e.g. on bio-monitoring in compliance with the EU WFD. While the SWCIS presents a new approach to data management and information sharing in Armenia, many of the participating institutions have not fully adopted the concept of "open access" – the sharing of data among institutions and the public has yet to be improved.
- **Compliance.** The MNP-SEI, key responsible organization for compliance and enforcement monitoring has insufficient financial resources to properly equip and staff its 11 regional offices. Although extensive training has been provided by international donors, there is a continuous loss of most experienced inspectors resulting from too low salaries. Moreover, the authority and responsibilities of the MNP-SEI and its regional offices related to compliance with water use and wastewater discharge conditions as stipulated in WUPs are not clearly defined and coordinated with responsibilities of the MNP-WRMA and the MNP-BMOs, leading to fragmented compliance and enforcement, or duplication.

Literature cited

The description of the institutional structure in Armenia is based on the review of relevant legislative documents regulating responsibilities in the water management sector by the UNDP/GEF Kura-Ara(k)s Project National Expert on IWRM, Ms L. Harutunyan, with inputs on WUAs and irrigation water use from the former UNDP/GEF Kura-Ara(k)s Project National Coordinator for Armenia, Mr. T. Kalantaryan. Additional information was obtained from the following publications:

European Neighborhood Policy Instrument, 2011. Shared environmental information systems – Armenia country report, Yerevan, Armenia, September 2011, 32 pp.

Ministry of Nature Protection, 2011. Water resources management in the Republic of Armenia: achievement and next Steps, Yerevan, 2011, 19pp.

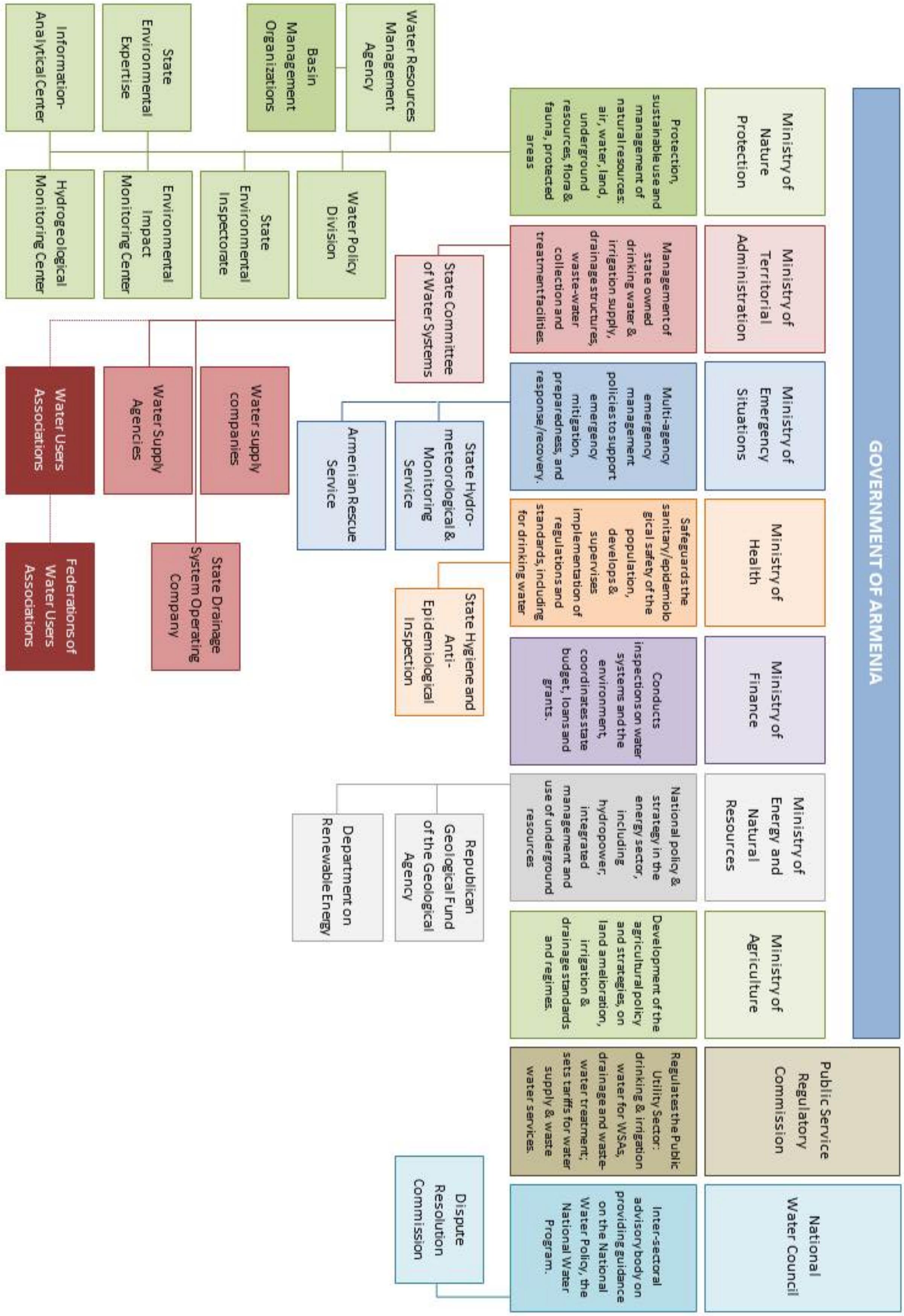
Ministry of Nature Protection of Armenia, 2012. Ten years of reforming water management sector in Armenia: towards the EU Water Framework Directive. Water Resources Management Agency, Ministry of Nature Protection of the Republic of Armenia, Yerevan, 2012, 53 pp.

Mkhitaryan L., 2009. Towards performance based utility sector in Armenia: case of drinking water supply services. Caucasus Research Resource Centers – Armenia, Research No. C08-0198, Yerevan, Armenia, 2009, 27 pp.

World Bank, 2009. Disaster risk reduction and emergency management in Armenia. World Bank, Europe and Central Asia region, October 2009, 59 pp.

World Bank, 2011. Republic of Armenia water sector note. World Bank, Sustainable Development Department, Europe and Central Asia Region Report No. 61317-AM, May 2011, 123 pp.

Figure 3.3.1.1 Institutional framework on water management in Armenia.



3.3.2. Azerbaijan

The main actors involved in water resources management in the Republic of Azerbaijan include:

- Ministry of Ecology and Natural Resources (MENR):
    - Ecology and Nature Protection Policy Division (MENR-ENPPD).
    - Environmental Protection Department (MENR-EPD).
    - National Environmental Monitoring Department (MENR-NEMD).
    - National Geological Exploration Service (MENR-NGES).
    - Department of National Hydrometeorology (MENR-DNH).
    - Caspian Complex Ecological Monitoring Administration (MENR-CCEMA).
    - Department for Reproduction and Protection of Bio-resources in Water Reservoirs (MENR-DRPBWR).
    - State Expertise Administration (MENR-SEA).
    - Climate Change and Ozone Center (MENR-CCOC).
    - Department on Forest Development (MENR-DFD).
    - Department on Protection of Biodiversity and Development of Specially Protected Nature Areas (MENR-DPBDSPNA).
    - State Information - Archive Fund (MENR-SIAF).
- Ministry of Emergency Situations (MES), especially:
    - State Agency for Water Resources (MES-SAWR).
- Ministry of Health (MH).
    - Center for Hygiene and Epidemiology (MH-CHE).
- Ministry of Economic Development (MED).
    - Tariff Board (MED-TB).
- “Azersu” Joint Stock Company (Azersu JSC).
- “Amelioration & Water Management” JSC (AWM JSC).
- State Company for Alternative and Renewable Energy Sources (SCARES).
- Water Users Associations (WUA).
- Ministry of Agriculture (MA).
    - The Phyto-sanitary Control Service (MA-PCS).

The Ministry of Ecology and Natural Resources (MENR) is the key state agency responsible for formulating and implementing the environmental policy; developing environmental protection measures; screening of development activities for potential adverse environmental impact; monitoring of the quality of air, soil, precipitation, surface and groundwater, biodiversity, forests, radioactivity; monitoring the implementation of environmental legislation and imposing sanctions; and administering a pollution permit system. The MENR provides forecasts of natural and human-induced environmental processes, including climate change. The MENR is the designated national authority for participation in the Clean Development Mechanism (CDM). The MENR manages a database on the state of the environment.

The MENR executes the state water policy, aimed at the conservation and sustainable use of water resources – surface water and groundwater, and the prevention of their pollution. The MENR carries out water resources inventories, and manages the monitoring stations network for hydrometric, hydro-geological and hydro-chemical observations. The MENR prepares water balances, evaluates groundwater resources and yields, and deals with issues on rational use and the regeneration of water resources. It establishes and approves standards of maximum allowable discharges (MAD) of wastewater and controls them through regional offices. The MENR includes several water-related departments and services:

The Ecology and Nature Protection Policy Division (MENR-ENPPD) defines the main directions of the policy on the conservation and protection of water resources from pollution. It coordinates the monitoring and implementation of environmental legal acts, and enforces compliance of planned activities affecting water resources with existing legislation.

The Environmental Protection Department (MENR-EPD) of the MENR is responsible for verifying compliance of wastewater discharges and law enforcement - fines and claims.

The National Environmental Monitoring Department (MENR-NEMD) of the MENR ensures the monitoring of surface water quality, currently using 44 monitoring stations - 27 in rivers, 4 in reservoirs (Aghstafa, Jeyranbatan, Mingechevir and Shamkir), and 11 in lakes (7 lakes on Absheron peninsula: Beyuk-shor, Lake Krasnoe, Yasamal-1, Masazyr, Kurdekhany, Byulbyulya, Khodzhakhassan; and 4 lakes in other regions) and 1 in the port of Baku.

The total number of parameters included in the programs for monitoring inland surface water quality by different organizations is: MENR-NEMD - 47; the Center of Hygiene and Epidemiology (MH-SHE) - 41 (including 7 microbiological parameters); and MENR-EPD - 38.

The MENR-NEMD takes water samples downstream and upstream of wastewater discharges as part of compliance verification procedures.

The National Geological Exploration Service (MENR-NGES) is responsible for groundwater monitoring, as well as the regulation and control of groundwater abstraction, including reviewing of Water Use Permit requests for groundwater. Quality standards for groundwater are currently not in place. The MENR-NGES maintains a groundwater cadaster with groundwater quality information from over 2,500 boreholes in the country.

The Department of National Hydrometeorology (MENR-DNH) is responsible for monitoring surface water reserves and flows. It is also the focal point for climate change, including the Communications to the UNFCCC, and other climate change-related international obligations, including greenhouse gases inventory. There are 11 regional subdivisions of the MENR-DNH, responsible for 106 stations executing hydrological observations.

The Caspian Complex Ecological Monitoring Administration (MENR-CCEMA) is responsible for monitoring the environmental status of the Caspian Sea. It analyses norms and limits of pollution outflows from communal and industrial sources into the Caspian Sea, and presents information to the MENR. It implements methodological guidance to pollution monitoring, participates in developing a unified information system on the use of natural resources of the Caspian Sea and the development of a database.

The Department for Reproduction and Protection of Bio-resources in Water Reservoirs (MENR-DRPBWR) is responsible for scientific research, monitoring, control and surveillance of the fisheries in the Caspian Sea, and improving reproduction of several fish species.

The State Expertise Administration (MENR-SEA) issues permits for wastewater discharges, in accordance with the Law on Environmental Protection (1999). Permissible volumes of wastewater discharged into water resources or their watersheds, description of outflows, as well as permissible limits of discharges of hazardous substances in wastewater are included in wastewater discharge permits. Fees rate vary from region to region depending on cost of services, but currently no volumetric fees are applied to wastewater discharge to the environment. The MENR-SEA is also responsible for issuing groundwater use permits, in cooperation with the MENR-NGES.

The Climate Change and Ozone Center (MENR-CCOC) was established to provide support to implementing commitments to the UNFCCC, and to facilitate coordination and support to planning and implementation of climate change-related activities.

The Department on Forest Development (MENR-DFD) is a body which implements monitor of forest protection in areas included in the state forest fund, executes forest restoration and reforestation activities, grows planting materials, supplies seeds of forest trees and bushes, carries out state records and cadaster of forest fund lands, and implements the national legislation on forests.

The Department on Protection of Biodiversity and Development of Specially Protected Nature Areas (MENR-DPBDSPNA) is the government body responsible for monitoring in Protected Areas and Objects; monitoring of hunting and hunting reserves on compliance to hunting rules; the inventory and conservation of biological diversity towards sustainable development; the restoration and increase (including artificially) of biological resources and preservation of their genetic fund; the sustainable use of the specially protected state hunting fund in Azerbaijan; the execution of activities in the field of environmental awareness; the organization and development of eco-tourism; as well as the implementation of relevant legislation.

The State Information - Archive Fund (MENR-SIAF) on environmental protection and the use of natural resources is managed by the MENR. The hydro-meteorological and geological databases, together with the environmental monitoring bulletins and monthly and annual reports of the main departments and regional environmental committees of the MENR provide the basis for the database. Many data sets and much information stored in the MENR-SIAF are not in electronic form and are not easily accessible to users, including the general public.

The Ministry of Emergency Situations (MES) is the lead organization for all aspects of managing emergency situations in Azerbaijan. It coordinates activities for the protection of the population from natural and man-made disasters, including fire; for elimination of consequences of disasters; and implementation of the state policy in the field of civil defense, rescue and restoration works.

The State Agency on Water Resources (MES-SAWR) of the MES was recently assigned with new guidelines, activities and responsibilities, as described in the Charter approved on November 22, 2011. The main tasks include:

- Undertake measures for the protection of water reservoirs of national importance.
- Carry out monitoring of water resources and entities, hydro-technical facilities and water supply systems, in cooperation with other stakeholders.
- Undertake measures to improve water resources management in the country, involving relevant authorities.
- Provide integrated management of water entities (facilities), efficient operation of hydro-technical facilities, stock-taking of water supply systems listed on the MES-SAWR asset register.
- Participate in protecting water entities, hydro-technical facilities and water supply systems in emergency situations, in mitigating the consequences from emergencies, in cooperation with other structural units of the Ministry and relevant public institutions.
- Ban the exploitation of technical facilities, equipment, enterprises and other entities that harmfully impact on water resources, provide recommendations on limiting and suspension of exploitation.
- Participate in developing and implementing measures aimed at preventing the harmful impact of flash floods, ground- and surface waters, participate in addressing impacts.
- Develop recommendations to rehabilitate water industry entities damaged or destroyed as a result of a natural disaster or accident.
- Develop recommendations for measures on the integrated use of water resources, elaborate water resources protection schemes, describe activities for the water industry, and identify future demands for water resources in the country.

The Ministry of Health (MH)

The Center for Hygiene and Epidemiology (MH-CHE) of the MH is responsible for setting drinking water standards and monitoring the quality of surface waters used for drinking water supply and for recreational purposes. The MH-CHE is a consulting party in the assessment process on issuing WUPs for surface & groundwater use as well as wastewater discharge. There are locally based divisions of the MH-CHE that monitor and control water quality.

The Ministry of Economic Development (MED) coordinates the implementation of the State Program for the Socioeconomic Development of the Regions of Azerbaijan for 2009–2013. The MED finances the development and improvement of the energy, water and sanitation infrastructure in the country.

The Tariff Board (MED-TB) under the MED is responsible for the approval of all tariffs and fees, except those relates to taxes and custom payments. The MED-TB is chaired by the Minister of Economic Development. Tariffs and fees are set at meetings of the MED-TB, which are organized after receiving proposals from relevant authorities. Control over the regulations for calculation and payment of fees (including the transfer of calculated fees to the state budget) and actual water use volumes is exercised by the Cabinet of Ministers and Ministry of Taxes. Current tariffs and fees only partially account for the actual economic value of providing water of appropriate quality to customers. No provisions are included in regulations to adjust automatically (e.g. once per year) the level of the water resource fees for inflation.

The "Azersu" Joint Stock Company (Azersu JSC) is in charge of implementing the state policy and strategy in the field of water supply – drinking water - and sanitation services to consumers in a centralized manner, including community water supply, water treatment, transportation and sales of water. Their primary responsibilities include: (a) integrated use of water resources, assessing needs in water resources, (b) developing forecasts and norms of water use, (c) forecasting the distribution of water between different sectors of economy, (d) In cooperation with the Tariff Board, determine water use fees. Azersu JSC is responsible for the construction, operation & maintenance of intake structures, reservoirs, pumping stations, water pipelines and sewage collectors. Azersu JSC collects wastewater collection and treatment fees.

The "Amelioration & Water Management" (AWM JSC) is a state-controlled JSC responsible for providing water to economic sectors, by means of assessing needs for water and developing forecasts and norms of water use. Tthe AWM JSC provides water to irrigation systems and oversees the development and management of irrigation and drainage systems in the country. Overall functions and responsibilities include:

- Distribution of water to industries and the agricultural irrigation sector.
- Design and construction of new state-owned irrigation and drainage systems, and reconstruction of existing systems.
- Ensuring state control in water use and protection, among others by maintaining a register on water use and conservation.
- Supervision of activities of water users associations.
- Mitigation of salinity problems on irrigated lands.
- Arranging measures to combat flooding and flood water.
- Preparing overall schemes for the integrated use of surface water and their protection, together with other relevant state bodies, including determining water use fees.
- Ensuring the use of transboundary water objects, inter-state joint use of land reclamation and irrigation systems.

The AWM JSC has established District Irrigation Departments (DIDs), the main responsibility of which is to plan and implement bulk water supplies to Water Users Associations (WUAs) at the on-farm level.

The AWM JSC is the responsible organization for issuing Water Use Permits for surface water use, coordinating the decision making with the MENR-SEA – on the need for obtaining an EIA - and the MH-CHE – on the need to comply with state water quality standards, depending on the purpose of water use.

The State Company for Alternative and Renewable Energy Sources (SCARES) is the state-owned company providing public services on alternative and renewable energy sources, as well as identifying sources of renewable energy, and carrying out other works related to the development of this field.

Water Users Associations (WUA) are voluntary community farmer associations responsible for management of on-farm irrigation systems. After irrigation & drainage system improvement, WUAs enter into 20-year management transfer agreements with contracts for the provision of bulk water supply. In accordance with the Law on Amelioration and Irrigation (LAI), a WUA has the right to set its own WUA Irrigation Service Fee (WUA-ISF) to cover all costs of management at the WUA level. By January 2010, about 550 WUAs covering an area of 1,320,497 ha had re-registered under the LAI.

Ministry of Agriculture (MA)

The Phyto-sanitary Control Service (MA-PCS) was established under the MA in 2006, dealing among other things with obsolete pesticides, which still pose an environmental problem in Azerbaijan.

Conclusions

The management of water resources in Azerbaijan is undergoing changes since the Preliminary TDA was drafted. The Ministry of Emergency Situations has emerged as an additional, second authority for water management, though the Ministry of Ecology and Natural Resources remains the responsible authority for the implementation of the water policy, for water quality management, and overall ecosystem protection. The "Amelioration & Water Management" JSC remains the authorized company for the allocation of irrigation water, while the "Azersu" JSC is emerging as an important player in managing drinking water supply.

The practice of water management as implemented in Azerbaijan by the listed organizations shows the existence of a number of key issues for improvement, summarized below:

- **Coordination.** Lines of communication and coordination are weak between ministries and other organizations involved in aspects of water resources management. There are some transfers of information, but this is done on an *ad hoc* basis, and commonly through personal contacts. There is limited communication between water management authorities and authorities concerned with land, ecology and related disciplines. Overlap and gaps remain in the assignment of tasks and responsibilities of authorities. Despite reforms in the legislative framework of laws and bylaws during the first decade of the 21st century, shortcomings in coherence between legal acts remain.
- **Monitoring & information management.** To some extent monitoring of water resources is being implemented, for both water quality and quantity, but the information generated through monitoring does not transmit to actions to improve management, nor water resources. Largely management actions are taken only on an *ad hoc* basis, in response to a crisis or emergency. While the MENR has initiated investments in the hydro-meteorological observation network, the number of monitoring locations remains too limited to collect sufficient meaningful information on water resources conditions. The capacity of managing information from monitoring to the decision making level is also in need of improvement. Information on groundwater resources assessment is outdated, there is a need to reassess data on groundwater volumes and their quality. No integration is established with (limited available) information on land quality, issues of land degradation, human impacts on land, ecosystem health and others.
- **Capacity.** Throughout the water sector, staff numbers seem too limited to properly fulfill management tasks. Staff typically is insufficiently paid, causing high staff turn-over, meaning knowledge and experience is lost. Training and education for specific areas of expertise are needed in all involved organizations. The technical capacity in some institutions remains insufficient, for proper monitoring, operation & maintenance of installations.

Although the current situation is one of change, initiation of the Water Policy Dialogue provides an ideal opportunity for all involved organizations to come together and develop stronger integrated management strategies. This will be addressed in the Institutional Trend Analysis (Chapter 6), and in the National IWRM Plan development in line with the EU Association Agreements, referring to the EU WFD.

Literature cited

UNECE 2010. Environmental performance review – Azerbaijan, second review. United Nations New York & Geneva, Environmental Performance Review Series No. 31, 2010, 218 pp.

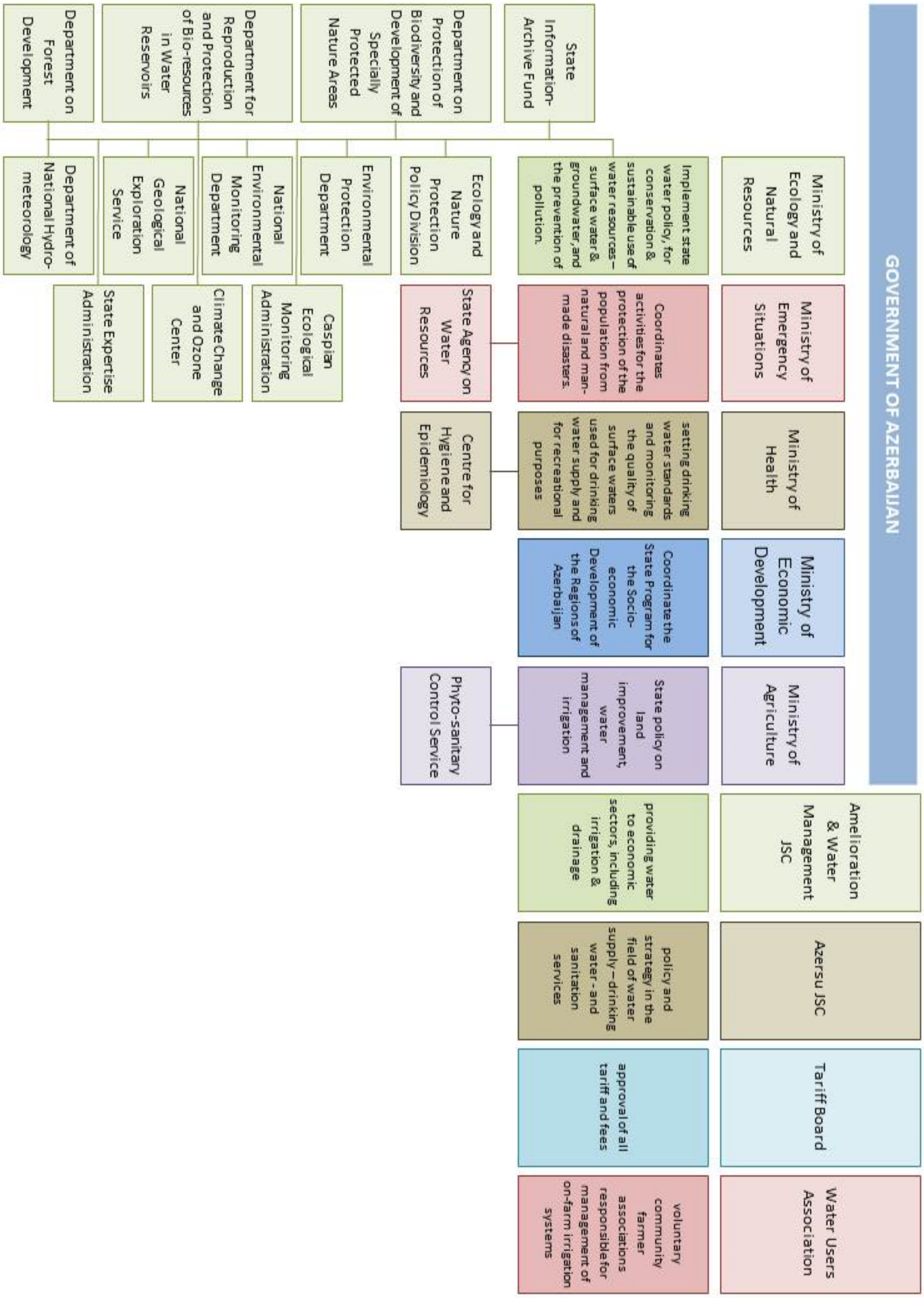
Anonymous 2011. National water strategy 2012-2030 of the Republic of Azerbaijan, draft November 2011, Baku, 118 pp.

European Environment Agency 2011. European Neighborhood and Partnership Instrument – Shared Environmental Information System. Azerbaijan Country Report. November-December 2011, Baky, Azerbaijan, 35 pp.

State Agency on Water Resources, 2011. Charter.

World Bank, 2011. Azerbaijan - Water Users Association Development Support Project. Washington D.C.

Figure 3.3.2.1 Institutional framework on water management in Azerbaijan.



3.3.3. Georgia

Water management-related responsibilities in Georgia are divided among different state institutions, with the key entities being the Ministry of Environment and Natural Resources Protection. Protection and management of surface and underground water as well as the state control of environment protection lies within the competences of the Ministry of Environment and Natural Resources Protection. The management of drinking water quality is the responsibility of the Ministry of Agriculture, while the coordination of the development of water supply and sanitation systems is undertaken by the Ministry of Regional Development and Infrastructure. Specific tasks and responsibilities of each of these organizations, as well as some other institutional stakeholders involved in water management, will be discussed in more detail below.

The Ministry of Environment and Natural Resources Protection (MENRP) is responsible for implementing the state policy in the field of environment protection and for the state management of environment protection and natural resources use. The Ministry establishes and oversees emission and discharge limits; defines quotas and issues licenses for natural resources consumption; organizes the state system of hydro-meteorological and environmental pollution monitoring; issues environmental impact permits; approves technical regulations on water abstraction as well as standardized discharge limits for activities not subjected to an environmental impact permit. Technical environmental regulations provide for standardized water discharge and air emission limits, and 5 year water abstraction plans approved by the Ministry. The MENRP also implements state control in the field of environment protection and natural resources use, which includes monitoring of the implementation of conditions agreed under environmental impact permits and technical environmental regulations; manages protected areas; prepares national state of environment reports, national environmental action plans, etc. The following structural subdivisions of the MENRP implement water management-related responsibilities:

The Service of Water Resources Management (MENRP-SWRM) is responsible for defining priority directions in the field of surface water management and for ensuring their implementation. It supports the harmonization of the national water management related legislation with the relevant EU directives; approves maximum allowable discharge limits; approves technical environmental regulations on water abstraction; compiles and processes water use data; coordinates the development of river basin management plans; coordinates the implementation of obligations under international agreements related to surface water management; and reviews environmental impact assessment reports; etc.

The Service of Wastes and Chemicals Management (MENRP-SWCM) participates in implementing the state policy in the field of waste and chemicals management; develops the national waste management strategy and action plan, and coordinates their implementation ; regulates and registers wastes and chemicals; coordinates the development of databases; coordinates the implementation of obligations under international agreements in the field of wastes and chemicals management; manages persistent organic pollutants; coordinates the management of hazardous and specific wastes; participates in defining the location of regional landfill sites and coordination of landfill construction activities; participates in regulation of production, transportation, import, exports, re-export or transit of materials with limited turnover; reviews environmental impact assessment reports, etc.

The Service of Climate Change (MENRP-SCC) participates in the development and implementation of the state policy and the strategy on climate change; assesses risks related to impacts of climate change on the sectors of economy and ecosystems, and develops corresponding prognoses; coordinates the development of the national climate change mitigation plan and supports its implementation; coordinates the preparation of the national communications to the UNFCCC; ensures implementation of obligations under the Kyoto Protocol; reviews environmental impact assessment reports, etc.

The Service of Land Resources Protection and Entrails of the Earth (MENRP-SLRPEE) participates in developing and implementing of the state policy on sustainable management of land resources and entrails of the earth; coordinates the planning and implementation of mitigation measures against desertification and land degradation; develops databases on lands contaminated with hazardous substances and wastes, etc.

The Service of Natural and Anthropogenic Hazards (MENRP-SNAH) participates in coordinating the development and implementation of the state strategy and policy in the field of reducing natural and anthropogenic hazards; coordinates the planning and implementation of measures for reducing risks related to natural and anthropogenic hazards; supports institutional capacity building of early warning systems; runs the state registry on measures for reducing natural and anthropogenic hazards and supports the development of hazard maps; coordinates implementation of obligations under international conventions related to the reduction of natural and anthropogenic hazards, etc.

The Department of Environmental Impact Permits (MENRP-DEIP) issues environmental impact permits; coordinates activities related to issuing environmental impact permits, including the organization of ecological expertise. It receives EIA documentation from a developer, collects comments from involved structural subdivisions of the MENRP, provides these comments to the developer who then revises the EIA and submits the final version. Subsequently, the DEIP organizes the ecological expertise upon which an environmental impact permit is issued (or rejected). The ecological expertise is conducted by an ad-hoc commission of experts, established for each specific expertise.

The Service of Biodiversity Protection (MENRP-SBP) participates in the development and implementation of the state policy in the field of biodiversity protection; coordinates the development and implementation of the national strategy and the action plan on biodiversity protection; manages biological resources (except woody species in the forest); develops measures and regulatory mechanisms for the protection of biodiversity components, including plant and animal species, their habitats and in general ecosystems; participates in decisions on the extraction of species included in the Red List from the natural environment; coordinates the implementation of obligations under international conventions on biodiversity protection; coordinates the state system of biodiversity monitoring; reviews environmental impact assessment reports, etc.

Department of Supervision of Environmental Protection (MENRP-DSEP) is a state sub-agency establishment under the MENRP responsible for implementing the state control in the fields of environmental protection and natural resources use. The Department controls the implementation of conditions under permits and licenses in the fields of environmental protection and natural resources use; reveals and prevents environmental pollution and illegal use of natural resources; reveals and prevents administrative violations in the field of environmental protection; monitors implementation of legislation; runs databases of the objects of regulation, etc. The Department has 8 territorial units throughout Georgia.

The Agency of Protected Areas (MENRP-APA) is a Legal Entity of Public Law (LEPL) under the MENRP. The Agency manages Protected Areas (PA): State Reserves, National Parks, Nature Monuments, Managed Reserves, Protected Landscapes, Biosphere Reserves, World Heritage Sites and Wetlands of International Importance. The Agency has 22 PA Administrations throughout the country, which are responsible for the protection and restoration of PAs including ecosystems, flora and fauna species and their habitats; they prevent destruction, capture or damage of plant and animal species; prevent spreading of foreign species of flora and fauna; collaborate with the local self-governance bodies, government institutions, NGOs and other stakeholders; control visitors, transportation means, and use of natural resources in the PAs and buffer zones; detain trespassers and means of transportation; prevent administrative violations in the PAs; provide eco-tourism services to visitors; implement PA management plans; monitor legally permitted activities in PAs, organize scientific research, monitor and register wild plant and animal species as well as natural ecosystems, genetic resources and natural processes. From the 22 territorial administrations 12 are located in the Kura Basin.

The National Environmental Agency (MENRP-NEA), a LEPL under the MENRP is responsible for creating and maintaining compatible monitoring systems for meteorological, hydrological, and geodynamic processes, as well as the geological and environmental quality conditions on the territory of Georgia. The Agency collects environmental observation data and distributes them through the national and global networks; manages databases on hydro-meteorological, geological and state of environment data and prepares corresponding information reports; processes environmental observation data and assesses the state of environment; participates in assessing risks of hydro-meteorological, geological and ecological hazards; prepares warnings about anticipated hazardous hydro-meteorological, geological or environmental conditions and distributes this information to decision makers and the public; establishes the need for the evacuation of the population from hydro-meteorological and geological disaster zones; studies physical processes related to climate change and participates in the development of adaptation measures addressing these changes; issues licenses for natural resources use (except for oil and gas) and coordinates activities related to issuance of licenses; establishes quotas for natural resources consumption; ensures the implementation of obligations under international conventions in the fields of hydro-meteorology, geology and environmental pollution monitoring, etc.

The Centre of Environmental Information and Education (MENRP-CEIE), a legal entity of public law under the MENRP is responsible for supporting access to environment-related information, public participation in environmental decision making, access to justice on environmental matters, public awareness raising on environmental protection, and capacity building of specialists in the field of environmental protection. The Centre creates and administers an unified database on environment related information; collects and distributes environmental information; creates an environmental library; supports the development of the registry of environmental pollutants; supports the publication of documentation related to the issuing of environmental impact permits; supports the publication of information related to the issuing of licenses for natural resources use; develops meta-bases on environmental information; organizes capacity building trainings for different target groups, etc.

The Ministry of Energy (ME) implements the state policy in the field of energy. It monitors the implementation of the state strategy, policy and programs, and supports the coordination of their implementation. It supports attracting investments in the energy sector, and ensures the implementation of projects in the energy sector, etc.

The Department of Energy (MEn-DE) prepares recommendations for effective functioning of the energy sector; studies alternative energy sources in the country and develops recommendations; supports projects on clean development mechanisms; develops energy balances and coordinates their implementation; develops energy sector long, mid and short term programs and coordinates their implementation; monitors the volume of export and import of energy carriers; supports and coordinates the development of scientific, research and project design directions; participates in developing the energy sector strategy for emergency situations; participates in developing the main directions of the state policy in the energy sector; participates in projects planned and implemented by international organizations; participates in developing the main policy directions in the field of natural resources management and use.

The Ministry of Labor, Health and Social Affairs (MLHSA) develops and implements the state governance and state policies in the fields of labor, health and social affairs. The Ministry ensures public health protection; regulates medical and pharmaceutical activities; ensures social support (aid) of the population and child care; coordinates issues related to alternative civilian service; organizes defining sanitary hygienic and occupational safety norms, etc. With the aim of ensuring a safe environment for public health the Ministry develops and approves environmental quality standards for ambient air, surface & groundwater, soil, noise, vibration and electromagnetic radiation, including establishing maximum allowable concentrations of chemical and microbiological parameters and norms of harmful impact. The Ministry also establishes quality norms and technical regulations for safe drinking water according to the recommendations of the World Health Organization (WHO).

The Department of Health Protection (MLHSA-DHP) develops and implements national programs and regulations in the fields of health protection, medicine, pharmaceutics and other; prepares national reports on social and health conditions of the population; coordinates organizations regulating the health protection sector.

The National Center for Disease Control and Public Health (MLHSA-NCDCPH), a LEPL under the MLHSA ensures favorable epidemiological conditions in the country in accordance with the state policy in the field of health protection. This includes revealing risks for communicable and certain non-communicable diseases, as well as the control and prevention of these diseases. The Center implements and monitors state programs and measures in the field of public health including ensuring the proper functioning of the unified epidemiological supervision system for communicable diseases and the implementation of preventive measures; promoting healthy life styles; monitoring and analysis of public health conditions; managing medical statistics; organizing the national reference laboratory network; ensuring biological safety; organizing the national depository of bacteria and viruses; defining epidemiological standards; participating in developing hygienic norms and standards etc.

The Ministry of Agriculture (MA) implements its competences related to agricultural food production, soil conservation and restoration of soil fertility in the sectors of plant protection, livestock rearing, agro-engineering and veterinary services. The Ministry implements reforms in the agricultural sector; supports the development of the agricultural, food and processing industries; implements state supervision in the field of soil conservation and improvement-restoration of soil fertility; coordinates activities for livestock production; registers and tests new pesticides, agrochemicals and varieties of animals and plants; plans and supports the use of pesticides and agrochemicals, etc. Another competence of the Ministry is laboratory control on compliance of drinking water with quality parameters established by the MLHSA.

The Department of Melioration Policy (MA-DMP) under the MA is responsible for the development of the state policy in the field of irrigation & drainage and soil improvement, as well as for overseeing its implementation. The MA-DMP undertakes monitoring and registration of irrigated lands and develops a corresponding data base; and implements the state control on rational land use, soil conservation and improvement of soil fertility.

The National Food Agency (MA-NFA) a LEPL under the MA is responsible for implementing state supervision on food safety and compliance with hygienic, veterinary-sanitary, and phyto-sanitary rules and requirements. The Agency registers and controls pesticides, agrochemicals, and veterinary products and issues licenses for the production of biological pesticides. The Agency is also responsible for drinking water quality control.

The United Melioration Systems Company Ltd (UMS) is a state owned Ltd providing irrigation and drainage services in Georgia. The company also delivers technical water to industries and hydropower stations. The Company is managed by the Ministry of Agriculture of Georgia.

The Ministry of Regional Development and Infrastructure (MRDI) is responsible for implementing the regional development policy. The Ministry coordinates the development of water supply and sanitation systems; elaborates the state policy for the development of the motorway networks of international and national importance, etc.

The Department of Infrastructure Development (MRDI-DIS) under the MRDI develops the state policy for the rehabilitation and development of the international and national motorway networks, water supply systems and other infrastructural facilities. The Department participates in the preparation of medium and long term programs and priority directions for infrastructural objects, and has a responsibility to attract international aid and investments for infrastructure development.

The United Water Supply Company (UWSC) Ltd is a state owned company providing water supply and sanitation services throughout Georgia, except for Tbilisi, Mtskheta, Rustavi and the Adjara Autonomous Republic. Tbilisi, Mtskheta and Rustavi are served by Georgian Water and Power (GWP), a private Ltd. The UWSC is managed by the MRDI. The company has 6 regional offices (4 in the Kura Basin) and 53 service centers in the regions. The company employs 2,400 people. Main activities of the UWSC include water abstraction, treatment and supply to the customers; design, construction, installation, maintenance and operation of water supply and wastewater collection networks.

The Ministry of Economy and Sustainable Development (MESD) implements its competences in the fields of economic policy, trade and investments, tourism, state property management, urban development and spatial planning, construction, transport and other. The Ministry analyses the economic state of the country and elaborates its economic policy to ensure a sustainable economic development; reviews programs to be financed from the state budget and by international donor organizations and coordinates the monitoring of their implementation together with the Ministry of Finances of Georgia.

The Department of Sustainable Development (MESD-DSD) under the MESD defines the Strategy for Sustainable Development, as well as for state programs supporting its implementation. The Department assesses innovative projects in support of sustainable development; supports the identification of the country's investment potential and resources related to sustainable development; elaborates and implements initiatives for sustainable and safe economic development, etc.

The Technical and Construction Supervision Agency (MESD-TCSA) is a LEPL under the MESD. The Agency implements the state control and supervision of objects and related processes containing high risks or threats such as demolition, explosion, emission and intoxication which pose risks for human health, property and the environment. The Agency issues construction permits for objects of special importance, among others including artificial reservoirs, dams, hydro-technical constructions, etc. Subsequently the Agency registers them and carries out their mandatory inspection.

The Ministry of Finances (MF) develops the financial-budgetary policy of Georgia, defines the main directions of the annual national budget and related financial programs, and manages state budget expenditures and incomes. The Ministry participates in development of the tax policy and ensures tax enforcement.

The Ministry of Internal Affairs (MIA), among other competences, implements civil safety measures related to natural disasters and other emergency situations, and coordinates the response to emergency situations.

The Emergency Situation Management Department (MIA-ESMD) coordinates the prevention of emergency situations caused by natural, man-made or any other type of disaster, and takes measures to mitigate and eliminate their consequences; develops the main directions of the state policy on fire safety and oversees its implementation; manages the country's unified warning system, etc. The department develops national emergency response and civil defense plans and coordinates their implementation. The department collaborates with other relevant state institutions and local self-government bodies.

The National Energy and Water Supply Regulatory Commission (NEWSRC), a LEPL, is a non-budgetary national regulatory body which is independent from the State Authorities, departments and organizations. The Commission is comprised of 5 members, appointed and dismissed by the President of Georgia. One of the members is appointed as Head of Commission. Members of the Commission are appointed for 6 years. The Commission defines rules and conditions for licensing electricity generation, transmission, dispatch and distribution, natural gas transportation and distribution as well as water supply; issues licenses and oversees implementation of license conditions. The Commission defines the procedures of establishing tariffs and service fee payments as well as the tariff limits, for electricity generation, water supply and natural gas transportation, distribution and consumption. The NEWSRC also defines the procedural rules for dispute resolution between licensees and customers.

Local Self-Governance Institutions are responsible for managing forest and water resources of local importance – small rivers, lakes, wetlands, groundwater etc. not exceeding beyond the territory of a municipality, and of no special esthetic and scientific importance. The local self-governance institutions are responsible for supervising measures for the rational use and protection of water; control of water use and protection; prevention of unlawful use of water. They also participate in developing integrated schemes for water protection, water management balances, etc.

Conclusions

Overall, water resources management remains highly centralized and fragmented in Georgia. There are no mechanisms in place for managing water resources at a local level. At the same time, the various aspects of water resources management are dealt with by different state agencies, while exchanging information and coordination among them requires significant strengthening.

At this time there are no official prerequisites for introducing the river basin model of water resources management, even though a new Law on Water which would follow the principle of river basin oriented water resources management is planned to be finalized within the framework of the UNECE Water Policy Dialogue. Taking the fragmented institutional setting into consideration, as well as the limited financial and administrative capacity of the MENRP, shifting to integrated water resources management will be challenging for Georgia.

A series of structural and legislative changes over the past several years have significantly reduced the regulatory authority of the MENRP. As a result of the 2005-2007 reforms in the system for issuing licenses and permits, a number of water-related licenses and permits had been abolished. At present surface water abstraction and effluent discharge is regulated by the environmental impact permit and technical environmental regulations issued by the MENRP. An environmental impact permit is required for the activities having a significant potential adverse impact on the environment. It involves completing the Environmental Impact Assessment (EIA) procedure. Activities which are assessed to have less potential impact on the environment are not subject to environmental impact permitting, but are obliged to comply with technical environmental regulations, both for surface water abstraction and effluent discharge. Overall, environmental impact permit system needs significant strengthening, especially in terms of post decision making surveillance and enforcement. In addition, it is a tool for general environmental decision making, and not particularly focused on water.

As a result of the reorganization of the MENRP in 2011, natural resources management competencies were transferred to the Ministry of Energy, which diminished the role of the Ministry of Environment. Due to this reorganization, the Ministry of Energy, which became the Ministry of Energy and Natural Resources, was responsible for issuing licenses for the use of groundwater and other natural resources. In addition, the Ministry of Energy and Natural Resources shared responsibility over state environmental control and supervision with the Ministry of Environment, which was an evident example of duplication of competences.

Due to recent reorganizational changes in spring 2013, the natural resources management-related competencies and responsibilities were transferred back to the Ministry of Environment, becoming the Ministry of Environment and Natural Resources Protection. The Department of Supervision of Environmental Protection was created under the MENRP, responsible for the overall state control of environmental protection and use of natural resources. It has been also planned to strengthen the overall capacity of the Ministry, increasing the number of staff and organizing capacity building activities. In addition, Georgia recently committed to developing and signing a bilateral agreement with Azerbaijan on transboundary waters based on the UNECE Convention on the Use and Protection of Transboundary Rivers and International Lakes. All these initiatives can have a positive impact on improving water resources management in Georgia, including at the transboundary level.

Literature used

Law of Georgia on Environment Protection, Tbilisi, 10 December 1996

Law of Georgia on Environmental Impact Permit, Tbilisi, 14 December 2007

Law of Georgia on Ecological Expertise, Tbilisi, 14 December, 2007

Law of Georgia on Public Health, Tbilisi, 27 June, 2007

Law of Georgia on Safety and Free Movement of Products, Tbilisi, 8 May 2012

Organic Law of Georgia on Local Self-Governance, Tbilisi, 16 December 2005

Resolution of the Georgian Government N98, 26 April 2013, Tbilisi on approval of the Statute of the Ministry of Environment and Natural Resources Protection of Georgia

Resolution of the Georgian Government N97, 26 April 2013, Tbilisi, on Approval of the Statute of the Ministry of Energy of Georgia

Resolution of the Georgian Government N132, 16 March 2011, Tbilisi on approval of the Statute of the Ministry of Environment Protection of Georgia

Resolution of the Georgian Government N133, 16 March 2011, Tbilisi, on Approval of the Statute of the Ministry of Energy and Natural Resources of Georgia

Resolution of the Georgian Government N26, 18 February 2009, Tbilisi, on Approval of the Statute of the Ministry of Agriculture of Georgia

Resolution of the Georgian Government N77, 10 September 2004, Tbilisi, on Approval of the Statute of the Ministry of Economy and Sustainable Development of Georgia

Resolution of the Georgian Government N10, 30 January 2009, Tbilisi, on Approval of the Statute of the Ministry of Regional Development and Infrastructure of Georgia

Resolution of the Georgian Government N 249, 31 December 2005, Tbilisi, on Approval of the Statute of the Ministry of Labor, Health and Social Affairs of Georgia

Resolution of the Georgian Government N39, 21/05/04, Tbilisi, on Approval of the Statute of the Ministry of Finances

Resolution of the Georgian Government N313, 11 August 2011, Tbilisi, on approval of the rules on implementing state control by the Agency of Natural Resources LEPL included in the system of the Ministry of Energy and Natural Recourses of Georgia

Ordinance of the President of Georgia N 614, 27/12/2004, Tbilisi, on Approval of the Statute of the Ministry of Interior

Resolution of the Georgian National Energy and Water Supply Regulatory Commission N2, 28 February 2012, Kutaisi, on Approval of the Statute of Georgian National Energy and Water Supply Regulatory Commission

Order of the Ministry of Environment and Natural Resources Protection of Georgia N7, 10 May 2013, Tbilisi, on Approval of the Statute of the Service of Water Resources Management of the Ministry of Environment and Natural Resources Protection of Georgia

Order of the Ministry of Environment and Natural Resources Protection of Georgia N20, 10 May 2013, Tbilisi, on Approval of the Statute of the Service of Wastes and Chemicals Management of the Ministry of Environment and Natural Resources Protection of Georgia

Order of the Ministry of Environment and Natural Resources Protection of Georgia N23, 10 May 2013, Tbilisi, on Approval of the Statute of the Service of Climate Change of the Ministry of Environment and Natural Resources Protection of Georgia

Order of the Ministry of Environment and Natural Resources Protection of Georgia N15, 10 May 2013, Tbilisi, on Approval of the Statute of the Service of Land Resources Protection and Entrails of the Earth of the Ministry of Environment and Natural Resources Protection of Georgia

Order of the Ministry of Environment and Natural Resources Protection of Georgia N9, 10 May 2013, Tbilisi, on Approval of the Statute of the Service of Natural and Anthropogenic Hazards of the Ministry of Environment and Natural Resources Protection of Georgia

Order of the Ministry of Environment and Natural Resources Protection of Georgia N24, 10 May 2013, Tbilisi, on Approval of the Statute of the Department of Environmental Impact Permits of the Ministry of Environment and Natural Resources Protection

Order of the Ministry of Environment and Natural Resources Protection of Georgia N11, 10 May 2013, Tbilisi, on Approval of the Statute of the Service of Biodiversity Protection of the Ministry of Environment and Natural Resources Protection

Order of the Ministry of Environment and Natural Resources Protection of Georgia N26, 10 May 2013, Tbilisi, on Approval of the Statute of the sub-agency establishment of the Ministry of Environment and Natural Resources Protection – Department of Supervision of Environmental Protection

Order of the Ministry of Environment and Natural Resources Protection of Georgia N3, 10 May 2013, Tbilisi, on Approval of the Statute of the Agency of Protected Areas, a Legal Entity of Public Law

Order of the Ministry of Environment and Natural Resources Protection of Georgia N12, 10 May 2013, Tbilisi, on approval of the typical statute of the territorial administrations of the Agency of Protected Areas

Order of the Ministry of Environment and Natural Resources Protection of Georgia N27, 10 May 2013, Tbilisi, on approval of the Statute of the National Environmental Agency, a Legal Entity of Public Law

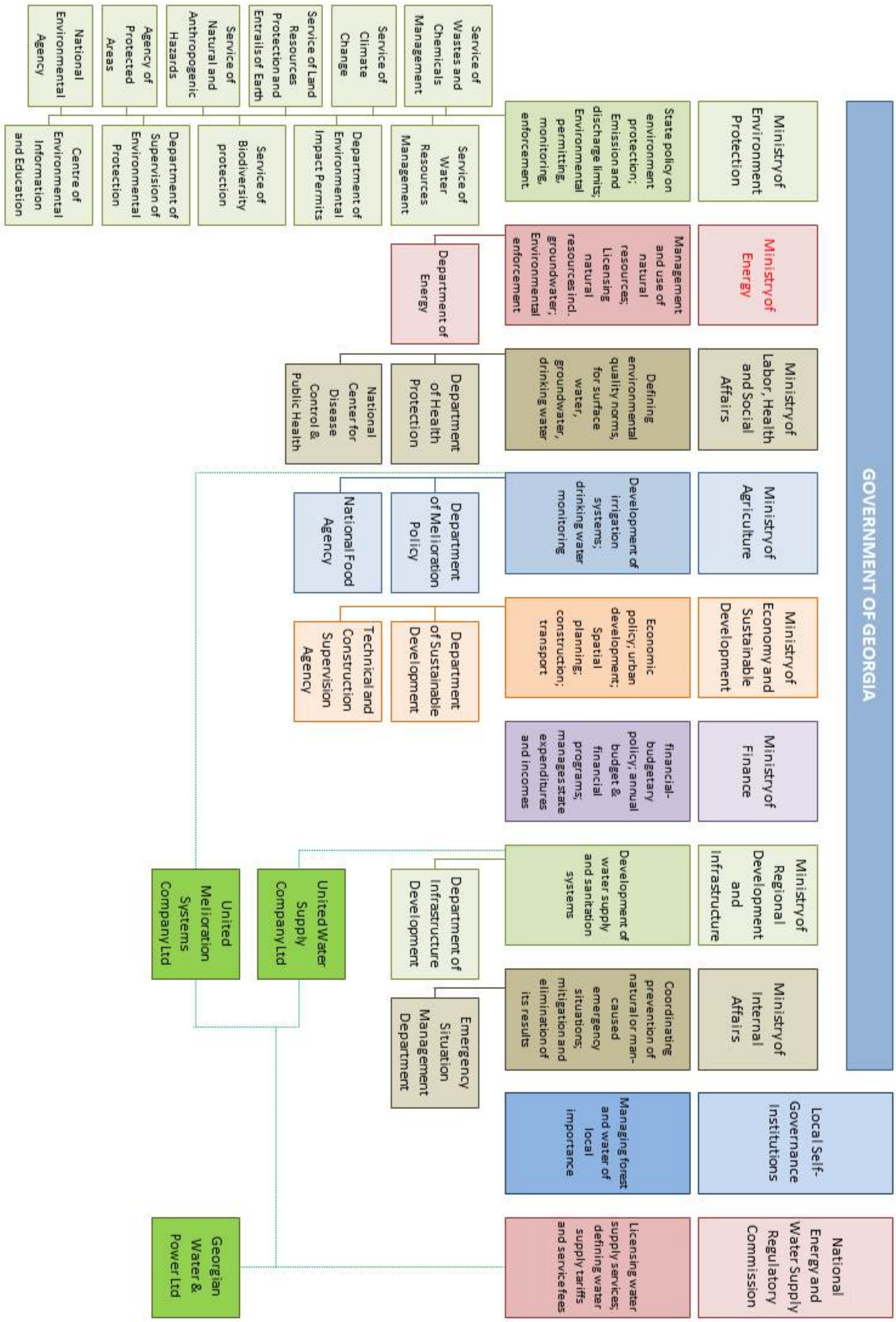
Order of the Ministry of Environment and Natural Resources Protection of Georgia N6, 10 May 2013, Tbilisi, on approval of the Statute of the Centre of Environmental Information and Education, a Legal Entity of Public Law

Order of the Ministry of Energy of Georgia N84, 1 May 2013, Tbilisi, on Approval of the Statute of the Structural Sub-divisions of the Ministry of Energy

Order of the Ministry of Labor, Health and Social Affairs of Georgia N107/N, 27 March 2007, Tbilisi, on Approval of the Statute of the National Center for Disease Control and Public Health LEPL

Order of the Ministry of Economy and Sustainable Development N1-1/1527, 23 July 2012, Tbilisi, on Approval of the Statute of the Agency of Technical and Construction Supervision, a Legal Entity of Public Law

Figure 3.3.3.1 Institutional framework on water management in Georgia.



4. MAIN TRANSBOUNDARY PROBLEMS

4.1. Variation and reduction in hydrological flow

4.1.1. Description of the problem

The current section presents an analysis of river flows, especially the temporal changes which have been observed in the flow regime of the Kura and Ara(k)s rivers over the last decades, based on available records of river flows over a reasonably long period of time.

The hydrological regime of the Kura Ara(k)s river basin is the result of a range of both natural and anthropogenic factors. Seasonal and annual flow volumes typically reflect variable climate conditions, specifically temperature and precipitation, determining surface-groundwater flow components as well as evapotranspiration. Water abstraction for human needs has been a feature of the Kura Ara(k)s river basin since ancient times. Long before the beginning of hydrological observations river water was used for irrigation and water supply. However, for an extended period of time water use was not significant, as technology did not lend itself to large scale water abstraction and population numbers were relatively low. While it is difficult to separate the impacts of climate change on river flow from those of increasing abstractions, analytical evidence of recent changes in climate indicates the scale of impact on river flows.

Since the 1930s the development of the agricultural and industrial water sectors has vastly increased abstractions from the rivers. Numerous large and small reservoirs have been constructed, including the Mingechevir Reservoir in Azerbaijan (1953) on the Kura river and the Ara(k)s Reservoir on the Ara(k)s river (1970). Since then many other reservoirs have been constructed on various tributaries of the Kura and Ara(k)s in all three countries of the South Caucasus.

It is evident that the construction of these reservoirs and the related abstractions from the rivers, as well as losses due to evaporation from the reservoir surfaces and infiltration into the reservoirs' bottoms, have had an adverse impact on the remaining available water.

The Second National Communications (SNCs) to the UNFCCC produced by all three countries report on significant decreases in average annual precipitation in Armenia and Azerbaijan since 1960, minus 6.0% and minus 9.9% respectively, while the average annual precipitation in eastern Georgia, located in the Kura basin, increased by 6.0%. Meanwhile, overall precipitation as well as its observed decrease vary considerably around the region, mainly due to the highly varied mountain topography.

The SNCs also reported on increases in average annual temperature, from 0.52°C in Azerbaijan and 0.6°C in eastern Georgia to 0.85°C in Armenia, largely during the second half of the 20^{th} century – rather significant increases over such a short time. As temperature is a key factor in determining evapotranspiration, the change affects the rates of plant water use, especially noted in irrigated agriculture.

4.1.2. Transboundary relevance

Changes in the flow regime of the Kura and Ara(k)s rivers are both a national and a transboundary, regional issue. In the South Caucasus the concern over water availability tends to increase downstream, with the upper basins still showing a reasonable surplus, while the lower basin already is in a water stress situation. Armenia and Azerbaijan are both considered water stressed countries. Water shortages are most keenly felt in Azerbaijan, where the annual deficit in assessed to be in the order of 4 to 5 km^3.

Consequently, any increase in water use in the upper reaches of the Kura and Ara(k)s rivers is a very sensitive transboundary issue. While any reduction in river flow in the upstream basin may create serious difficulties in the lower reaches of the Kura and Ara(k)s river basin, this is especially true when high-volume water users such as irrigation are being expanded. Hydropower development is also a major concern for downstream users, especially for the irrigation sector. While hydropower is not generally a major consumptive user, large hydropower dams tend to significantly impact on the seasonal flow regimes, which usually clash with irrigation seasons. Reservoirs related to large dams also cause increased significant water losses due to evaporation and infiltration. Intersectoral concerns can be minimized when applying a regional approach to dam operation. Hydropower development also raises concerns on maintaining environmental flows to support riverine ecosystems, concerns which will only grow with further water resources development and the impacts of climate change.

The need to manage water as an international transboundary resource in the region is relatively new, linked to the change from a single country to three distinct nations at the end of the twentieth century. However, from a river basin perspective and from environmental perspectives, political boundaries are not overly relevant, but simply require a regional adaptive approach to water resources management.

4.1.3. Why perception exists of this problem

There is much anecdotal evidence, in many parts of the basin, of an overall decline in surface water availability, with many water users complaining about the lack of water. However, there is also quantitative evidence, as is shown later in this section.

The lack of efficiency in irrigation operations and irrigation water use is a well understood problem in the region, cited in all three South Caucasus countries as a priority issue during the November 2011 Capacity Needs Assessment country meetings, during which dealing with the decline in river flows was raised as a priority.

In addition to the growth of irrigation and water use inefficiency, climate change has already made its impacts felt. However, it is difficult to separate the impact of climate change from the impact of irrigation abstractions but, as the next section shows, the decline in river flows is clear.

4.1.4. Factual evidence regarding the problem

Reduction in annual river discharge

During the Soviet period, an extensive network of surface water monitoring stations was maintained in all three countries. Although following independence a significant number of stations have been closed, especially in Armenia and Georgia, monitoring of the river flow is still ongoing. Accordingly, there is strong factual evidence of river discharges throughout the second half of the 20th century, the trends of which are discussed for selected stations.

The Kura river discharge time series for the Tbilisi hydrological station, representing the Kura river in Georgia, is shown in figure 4.1.4.1. There is no declining trend evident from this time series, neither in the data series itself, nor in the five year running mean calculated for it, a simple trend analysis approach which helps to identify if there is a trend or not.

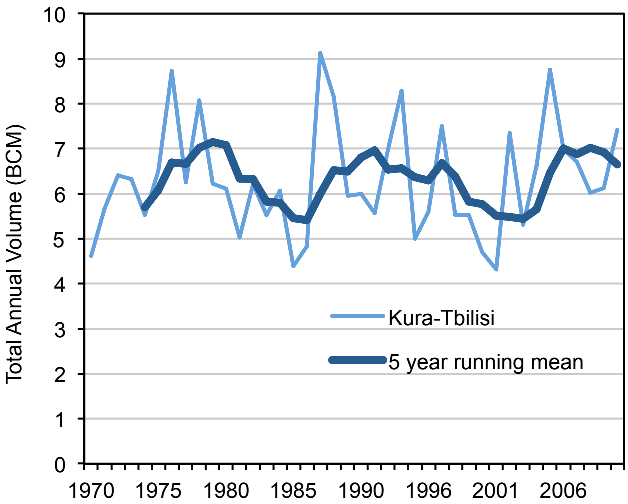
However, a downward trend in river discharge is visible in the time series for the Armenian station of Surmalu on the middle Ara(k)s river, as shown in figure 4.1.4.2.

For Azerbaijan, three stations were analyzed, at Yevlakh on the middle Kura river, Novruzlu on the downstream Ara(k)s river, and Surra, directly downstream of the confluence of the Kura and Ara(k)s rivers. Again, in figure 4.1.4.3 the downward trend over the last 60 years is evident in both the data series and the five year running mean.

Seasonal variation in river discharge

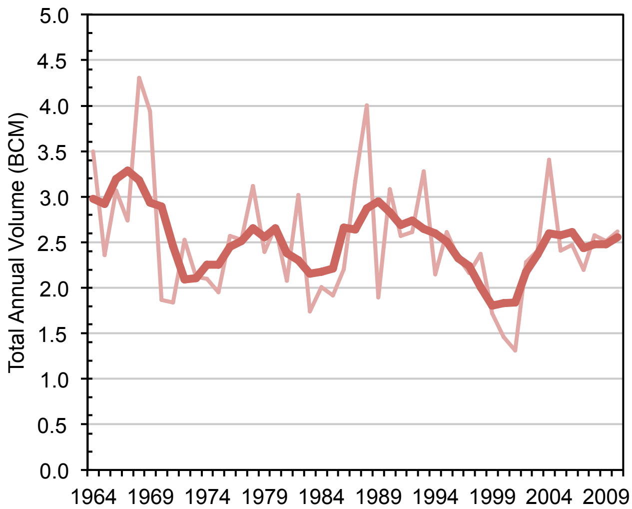
To assess the seasonal variation in river discharge, two analyses were performed. The first was to calculate differences in mean and standard deviation between a base period of climatic ‘norm’, represented by the years 1950 to 1979, and the more recent period of 1980 to 2010. Standard deviation is the primary indicator of variation in the data and the test is often performed to determine whether there are differences between data sets. The analysis was carried out on monthly flow data from the station at Surra, in Azerbaijan, selected because it is located just downstream of the confluence of the Kura and Ara(k)s rivers, and thus representative of the river as a whole. Table 4.1.4.1 presents the analysis.

Figure 4.1.4.1 River flow time series for the Kura river at Tbilisi, 1970 to 2010.



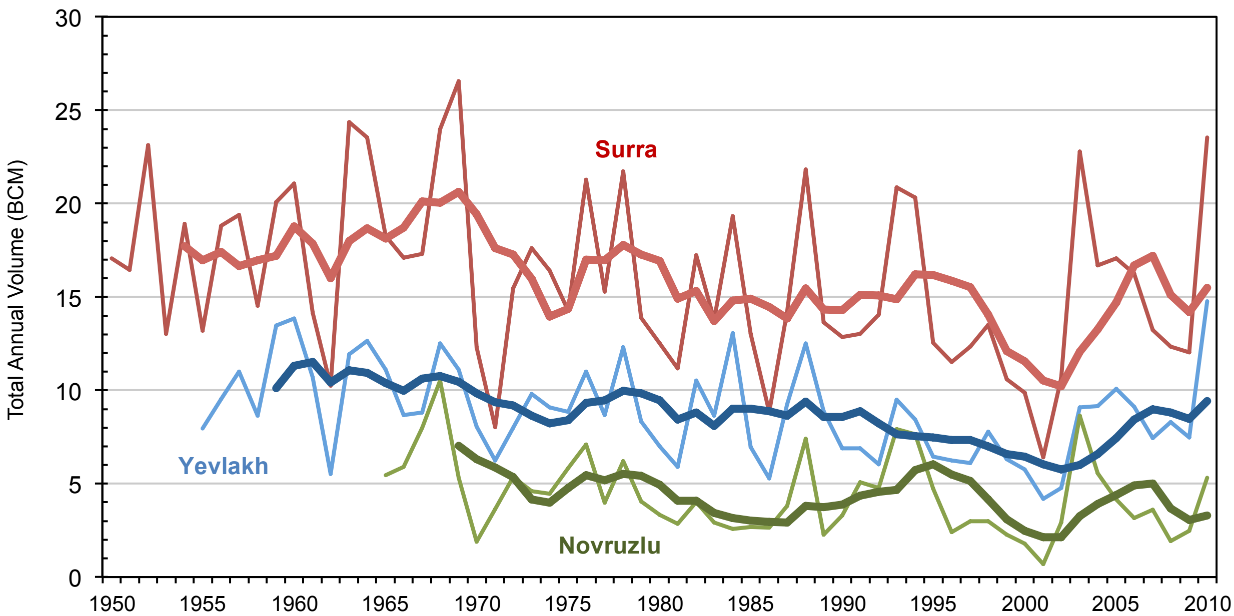
Source: Georgia National Environment Agency (2012).

Figure 4.1.4.2 River discharge time series for the Ara(k)s river at Surmalu, 1964 to 2010.



Source: Hydro-meteorological Survey Armenia (2012).

Figure 4.1.4.3 River flow time series, Kura Ara(k)s river in Azerbaijan, 1950 to 2010.



Source: Azerbaijan Hydro-meteorological Department, Ministry of Ecology and Natural Resources (2012).

Table 4.1.4.1 confirms the earlier conclusion that at Surra a significant decline in river discharge can be observed - an almost 20% lower mean value for the 1980 to 2010 period compared with the 1950 to 1979 period. Considering the overall annual difference in standard deviation, a small decline is observed for the 1980 to 2010 period, suggesting less variation in discharge.

When comparing the monthly distribution of river discharge for the two periods identified, it shows that the summer months have high negative changes in standard deviation, evidence of a lower level of variation in river discharge in the period after 1980, but positive differences in standard deviation for the winter months, suggesting a higher variation in river discharge during winter.

Table 4.1.4.1 Comparison of mean and standard deviation for monthly flow data at Surra, Azerbaijan in different periods.

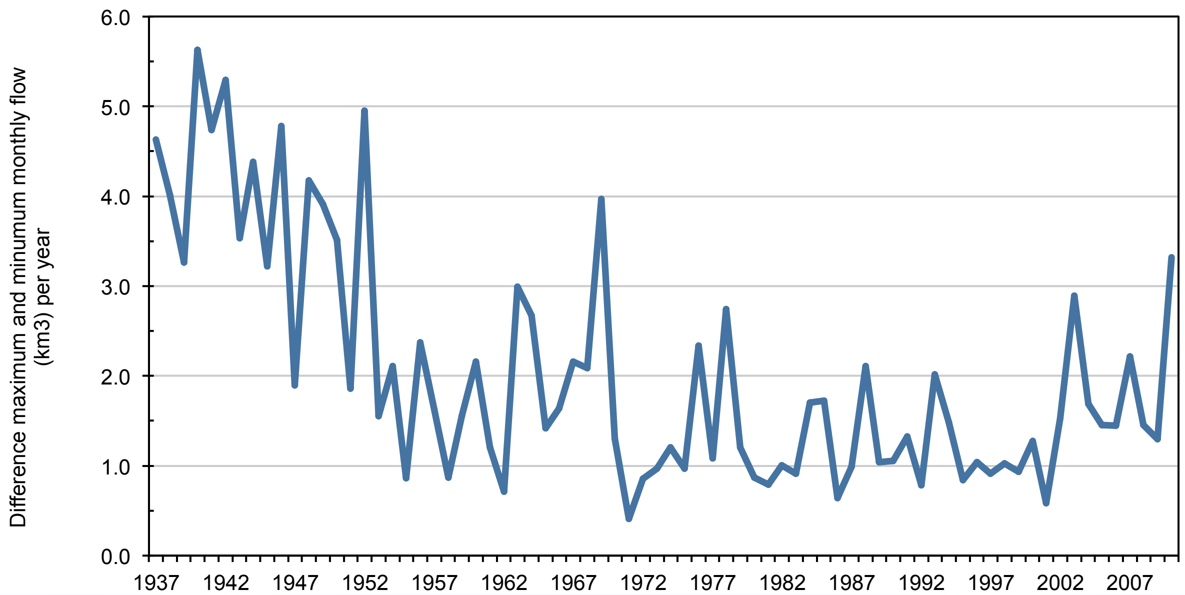
		Month												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Av**
1950-1979	**Mn**	548	556	574	748	863	706	415	323	366	414	439	516	539
	SD	158	174	174	337	441	369	200	138	117	133	126	131	136
1980-2010	**Mn**	508	511	516	543	606	469	320	312	288	321	416	493	442
	SD	166	187	204	251	376	301	137	86	78	102	142	154	128
Diff	**Mn**	-40	-45	-58	-205	-257	-237	-95	-11	-39	-93	-23	-23	-97
	SD	+7	+13	+30	-86	-66	-68	-63	-51	-39	-31	+16	+22	-8

Notes: Mn – Mean; SD – Standard deviation; Av – average; Diff – Difference in mean and standard deviation between two time periods.

It is also notable that the negative differences in standard deviation observed for the summer months are significantly larger than the positive values for the winter months. Analyzing the average change in standard deviation for the months of April through October shows a reduction of standard deviation of 58% between the two periods. This suggests a much more significant decrease in variation of river discharge during the summer period.

An additional analysis was carried out on the annual differences between highest and lowest monthly flows for the whole period of 1950 to 2010, also for the Surra station in Azerbaijan, presented in figure 4.1.4.4. The graph suggests the impact of reservoirs constructed since the 1950s, by means of a smaller difference between maximum and minimum flow during one year. The average annual difference reduced to about 1.5 km^3 after 1950, down from about 4.0 km^3 in the years before. During the period of regulated flow no apparent decrease in variation over the period, and no obvious trend is observed. Any variation, however, may be masked by the seasonal nature of the variation, as suggested by the standard deviation analysis described above. Higher variation in summer flows combined with lower variation in winter flows would reduce differences between annual highs and lows and mask a trend in flow variation.

Figure 4.1.4.4 Differences between high and low monthly flows in individual years at Surra hydrological station (Azerbaijan) between 1950 and 2010.



Source: Azerbaijan Ministry of Ecology and Natural Resource (2012).

4.1.5. Gaps in evidence

Due to economic transition and financial challenges in all three project countries during the last two decades, following independence after the breakup of the Soviet Union, the number of hydrological stations has declined, especially in Armenia and Georgia, causing problems with associated data availability. The analysis carried out in earlier sections was based on rather limited data and, while fairly conclusive itself, would benefit from analyzing a greater base of data.

It is likely that there is a more local aspect to the issue of a reduction in river flows and reduced variation in those flows during the summer months. For example, given one of the main causes of the flow reduction - increased abstractions - it is likely that some of the major tributaries experience far greater reductions and other variation patterns than does either the main Kura or Ara(k)s channel. Analyses of these tributaries are not currently possible because of the lack of data.

As is presented in Section 4.1.8 below, there are two main causes of the variation and reduction in river flows: "increased water use" and "climate change". It is not possible to determine how much of the overall changes each of these causes accounts for, as practically no reliable data on actual water abstractions – volumes and locations – are available. Would these data become available, river flow impacts specifically from abstractions and the growth of those abstractions over time could be better quantified. Additionally, with better information on water abstraction, remedial actions against inefficient water use could also be more easily identified.

The variation and reduction in hydrological flow increases the need to ensure environmental flows in the rivers, including on tributaries. Currently, environmental flows are calculated based on outdated methods which do not sufficiently reflect the best practices approach on ecosystem management that are advocated internationally and employed within the EU countries. The calculation methods need to be reviewed and, as needed, revised to more accurately reflect the flow regimes necessary to support ecosystem functions.

4.1.6. Environmental impacts caused by the problem to date

The main impacts on the environment due to the reduction and variation of river flows include:

- Degradation of riverine ecosystems and natural landscapes. Ecosystem degradation affects the suitability of natural habitats for rare plant and animal species, the reduction in species abundance and diversity, and in some causes the disappearance of species.
- Worsening of biological processes such as fish spawning.
- Reduction of the natural self-cleaning ability of rivers for organic pollutants, and increasing of the concentration of all pollutants, including their extended transportation downstream.
- Changes to groundwater recharge and outflow regimes and the direct interrelationships between aquifers and rivers, impacting the water quality and quantity of both systems.

Reductions in river flow have a direct impact on fish and the composition of fish species in the Kura Ara(k)s river basin. Statistics show that in Azerbaijan in the early 1950s, i.e. before the implementation of major water projects in the basin of the Kura river, annual catches of valuable anadromous fish species in the river accounted for 30,500 tons. In 1982, after the construction of reservoirs regulating river discharge and related increased abstractions, annual catches were observed to have decreased by a factor of 15, accounting to only 2,000 tons. Besides the regulation and reduction of river flow, also overfishing is considered a significant impact factor, both on the river as well as the Caspian Sea. Fish breeding stations have been built at the mouth of the Kura river in an attempt to mitigate this problem. Semi-anadromous fish species as well as non-migrating freshwater species have also been affected, typically by a reduction of the flood pulse, reducing the extent of the seasonally flooded riverine areas. This problem has been worsened by the construction of flood protection works along the downstream Kura and Ara(k)s main channels, and the transformation of the former floodplain into agricultural lands.

Large abstractions of surface water and groundwater, mainly for irrigation, have damaged terrestrial riverine ecosystems, largely by means of reducing the seasonal flood pulse. For example, 5,000 ha of floodplain riparian forests in the valley of Iori/Qabirri – the left tributary of the Kura river, and partly the natural border between Azerbaijan and Georgia – were negatively impacted due to reduction of river flow and changes in its regime following the construction of the Dali Reservoir, a 50 meter high dam, with a reservoir area of 3 km^2. Although originally built to support irrigation purposes in Georgia and Azerbaijan, the irrigation system never was activated, and consequently, the reservoir has no function and has not operated since its construction, though the degradation of the riparian forests continues.

The variation and reduction of hydrological flow directly impacts on the concentration of pollutants in the rivers, as for key polluters, including municipal sewage water and industrial production, the outflow of pollutants in time – the pollution load - is relatively constant. With reduced flows, aquatic organisms therefore are exposed to these higher concentrations, affecting their health state and potentially increasing their lethality. Additionally, lower flow volumes lead to lower flow velocities, negatively impacting on oxygenation processes of river water, and decreasing the effectiveness of aquatic self-purification processes. As such, pollutants are transported over a larger distance downstream, potentially also across borders into neighboring countries, expanding the distance range of which humans as well as aquatic organisms are exposed to pollutants.

Changes in volumes and seasonality of river flow affect infiltration and seepage relationships between surface water and groundwater. Increased risks for high precipitation and related flooding events, due to climate changes as well as surface cover changes in the terrestrial part of the river basin, reduce groundwater recharging during the high water period, and affect the groundwater outflow during the low water season. Accordingly, the rivers chemical regime is affected – pollution loads during the low water season become less diluted, while during high water periods pollution is transported over a larger distance downstream. In turn this will affect populations of aquatic organisms, who might respond differently to the changes in flow and chemical conditions.

4.1.7. Socio-economic impacts caused by the problem to date

278. The main socio-economic consequences of the variation and reduction in river flows center on the reduced access to water in sufficient quantity and quality for drinking and other domestic purposes, and on meeting the needs of other sectors of the economy, including:

- Reduced productivity of agricultural land in some areas due to lack of irrigation water, and related reduction of income in the agricultural sector.
- Negative impact on the quality of agricultural products, and related health effects among the population due to irrigation with contaminated water.
- Poor state of sanitation systems, with increased cases of infectious, water-borne diseases, and related increase in water treatment costs.
- Reduced efficiency and rate-of-return on investments in the hydropower sector.
- Irrational use of groundwater resources in attempt to replace the lost river flows.
- Loss of commercial fish populations in reservoirs by blocking spawning routes.

Most of the listed issues are very much transboundary in nature, because the increase in water consumption in the upper reaches of the river negatively impacts on the access to water for economic and social needs in the downstream reaches of the river, potentially limiting their development and impacting health conditions of people and nature.

The problem of water shortages in the agricultural sector is strengthened by poor maintenance of irrigation systems and bad practices. In Georgia many irrigation schemes have not received sufficient water for the past 20 years, resulting in lower productivity, increase fallow land area, and increased poverty in rural areas. A similar trend is observed in Armenia, where the lack of sufficient water for water-intensive crops has reduced watering schedules from six to seven times per year to two times a year, reducing yield and farmer income (UNDP/GEF, 2006).

In dry years, excessive intakes during the summer cause a drying up of the smaller tributaries to the Kura and Ara(k)s within Armenia and Azerbaijan. This has major consequences for people who rely on this water for domestic purposes and for small scale subsistence farming and gardening.

While hydropower development is one cause of variation and reduction of hydrological flow, the sector is also impacted by its changes.

A reduction or lack of water resources contributes to desiccation of the soil and hence soil erosion in the basin. Already there are severe environmental and social problems associated with this problem. At present, in Azerbaijan, some 600,000 hectares of arable land has been damaged by erosion at various stages and grades (Imanov, 2007). In Armenia an estimated 44% of the total land is affected by desertification at different levels. In south-east Georgia about 3,000 hectares of land is affected by desertification and 5,110 hectares of land is severely eroded.

4.1.8. Causes of the problem

4.1.8.1. Primary causes

The decline in river flows is connected with several immediate causes: the increases in water use, watershed functional changes, and changes in temperature and precipitation.

Water use

Until the 1950s, negative impacts due to human economic activities were not evident, at least with regard to water quantity. The expansion of economic activities in the Kura Ara(k)s basin, combined with ongoing population growth, has increased the water use in the basin, especially over the past 50 years, increasing abstractions from both rivers and from groundwater, resulting in a reduction in river flows. Increased water use is associated with water resources development, such as reservoirs and canals, which change river flow regimes while becoming their own loss mechanism through evaporation and infiltration. Inter-basin transfers also are a factor of impact on downstream flow volumes or flow regimes, or both.

The development in irrigated agricultural lands in the Kura Ara(k)s basin is shown in table 4.1.8.1, showing a steady increase during the 20th century until the 1990s, after which growth flattened.

Table 4.1.8.1 Development of irrigated land use in the South Caucasus (x 1,000 ha).

Country	Year										
	1925	1935	1945	1955	1965	1975	1985	1995	2000	2005	2010
Armenia	70	90	120	180	255	300	310	173	n/a	149	152
Azerbaijan	510	630	685	880	1,040	1,160	1,340	1,453	1,426	1,433	1,425
Georgia [a]	110	180	210	265	306	283	345	350	160	[b] 30	24
TOTAL	690	900	1,015	1,325	1,581	1,743	1,918	1,930	*1,586*	1,612	1,601

Notes: a – data for 2005 and 2010 are in accordance with contracts signed between farmers and United Melioration Systems Company, the actual area irrigated is slightly lower; b – for 2007, data for 2005 not available. Sources: Armenia – UNDP-SIDA (2005a), State Committee for Water Economy (2012), National Experts. Azerbaijan - State Statistical Committee of the Republic of Azerbaijan, based on data from the Joint Open Company of Irrigation and Water Industry (2012). Georgia – data before 2000 – UNDP/GEF (2007), data after 2000 - State Statistics Committee of Georgia (2012 inquiries) and Irrigation Water Supply Company (personal communication).

At present, in the Kura Ara(k)s sections of Armenia and Azerbaijan an about equal, dominant part of abstracted water is used for agricultural purposes (Table 4.1.8.2) However, in absolute volumes, agricultural water withdrawals in Azerbaijan significantly outpace both Armenia and Georgia, related to a larger population, more arid conditions in the country as well as the far larger area of land under irrigation. In Georgia meanwhile the largest volume of water withdrawal is used for drinking water supply, both in percentages and well as in absolute volume, compared to Armenia and Azerbaijan.

Table 4.1.8.2 Water use by sector in the South Caucasus in 2011.

	Armenia		Azerbaijan		Georgia	
	Actual use (MCM)	% of total	Actual use (MCM)	% of total	Actual use (MCM)	% of total
Agriculture	1,444.5	83.1	5,746.1 (4,966.8)	72.7 (77.2)	247.7 (216.3)	23.7 (24.5)
Industry	218.8	12.6	1,760.3 (1,295.4)	22.3 (20.1)	357.9 (303.0)	34.4 (34.3)
Domestic / Urban	74.8	4.3	396.7 (174.2)	5.0 (2.7)	439.2 (364.9)	42.0 (41.3)
TOTAL	1,738.1	100.0	7,903.1 (6,436.4)	100.0	1,044.7 (884.2)	100.0

Notes: in brackets water use in the country's Kura Ara(k)s section. Sources: ArmStat (2012); AzerStat (2012); GE-MEP (2012).

An assumed other, albeit indirect, envisioned important factors impacting on a reduction of river flow are the increased abstraction from groundwater sources, as replacement strategy for insufficiently available surface water sources, as well as increased surface water pollution. However, complete and reliable information on these issues are not available, due to the absence of proper hydro-geological baseline monitoring, limited water intake monitoring as well as insufficient knowledge on the hydraulic inter-linkages between the surface and groundwater resources. Future efforts should be made to verify this through improved transboundary groundwater monitoring and abstraction impact evaluation on groundwater resources.

Changes in watershed functionality.

While commonly not having a direct impact on total annual flow volumes, watershed functional changes are an immediate cause for alterations of the seasonal river flow regime. Functional changes distinguish between physical changes in the watershed, such as deforestation, reforestation, urbanization and others, as well as poor land use practices – e.g. absence of contour plowing, storm water management, and others.

Deforestation/reforestation and other watershed functional changes regulate water runoff characteristics in the watershed area, specifically the interrelationship between direct surface runoff to the rivers and recharge percolation to the groundwater systems, water which subsequently contributes to river flows in later seasons.

Unfortunately, though the impacts are widely understood from studies in other parts of the world, a very limited number of studies seem to have been implemented to quantitatively link watershed changes to changes in river flow. Research at the Tandzut river, tributary to the Debed transboundary river in Armenia, indicates that a decrease in forest cover in the basin from 32% (1975-1990) to 17% (1992-2000) has led to a 13% increase in the average flow in recent years, while the minimum flow increase by 25% - due to a reduction in soil water absorption capacity. Variation in seasonal flow regime after deforestation increased, and maximum flows increased twofold (Ansbaek *et al.*, 2011).

Changes in temperature and precipitation

Analyses in Armenia, Azerbaijan and Georgia in the framework of their SNC to the UNFCCC showed that significant changes in temperature and precipitation were observed during the 2nd half of the 20th century.

While significant variation in temperature and precipitation is conditioned by the highly variable topography and elevation of the South Caucasus, as well as inter-annual climatic variation, the region as a whole has experienced temperature increases between 0.5^{o}C and 1^{o}C (Table 4.1.8.3). Armenia and Georgia both note that mean summer temperatures (June, July, August), important because of the growing season, have risen at a faster rate than the mean annual temperatures, while winter temperatures (December, January, February) varied around a stable mean. Analyses showed that also the rate of temperature rise has increased – in Azerbaijan the rise in mean annual temperature between 1961 and 1990 was 0.34°C, while the rise over the 10-year period 1991-2000 was 0.41°C, which is a factor 3 faster. A comparable trend has been observed for the summer temperatures in Armenia.

Table 4.1.8.3 Regional comparison of recent changes in climate.

Indicator	Armenia	Azerbaijan	East Georgia
Period	1929-2007	1960-2000	1955-2005
Change in mean annual temperature (°C)	0.85	0.52	0.60
Change in summer temperature (°C)	1.0	n/a	1.5
Change in mean annual precipitation (%)	-6.0	-9.8	+6.0

Notes: Statistics for Azerbaijan are for the whole country, as specific Kura Ara(k)s basin values are not available; statistics for Georgia are for east Georgia.

Changes in precipitation are more variable across the region, with an increase observed in Georgia, and decreases in Armenia and Azerbaijan, according to a northwest to southeast trend. Decreases in precipitation average between 6% and 10%, reaching as high as 17% in Azerbaijan. Notable also precipitation as snow has decreased, in Armenia predominantly noted at altitudes above 1,700-1,800 GSL.

While the reduction in flows is evident, with the currently available information it is difficult to attribute separate degrees of impact to the identified main immediate causes flow reduction - increased water abstraction, watershed functional changes, or changes in temperature and precipitation. However, the response to the impacts will need to be the same regardless – strengthening the conservation and rational use of the available water resources.

4.1.8.2. Intermediate causes

The underlying reasons for the variation and reduction of hydrological flow are attributed to economic development and global climate change.

Economic growth is needed to improve the living conditions of an ever increasing population in the Kura Ara(k)s basin, and water demands will grow along with the economy. However, a good portion of the actual water abstraction is poorly used, due to inefficiencies and losses. Major issues behind inefficient use of water are a combination of inappropriate and outdated designs of water systems, deterioration of systems due to low investment in their operation and maintenance, and limited understanding of appropriate water saving technologies and methods. In turn, the low investment is due to the poor allocation of national budgets to the water sector.

The effectiveness of irrigation in the South Caucasus is assessed as low (35-40%), mainly due to the low efficiency of water transportation within the irrigation systems and inadequate on-farm irrigation methods. Most of the irrigation canals in Armenia, Azerbaijan and Georgia are open and unlined, with consequent evaporative losses and seepage losses totaling 40 to 60% (UNDP/GEF, 2006). While seepage losses may eventually be returned to groundwater, there is insufficient information available to assess this aspect of water use, or indeed any other.

Table 4.1.8.4 shows the development of water withdrawal for irrigation between 1945 and 2010, showing a four-fold increase in total water consumption up to 1990. This table also shows a doubling of the water use per unit area, largely between 1975 and 1985, while the increase in irrigated land (table 4.1.8.1) during this period amounted only to 9%. This points to the increased water use inefficiency in irrigation or/and to the growing of more water-intensive crops. Accordingly the impact of irrigation on the reduction in river flows is evidently caused by two parallel developments: the growth of area under irrigation, and the reduction of irrigation efficiency, due to losses or crop selection.

Meanwhile, the irrational use of water is not a prerogative for the irrigated agriculture sector, but also a common feature in both the industrial and domestic sectors. A significant portion of the water allocated for domestic use is lost through leakages in water supply networks. High levels of losses, on the order of 20% to 40%, have been noted in the distribution networks in Armenia. In some places the analyzed losses reached 72%. Most existing water supply systems in the South Caucasus were built 30+ years ago, with insufficient maintenance since that time, and accordingly they require rehabilitation or replacement.

Table 4.1.8.4 Total water withdrawals for irrigation in the South Caucasus countries - 1945 to 2010.

Parameter	Year										
	1945	1955	1965	1975	1980	1985	1990	1995	2000	2005	2010
Armenia											
Water Use (mln m^3/ yr)						2,730	3,500	1,480	1,090	1,500	1,160
Unit Area Water Use (1000 m^3/ha)						8.80				10.07	7.63
Azerbaijan											
Water Use (mln m^3/ yr)	2,664	2,688	3,450	4,740	6,660	9,132	8,627	7,720	3,819	5,710	5,497
Unit Area Water Use (1000 m^3/ha)	3.9	4.3	4.6	4.1	5.5	6.8	6.1	5.3	2.7	4.0	3.9
Georgia											
Water Use (mln m^3/ yr)	-	-	-	-	[b] 1,566	-	[b] 1,354	[b] 1,445	208	87	59
Unit Area Water Use (1000 m^3/ha) [a]	-	-	-	-	-	-	-	-	2,5	2,5	2,5

Notes: [a] – Assessment based on estimates of United Melioration Systems Company. For the period before 1980 no reliable could be identified. Sources: Armenia – State Committee for Water Economy (2012). Azerbaijan - State Statistical Committee of the Republic of Azerbaijan, based on data from the Joint Open Company of Irrigation and Water Industry (2012). Georgia – Ministry of Environment Protection (2012 inquiries), State Statistics Committee of Georgia (2012 inquiries), Irrigation Water Supply Company (personal communication), [b] – UNDP-SIDA (2005b).

In Georgia, the total length of water supply pipe systems amounts to about 9,500 km, of which 5,000 km are obsolete and require replacement. Total water supply based on intake registration in the Georgian part of the Kura Ara(k)s basin is 350 liters per capita per day (GE-MEP, 2012), while assessments indicate that less than half of this can be attributed to actual consumption – the other half is lost due to leaks in the distribution system.

Such losses and inefficiencies install an unnecessary large, negative impact on rivers from which they are abstracted, and with decreasing available volumes and increasing competition, improving efficiencies and minimizing losses are becoming increasingly important. Network losses also have a huge impact on operating costs, so improving water use efficiencies also will provide for immediate economic return.

4.1.8.3. Root causes

The root causes of variation and reduction in hydrological flow include the lack of funding at all levels, at the national and regional development sectors as well as the private sector, including farms - for water management and improving water use efficiency.

However, the most important root causes are the limited capacity for water resources management and the limited understanding of the water resources management process. The limited capacity encompasses governance - policy, laws, regulations and enforcement; institutional capacity - lack of inter-ministerial coordination, lack of cooperation on information exchange and other matters; insufficient staffing and education & training of the staff, outdated and poor supply of equipment and other tools, etc.

All related sectors are hampered in good management by the lack of quality information, as monitoring systems are inadequate, and information management systems either do not exist or their use is not fully understood. Therefore there is no clear picture of existing volumes of surface water and groundwater to meet the needs of ecosystems and other uses such as hydropower, agriculture, municipal needs, fisheries, etc.

While information on current and projected water needs and demands in the region is available, often its quality and completeness is insufficient for effective resource management. While licensing of water use is enforced for some sectors, hardly any reliable information is available on actual vs. licensed volumes of water intake. In other sectors water abstraction is uncontrolled at all.

Throughout regional societies there is also a low level of awareness about the importance of water, of managing water properly, and of the need to conserve water and not waste it. This is equally the case in many parts of government and in civil society. Until recently, water resources have not become mainstreamed into public policy the way energy and finances have.

The trend analysis in chapter 6 shows that sectoral development plans do not fully consider other sectoral needs at the national level or at the regional level. The costs of services provided by a specific volume of water in the system are not well understood, and assessments to calculate this value are currently underdeveloped within the region. This hampers the sustainable development potential across the region, as climate change increases the likelihood of irrational use, scarcity and stresses between sectors and countries as water security, food security, energy security and environmental security are jeopardized. This has potential to lead to conflicts within and between countries if steps are not taken to address the multi-sectoral water needs and to develop the means to ensure all basic needs are met by the available water resources in the region.

As it the case in many transboundary river basins, there is not yet a commonly developed regional, transboundary view of the basin as a whole. National needs are prioritized and the need for joint management not understood.

4.1.9. Causal chain diagram

Figure 4.1.9.1 presents the causal chain diagram for the transboundary issue “variation and reduction in hydrological flow”. It shows that the lack of effective integrated planning & management of water resources tends to lead to conflicts over water. In the transboundary context decreasingly available resources may sharpen upsteam-downstream relationships between riparian states if no basin-wide common approach is accepted. Lack of inter-sectoral cooperation may cause an addition layer of conflict within any riparian state, focused on competition on finite water resources.

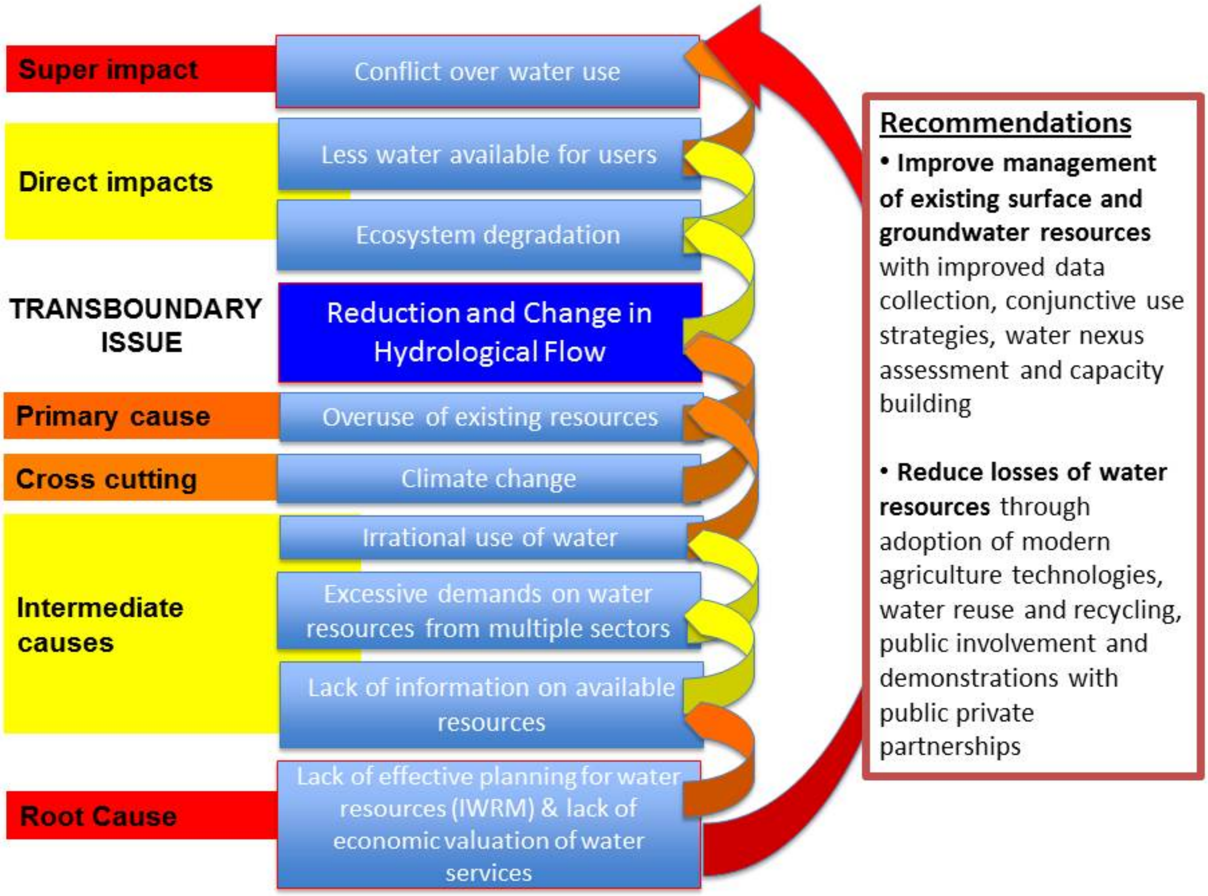
Accordingly, there is a need for integrated water resources management plans to be implemented in all three countries with common priorities negotiated between riparian countries and all stakeholder sectors, to implemented in a coordinated, transparent way. This process will need to include also the “silent” water user - basin ecosystems, as an interested stakeholder. The process can only thrive on a properly designed and implemented information monitoring program, collecting relevant information on river flow, water abstraction, ecosystem conditions etc., to be shared among its stakeholders.

4.1.10. Cross-cutting issue – Future impact of climate change

The impacts of forecasted climate change bring significant risks for the future in the water management sector, showing important impacts on water resources in all three South Caucasus countries. As shown, primarily analyses forecast an overall increase in air temperature, causing related increases in evapotranspiration rates, and a general decrease in precipitation.

In addition to overall forecasted trends in increasing temperature and decreasing precipitation, the occurrence of extreme events – heat waves & droughts, flooding, heavy rain, etc. - is envisioned to increase, based on observed changes in recent decades. Especially a change in precipitation patterns, towards more frequent occurrence of heavy precipitation and droughts, will have a notable direct impact on hydrological flow, especially the seasonality of flow patterns. Heavy precipitation supported by glacier melting in the Great Caucasus increases the risk of flashfloods and flooding, while more water is “lost” for economic use purposes. Accordingly, the river base flow during extended drought period may decrease.

Figure 4.1.9.1 Causal Chain Diagram for the transboundary issue "Variation and Reduction in Hydrological Flow".



To assess the possible impact of climate change on river flow, detailed studies have been conducted (AM-MNP, 2010; GE-MEPNR, 2009), including for several transboundary sub-basins of the Kura Ara(k)s basin in the South Caucasus - the Debed-Khrami river basin (Armenia-Georgia), the Aghstev/Agstafachay river basin (Armenia-Azerbaijan), and the Alazani/Ganikh river basin (Georgia- Azerbaijan) (UNDP/ENVSEC, 2011). Although a large variation in their outcomes is observed, due to different datasets for climate conditions and river flows as well as the regression models applied, all scenarios forecast changes in river flow towards a significant reduction. For Armenia a decline in flows of almost 25% by 2100 is predicted. East Georgia shows a decline in river flows of 8.5% based mainly on increased evapotranspiration, and Azerbaijan shows a decline in river flows of more than 20%, even during the 2021 to 2050 period, worsening toward 2100 (Hannan *et al.*, 2013).

The actual local and regional social and economic impacts of a reduction in river flow depend also on the envisioned future developments in the Kura Ara(k)s basin. Demands for water are most likely to grow in the decades to come, to fulfill the increased needs for irrigation and urban water supply. Growth in irrigation water needs are caused by an expansion of the area under irrigation to comply to increasing needs for food as well as in response to increased crop water needs due to rising temperatures, declining precipitation and land degradation. Growth in urban domestic water requirements, while only limitedly impacted directly by climate change, mainly follows an anticipated higher priority given to public health.

In addition to changes in annual river flow, envisioned changes in flow seasonality combined with the expected growth in demand will have even larger impacts on water supply. Analyses show that in some tributaries even modest increases in water use may cause a gap between water supply and demand in specific months. For the transboundary Iori/Qabirri river basin a 10% increase in demand is by 2050 envisioned to result in a supply gap in August in both Georgia and Azerbaijan, while in Azerbaijan also a shortage will be observed in March and April (GE-MEPNR, 2009). By 2100, the gap is expected to be also observed in June. This has implications for agriculture, as these are critical months for crop production.

4.1.11. Conclusions and recommendations

In conclusion, in all three countries the variation and reduction of hydrological flow regimes has serious social, economic, political and environmental impacts, and as developments are ongoing, the demand for water in the agricultural and energy sectors will also increase. This leads to serious challenges, as within any given point there is a finite amount of water within the basin, including groundwater resources. The gaps in information regarding accurate groundwater resource availability and recharge rates, the lack of monitoring of abstraction of both surface and groundwater resources, and the deterioration of the hydrological monitoring network create challenges for the region, especially as impacts of climate change are more acutely felt. As water scarcity emerges, the regional security is threatened in terms of food security, water security, energy security and environmental security. Steps are urgently needed to address this in order to optimize the rational use of existing resources and to take steps to improve the security of water resources for future generations and their economies across the region.

Recommendations for improving adaptation to the variation and reduction in hydrological flow include the development and implementation of IWRM plans at the national level with linkages to priorities at the regional level, in order to most effectively use available resources and preserve regional security, This includes improved flow monitoring for surface and groundwater resources as well as information sharing among riparian countries, towards informed decision making on sustainable water resources use. Also the implementation of national IWRM plans and tributary River Basin Management plans will be a promising first step towards a possible future Kura and Ara(k)s River Basin Management plan in line with EU WFD, through which the conceptualization of the regional waters as a commonly managed resource may be possible. Although currently such a plan and its organization is not feasible, careful steps can be taken towards rational water use in the region under the very real threat of increased variation and reduction of hydrological flow as a result of climate change.

Specific targets and activities to make this possible include two key objectives: To achieve improved management of existing quantities of groundwater and surface water resources; and To achieve reduced losses of water resources. These will involve both national and regional level efforts to maximize the basin wide management approach.

Achieve improved management of existing quantities of groundwater and surface water resources

Update hydro-meteorological data collection systems with improved national and transboundary stations including the use of online real time monitoring techniques and established data information exchange mechanism to make information regionally available: The hydrological and hydro-meteorological monitoring equipment across the region has deteriorated in the past 20 years. While some updates have been initiated, in order to improve water resources management it must be possible to reliably gauge flows. Updating the data collection systems with improved national and transboundary stations can employ real-time monitoring techniques that reduce travel costs, and enable establishing data information exchange throughout the region in support of sustainable management of shared basin resources.

Develop national and regional conjunctive use strategies for sustainable utilization of surface and groundwater resources based on future trends in water use for different sectors and the potential impacts of climate change, and using updated monitoring information for the groundwater aquifers in line with international BAT for national and transboundary aquifers: Incomplete information on available surface and groundwater availability increases the risks of overuse and damage to resource systems, especially as water stress is expected to increase due to climate change as well as the further development of water use. The development and implementation of national and regional conjunctive use strategies will enable the sustainable use of both surface and groundwater to meet demands for water security, food security and environmental security in periods of abnormal fluctuations and scarcity, ensuring minimal disruptions to social and economic welfare both nationally and regionally.

Assess water demands and sectoral net economic return to GDP per unit of water, applying the most appropriate and staged water nexus approaches to develop, and implement demand management mechanisms to optimize the utilization of available water resources, including allocations to environmental flows in sub-basins for subsequent use on the regional level: Without a clear understanding of the role that water resources play in the economy of the countries and the region, as well as the role of water for ecosystems, decisions are made on water allocations that may be suboptimal and on development plans that may be unsustainable, as water resource scarcity increases in line with increasing demands and increasing impacts of climate change. Conflicts between users emerge when there is resource scarcity and in areas as critical as the Kura Ara(k)s basin the threat of increasing scarcity and exacerbating tensions are significant. The economic valuation of services from water contribution to the GDP is an emerging field internationally, to support governments at local, national and regional levels making the best use of available water resources while continuing to support vital ecosystem functions. Use of the nexus approach in the basin for food security/water security/energy security/environmental security will enable decision makers to see the importance of tradeoffs for allocating available water resources and take steps towards improved sustainable management. A tailored best practices approach will be required in order to build on existing and new information, to build consensus on various scenarios and to develop a methodology that will support harmonization of water-dependent development for decades to come.

Provide support for capacity building to improve the sustained implementation of IWRM and ongoing assessments based on the water nexus and economic approaches: The UNDP/GEF project has identified many capacity needs for sustainable water resource management in the basin. Capacity building measures through the UNDP/GEF EU Kura Ara(k)s IWRM Academy initiated the process, yet additional efforts are needed to sustain future generations of water resource managers, especially as they work to address the competing demands of multiple sectors and employ international best practices. It will be critical to further harmonize the capacity building measures across the region so that future decision makers will be familiar with regionally specific conditions and share common understandings of the cause and effects of water scarcity and strategies for addressing those, including emerging natural resource economic approaches.

Achieve reduced losses of water resources

Adopt modern technologies to improve water use efficiencies in irrigation systems, using incentive structures for farmers based on the public/private partnership approach: The agricultural sector is the biggest water user across the wider Kura basin, with significant water losses emerging from the use of water intensive practices that fail to optimize yields while negatively impacting soil health and environmental conditions. The adoption of modern technologies in irrigation systems for improved water efficiency will be best realized through the creation of public/private partnerships to encourage farmers to adopt updated practices, though incentive structures, possibly provided through Water User Associations in areas where these exist and are functional. The implementation of such efforts has the potential to have a win-win-win outcome of reduced water use, increased crop yields and increased incomes for participating farmers and agricultural industries.

Improve public awareness and participation in decision making, among farmers, water end-users and other stakeholders, through among others Water User Associations, Basin Management Authorities and gender mainstreaming at local levels: All sectors of society in the region depend on the local and regional water resources. The loss of water due to outdated practices, beliefs and behaviors diminishes the overall amount of water available within the system, at great social and economic costs. These losses are also largely due to failure to understand the nature of water scarcity, the costs of water services, and the simple steps needed to improve water resource management at the household, community, and municipal levels. Building on experiences and lessons learned both regionally and internationally, implementing public awareness campaigns and increasing public participation in local water resource management through Water User Associations and gender mainstreaming will enhance local ownership of the problems and stimulate innovative solutions to shared challenges that have potentially deleterious impacts as demand for water increases, climate change impacts become more severe and water resources grow increasingly scarce.

Implement demonstration projects on alternative agricultural practices, including no-till rotations and low water use crop varieties, to increase yields and their reliability with public/private partnerships: Throughout the Kura Ara(k)s basin there are arid areas that suffer disproportionately from lack of water resources. In these areas, the challenges to successful water resource management and the costs of failure are significantly higher than in more water rich areas. There are strains of various crops, some endemic to the region, which have more resilience to harsher arid conditions that can be cultivated for increased yields and lower water demand. Additionally, no till agricultural practices enable to maintain soil integrity while decreasing erosion, lower water demand as well as the need for agrochemicals. The demonstration of uses of these technologies and commercial development of drought tolerant species of food crops has the potential to be extremely beneficial for public private partnerships while at the same time reducing water use, improving environmental conditions and improving the sustainable quality of life for residents in the most arid parts of the basin.

4.1.12. Literature cited

AM-MNP, 2010. Second National Communication on Climate Change – a report under the United Nations Framework Convention on Climate Change, Republic of Armenia, Ministry of Nature Protection, Yerevan, Armenia, 2010, 134 pp.

Ansbaek J., A. Pichugin, V. Tonoyan, A. Gevorgyan, B. Zaqaryan, P. Ronchak & S. Minasyan, 2011. Debed pilot river basin management plan – Armenia. EPTISA Servicios de Ingeniera S.L. (Spain) & Grontmij Carl Bro A.S. (Denmark), September 2011, 84 pp.

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

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

GE MEP, 2012. Ministry of Environment Protection of Georgia, water use in Georgia between 2000-2010. Available in Georgian at http://aarhus.ge/index.php?page=118&lang=eng

GE-MEPNR, 2009. Second National Communication to the UNFCCC, Ministry of Environment Protection and Natural Resources of Georgia Tbilisi, Georgia, 2009, 240 pp.

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

Hannan T., H.J.L. Leummens & M.M Matthews, 2013. Desk study – Climate Change. UNDP/GEF project "Reducing

Imanov F., 2007. Water infrastructure of Kura river basin within Azerbaijan. International congress on river basin management, p. 99-105.transboundary degradation in the Kura Aras river basin", Tbilisi-Baku-Yerevan, 2013, 72 pp.

UNDP/ENVSEC, 2011. Regional Climate Change Impacts Study for the South Caucasus Region. Tbilisi, Georgia, 62 pp.

UNDP/GEF, 2006. Irrigation and drainage. TDA Thematic Report, UNDP/GEF Project "Reducing trans-boundary degradation of the Kura-Aras River basin", 26 pp.

UNDP/SIDA, 2005a. Preliminary background analysis of the Kura Aras river basin in Armenia. Technical Report, UNDP/SIDA project "Reducing trans-boundary degradation of the Kura Araks river basin", Yerevan, Armenia, 136 pp.

UNDP-SIDA, 2005b. Preliminary background analysis of the Kura Aras river basin in Georgia. Technical Report, UNDP/SIDA project "Reducing trans-boundary degradation of the Kura Aras river basin", Tbilisi, 2005, 177 pp.

4.2. Deterioration of water quality

4.2.1. Description of the problem

In the Preliminary TDA, published in 2007, and in UNECE assessments published since, water quality in the Kura Ara(k)s river basin was described as increasingly deteriorating in downstream direction for a number of parameters (UNECE, 2011). The observed deterioration of water quality in the river basin is a relevant and progressively increasing problem for the countries of the basin, especially also in relation to the increasing pressure on water resources in each country towards meeting the needs of future development plans, in addition to the potential linked impacts of climate change on water quantity and quality in the region.

Polluting substances enter the water in the Kura Ara(k)s basin from various land-based sources, including industrial and mining enterprises, agricultural lands, houses and farms in rural areas, and especially from municipal sewer systems in urban areas. The quality of surface waters is also influenced by such factors as the hydro-morphological, hydro-geological and hydro-chemical features of the river basin. There are also other, less significant factors causing pressures on the water quality of the river basin, such as the building of local and transnational roads.

Many cities and businesses in the Kura Ara(k)s basin nowadays do not have water treatment plants. The existing wastewater treatment plants in the basin were built 25-30 years ago and most are now out of service. Those that are still functioning provide only a partial mechanical treatment, while biological and chemical wastewater treatment in most parts of the basin is not provided (UNECE, 2011). The impacts are cumulative for local and regional populations. In the Kura directly downstream of the Mingechevir reservoir, a fairly high level of nutrients is observed in the dam-discharged water, despite the presence of nutrient filtering ponds. Further downstream the concentration of nutrients and salt in the water continues to increase, suggesting the discharge of untreated water into tributaries from agricultural areas, farms, and especially urban municipal sewer systems. The absence or poor functioning of existing treatment facilities throughout the Ara(k)s river basin in Turkey, Armenia, Azerbaijan and Iran provides for large volumes of untreated sewage water to enter the river and its tributaries. This causes issues of downstream pollution in all countries, including transboundary ones. The limited number and poor functioning of treatment facilities in all countries in the basin along the Kura and Ara(k)s rivers and their tributaries provide large amounts of untreated sewage water to the rivers, causing domestic and transboundary water pollution especially in Azerbaijan.

This chapter examines the water quality trends in Armenia, Azerbaijan and Georgia based on nationally provided data for water quality and is based on the Desk Study on Water Quality Hot-spots in the Kura Ara(k)s river basin, produced in 2013 by the UNDP/GEF Kura Ara(k)s project (Abu Elseoud, 2013)

4.2.2. Transboundary relevance

The Kura Ara(k)s river basin is located on the territory of Armenia, Azerbaijan, Georgia, Islamic Republic of Iran and Turkey. The basin includes major transboundary tributaries - the Araks/Ara(k)s, Iori/Qabirri, Alazani/Ganikh, Debed, Aghstev/Agstafachay, Potskovi/Posof and Ktsia-Khrami. In the basin, water flows from the upper catchments in the highlands in Turkey to the lowlands in Azerbaijan, entering the Caspian Sea through the Kura Delta. Other routes for water leaving the basin include evapotranspiration, infiltration, direct consumption by biological organisms, including humans, or abstraction for processing, concentrating the pollutants that are not naturally bound within the environment.

In 2006, Armenia, Azerbaijan and Georgia signed the European Neighborhood Policy Action Plans with the European Union (EU). Under these plans, each country is committed ”to identify possibilities with neighboring countries for enhanced regional co-operation, in particular with regard to water issues”. The three countries are also committed to the approximation to the EU Water Framework Directive (EU-WFD) and the development of River Basin Management Plans (RBMP), including for transboundary river basins.

Against this background, although no monitoring data exist on transboundary water management issues, the relationship between issues at the national and transboundary levels appears quite evident: as it will be discussed more extensively later in this chapter, this suggests that transboundary water management issues could already be controlled and addressed at the national level, by assuring a more coordinated and effective approach to water management. In any case, this quick review highlights the need for building a strong information base on water status and water management issues, both at the national and transboundary level.

Transboundary cooperation in water management in the Kura Ara(k)s river basin becomes increasingly important nowadays. On one hand, there are several factors promoting such cooperation, such as existing treaties and agreements, as well as increased donor support for regional cooperation. Information and experience obtained from the implementation of several projects conducted in the last 15 years clearly demonstrated the need for: (i) further promoting advocacy and policy dialogue; (ii) supporting aid coordination and management; (iii) undertaking initiatives targeted to better cooperation in the area of transboundary water management. On the other hand, challenges do exist from technical and political standpoints. Therefore the necessity to improve the existing situation concerning the protection and use of transboundary river basins is high on the agenda of all Governments of South Caucasus countries. Moreover, application of a harmonized regional approach toward sustainable management of the transboundary river basin is necessary in addition to countries' individual reforms and actions.

Relationship to other transboundary problems

The deterioration of water quality is closely linked with the other three major transboundary problems defined for the Kura Ara(k)s river basin: "variation and reduction in hydrological flow", "ecosystem degradation", and "flooding". The Kura and Ara(k)s rivers are characterized by high levels of sediment load, increasing significantly during the period of high discharge and floods. During the flooding period different types of pollution can be washed downstream: nutrients, pesticides and herbicides from agricultural lands; and mixtures of pollutants from contaminated industrial sites along the river banks. Changes and reduction of hydrological flow may lead to increased pollutant concentrations in specific river sections, which can have a detrimental effect on the aquatic ecosystems as well as humans.

Transboundary ecosystem degradation including increased trends of biodiversity loss, deforestation, and land degradation are observed throughout the basin. The decline of species has intensified over the last few decades, to a large extent due to habitat fragmentation and degradation as well as the excessive use of natural resources. River water quality and quantity are considered key factors affecting the aquatic ecosystem health and the diversity of species in the river basin. The deterioration of water quality leads to loss of biodiversity in the aquatic and riverine ecosystems, while possibly also impacting on the agro-biodiversity on irrigated lands.

4.2.3. Why perception exists of this problem

The Kura Ara(k)s river basin is home to about 11 mln people. As such there is a pressure on the quality of surface and groundwater. Pollutants enter the rivers in the basin from industrial and mining enterprises, agricultural lands, farms, and especially urban municipal sewer systems. Most cities and business do not have (functioning) wastewater treatment plants, while those that are formally functioning provide only partial mechanical treatment. Biological and chemical treatment of wastewater is not carried out at all in the basin. The pollution pressure is increasing from the upstream to the downstream areas along the rivers.

In the Kura river, a fairly high level of nutrients is observed in the Shikhli station downstream of the border between Georgia and Azerbaijan, an indication of the organic pollution load entering Azerbaijan due to the discharge of untreated/partially treated sewage water of Tbilisi and Rustavi. The concentration of nutrients decreases after the Mingechevir reservoir, due to the high velocity of the water released downstream of the dam, which replenishes the Dissolved Oxygen (DO) concentrations. Further downstream the concentrations of nutrients and salts in the river water continues to increase again, suggesting the discharge of volumes of untreated water into the main river and its tributaries, from agricultural areas, farms, and especially the urban municipal sewer systems in the cities of Azerbaijan.

Wastewater treatment is a rare luxury in rural areas of Armenia, and domestic wastewater is subjected to either direct disposal into water bodies or on land. The same is true for most settlements in the Ararat Valley, where the groundwater table is relatively high, causing a high risk of contamination of groundwater aquifers with domestic wastewater and fertilizers.

Meanwhile, the increased concentrations of components like sulfate, total dissolved salts (TDS) and others in the lower reaches of the Kura and Ara(k)s rivers also result from hydro-chemical processes. In addition, also the background concentrations of chromium, copper, vanadium, nickel and some other metals are particularly high in the mineral-rich Kura Ara(k)s basin. The metal content in water and sediments of the Kura and Ara(k)s rivers and their transboundary tributaries is further increased by human activities, particularly mining, in some parts of the basin (Armenia, Georgia).

At the same time, technologies used in agriculture, industry, mining, recycling of household and industrial waste as well as water management activities in the Kura Ara(k)s river basin are outdated and not environmentally friendly.

All the three countries in the basin count on the natural phenomena of diluting the pollution load directly discharged in the river stream with running fresh water, its success depending on the type of contaminants, water quantity and quality features of the discharged water as well as the receiving water body. Accordingly, the seasonal variability of water flow volumes in the Kura Ara(k)s river basin has a direct impact on its water quality. During the high-flow period, characterized by high volumes of water discharged and high water velocities, the dilution of an equal pollution load into a larger volume of water will result in lower concentrations of polluting substances in the receiving water body. In addition, the high flow velocity of water during the high-flow period in the mountainous rivers replenishes the DO concentration and reduces the nutrients load. However, during the low flow seasons, when the volume of water transported by the river reaches its minimum and water velocities are at their lowest, an equal pollution load will impact much more on the water quality in the downstream section of the river, causing increased concentrations of polluting substances. Therefore, using the annual average concentrations of pollutants as an indicator for the water quality in a river may be misleading, because in the high-flow season the water in the river may show a good quality, while during the low flow season concentrations may exceed the allowable limits.

Although the dilution of pollution is not a proper solution for the ecosystem sustainability, the countries at present are forced to use water bodies as recipients of polluted water from different sources, due to historical precedent, and to date the lack of finances and investments to build/operate wastewater treatment facilities (WWTPs). In this, the countries rely on the assimilation capacity of its rivers to dilute and “treat” the pollution load. In order to approach sustainability, however, it is crucial to develop a long term plan to construct WWTPs at or near all pollution sources to properly treat the wastewater before discharging it back into the rivers. While this investment plan may take 15-20 years to be implemented, for the short term the countries should develop environmental management plans to control the volume of wastewater discharged to the river from different sources during the low flow season, by designing and maintaining environmental flow requirements in each river. As such the quality of water in the river during the low flow periods can be improved.

A significant challenge facing the proper integrated management of water quality in the Kura Ara(k)s river basin is the lack of a uniform or compatible system of standards and methods to assess the chemical and ecological status of water quality in the riparian countries. Because of this, an identical concentration of a specific substance in water provides for a different chemical water quality assessment in different countries: possibly varying from "background condition" to “polluted” for the same concentration of a parameter in the same water body. At present the government systems of standards and water quality assessment in most riparian countries do not take the natural features of the basin into account; they are mainly based on the old Soviet standards and assessment approach. In 2011, Armenia was the first country to adopt a new system of standards based on a 5-class assessment for chemical water quality taking background concentrations of components into account. Studies have been initiated in the both Azerbaijan and Georgia to develop new water quality standards comparable to the methodology applied in Armenia, but this process is not yet finalized and the two countries are still applying the old Soviet system of standards. There is recognition in these countries that updates must be made to the system.

4.2.4. Factual evidence regarding the problem

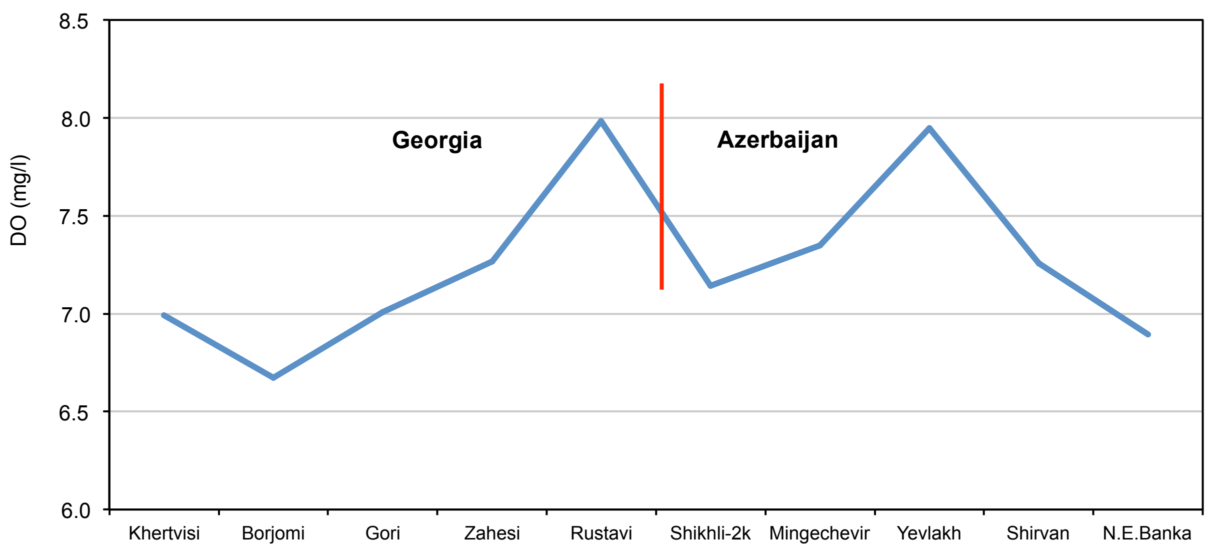
This section presents factual data on surface water quality in the Kura Ara(k)s river basin, with an emphasis on transboundary tributaries, and a preliminary assessment of the current situation. For the Kura Ara(k)s basin water quality data were obtained from the national monitoring programs from each country during the period 2007-2011. In addition to that, the following published reports of international programs implemented in recent years in the region were also used as sources of data:

- EU Project "Trans-Boundary River Management Phase II for the Kura River basin - Armenia Georgia Azerbaijan", 2009-2011.
- TACIS/2008/137-153 (EU) Water Governance in the Western EECCA Countries, 2009-2010.
- UNECE, 2011. Second assessment of Transboundary Rivers, Lakes and Groundwaters. United Nations Economic Commission for Europe - Convention on the Protection and Use of Transboundary Watercourses and International Lakes.
- NATO Science for Peace Program *"South Caucasus River Monitoring"* 2003 – 2008.

The Kura River basin

Dissolved Oxygen (DO). The average annual concentration of DO in the Kura river basin is satisfactory or higher, largely exceeding 7 mg/l (Figure 4.2.4.1), conditioned by the rather natural hydro-morphological conditions and hydrological regime of the river. The higher the flow rate, the higher the DO concentration. The lowest concentration of DO was measured at Borjomi in Georgia and N.E. Banka in Azerbaijan. The DO increased in downstream direction in Georgia, reaching a maximum concentration at Rustavi, just before the outfall of the Tbilisi WWTP. The impact due to wastewater from the WWTP is clearly shown in the DO reduction from almost 8 mg/l in Rustavi, to 7.2 mg/l in Shikhli, across the border in Azerbaijan.

Figure 4.2.4.1 Average concentration of DO in the Kura river.

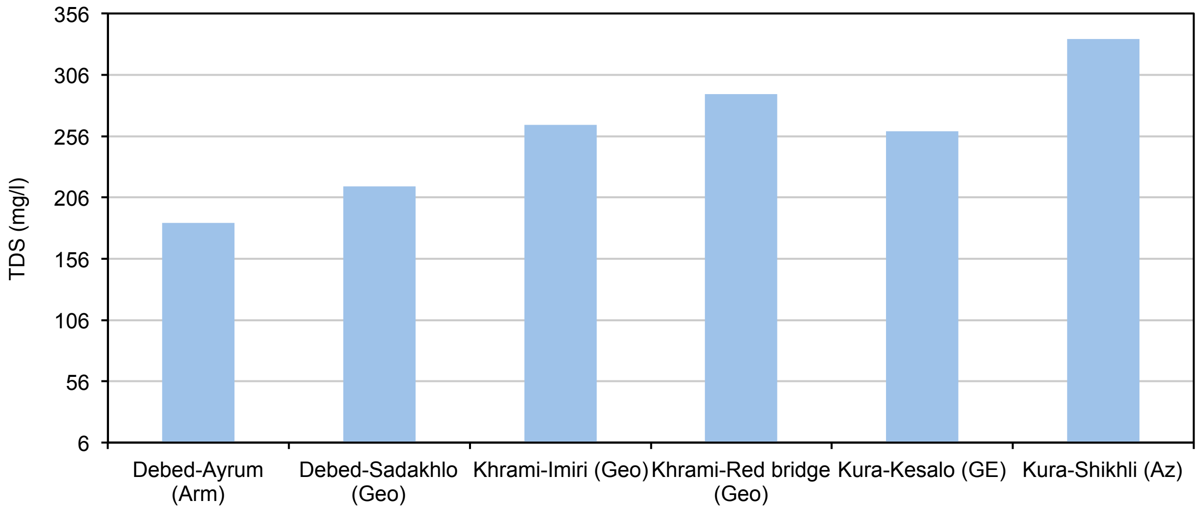


Note: Calculations based on averaging monthly data collected during years 2007-2011.

Total Dissolved Solids (TDS). Figure 4.2.4.2 shows the variation in average annual TDS concentration in 2009 along the Kura river across the Armenia-Georgia border and the Georgia-Azerbaijan border. The TDS concentration varies from 185 mg/l at Debed-Ayrum (Armenia) to 335 mg/l at Shikhli in Azerbaijan. The low TDS values are related to the natural conditions and the hydro- and geo-chemical features in the upper and middle reaches of the river basin, while the anthropogenic influence is low. In Georgia, the average monthly TDS values also vary in the range of 200-400 mg/l (NATO, 2008).

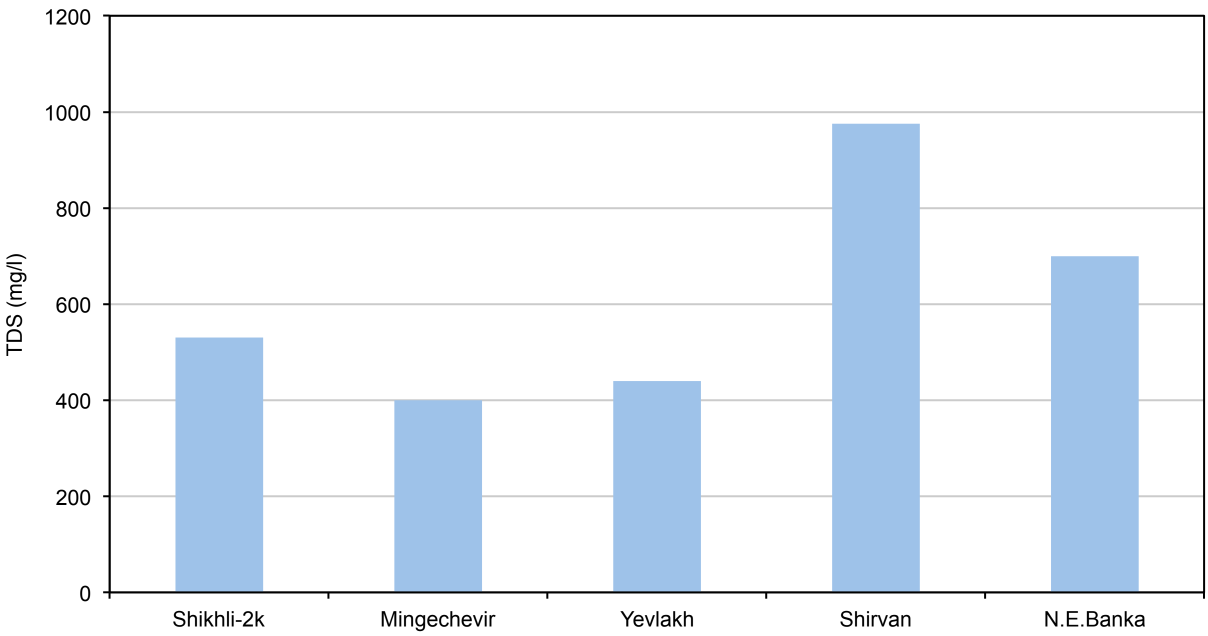
In Azerbaijan, the hydro-morphology and geochemistry of the basin are different. Figure 4.2.4.3 presents an increasing trend of average annual TDS values in downstream direction, especially after the Mingechevir reservoir. Towards the river mouth probably the interaction of river water with very saline groundwater intensifies, enriching river water with dissolved salts and, in particular, sulfates. The high TDS at Shirvan, located about 45 km downstream of the confluence of the Kura and Ara(k)s rivers at Sabirabad, may reflect slower flow velocities in the lowland river stretches, providing greater solute acquisition opportunities and contributions from solute-rich agricultural runoff.

Figure 4.2.4.2 TDS concentration at transboundary locations in the Kura river basin in 2009.



Source: EU (2011).

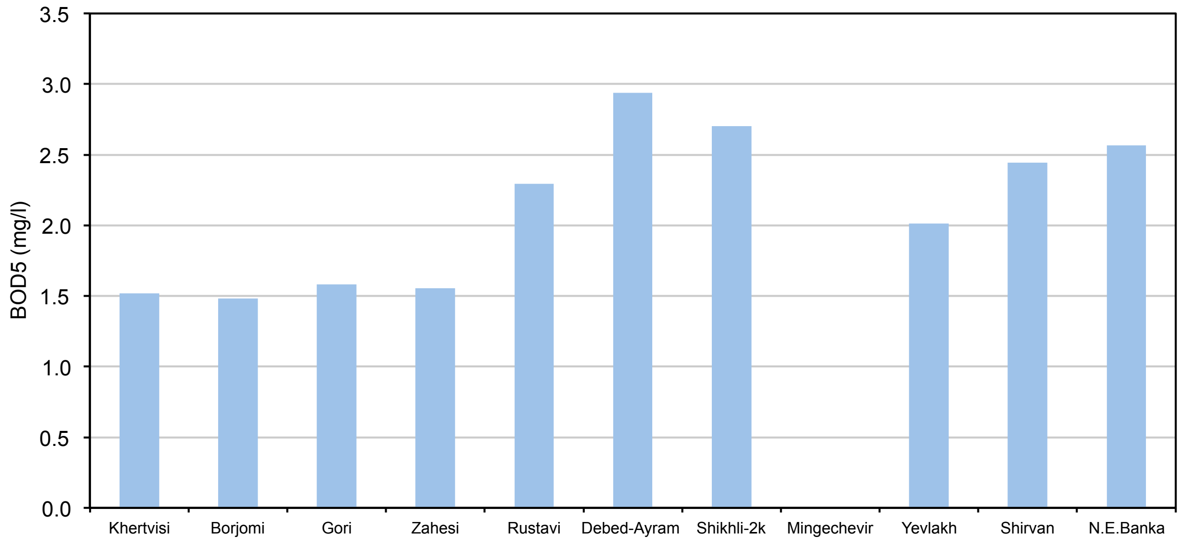
Figure 4.2.4.3 Annual TDS concentration for stations along the Kura river in Azerbaijan in 2010.



Biological Oxygen Demand (BOD_5) Figure 4.2.4.4 presents the annual average concentration of BOD_5 in the Kura river during the period 2007-2011. It shows that the BOD_5 is less than 3 mg/l, the limit for water under pressure, at all measured sites.

Figure 4.2.4.4 shows that at Khertvisi, downstream of the Turkey-Georgia border, the BOD_5 is low, water is oligotrophic and of good quality. At Shikhli, downstream of the Georgia-Azerbaijan border, the BOD_5 value has almost doubled, indicating pollution with organic substances. However, the value of BOD_5 exceeds the norm of 3 mg/l only in 10-20% of all water samples analyzed, suggesting that the combination of specific hydrological regime, the natural features of the river basin, especially its mountainous character in the upper and middle reaches, causes a rather fast oxidation of organic substances. Another suggestion can be the possibility of low level of organic load entering the river in the upper and middle reaches as a result of low anthropogenic activities in these regions, but not enough data are available to analyze this issue on the level of discharges from different sources along these reaches.

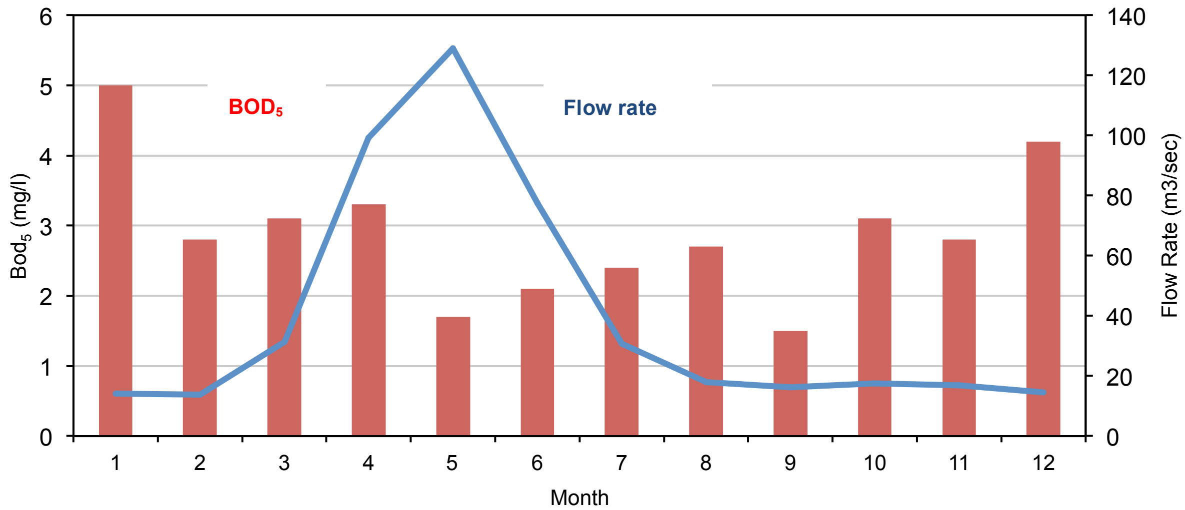
Figure 4.2.4.4 **Average annual concentration of BOD_5 at locations along the Kura river.**



Note: Average values based on monthly observations for the period 2008-2011.

Figure 4.2.4.5 presents the relationship between the average monthly BOD_5 concentration and the monthly flow rate at Debed-Ayrum in Armenia near its border with Georgia, upstream of the confluence of the Debed river with the Khrami river in Georgia. It shows that during the low flow seasons the average BOD_5 concentration reaches 5.0 mg/l, which exceeds the MAC of 3 mg/l according to Georgian standards by more than 60%, although the average annual concentration for this station does not exceed the MAC. This example clearly shows that counting on average annual concentrations as the sole indicator for river water quality may not be sufficient to accurately assess the status of water quality, but that the seasonal variability of the pollutant concentrations must be taken into consideration, especially in rivers with a high seasonal variability in water flow volumes.

Figure 4.2.4.5 **Relationship between monthly average concentration of BOD_5 and flow rate at the Debed-Ayrum monitoring station (Armenia).**



Note: Average values based on monthly data for period 2008-2011.

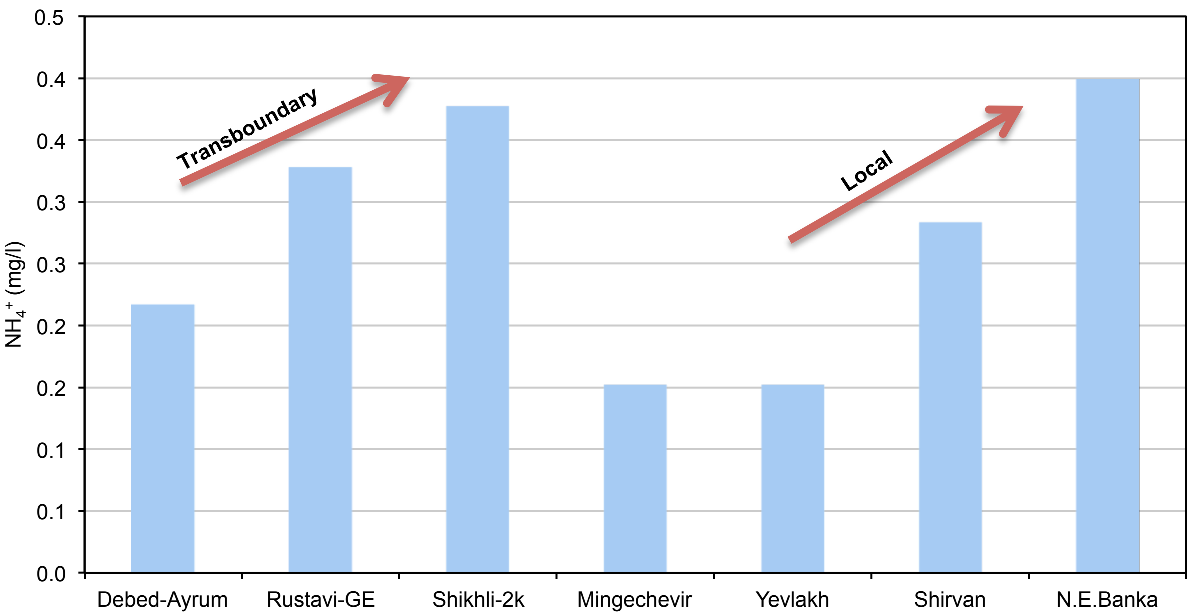
Figure 4.2.4.5 also demonstrates the inverse relationship between the flow rate and the BOD_5 concentration, with high flow rates leading to higher water velocities which increase the DO content in the water body, which consequently decrease the BOD_5 concentrations. A higher flow rate also contributes to the dilution of any pollution load, reducing pollutant concentrations. During low flow seasons, an equal pollution load released to the river, will show in higher BOD_5 concentrations, up to values exceeding the MAC of 3 mg/l. At Debed-Ayrum this is observed during 5 months of the year, which hints at a high organic load released with untreated sewage water from residential areas along the Debed river. This load merges with the pollution load of the Khrami river, to finally discharge into the Kura river at the Georgian-Azerbaijan border.

Ammonium (NH_4^+): Figure 4.2.4.6 shows the average annual concentration of NH_4^+ for the monitoring stations Debed-Ayrum in Armenia, Kura-Rustavi in Georgia and 5 monitoring stations along the Kura river in Azerbaijan. Figure 4.2.4.6 shows two trends in increasing NH_4^+ concentrations. The first trend is transboundary, with the NH_4^+ concentrations increasing between Rustavi and Shikhli (Azerbaijan), related to the discharge of untreated wastewater from the Gardabani WWTP, which operates with a low efficiency and provides only mechanical treatment. After the Mingechevir reservoir the NH_4^+ concentrations decrease, due to the trapping of most sediments and nutrients carried by river water in the reservoir. The second trend of increasing NH_4^+ is observed between Yevlakh and N.E. Banka, a result of the local impacts of untreated wastewater released from villages and farmlands in the vicinity of the river, in addition to the outflow of agriculture drainage water with high nutrients load.

In figure 4.2.4.7 the average annual NH_4^+ concentration in 2010 for different monitoring stations in Georgia shows an increasing trend in downstream direction from Khertvisi near the Turkey-Georgia border towards Rustavi upstream of Georgia-Azerbaijan border. This trend is typical for river water impacted by municipal wastewater and agricultural drainage water, causing an increasing organic pollution load from upstream to the downstream section of the river. Meanwhile, even at the Rustavi monitoring location the observed average annual NH_4^+ concentration is still below the MAC adopted in Georgia (0.39 mg/l).

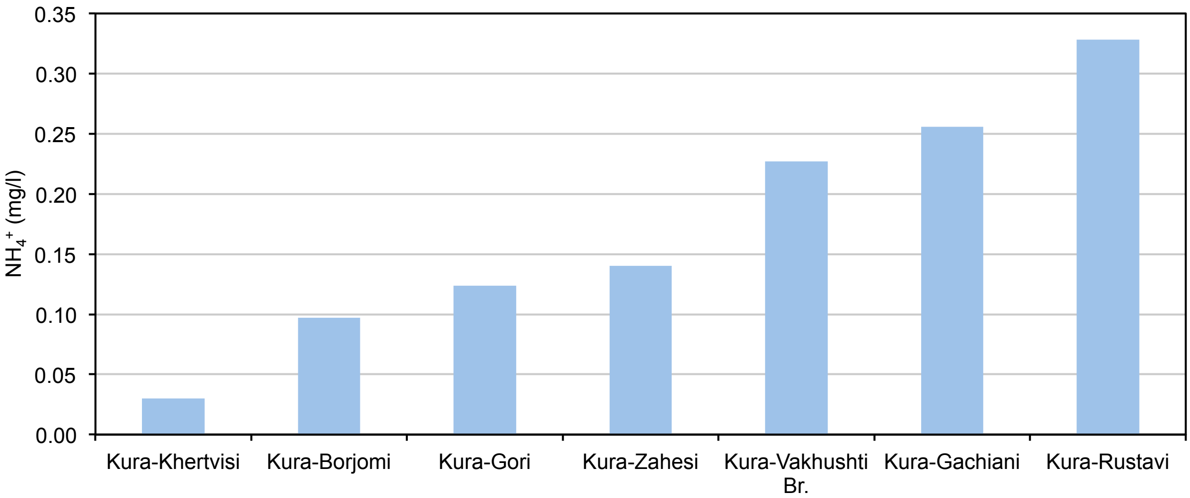
Overall, the concentrations of BOD_5 and NH_4^+ indicate a limited impact of human activities on water quality in the Kura river basin, as most measured concentrations did not exceed the established MAC limits. Exemptions were observed for certain months during the low flow seasons. The above analysis also shows the occurrence of certain transboundary issues in water quality, caused by the releases of organic pollutants into the river from municipal and agricultural sources. Although the impact on chemical river water quality appears to be still limited, there is an urgent need for the riparian countries to develop a long-term integrated regional environmental compliance action plan aiming at reducing the pollution loads from different sources, with special focus on municipal wastewater from main cities and villages located in the river basin. Meanwhile there is a lack of information on the impact of pollution loads on the biological river water quality.

Figure 4.2.4.6 Average annual concentration of NH_4^+ in the Kura river.



Note: Based on monthly data for the period 2007-2011, except for Rustavi – 2007-2010.

Figure 4.2.4.7 Average 2010 concentrations of NH_4^+ at locations along the Kura river in Georgia.



Heavy Metals: In the countries of the Kura Ara(k)s river basin increased attention is paid to the problem of heavy metal pollution of the aquatic environment. Mining activities, metallurgical, chemical and leather industries, as well as natural geochemical and hydro-chemical processes all pose a threat to surface water contamination with heavy metals. However, the available data on heavy metals concentration in surface water still is limited, and proper attention must be given to QA/QC procedures for laboratory analysis in order to ensure sufficient accuracy and reliability of heavy metal monitoring data in the three countries. Therefore, at this stage, the analysis of the actual situation in the Kura river basin is limited to only two metals: copper (Cu) and zinc (Zn).

Figure 4.2.4.8 and figure 4.2.4.9 present Cu and Zn concentrations measured at transboundary stations in the Kura river basin as collected by the EU Kura II project. Figure 4.2.4.8 shows that Cu concentrations in the Debed and Khrami rivers are almost identical, suggesting that the Cu content is determined by natural river characteristics, and not the result of anthropogenic pollution. It can also be noted from both figures that the Cu and Zn concentration at Shikhli, downstream of the Georgia-Azerbaijan border, follows the same trend as observed at the Khrami-Red Bridge station.

Figure 4.2.4.8 Total Cu at transboundary locations in the Kura river basin in 2009 (EU, 2011).

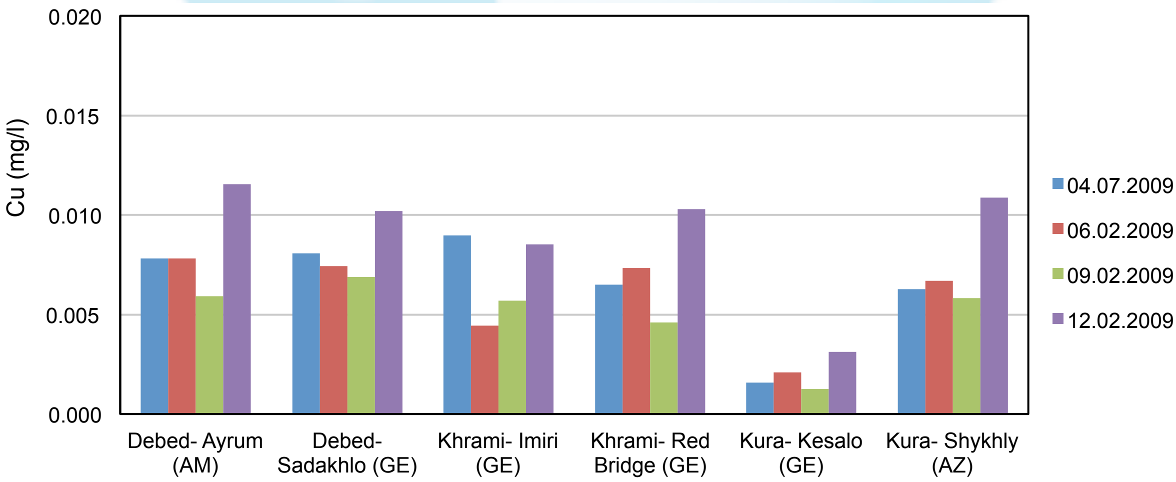


Figure 4.2.4.10 presents the average annual concentrations of Cu and Zn for 4 monitoring stations along the Debed river in Armenia. It shows that the measured concentrations vary from 0.002 and 0.0038 mg/l for Cu and Zn respectively in Hnkoyan Village in the upper catchment, to 0.0156 and 0.0225 mg/l for Cu and Zn near the Armenia-Georgia border, values mainly attributed to mining activities in the city of Akhatala.

Figure 4.2.4.9 Total Zn at transboundary locations in the Kura river basin in 2010 (EU, 2011).

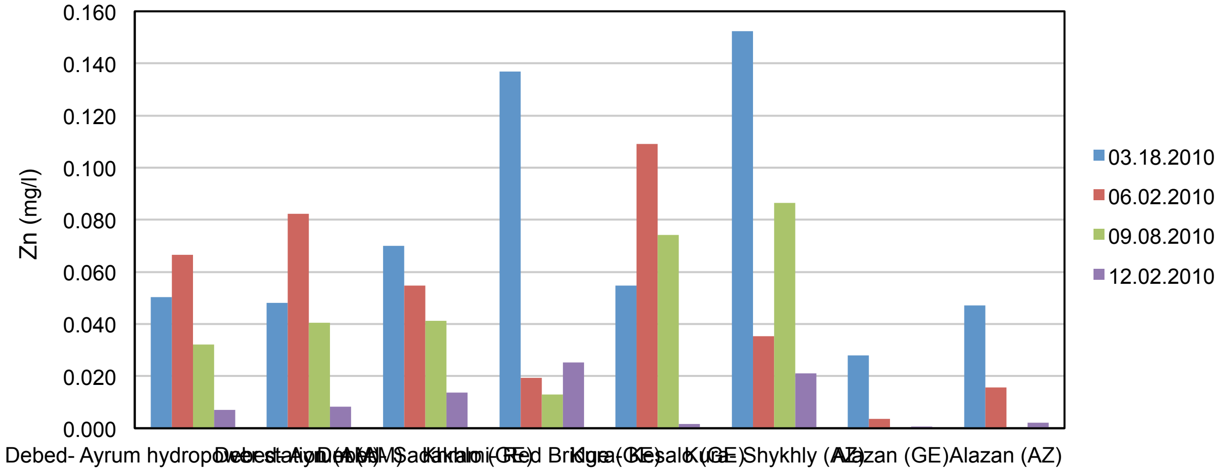
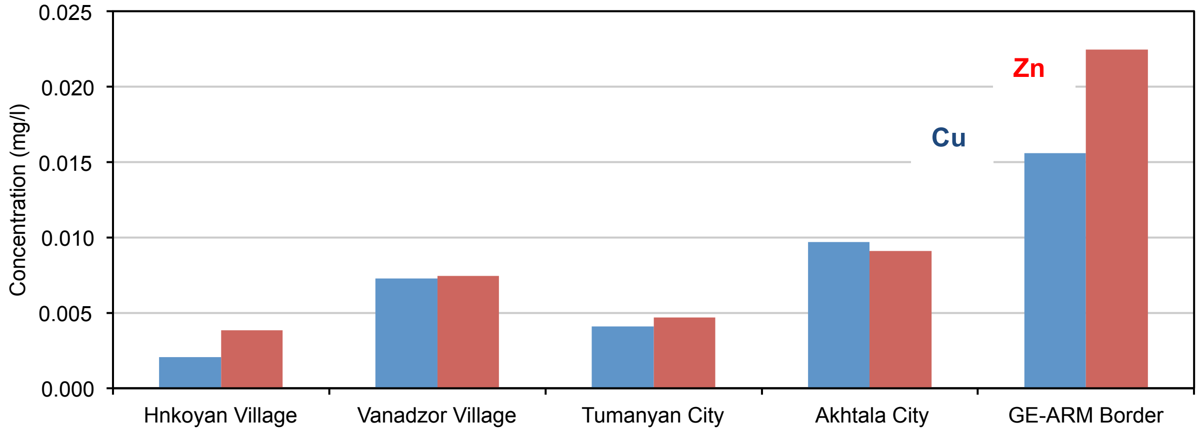


Figure 4.2.4.10 Average annual concentration of Cu and Zn in the Debed river.

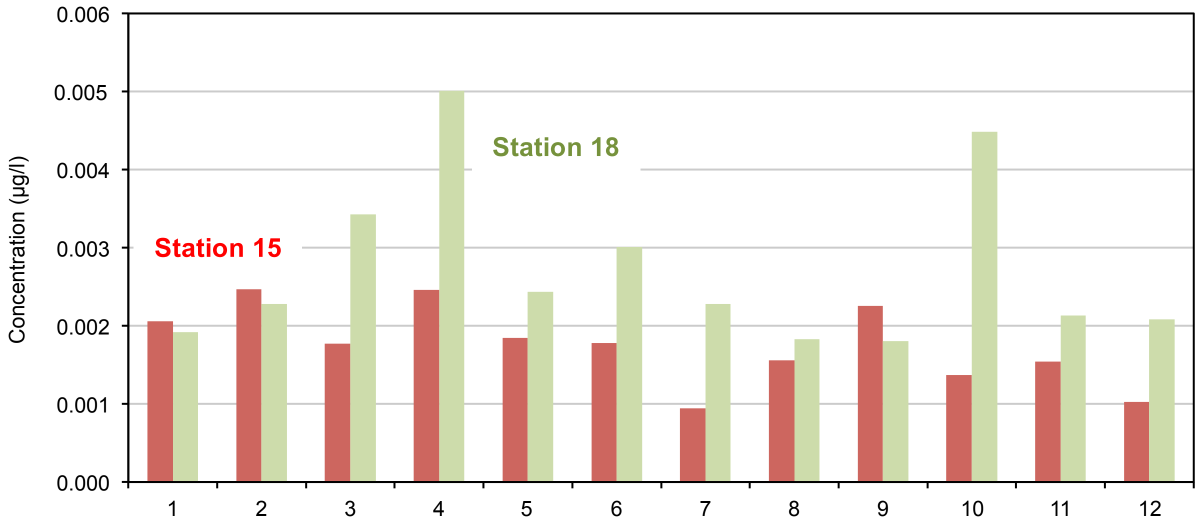


Note: Based on monthly measured concentrations during the period 2008-2011.

The figures 4.2.4.11 and 4.2.4.12 show the average monthly concentration of Cu and Zn for 2 stations along the Aghstev river in Armenia. Station 15 is located in the upstream section of the river, about 1.2 km upstream of Dilijan, while station 18 is located near the Armenia-Azerbaijan border, 9 km downstream of Idjevan. Both figures show a systematic slight increase of concentrations from the upstream to the downstream section in most months, indicating concentrations increase due to natural characteristics of the river, while the anthropogenic impact is minimal. Peaks for Cu in spring and autumn can be explained by rain carrying traces from soils in the catchment, combined with increased transportation of sediments.

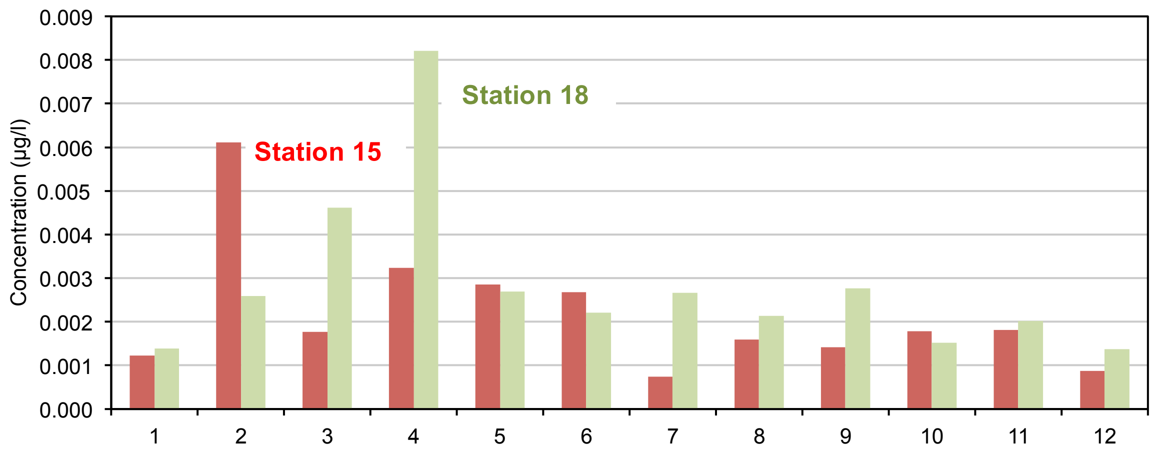
Figure 4.2.4.13 presents the average annual concentrations of Zn as observed at monitoring stations in Azerbaijan. A transboundary impact is clearly visible for Shikhli, downstream of the border with Georgia. Also the Mingechevir reservoir's impact on trapping the Zn load can be observed, as concentrations downstream the reservoir are much lower than those in the upstream area. However, due to the local sources and the contribution of the Ara(k)s river, Zn concentrations increase again in Shirvan, to reach a maximum of 0.0166 mg/l. Further downstream the Zn concentrations decrease sharply in N.E. Banka, to 0.00235 mg/l. High concentrations in Shikhli are due to transboundary loads from anthropogenic activities in Georgia, including releases from the Khrami river, while the high concentrations in Shirvan station are due to local sources upstream of the station as well as the contribution from the Ara(k)s River.

Figure 4.2.4.11 Average monthly Cu concentration for two stations in the Aghstev river (Armenia).



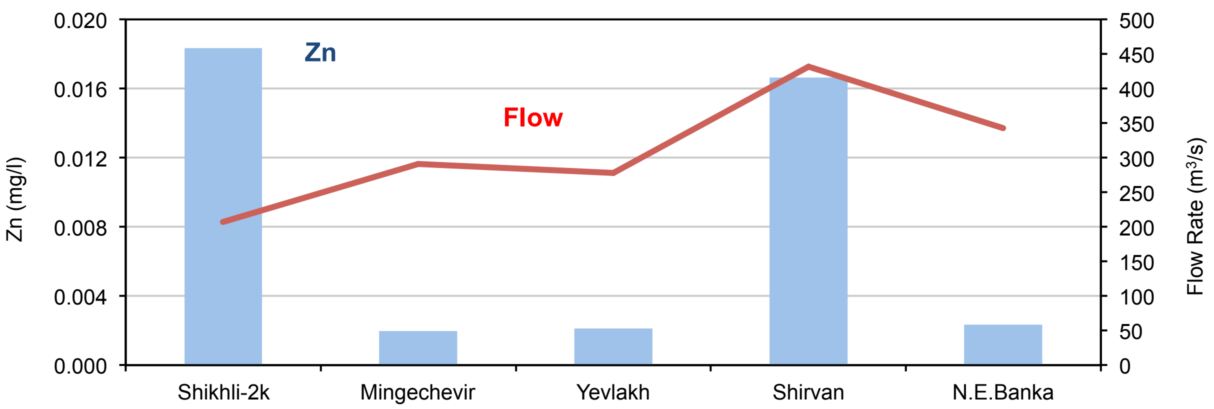
Note: Based on data collected from period 2008-2011.

Figure 4.2.4.12 Monthly average concentration of Zn in two stations in the Aghstev river (Armenia).



Note: Based on data collected from period 2008-2011.

Figure 4.2.4.13 Average annual concentration of Zn in the Kura river in Azerbaijan.

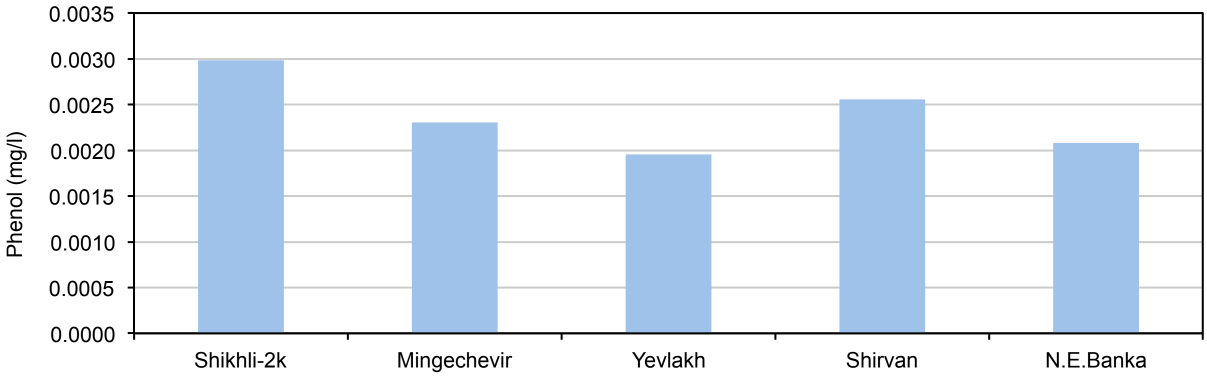


Note: Based on data collected during the period 2007-2011.

Phenol: Figure 4.2.4.14 shows that the concentration of phenol in the Kura river at Shikhli, downstream of the border between Georgia and Azerbaijan, exceeds the Azerbaijan and Georgia MAC limits (0.001 mg/l) at least 2-fold, hinting at the high level of pollution coming from Georgia, possibly from industrial discharges from the Rustavi industrial area, located about 20 km upstream of Georgia's border with Azerbaijan. The concentration of phenol reduces after the Mingechevir reservoir, possibly due to less anthropogenic activities in this river stretch. Further downstream the phenol concentrations slightly increase at Shirvan, indicating the impacts from high population numbers and the lack of sanitation services in the cities of Shirvan, Salyan and others. Additionally also the Ara(k)s river can have contributed to the increase in phenol concentrations.

The 5-year monitoring data (2008-2012) from N.E. Banka, show the average annual concentrations of phenol exceeding the MAC limit by 1.2 times, due to industrial activities, especially the petroleum sector.

Figure 4.2.4.14 Average annual concentration of phenol in the Kura river in Azerbaijan.



Note: Based on data collected during the period 2007-2011.

The Ara(k)s river basin

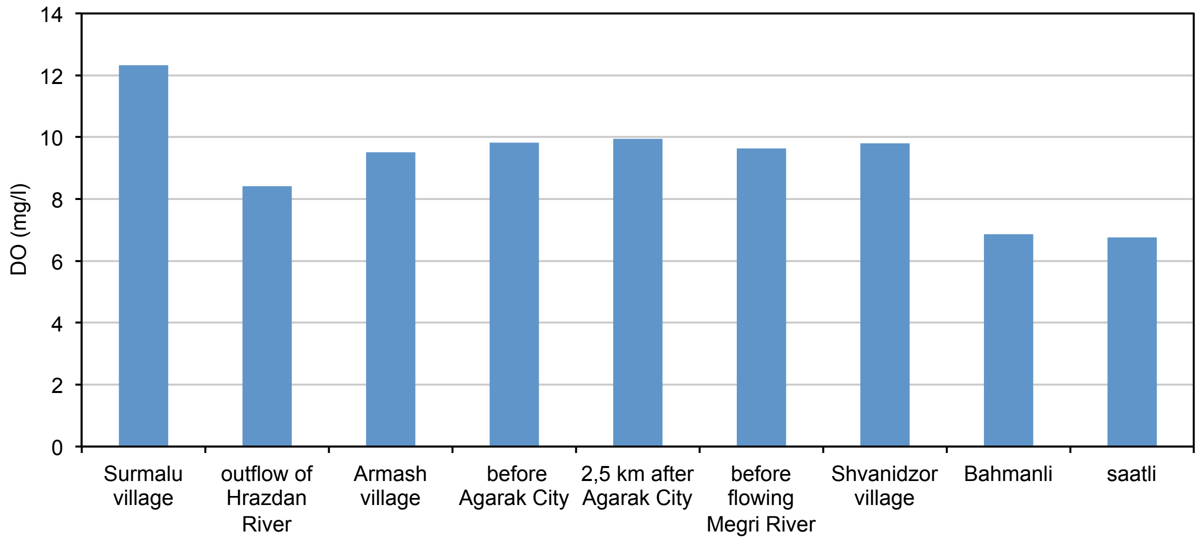
To analyze the surface water quality in the Ara(k)s river basin, monitoring data from 9 monitoring stations were used, of which 7 are located in Armenia and 2 in Azerbaijan. The data cover the period 2008-2010.

Dissolved Oxygen (DO): Data for 2009 show that the concentration of DO throughout the Ara(k)s basin is high, exceeding 6.5 mg/l (figure 4.2.4.15). It shows that the DO concentrations are higher in the upper catchment area, reaching a maximum of 12 mg/l at Surmalu. A sharp decrease is observed at the outflow of Hrazdan tributary, related to its high organic load from untreated sewage water from Yerevan and its surrounding area, depleting the DO concentrations. Due to the hydro-morphological characteristics of the Ara(k)s river and relative high flow velocities in its middle reach, the DO recovered due to natural aeration, reaching about 10 mg/l at the Armenia-Iran border. In its lower reaches the DO concentrations decreases to less than 7 mg/l, largely linked to the changes in hydro-morphological features of the river from a (semi)mountainous to lowland river with reduced slopes and low flow velocities, both of which reduce the natural aeration process. Overall, the average annual concentrations of DO are considered satisfactory in the whole Ara(k)s river.

The observed pH values are normal and typical for (semi)mountainous rivers in all monitoring stations.

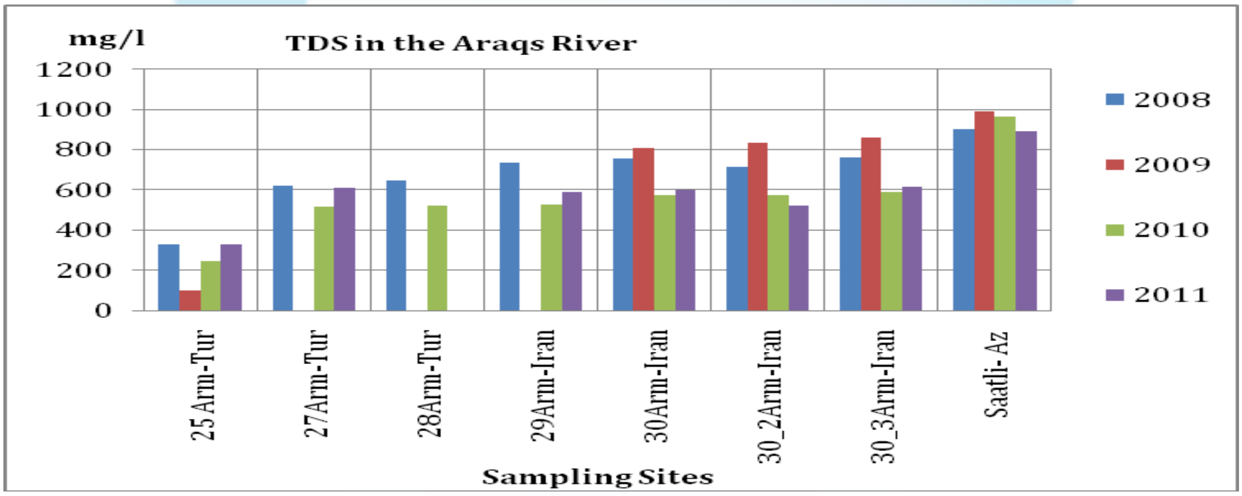
Total Dissolved Solids (TDS). The average annual concentrations of TDS along the Ara(k)s River for 2008-2010 are presented in figure 4.2.4.16. It is shown that at the river's source and in the upstream catchment of the Akhuryan tributary, the TDS is low, 100-300 mg/l (station 25). At the mouth of the Hrazdan tributary (station 27), on the Armenian-Turkish border, the TDS increased almost 2-fold, but the water is still low-mineralized. The TDS values at the exit of the Ara(k)s river from Armenia to Turkey/Azerbaijan at Armash (station 28) are low and practically coincide with the values at the mouth of the Hrazdan River.

Figure 4.2.4.15 Average annual concentration of DO in the Ara(k)s river (year 2009).



Further downstream, TDS values in Ara(k)s river water increase to 500-600 mg/l, indicating the impacts of anthropogenic activities in the basin, in particular the contribution of untreated/ partially treated sewage waste from urban areas, as well as from agricultural drainage water. At point 29 the river forms the Armenian-Iranian border, 2 km before Agarak City. For all the three stations at the Armenian-Iranian border the TDS is rather high - 600-800 mg/l. At the confluence with the Kura river at Saatli in Azerbaijan, the TDS reaches 900-1,000 mg/l, most likely due to natural hydro-chemical conditions that increase the sedimentation load to the river during the flooding period and the leaching of soil contamination. Addition factors include the anthropogenic impact from agriculture drainage water and point source discharges of untreated sewage. It is concluded that the water quality in this basin is rather good in the upper reach, while being classified as medium saline in its middle and lower parts.

Figure 4.2.4.16 Average annual TDS along the Ara(k)s River for the period 2008-2011.

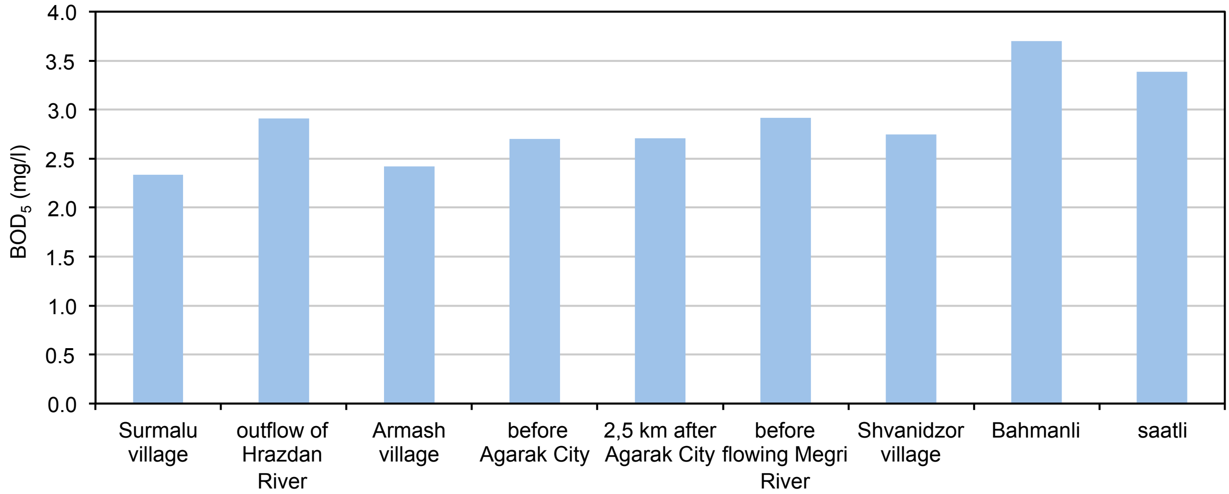


Note: Site 25 - entry point Armenian-Turkish border; 27 - below the outflow of Hrazdan river; 28 - exit point Armenian-Turkish border; 29 - entry point Armenian-Iranian border; 30 - below the outflow of Karchevan river (after tailing dam Agarak mining factory), Armenian-Iranian border; 30-2 - before confluence of Meghri river, Armenian-Iranian border; 30-3 - exit point Armenian-Iranian border; Saatli-Az - mouth of the Ara(k)s river.

BOD_5. Figure 4.2.4.17 presents the average annual concentration of BOD_5 in the Ara(k)s river between Surmalu in the upper catchment of the river to Saatli in Azerbaijan. It shows that at the entry point on the Turkey-Armenia border the BOD_5 varies between 1.8-2.8 mg/l with an average value of 2.33 mg/l. The highest concentration was measured the downstream of the outflow of the Hrazdan river, indicating at pollution with organic substances coming from Hrazdan river to the Ara(k)s river.

Increased concentrations of organic matter in the Ara(k)s river have several sources in Armenia: agricultural drainage water; wastewater from poorly functioning WWTP, if these exist at all; unlined landfills and illegal waste dumps of rural households; and livestock farming. All these activities occur in the most densely populated region of Armenia, the Ararat valley, providing 80% of all waste generated in Armenia (excluding mining wastes). An important source of pollution of the Ara(k)s river is water contributed by the Hrazdan tributary, contaminated with municipal wastewater from Yerevan as well as by agricultural drainage water. On the other hand, in the Armenian mountain tributaries to the Ara(k)s, e.g. the upper and middle reaches of the Hrazdan, Arpa, and Azat rivers the nutrient content is rather low, and water can be characterized as oligotrophic, while the water quality in the lower reaches of the Hrazdan river is eutrophic, which directly affect the water quality in the Ara(k)s downstream the outflow of Hrazdan river.

Figure 4.2.4.17 Average annual concentration of BOD_5 along the Ara(k)s river.



Note: Based on data collected during the period 2008-2011.

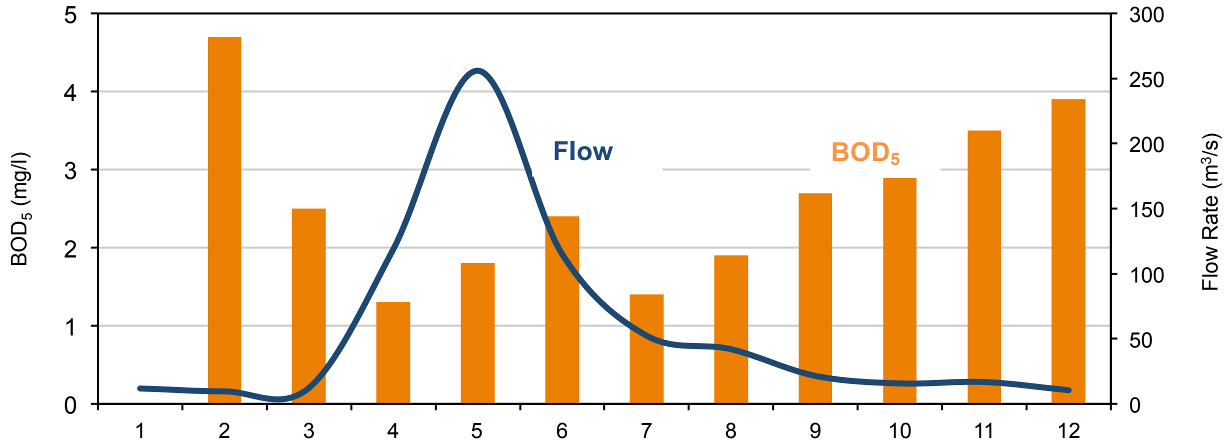
In Turkey, sources of organic pollution to the Ara(k)s river include: agricultural drainage water, household water from municipal sewer systems, leakage water from city landfills, unorganized waste dumps of rural households; and livestock farming (UNECE, 2011). However, BOD_5 values along the river remain close to 3 mg/l. This indicates that the combination of hydrological regime and hydro-morphological conditions in the middle reaches of the river creates conditions for the rapid oxidation of organic matter, limiting an increase in BOD_5 values. As such also the transboundary significance of organic pollution seems to be limited.

BOD_5 values at the Armenian-Iranian border, starting from Agarak, indicate that the Ara(k)s river is polluted with organic substances somewhere along the Azerbaijan-Turkey or Azerbaijan-Iran border. As the river banks, both on the Azerbaijan and Iranian sides, are not industrialized, the sources of pollution probably include municipal sewage, agricultural drainage water, wastewater from landfills, and rural households.

Overall the BOD_5 concentration along the Ara(k)s river shows an increasing trend from the upstream to the downstream area, coming close to the MAC limit of 3 mg/l in almost all sites. This is considered high for a mountainous river, and as such an indication of a high organic pollution load received by the river from the anthropogenic activities. In its downstream stretches in Azerbaijan the hydro-morphologic characteristics of the river changes towards lesser slopes and lower water velocities. These features reduce the natural aeration process and cause an increase in BOD_5 concentrations to be observed at Bahmanli and Saatli.

Figure 4.2.4.18 presents the seasonal relationship between BOD_5 and the flow rate for the station before the outflow of the Meghri tributary, at the Armenia-Iran border. It shows the inverse relation between BOD_5 concentration and flow, caused by higher flow rates improving the water aeration processes to replenish the DO content, which favors a better oxidation of the organic load and reduces BOD_5. Increased flow volumes also dilute the pollution load, further decreasing the concentration of the any pollutant.

Figure 4.2.4.18 Monthly variations of BOD_5 and flow rates at the Ara(k)s river in southern Armenia.

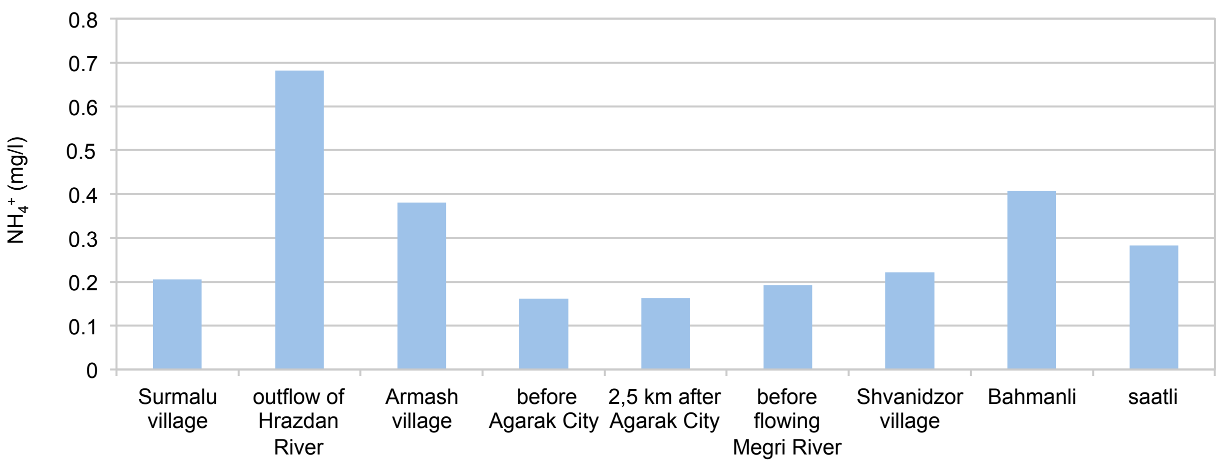


Ammonium: Figure 4.2.4.19 shows that the values of NH_4^+ along the Ara(k)s river are below the MAC of 0.4 mg/l, except for the outflow of Hrazdan tributary in Armenia and Bahmanli in Azerbaijan. Downstream of the outflow of the Hrazdan tributary, the NH_4^+ concentration exceeds the MAC by 1.7 times to reach on average 6.8 mg/l, a result of the significant outflow of municipal wastewater from the Yerevan WWTP into the Hrazdan river without chemical and biological treatment applied. At the mouth of the Hrazdan river the average annual concentration of NH_4^+ in 2009 and 2010 was 4.5 and 5.7 mg/l respectively. Other NH_4^+ pollution sources in this area include agricultural drainage water, leachate water from landfills, and illegal accumulations of rural household wastes.

After the Hrazdan river the NH_4^+ concentration rapidly decreases, and within 30-40 km - at Armash - reaches 0.38 mg/l, indicating the river's natural self-cleaning capacity due to its specific hydrological regime and hydro-morphologic features. Further downstream NH_4^+ remains below the MAC, ranging between 0.1616 and 0.221 mg/l at Shavindzor, the last station before the Azerbaijan border. Overall, however, the observed concentrations are high for a mountainous river.

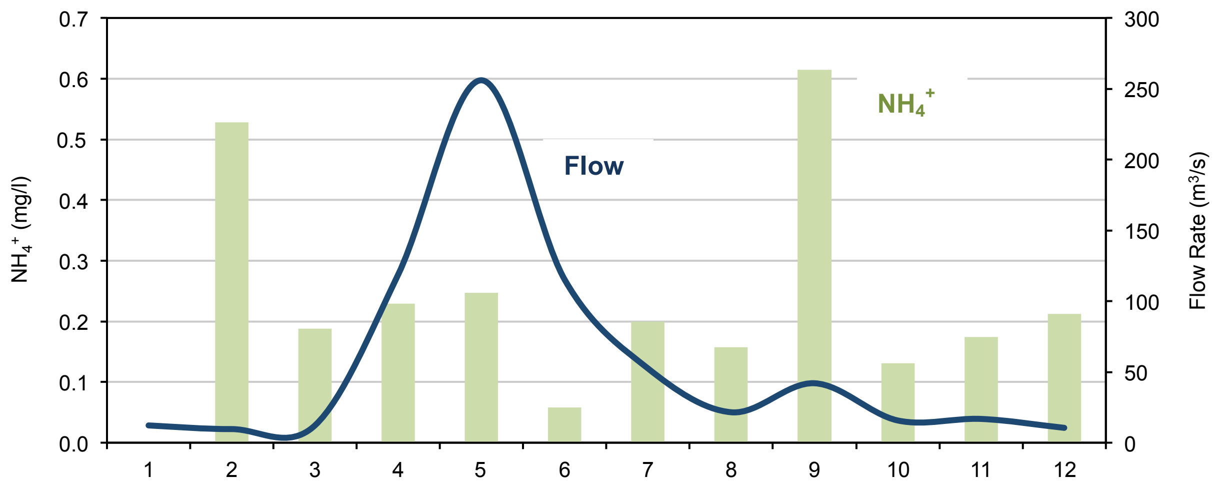
In Azerbaijan increased concentrations of NH_4^+ are observed, reaching 0.407 mg/l at Bahmanli, indicating a high organic load. The presence of wetlands and the low flow velocities reduce DO and increase NH_4^+ and BOD_5. More study is needed to differentiate between contributions from transboundary sources and local sources, taking into account that NH_4^+ at the Armenia-Iran border indicated a limited pollution load, offset by processes of self-purification, while the population density in this part of the Ara(k)s basin is low, and hence the municipal and agricultural pressures on river water quality are is low as well.

Figure 4.2.4.19 Average annual concentrations of NH_4^+ along the Ara(k)s River.



Note: Based on data collected during the period 2008-2011.

Figure 4.2.4.20 Relationship between NH_4^+ and flow rate in the Ara(k)s river near Meghri.

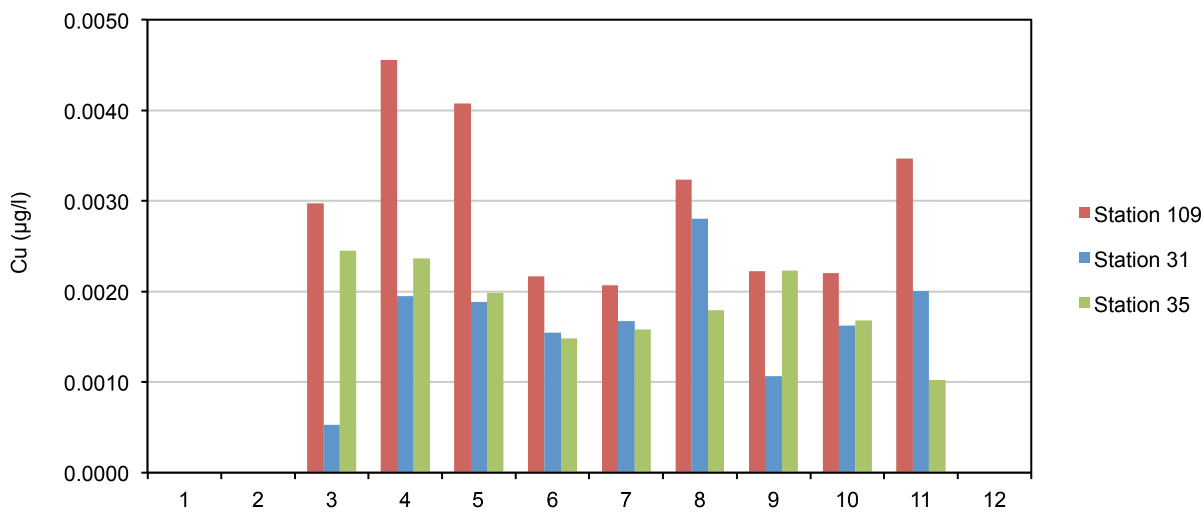


Note: Based on data collected during the period 2008-2011.

Figure 4.2.4.20 shows the seasonal variation of NH_4^+ concentration and the flow rate in the Ara(k)s river for the station before the outflow of the Meghri tributary, at the Armenia-Iran border. It shows that during low flow months the Ara(k)s river experiences a very high level of NH_4^+, reaching 0.614 mg/l in September, or 1.57 times higher than the MAC. High concentrations in low flow months indicate the high organic load in the Ara(k)s river water at this stretch, which is diluted naturally during the flooding period and related high rates of flow in the river, while also natural self-cleaning takes place. During the low flow season, the significantly lower volume of water increases the concentration of organic pollutants, while also self-purification is less significant due to lower oxygen availability.

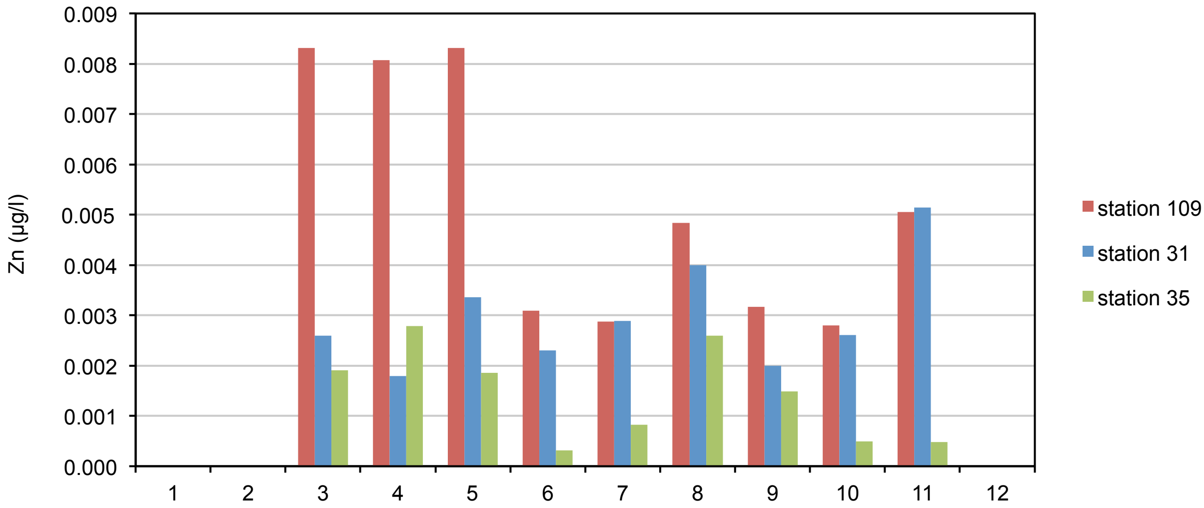
Heavy Metals (Cu, Zn). The figures 4.2.4.21 and 4.2.4.22 present the average monthly concentrations of Cu and Zn in the Akhuryan river, showing comparable trends – higher concentrations in the upper reaches near its intake from Lake Tseli, to gradually reduce to minimum values between the intake and the outflow of the river into the Ara(k)s river. This trend is constant in all months of the year, indicating there are no sources of heavy metals along the Akhuryan river in both Armenia and Turkey. The average concentrations of Cu and Zn are low and typical for upper reaches of mountainous rivers in Armenia.

Figure 4.2.4.21 Average monthly concentration of Cu in the Akhuryan river.



Note: Based on data collected during the period 2008-2011.

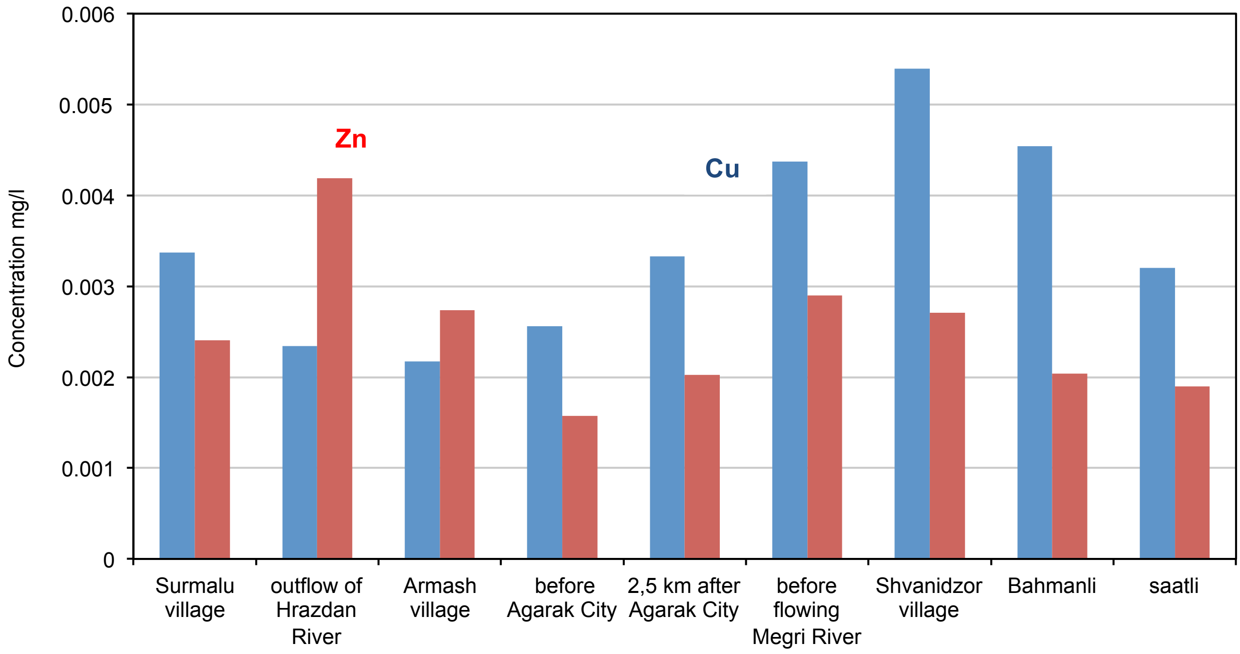
Figure 4.2.4.22 Average monthly concentration of Zn in the Akhuryan river.



Note: Based on data collected during the period 2008-2011.

In figure 4.2.4.23 the average annual concentrations for Cu and Zn are presented for 9 monitoring stations along the Ara(k)s river. Until the Armenia-Iran at Agarak, the Cu concentration remains almost unchanged compared to the upper reaches, suggesting the absence of pollution sources between the Turkey-Armenia border and the Armenia-Iran border. Going downstream from Agarak towards Shvanidzor, the Cu concentration almost doubles, assumed to be the result of the operations of the Agarak Copper-Molybdenum Industrial Factory in the Armenian part of the basin. Increasing Cu concentrations due to mining activities in Armenia contribute to the relatively high concentration of Cu in Bahmanli (Azerbaijan). Towards Saatli the Cu concentration decreases, indicating the absence of local sources of pollution along the Azerbaijan section of the Ara(k)s river downstream of Bahmanli, indicating that the observed concentrations of Cu are due to transboundary impact from Shvanidzor village.

Figure 4.2.4.23 Average annual concentration of Cu and Zn along the Ara(k)s river.



Note: Based on monitoring data collected during the period 2008-2011.

The increased Zn concentrations in the Ara(k)s river downstream of the Hrazdan tributary suggests a source of Zn either between Surmalu and the Hrazdan river on the Ara(k)s river, or along the Hrazdan river, but insufficient data are available to identify the source of this high Zn concentration. Further downstream the Zn concentrations decrease until Agarak, after which a slight increase is observed, although still much lower than the MAC. As with Cu, the highest concentrations of Zn occur between the Meghri outflow and Shvanidzor village, due to mining activities. Lower concentrations in downstream direction indicate the source of pollution coming from this village. After Bahmanli the Zn concentration reduces further towards the Saatli station, indicating that there are no local sources of Zn pollution between these two stations in Azerbaijan, and the concentrations of Zn are due to transboundary impact from Shvanidzor village.

Overall, the measured concentrations of Cu and Zn in the Ara(k)s river are low, except at Shvanidzor village in Armenia, where relatively high concentrations of Cu, reaching 0.0054 mg/l were observed. Therefore there is a potential for downstream transboundary impacts from mining activities in Agarak and Shvanidzor village.

4.2.5. Gaps in evidence.

The current analysis was conducted based on best available national information provided by each of the project countries. The countries firmly expressed support for the current conclusions reached, but information on water quality across the region remains limited. It is difficult to differentiate between transboundary and local pollution due to a lack of data on water quality for transboundary stations, lack of comparability and compatibility of the monitoring data collected by different institutions in the countries. Also there is a gap in information on point and non-point sources of pollutions, including the volume of wastewater released from each source and the pollutants' concentrations in these wastewaters. The recommendations section suggests means to overcome this and to fill the gaps both nationally and regionally for improved national and transboundary water resource management.

4.2.6. Environmental impacts caused by the problem to date.

Water pollution affects plants and organisms living in the water bodies; and often the effect is damaging to individual species and populations, but also to the natural biological communities. The environmental impacts caused by poor water quality include ecosystems degradation, characterized by altered productivity of ecosystems due to changes in nutrient balances, eutrophication etc., including in agro-ecosystems; changes in ecosystem species composition, including the loss of endemic and rare species of aquatic flora and fauna, and increase of invasive species, due to changes in environmental and habitat conditions; increased soil contamination in flooding zones; loss of beneficial ecosystem functions; downstream spreading of contaminants; losses of ecosystem resilience to extreme events; increased susceptibility to pests and shifts in micro climates; and damage and contamination to groundwater resources. Overall, the loss of valuable ecosystem services due to water quality deterioration is anticipated to be substantial.

4.2.7. Socioeconomic impacts caused by the problem to date.

Impacts to socioeconomic conditions due to the deterioration of water quality include loss of productivity due to a more frequent occurrence of water borne diseases, which also negatively impacts on the health care budget. Exposure to polluted water can cause diarrhea, skin irritation, respiratory problems, etc., depending on the pollutant in the water body. Stagnant water and untreated water provide a habitat for mosquitos and other parasites & insects that cause a large number of diseases. Among these, malaria is undoubtedly the most widely distributed and causes most damage to human health, though current strains in the region have lower mortality rates than those in sub Saharan Africa. Nonetheless, with climate change disease vectors are shifting, which increases potential risk in the South Caucasus. Diarrheal disease remains one of the major causes of morbidity and mortality among young children and according to the WHO's World Health Report in 2005, every 15 seconds a child dies of diarrhea and 15% of deaths among children under five years of age in developing countries is due to diarrhea. The costs of water borne diseases are not only to those who suffer from the illness but the loss of the productivity of caretakers as well.

The loss of soil productivity results in lower crop yields and lower profitability per hectare as well as per cubic meter of water. An additional socio-economic impact includes the increased costs of water treatment, including drinking water, industrial water uses and agricultural water uses. The remediation and the damage costs resulting from water pollution are much higher than the costs of pollution prevention measures.

Other socio-economic impacts include costs of lost contaminants which could be re-used in industrial, mining or agricultural processes. Untreated wastewater increases eutrophication in ponds, lakes and reservoirs, and can result in die-off of fish, including commercially valuable species, due to direct impact from excessive loads, or via pollution impacts on the biological food web. Any nutrients discharged with municipal wastewater could be reclaimed and used safely in agriculture. The deterioration of water quality also results in loss of potential income in aquaculture and (eco)tourism. Fear of contaminated water is often a significant obstacle to attracting tourist who otherwise would be very interested to explore the region. Overall the costs of contaminated river water resources to socio-economic development of the region are expected to be high.

Deterioration of water quality also restricts the water availability for certain uses and increases the cost of its treatment. In other words, water quality may lead to water scarcity - in spite of the availability of water in adequate quantities in certain rivers, they may not be suitable for use because of its bad quality.

4.2.8. Causes of the problem

4.2.8.1. Primary causes

The primary causes of the deterioration of water quality in the Kura Ara(k)s basin result from anthropogenic land, air and water pollution. Though t some increased levels of some substances occur naturally due to the geological and morphological conditions of the river basin, the overall increase in pollutants is human-caused. This includes not only pollution to water, and use of the river system as a recipient body for waste discharges from municipal, industrial and agriculture activities, but also pollution from contaminated soils that is washed into the surface and groundwater. This includes "historical" pollution as well as more recent pollution, including municipal and agricultural solid wastes from household and agricultural fields. In addition, pollution from agrochemicals, industrial chemicals and mining are present in the basin though often the sources are non-point and difficult to determine. Municipal wastes from dumping of untreated or partially treated sewage either directly into the rivers or onto the lands that are frequently flooded also contribute to the pollutants in the river system. Pollution from air, which falls onto the land and washes into the waters or falls directly into the water is also a source of pollution in the river system. Overall the anthropogenic activities are the primary cause of deterioration of water quality, at the local, national and regional levels.

4.2.8.2. Cross cutting

The cross cutting issue of climate change has potential to exacerbate the deterioration of water quality, as increasing human demands on the available water resources are confronted with anticipated lower flows of water within the system, thereby increasing the concentrations of pollutants, if loads remain unchanged. Additionally, a climate change induced rise in temperature will increase wind erosion, resulting in more pollutants being trapped in river systems. The increased occurrence of extreme weather events, including increased flooding and its severity, will increase the negative impacts of pollution by washing industrial, land based point source and non-point source pollution into the river system. This will increase the spread of pollutants and increase risks of hazardous spills. Drought events will mean that scarcer water will be used, which is already more seriously impacted by pollution due to the reduced dilution capacity. Droughts may further spread pollutants as water will be reused more often. The threat of increasing deterioration of water quality due to climate change is high due to its impact on an increased variation in flows, extreme weather events and increased desertification and must be addressed in an integrated manner.

4.2.8.3. Intermediate causes

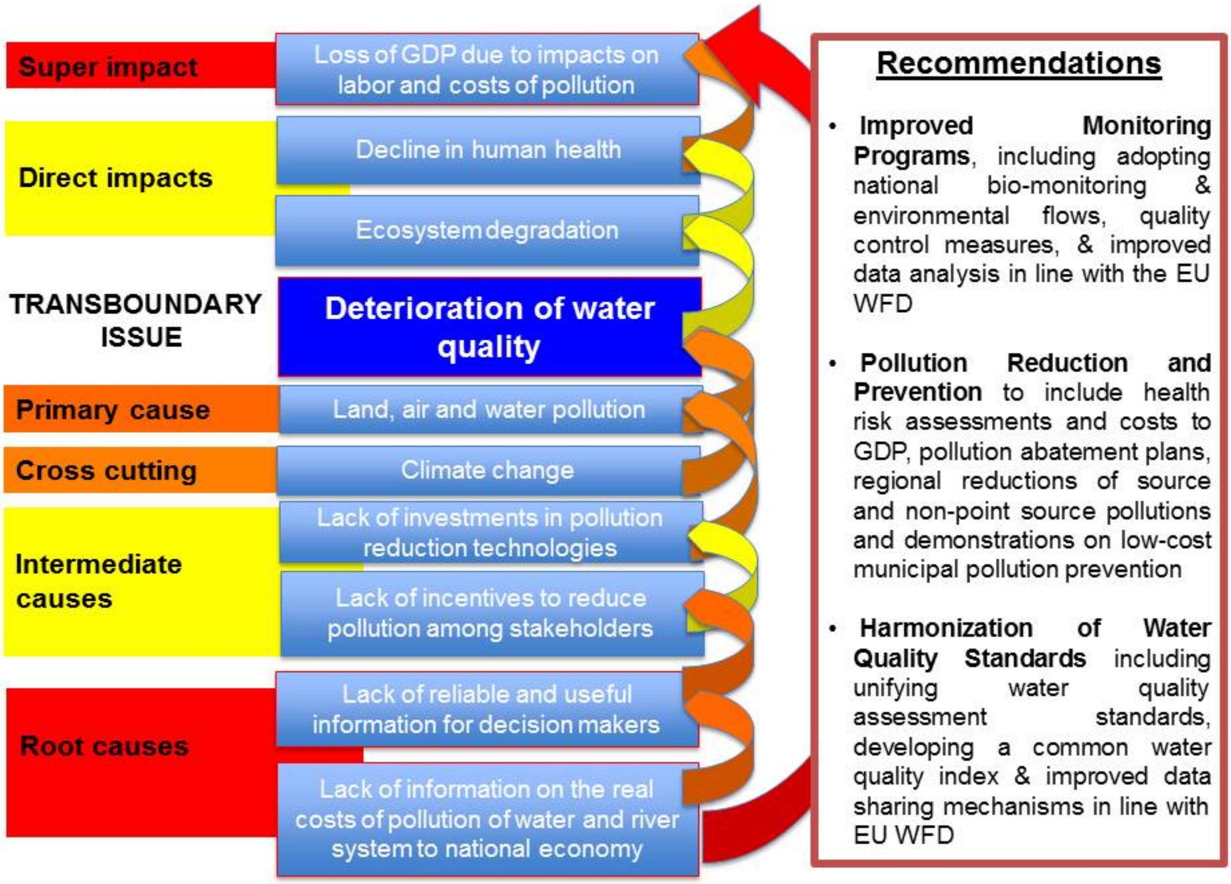
The intermediate causes of deterioration of water quality are the lack in investment in pollution reduction measures as well as the lack of incentives to reduce pollution from outdated technologies. The current practices for agricultural, industry, mining, and municipal waste disposal remain largely from those implemented during the Soviet era, and they do not sufficiently protect ecosystems from the deleterious impacts of pollutants. The lack of investment in pollution reduction technologies and practices stems from a low level of understanding of why changes should be made and the low level of green technology employed in the basin. For example, updated farming practices towards applying no-till farming, drip irrigation as well as drought, pest, and fungal-resistant crops reduce the use of water that carries herbicides, pesticides, and fertilizers as well as salts from the soils into the river system and groundwater. However as there are low incentives to reduce pollution from outdated technologies, farmers, and other private and public stakeholders do not see the benefit of investing in improving and updating technologies and practices, and therefore these remain underdeveloped in the region. Additionally, because the laws and regulations on polluters are not strictly enforced and monitoring capacity is limited, there is not an incentive to adopt practices or technologies that would reduce pollution to the land and rivers to reduce deterioration of water quality.

4.2.8.4. Root causes

The root causes of deterioration of water quality are the lack of reliable and useful information for decision makers as well as of information on the real costs of pollution of water and river systems to the national economies. While monitoring agencies collect valuable information, its reliability as well as its analysis and presentation is not reaching the potential to induce decision makers to make stronger policies to enforce and update existing regulations on pollution abatement. Any analysis must be reliably, based on quality control and quality assurance and regular calibration of equipment, using reference laboratories and international best practices. Further the data presented must be meaningful, using appropriate analysis tools accessible to decision makers and based on best practices for information dissemination to enhance decision support. In addition, experience has shown that technically trained decision makers must also be able to justify costs of increased monitoring, increased enforcement and improved water management to other decision makers, including parliamentarians and those who control the distribution of state budgets. For informed decision making, information on the real costs of water and river system pollution to the national economy as a result of deteriorating water quality must be stressed. Without this, water quality improvements become another perceived drain on state budgets without a clear cause and effect relationship, drawn to the socio-economic and environmental costs and losses to the GDP, including lost labor costs, lost land productivity costs of riverine and water dependent sectors, and the eventual costs of clean-up of damaged ecosystems.

4.2.9. Causal chain diagram

Figure 4.2.9.1 Causal Chain Diagram for the transboundary issue "Degradation of Water Quality".



4.2.10. Conclusion and recommendations

The analysis of the available data from water quality monitoring in the Kura Ara(k)s river basin shows limited evidence of transboundary pollution on an annual basis, due to the hydro-morphological characteristics of the rivers in the upstream countries. These largely mountainous rivers are characterized by high velocities of water flow, contributing to improved aeration processes and the breakdown of organic matter. However, the information provided by the countries presented here and in the Desk Study on Water Quality Hot-spots shows that in certain months, especially during the low flow seasons, the occurrence of transboundary pollution can be observed in Azerbaijan from the upstream countries, a combined consequence of the high and constant pollution load with low rate of flows in the rivers.

Some countries are making progress in managing transboundary water resources, in adopting broadly recognized principles, including responsibility for cooperation and joint management and the incorporation of transboundary water issues in revised legal and institutional frameworks. Support from the UNECE has been requested by Georgia and Azerbaijan to establish a bilateral agreement on the management of the transboundary waters between the two countries. Georgia also requested the support of the UNECE in the preparation of the ratification and the implementation of the UNECE Water Convention. In 2010, UNDP launched a cooperation project between Georgia and Armenia on fostering transboundary cooperation in the Kura Ara(k)s river basin, aiming to strengthen the dialogue between Armenia and Georgia on cooperation frameworks for transboundary water management and identification of existing transboundary water quality monitoring schemes. The project also provided support for the comparative analysis of the EU WFD approaches and water sector legislation in Armenia.

Building on initiatives for better management of transboundary water in the south Caucasian region, and based on the analysis of current water quality management in the region, the following are recommended actions to strengthen regional cooperation and capacities in transboundary water management:

Improve Monitoring Programs

Adopt revised national physicochemical and hydromorphological monitoring programs for both surface and groundwater, including geographical coverage, sampling schedule and parameters measured in line with the EU WFD and international standards: There is a general recognition that suitable data of sufficient quality on which to build decisions are limited in the context of water quality and wastewater discharges in the Kura Ara(k)s river basin. The frequency, distribution, and location of monitored parameters are currently insufficient to identify the location and extent of pollution point sources or ‘hot-spots’ and non-point sources, including microbial pollutants from wastewater discharge. The national monitoring plans should provide steps needed to address these shortcomings: capacity needs, equipment needs. This should also include a staff retention plan to provide incentives for well-trained staff to remain working in monitoring laboratories, to reduce the high rate of staff turnover. The adoption of the EU WFD and international standards for best practices for all countries are a critical step towards making improvements in monitoring in support of alleviating pollution sources locally and regionally.

Adopt national bio-monitoring programs with shared databases on local taxonomy and water status indicators including environmental flows: Physicochemical analyses give a measurement which is valid only for the instance in time when the sample was collected, whereas biological methods reflect the effects of the physical and chemical conditions to which the organisms were exposed over a period of time. Biological monitoring should be widely expanded, including the establishment of appropriate reference conditions, to determine the ecological status of water bodies, and shared databases on local taxonomy and water status indicators.

Improve Quality Assurance & Quality Control in sampling & analytical practices: Currently there is a need to update and ensure quality control and accuracy in water quality monitoring & analytic procedures so that data can be trusted and lead to best decision making. Each basin country should establish a national reference laboratory for water quality monitoring, responsible to provide technical support to other laboratories in that country, and ensure the proper implementation of the Quality Assurance/Quality Control (QA/QC) procedures. The national reference laboratories will run regular

proficiency tests of laboratory analyses for the main pollutants, and will evaluate the performance of other national laboratories in line with developing and implementing common procedures of the EU WFD.
Development of water quality information strategies and tools for improved decision making including improved inter-sectoral information exchange: Information collected by the monitoring agencies must be used to improve decision making, including the allocation of resources to reduce negative impacts and improve overall water management. The countries need to strengthen the national capabilities to interpret water quality monitoring data, towards developing decision support systems using mathematical models and GIS techniques as well as hot-spots maps. Efforts should be made to complete an emission inventory for the main sources of pollution in the Kura Ara(k)s river basin, to determine the exact location and contribution of each source to the pollution load entering the river basin, as well as areas where there is increase in pollution from non-point sources, so that targeted national and regional interventions can improve the conditions, especially in light of pending impacts of climate change, including increased water scarcity in the region.

Pollution Reduction and Prevention

Assess health risk from water borne diseases for local communities with emphasis on the gender dimension in the water sector, and conduct an economic valuation of the environmental and socio-economic impacts due to water pollution, including losses to GDP: Poor water quality impacts on communities, human health and the overall economic productivity, due to losses to the workforce, especially for women as caretakers for the young, infirm, and elderly who are disproportionately vulnerable to these illnesses. An assessment of health risk from water borne diseases for local communities, to include losses to GDP at local and national levels will provide a more complete understanding of these problems. Implementation of gender mainstreaming activities to empower women as stewards of local water quality will serve to improve local conditions and improve gender balance within water resources management, within communities and across the basin.

Reduce water pollution through development and implementation of integrated river water pollution abatement plans: Pollution in rivers is a serious challenge for water resource managers that must be addressed. Technical and financial support to all basin countries is needed to develop integrated regional river water pollution abatement plans that will include environmental compliance action plans for the main sources of pollution in the river basin, including an assessment of the estimated cost to implement these compliance plans, and the costs to governments of continued business as usual. These plans should encourage the use of Best Available Technologies (BAT) and Best Environmental Practices (BEP) in pollution reduction throughout the region for all sectors. Linking these plans regionally will significantly strengthen the impacts and increase opportunities for increasing benefits for the region.

Develop and implement a regional strategy for addressing point and non-point source pollution from contaminated sites and agricultural activities, including demonstration projects for BEP: The absence of lined landfill sites with leachate traps, the practice of co-disposal of both municipal and hazardous wastes in uncontrolled landfill sites, the existence of soil contamination at the former industrial complexes, and high levels of agricultural run-off all negatively impact on the health of river ecosystems. Strategies to address this should include: routine leachate monitoring at existing and former landfill sites and illegal dumps adjacent to the rivers; an improved mechanism to record and verify industrial and municipal waste sources and flows; oversight of agricultural water runoff; and an integrated solid waste management program. These should be in line with the EU Waste Directive and encourage the use of BAT and BEP in pollution reduction and treatment throughout the region for all sectors. Cost recovery mechanisms to induce polluters to bear the actual costs of monitoring and remediation should also be included within the strategy. Demonstration projects using BAT and BEP should be implemented in areas where there are high impacts from industrial pollution, including mining and historical industrial sites, as well as areas with high levels of agricultural discharge.

Implement demonstration projects on the use of the best available technologies in pollution prevention and treatment for municipal sources: Historically river systems have been used for waste disposal from industrial, municipal and agricultural sources. The improved understanding of ecosystem interdependence, combined with increasing impacts due to climate change, as well as the increased costs for treating water for consumptive uses will no longer support this approach. Demonstration projects must clearly show how measures can be taken to reduce waste discharges into the river system, with emphasis to the municipal wastewater. Many small communities throughout the region are often negatively impacted by the lack of connection to municipal water supply and sanitation. The costs to extend wastewater/sewage lines can be extremely high. Demonstration projects with constructed (engineered) wetlands for sewage water treatment in small villages can be implemented in the basin countries as a low-cost technology most suitable for small communities. The budgets will be based on the specifics of the pilot projects designed for demonstration in each country.

Harmonization of Water Quality Standards

Adopt harmonized national WQ standards in line with the EU WFD and international best practices: Currently the discrepancies between national water quality standards create significant challenges for comparison of the water quality status between riparian states. It is recommended to review and update water quality standards in all basin countries, towards designating common norms for the main water pollutants, and improved information sharing.

Introduce a unified water quality assessment system and harmonize methods and procedures for laboratory analysis for different polluting substances, including inter-laboratory testing: Different approaches in sampling and analysis of water quality in the basin may create discrepancies and incomparability in the information collected by different institutions. By defining a unified water quality assessment system and harmonizing methods and procedures for laboratory analyses for different polluting substances, including inter-laboratory testing, the countries can build the national and regional capacities, improve overall monitoring QA/QC procedures for better harmonization in water quality monitoring that goes in line with the approach advocated in the EU WFD.

Develop a common water quality index and related river basin status assessment criteria: Knowledge about the health of the river system is dependent on the quality of information and the assessment criteria. Incomplete information leads to incomplete measurement criteria and assessment and can lead to incorrectly targeted remediation efforts. In line with the EU WFD, the development of a common and inter-calibrated water quality index and related river basin status assessment criteria can be implemented in all basin countries, to evaluate the water quality in the river basin in a unified way, and bring each of the countries into closer approximation of the EU WFD, as well as benefit from appropriately targeted resources to river system health improvements.

Improve data sharing on water quality in regional technical task force(s): While there have been many international projects that have sought to bring regional technical experts together to share information on water quality, when these projects ended the information exchanges did not continue in a systematic manner. In order to improve sustainability, one of the mechanisms that could be applied is the establishment of a permanent taskforce for water quality monitoring information, which will define the transboundary stations to be monitored by each country, the number of parameters to be measured, the frequency of measurements, the reporting format for these data and the responsible authority in each country to collect and analysis these data. In the event that it is not politically possible to establish a single task force, two bilateral task forces could be developed to serve to harmonize efforts regionally. A key initiative of this/these task forces(s) is to evaluate the quality of the data and review regional indicators on the state of water quality including recommendations for decision makers. Efforts should be made to encourage other basin countries - Turkey and Iran - to cooperate in providing required information on water quality in their river basins, at the regional level as well as bilaterally.

In conclusion, the Kura Ara(k)s river basin has historically suffered from high stresses by human activities, especially in the second half of the twentieth century, which has led to a drastic negative impact on the quality and quantity of the water in the river basin. Ranges of factors, including industrial pollution, domestic waste, agricultural pesticides, large-scale irrigation/flood control, and hydropower schemes in addition to terrestrial watershed degradation have significantly affected the basin. All riparian countries have contributed to this situation. However, as some countries in the region experienced a significant economic decline during the last decades, the stress on water quality in some parts of the river has decreased, at least temporarily. For the future, as the economies in the region are envisioned to grow, with some industrial activities already being restored, and with an envisioned decrease of the annual flow volume resulting from climate change, it is expected that threats to river water quality will again increase.

Therefore, the riparian countries are invited to consider the above listed recommendations to improve the management of water quality in the region. These recommendations should be further discussed between the basin countries, to agree on a priority list for actions to improve water quality management in transboundary rivers. This list of priorities should be translated into a regional program of measures, with appropriate timetable and required resources for implementation. The countries may seek the support of the donor community in filling technical and financial gaps in available resources in each country for an efficient implementation of the plan of measures.

4.2.11. Literature cited

Abu Elseoud A., 2013. Desk study – Water quality hot-spots in the Kura Ara(k)s river basin. UNDP/GEF project “Reducing transboundary degradation in the Kura Ara(k)s river basin”, Tbilisi-Baku-Yerevan, 2013, 41 pp.

EU, 2011. EU Project "Trans-Boundary River Management Phase II for the Kura River basin - Armenia Georgia Azerbaijan", 2009-2011.

TACIS/2008/137-153 (EC) Water Governance in the Western EECCA Countries, 2009-2010.

UNDP/GEF, 2007. Kura-Aras river basin – Transboundary Diagnostic Analysis. RER/03/G41/A/1G/31: Reducing Transboundary Degradation of the Kura-Aras River Basin, January 2007, 122 pp.

UNECE, 2011. Second assessment of Transboundary Rivers, Lakes and Groundwaters. United Nations Economic Commission for Europe - Convention on the Protection and Use of Transboundary Watercourses and International Lakes,

NATO Science for Peace Program *“South Caucasus River Monitoring”* 2003 – 2008.

4.3. Ecosystem degradation

4.3.1. Description of the problem

Today, large patches of natural ecosystems in the Kura Ara(k)s basin, as in the whole of the Caucasus Biodiversity Hotspot, have been transformed by human activities, with plains, foothills, and subalpine belts the most heavily impacted. About a quarter of the region remains in reasonable natural condition, while less than 12 percent of the region, mainly forest, is considered pristine vegetation. Only about 5% of natural riparian forests remain today in the South Caucasus (Zazanashvili *et al.*, 2009). Most remaining old growth forests have been fragmented as a result of commercial logging as well as land development, including agriculture (Williams *et al.*, 2006). Natural steppes, traditionally used as winter pastures, have become overgrazed and taken on the character of semi-deserts, as their soil quality and species composition have been extensively modified. Additionally, natural steppes and semi-deserts of the Kura Ara(k)s lowland were destroyed due to the development of, mainly irrigated, agriculture (USAID, 2010).

Besides as well as due to the degradation of ecosystems, also biodiversity of the Kura Ara(k)s basin has deteriorated. Several mammal species are critical endangered, including the Caucasian Leopard (*Panthera pardus saxicolor / ciscaucasica*) in mountain ecosystems, and the Striped Hyena (*Hyaena hyaena*) in lowland ecosystems and floodplains. Overall, the numbers of large carnivores like Leopard, Hyena, and Lynx (*Lynx lynx*), as well as large herbivores (Bezoar Goat *Capra aegagrus*, Eastern Tur *Capra cylindricornis*, Western Tur *Capra caucasica*, Mouflon *Ovis orientalis*, Chamois *Rupicapra rupicapra*, Caucasus Red Deer *Cervus elaphus maral*, Roe Deer *Capreolus capreolus*, Wild Boar *Sus scrofa*) have fallen dramatically in the past century (Zazanashvili *et al.*, 2009). Currently about 10% of vascular plant species is listed in national and international Red Lists of Endangered Species (Williams et al., 2006). There is an obvious (although not accounted) decline of valuable tree species in recent years, in particular Chestnut (*Castanea sativa*) and Oriental Beach (*Fagus orientalis*) (Tarkhnishvili, 2006). A remarkable decline has been recorded for several bird species, in particular the Lesser Kestrel (*Falco naumanni*) and Imperial Eagle (*Aquila heliaca*). However, the decline of these species is recorded throughout their ranges and is not specifically connected with the Kura Ara(k)s region itself (Tarkhnishvili, 2006).

During the last 50 years a significant decline in the number of sturgeons entering the Kura river from the Caspian has been observed (Caspian Environment Program, 2010). A significant part of the sturgeon spawning grounds in the upstream river sections became inaccessible after the construction of in-stream reservoirs and dams, most notable the Varvara and Mingechevir dams on the Kura and the Bahramtapa dam near Imishly on the Ara(k)s (USAID, 2010). The remaining sturgeon spawning areas in the Kura Ara(k)s river are assessed at 307 ha (Negroni, 2012).

The construction of reservoirs also caused a change in the freshwater fish species composition in the middle and upstream stretches of the Kura since the late 1950s. It caused the disappearance of some fish species, including the Caspian Salmon (*Salmo trutta caspius*) and the Caspian Lamprey (*Caspiomyzon wagneri*) from the Kura, Alazani, and Iori rivers upstream of the Mingechevir reservoir. On the other hand, the Kura Roach (*Rutilus rutilus caspicus*) and two species of Bream (*Abramis brama orientalis* and *Abramis sapa bergi*) colonized the middle stream of the Kura, along with a number of introduced species from the Russian Far East (Tarkhnishvili, 2006). Comparable developments are considered valid for the Ara(k)s river.

4.3.2. Transboundary relevance

The problem of ecosystem degradation resulting from human development activities has several impacts on the transboundary level:

- **Hydrological flow**: Disturbance of the hydrological cycle – increased peak run-off during flooding and decreased flow during the low water period, due to deforestation and overgrazing – in the upstream basin may extent to the downstream countries. However, only limited quantitative information underpinning the actual significance of the problem is available for the region.

  Increased surface run-off over groundwater feeding to the river also increases surface erosion as well as risks of landslides and mudflows. Increased peak discharges affect additionally the intensity of bank erosion as well as other hydromorphologic processes. Landslides, mudflows as well as intensive floods may cause significant damage to infrastructure (roads, bridges, pipelines). Increased sediment load in the river increases water turbidity, negatively impacting aquatic flora & fauna as well as drinking water quality. Due to their direct impact on the river system, any local action may typically have transboundary consequences.

- **Regional climate conditions**: Ecosystem degradation due to deforestation & overgrazing affects the local and subsequently regional transboundary climate conditions. Together with factors like constructed reservoirs, and reduction in the extent and duration of flooding they impact on the natural balance between direct evaporation, plant transpiration and groundwater recharging.
- **Fish spawning**: Damming of the main streams Kura and Ara(k)s in the downstream areas has resulted in traditional spawning grounds for migratory fish species in upstream areas becoming inaccessible, and new sub-populations in storage lakes and upstream areas to develop.

  River flow regulation in combination with the construction of flood protection dikes along the rivers, the transformation of former floodplain areas into agricultural fields, and the increased human pressure on remaining floodplain areas has destroyed traditional seasonally flooded spawning grounds or minimized their effectiveness for spawning as well as their value and function for other species of flora and fauna. This affected both freshwater populations in the direct regions of impact as well as those further up- and downstream.
- **Species populations**: Habitat destruction, degradation and fragmentation decreased the connectivity between large areas of natural habitats typically needed for large predators, increasing the competition between species and individuals in remaining areas as well as conflicts with humans. As such, changes due to human development in one country can have transboundary impacts.

4.3.3. Why perception exists of this problem

During the 20th century, human development activities increased throughout the Kura Ara(k)s basin, which resulted in only limited natural areas remaining, the majority being destroyed, degraded or fragmented.

The problem caused by this – ecosystem degradation – is perceived by environmentalists and local citizens alike. The ever-expanding human activities reduced populations of a significant number of flora and fauna species, including previously valued hunting & fishing species, both due to overharvesting by increasing population numbers as well as reducing availability of suitable habitats for the species.

The expansion of human activities also deprived the local communities of other services provided by nature. The transformation of steppe and semi-deserts into mainly irrigated fields also destroyed many local wetland depressions, providing sources of freshwater, firewood, medicines and other non-timber forest products, etc., in addition to suitable habitats for flora and fauna species, including hunting species. This also applies to floodplain forests, which, if not affected by reduced direct flooding due to dam construction or logged for fuel, were negatively affected by river dikes erected for flood protection of newly established agricultural fields and settlements.

4.3.4. Factual evidence regarding this problem

The process of updating the Preliminary TDA showed that factual evidence on ecosystem degradation is limited throughout the three riparian countries. Publically available quantitative information seems largely to refer to data collected in the pre-1990 Soviet era, with limited actual citations provided, while qualitative descriptions focus on the negative impact without providing quantitative cause–effect relationships. Meanwhile typically attention is commonly paid to either the Caucasus Biodiversity Hotspot, or a specific country, with hardly any information available specifically for the transboundary Kura Ara(k)s river basin.

As such, although agreement exists on the immediate causes of ecosystem degradation (section 4.3.8), quantitative supportive information is largely limited, incomplete and/or inconclusive, also due to interactions between different causes and consequences. Below an overview of available factual information is presented with respect to the defined key immediate causes “habitat destruction, fragmentation and degradation”, “excessive use of biological resources” and the cross-cutting issue of “climate change”. The immediate cause “pollution” is discussed in chapter 4.2.

Habitat destruction, fragmentation and degradation

Logging

Increased timber logging occurs in forests of the Kura Ara(k)s basin since the beginning of 1990s, following the break-up of the Soviet Union and the halting of timber import from Russia. The foothills of the Great and the Lesser Caucasus are the areas that have been affected the most, including old-growth stands untouched for centuries. Trees are cut for household use and commercial purposes, mainly for construction as well as furniture. The increased logging for subsistence purposes was triggered by a lack of fuel and alternative energy sources as well as harsh socio-economic conditions, doubling to tripling firewood consumption in some areas (www.eoearth.org) (Table 4.3.4.1).

Table 4.3.4.1 Official and illegal logging in the 21th century (x 1,000 m³).

Country	2002 [a]	2003	2004	2005	2006	2007	2008	2009	2010	2011
Armenia	93.0 (36.1)	90.1 (22.9)	144.1 (21.8)	89.2 (14.9)	108.8 (5.6)	72.6 (5.6)	68.0 (2.9)	83.9 (2.3)	80.9 (2.9)	50.5
Azerbaijan	64.21 (41.0)	22.06 (49.0)	33.68 (46.0)	35.45 (38.0)	34.44 (37.0)	55. 29 (31.0)	41.0 (30.0)	46.91 (34.0)	45.09 (34.0)	
Georgia [b]	(28,301)			(45,255)	(25,392)	805,423 (98,675)	818,231 (21,331)	697,461 (30,684)	798,881 (32,936)	595,433 (7,451)

Notes: [a] - in brackets illegal logging is displayed (logging that was formally documented and against which measures were taken in accordance with legislation); [b] – for Georgia data for the country are displayed. Logging in the Kura Ara(k)s basis between 2007-2011 accounted for 70% of overall logging, while illegal logging accounted for 76%. Sources: "Hayantar" SNCO - Ministry of Agriculture of Armenia; Ministry of Ecology and Natural resources of Azerbaijan (2012), USAID (2009a), WB (2007; in IFAD, 2010); Georgia Ministry of Energy and Natural Resources, LEPL Agency of Natural Resources, GeoStat.

While statistics are available on licensed and illegal logging, especially the data on logging for subsistence purposes are not available. Information on official logging meanwhile is based on licenses issued, while illegal logging is based on infringements prosecuted. Accordingly, these data may deviate from the actual conditions in the field, depending on the level of patrolling, on compliance with licenses, on enforcement of protection regimes as well as activeness of prosecution of infringements. In Armenia no formal stock-taking of forests has taken place since 1993, as such any management of forests is based on outdated information (USAID, 2009a).

FAO statistics on forestry (table 4.3.4.2) show a continuing decrease in forest cover and timber stock in both Armenia and Georgia, while national statistics for Azerbaijan show an increasing total growing stock on largely stable forested area (FAO, 2010; AZ-MENR, 2012). Between 1990 and 2010, Armenia lost about 25% or 85,000 ha of forest, compared to 1%, or 37,000 ha in Georgia. Data tend to be disputed, different studies presenting a significant range in forest cover in the countries (USAID, 2009a). In Georgia, experts believe that illegal logging (including fuel wood harvesting) accounts for three times more than the official quotas (CEFP, 2004).

The forest cover in the central part of the Great Caucasus range appears to have been only insignificant reduced and affected. In some parts of Georgia nowadays even an increase in the area of forests is observed, for example, pine forest, due to the ongoing depopulation of some mountainous regions (Nikolaishvili et al., 2010).

Commercial logging mainly targets the high-stem broadleaf forests, dominated by Oriental Beach (*Fagus orientalis*). This type of human disturbance possibly has caused the most dramatic biodiversity loss, because these forests have an especially high value for endemic animals and plants, some of which are Pliocene and Miocene relicts (Tarkhnishvili, 2006).

Table 4.3.4.2 Country specific forest resources in the Kura Ara(k)s river basin.

Country	Forest cover (x 1,000 ha)				Total growing stock (x mln m^3)			
	1990	2000	2005	2010	1990	2000	2005	2010
Armenia	347	304	283	262	43.3	38.1	35.5	32.9
Azerbaijan	989.3	989.3	989.3	1021.0	127.0	133.1	139.3	144.2
Georgia	2,779.0	2,768.0	2,755.0	2,742.0	419.9	445.4	455.9	466.5

Sources: FAO Forestry Department 2010 (http://countrystat.org/for/cont/pxwebquery/ma/t06fo000/en) for Armenia and Georgia; Ministry of Ecology and Natural resources of Azerbaijan (2012).

Logging for fuel affects forest ecosystems throughout the basin. Many people living near forests today are still reliant upon (fallen) timber in the forests for use as fuel wood for cooking and heating and in some cases for use as building materials (USAID, 2010). These forests also provide valuable non-timber forest products include wild fruits, nuts, mushrooms, berries, medicinal plants, honey (Ministry of Nature Protection of Armenia, 2009).

Floodplain forests have undergone rapid degradation. Formerly widespread throughout the valleys of the Kura and Ara(k)s rivers and their main tributaries, today their occurrence is limited to relatively small patches. The largest areas of floodplain forests occur along the middle and lower sections of the Iori/Qabirri and Alazani/Ganikh tributaries in Georgia and Azerbaijan. Significant areas, although more fragmented, occur also between Tbilisi and the Mingechevir Reservoir, while small isolated patches remain in other parts of the entire valley of the Kura River and its larger tributaries, starting from the upstream areas in Turkey and southern Georgia. As a result of the construction of reservoirs on the Kura river also more than 30,000 hectares of tugai forests was flooded and destroyed (Tarkhnishvili, 2006).

Besides impacting on habitat availability, quality, connectivity and flora & fauna species, logging also particularly affects erosion intensity, mainly in the mountainous areas. In deforested areas the incidences of landslides and mudflows become more frequent phenomena, a result of a destroyed forest root zone. Increased surface runoff intensifies top soil removal, causing an overall decline in forest productivity and regeneration rate of forest in some landscapes (Nikolaishvili et al., 2010). For example, in the mountainous area of Azerbaijan the annual erosion rate is estimated at 100-500 m^3 per hectare (IFAD, 2010).

Agricultural development

Throughout the South Caucasus, agriculture is an important sector of the economy, if less so at the commercial, the more at the subsistence level. Since the mid-20th century, the Soviet authorities actively promoted the development of the sector in the region, by means of establishing large collective farms, in many places equipped with irrigation systems to provide sufficient water to cash crops. Especially in the Kura Ara(k)s valley in Azerbaijan, dikes were built on the banks along the main rivers Kura and Ara(k)s, to protect the surrounding former floodplain against flooding and turn the land into irrigated agricultural fields.

As a result, large areas of previously natural forests, meadows, steppes and semi-desert landscapes with their characteristic environmental processes and adapted flora and fauna diversity were destroyed permanently.

Following independence from the Soviet Union, the three riparian countries engaged in a process of privatization the former soviet state farms to the local rural community. Today, throughout the South Caucasus, agriculture is dominated by smallholders, producing over 90% of agricultural output. Meanwhile productivity of key crops grown is suboptimal, compared to top producers in the world, due to several reasons, varying across the region: too small land plots to make farming economically viable, the low degree of entrepreneurship, the lack of cooperative development, low public investment, the aging rural population, limited access to extension service, and the low use of fertilizers & pesticides (USAID, 2011).

Except for western Georgia, irrigation is essential for crop production on most arable land in the South Caucasus. Many irrigation and drainage systems, built during the Soviet era and being not optimal designed from the start, seriously deteriorated during the past two decades due to inadequate funding for maintenance and rehabilitation. This increased the already significant water losses and caused irregular and insufficient irrigation water availability, negatively affecting crop yields. Poor irrigation practices and deteriorated collector-drainage and irrigation networks contributed to water logging and secondary salinization. It is estimated that in Azerbaijan about 42% of the soils is affected by various degrees of salinization (IFAD, 2010). Similar patterns are considered to be observed in the lowlands of Armenia and Georgia.

As a result, a significant area of land transformed into agricultural fields during the Soviet period remains fallow, 12% in Azerbaijan, 36% in Armenia, and 65% in Georgia (National statistical data 2012). While on a small scale possibly natural restoration processes are ongoing, the majority of these lands will not restore towards their natural state, as environmental processes, largely the water regime, were permanently altered.

Species degradation

Habitat destruction, fragmentation and degradation caused the degradation of biodiversity of the Kura Ara(k)s basin. The Ministry of Nature Protection of Armenia (2009) states that “35 valuable species have become extinct in the territory of Armenia”. Tarkhnishvili (2006) mentions the Near Eastern Tiger (*Panthera tigris virgate*) being extinct, and www.conservation.org (2012) states that “no species were recorded as being extinct”. Meanwhile agreement exists as to several mammal species being critical endangered, including the Caucasian Leopard in the mountain ecosystems, and the Striped Hyena in lowland ecosystems and floodplains. Overall, the numbers of large carnivores (such as Leopard, Hyena, Lynx), as well as large herbivores (Bezoar Goat, Eastern & Western Tur, Mouflon, Chamois, Caucasus Red Deer, Roe Deer, Wild Boar) have fallen dramatically in the past century (Zazanashvili *et al.*, 2009). Also about 10% of vascular plant species is listed in national and international Red Lists of Endangered Species (Williams et al., 2006). However, declines of plant species are not so well documented (Zazanashvili *et al.*, 2009). There is an obvious (although not accounted) decline of valuable tree species with in recent years, in particular Chestnut and Oriental Beach (Tarkhnishvili, 2006).

A remarkable decline has been recorded for several bird species, in particular the Lesser Kestrel and Imperial Eagle. However, the decline of these species is recorded throughout their ranges and is not specifically connected with the Kura Ara(k)s region itself (Tarkhnishvili, 2006).

During the last 50 years a significant decline in the number of sturgeons entering the Kura river from the Caspian has been observed. At its peak, the Caspian Sea is said to have held up to 90% of the world’s sturgeon population. Today, official sturgeon catches have dropped from 13,800 tons/year in the period 1910-1930 to about 150 tons in 2007 (Negroni, 2012), peaking in the late 1970s at about 27,000 tons. Meanwhile, illegal sturgeon catches in all Caspian riparian states exceed the legal catch significantly, assessed at about 2,200 tons in 2006-2008 period (Caspian Environment Program, 2010).

A significant part – 90% (Negroni, 2012), of the sturgeon spawning grounds in the upstream Kura and Ara(k)s river sections became inaccessible after the construction of in-stream reservoirs and dams, most notable the Varvara and Mingechevir dams on the Kura and the Bahramtapa dam near Imishly on the Ara(k)s (USAID, 2010). The remaining sturgeon spawning areas in the Kura Ara(k)s river are assessed at 307 ha, largely directly downstream the first reservoir dams on both the Kura and Ara(k)s rivers, conditioned by the remaining presence of pebbles and gravel (Negroni, 2012). To mitigate the impact of spawning grounds having become inaccessible, about 20 sturgeon hatcheries were established in the Caspian riparian countries, 4 of which are located in Azerbaijan. While the impact of the yearly release of millions of fingerlings on supporting the sturgeon population is unknown, the continued decreasing wild population has created problem in obtaining sufficient wild breeders for the use in the hatcheries (Negroni, 2012).

The construction of large reservoirs not only affected sturgeon species, it also caused a change in the freshwater fish species composition in the middle and upstream stretches of the Kura and Ara(k)s since the late 1950s. Some fish species disappeared, including the Caspian Salmon and the Caspian Lamprey from the Kura, Alazani/Ganikh, and Iori/Qabirri rivers upstream of the Mingechevir reservoir. On the other hand, the Kura Roach and two species of Bream colonized the middle stream of the Kura, along with a number of introduced species from the Russian Far East (Tarkhnishvili, 2006).

Unsustainable use of natural resources

Overgrazing

Overgrazing is a problem associated with the sub-alpine and alpine pastures as well as the steppe and semi-desert ecosystems in the south-eastern part of the Kura Ara(k)s basin. Overgrazing by domestic sheep, goats and cattle has eroded the natural vegetation in more than 30 percent of subalpine and alpine summer ranges and about 50 percent in the winter ranges of the steppe and semi-desert areas (www.eoearth.org), mainly because seasonally livestock is abundant and grazing is effectively uncontrolled (USAID, 2010). Pastures are inadequately managed – no effective rotation schemes are in place - affecting the vegetation composition as well as the overall productivity of the pastures. Livestock also often is grazed in or wanders into forest ecosystems, negatively impacting on the undergrowth vegetation layer as well as the natural regeneration of trees. In the semi-arid ecosystems, used as winter pastures for sheep, overgrazing is the cause of widespread and especially severe erosion (GE-MEPNR, 2009).

Overgrazing causes habitat loss for several endemic Caucasian rodents, such as the Long-clawed Mole Vole (*Prometheomys schaposchnikowi*) and birch mouse species (*Sicista spp.*). Overgrazing also affects the suitability of habitats for ungulates and birds, including the Besoar Goat, the Daghestanian Tur, and the Caucasian Black Grouse (Tarkhnishvili, 2006). Overgrazing and resulting lack of grasses in conjunction with hunting has led to the near extinction of Red Deer and Goitered Gazelle (GE-MEPNR, 2009).

Overgrazing causes degradation of the natural plant cover, it being replaced by secondary communities with lower species diversity (Tarkhnishvili, 2006). Overgrazing is evident at all altitudes in pasture areas, with original vegetation being replaced by unpalatable or grazing-resistant species (e.g. weeds). Environmental pressures on pastureland are intensified by the declining practice of moving livestock between summer and winter pastures, and increased livestock density, especially in areas close to the villages (i.e., communal winter pastures). Under-utilization or abandonment of more distant pastures affects soil properties, alters the plant composition, and affects the natural fauna species that depend on them. Degradation of high- altitude summer pastures contributes to the declining numbers of wild goats and chamois; overgrazing of lowland grasslands affects the native flora and fauna of steppe ecosystems (IFAD, 2010).

Many pastures are owned and managed by the State and leased to individuals or companies through grazing permits that usually last 10-15 years. Allocation of grazing rights is based on the number of animals, in theory, but specific laws on contracts or permits and monitoring to check adherence to official stocking rates are virtually absent.

Hunting & fishing

Illegal and unsustainable hunting increased significantly since the 1990s, the start of the economic crisis following independence of the South Caucasus countries from the Soviet Union. It is the main cause of decreased populations of Red Listed species, including Red Deer, Western Tur, Bezoar Goat, Chamois, Wild Goat, Wild Boar, Wolf (*Canis lupus*), Brown Bear, and the endemic Pheasant (*Phasianus colchinus*) (GE-MEPNR, 2009), as well as common species like Quail, pigeons & doves, ducks, coots, snipes, hares and foxes (USAID, 2009a).

Today, only three small populations of Red Deer remain and these are all in existing protected areas (GE-MEPNR, 2009). The numbers of Chamois, Wild Goat and Brown Bear populations have all decreased, while the populations of Turs, still numbered in the hundreds of thousands in the middle of the 20th century, have now been drastically reduced. Today, only about 4,000 of the eastern subspecies and 6,000-10,000 of the western subspecies remain (www.eoearth.org). Poaching also poses a threat to the country's populations of water birds, many of which are popular targets for hunters (GE-MEPNR, 2009). The impact of excessive hunting and poaching has been exacerbated by deforestation, transformation of the land for agriculture, and overgrazing, all of which have reduced and fragmented suitable habitats of these species (Tarkhnishvili, 2006).

The decreasing wild ungulate populations, particularly the Chamois, East Caucasian Tur and Red Deer, due to the increased hunting pressure, likely explains the increased occurrence of conflicts between large carnivore species, such as the wolf, and local communities (Tarkhnishvili, 2006).

As with collecting fuel wood from the forests for heating and cooking, poverty and lack of other resources forced many people also to rely more heavily on hunting and fishing to provide food for the table. A number of endangered or threatened waterfowl species and fish populations are feeling these negative impacts today (USAID, 2010).

Illegal fishing, especially unsustainable fish harvesting using destructive methods such as explosives and electro-fishing, chlorine poisoning, etc. is a major threat for river fish fauna throughout the entire Kura Ara(k)s basin (GE-MEPNR, 2009). After the collapse of the Soviet Union, large-scale organized sturgeon poaching developed and is considered to be one of the main factors responsible for the dramatic decline in officially recorded catch (Caspian Environment Program, 2010). Poaching and overfishing of sturgeons, particularly in the lower reaches of Kura in Azerbaijan, has contributed to the considerable decline in their population (Tarkhnishvili, 2006).

Water use

Studies suggest that the discharge reduction of the Kura and Ara(k)s amounts to 40% and 27%, respectively, at the confluence of the two rivers. Key causes include direct water abstraction for irrigation, the construction of artificial reservoirs leading to increased evaporation, and urbanization leading to increased communal water demand (UNDP/SIDA, 2005). Annual runoff of the Kura into the Caspian Sea has decreased by about 15-20% when compared to the pre-irrigation period (Imanov, 2007), although temporal analysis of annual discharge at the downstream hydrological station of Surra hints at a reduction as large as 40-50% (Hannan *et al.*, 2013).

Agriculture is the major water user in the Armenia and Azerbaijan, even though its contribution to the national GDPs is below one fifth in all countries. Due to unsystematic and non-normalized irrigation of lands, poor construction quality of the irrigation & collector-drainage network, as well as the shortage of budgetary financing, insufficient maintenance and poor operation level of inter-farm facilities, it is estimated that about 40 to 60% of the water which is taken in from the rivers to be used for agricultural purposes is lost in the distribution systems (Imanov, 2007; OECD, 2012). Most irrigation canals are open and unlined, resulting in high filtration rates. According to available data, the average irrigation efficiency does not exceed 50%, only in individual cases 60 to 70% is reached.

Domestic water supply is characterized by similar losses, with at least 20 to 40% of the water lost in the distribution networks (German Ministry for Economic Cooperation and Development, 2010). OECD (2012) reported on losses in Georgia estimated at 40-60%, while the five drinking water supply companies in Armenia reported losses up to 80%. While for Baku losses of only 5-6% were reported, following extensive recent repairing, anecdotal evidence from rural areas hints at equally high losses as in Azerbaijan's neighboring countries.

Poor irrigation practices led to the deterioration and salinization of reclaimed land, especially noticeable already in Azerbaijan. At present, 631,000 ha (43%) of irrigated lands in Azerbaijan are subject to various degree of salinization, including 140,000 ha of medium-saline lands and 66,000 ha of highly saline lands. Additionally, 267,000 ha of lands require reclamation due to the occurrence of high groundwater tables (Imanov, 2007).

Although hydropower is a non-consumptive water user, it either stores larges amount in reservoirs behinds high dams, or applies run-of-river methods in which a significant to all river water is entered in a tube, transported to a small HPP several kilometers downstream, and released back into the river. Profit maximization and lack of enforcement give rise to overdesigned installations, leaving stretches of the river dry during the low water season, impacting on aquatic ecosystems as well as the local community depending on these water resources. At present hydropower in Armenia, Azerbaijan and Georgia annually generates about 13,000 GWh, of which 60% in Georgia, predominantly in the western part of the country, 21% in Azerbaijan and 19% in Armenia (national statistical data, 2012). All three South Caucasus countries are planning to expand their hydropower sector, with the countries' potential currently not being utilized by far. As example, Georgia currently exploits only 25% of the hydropower resources identified as economically viable (SEEC, 2007). Especially Armenia and Georgia envision expanding their hydropower sector in the near future, towards covering internal needs and subsequently becoming net exporters of hydro-generated electricity (German Ministry for Economic Cooperation and Development, 2010). Overall, existing plans show evidence of the number of HPPs to be tripled, from the current 200 to more than 600 in the coming decades (Ministry of Energy & Natural Resources of Armenia, 2012; Ministry of Energy & Natural Resources of Georgia, 2012; Ministry of Industry and Energy of Azerbaijan, 2012).

It is currently unclear how water demand will develop in the future. While industrial as well as agricultural water withdrawal has decreased after 1990, both sectors plan for an economic upturn which would increase water demands again. The slowly increasing welfare of the region's population is also likely to impact on water resources towards increasing demands. Meanwhile, the specific existing plans for expanding the hydropower sector already can be envisioned to expand their negative effects on the variation and reduction of hydrological flow, further impacting on aquatic ecosystems and the local communities.

It is especially not clear whether and how the importance of agriculture on water resources use will change in the coming decades. While a resurrection of previously used irrigated lands can be expected, with an envisioned increase of water needs, alternative developments may result in an increase in water use efficiency, notable drip irrigation, crop selection to reduce crop water needs while maintaining production levels, etc. A similar uncertainty concerns the future development of industrial water demand, which decreased significantly after the collapse of the Soviet Union and increased slightly after the production was partly resumed. Again a parallel process of increasing use efficiencies and introduction of closed water use circuits may counterbalance any increase in industrial water use. The future amount of water used for all purposes will also largely depend on interventions such as water pricing, metering, rehabilitation of infrastructure and water saving technologies (German Ministry for Economic Cooperation and Development, 2010), as well as any envisioned impact on water resources due to climate change.

Overall, water use impacts directly and indirectly on the status of ecosystems in the Kura Ara(k)s river basin. Ecosystem degradation due to water use occurs notably as a reduction in hydrological flow, with more water abstracted for human activities in irrigation, hydropower, and the processing industry, or for consumption. A reduction in flow volumes impacts on the state of aquatic ecosystems and their flora & fauna species, via the amount of available water, changes in flow velocity, temperature and oxygen regimes, etc. When pollution outflow volumes remain unchanged, a reduction in flow also will cause increased pollution concentrations in the aquatic environment, while changes in chemical balances will reduce the river's self-purifying capacity as a result of which pollution will be transported further downstream.

Climate change

Climate change – mainly temperature and precipitation changes – are already reported in all three riparian countries. While in addition to significant inter-annual variation also the spatial variation in temperature and precipitation is large, due to the highly variable topography and elevation of the South Caucasus, the region as a whole has experienced temperature increases between 0.5^{o}C and 1^{o}C (Table 6.1.1.1). Armenia and Georgia both note that mean summer temperatures (June, July, August), important because of the growing season, have risen at a faster rate than the mean annual temperatures, while winter temperatures (December, January, February) varied around a stable mean. Analyses showed that also the rate of temperature rise has increased – in Azerbaijan the rise in mean annual temperature between 1961 and 1990 was 0.34°C, while the rise over the 10-year period 1991-2000 was 0.41°C, which is a factor 3 faster. A comparable trend has been observed for the summer temperatures in Armenia.

While there has not yet been a fully quantitative assessment of expected ecosystem changes in the region envisioned to occur due to climate change, a qualitative analysis shows that the most notable impacts of climate change on ecosystems in the Kura Ara(k)s basin will be the displacement of natural boundaries of sensitive areas of the eastern South Caucasus temperate forest ecosystems, a loss of resilience of flora and fauna to invasive species, a loss of natural ecosystem "corridors" for migration of rare and endemic species, increased cases of forest fires, degradation of landscape diversity, and loss of biodiversity (ZOI, 2011).

As a consequence of changing climate conditions, more than 17,000 hectares of forest (5-5.5%) in Armenia may disappear due to unfavorable environmental conditions for forest growth, including related factors as outbreaks of diseases and pests and a larger risk of forest fires (AM-MNP, 2010). In Georgia, the anticipated climate changes could turn a significant part of the Dedoplitskaro region into subtropical arid steppes, covered by vegetation typical to semi-deserts and desert, with subsequent impoverishment of biodiversity (GE-MEPNR, 2009).

Changes in climatic conditions are envisioned to also impact on flora and fauna composition. According to Tarkhnishvili et al. (2002), humidity in south-east Georgia increased since the 1950s, as a result of which the populations of amphibian and reptile species typical for arid and shrubby habitats in Georgia declined and underwent fragmentation, including species like the Syrian Spadefoot (*Pelobates syriacus*), the Montpellier Snake (*Malpolon monspessulanus*), the Collared Dwarf Snake (*Eirenis collaris*), and the Levantine Viper (*Macrovipera lebetina*). At the same time the populations of species typical for humid and forested habitats increased. In addition, the distribution area of three species of green lizards – Sand Lizard (*Lacerta agilis*), Ocellated Lizard *(Lacerta media)*, Caucasus Emerald Lizard *(Lacerta strigata*) extended towards the Tbilisi region.

4.3.5. Gaps in evidence

Comprehensive basin-wide stock-taking in the environmental thematic fields affected by human development activities – flora, fauna, and abiotic conditions - has not been executed for at least 20 years. This includes the natural conditions and occurrence of *inter alia* forest resources, fish populations, water quality, game species, vegetation conditions, as well as the impacts of expansion/decreasing socio-economic development processes. Today, in the newly established economic conditions, the state monitoring network largely is brought to a minimum, while in many disciplines the data collection is largely limited to irregular activities of scientific institutes.

The most common type of monitoring executed in the three basin countries, in addition to hydro-meteorological monitoring, is related to the regular collection of water samples analyzed for chemical water quality, although both monitoring systems are infested by (too) large spatio-temporal gaps to optimally contribute to informed decision making (see also section 4.2).

The status assessment for herbaceous species has not been completed and so rare, endemic and endangered species of non-woody plants remain unprotected by legislation (Succow, 2009). Although the inventory of fauna species, especially mammals and birds, appears to be more complete, still large data gaps exists with respect to population numbers in different seasons as well as their spatial distribution.

For those cases in which inventory and monitoring are conducted, significant problems exist with the access to information, as well as the sharing of data between state and other management organizations. In many cases also limitations are noted with respect to the proper interpretation of collected data, within disciplines, while linking of information between disciplines is virtually absent.

The absence of a comprehensive and complete information system on biodiversity excludes the practical assessment of the impact of natural and anthropogenic factors on biodiversity, reliable calculation of the damaged caused and adoption of decisions based on accurate information (Ministry of Nature Protection of Armenia, 2009).

4.3.6. Environmental impacts caused by the problem to date

The degradation of ecosystems caused by human development activities has a multitude of impacts on, again, nature and, ultimately, humans.

Natural ecosystem components and processes – biological, chemical and physical – provide valuable services to humans. They provide not only direct goods like meat, fish, fuel wood, medicines and water, but also regulate nature's processes like flooding, erosion & sedimentation, climate regulation, pollination and pollution abatement. Factors important for providing these ecosystem services include natural hydrological cycles, including climate regulation, nutrient cycles and soil fertility, all determining the final capability of nature for primary production and sustaining a biological diversity adapted to the specific environmental and climatic conditions. Ecosystem services provide important constituents of human well-being, including basic materials for good life – food, shelter, health –clear air & water, and security – personal safety, security from disasters (MEA Millennium Ecosystem Assessment, 2005).

Human development activities impact on the type and magnitude of services provided by specific ecosystems. The development of agriculture, for example, causes a shift from regulating services – water balance regulation, pest control, pollination – to provisioning services – timber, fodder, meat, crops, etc.

These changes have helped to improve the lives of billions, but at the same time they weakened nature's ability to deliver other key services such as purification of air and water, protection from disasters, and the provision of medicines.

An excessive degradation of ecosystems in the Kura Ara(k)s basin has a number of identified negative environmental consequences, a non-exhaustive list of which includes:

- Change of the hydrological flow of the rivers. Timber logging as well as overgrazing result in changes in the balance between surface runoff and groundwater discharge, towards increased peak flows and related risks of flooding followed by decreased base flow during the low water season. The increase of surface run-off in land clearing areas also reduces soil and sub-soil processes acting to bound and detoxify polluting compounds (www.greenfacts.org).
- Decrease of the natural regulatory service of the aquatic environment to handle pollution. Human-induced changes in aquatic micro- and macro-flora & fauna affect the decomposition of organic waste and other pollutants. The loss of floodplain wetlands – due to diking and land conversion for agriculture – also caused a reduction in the intrinsic purification capacity of the river's aquatic ecosystems (Millennium Ecosystem Assessment, 2005) as well as its capacity to mitigate flooding.
- Degradation of the vegetation cover in deforestation and overgrazing areas causes a reduction of soil particle retention capacity, especially of fertile top soils, and increases the risk of landslides and mudflows, both affecting the volume of dissolved solids and the sediment load in the river water, as well as the capacity for vegetation regeneration. The erosion processes also result in irreversible losses of soil fertility, which will hamper any future vegetation restoration initiatives.

Although the valuation of ecosystem services is difficult, occasionally impossible and never undisputed, there is an increasing understanding that in the long run ecosystem degradation as a result of human developments results in a net loss of ecosystem services. This in turn will result in a net loss of income and additional costs for governments.

4.3.7. Socio-economic impacts caused by the problem to date

The degradation, fragmentation and destruction of ecosystems and biodiversity have a direct impact on the economic development in the Kura Ara(k)s basin. Ecosystem degradation affects the still widespread use of bio-resources, including grazing in alpine and subalpine meadows as well as natural plain grasslands, the gathering of edible & medicinal plants and berries, the use of timber, hunting & fishing, etc. These bio-resources are still important in supporting the economy of the basin countries, both for meeting the subsistence needs of the local community as well as supplying the agricultural, food and other productive sectors with raw materials.

Although the level of air, soil and water pollution decreased as a result of the reduction in industrial production volumes, the degradation of different ecosystems and species populations is ongoing. As such, ecosystem degradation is both an important consequence of the decreasing living standards of the population (Ministry of Nature Protection of Armenia, 2009) as well as a driver.

The risk of damage to human life due to flooding increased as a result of the deterioration and destruction of natural floodplains. Floodplains were widely transformed into agricultural fields, protected from the main streams by dikes and walls - infrastructure which deteriorated throughout the basin due to a lack of maintenance (German Ministry for Economic Cooperation and Development, 2010) – despite the beneficial flood regulatory capacity of constructed reservoirs, which reduced the risk of flooding by introducing the possibility to regulate river flow (UNDP/GEF, 2006). Because of the loss of the large floodplain areas, the remaining ones have become even more important refugia for flora, fauna and additional wetland services provided. The remaining floodplain has is insufficiently in surface area to effectively protect the surrounding and downstream watershed against floods and droughts (UNEP, 2009).

4.3.8. Causes of the problem

4.3.8.1. Primary causes

In the riparian countries' latest update reports to the UN Convention on Biological Diversity (GE-MEPNR, 2009a; AZ-MENR, 2010; AM-MNP, 2009), the immediate causes of ecosystems and biodiversity degradation were elaborated upon (Table 4.3.8.1). Summarizing the factual information presented in section 4.3.4, these causes remain in line with the previously identified major threats for the Caucasus Biodiversity Hotspot (Williams et al., 2009).

Table 4.3.8.1 Summary of immediate causes of ecosystem degradation as reported by the three Kura Ara(k)s river basin countries to the Convention on Biological Diversity.

Causes of ecosystem and biodiversity degradation	Armenia	Azerbaijan	Georgia
Destruction and fragmentation of habitats Land conversion for agriculture (including irrigation), infrastructure, urbanization, timber logging, mining, industry	X	X	X
Extensive use of natural resources: (Over)grazing, poaching, illegal trade of biological resources, water extraction, tourism & recreation; commercial & subsistence levels	X	X	X
Environmental pollution Water, soil, atmosphere, solid waste, hazardous waste	X	X	X
Introduced alien species	X	X	X
Climate change Water availability, natural disasters	X	X	
Natural pathogens		X	

Source: GE-MEPNR (2009); AZ-MENR (2010); AM-MNP (2009); USAID (2009b); USAID (2010).

The impacts of anthropogenic influence are more substantial on the forest, semi-desert and steppe ecosystems, as well as on the aquatic ecosystems (Ministry of Nature Protection of Armenia, 2009).

The **destruction and fragmentation of natural habitats** mainly refers to the direct transformation of natural areas into human-made cultural areas, as a result of which also the connectivity between natural landscapes is worsened, which affects largely on large mammal species. Key drivers are mainly larger-scale commercial development processes including land conversion for agriculture, especially irrigation structures, timber logging as well as the development of the mining industries.

The **excessive use of natural resources** refers to the increased pressure on ecosystems without completely destroying them or their functional characteristics and processes, as well as the services they provide to the community. Key drivers can be both large-scale commercial development processes, e.g. water extraction of irrigation, as well as activities currently supporting the local population with a subsistence existence – overgrazing, poaching of fish and wildlife, timber logging, etc.

Pollution is an immediate cause for the deterioration of water quality – its chemical as well as biological state. More information on this issue is presented in chapter 4.2 "deterioration of water quality".

No comprehensive information was available on the two other immediate causes of ecosystem degradation, **introduced alien species** and **natural pathogens**.

The Second National Communications of Armenia, Azerbaijan and Georgia to UNFCCC suggest that **climate change** will result in expansion of desert, semi-desert and arid sparse forest areas, with a vertical shift of their upper limits. Desertification trends are envisioned in all areas of Armenia and Azerbaijan, and some areas of Georgia. An upward shift of steppe ecosystems by as much as 250-300 m is expected, as is a consummate shrinking of meadow ecosystems (AM-MNR, 2009). Besides shifting in locations of ecosystems, also significant changes in their structure and composition will take place.

Notably the **change in hydrological flow** was not listed as an immediate cause for ecosystem degradation by the basin countries, according to the source literature listed with table 4.3.8.1. However, the alteration of the flow regime of a river has a demonstrable impact on e.g. the occurrence of extreme events - the extent of flooding, droughts, as well as related sedimentation and river hydromorphologic processes. As such, changes in hydrological flow directly or indirectly also affect biological characteristics and processes, e.g. fish spawning, pollution dilution & breakdown, food web alterations, species abundance and composition. Meanwhile the change in hydrological flow – variation and reduction – has strong linkages with two immediate causes already discussed: the destruction and fragmentation of habitats is one factor responsible for changing the run-off in the terrestrial part of the basin, including the changed balance between surface runoff and groundwater seepage. Also climate change is a factor of influence on hydrological flow, notably temperature changes which affect the evapotranspiration features in an area, as well as changing precipitation patterns.

4.3.8.2. Intermediate causes

The underlying cause to ecosystem degradation can be described as “unsustainable land, water and natural resources management practices”. It refers to the commonly applied segmented approach in planning and decision making on issues of land and water which impact on environmental conditions in the Kura Ara(k)s basin at all levels - policy making, executive planning and implementation. It refers both to the government as well as the private management sectors planning for economic development, but also to those public authorities and concerned parties actively working towards preserving ecosystems.

It also refers to issues of environmental conservation not being considered within segmented planning and decision making in all sectors as a result of a lack of information and understanding on the ecosystems’ functional characteristics and processes, and the values these have for mankind, also in economic sense. This in turn does not trigger a process of information gathering to fill knowledge gaps.

As a result, the valuation of economic benefits from services provided by ecosystems, and an honest assessment / comparison of costs-benefits of economic development activities hardly ever is completed. Complicating factor in these is that an unbiased, complete and verifiable approach and methodology to economic valuation of ecosystem services still has not been elaborated.

The segmented approach also leads to gaps and contradictions in legislation – laws, normative documents, etc. - and the related lack of a clear delineation of jurisdiction for enforcement agencies. It limits coordination and communication among institutions, possibly resulting in duplication of efforts and misunderstandings. It also leads to budget allocations for monitoring, research and solution solving to be typically insufficient to move forward, in valuation, awareness raising, demonstration of benefits and ultimately – basin-wide implementation.

The segmented approach also refers to transboundary cooperation between countries, in which the lack of cooperation hinders control of e.g. over-fishing, illegal trade natural resources (timber, wildlife) and the pollution of waterways, to name a few.

4.3.8.3. Root causes

The overall main threat causing ecosystem degradation - the disruption of ecological processes, the destruction, fragmentation and degradation of habitats (aquatic and terrestrial) and their natural flora & fauna diversity - is the ongoing development of economic activities throughout the basin, mainly since the 1950s (Yessekin, 2006). It refers to a focus on the direct short-term monetary benefits from economic use activities without taking the full costs, especially environmental/ecological costs, into account. Decision making overall is human-centered, focusing on maximizing economic profit, if not for personal benefit then for the wealth of the nation and its population.

The root cause for ecosystem degradation can as such be formulated as the lack of appreciation of ecosystem values, functions and services they provide to mankind.

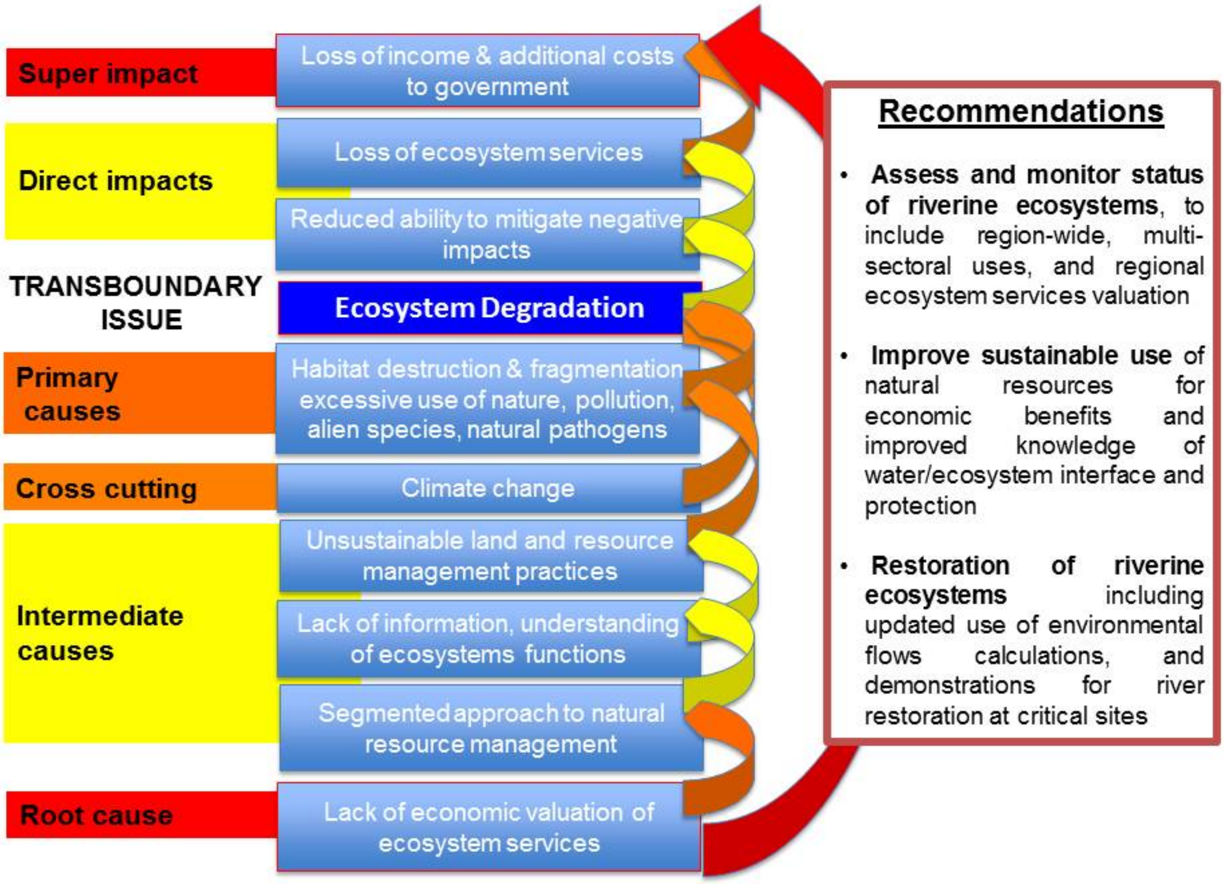
Population growth, urbanization – the enlargement of cities, towns and villages, development of related transport infrastructure – and the strive to increase wealth – personal or communal - appear to be overarching drivers of these issues.

At the rural subsistence level, present-day rural poverty and the related lack of access to alternative sources of food, fiber and energy remain additional underlying causes driving the processes of unsustainable land, water and natural resources management.

4.3.9. Causal chain diagram

Figure 4.3.9.1 presents the causal chain diagram for the transboundary issue "ecosystem degradation". It shows that the overall lack of knowledge, awareness and understanding of the role and functions of ecosystems and their biological components in providing the framework for human welfare in the end will lead to a loss of income, and additional costs for governments and the community at large to maintain the welfare gained by misusing nature's values.

Figure 4.3.9.1 Causal Chain Diagram for the transboundary issue "Ecosystem Degradation".



With water being a key linking factor between the lands in a river basin, addressing ecosystem degradation requires integrated water resources management plans to be implemented in all three countries, with common transboundary priorities negotiated between the riparian countries and all stakeholder sectors, to be implemented in a coordinated, transparent way. In order to strengthen the participation of ecosystems as the "silent" water user, specific attention needs to be paid to economic valuation of the services and functions provided by ecosystems, to be included in more comprehensive environmental impact assessment procedures, for decision makers being able to weight benefits and costs of development as well as conservation efforts in a more balanced way.

Intersectoral cooperation and planning for decision making pillars on a broad up-to-date information base on the characteristics and functional processes of ecosystems, their environmental boundary conditions – climate, soils, water - interacting to creating the enabling conditions for the ecosystems' biological components – flora and fauna. This information base needs to be generated and interlinked from the current patchwork of unlinked monitoring nuclei existing within sectors and the riparian countries. Special attention needs to be paid to filling gaps, data storage, information analysis & exchange as well as interpretation for decision making.

To successfully address ecosystem degradation, besides knowledge there is an urgent need to improve awareness and understanding, among government stakeholders, the private sector as well as communities, on ecosystem values and their benefits to mankind. Issues of special attention include the integration of water & land issues on the river basin level, the need for inter-sectoral cooperation, on the national as well as transboundary levels. Pilot initiatives introducing new promising approaches towards improving the use of natural resources or addressing adverse impacts of current water and land use practices, including e.g. constructed wetlands, river restoration, etc. is considered a suitable tool to create momentum for a shift in understanding and related decision making.

4.3.10. Cross-cutting issue – Future impact of climate change

Ecosystems in the Kura Ara(k)s river basin – already seriously stress due to uncontrolled economic developments as well as the subsistence-level use of natural resources – are envisioned to suffer further due to the forecasted changes in climate conditions in all three South Caucasus countries. As shown, primarily analyses forecast an overall increase in air temperature, causing related increases in evapotranspiration rates, and a general decrease of precipitation.

Key processes conditioned to occur in relation to climate change include the expansion of dryer ecosystems, from broadleaf forests to more open types in the mountainous regions, from steppes to semi-deserts in the plains, conditioned by precipitation changes. Forecasted changes in temperature will also steer a vertical spatial zoning component, with ecosystems shifting upslope in the predominantly mountainous region. Accordingly the top end ecosystems in the high mountains can only shrink. Shifting in ecosystems will include changes in the spatial distribution of biotic components, related to the expansion or shrinkage of their preferred ecological niche. As a result, species populations of "threatened" ecosystems may reduce, including already rare and endangered species, while species typical for expanding ecosystems may thrive.

4.3.11. Conclusions and recommendations

In conclusion, ecosystem degradation has shown to be a qualitative factor, its social, economic, political and environmental impacts largely unknown, due to the lack of proper understanding of the actual intrinsic variety of values provided by ecosystems to mankind, hence the lack of comprehensive inventory and monitoring.

Meanwhile, while climate change is ongoing and a factor of importance for the future, especially in the already water-stress environment of the eastern and southern Kura Ara(k)s basin, it is considered that the human-induced immediate threats, underlying threats and their root causes have at present an overarching impact on ecosystem degradation, considering also that climate change is an all-time feature in driving ecosystem development.

Habitat destruction, fragmentation and degradation in combination with the excessive and unsustainable use of natural resources have shown to be destructive forces for ecosystems in many parts of the Kura Ara(k)s river basin. Meanwhile however, the understanding is rising that ecosystem degradation comes at a cost to the unbridled economic development and well as subsistence level engagement with natural resources. Continued degradation of ecosystems due to the expansion of human activities while being exacerbated by climate change, the increase of extreme events of floods and droughts as well as the overall decrease in available water, will increase the costs to safeguards benefits gained by economic development, e.g. for flood mitigation, the provision of food & energy security, etc. Currently however, the amount, quality and reliability of information is by far insufficient to establish undisputed cause-effect relationships.

Recommendations emerging from the CCA and TDA overall on ecosystem degradation include:

Monitoring and assessment of the status of riverine aquatic ecosystems

Develop and implement national aquatic and riverine biological and environmental monitoring & assessment programs, interlinked at the regional level, including harmonized data collection, analysis and assessment, to be updated regularly: Without more up-to-date and complete information on the taxonomy on the flora and fauna of aquatic and riverine ecosystems specific to the South Caucasus region, it will be difficult to judge improvements and know where to target efforts for the long term sustainable management of riverine ecosystems. By taking steps to actively address gaps in current information on ecological processes, updating the biodiversity taxonomy specific to the basin, including a description of environmental preferences, and creating a shared database, the management of ecosystems at the local, national and regional levels can be significantly enhanced. This will enable ecosystem health and functions to be measured and improved upon. This will also contribute to the shared knowledge on impacts of developments interferences, to the economic valuation of ecosystems services, and to mainstreaming environmental impacts into sectoral planning processes.

Conduct economic valuation of ecosystem services in support of improved decision making and public awareness: Strengthening the mainstreaming of environmental protection into sectoral planning processes and expanding public interest in actively protecting the health of the ecosystem requires that information on how ecosystems function, the services they provide, and the economic benefits of these services are properly valued. State-of-the-art methodologies can guide how to more fully assess the value of the services, towards improving water management for multiple sectors. By conducting an economic valuation of ecosystem services for the riverine ecosystems in the basin, it will be possible to more accurately assess the actual impacts of development processes, and create positive incentives for protection of ecosystems.

Support the mainstreaming of aquatic and riverine ecosystem concerns into sectoral economic development (agriculture, hydropower, forestry etc.), by means of implementation support to National Biodiversity Action plans, intersectoral cooperation and planning, in line with the Water Nexus approach towards improved environmental security: Information on ecosystem functions and processes as well as the value of their services must contribute to the overall implementation of the sustainable development strategies targeting the improvement of the health of river systems, in line with international best practices. The use of the Water Nexus approach for multi-sectoral planning includes environmental security as one of four key elements, in addition to water security, food security and energy security. Improved resilience to the negative impacts of climate change, extreme weather events, water quality hazards, and variable flows can be addressed by the nexus assessment towards the development of basin strategy that mainstreams aquatic and riverine ecosystem management into multi-sectoral planning to ensure sustainable development.

Improved sustainable use of natural resources

Assessment and update of legal and policy mechanisms for the protection of areas of ecological significance to river system health: Protection of the ecosystems has not been a top priority for the region, as economic and political transitions have taken precedence for the past two decades. However, as these situations begin to stabilize and incentives for improved stewardship emerge both nationally and internationally, assessment and updating of these legal and policy mechanisms in line with the EU Directives will continue. Strengthening the protection of areas of ecological significance contributing to river system health will enable the countries to benefit from the services provided by these critical ecosystems.

Public awareness raising on the sustainable use of floodplain forest, wetlands, and riverine ecosystems, focusing on ecosystem services provided as well as the protection and use of endemic, migratory and rare flora and fauna species: Communities and decision makers at all levels can insufficiently appreciate the importance of the sustainable use of riverine ecosystems without a concerted effort to raise awareness of the benefits of services provided by ecosystems. Knowledge needs to be increased on means to sustainable manage resources at the community level with support from higher level governance institutions. A concerted awareness effort can highlight ecosystems services, their benefits and mechanisms for sustainable use with benefits to stakeholders for protecting them.

Strengthen EIA and SEA procedures towards a more complete, transparent assessment of development impacts on surface and groundwater, and aquatic and riverine ecosystem services and their values, for use in decision making processes on (sectoral) economic development: The best practices for implementation of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) in line the EU Directives and the Equator Principals applied by international financing institutions (IFIs) require that impacts on surface and groundwater resources and the riverine environment at large are considered in all decision making on development activities. Meeting these requirements is challenging when there is a lack of information, a lack of methodological procedures, and a lack of enforcement. Capacity building and improvement of formally endorsed assessment procedures at the national and regional levels will support improved understanding of and compliance with legislation, and support the long term sustainable management of resources.

Conduct demonstration projects on opportunities for mainstreaming river system biodiversity conservation and sustainable use of biological resources into economic development and production processes with public/private partnerships: Without incentives to change behavior, humans will continue to engage in unsustainable practices, unless they see clear benefits for adopting new behavior. It is critical to show incentives for improved mainstreaming of river system biodiversity conservation and the sustainable use of biological resources. These incentives can include economic development opportunities from sustainable production processes, using e.g. public/private partnerships. Demonstration projects may focus on local fisheries management, sustainable cultivation and harvests of endemic species following green industrial processing practices, as well as ecotourism development opportunities. These should include strategies for scaling up and replication based on sustainable use of natural resources, and economic costs and benefits, based on international experiences.

Restoration of Riverine Ecosystems

Assess, update and implement environmental flows in different sub-basins in line with international best practices, including flow assessment & design, legislative support, monitoring and enforcement: The use of bio-monitoring and rapid ecological assessment to assess environmental flows and impacts on ecosystem health has been tested in pilot sites by the UNDP/GEF project. The current approach in environmental flow calculations based on averaged information does not allow maintaining ecosystem health in line with international best practices and the EU WFD. Environmental flow monitoring and management, combined with rapid ecological assessment and bio-monitoring need to be expanded to additional sites and tributary basins to more fully document the state of river ecosystems and the relation to flow variation, to optimize aquatic ecological processes and improve river system health throughout the Kura Ara(k)s basin. Strengthening environmental flows is especially of importance as competing uses and trade-offs between sectors emerge, and climate change impacts become felt.

Implement river restoration plans at critical sites for improved ecosystem services, water supply and safety, to enhance surface and groundwater management in line with environmental security priorities: Degradation of riverine ecosystems at critical sites throughout the basin has significantly diminished the viability of many endemic, vulnerable and rare species, and devalued the services performed by these ecosystems. The loss of tugai forests, wetlands, floodplains and other unique riverine ecosystems may be repaired via a concerted effort to improve and revive ecosystem functioning, to the benefit of rare, endemic as well as migratory species, some of which may be commercially viable. Improved riverine wetland ecosystem functioning will also have positive impacts on water retention and flood peak reduction, improve water availability beyond the flood season and reduce flood hazards, As such, the design and implementation of river restoration plans will simultaneously encourage environmental security, food security and water security priorities for all countries throughout the basin.

4.3.12. Literature cited

AM-MNP Ministry of Nature Protection of Armenia, 2009. Fourth National Report to the United Nations Convention on Biodiversity Conservation: Armenia. 78 pp.

AM-MNP Ministry of Nature Protection of the Republic of Armenia, 2010. Second National Communication on Climate Change – a report under the United Nations Framework Convention on Climate Change, Republic of Armenia, Ministry of Nature Protection, Yerevan, Armenia, 2010, 134 pp.

AZ-MENR Ministry of Ecology and Natural Resources, 2010. Fourth National Report to the United Nations Convention on Biodiversity Conservation: Azerbaijan. 167 pp.

Caspian Environment Program, 2010. Caspian Sea – State of the Environment. Interim Secretariat of the Framework Convention for the Protection of the Marine Environment of the Caspian Sea and Project Coordination Management Unit of the “Caspeco” project, 102 pp.

CERF, 2004, Caucasus Ecosystem Profile.

FAO, 2010. Forestry country statistics (http://countrystat.org/for/cont/pxwebquery/ma/t06fo000/en)

GE-MEPNR Ministry of Environment and Natural Resources of Georgia, 2009a. Fourth National Report to the United Nations Convention on Biodiversity Conservation: Georgia. 94 pp.

GE-MEPNR Ministry of Environment Protection and Natural Resources of Georgia, 2009b. Second National Communication to the UNFCCC, Ministry of Environment Protection and Natural Resources of Georgia Tbilisi, Georgia, 2009, 240 pp.

GE-MEPNR, 2010. National report on the state of the environment of Georgia 2007-2009. Ministry of Environment and Natural Resources of Georgia, Tbilisi, Georgia, 213 pp.

German Ministry for Economic Cooperation and Development, 2010. Adaptation to climate change in the Kura Aras river basin – river basin snapshot. German Ministry for Economic Cooperation and Development – KfW Entwicklungsbank, September 2010, 46 pp.

Hannan T., H.J.L. Leummens & M.M Matthews, 2013. Desk study – Climate Change. UNDP/GEF project “Reducing transboundary degradation in the Kura Ara(k)s river basin”, Tbilisi-Baku-Yerevan, 2013, 72 pp.

IFAD International Fund for Agricultural Development, 2010. Republic of Azerbaijan – Integrated Rural Development Project, project design report. Volume 1 – main report, December 2010, 133 pp.

Imanov F., 2007. Water infrastructure of Kura river basin within Azerbaijan. International congress on river basin management, p. 99-105.

IUCN, 2011. Red list of threatened species, version 2011.2.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Washington, DC, 155 pp.

Negroni G., 2012. Inventory of spawning grounds in the Caspian States – country baseline survey of spawning grounds in Azerbaijan, Iran, Kazakhstan, Russian Federation and Turkmenistan. Draft final report, CASPECO Working Group on Spawning Grounds, UNDP/GEF Caspian Environment Program, January 2012, 93 pp.

Nikolaishvili D.A, L.G. Matchavariani & R.G. Maisuradze, 2010. Landscape changes of Georgia: estimation of an integrated parameter. International Journal of Environmental Science and Development, Vol.1, No. 2, June 2010.

OECD, 2012. Strengthening the economic and financial dimension of integrated water resources management in Armenia, Azerbaijan and Georgia – case study on the Kura river basin. Task force for the implementation of the environmental action program for Central and Eastern Europe, Caucasus and Central Asia, annual meeting, 24-25 September 2012, Oslo, Norway, 45 pp.

SEEC, 2007. Georgia: Strategic Environmental Assessment of Power Sector Development. South East Europe Consultants Ltd., Final report, December 2007, 252 pp.

Succow, 2009. Potential analysis for further nature conservation in Azerbaijan – a spatial and political investment strategy. Michael Succow Stiftung zum Schutz der natur, Greifswald, 2009, 162 pp

Tarkhnishvili D., 2006. Biodiversity and ecosystems of the Kura Aras river basin. TDA Thematic Report, UNDP/GEF “Reducing transboundary degradation of the Kura Aras river basin”, 32 pp.

Tarkhnishvili, D., A. Kandaurov and A. Bukhnikashvili. 2002. Declines of amphibians and reptiles in Georgia during the 20th Century: virtual vs. actual problems. Zeitschrift für Feldherpetologie 9: 89-107

UNDP/GEF, 2006. Diagnostic analysis of floods in the Kura Aras river basin. TDA Thematic Report, UNDP/GEF “Reducing transboundary degradation of the Kura Aras river basin”, 19 pp.

UNDP-SIDA, 2005. Preliminary background analysis of the Kura Aras river basin in Armenia. Yerevan, 2005, 136 pp. / Preliminary background analysis of the Kura Aras river basin in Georgia. Tbilisi, 2005, 177 pp.

UNEP, 2009. Water security and ecosystem services: The critical connection. UNEP Division of Environmental Policy Implementation, Nairobi, Kenya, March 2009, 56 pp.

USAID, 2009a. Biodiversity analysis update for Armenia. 196 pp.

USAID, 2009b. Biodiversity analysis update for Georgia. 89 pp.

USAID, 2010. Biodiversity analysis update for Azerbaijan. 83 pp.

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

Williams L., N. Zazanashvili, G. Sanadiradze & A. Kandaurov, 2006. An Ecoregional Conservation Plan for the Caucasus, 2nd edition. WWF Caucasus Program Office, May 2006, 225 pp.

Yessekin B.K, M.J. Burlibaev, V.P. Bogachev, E.A. Kreuzberg, V.V. Sadomsky & V.I. Sokolov (Eds), 2006. Conserving ecosystems of inland water bodies in Central Asia and the South Caucasus. The Central Asian Regional Ecological Center – Global Water Partnership for Central Asia and Caucasus, Almaty/Tashkent, 2006, 67 pp

Zazanashvili, N. and Mallon, D. (Editors) 2009. Status and Protection of Globally Threatened Species in the Caucasus. Tbilisi: CEPF, WWF. Contour Ltd., 232 pp.

ZOI Environment Network, 2011. Climate change in the South Caucasus – a visual synthesis. Geneva, 60 pp.

4.4. Flooding

4.4.1. Description of the problem

Flooding is a natural, climate-induced event, though is often exacerbated by human interference with the hydraulic characteristics of river channels, flow regimes or the runoff characteristics in the terrestrial watershed. High river flows become floods when the flow of water exceeds the capacity that can be contained within a river's natural banks. Immediate natural causes of flooding include a variety of factors. The primary factor is precipitation, mainly intense rainfall, while additional factors include concurrent snow melting, antecedent soil and land conditions, vegetation cover, and basin topography.

Though there are significant, long term benefits from flooding, including the enrichment of the soils on the floodplain, enhancement of conditions for fish spawning, and the renewal of wetlands, flooding is usually considered a hazard resulting in loss of human life and property, as well as damage to natural surroundings.

Flooding becomes a hazard to humans when people move into the floodplain and begin to carry out economic activities such as agriculture, and build their homes and other buildings in areas of high flood risk. Accordingly, previously existing wetlands, which in natural condition provide important flood absorption and mitigation services, are drained and destroyed, while the expansion of urban areas leads to increased concentration of surface run-off in paved and build urban areas, causing more frequent peaks in flow discharge. Human civilizations have always centered near water bodies, especially rivers, because they are a source of water and an effective waste removal system. They have accepted the risk of the more frequent, less damaging floods but have also adapted to them by confining their building and other activities to a safe distance from the hazard. However, as population pressures increase, people are forced to move into more flood prone areas, with ever-higher risks and vulnerabilities. The poor are often the most severely affected by flooding because they tend to live in the more vulnerable zones, closer to the river, and are also less able economically to recover from the ensuing losses.

With regard to larger, more damaging floods, people are unaware of the real flood risk because these floods are rare events, with return periods typically exceeding a human lifetime. Flood risks can also change with time as conditions in the watershed change and river courses are altered, both situations mostly due to interference by humans. Additional changing climate conditions also can alter flood risks.

Flooding is a natural and a recurring phenomenon. Floods are very rarely a result of anthropogenic causes alone, but there are many anthropogenic factors which worsen the magnitude and frequency of floods or which increase the hazard and the risk from flooding. Deforestation and overgrazing of the watershed, draining wetlands, urbanization, all are processes influencing the likelihood, frequency, magnitude and impact of floods. Construction projects which affect the flow regime or its hydraulic characteristics can also be more damaging. Ironically, flood protection barriers such as dykes, walls or other embankments often cause greater damage than would have occurred without them, specifically when the design parameters of the construction are exceeded by a particular flood and the land behind the protection works has become occupied by humans. Maintenance of flood protection structures is an issue, as poorly maintained structures tend to fail precisely when large floods occur. Reservoirs are often designed to protect from floods, but rarely this is their single objective. Most often, reservoirs are multipurpose by design, combining variations of irrigation, hydropower generation and flood control. But when other demands rise, the flood control objective tends to be forgotten, making the reservoir a risk factor in increasing flood magnitudes and damages.

Flood events and damages from them are features of the Kura Ara(k)s river basin, and Georgia, Armenia and Azerbaijan are all susceptible to flooding and the losses associated with them. Flood magnitudes, and therefore flood damages, tend to increase downstream, and floods in the Kura Ara(k)s basin are no exception, with the result that flood impacts in Azerbaijan tend to be greater.

Perhaps the worst flood in the region in recent years occurred in May 2010, when intense rainfall in the Kura Ara(k)s river basin caused major flooding in Azerbaijan, with the river rising to its highest level in 100 years, causing dam breaks and flooding of many riparian towns and villages. Hardest hit areas were the districts of Sabirabad, Imishli, and Saatli, near the confluence of the Kura and Ara(k)s rivers. The event affected more than 24,000 people, with tens of thousands of homes destroyed and 50,000 hectares of farmland inundated.

Mudflows associated with flooding are an added concern because they cause additional, usually permanent damages to the affected areas. Mudflows are mainly phenomena of the upper catchments where steep river slopes result in the high velocity water flows needed to carry high sediment loads. The word mudflow is misleading, because along with the mud also sediments ranging from sand-sized, to gravel-sized, to boulders the size of cars are transported. Mudflows typically are very damaging to property and to agricultural land because of the difficulty and cost of removing the mud, stone, rocks and other debris. The additional density of the flow also damages and destroys structures where water alone may not. While mudflows are not generally transboundary in nature, their impacts when associated with flooding increase the transboundary degradation for severe flooding events.

Mudflows have increased over the last few decades because of erosion from increasingly deforested and otherwise degraded areas in the river basin. Deforestation is one of the causes of flooding, as it reduces the natural ability water to infiltrate into the soil when it rains, to release that water again slowly into rivers in later seasons with groundwater outflow. The hydraulic forces of the floods themselves cause erosion of the banks and floodplains, further amplifying the force and amount of mudflows.

In a transboundary situation like the Kura Ara(k)s river basin, floods are a transboundary issue. Changes to watershed and hydraulic conditions of the channels upstream affect the actual flood characteristics as well as the flood risk and flood hazard downstream. Given that such many significant alterations have been made in all parts of the basin, part of the solution is addressing flood risk management as a regional, transboundary concern.

4.4.2. Transboundary relevance

In a transboundary river system, flooding becomes a transboundary issue where either a development in the upstream countries causes or worsens flood magnitudes or frequencies in downstream countries or the solutions for mitigation of flood damages are better with transboundary coordination and cooperation.

Such is the case in the Kura Ara(k)s river basin, where uncoordinated water resources development affecting the river and its watershed, are common. Upstream changes in land cover, including deforestation, overgrazing, alterations of the natural floodplain, urban development, and agriculture have all increased the risk of floods downstream. All three countries of the Kura Ara(k)s basin have made such changes, and accordingly the most effective approach to reduce flood risk and mitigate flood damages is therefore also found at a transboundary level.

Best practices in flood management include taking an integrated approach at the river basin level. The emphasis has also changed from relying on technical structures to protect flood prone areas to improved flood planning and management to prevent or minimize flood damages before they happen. Part of that approach is to incorporate flood management into the overall development planning process so that changes to the river or watershed in one part of the basin do not cause damage in other parts. In the case of the Kura Ara(k)s river basin, this requires a transboundary, basin-oriented, integrated approach to water resources planning and management.

An important part of flood management to mitigate damages, and especially to protect people from harm, is an early warning system. In a transboundary situation, warnings need to come from upstream countries as the antecedent conditions and other precursors to floods are detected earliest in the upper catchment. Establishing such a system will require cooperation and coordination among the countries involved in terms of planning the system, making joint investments in it and in its operation.

There is a considerable need for a shared knowledge base on the Kura Ara(k)s river system, and developing a transboundary early warning system can serve as a good platform for further cooperation on information sharing.

It is quite certain that climate change will further increase the flood risk in all three countries and flood management systems will be needed to minimize damages. A coordinated flood management system will be beneficial to all, as ideas for mitigation, approaches to planning, and overall costs can be shared.

4.4.3. Why the perception exists of this problem

That floods occur relatively frequently and may cause significant damage is a well-known fact in the Kura Ara(k)s basin and an issue of concern for the governments and their responsible ministries. Flood events are reported in the news, and usually contain anecdotal information on the damages caused, number of people affected, etc. People have become aware that floods are frequent and damaging events. However, information on flood frequencies and magnitudes and on actual flood damages in the basin is sporadic because it is not common practice to collect and maintain data on floods.

4.4.4. Factual evidence regarding the problem

The two most important types of information with regard to flooding are:

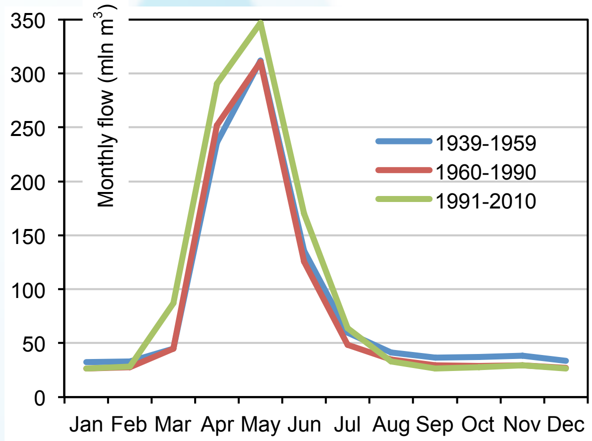
- Hydrology – the magnitude of flow in the river at the time of the flood.
- Damage and risk – the monetary value of the impact of the flood, or related proxy information.

As has been noted in the previous section, information on floods and flood damages in the region is sporadic. However, there is sufficient evidence which can be pieced together from various sources to show the reality of the flooding situation.

Throughout most of the region floods occur most often in late spring because they are generated by a combination of rainfall and snowmelt. The magnitude of the flood is the result of many variables, but rapid snowmelt due to high spring temperatures coinciding with intense rainfall are the primary factors. Hydrological data from the region confirms the spring as the high flood season (Figure 4.4.4.1).

Accurate information on the higher flood peaks is usually not available because the conversion from daily water level data (which is what is actually measured) to averaged flow values is imprecise due to the difficulties in establishing the level-flow relationship in extreme conditions. However, there is indicative, indirect information after the flood such as high water marks, and anecdotal evidence from people having witnessed the flood who can report on maximum standing height of the water, both of which provide a qualitative indication of the magnitude of the flood.

Figure 4.4.4.1 Average monthly flow in different periods at Khertvisi (Georgia).



Source: Data provided by the National Environment Agency, Ministry of Environment Protection of Georgia (2012).

In the upper catchments mudflows may be a feature of floods, with the higher velocity flows eroding river banks and beds and being able to carry high sediment loads. Mudflow floods are far more damaging than floods with clearer water, because removing the sediments left behind following the flood is costly and often impossible. Property in villages and especially agricultural land may be permanently damaged. Again, while there may not be specific monitoring data from the region on mudflows they are well documented occurrences, based on information from witnesses. They are also a well understood feature of floods in mountain environments with easily erodible surface geology, as is the case in the South Caucasus. Mudflows are greatly exacerbated by watershed degradation, and many of the upper catchment areas of the South Caucasus are greatly degraded.

Each country of the South Caucasus has areas affected by flooding and flood damages, as is evident in table 4.4.4.1. The table shows selected, large floods between 1995 and 2011 for which information is available. It does not cover the full extent of flood damages because many smaller floods go unrecorded. However, it does indicate that floods are a recurring and damaging problem, having affected almost 2 mln people with damages estimated at US$ 130 mln.

In 2010, the World Health Organization Regional Office for Europe (WHO-ROE, 2010) conducted a study on flood hazard in the South Caucasus. Their summary, reproduced in table 4.4.4.2, indicates the extent of the hazard. The same WHO-ROE study produced flood hazard maps for the three countries of the South Caucasus, presented later in this section.

While table 4.4.4.1 lists selected large floods, table 4.4.4.2 shows that more people inhabit areas with medium to very low Flood Hazard Intensity Level (FHIL). While neither of the tables provides complete information on flood damages and hazards, they do indicate that flooding is a significant problem in the region.

Table 4.4.4.1 Estimated damage from selected floods: Armenia, Azerbaijan and Georgia.

Country	Date	Affected № of people	Economic damage (x 1,000 US$)
Georgia	12-Jun-2011	1,750	n/a
Azerbaijan	4-May-2010	70,000	n/a
Azerbaijan	21-Sep-2009	5,000	n/a
Georgia	15-Jul-2004	n/a	2,156
Armenia	5-Mar-2004	n/a	n/a
Azerbaijan	16-Apr-2003	31,500	55,000
Armenia	22-Jun-1997	n/a	8,000
Azerbaijan	5-Jun-1997	75,000	25,000
Georgia	1-Jan-1997	n/a	19,500
Georgia	26-Apr-1997	300	10,000
Azerbaijan	5-Oct-1995	6,000	4,000
Azerbaijan	21-Oct-1995	2,800	n/a
Georgia	1-Jul-1995	300	2,200
Azerbaijan	15-Jun-1995	1,650,000	5,500
Totals (approx.)		**1,842,650**	**131,356**

Source: EM-DAT (2012); period 1995 to 2011.

Table 4.4.4.2 Flood hazard in the South Caucasus - people affected.

Flood Hazard Intensity Level	Armenia		Azerbaijan		Georgia	
	People	% Pop.	People	% Pop.	People	% Pop.
Very high	4,606	0.15	2	0.00	1	0.00
High	174,984	5.66	921,686	10.32	585,842	13.89
Medium	1,943,326	62.88	2,947,252	32.99	2,094,122	49.63
Low	169,170	5.47	545,740	6.11	440,389	10.44
Very low	798,293	25.83	4,519,248	50.59	1,047,271	24.82
Total	3,090,379		8,933,928		4,167,625	

Source: WHO-ROE, 2010. Information on methodology for the calculation of the Flood Hazard Intensity Level can be found at http://www.who-eatlas.org/methodology/Methodology_flood_hazard.pdf

Armenia

Armenia is one of the most disaster-prone countries in the southern Caucasus. The country is vulnerable to disasters due to both natural hazards, including earthquakes, droughts, floods, landslides, avalanches, mudslides, strong winds, snowstorms, frost and hail; and technological hazards, including transport and industrial accidents (GFDRR, 2010) (Figure 4.4.4.2).

Armenia's rivers discharge between 55% and 70% of the annual water volume during spring, during the snowmelt period (Figure 4.4.4.3). The mountain environment and the steep slopes of river channels provide for rapid runoff and high rates of flow often to become floods. When snowmelt is coincident with rainfall, the risk and magnitude of both flooding and mudflow increases dramatically. April to August is typically the most dangerous period for floods. Accordingly seasonal, damaging flooding is observed each year in almost every district in Armenia, but some districts are more susceptible. From 1994 to 2007 the Marzes with the highest cumulative incidence of floods were: Gegharkunik (159 floods); Lori (85); Shirak (72); and Aragatsotn (71) (SEI, 2009). According to the Ministry of Emergency Situations' Armenian Rescue Service, 20-30% of the country's territory is vulnerable for flooding and mudflows (SEI, 2009).

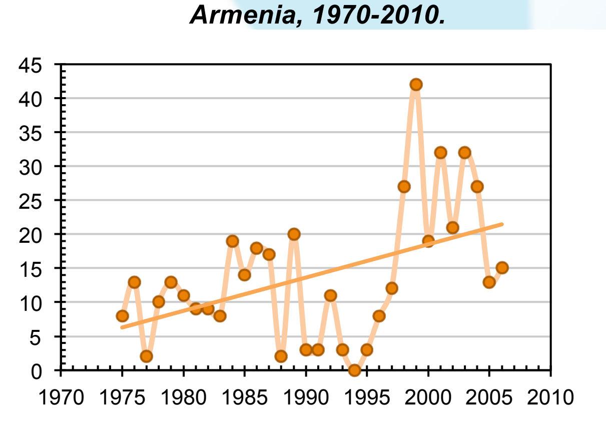
Large floods in 2004 caused an estimated damage of US$ 10 mln, while the 2005 flooding is estimated at US$ 5 mln. The single flood event of June 1997 affected 7,000 people and caused an economic loss of US$ 8 mln. The average annual loss due to floods is estimated at US$ 0.7 mln (GFDRR, 2010).

More than half of Armenia is susceptible to mudflow, especially the medium-altitude mountainous areas, but also the cities of Yerevan and Kapan. Between 2004 and 2007 mudflows damaged some 200 settlements and 600 sites on main transportation routes (WB, 2009). The GFDRR estimates that mudflow damages during this period amounted to US$5.7 to 7.1 mln (GFDRR, 2010).

Overall, given the intensification of anomalies with air temperature and atmospheric precipitation due to climate change, the occurrence of floods and mudflows has increased in the country during the last decade. Particularly, the damage caused by mudflows in 1994-2007 exceeds US$ 13.8 mln (5.6 billion AMD), and the damage caused by flooding for the same period amounts up to US$ 32.0 mln (13 billion AMD) (AM-MNR, 2009).

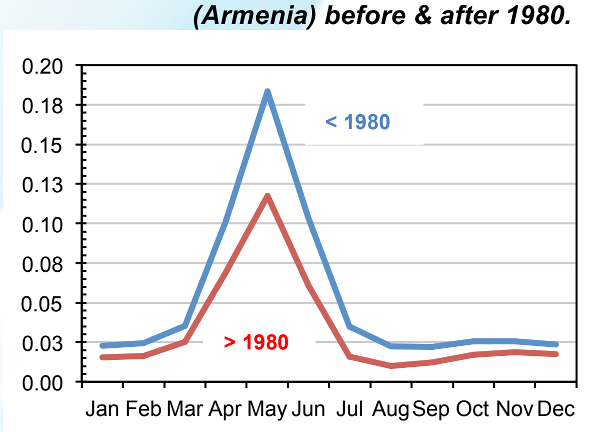
Meanwhile, figure 4.4.4.4 shows that the estimated FHIL for most rivers in Armenia is assessed as medium, while only some areas show a high FHIL and only a few areas a very high FHIL.

Figure 4.4.4.2 Occurrence of heavy rains in Armenia, 1970-2010.



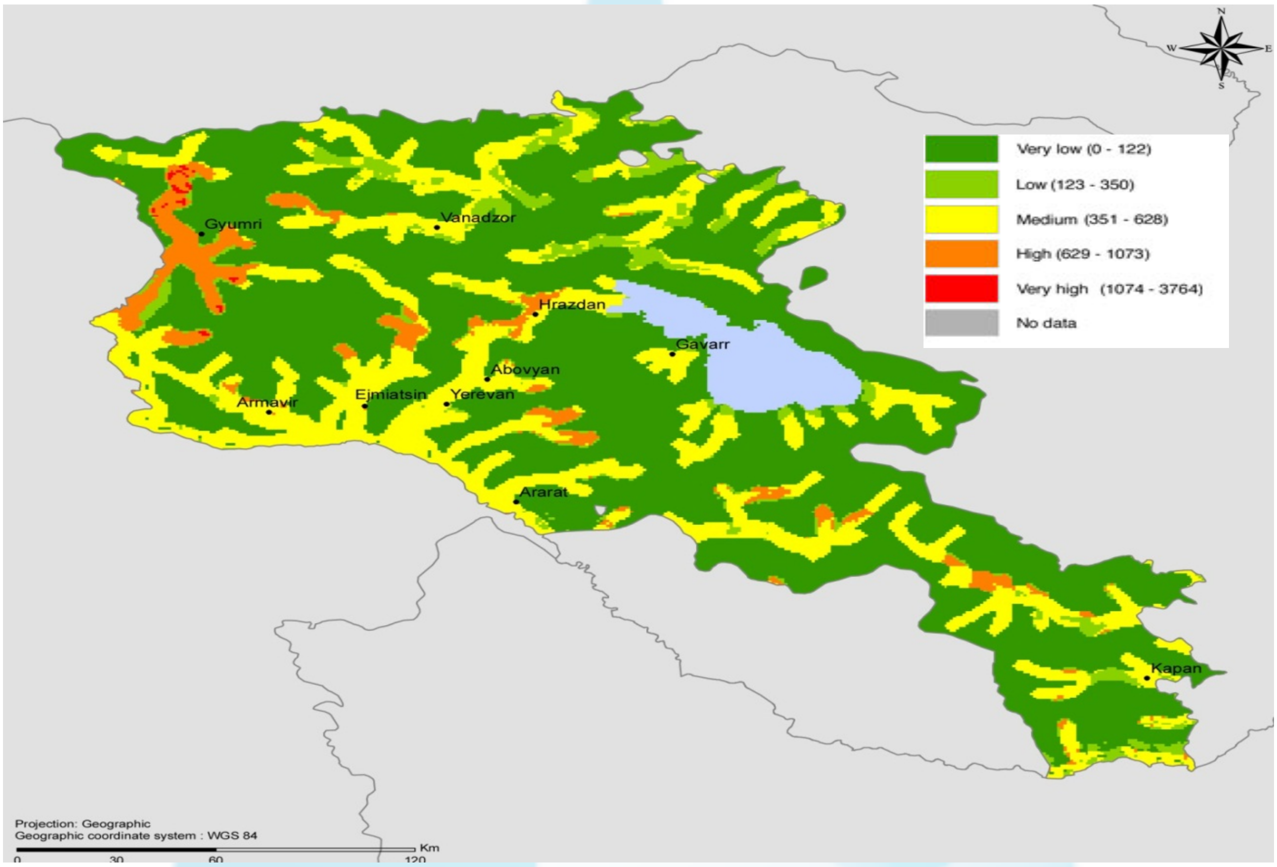
Source: AM-MNP (2010).

Figure 4.4.4.3 Average monthly flows at Areni (Armenia) before & after 1980.



Source: Hydro-meteorological Service Armenia (2012).

Figure 4.4.4.4 Armenia: flood hazard distribution map, 2010.



Source: WHO-ROE (2010).

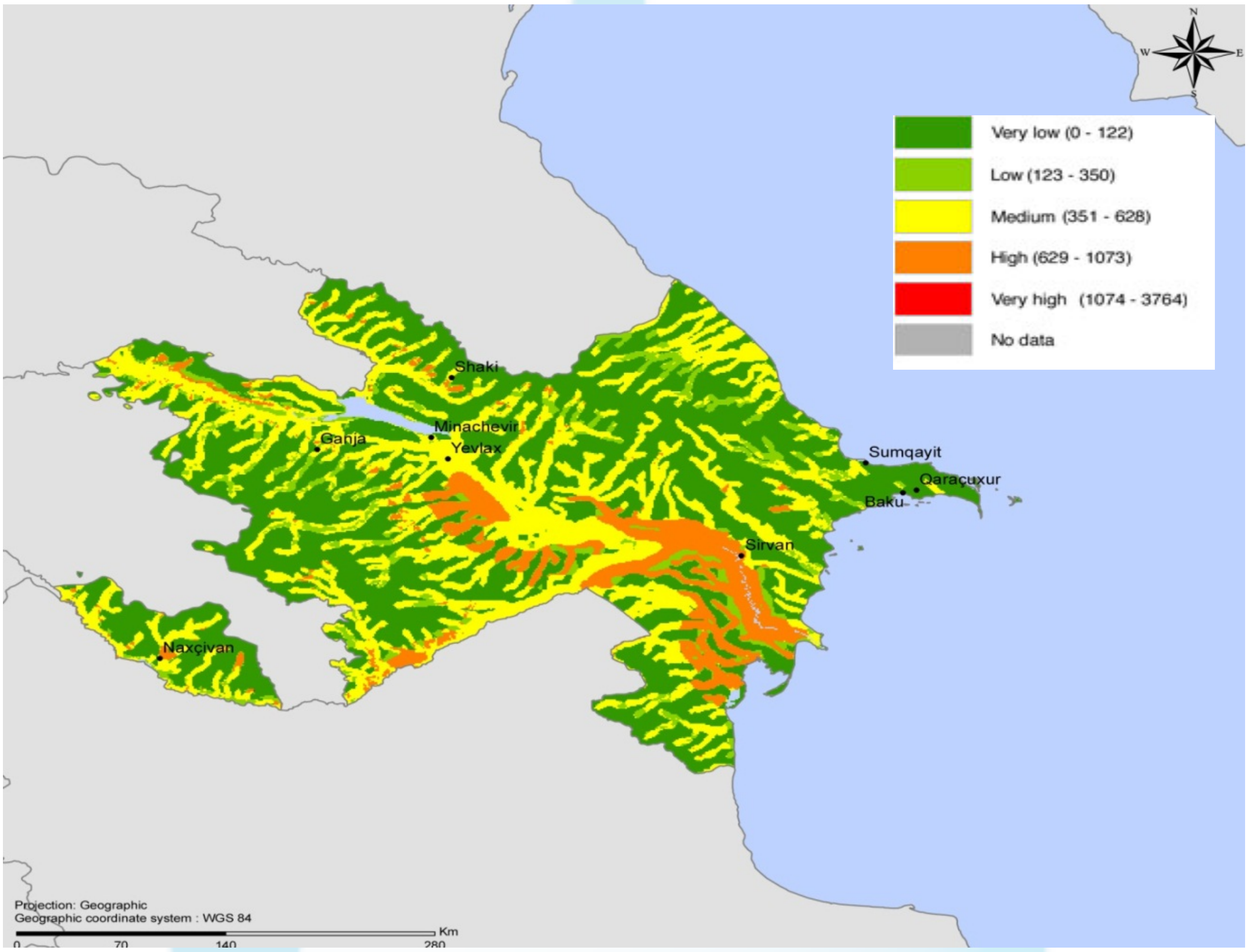
Azerbaijan

Floods and mudflows regularly affect large areas of Azerbaijan, in particular floodplains near the confluence of the Kura and Ara(k)s rivers and the steep alluvial plains along the tributaries. Figure 4.4.4.5, the FHIL map for Azerbaijan, confirms the high hazard for much of the downstream Kura Ara(k)s floodplain in Azerbaijan. The worst floods in Azerbaijan's Kura Ara(k)s river basin occur when the peak floods from the Kura and the Ara(k)s coincide in the lower Kura basin. The figure also shows high risks along the rivers discharging water from the northern slopes of the Lesser Caucasus mountains, as well as in the closed depression between the Kura Ara(k)s main river and the Caspian Sea (WHO-ROE, 2010). The volume of sediments each mudflow transports may reach between 0.2 and 1.0 mln m^3. A flood in 2003 caused over US$ 50 mln in losses and damaged over 7,150 private and public buildings. A 100-year flood event could impact 15,000 km^2, affect 300,000 people, and result in damages of US$ 396 mln (UNDP/GEF, 2011).

Perhaps the worst single flood event in Azerbaijan in recent years occurred in May 2010, when intense rainfall in the Kura Ara(k)s river basin caused major flooding in Azerbaijan, with the river rising to its highest level in 100 years, causing dam breaks and flooding in many riparian towns and villages. The hardest hit areas included the districts of Sabirabad, Imishli, and Saatli, near the confluence of the Kura and Ara(k)s rivers. The event affected as many as 70,000 people, with tens of thousands of homes destroyed and 50,000 hectares of farmland inundated. The average annual economic loss due to floods has been estimated to vary between US$ 5.7 mln (GFDDR, 2010) and US$ 18-25 mln (AZ-MENR, 2010).

The Mingechevir reservoir at least temporarily improved the flood situation in the Kura Ara(k)s lowlands, but floods still are still a regular feature. Anecdotal evidence indicates that before the construction of Mingechevir Reservoir (1953) and Shamkir Reservoir (1982) floods occurred every year during the snowmelt period, inundating large areas of land and settlements on the floodplain. Apparently the reservoirs reduced flood peak flows downstream, reducing the frequency of damaging flood events. This is likely the main reason why the reach of the river downstream of Mingechevir shows only a medium flood hazard rather than high.

Figure 4.4.4.5 Azerbaijan: flood hazard distribution map, 2010.



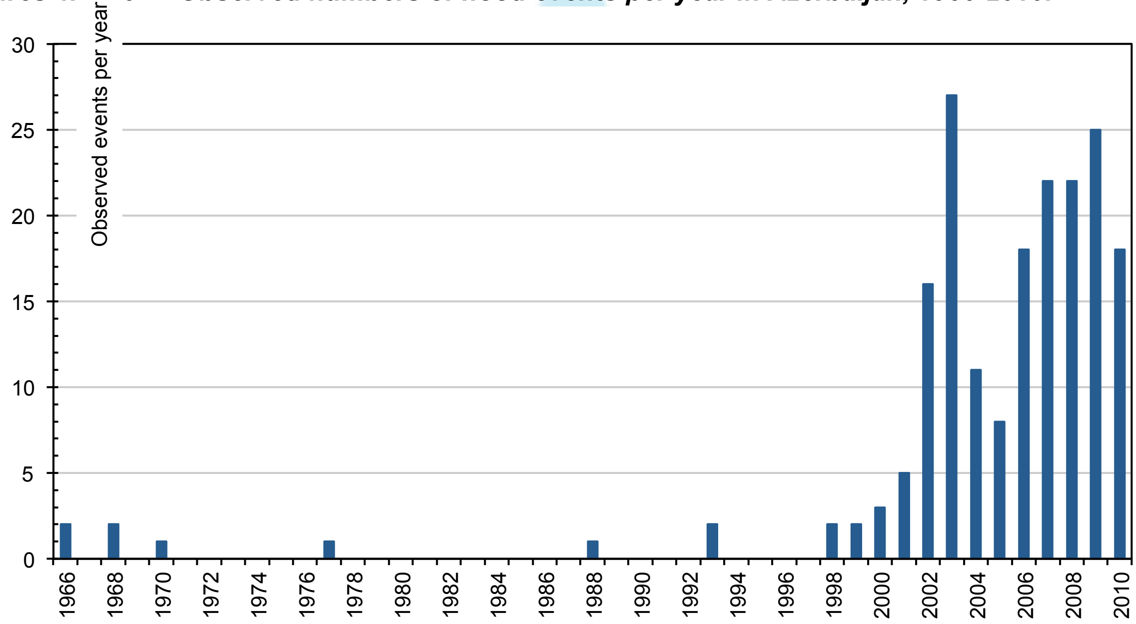
Source: WHO-ROE (2010).

Larger floods meanwhile are exacerbated on the delta, due to the significant increase in water levels in the Caspian Sea between 1977 and 1997, due to which sedimentation of the river bed increased (UNECE, 2004).

To protect the former floodplain lands developed into agricultural field from renewed flooding, protection works have been constructed along the lower sections of the Kura and Ara(k)s rivers, as well as in the Kura river delta. Currently there are some 1,800 km of flood protection structures, built by the Joint Stock Company Azerbaijan Amelioration and Water Economy (JSC AWE) (UNECE, 2010).

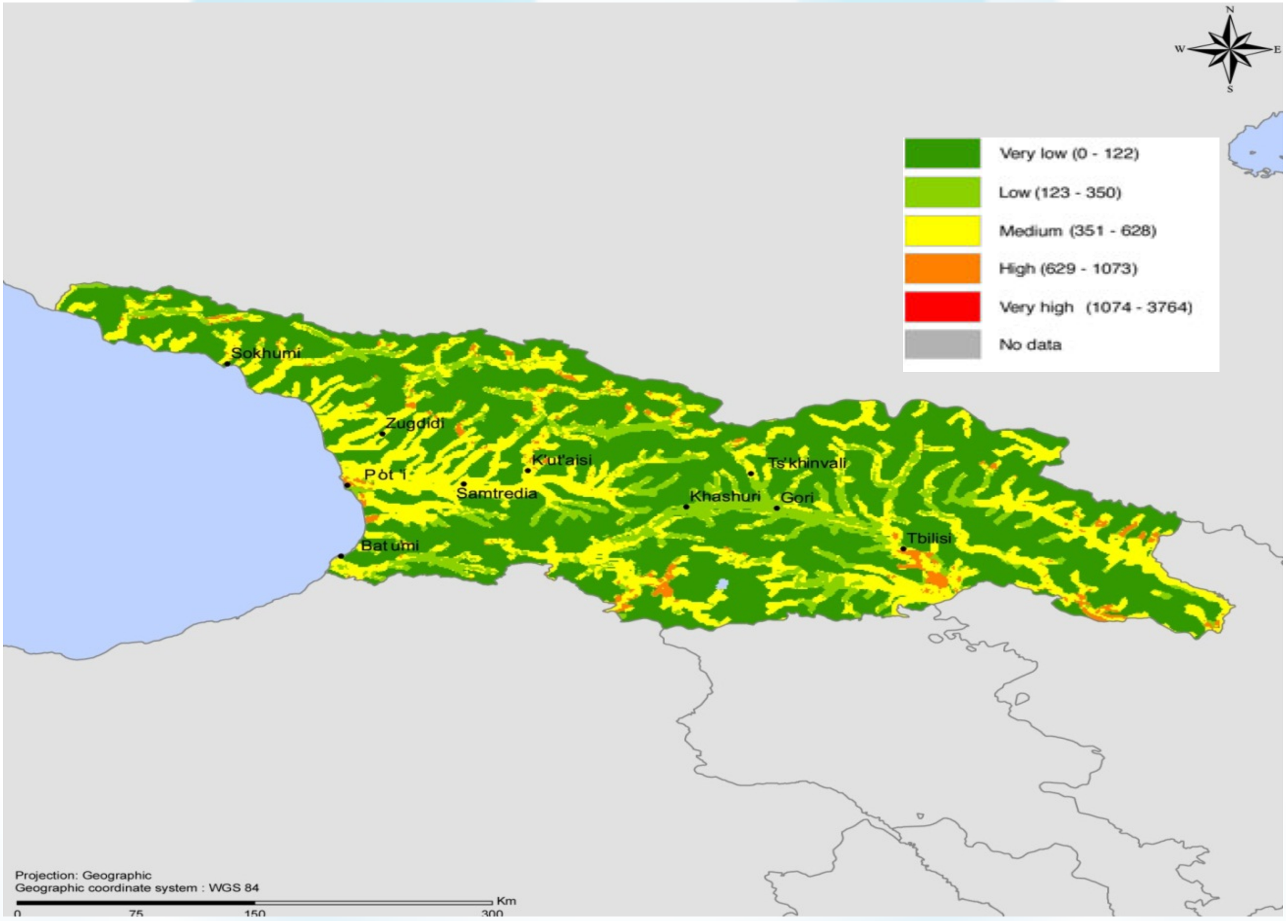
In the framework of preparing the SNC to the UNFCCC in 2010, an analysis on changes in flood frequency between 1966 and 2010 was completed. The results, presented in figure 4.4.4.6, show a dramatic increase in flood frequency in recent years. Probably also other variables other than climate change play a role, e.g. lack of coordination of discharge regulation, the deterioration of flood protection works (due to insufficient maintenance), but the strength of the trend shows that the risk of flooding and expected damage deserves serious consideration for the future. The Azerbaijan Government has moved responsibility for this to the newly formed Ministry of Emergency Situations that now oversees flooding prevention and management services, including reservoir management for the country.

Figures 4.   6   Observed numbers of flood events per year in Azerbaijan, 1966-2010.



Source: AZ-MENR (2010).

Figure 4.4.4.7   Georgia: flood hazard distribution map, 2010.



Source: WHO-ROE (2010).

Georgia

Flood events are frequent in Georgia. As is shown in Figure 4.4.4.7, Georgia's flood hazard is mainly medium, although some high hazard areas occur. - in upstream areas as well as related to concentrated human activities in rural districts, and the presence of widening floodplains within a (semi)mountainous environment. However, floods and damages do occur. The 1987 flood on the Lower Rioni River caused inundation of a vast territory, including human settlements, for a long period of time, resulting in some casualties and huge damage to the local agricultural sector. In 1997, the flood events in the Tbilisi-Gori-Kvemo-Kartli region killed 7 people, affected 500 others and incurred a reported economic loss of US$ 29.5 mln. In June 2005, the flood in the Mtskheta-Mtianeti region killed 1 person, affected 51 others and caused an economic loss of US$ 2 mln, mainly due to damage done to water supply systems and surface drainage systems in some towns, worsening the floods and contaminating water supplies. Over 300 homes were destroyed, and farmlands flooded, disrupting planting and the subsequent agricultural cycles. Livestock was also lost (UNISDR, 2007). On 13 May 2012, the flood in Tbilisi killed five people and caused several million dollars in damages (CENN/ITC, 2012). Between 1995 and 2009 the total cost of damage from floods amounted to over US$ 1 billion. The annual risk of economic losses caused by hydro-meteorological disasters, mainly floods, reaches US$ 4 bln. (UNISDR, 2007).

An analysis of floods and mudflows in Georgia was prepared by CENN/ITC (2012). Based on collected historical information, flood discharge analyses were completed for all hydrological stations in the country, and expected discharges for different return periods were calculated. Subsequent GIS modeling approaches were applied to complete a flood hazard assessment for water bodies, presented in map format. Results show that tributaries as well as the main Kura river as assessed as having a medium to high flood hazard.

4.4.5. Gaps in evidence

As any extreme event, floods need to be assessed on the basis of risk. Risk assessment of floods requires understanding of the relationship between the magnitude of the flood, the probability of a flood of that magnitude occurring, and the damage done by that flood. The result of a flood risk assessment analysis is a table of flood magnitudes, their probabilities of occurrence (being exceeded) and the damage caused by them, resulting in an 'expected damage' value which represents the present value of average annual damage. In order to plan for flood management, making investments in flood protection, establishing flood zones and zoning regulations, a flood risk analysis is necessary.

Most of the information needed for a flood risk assessment is not available in any of the three countries of the South Caucasus, which makes flood management and planning a difficult task. This may be part of the reason why flood mitigation tends to be focused on inefficient structural measures.

While river flow data are collected systematically, high flow information is not readily available, because of the difficulty in establishing the relationship between flow volumes and water level during extreme events. Still, reasonably good methods exist to estimate high flows, but they are not in regular use in the region.

In addition to gauging high flows, typically also the upper river basin tributaries are mostly ungauged, despite some of the most severe and most frequent flooding occurring in the upper reaches of the basins. Early warning systems rely on upper catchment information as this is where floods are triggered. Specialized meteorological equipment, most importantly rain gauges which measure storm intensity, is an intrinsic part of early warning systems. Some progress has been made in installing such equipment under international projects, but the coverage remains limited.

The other important type of information is flood damages. These are always estimates, largely based on anecdotal evidence, but by means of good post-event surveys a valuable database can be established over time. It is important to establish a transboundary integrated approach to post-flood surveys as early as possible, in order to elaborate the relationship between flood magnitude and flood damage, as especially the larger event tend to occur rarely. The magnitude-damage relationship is localized, meaning that each relationship is unique to a particular flood-prone area and is not generally transferable, so damage information must be collected by area.

Gaps in knowledge prevent the full assessment and comprehensive analysis of the impact and consequences of flooding. In summary, major knowledge gaps include:

- Reliable data on all issues related to flooding: river flows, meteorology.
- Information on flood damages and the socio-economic impacts of flooding.
- Information on environmental impacts from flooding.
- Information on changes in land use which affect flood magnitudes and damages, such as watershed degradation, deforestation, agricultural development, urbanization.
- Understanding the relationships between natural and anthropogenic causes of flooding.
- Data interpretation and sharing for flood risk assessment, flood forecasting and early warning.
- Understanding of functional flood-zone demarcation and associated regulations.
- The role of ministries and institutions involved in land use planning and flood management.
- Understanding of the value of and methods in total flood management.
- Absence of agreed institutional mechanism for information exchange between the riparian countries.

4.4.6. Environmental impacts caused by the problem to date

In nature, flooding is largely a beneficial process, a key driver of riverine ecological processes on the surrounding floodplain area. As riverine ecosystems are adapted to the natural flooding regime, even depend on it, the environmental impacts caused by flooding under natural conditions can be considered positive. In lowland areas, in addition to water, natural flooding of the terrestrial floodplain zone replenishes the area with water, sediments and nutrients beneficial to vegetation growth, which in turns supports a variety of fauna species, herbivores and carnivores alike. Natural overland water flow patterns in floodplains commonly create a highly diverse micro-topography giving additional support to an increased diversity of biological life, flora and fauna alike, as it increases the variety in niche habitats. Typically floodplains include a variety of aquatic habitats, as pot-hole lakes, oxbow lakes etc., in which an adapted community of micro- and macro flora and fauna thrives, depending on the regularity of replenishment with fresh flooding water.

In mountainous areas, flooding is more a neutral process, with flow velocities, volumes of water and the energy contained in it too high for any significant development processes in the adjacent floodplain, if present at all. However, under natural conditions the width of the flow channel is conditioned largely by topographical, geological and flow features, and the river assumes that specific width needed for the water capacity to pass. Accordingly, the river corridor is a 3-dimensional dynamically shifting longitudinal structure adaptive to higher and lower flows, subsequently conditioning all its other features. The river corridor being dynamic, it also supports reducing flood risks downstream, as the river has sufficiently lateral space to accommodate and retain high floods.

Flooding can be detrimental to established biological diversity, though. Severe flooding, with high sediment loads, has the capability to reset the successional ecological processes, through its impact on floodplain environmental conditions. Established vegetation communities can become covered with thick layers of fresh sediment, setting the community complexity back to pioneer vegetation, Floodplain water bodies may change their environmental characteristics – chemical composition, transparency etc., while populations of primarily terrestrial as well as aquatic species may be “reset” due to drowning, not being able to timely reach “safe havens”. However, maintaining the dynamics largely undisturbed will allow for the floodplain ecosystems to restore with time, if not at their current location, on any other in the vicinity.

The environmental impacts due to flooding may adopt a negative connotation when floodplains become subjected to significant human alterations and river flow, including flooding, becomes controlled. Ecosystems in the human-altered environment adapt to the new conditions, including the specific, installed flooding regime. Any significant breach of this regime may cause a serious negative impact on the established balance, which could be interpreted as “damage”.

Flooding may also distribute human-induced aquatic pollution to areas outside the river bed, contaminating the floodplain’s aquatic environment and flooded lands with dissolved pollutants and solid waste from upstream areas. This may also trigger processes of bioaccumulation in the higher food web layers.

In human-altered basins flooding is also instrumental to increased erosion. On land, high floods relate to high precipitation and/or intensive snow melting, which affect erosion of the topsoil, accelerated by habitat destruction, fragmentation and degradation, as well as the unsustainable use of natural resources. In the aquatic zone flooding will increase bank erosion processes. Overall the erosion products can be beneficial to downstream areas, providing sediments and nutrients, but also detrimental if loads are excessively large.

4.4.7. Socio-economic impacts caused by the problem to date

Floodplain areas have played a major role in the economic and social development history of most countries. This is evident from the high population densities in floodplains that have developed since historic times. People have always been attracted to rivers and floodplains because of the easy accessibility of necessary resources – water, fertile lands for agriculture, aquatic food products, etc. The continuous availability of many of these ecological services depends to a large extend on natural flooding being maintained.

At present, however the connotation of the word "flooding" largely is given a negative interpretation, associated with the occurrence of water where it shouldn't be, being it a (former) floodplain or any other area, bringing damage to human-altered conditions and systems, for living, production of food, etc. In occupying the floodplains, people have learned to cope with the risk of flooding, although especially larger floods can create serious impacts. But as population pressures increased, people were forced into areas with ever-higher risks from and vulnerabilities to floods. It is usually the poor who are most badly affected by flooding because they tend to live in the more vulnerable zones, closer to or further into the floodplain, and are also less able economically to recover from the ensuing losses.

Anthropogenic changes to the watershed and the river channels have an impact on flooding conditions which populations have difficulty adjusting to. While various human activities and socio-economic systems have different degrees of susceptibility or resilience to the impact of floods, usually people do not have an understanding of the link between susceptibility to flooding and any such changes, especially related to higher or more damaging floods. Accordingly, people do not act to avoid or reduce their risks. People do tend to expect governments to act on their behalf to protect them from flooding.

In the Kura Ara(k)s river basin, the socio-economic consequences of flooding include:

- Loss of human life and property, destruction of crops, permanent damage to agricultural land (where mudflows are involved), loss of livestock, destruction of important civic infrastructure, disruption to water & electricity supply, transport & communication networks, education and health care.
- Deterioration of health due to the spreading of waterborne diseases caused by the floods directly and through loss of water supply systems, and the disruption of access to medical care, which may cause short term and long term impacts on the health of the affected people.
- Loss of livelihoods as economic activities come to a standstill due to disruption of communication links and other infrastructure, which may take a long time to restore, leading to production losses in agriculture, industry, etc.
- High costs of relief and recovery, including initial emergency relief, the cost of relocation of people, rehabilitation of property, etc. Also the additional lost opportunity cost of this money not being used for other development plans should be taken into account. Frequent, large floods can significantly retard economic development as money is redirected to flood relief. Frequently recurrent flooding also discourages investment and development by the government and the private sector. Loss of resources can lead to high costs of goods and services, also delaying development.
- Political implications, in terms of public discontent and reprisals due to ineffective or inadequate responses by government agencies to relief operations and post-event rehabilitation and recovery.

4.4.8. Causes of the problem

Flood risk management is one of the primary and common concerns in all three South Caucasus countries. A Causal Chain Analysis (CCA) has been carried out to determine the primary, intermediate and the root causes of the transboundary flooding issue in the Kura Ara(k)s river basin. The casual chain diagram for flooding is presented in Figure 4.4.9.1.

4.4.8.1. Primary causes

Natural causes

The most immediate cause of flooding is entirely natural. In the region most floods are caused by the coincidence of high rates of snowmelt due to high spring temperatures and intense rainfall. Spring floods can cover a very wide area and therefore tend to cause the greatest damage on a national and regional scale.

There are also so-called 'flash floods' which are caused by intense rain storms and can happen at any time of year, though they are more prominent in the summer months because of terrestrial heating producing an unstable lower atmosphere and setting up conditions for intense rainfall generation. Flash floods tend to be more localized and, though damage may be extreme where they occur, they have less of an overall economic impact at the national and regional level.

Mudflows, which are commonly associated with floods in the South Caucasus, especially in the mountainous part of the catchment area, are caused by high intensity flood flows picking up sediments from the river bank and bed and carrying them downstream, depositing them when the force of the flood subsides as it reaches flatter areas in the lower floodplains. Mudflows can be very damaging, because the higher particle density of the flood wave makes that obstacles such as buildings are hit harder, inflicting greater destruction. Plus, the sediment and other debris deposited as the flood subsides is very difficult, even practically impossible, to remove, resulting in permanent damage to land, including valuable agricultural land.

Human-induced causes

Human activities generally do not cause flooding, but can increase the overall flood risk: flood magnitudes, frequencies and damages associated with them. These activities include: habitat destruction, fragmentation and degradation of the terrestrial watershed, mainly deforestation and overgrazing, leading to increased surface runoff and related erosion rates; alteration of the river channel; construction of dykes, flood protection walls and other forms of embankment; inappropriate operation of reservoirs; and poor maintenance of dams and other river channel constructions, increasing the risk of their failure during high flows. Human settlements and economic use encroaching on flood prone areas also increase the damages.

Changes in temperature and precipitation due to climate change

Analyses executed by Armenia, Azerbaijan and Georgia in the framework of their SNC to the UNFCCC showed that significant changes in temperature and precipitation were observed during the 2^{nd} half of the 20^{th} century.

While showing significant variation, conditioned by the highly variable topography and elevation of the South Caucasus, the region as a whole has experienced temperature increases between 0.5°C and 1°C (Hannan *et al.*, 2013), largely due to a rise in mean summer temperatures (June, July, August), while winter temperatures (December, January, February) varied around a stable mean. Also the rate of temperature rise has increased – in Azerbaijan the rise in mean annual temperature between 1961 and 1990 was 0.34°C, while the rise over the 10-year period 1991-2000 was 0.41°C, which is a factor 3 faster. A comparable trend has been observed for the summer temperatures in Armenia. The impact of temperature changes on flooding features relates through the watershed vegetation cover. Higher temperatures may lead to sparser vegetation in the lower topographical zones, while in elevated areas on the contrary vegetation cover may increase.

Changes in precipitation are more variable across the region, with an increase observed in Georgia, and decreases in Armenia and Azerbaijan, according to a northwest to southeast trend. Decreases in precipitation average between 6% and 10%, reaching as high as 17% in Azerbaijan. The changes in precipitation contribute to determining vegetation patterns in the watershed, which in turn define the water runoff characteristics.

Studies in the South Caucasus suggest an increase in extreme events. While region-wide comprehensive and integrated analyses remain to be completed, country data on past events during recent decades show in Azerbaijan a significant increase in flooding events (AZ-MENR, 2010), while in Armenia a trend of the increasing occurrence of heavy rains was observed (AM-MNP, 2010), among other extreme events. Meanwhile information seems to focus on post-factum observations and impact, rather than on inter-sectoral causal relationships, taking stock of changes in precipitation, watershed functional changes, etc. However, the response to the impacts will need to be the same regardless – strengthening the conservation and rational use of the available water resources.

4.4.8.2. Intermediate causes

Insufficient knowledge

While floods are a natural phenomenon, human interference in the natural balance of the river basin has a well-known and recognized worsening impact on flooding in terms of magnitude and frequency, and cause greater risk of flood occurrence and of damage incurred.

At the same time there is a widespread lack of knowledge and understanding on the features of the natural river flow regime, including high water flow hydraulics and flooding, on the environmental processes in the basin that generate floods and regulate their magnitude, as well as on the human-induced factors that contribute to the occurrence and significance of a flood.

The lack of understanding drives the implementation of structural changes – embankments, dykes, etc. - insufficiently adapted to the natural conditions at hand, without understanding the consequences with regard to flooding. Many structural changes, especially in-channel ones, alter the hydraulics of river flow, even more so during floods because of the high velocities and highly turbulent flow characteristics. Often, structures which are intended to protect a population from flooding at one location “transfer” the problem downstream, by increasing velocities through the protected reach of the river without sufficient energy loss mechanisms. As normally in downstream direction the volume of water further increases, the approach of “protection by increased discharge” at one location only further worsens flooding problems in downstream areas. As such, before any structure is designed, a complete analysis of the basin flow conditions is needed. This is normally done through hydraulic modeling, but requires accurate and sufficient hydrological and hydraulic information.

There is also limited knowledge of the ecological processes at work in floods, and the relationship between a river basin’s ecological and environmental features and the occurrence of floods. Floods are a natural phenomenon; complex in their genesis and spatial features, but analyzing floods on an ongoing basis leads to an understanding of that complexity and therefore leads to ideas for managing them. There is an increasing acceptance in the world that rivers, especially those with large inter-seasonal variation in flow volumes, require a certain spatial “working space” to discharge also high water volumes. For various reasons, human developments encroach into this riverine zone, largely unaware of the increasing risks related to this, whether at the current location or at any relevant downstream location.

Typically there is also a lack of knowledge and acceptance of the direct and indirect benefits provided by natural floods. Direct benefits include more lush vegetation for grazing, water for agriculture, fisheries resources. A direct benefit also is the reduction of flood peaks in downstream areas, as floodplains provide for flood water storage and reduction of flow velocities. Examples of indirect benefits include better opportunities for fish spawning, pollution abatement and nutrient replenishment, etc.

At present, in many flood-prone areas flood forecasting equations have been developed, which investigate the conditions which drive floods. Flood forecasting equations are developed over many years of experiencing and analyzing floods and are crucial in flood management.

Lack of pro-active planning and coordination

The lack of knowledge and understanding drives a commonly applied responsive approach to flooding - the focus on dealing with the ensuing disaster, rather than proactively tackling the issue at hand by planning ahead to minimize risks and damages. Planning ahead for a problem that is certain to arrive, and coordinating the implementation of response measures, results in far lower costs than cleaning up afterwards. Successful planning for flood mitigation requires cooperation between all stakeholders involved, both between national sectors as well as across borders in the transboundary river basin. On flood mitigation there is currently no coordination between the upstream and downstream areas of the Kura Ara(k)s basin.

A reactive management approach – or, the lack of understanding for the need of foresight in possible consequences of human actions – results besides in poorly designed structures also in poor maintenance of these structures. As typically these structures tend to fail during extreme events, because of the increased pressures inflicted, the damage done commonly is even greater in the very areas that they were intended to protect.

While not offering a solution to poor understanding and poor pro-active planning, one of the most effective responsive means towards minimizing flood damages is an early warning system. Early warning systems can take many forms and be relatively localized, such as in higher sub-basins, or be very extensive, covering entire large river basins, even transboundary river basins like the Kura Ara(k)s river basin.

4.4.8.3. Root causes

From an anthropocentric point of view, the root cause of high flood risk and extensive flood damages in the South Caucasus is the continued reliance on outmoded flood protection measures based on localized structural solutions rather than developing and implementing integrated national flood management plans, in which due attention is paid to interlinking measures at the transboundary river basin level. An effective flood management plan uses a combination of structural and non-structural measures to reduce the flood magnitude and frequency, where possible, and to mitigate flood damages.

Flooding is a complex process and a flood management plan needs to be multi-sectoral, needs to encompass aspects of law and policy, based on foresight and proactive responses - planning ahead for the eventually of floods and putting interventions in place before, during and after they occur. Institutions need to be coordinated to bring together information of hydrology and hydraulics, watershed land use and floodplain activities, property values, socio-economic factors, ecological conditions, and many more, both at the national as well as at the transboundary level.

Preparation and implementation of integrated flood management plans requires first of all an appropriate comprehensive understanding and acceptance of the cause and consequence of floods in relation to human developments. Subsequently, specialized knowledge, and therefore specialized training and education are required.

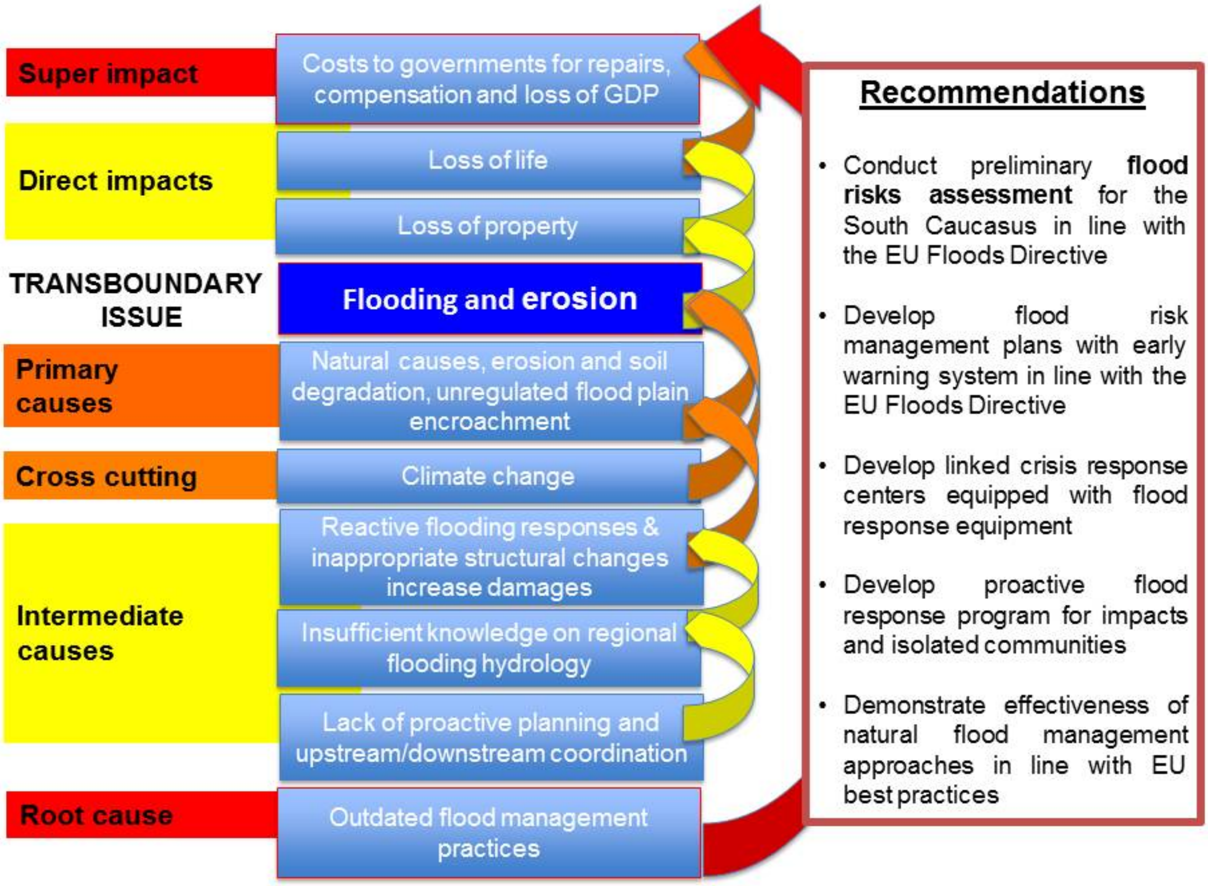
4.4.9. Causal chain diagram

Figure 4.4.9.1 presents the causal chain diagram for the transboundary issue “flooding”. It shows that the current reliance on outdated flood management practices, characterized by local, sectoral and largely structural actions to tackle risks of flooding, most commonly applying a response approach after damage has occurred, in the end will lead to additional costs for governments and the community to cover repairs, compensation payments and loss to GDP. Costs are also incurred because the outdated flood management approaches insufficiently take ecological benefits provided by flooding into account, resulting in loss of income, at the commercial as well as subsistence level, and additional costs are needed to provide for alternative source to deliver compensation services.

In the human-dominated society of the Kura Ara(k)s basin, flooding is intrinsically linked to overall water management, as such flood management should be linked with and integrated in national IWRM plans, with common transboundary priorities negotiated and agreed between the riparian countries and all their stakeholder sectors, to be implemented in a coordinated, transparent way.

Intersectoral cooperation and planning for decision making on flood mitigation needs to be based on first of all understanding and acceptance of the natural features of flooding, its processes on a basin-wide scale as well as the consequences of river flood characteristics for human developments. Increased understanding needs to guide the development of a comprehensive up-to-date information base on the watershed characteristics and functional processes of its ecosystems in acting to develop floods – climate, topography, geology & soils, vegetation cover, water flow. Information also needs to be included on the interactions between human activities in increasing or mitigating risks for flooding and incurred damages, with special attention to be paid to extreme events. Increased understanding and knowledge can guide a change in thinking from responsive action to informed pro-active decision making, based on cooperation among all stakeholders, sectors and riparian countries in transboundary river basins.

Figure 4.4.9.1 Causal Chain Diagram for the transboundary issue “Flooding”.



4.4.10. Cross-cutting issue – Future impact of climate change

While the information on climate change as a cross-cutting issue impacting on flooding frequency, magnitude and damage is limited, a variety of country analyses hint at ongoing intensification of climate-related extremes – temperature and precipitation, including flooding and heavy rain. Increases in frequencies and in magnitudes of flooding have been recorded across Europe and in many other countries. The widespread nature of this phenomenon is a serious indication that global climate change is at the root of it.

While in recent years an increasing amount of quantitative and qualitative information on flooding and related mudflows in the South Caucasus region became available, in terms of long term past trends on the number and frequency of events, the number of people affected, and the economic losses suffered, the majority of that information is post-factum impact oriented, not on comprehensive cause-effect processes.

Meanwhile, since the mid-twentieth century widespread human development activities have been realized in the Kura Ara(k)s basin – land reclamation for irrigated agriculture, including dams in and dykes along the rivers; the rise and fall of large industries, typically located on the banks of the rivers; hydropower generation; and others. All these activities have brought people closer to the river – into floodplains previously intentionally left uninhabited, onto river banks, while at the same time limiting the river in its spatial dynamics – forced into one main channel surrounded by dykes aiming to avoid overflowing, And all these activities increased the risk of flooding, interpreted as “impacting on human structures, lives and other values”.

Accordingly, separating the impact of climate change as a driver of increase flooding from the human development-driven impacts on river flow and flood regimes is currently not possible. Both processes are intrinsically linked and interwoven, at the basin level and globally, and insufficient information is available to untangle it. However, despite this, estimates reckon that, over the last 30 years, climate-related economic losses, either from natural disasters or from slower onset phenomena such as erosion, have totaled at least US$ 3.2 billion (UNDP/ENVSEC, 2011).

4.4.11. Conclusions and recommendations

The impacts of climate change exacerbate the already increasing challenges of flood management in the transboundary context. Human habitation and socio-economic development of flood-prone areas increase the likelihood that the costs of flooding will increase concurrently with the degree of flooding severity in coming years. Measures to address this on a basin wide level should be taken to reduce negative impacts to development. The use of more sustainable and environmentally beneficial approaches to flood management would serve to reduce negative impacts, reduce costs and improve conditions. As the countries of the South Caucasus move to align national policies with the EU, including the EU Floods Directive, there is potential to shift to more effective and lower impact strategies for flood management. Additionally, as flooding is part of the naturally occurring hydrological processes of the river basin, harnessing the beneficial aspects through water storage via updated approaches linked to natural flow patterns has potential to provide not only environmental benefits but socio-economic benefits as well. Further, as is suggested in the EU Floods Directive, development of coordination between riparian countries also serves to improve responses and enables proactive management strategies to be employed in order to reduce the severity of negative impacts of flooding events. The EU Floods Directive states "Flood prevention, protection and mitigation' sets out its analysis and approach to managing flood risks at Community (transboundary) level, and states that concerted and coordinated action at Community (transboundary) level would bring considerable added value and improve the overall level of flood protection." (Para.5 Introduction, EU Floods Directive).

Based on the experiences and issues related to flooding events, especially in light of increasing severity of local and regional impacts due to climate change, the following recommendations have emerged for reducing the hazards of floods, to assess status and develop improved measures in line with the EU Floods Directive, link crisis response centers, demonstration measures for reduced impacts and empowerment of local communities:

Conduct a preliminary floods risk assessment for the South Caucasus, including flood hazard and flood risk mapping in line with the EU Floods Directive: Based on observed trends, increasingly severe flooding events are expected throughout the region, and the existing flood protection infrastructure is often in poor repair, putting communities at risk locally and potentially regionally if severe conditions persist. Knowledge on the current status of flood protection infrastructure needs to be updated throughout the region in order to most accurately target resources and minimize the most severe damages, and flood hazard maps and flood risk maps for the wider basin should be developed as a tool to best understand where actions are needed. The EU Floods Directive provides guidance on this and while working at the wider basin level, tributary basins should also be considered (Chapters 2 and 3, EU Floods Directive).

Develop flood risk management plans including early warning systems for national and transboundary areas in line with the EU Floods Directive: Flood risk management plans should include agreed objectives to reduce negative impacts on human life, human health, the environment, cultural heritage, and economic activities. They also should include cost and benefits calculations; descriptions of flood extend and flood conveyance routes as well as areas with the potential to retain flood water during high flows, such as natural floodplains; spatial plans for soil and water management, land use, and nature conservation. These should also address prevention, protection, preparedness, including flood forecasts and early warning systems (Chapter 4, EU Floods Directive).

Strengthen linked crisis response centers for flood hazard mitigation equipped with flood forecasting capacity and response equipment: Flooding in the wider Kura Ara(k)s basin results in significant transboundary impacts, including the loss of life, loss of property and isolation of communities, as communication and transportation infrastructure are damaged. Development of linked crisis response centers for flood hazard mitigation, equipped with the technical means for flood response, may be able to reduce the impacts of flood events and in extreme cases provide support to neighboring communities in transboundary areas. Linking these crisis response centers across the basin also increases the opportunity to share information, lessons learned, and best practices.

Develop community action plans for flood responses, and train the local communities in most vulnerable areas: In many remote areas of the region communities become isolated when severe flooding events occur, because of disrupture in infrastructure, communication and response capabilities. These communities often suffer due to this isolation, and commonly assistance is available only when the crisis has passes. Empowering local communities in high-risk areas to develop community action plans for flood mitigation and flood response, including training in basic medical practices, impact prevention, and community safety measures, and training residents on emergency procedures in case of a severe flood event creates a pro-active basis for self-support. As such, the local impacts of flooding will be reduced, the transboundary impacts will be increased resilience of vulnerable communities across the basin, with potential for sharing experiences, lessons learned, as well as for providing direct support to neighboring areas across borders.

Conduct demonstration projects to reduce flood severity by developing floodplain buffer zone rehabilitation plans, implemented at key pilot sites: The benefits of natural flood management strategies can be counterintuitive to those who have been negatively impacted by raging waters or sought to prevent the loss of life that can be associated with extreme events. However, using natural flood management can be beneficial as a way to work with nature instead of against it. The EU Floods Directive states "Flood risk management plans should focus on prevention, protection and preparedness. With a view to giving rivers more space, they should consider where possible the maintenance and/or restoration of floodplains, as well as measures to prevent and reduce damage to human health, the environment, cultural heritage and economic activity." (Introduction, paragraph 14). A set of demonstration projects at key sites can serve as a model for this approach throughout the basin with benefits for local communities as well as regionally as flood risk management plans are developed, implemented and updated within the wider Kura basin.

4.4.12. Literature cited

AM-MNPR Ministry of Nature Protection of Armenia, 2009. Vulnerability of water resources in the Republic of Armenia under climate change. Ministry of Nature Protection of Armenia, Yerevan, 27 pp.

AM-MNP Ministry of Nature Protection of the Republic of Armenia, 2010. Second National Communication on Climate Change – a report under the United Nations Framework Convention on Climate Change, Republic of Armenia, Ministry of Nature Protection, Yerevan, Armenia, 2010, 134 pp.

AZ-MENR Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, 2010. Second National Communication to the United Nations Framework Convention on Climate Change, Ministry of Ecology and Natural Resources of Azerbaijan, Baku, 2010, 85 pp.

CENN/ITC, 2012. Atlas of natural hazards and risks of Georgia. Caucasus Environmental NGO Network / Faculty of Geo-Information Science and Earth Observation ITC, University of Twente, the Netherlands, 2012, Tbilisi, April 2012, 124 pp.

EM-DAT: The OFDA/CRED International Disaster Database on 19.1.2012, www.em-dat.net - Université Catholique de Louvain - Brussels – Belgium, www.emdat.be

GFDRR Global Facility for Disaster Reduction and Recovery, 2010. Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI) - Risk Assessment for Central Asia and Caucasus Desk Study Review, 172 pp.

Hannan T., Leummens H.J.L. & Matthews M.M., 2013. Desk study – Climate Change. UNDP/GEF project "Reducing transboundary degradation in the Kura Ara(k)s river basin", Tbilisi-Baku-Yerevan, 2013, 72 pp.

UNISDR, 2007."Central Asia and Caucasus, Disaster Risk Initiative – Risk Assessment for Central Asia and Caucasus".

SEI Stockholm Environment Institute, 2009. The socio-economic impact of climate change in Armenia. UNDP Climate change impact assessment project, UNDP Armenia – Ministry of Nature Protection of Armenia, Yerevan, 139 pp.

UNDP/ENVSEC, 2011. "Regional Climate Change Impacts Study for the South Caucasus Region.

UNDP/GEF, 2011. Integrating climate change risks into water and flood management by vulnerable mountainous communities in the Greater Caucasus region of Azerbaijan, 2011

UNECE, 2004. Environmental Performance Review Series No. 19, Azerbaijan

UNECE, 2010. Environmental Performance Review Series, Second Edition, Azerbaijan

WHO-ROE World Health Organization Regional Office of Europe, 2010. The WHO e-atlas of disaster risk for the European region, Volume 1 – exposure to natural hazards, version 2.0. www.who-eatlas.org/europe/

World Bank, 2009. Disaster risk reduction and emergency management in Armenia. World Bank, Europa and Central Asia region, Global facility for disaster reduction and recovery "Armenia: Institutional arrangements for disaster risk management and reduction", October 2009, 59 pp.

5. LINKAGES, COMMONALITIES, BARRIERS AND OPPORTUNITIES

There are linkages between the four major transboundary issues that are the focus of this Updated TDA. These linkages are important to understand in order to target interventions that can be most useful and successful. These linkages are also complimented by common and shared causes that impede improvements to the situation under the current conditions. Some of these conditions are both structural and physical which cannot be overcome by interventions at this time. Identification and acknowledgment of these barriers will be key to focusing efforts on the opportunities that also exist to reduce the transboundary degradation of the Kura Ara(k)s River Basin.

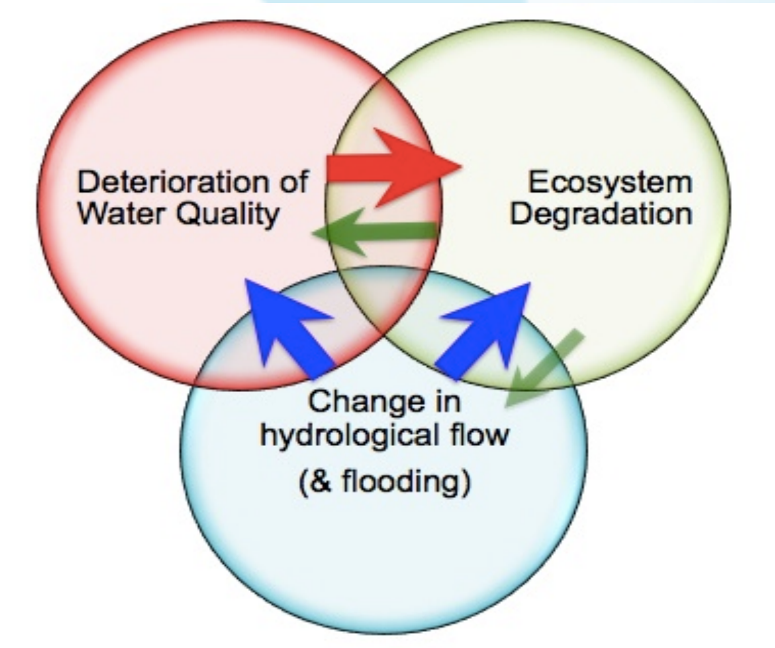
5.1. Linkages between problems

As noted throughout the causal chain analyses for each of the transboundary issues, there are often overlaps between issues, as well as impacts of one of the issues on the others. The complexity of these issues is common in ecological systems where dynamic interactions lead to shifts in natural conditions. In the causal chain analyses the relationship within the issue are analyzed, however there are the relationships **between** the issues that must be considered here.

The diagram in Figure 5.1.1 provides a graphic representation of the impacts that the transboundary issues have on one another. The addition of flooding to the change in hydrological flow is because it is not an everyday issue, but rather a sporadic event, and in its impact on the other issues behaves closest to the changes in hydrological flows. The arrows between the circles indicate the impact relationship. The color of the arrow corresponds to the impacting issue, it points to the issue receiving the impact. The size and the transparency of the arrows reflect the strength of the impact.

The relationship between change in hydrological flow (and flooding) and deterioration of water quality is a strong, uni-directional relationship. The decline in water resources – less water in the river - results in a concentration of pollutants in the water. In the event of flooding, water quality is negatively impacted because of the overflow of systems such as tailing ponds for mines, sewage systems, and agricultural fields, from where land based source and non-point source pollutants are washed into the river system. In contrast, the deterioration of water quality does not have an impact on changes in hydrological flow, nor on flooding. Large debris in the river may impact flooding, however that is beyond the project scope for "deterioration of water quality".

Figure 5.1.1 Relationships between transboundary issues.



The relationship between deterioration of water quality and ecosystem degradation is more complex and interdependent. This was defined in the causal chain analyses but deserves additional attention here, as these linkages are quite important when considering remediation efforts.

As indicated in Figure 5.1.1 the stronger of the two impacts is the negative impact of water quality deterioration on the ecosystems, which results in ecosystem degradation. This includes poor quality water reducing the capacity of the river system to function optimally. Various flora and fauna within the river system that are beneficial and widely diverse are not able to thrive in poor water quality. Additionally, the poor water quality leads to an increase in species that are more tolerant, which creates balance shifts within the ecosystem. Poor water quality also negatively impacts the ecosystem conditions on land, especially when irrigation of fields uses this water. The soil conditions degrade in this case, reducing the ability of terrestrial life, from soil microbes to mega-fauna, to thrive. This also negatively impacts beneficial insect populations responsible for pollination and natural management of pest populations. The ecosystem balance is seriously jeopardized by the deterioration of water quality.

The impacts on water quality from the ecosystem being out of balance as described above leads to the decline in the natural ability of the ecosystem to absorb pollutants. Persistent organic pollutants are not soluble within the river ecosystem in any case, but soluble pollutants, including excess nutrients and sewage, can be broken down by a healthy, robust ecosystem, when the pollution loads are not excessive. Degraded ecosystems, with a decline in species biodiversity, lacks this regenerative potential and therefore the conditions in water quality worsen instead of improve. Additionally, when the ecosystem is degraded due to overgrazing or deforestation, there are fewer terrestrial barriers to retain runoff from the land into the river system, also resulting in a notable decline in water quality. This impact also leads to a decline in groundwater recharge, reducing the natural filtering abilities that improve water quality, and even a decline in groundwater quality due to loss of valuable ecosystem services within the soils and the wider ecosystem.

The relationship between change in hydrological flow and ecosystem degradation is much stronger and direct, with hydrological flow impacting on ecosystem degradation. The relationship in the other direction is relevant, but much weaker. A change in hydrological flow, especially a reduction in hydrological flows, negatively impacts ecosystems, with less water available for riparian species. The decline in water availability results in drier soil conditions, negatively impacting floodplain forests, wetlands, and related areas. The lower reaches of the Kura and Ara(k)s basin are characterized by a meandering profile, which is a natural process of energy loss typical of channels where river basin slopes flatten. The process of meandering typically results in the many oxbow lakes, as seen in the lower Kura and Ara(k)s. These oxbow lakes, now disconnected from the river system except at high flows, play an important role in the ecological balance of the basin. A decline in hydrological flow further isolates these lakes, and results in lower levels of biodiversity richness. The impact of hydrological flow reduction also negatively impacts soil fertility, which reduces the ability of beneficial endemic species to flourish, and the ability of ecosystems to maintain a healthy dynamic balance. Severe flooding degrades ecosystems because of the high erosion they cause leading to carrying away soil nutrients.

In comparison, the conditions created by ecosystem degradation, including overgrazing and deforestation, have negative impacts on hydrological flow. The main impact is that there is less of a natural buffer created by grasses and other vegetation to slow and retain surface flows when there is excess water after rainfall. As a result, there is less opportunity for groundwater recharge to occur, which negatively impacts on the hydrological flow during the dry season. Deforestation leads to the loss of benefits from shade, enhanced ground cover, root systems and the water percolation capacity of soils. When these changes occur there is a significant impact on groundwater and river system health, including the hydrological flow.

The relationship with regard to flooding is equally serious. When flooding events occur in a degraded ecosystem, the natural buffering capacity of the riparian ecosystem cannot be optimally used. The ability for the ecosystem to deter flooding declines with ecosystem degradation. When the degradation is caused by overgrazing, floodwaters sweep through low lying areas and cannot be absorbed into the soils. When degradation is caused by deforestation, the potential for severe problems as a result of flooding increases significantly because of associated landslides, mudflows and severe erosion. This cyclical relationship between flooding and ecosystem degradation leads to each condition negatively impacting the other in a downward spiral.

In all cases the causal relationships must be observed and carefully identified separately from apparent correlations. Therefore, as noted within the previous chapters, it is important to determine what is actually causing each problem. The causal chain analysis provides this understanding to a degree, but it is recognized that information is currently not complete in many areas and, as a result, it is critical to acknowledge that imperfect information may result in imperfect solutions. It is also important that solutions address the problems they intend to solve without creating additional negative impacts. Strategic environmental assessments provide a tool for selecting appropriate solutions that should be employed wherever possible.

5.2. Common causes for transboundary issues

As noted above, there are correlations between transboundary issues and some degreed of causality as well. Within the causal chain analyses there are several common causes that arise which, if addressed, may be able to resolve some aspects of these issues, and similarly improve conditions of linked issues. The common causes are those which, if resolved, could widely benefit the wider region and reduce the degradation of the Kura Ara(k)s river basin. These common causes are:

- **Lack of information that is reliable and useful to decision makers:** The lack of reliable information, presented in a way that makes it useful to decision makers by clearly explaining the relevance of the information, results in unnecessary costs for decision makers and ecosystem monitoring that does not adequately serve its intended purposes.
- **Lack of economic value to water resources and water quality:** Decision makers need to know the economic costs and benefits of water management, including water quality management. In order to justify allocation of limited government budgets to water resource management, verifiable information on conditions, the economic evaluation of the status quo, and the recommended improvements will enhance the decision making for stronger environmental management.
- **Lack of valuation of ecosystem services:** Like the need to evaluate the economic value of water resources and water quality management, there is a strong need to establish an economic value for ecosystem services. This is outlined in the causal chain analysis for ecosystem degradation. Sound decision making would be possible if a proper evaluation for the ecosystem services were conducted within the Kura Ara(k)s basin, one that includes an analysis of costs for replacement services if ecosystems become too degraded to provide these services. To date, such a valuation has not been undertaken, and therefore decisions do not account for the costs of ecosystem degradation.
- **Underdeveloped coordination in planning for water resource use:** There is a lack of intersectoral coordination in water resource management and planning. While efforts are being made in this direction, the lack of coordination currently results in overuse of finite resources. It also results in competing priorities within and between national sectoral development plans, limiting the effective allocation of water resources; a situation to worsen in future. Tensions will increase if there is inequitable distribution of authority over water dependent sectors, including energy, agriculture and municipal water supply, made worse by the lack of coordination between water users and water management agencies for different sectors. The standard approach to water resource management can be plagued by institutional sclerosis, due to a lack of flexibility, to be overcome by integration of water resources management with support and buy-in from the highest political levels possible.
- **Under-resourced monitoring programs for water quality and water quantity including deteriorating equipment and lack of best practices:** There is growing awareness and appreciation of the benefits of best practices in water management for both quality and quantity monitoring. However, to date, throughout the basin, these monitoring programs lack sufficient funding to be realized. Without funding, equipment will continue to deteriorate, capacity cannot be developed sufficiently, and staffing will remain insufficient to conduct monitoring in line with best practices.
- **Limited capacity and lack of transboundary coordination:** The challenges outlined will be more challenging due to the limited capacity currently within the national water management institutions. While people directly involved realize this, without higher-level support it is impossible to achieve the level of capacity needed for sustainable water resources management. To be fully effective in water management, mechanisms for transboundary coordination must be considered in the institutional development and implementation of national water resources management. In all cases, all countries are both upstream and downstream riparian states and effective regional coordination is critical.

These common causes are gaps in institutional structure and capacity, also reflected in the Capacity Needs Assessment conducted for the IWRM/SAP component of the UNDP/GEF Kura Ara(k)s project, and presenting significant barriers to improving basin-wide water management. The project is currently supporting the development of National IWRM Plans as well as the capacity for their implementation. However, in order to do this in a way that will be sustainable in the future, commitment from the governments to address these common causes must be made by all countries. The benefit is that once each of the countries fills these gaps, successful river basin management will be much easier throughout the basin, and with the economic costs and benefits recognized, high level support should be forthcoming.

6. REGIONAL DEVELOPMENT TRENDS RELATED TO WATER MANAGEMENT

The chapter on regional development trends introduces the historical, current and future directions for the major water dependent sectors – hydropower, agriculture - as well as the anticipated impacts on water availability due to climate change and the socio-economic challenges of increasing populations in the basin, impacting on development and increasing demands on municipal water resources.

Accordingly, all these development trends towards increasing demands on water resources will impact the water resources available to the river basin ecosystems, necessary to maintain ecosystem services and environmental health. As such the chapter concludes with an initial assessment of the impact of the main water use sectors hydropower, municipal water use and agriculture on river water crossing borders, based on the future plans identified.

6.1. Climate change trends

The current section presents an overview of climate change aspects in the South Caucasus countries of Armenia, Azerbaijan and Georgia. Factual information is presented on the observed changes in temperature and precipitation in the Kura Ara(k)s river basin during the 20th century, followed by an overview of the envisioned changes during the 21st century, obtained as outcomes of a process of climate change scenario analyses completed in the three countries.

The analysis of climate change trends is based on three individual country Second National Communication (SNC) documents, submitted by Armenia, Azerbaijan and Georgia to the UNFCCC in 2009 and 2010 (AM-MNP, 2010; AZ-MENR, 2009; GE-MEPNR, 2009). The countries applied a similar approach to analyzing ongoing climate change and prognoses for the future, adapted in accordance with national priorities and differences in climatic and topographic conditions.

An extended overview of climate change issues in the three Kura Ara(k)s basin countries is provided in Hannan *et al.* (2013).

6.1.1. Observed recent changes in climate

Observed climate conditions - mainly temperature and precipitation – in recent decades were analyzed to determine trends in the collected monitoring data that may indicate that climate change is already ongoing. Historical records were also used to characterize average climate statistics for a defined 'baseline period' – mean, standard deviation - which subsequently were compared with observed climate data for the 'most recent period', to conclude on any possible statistically significant differences between the two periods.

The countries diverted in the years assigned to the 'baseline period': Azerbaijan and Armenia considered the years 1961 to 1990, while Georgia defined the years 1955 to 1970. Also the countries varied in the number of years considered to characterize the 'most recent period': Armenia largely applied a continuous time-series approach with individual years compared to the 'baseline period', while Azerbaijan and Georgia averaged a defined number of recent years, being 1991-2000 and 1990-2005 respectively.

Table 6.1.1.1 presents the recent changes in climate by country in the Kura Ara(k)s river basin. The whole region has experienced temperature increases between 0.5°C and 1°C in the last decades of the 20th century. Armenia and Georgia both note that mean summer temperatures (June, July, August), important because of the growing season, have risen at a faster rate than the mean annual temperature, while winter temperatures (December, January, February) largely varied around a stable mean, although with a strong west-east regional component. Meanwhile inter-annual as well as geographical distribution of these changes is very uneven throughout the region (Figure 6.1.1.1).

Armenia shows an overall trend of mean annual temperature increase of 0.85°C during most of the 20th century, largely caused by an increase during the summer months (June-August), while the mean annual winter temperature did not show a significant change – neither increase nor decrease. During the same period precipitation decreased by 6%, albeit showing large variations – increasing in the southern and northwestern parts of the country, and decreasing in its northeastern and central parts.

Table 6.1.1.1 Regional comparison of recent changes in climate.

Indicator	Armenia	Azerbaijan	East Georgia
Period	1929-2007	1960-2000	1955-2005
Change in mean annual temperature (°C)	0.85	0.52	0.60
Change in summer temperature (°C)	1.0	n/a	1.5
Change in mean annual precipitation (%)	-6.0	-9.8	+6.0

Notes: Statistics for Azerbaijan are for the whole country, as specific Kura Ara(k)s Basin values are not available; statistics for Georgia are for east Georgia.

Figure 6.1.1.1 Overview of observed changes in mean annual temperature, mean summer temperature and mean winter temperature in Armenia, Azerbaijan and Georgia.

Source: UNDP/ENVSEC (2011), in: ZOI (2011). Armenia – period 1935-2008, Azerbaijan – period 1960-2005, Georgia – period 1936-2005.

While a notable variation among the different regions was observed, Azerbaijan's mean annual country temperature appears to have risen 0.5°C. Analysis also showed that the rate of temperature rise has increased - while the rise in mean annual temperature over the 30-year period 1961-1990 was 0.34°C, the rise over the 10-year period 1991-2000 was 0.41°C, a four-fold average annual increase. Meanwhile the average precipitation during 1991-2000 showed a decline across the country, varying from 1.2% to 17.7%, on average 9.9%.

For Georgia, only the observed change in climate conditions in the eastern Dedoplistskaro region was considered, as western Georgia is climatically very different from Eastern Georgia and not within the Kura Ara(k)s river basin. Mean annual temperature in the Dedoplistskaro region increased by 0.6°C between 1990 and 2005, compared to 1955-1970. Considering temperature extremes, the absolute minima remained unchanged, while the absolute maxima increased 2.1°C. Precipitation increased by 6%, with maximum increases of precipitation observed in spring months, and maximum decreases during the summer months. Accordingly, the 'moistening regime' – a data-efficient measure for evapotranspiration based on precipitation and temperature data – declined by 15%.

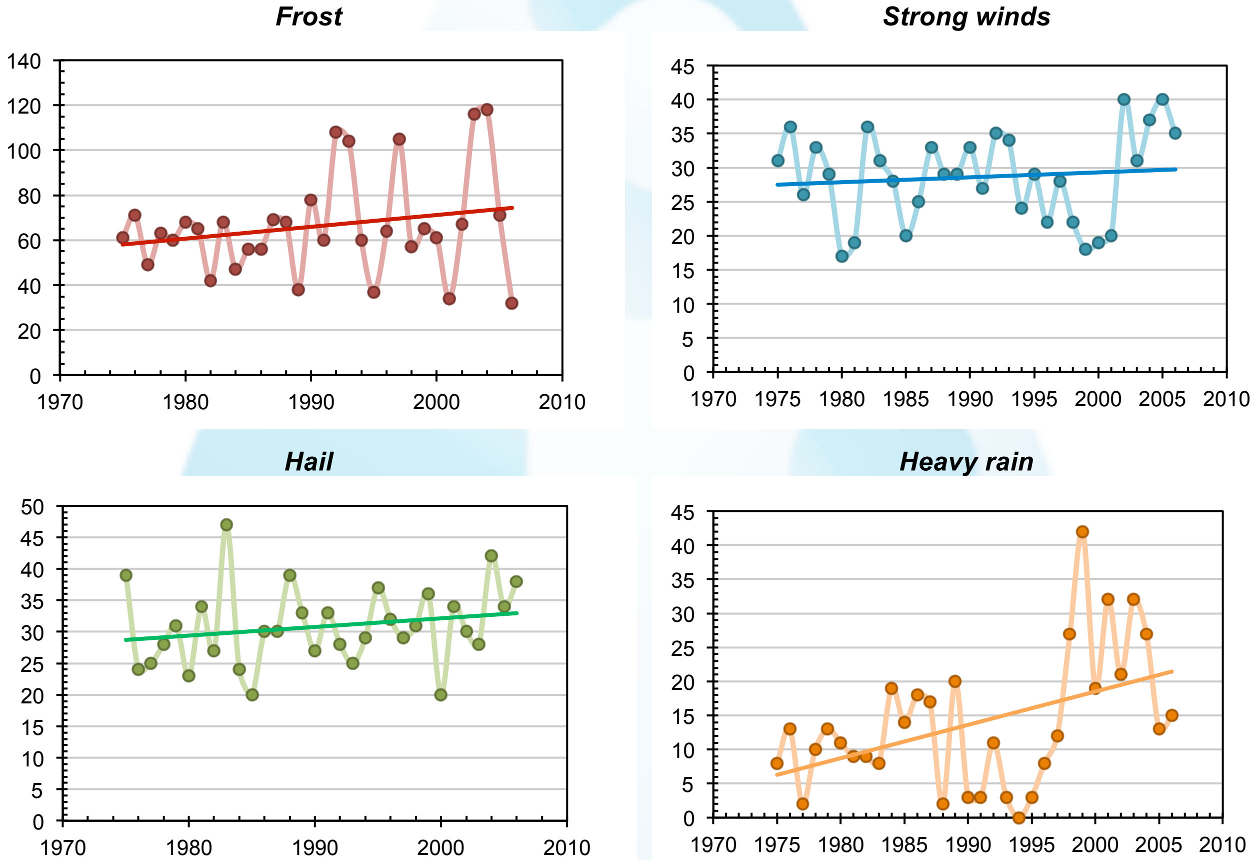
Extreme events

Observations in the three South Caucasus countries show that in recent decades the intensity and frequency of hazardous meteorological phenomena - frost, strong winds, hail, droughts, as well as heavy rain and flooding - has increased.

Armenia is one of the most disaster-prone countries in the southern Caucasus. The country is vulnerable to earthquakes, droughts, floods, landslides, avalanches, mudslides, strong winds, snowstorms, frost and hail. Although floods occur the most frequent, the average annual damages due to droughts and earthquakes are far higher, US$ 0.7 mln versus US$ 6.0 mln and US$ 8.9 mln respectively (GFDRR, 2010). Figure 6.1.1.2 presents the observed annual frequency of the selected extreme events frost, hail, heavy rainfall and strong winds - during the period 1975 to 2006, each of which showed an increased trend of occurrence.

Azerbaijan is vulnerable to disasters resulting from natural hazards - floods, earthquakes, droughts, landslides, avalanches, debris flows and mud flows. An analysis of flood frequency between 1966 and 2010 showed a dramatic increase in flood frequency in recent years (Figure 6.1.1.3). While probably also other variables other than climate change play a role, including the expansion of agricultural lands in floodplains, the trend shows that the risk of flooding and expected damage deserves serious consideration. As also for Armenia, floods occur more frequent than droughts, but the mean annual economic damage of droughts is higher than that of foods, US$ 6.0 mln versus US$ 5.7 mln (GFDRR, 2010). Mudflows associated with flooding are an added concern as they bring additional, usually permanent damages to affected areas.

Figure 6.1.1.2 Number of annual incidences in extreme hydro-meteorological events in Armenia (1975-2010).



Natural hazards in Georgia include floods, earthquakes, droughts, landslides, avalanches and mud flows. Of the South Caucasus countries, floods are the most frequent in Georgia, occurring throughout the country on an almost bi-annual basis. No clear trend in increased/decreased occurrence of flooding in recent decades was observed. The mean annual damage amounts to US$ 17 mln (CENN/ITC 2012). Droughts are observed across almost all of Georgia, although more frequent and pronounced in central and eastern Georgia. An overview of the length of drought periods in recent years is presented in figure 6.1.1.4. Of all natural disasters, droughts have affected the largest number of people. Between 1995 and 2008, drought damage to the agricultural sector totaled US$ 266 mln. Although droughts occur on a less frequent basis, their impact expressed as a mean annual value is as large as of floods (CENN/ITC, 2012; table 6.1.1.2).

The Dedoplistskaro region in eastern Georgia is one of the country's regions most affected by drought. Drought monitoring data for the period 1952–2007 show that for the period 1980-2007 the average annual duration of the drought period was 60 days, up from 49 days for the period 1952-1979, an increase of 22%. Also the frequency of droughts increased, from an average of 0.7/yr to 0.9/yr. Between 1998 and 2007 the frequency was even markedly higher, with 17 cases of drought observed during 10 years, an mean annual frequency of 1.7/yr, while the mean annual duration of the droughts increased up to 72 days (GE-MEPNR, 2009).

Figure 6.1.1.3 Observed numbers of flood events per year in Azerbaijan, 1966-2010.

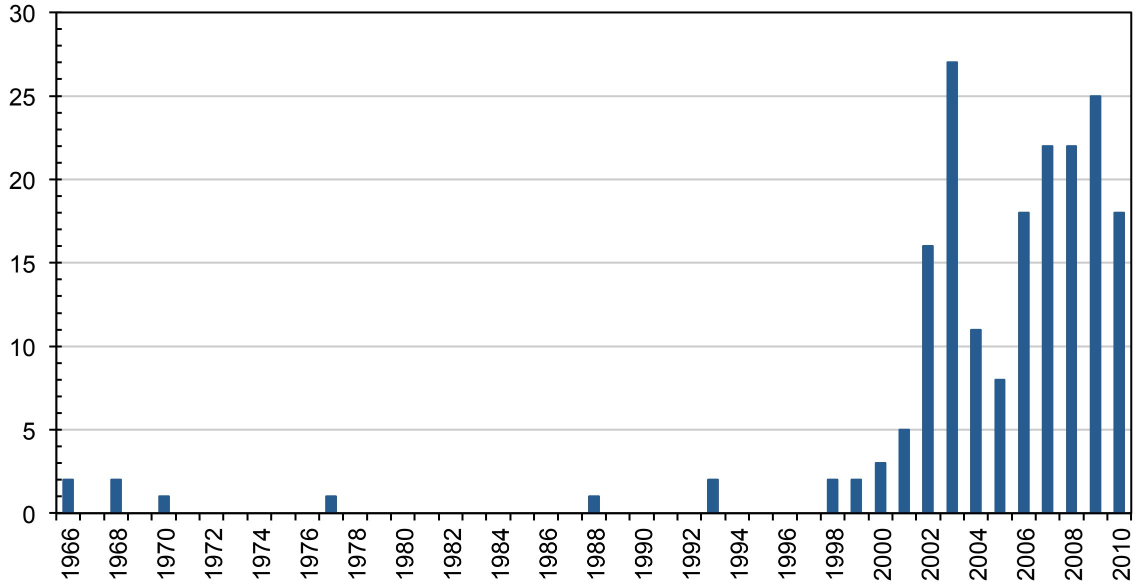
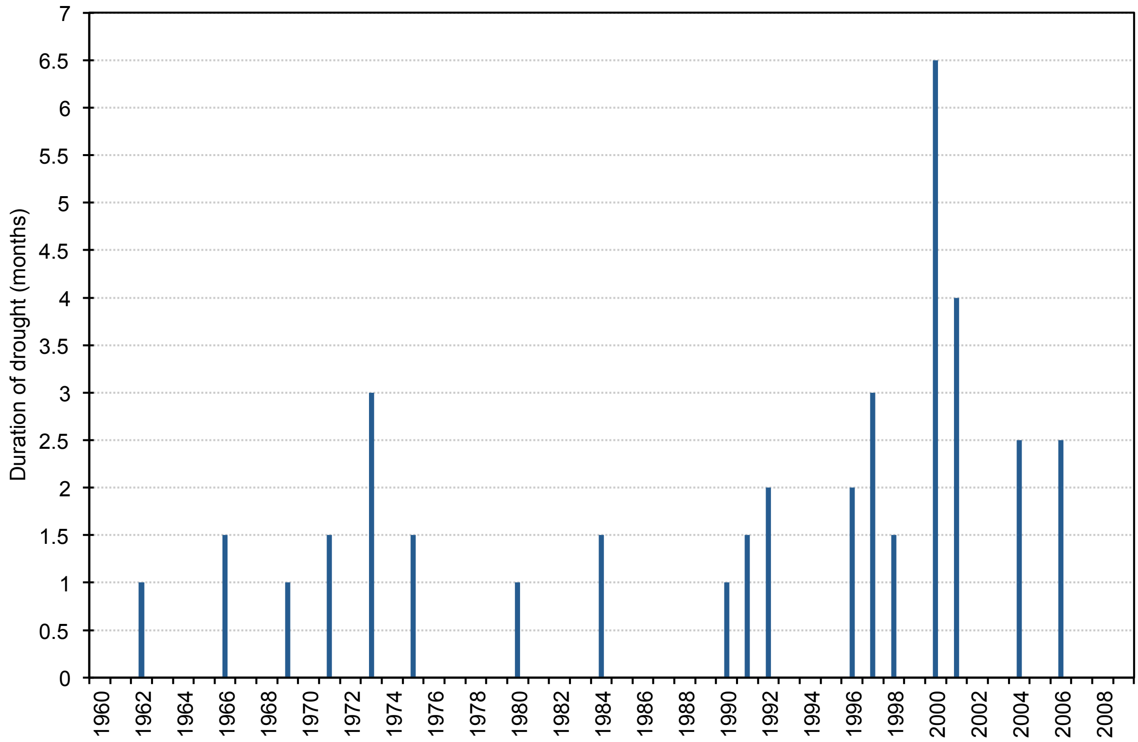


Figure 6.1.1.4 Duration of annual drought periods in Georgia between 1960 and 2009.



Source: GE-MEPNR (2010).

6.1.2. Projected changes in climate

To develop climate change scenarios, MAGICC/SCENGEN (5.3v2) computer software was used, allowing averaging the output of several Global Circulation Models (GCMs), which is considered more robust than using the individual results of only one GCM. For Armenia and Azerbaijan results of scenario analyses were average for the time periods 2021-2050 and 2070-2100, while Georgia used a variable approach for different parameters analyzed, but also considered the year 2100 as final date.

Table 6.1.1.2 Overview of recorded floods and droughts in Georgia between 1995-2010.

Year	flooding		Drought	
	Number of events	Impact (mln US$)	Duration (months)	Impact (mln US$)
1995	4	2.0	0	0
1996	11	17.8	1.5	10.6
1997	12	23.8	2.0	16.3
1998	2	1.3	1.0	3.8
1999	8	19.1	0	0
2000	2	1.3	6.0	187.5
2001	4	2.6	2.5	13.1
2002	16	49.2	0	0
2003	6	2.7	0	0
2004	10	12.8	0	0
2005	20	50.0	0	0
2006	8	9.4	1.5	3.1
2007	7	25.2	0	0
2008	16	23.8	0	0
2009	20	18.8	1.5	3.8
2010	18	12.9	3.5	28.1
Total	164	272.3	1.5	266.3

Source: CENN/ITC, 2012.

This section summarizes the results of scenario analyses for temperature and precipitation. Other approaches were used to assess impacts on humidity and related factors such as evapotranspiration, as well as water resources. Climate change forecasts were made based on the A2 and B2 climate change scenarios, commonly accepted as the most likely ones. The scenarios define the expected growth in GHGs (Green-House Gas), which in turn determine the rate of change of the climate. Table 6.1.2.1 presents the forecasted changes in climate parameters in the three countries of the Kura Ara(k)s river basin, according to simulations using the A2 development scenario.

Table 6.1.2.1 Regional comparison of forecast changes in climate for the A2 scenario.

Indicator	Armenia			Azerbaijan		East Georgia
	2030	2070	2100	2021 to 2050	2070 to 2100	2100
Change in mean annual temperature (°C)	1.1 to 1.2	3.2 to 3.4	5.3 to 5.7	1.5 to 1.6	3.0 to 6.0	4.1
Change in mean annual precipitation (%)	-2 to -6	-6 to -17	-10 to -27	+10 to +20	+20 to +80	-15
Change in precipitation, snow (%)	-7 to -11	-16 to -20	-20 to -40	n/a	n/a	n/a
Change in river flow (%)	-6.7	-14.5	-24.4	-22.5	-20.7	-8.5
Changes in groundwater yield	n/a	n/a	n/a	n/a	n/a	n/a

Note: statistics for whole countries, as specific Kura Ara(k)s Basin values are not available; n/a – not available.

For Armenia, all GCMs forecast a significant and continuous increase in mean annual temperature, with the increase in temperature predicted to be slightly higher in summer. The GCMs forecast a decrease in precipitation for the 21st century, under both the A2 and B2 climate change scenarios. The models also forecast a decrease in the volume of precipitation in the form of snow, 7-11% by 2030, 16-20% by 2070 and 20-40% by 2100, compared to the average for 1961-1990. The most significant changes are predicted to occur at altitudes above 1,700 meters.

For Azerbaijan, scenario forecasts show an average annual temperature increase for the period 2021-2050 of 1.5°C to 1.6°C, while for the period 2070-2100 the mean annual temperatures are modeled to rise by 3°C to 6°C. Also the maximum temperatures are predicted to rise, by 2°C to 7°C. Precipitation is forecasted to increase by 10% to 20% during the period 2021-2050, varying from 0 to 10% in the south-western to 20% in the eastern part of the country. Accordingly, the difference between precipitation and potential evaporation will increase from 0.4 to 1.2 mm per day. For the period 2070-2100, precipitation is forecast to rise between 20% and 80% from west to east across the country. However, doubts have been expressed on the accuracy of this particular model, especially as the analysis of past climate changes between 1960 and 2010 in fact shows a decline in precipitation.

For eastern Georgia, scenario analyses show that up to the year 2100 the mean annual temperature is envisioned to increase by 4^{o}C, or 36% compared to the average for the period 1961-1990, while the mean annual precipitation is predicted to decrease by 15%. The change will be more severe in summer, when both the temperature increase and precipitation decrease trends are greater than in other seasons.

6.1.3. Impacts of climate change to the region

As reported above, scenario analyses predict a significant change in both temperature and precipitation in the three South Caucasus countries Armenia, Azerbaijan and Georgia, although uncertainties are large. The impacts of these climate changes bring significant risks for the future.

A significant decrease can be envisioned in total as well as available water resources, caused by the forecasted air temperature increases, and related increases in evapotranspiration rates, and forecasted precipitation decreases. Precipitation patterns are envisioned to change, with periods of heavy precipitation interchanging with prolonged droughts, affecting the total volume of annual water resources as well as their seasonal distribution. More intense precipitation will change the balance between surface run-off and groundwater recharge, as well as increasing the risk for flooding and flash-floods. Higher temperatures cause glaciers to melt, together with groundwater outflow ultimately largely affecting the rivers' base flow.

Ultimately, any reduction in total annual river flow and seasonal distribution will affect water resources availability throughout the Kura Ara(k)s river basin, which will cause significant socio-economic difficulties for each country. The most immediate consideration from a transboundary waters point of view is that, in each country less water will enter from upstream neighbors. This is both a direct consequence of reduced river flows, related to lower precipitation, changes in seasonal water discharge and increased evapotranspiration, and well as an indirect consequence of climate change-driven increases in water consumption by the upstream neighbors. Additionally, upstream water consumption is also driven by population growth and economic development – in industry and agriculture, increasing abstractions and reducing transboundary flows even without the added impacts of climate change.

In many tributary catchments in the Kura Ara(k)s river basin most of the drinking water is supplied from groundwater sources. At present no reliable quantification of available groundwater resources exists, neither of any observed decrease in the recent past. However, the forecasted reduction in precipitation, surface water resources, as well as river flow volumes and their seasonality, is likely also to impact on the quantity of groundwater resources, in total volumes stored as well as yearly recharge. Additionally, reduced flows during the growing season may trigger farmers to use groundwater for irrigation, further depleting the resource.

The **economic impacts** of climate change are envisioned to impact on two key sectors of the economy in the Kura Ara(k)s basin:

- ***Agriculture and the food processing industry:*** The economy of the Kura Ara(k)s basin depends to a large extent on agriculture. Currently about half of the cultivated area is irrigated. While in recent decades irrigated agriculture declined, planned economic development as well as population growth will drive food requirements in the future, affecting water demands for its production. In addition to the envisioned expansion in (irrigated) agricultural lands, climate-change induced warmer and drier conditions will increase crop water requirements and hence demands for irrigation water. Combined with the forecasted reduction in river flow and change in seasonality, this creates new challenges for the agricultural sector. Adaptation to the changing hydrological regime will require a combination of sound policy decisions on water allocation among agricultural users as well as the fair division of water resources among all sectors. More efficient irrigation technologies and other water conservation measures, including proper crop choices, will be needed. Indirectly also climate change will increase the risks for degradation and desertification of agricultural lands, due to salinization with inappropriate irrigation & drainage, crop failures due to droughts, etc.

- ***Energy:*** Many plans exist to expand hydropower in the Kura Ara(k)s river basin, especially in Armenia and Georgia, both lacking significant mineral energy resources. The availability of water resources and the mountainous topography makes hydropower a suitable option to fulfill the energy needs of these countries. However, the projected decrease in climate change-induced river flow may impact on the actual power production of many HPPs, even when not considering the increasing need to maintain appropriate environmental flows. Accordingly, with decreasing water resources available, the importance of highly efficient production techniques will increase, to mitigate the impact of reduced river flows.

The above provides the background baseline information towards analyzing priority issues as influenced by the cross-cutting issue of climate change that are transboundary in nature. The assessment of the impacts (both environmental and socio-economic) of climate change issues are addressed in chapter 4 for the individual identified transboundary issues.

6.1.4. Literature cited

AM-MNP Ministry of Nature Protection of the Republic of Armenia, 2010. Second National Communication on Climate Change – a report under the United Nations Framework Convention on Climate Change, Republic of Armenia, Ministry of Nature Protection, Yerevan, Armenia, 2010, 134 pp.

AZ-MENR Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, 2010. Second National Communication to the United Nations Framework Convention on Climate Change, Ministry of Ecology and Natural Resources of Azerbaijan, Baku, 2010, 85 pp.

CENN/ITC, 2012. Atlas of natural hazards and risks of Georgia. Caucasus Environmental NGO Network / Faculty of Geo-Information Science and Earth Observation ITC, University of Twente, the Netherlands, 2012, Tbilisi, April 2012, 124 pp.

GE-MEPNR Ministry of Environment Protection and Natural Resources of Georgia, 2009. Second National Communication to the UNFCCC, Ministry of Environment Protection and Natural Resources of Georgia Tbilisi, Georgia, 2009, 240 pp.

GFDRR Global Facility for Disaster Reduction and Recovery, 2010. Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI) - Risk Assessment for Central Asia and Caucasus Desk Study Review, 172 pp.

ZOI Environment Network, 2011. Climate change in the South Caucasus – a visual synthesis. Geneva, Switzerland, 60 pp.

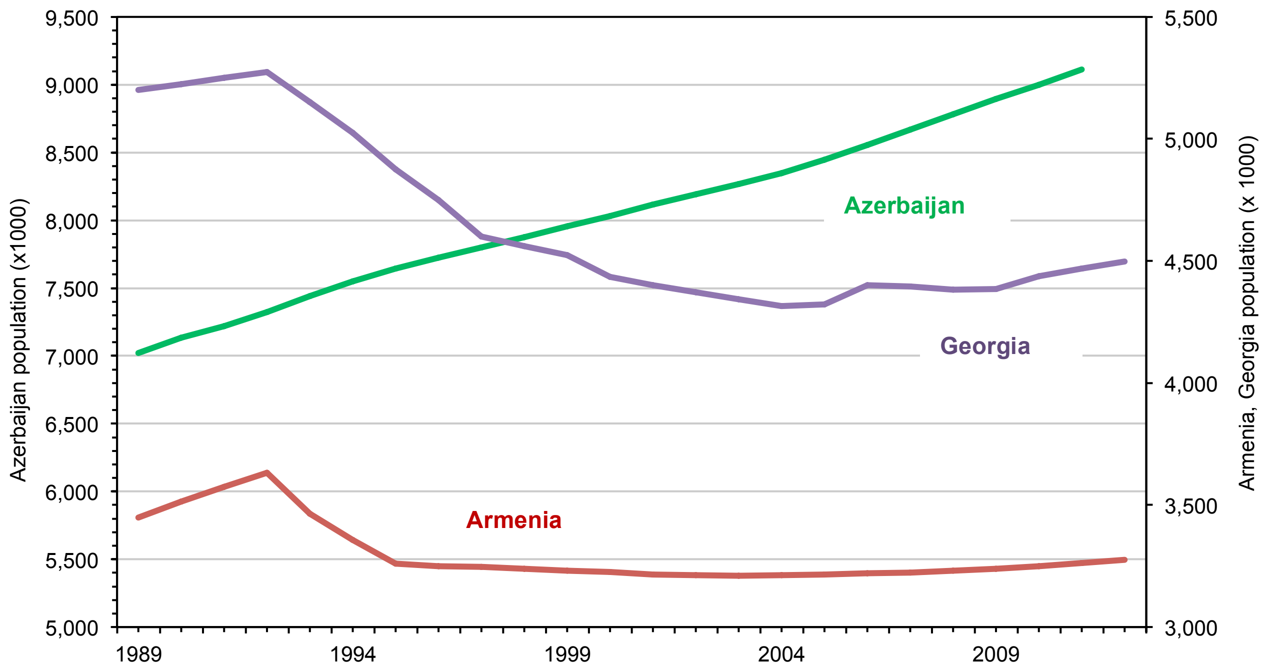
6.2. Social development trends

The trends in the region pertaining to social, economic and institutional development will have impacts on water management issues, and on transboundary water resources. This section provides an overview of social development trends that will shape the region, and provides a lens to better understand how national level social changes may impact on the wider basin and its water resources. The information here is based on historic trends with future development plans incorporated into the overall trend analysis.

6.2.1. Population

The development trends in national population since the three South Caucasus countries Armenia, Azerbaijan and Georgia gained independence show that population numbers in Armenia and Georgia started to decrease in the early 1990s, a process which continued until 2003/2004, followed by a slight increase in more recent years (Figure 6.2.1.1). This dip in national populations is likely due to post-independence conflicts as well as out-migration in search for economic opportunities, the economy having crashed following the disintegration of the Soviet plan-economy. Still today, the population of both Armenia and Georgia is lower than during the final days of the Soviet Union, 174,300 (-5%) and 700,000 (-14%) respectively. Meanwhile, Azerbaijan shows a constant increase in population from 1989 to 2009, amounting to more than 2 mln people (+30%), also far exceeding the population increases observed in Armenia and Georgia since the mid-2000s, being 64,000 and 181,000 respectively.

Figure 6.2.1.1 Population dynamics in the South Caucasus countries, 1989-2011.

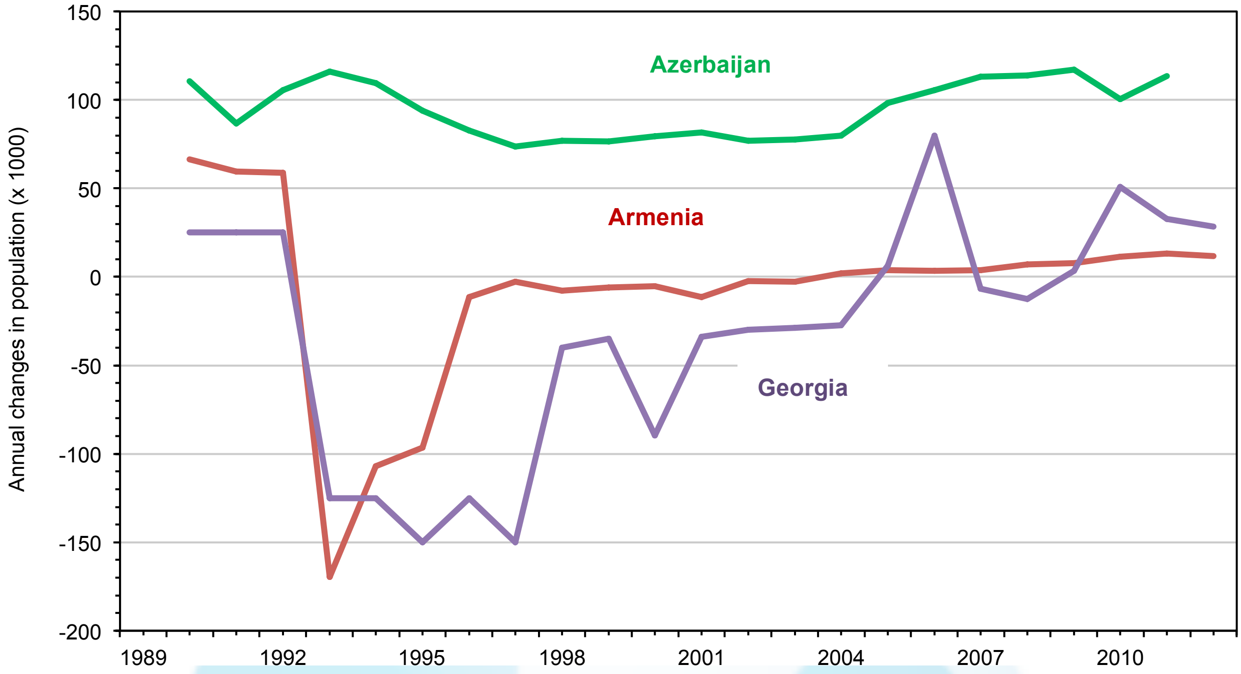


Source: National statistical data. Notes: Azerbaijan figures on left y-axis, Armenia and Georgia figures on right y-axis.

The annual dynamics of population changes (Figure 6.2.1.2) show the rather constant growth rate in Azerbaijan, a sharp decline towards negative growth and rapid increase in the early-mid 1990s towards a slow growth since the mid-2000s in Armenia, and sharp drop to negative annual growth to last throughout the 1990s and a relatively late and more gradual recovery to positive growth in recent years for Georgia.

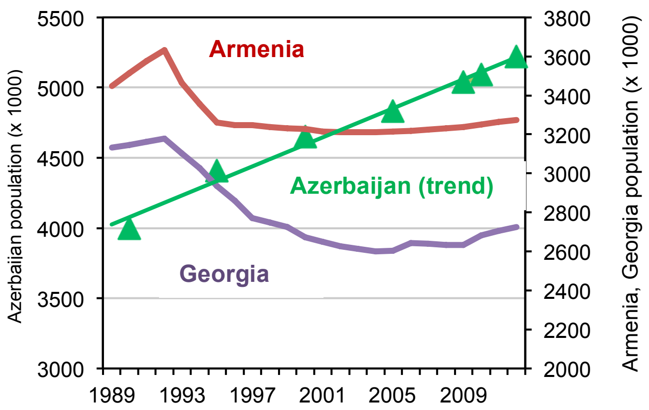
Comparable graphics for the Kura Ara(k)s basin sections in the countries, of importance for Azerbaijan and Georgia only, as Armenia as a whole is located within the basin, are presented in figure 6.2.1.3 and figure 6.2.1.4. Inherent with data used – Georgia pre-2000 basin data are inferred from country statistics, and country location – Armenia is completely within the basin, hence country data are basin data, the two figures largely are comparable to figure 6.2.1.1 and figure 6.2.1.2, with only for Azerbaijan specific basin data available, obtained from 10-year population census data.

Figure 6.2.1.2 Absolute changes in annual country population numbers for Armenia, Azerbaijan and Georgia.



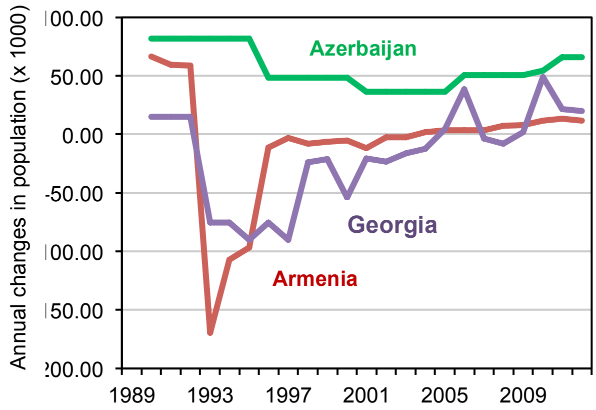
Source: National statistical data.

Figure 6.2.1.3 Population development in the Kura Ara(k)s basin sections of Armenia, Azerbaijan and Georgia.



Source: National statistical data.

Figure 6.2.1.4 Absolute annual changes in population in the Kura Ara(k)s basin sections of Armenia, Azerbaijan and Georgia.



Source: National statistical data. Note: The Kura Ara(k)s annual population increase in Azerbaijan is obtained by interpolation of 10-year population census data.

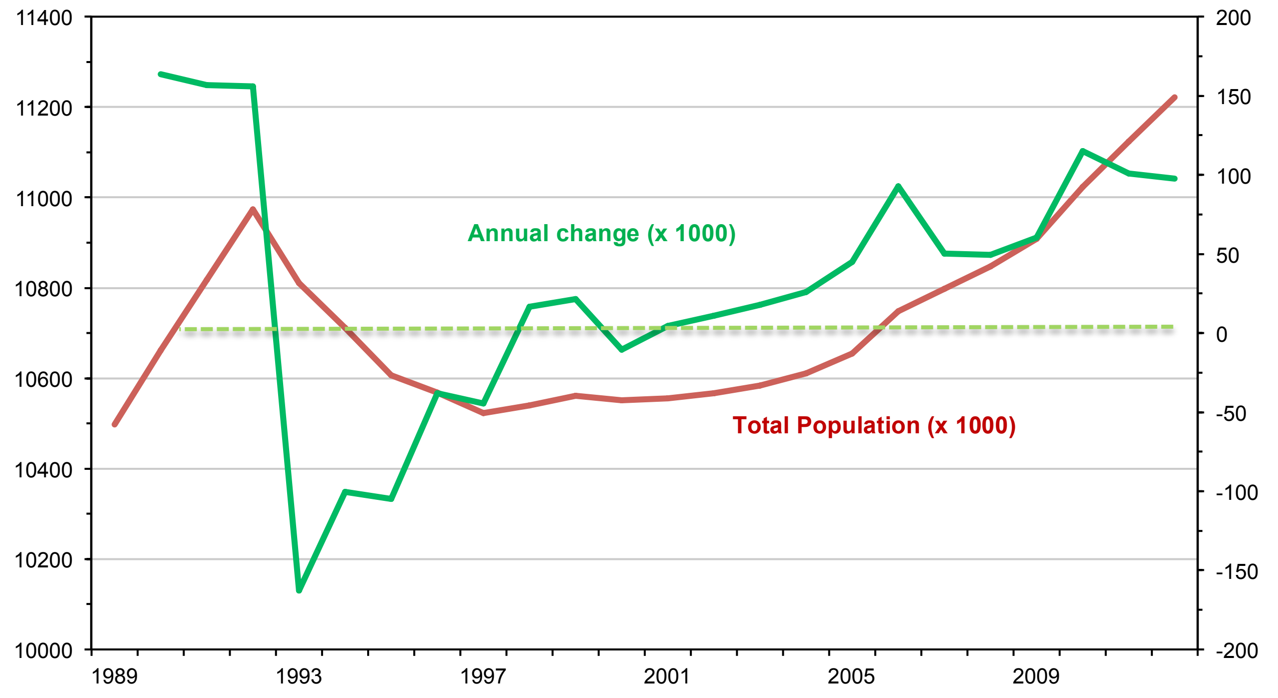
Figure 6.2.1.5 shows that the total population in the Kura Ara(k)s basin during the recent 25 years increased with about 700,000 persons, a growth, as discussed above, largely due to population growth in Azerbaijan. While in Azerbaijan the population increased, the total basin population between 1993 and 1997 decreased by almost 450,000 persons, due to the significant decrease in population in Armenia and Georgia. From 1998 the basin population started to increase, at first slowly linear until 2004, due to the continuing negative population growth in Armenia and Georgia, and since 2005 at a steeper slope, as the population numbers in both Armenia and Georgia also started to increase, with annual growth rates varying between 0.5 and 1.0%. Meanwhile, both the populations in Armenia and Georgia stay short of the absolute numbers inhabiting the basin at the end of the 1980s, lagging by 175,000 and 400,000 respectively (Figure 6.2.1.3). In 2010 the total basin population reached the level of the early 1990s, and continued to grow in subsequent years.

The annual growth rates for the basin countries are presented in figure 6.2.1.6. It shows the progressively decreasing growth rate for Azerbaijan, albeit still positive and since 2005 showing a rising trend again. The growth rates for Armenia and even more so Georgia show increasing trends, largely based on the significant negative growth in the 1990s. In recent years both countries show rather moderate annual growth rates.

These variations in growth rates can be explained by both major social and political shifts within the countries. Additionally the post-2008 increase in populations is believed to be also the result of the global economic crisis, with many workers returned to homelands due to declining employment opportunities. Armenia and Georgia are both very susceptible to this trend due to large ethnic diaspora outside of the region. Azerbaijan by comparison was less impacted by out-migration though the initial increase in population may also be due to IDPs in the early and mid-1990s. This is not known. Due to the timing of the 2008 economic crisis coinciding with the increase in oil revenues in Azerbaijan, the continued increase in population in the Azerbaijan portion of the basin is steadier.

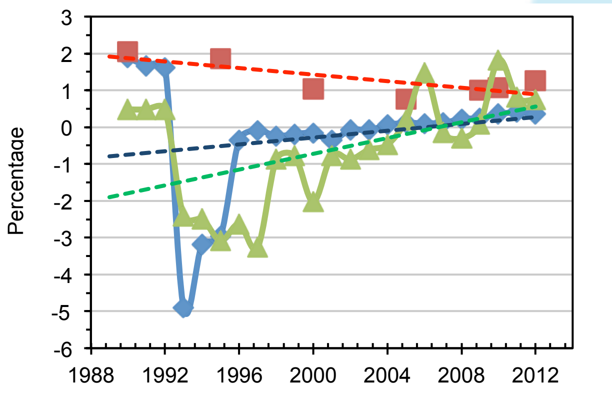
In order to obtain a general impression on the envisioned future population numbers in the Kura Ara(k)s basin until 2050, two modeling scenarios were completed. Scenario 1 assumes that future annual population growths will be equal to the country averages for the period 2000-2012 (AM: 0.10%, AZ: 1.03%, GE: -0.01%), while Scenario 2 was based on using the average country growth rates for the 2005-2012 period (AM: 0.24%, AZ: 1.02%, GE: 0.58%) to calculate future developments. The modeled population growth in the basin is presented in figure 6.2.1.7. Both scenarios hint at a continuing growth of the population in the Kura Ara(k)s basin until 2050 by 23% and 31% respectively. As both scenarios are based on weak assumptions, it should be taken into account that they are only presented to illustrate the possible developments based on observed current trends.

Figure 6.2.1.5 Development of total population in the Kura Ara(k)s basin.



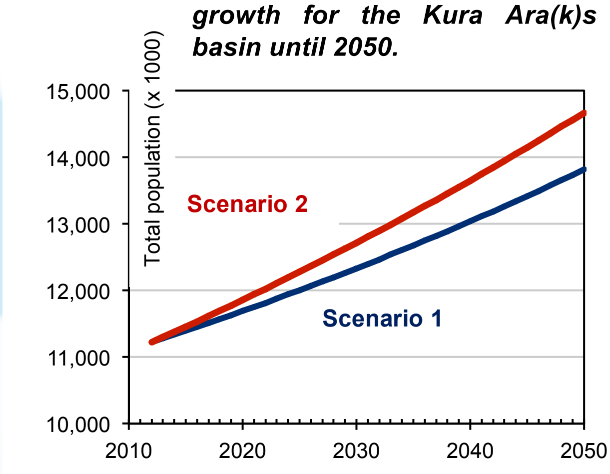
Source: National statistical data. Notes: Total population shown on left y-axis, absolute annual change on the right y-axis. Notes: Azerbaijan annual data were interpolated from 10-year population census data.

Figure 6.2.1.6 Observed annual population growth rate in the Kura Ara(k)s basin countries, 1989-2012.



Source: National statistical data.

Figure 6.2.1.7 Modeled scenario population growth for the Kura Ara(k)s basin until 2050.



Note: based on observed annual population growth averaged for 2000-2012 (scenario 1) and 2005-2012 (scenario 2).

The ongoing overall population growth in the Kura Ara(k)s basin, as evidenced by past data and demonstrated in the scenario analysis above, suggests that the demands on the basin's natural resources can be expected to increase, resulting in further pressures on the environment. The differences between the populations of the basin countries are likely to follow the same trends, with the population of Azerbaijan continuing to increase at a faster rate than those of the other South Caucasus countries, although in recent years the differences in annual growth rates slightly reduced. While the population of Azerbaijan is larger to begin with, the increase in population in this most arid of the Kura Ara(k)s basin countries will have serious ramifications for water resources management, including threats to regional water security, which in turn will impact on regional food, energy and environmental security, These threats must be managed now in order to reduce negative externalities from increased population growth in this part of the basin. Additionally the increased populations in the basin in I.R. Iran and Turkey must be considered for accurate assessments to be made.

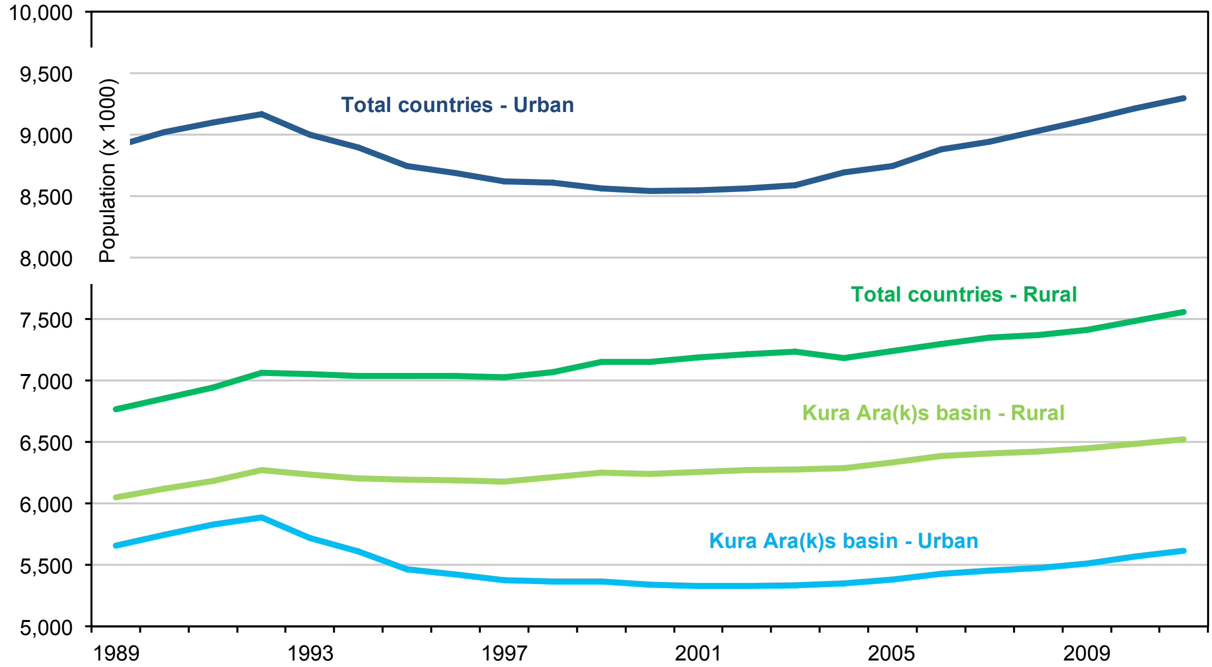
The impacts on the needs for water, and accordingly water abstractions of increasing populations will be driven by an increased demand for food from agriculture, largely depending on irrigation for its production, for potable water, and for water to satisfy municipal purposes, including sanitation. Additionally the increasing population with increased welfare state will be in need of more energy, paving the way for more hydro-power generated sources, especially in Armenia and Georgia. While HPPs are not direct consumers, their operation will have serious impacts on river flows, including transboundary ones, as well as water availability in different seasons. In order to satisfy the increasing needs generated by envisioned different sectoral developments driven by population growth, a multi-sectoral integrated water resources management approach urgently is needed.

6.2.2. Urban and rural distribution

More people in the three South Caucasus countries Armenia, Azerbaijan and Georgia live in urban areas, a division unchanged since independence from the Soviet Union. For the overall Kura Ara(k)s basin the situation is the opposite, a larger number of people lives in rural areas (Figure 6.2.2.1). The figure shows that the total urban population started to decrease in the early 1990s until the early 2000s, after which again an increase can be observed. Meanwhile the rural population steadily increased during the last 25 years.

While the rural population in Kura Ara(k)s river exceeds that of the urban one, due to many small towns and only few larger cities, overall however, the percentage division between rural and urban population is more balanced (Figure 6.2.2.2), as also the capitals Tbilisi and Yerevan are located within the basin. Following a small dip after independence, the share of the rural population slightly increased (Figure 6.2.2.2), due to the decrease in urban population (Figure 6.2.2.1).

Figure 6.2.2.1. Development of total urban and rural populations in three South Caucasus countries, compared to urban & rural populations in the Kura Ara(k)s basin.



Source: National statistical data. Notes: For Azerbaijan, urban and rural population numbers for the Kura Ara(k)s basin are linear interpolations between the national census data from 1989, 1999 and 2009.

Considering the rural/urban ratio individually for the three countries, some differences are observed. In Armenia the largest part of the population is considered urban, a result of the classification system applied, which assigns smaller rural cities to the urban class. In Azerbaijan on the contrary the largest part of the population lives in rural areas, while in Georgia the division is quite balanced (Figure 6.2.2.3).

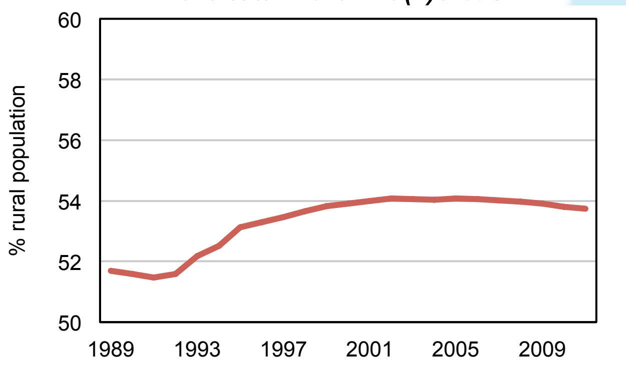
Within the Kura Ara(k)s basin, in Armenia the relative share of the rural population increased since the early 1990s, while in Azerbaijan a slight reduction can be observed (Figure 6.2.2.3). A reliable assessment of the development in Georgia is difficult, as pre-2000 data are based on extrapolations.

Meanwhile, when analyzing the absolute population numbers more nuances emerge. In Azerbaijan, despite a slowly changing urban-rural ratio in favor of the urban population, both in rural and urban areas an increase in population is observed during the last 25 years, of about 30% for both. In Armenia, while the relative share of the rural population increased, the absolute population number remained largely the same, the change in ratio accordingly caused by a decrease in urban citizens, with about 15%. In Georgia both the urban and rural populations decrease equally strong, with about 15% (Figures 6.2.2.4 and figure 6.2.2.5).

The rather stable distribution of urban and rural populations (Figure 6.2.2.2; Figure 6.2.2.3) in the basin suggests that this will continue. However, as the population is expected to further increase, especially Azerbaijan, also in the rural areas, pressures on the food and water resources will likely increase in both urban and rural areas.

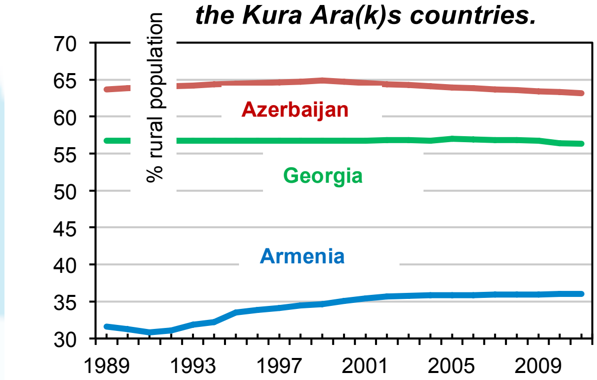
The impacts on water management due to the expansion of rural populations suggests also that farming practices which have been used in the past may not be suitable to feed increasing populations in Azerbaijan, especially when subsistence farming is concerned, due to an increasing competition for arable land. As a result there may be an increased need for trade with neighboring countries and an alternative approach to agriculture that does not put downstream populations at risk for food insecurity, due to increased water abstractions. Maintaining regional food security will require rational use of water resources throughout the basin. Future studies must also consider populations in Turkey and I.R. Iran, as well as to integrating the sectoral development plans for individual countries for agriculture, energy and municipal water use.

Figure 6.2.2.2 Change in rural population in the total Kura Ara(k)s basin.



Note: For Azerbaijan, rural population data were obtained from linear interpolation based on national census data from 1989, 1999 and 2009.

Figure 6.2 Change in rural population in the Kura Ara(k)s countries.



Notes: For Azerbaijan, rural population was obtained from linear interpolations between the national census data from 1989, 1999 and 2009.

Figure 6.2.2.4 Change in urban population in the Kura Ara(k)s basin.

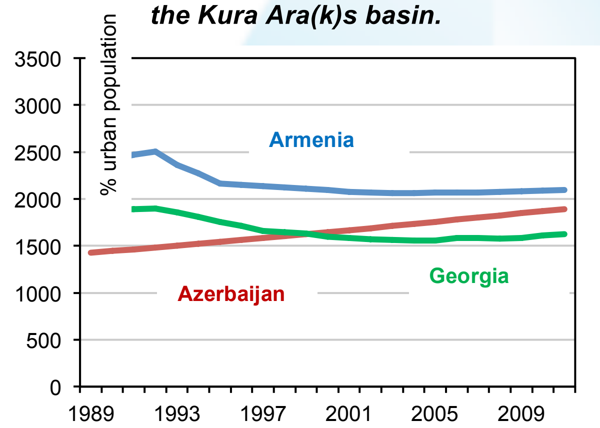
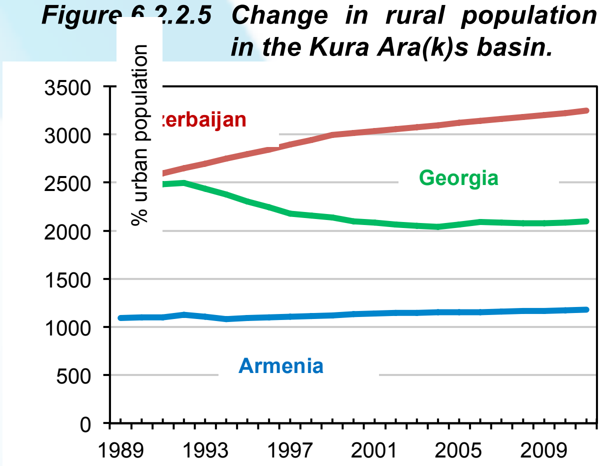


Figure 6.2.2.5 Change in rural population in the Kura Ara(k)s basin.



Source: National statistical data.

6.2.3. Human health conditions

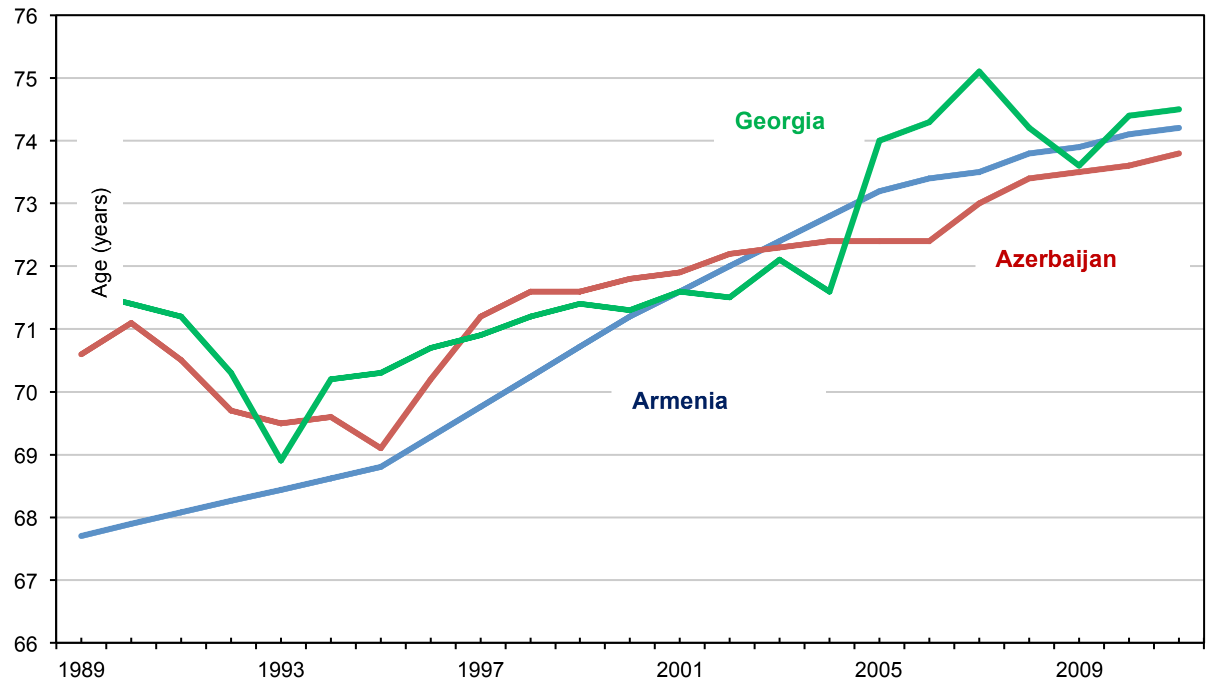
Historically populations of the Kura Ara(k)s Basin have had good longevity, though the 2005 Stakeholder Analysis found that residents in the basin claimed that the water sources made them ill. While the nature of the illnesses was not specified, this was the most dominant and pervasive complaint throughout the basin.

Life expectancy at birth has increased steadily in all three countries in the basin since the countries gained independence from the Soviet Union, about 3 years for both Azerbaijan and Georgia, while Armenia showed an impressive 6.5 years increase (Figure 6.2.3.1). Typically, in both Azerbaijan and Georgia in the early 1990 the life expectancy dropped by about 2 years. As Armenia's annual figures are based on 5-year census data, any decrease or increase has been hidden due to the interpolation technique applied. The continuing rise in life expectancy in all three countries since the mid-1990s suggests that the population, if conditions were to remain as they are today, would live longer than the same cohort 20 years ago, in part as continuation of environmental improvements. The increase in life expectancy is one factor contributing to the overall increase in population in the Kura Ara(k)s basin.

Infant mortality is considered also a strong indicator of environmental health. Annual infant mortality has significantly declined in all three South Caucasus countries since 1990 (Figure 6.2.3.2). In both Azerbaijan and Georgia, upon gaining independence from the former Soviet Union the infant mortality initially increased in the early 1990s. Armenia's data show a continuous decrease, which may be due to the use of inferred data from the World Bank database. In both Azerbaijan and Georgia the increase in infant mortality was quickly reverted, since 1994, but it took Georgia until 2005 to bring the rate below the pre-1990 level, while in Azerbaijan this was reached in 1995.

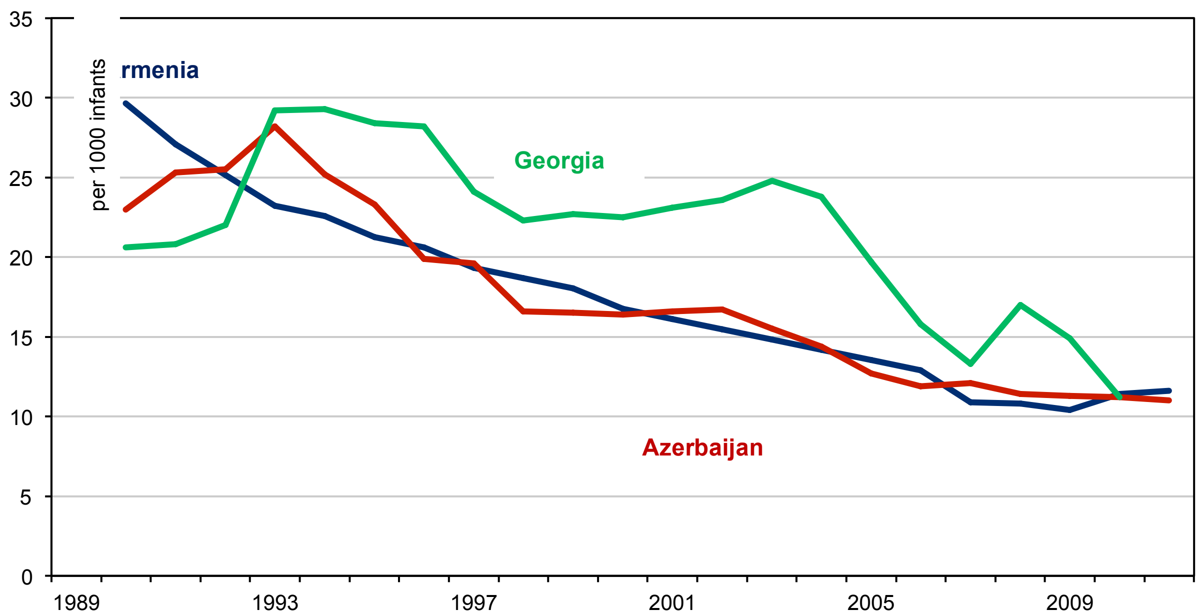
Figure 6.2.3.3 presents the division of infant mortality between male and female children, on the example of Georgia. It shows that from an initial difference of about 5‰ in favor of females further increased in the early 1990s years, to a maximum of 8‰, to significantly decrease only after 2003. While specific data for Armenia and Azerbaijan were not obtained, it can be assumed that their country trends resemble Georgia's.

Figure 6.2.3.1 Development of life expectancy at birth in the South Caucasus countries.



Source: National statistical data. Note: for Armenia, pre-2007 data are based on interpolations from 5-year census data (1990-2005).

Figure 6.2.3.2 Development of infant mortality in the South Caucasus countries.

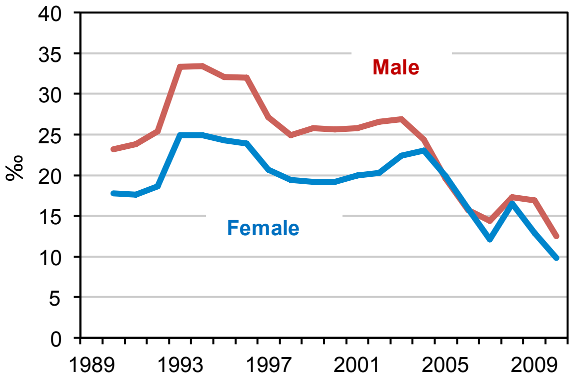


Source: National statistical data. Note: for Armenia, pre-2007 data are based on Work Bank data (UNICEF, 2011), corrected with averaged coefficient for the overlap years 2007-2011, for which national statistics were available.

Figure 6.2.3.4 presents the infant mortality in urban and rural areas, on the example of Azerbaijan. It shows that while initially the rural infant mortality rate exceeded that of urban areas, after 2004 the opposite became true. While in rural areas the mortality rate decreased further, in urban areas stabilization occurred in the mid-2000s, to slightly increase in recent years. Also, while in urban areas the mortality rate remained largely stable during the difficult years of the early 1990s, the rural infant mortality rate increased significantly, to drop below the early 1990s level only after 1995, when also the urban rate started to decrease.

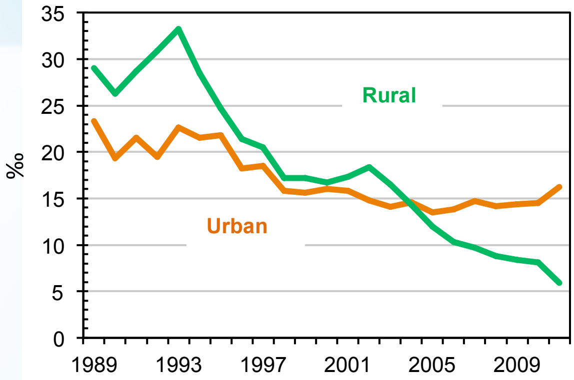
The dedication of government resources in all three South Caucasus countries towards improving and expanding the provision of drinking water resources and sewage water collection is commendable. An impact of this, especially as the deteriorated provision and collection piping network proactively is being repaired, and flush toilets appear in greater abundance throughout the region, will be an increase in sewage water containing nutrients and other pollutants entering into the river system, unless also the improvement to full wastewater treatment will be an integral part of those plans. At present practical improvements tend to focus on supplying drinking water only, while improvement of the wastewater treatment system still is only being planned. This has significant transboundary implications, especially between Georgia and Azerbaijan.

Figure 6.2.3.3 Trend of male and female infant mortality in Georgia.



Sources: National Statistics Service of Georgia (2012).

Figure 6.2.3.4 Development of urban and rural infant mortality in Azerbaijan.



Sources: State Statistical Committee of Azerbaijan (2012).

The current lack of sewage treatment throughout the region is already problematic; and as population numbers are envisioned to increase and water resources become scarcer – due to increased abstractions as well as forecasted climate change – problems might become more severe. In Georgia, as in Armenia and Azerbaijan, treatment of sewage is currently minimal, and the sewerage outflow from the large cities of Tbilisi and Rustavi enters into the Kura river following only a mechanical treatment, if treated at all, just upstream from the border with Azerbaijan. This has become an issue of discussion between Azerbaijan and Georgian experts, with various proposals made, including for Azerbaijan to financially contribute to support for sewage treatment in Georgia, to benefit from water with improved overall water quality flowing into Azerbaijan. While in theory this is an interesting argument, it is not in accordance with the EU Water Framework Directive that requires each country to take full responsibility for treatment of its effluents. While in the discussion examples of cases of upstream countries being paid by downstream countries not to use water for irrigation have been cited, the issues is not comparable, as this refers to a water quantity issue, rather than water quality. With respect to improving water for human consumption it should be noted that the cost of treating wastewater is far lower than the cost to improve the quality of water from polluted sources to potable level.

6.2.4. Gender issues related to water

The legacy of the Soviet Union emphasized more equity for men and women. As a result, being culturally different, Armenia, Azerbaijan and Georgia all have a socio-economic tradition that leads to greater gender balance than in many parts of the world. Across the region, female literacy rates are consistently high and have been for the past several decades. Historically, women represent more than half of the labor force in

Armenia and Georgia, and just below half in Azerbaijan. The mean age of women giving birth of their first child is also constant in the region – 22 in Armenia pre-2000, 25.7 in Azerbaijan's basin section pre-2000, to 23.3 in Armenia today and 24.2 in the basin in Azerbaijan today. An important indicator of future trends is the ratio of females enrolling in tertiary education. Pre-2000 women were slightly lower than men but, as noted in section 3.2.1.3, the ratio has now flipped with more women being enrolled in tertiary education than men.

Literacy rates, employment rates and higher education enrollment rates do not necessarily ensure that there will be gender equity in water management throughout the basin. Women continue to carry responsibilities for domestic water use, while men remain in positions as decision makers at all levels in communities. The future trends, as the economies continue to expand and as women become more economically active, indicate that gender mainstreaming in water management at the small scale and local level to the highest level decision making will be advancing. The more culturally determined variation warrants further analysis in separate thematic studies, which will be explored in subsequent work of the project.

The future of gender issues in water resources will depend largely on factors like economic development within and across the region, reversion to traditional gender roles which varies significantly by cultures across the region, initiatives to include women in water resource management including health related aspects, the emergence of economic opportunities for women in rural sectors and the increase in gender equity in river basin organizations. Trends will depend on sectoral development, overall economic health of the region and cultural aspects that are shaped by those. Comparatively women in Armenia, Azerbaijan and Georgia enjoy high equality rights, however as the future conditions shift and change, it is possible that some aspects will shift, especially if water and food security issues do not take climate change into account.

6.2.5. Literature cited

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

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

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

National Statistics Office of Georgia, 2012. www.geostat.ge

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

State Statistical Committee of the Republic of Azerbaijan, 2012. www.azstat.org

UNESCO, 2011. Levels and trends in child mortality - report 2011. UN Inter-Agency Group for Child Mortality Estimation. United Nations Children's Fund, New York, 24 pp.

World Bank, 2012. The World Bank Data Indicators. March 2012 (accessed March 2012). http://data.worldbank.org/indicator?display=default.

6.3. Economic development trends

6.3.1. Agricultural developments and water use

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

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

Armenia

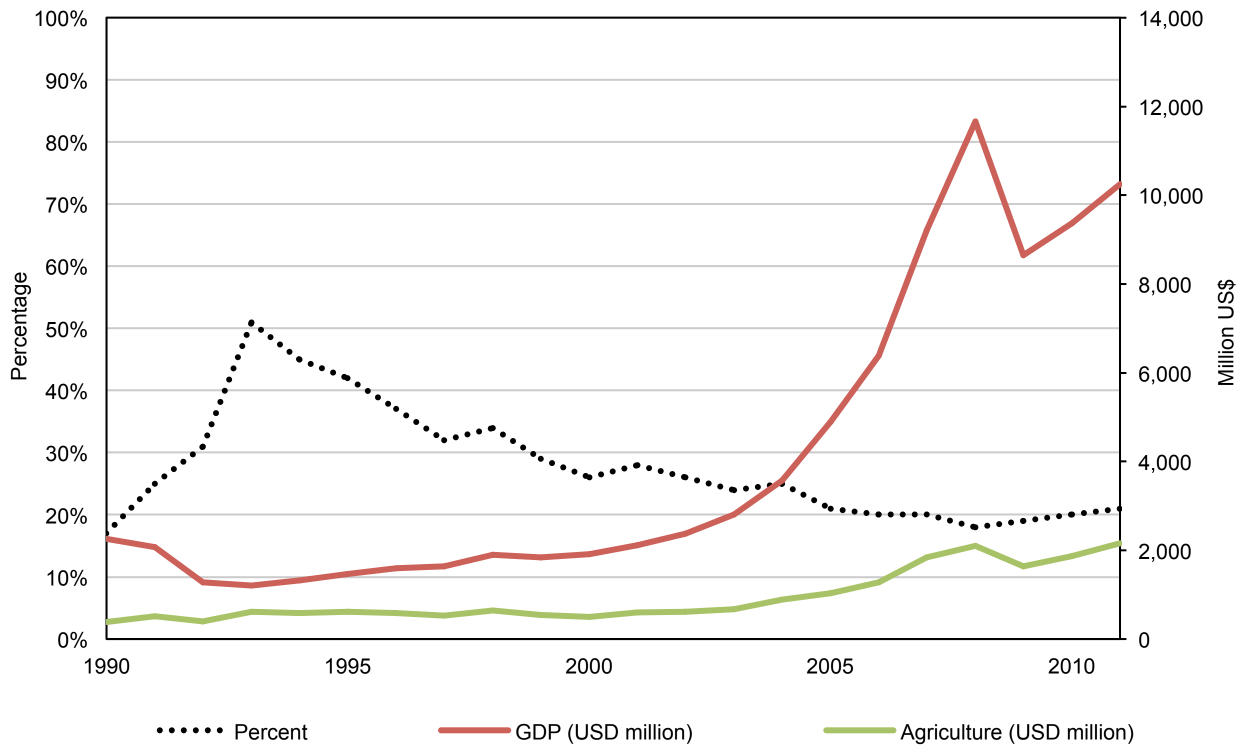
About 70% of Armenia – about 2.1 mln ha, was in 2011 in use for agriculture (AM-NSS, 2012), of which 450,000 ha were used for arable farming, 33,000 ha for perennial crops, 130,000 ha for haylands, and 1.1 mln ha as natural pastures. In addition, about 400,000 ha were in use for other agricultural purposes,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

Developments in the agricultural sector during the last 25 years, since 1990, show that the overall production as well as its total value remained largely stable until the early 2000s, while the contribution of agriculture to the country's GDP gradually decreased to 20%, having peaked in the early 1990 at 50% following the disrupture of the industrial sector (Figure 6.3.1.1). Since 2003, a fast increase in agricultural production was observed, both for arable farming (+100%) as well as livestock farming (+65%). Throughout this period the relative contribution of the main sectors arable and livestock farming remained in balance, 55-65% versus 45-35% respectively (Figure 6.3.1.2). In arable farming, the largest increase in production was observed in fruits growing (+128%), followed by vegetables (+80%) and cereals (+30%) (Figure 6.3.1.3).

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

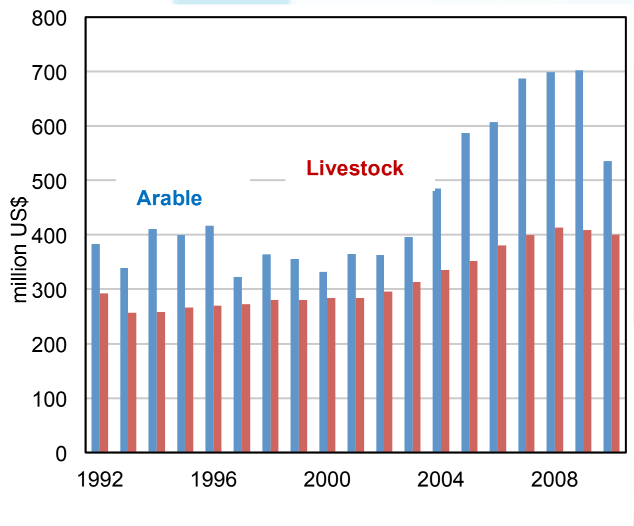
By the end of the 1980s, irrigation in Armenia reached its peak at more than 300,000 ha, highly dependent on regular maintenance and pumping stations with high energy consumption. The irrigation system included more than 70 reservoirs, 3,000 km of primary and secondary canals, 16,000 km of tertiary canals,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

Figure 6.3.1.1 Agricultural sector value share in the national GDP.



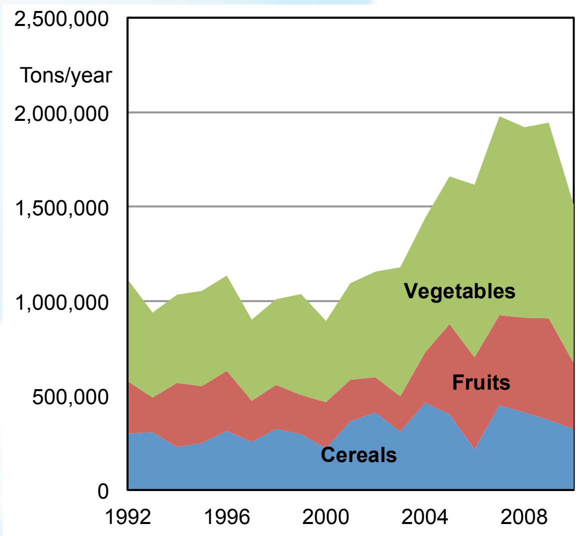
Source: The World Bank, http://data.worldbank.org/indicator/. Notes: Left y-axis refers to % agricultural contribution to the country GDP; left y-axis total value of country GDP and agricultural production in mln US$.

Figure 6.3.1.2 Development of crop and livestock production values.



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

Figure 6.3.1.3 Crop production in time for major crop groups.



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

Following independence, the area under irrigation rapidly declined to a current 150,000 ha (Table 6.3.1.1). Main causes for the decrease include degradation of water distribution & drainage systems, due to a lack of maintenance, excessive pumping costs, the shift from collective farms to private smallholdership, and bad management of supplier reservoirs, frequently causing water shortages during the vegetation season. Currently the water losses in the conveyance schemes are assessed to be as high as 60%.

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

Table 6.3.1.1 Development of irrigation in Armenia between 1985 and 2010.

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

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

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

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

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

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

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

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

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

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

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

Azerbaijan

In Azerbaijan, 55% of the country – 4,768,700 ha - land is use for agriculture, including natural pastures and meadows. Arable lands occupy 39.5% of agricultural lands, of which 12% was left fallow in 2011. Arable lands mainly were used for grains (60.1%), fodder crops (24.5%), and vegetables, including potatoes (11.2%) (AzerStat, 2012). About 30% of the agricultural land is irrigated – 1,424,400 ha, mainly arable lands, perennial crops and annual grasslands. During land reform after independence in 1991, 1,351 mln ha of land were given to farmers. At present agricultural production is mainly a prerogative of private farmers, producing 94.8% of gross output value, up from 2% in 1990 (AzerStat, 2012), equally divided over plant growing and livestock farming. Commercial enterprises tend to be involved in livestock farming (65% of value produced), especially poultry production. Development of agricultural production is presented in table 6.3.1.2.

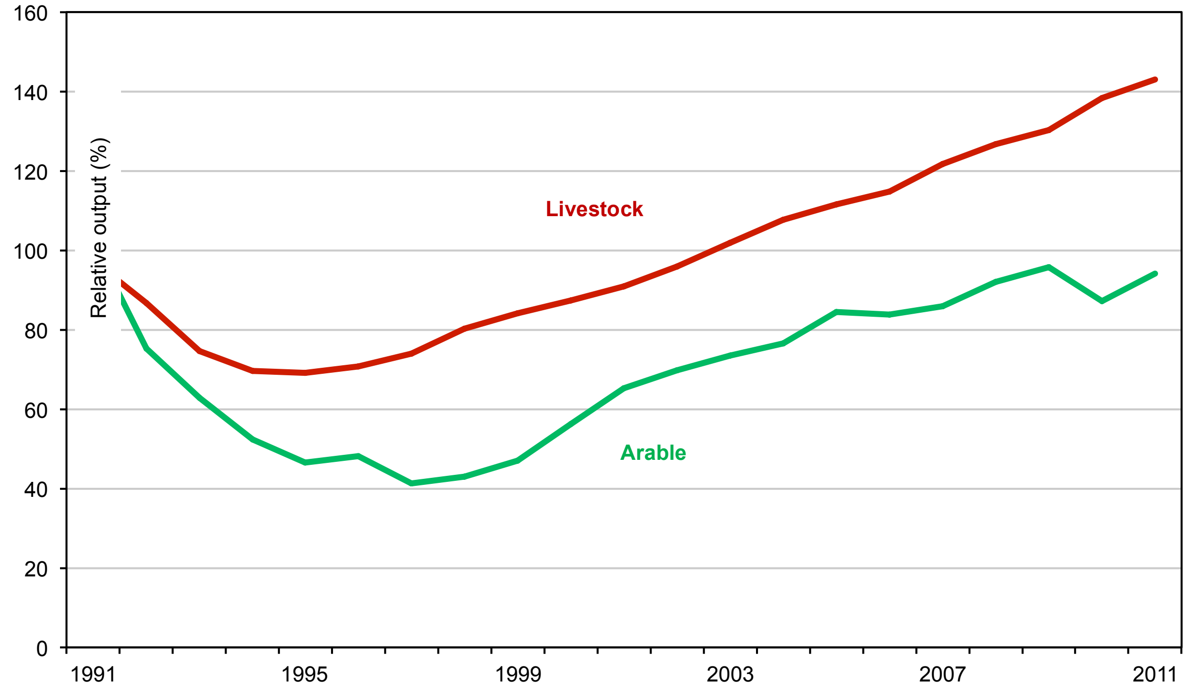
After the collapse of the Soviet Union, agricultural output significantly declined, both in arable cropping as well as livestock farming (Figure 6.3.1.4), as land, livestock and farming equipment was distributed and the collective farms were dismantled. Figure 6.3.1.4 shows that by 2003 livestock farming was restored to the 1990 output level, continuing to grow to a 50% increase in production output by 2011. As a result, overgrazing became an increasing problem, also due to the lack of integrated pasture management. Arable farming meanwhile did not manage to restore its previous production output high in 1990, although since 2000 the negative growth has been reversed. One reason is that irrigation channels, especially the tertiary arterial systems having degraded and not been maintained in many areas of the basin since the late 1980s.

Table 6.3.1.2. ***Development of crop production and livestock.***

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

Source: stat.gov.az

Figure 6.3.1.4 ***Relative annual agricultural output compared to the 1990 production level (1990=100).***

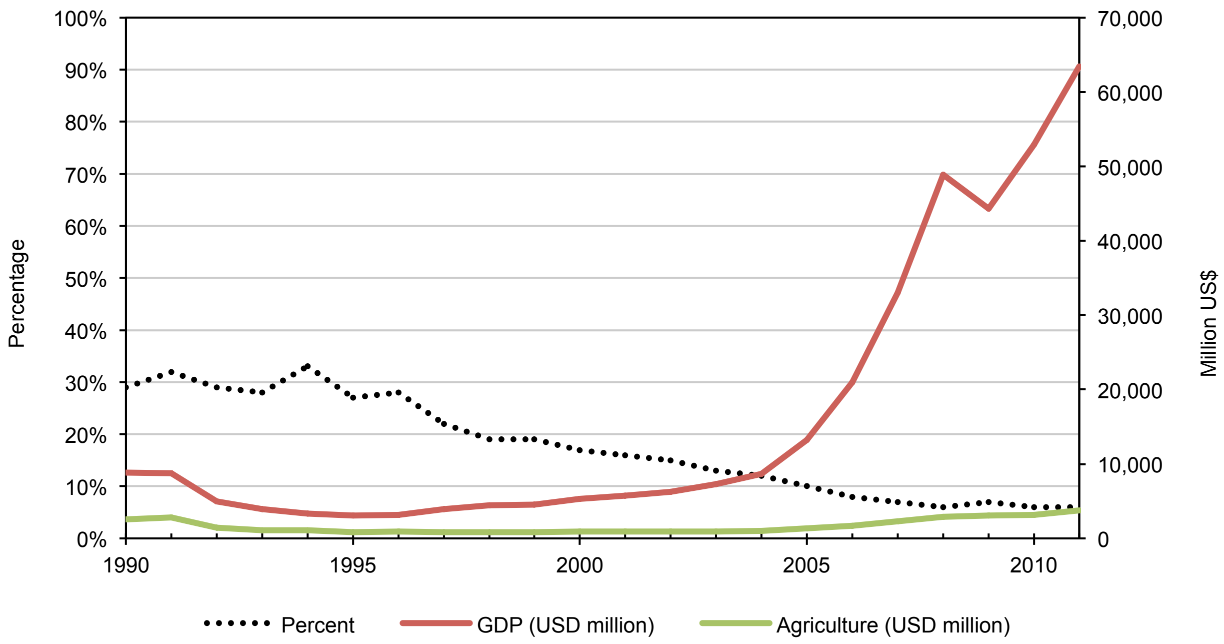


Source: stat.gov.az.

Figure 6.3.1.5 shows that since 1990 the relative contribution from the agricultural sector to the GDP decreased from about 30% in the early 1990s to 6% in 2011, largely due to the significant increase in contribution of the petroleum sector to the GDP. Meanwhile the overall value of agricultural production significantly increased since 2005, exceeding the 1990 level by about 50%. In the intermediate years agriculture suffered from a serious depression, during which annual production fell as low as 35% of the pre-1990 level. Meanwhile about 40% of the country's work force is employed in agriculture, while a larger part engages in subsistence farming.

The development of irrigation – in land surface cover and use of water – during the second half of the 20th century in Azerbaijan is presented in table 6.3.1.3.

Figure 6.3.1.5 Agricultural sector value share in the national GDP (Azerbaijan).



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

Table 6.3.1.3 Development of irrigation in Azerbaijan between 1945 and 2010.

Irrigation parameter	1945	1955	1965	1975	1980	1985	1990	1995	2000	2005	2010
Land areas (x 1,000 ha)	685	880	1040	1,160		1,340	1,423	1,453	1,426	1,433	1,425
Water use (mln m^3/yr)	2,664	2,688	3,450	4,740	6,660	9,132	8,627	7,720	3,819	5,710	5,497

Source: State Statistical Committee of the Republic of Azerbaijan, based on data from the Joint Open Company of Irrigation and Water Industry.

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

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

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

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

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

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

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

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

Georgia

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

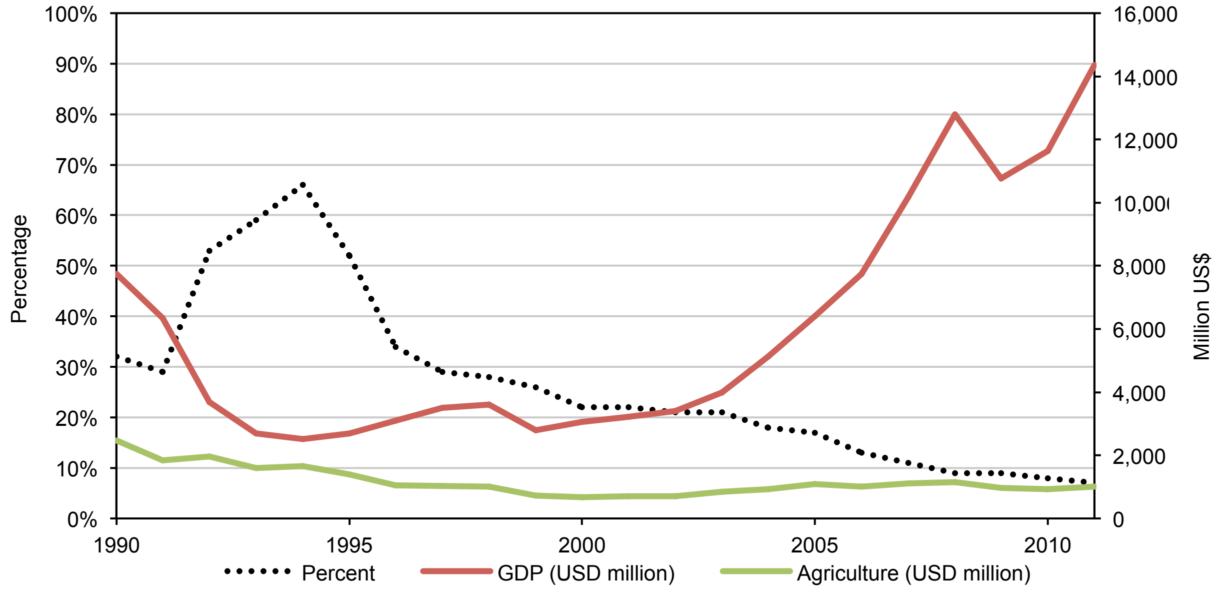
Table 6.3.1.4 Development of irrigation in Georgia between 1945 and 2010.

Irrigation parameter	1945	1955	1965	1975	1980	1985	1990	1995	2000	2005	2010
Land use (x 1,000 ha)	201	265	306	283		345		350	160	30	24
Water use (mln m^3/yr)					1,566		1,354	1,445	208	87	59

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

During the Soviet period, agriculture was a key sector of Georgia's economy, exporting vegetables, fruits and subtropical cultures to the Soviet Republics (G-PAC, 2010). Accordingly, the contribution of agriculture, including arable crops, livestock, forestry, hunting and fishing to the GDP was high, provided for 32% of GDP in 1990. While the share of agriculture to the GDP surged in the early 1990s, this represented only a relative increase compared to even worse conditions in other sectors of the economy, as the total annual production value continued to decrease until the early 2000s. Since 1994 the share of agriculture in GDP decreased significantly, via 22% in 2000 to 9% in 2011 (GE-MEPNR, 2008) (Figure 6.3.1.6). Data on irrigation expansion and decrease are presented in table 6.3.1.4.

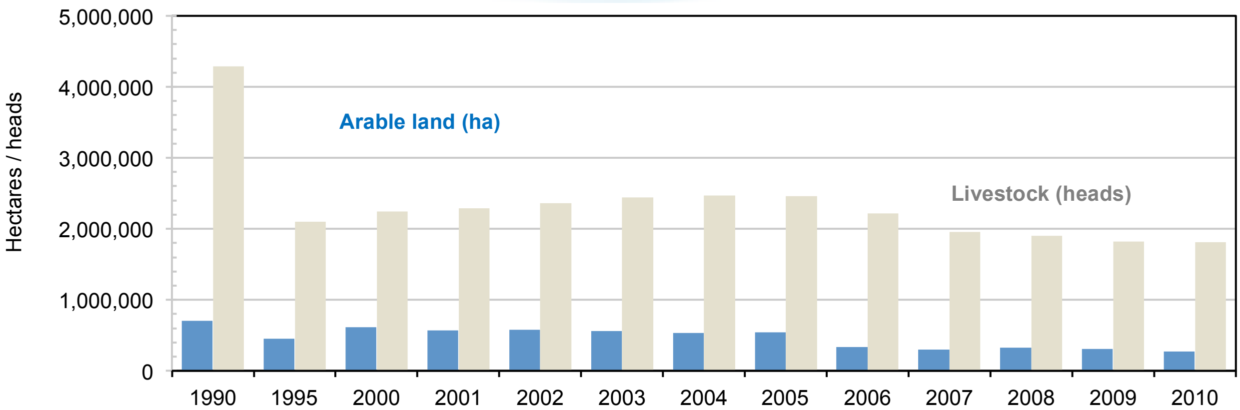
Figure 6.3.1.6 Agricultural sector value share in the national GDP (Georgia).



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

Sown areas declined by nearly 35% in the years immediately after independence, and livestock numbers (cattle, pigs, sheep) by 50%. Sown areas rose between 1995 and 2000, and then started to decline again. In 2010 the sown area constituted 40% of the 1990 level (Figure 6.3.1.7). In 2011 the irrigated area in Georgia amounted to 24,000 ha, down from 386,000 ha in 1988, largely located in the dryer eastern part of Georgia, in the Kura Ara(k)s river basin. The decline in livestock numbers after 1990 was followed by a period of expansion until 2004 but then moved into another phase of decline. At present livestock numbers constitute 42% of the pre-independence level, the lowest since independence, at 1.1 mln heads of cattle, 105,000 pigs, 630,000 sheep and goats, 6.4 mln heads of poultry. Livestock herds were affected by an outbreak of African swine fever in 2007, and increased exports to the Middle East and neighboring countries (USAID, 2011).

Figure 6.3.1.7 Land cultivation and livestock in 1990-2010 in Georgia.



Source: USAID (2011).

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

Nevertheless, the agricultural sector remains as one of the most significant sources of income of population of Georgia and one of the key contributing factors for eliminating poverty in the rural areas. Over 55% of the active labor force derives the majority of their income from the agricultural sector (GeoStat, 2010). Recently the government therefore is giving renewed attention to the development of the agricultural sector. While discussions are ongoing to make Georgia a net exporter of grains and cereals within the next 20 years, and the Strategy of Agriculture Development of Georgia for 2012-2022 has been drafted, still no officially approved document is available. The new government meanwhile has announced its priorities for reforms in agriculture to include economical strengthening of the rural areas, increased incomes and living standards of farmers by means of modernization of the sector, differentiation of agricultural services, increased competitiveness of the agricultural sector etc. which should significantly increase agricultural production, reduce import, towards a better self-sufficiency for agricultural products in the country (Georgian Dream, 2012).

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

Recently a trend of farm land consolidation is being observed, with the size of private commercial agricultural holdings having doubled to an average size of 10 ha (USAID, 2011). Since the early 2000s the Georgian government also invested in irrigation & drainage infrastructure rehabilitation programs. The total area suitable for irrigation is estimated at 725,000 ha (FAO Aquastat, 2012), of which 500,000 ha were already adapted in the early 1980s, systems which are largely deteriorated at present. The main source of water for irrigation is river diversion. The Ministry of Agriculture aims to enhance irrigation areas from 24,000 ha to 200,000 ha in next 3-6 years. The plan will refurbish primary and secondary canals, install efficient methods of irrigation systems, including drip irrigation. For this, state funding is planned to increase by US$ 32 mln in 2013. Rehabilitation of 10 irrigation channels is ongoing in 6 municipalities in the Kura Basin (Marneuli, Gardabani, Mtskheta, Sagarejo, Kareli and Kaspi). Two other irrigation & drainage improvement projects are planned to start in 2013, financed by the International Fund for Agricultural Development (IFAD; US$ 15 mln) and the World Bank (US$ 50 mln).

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

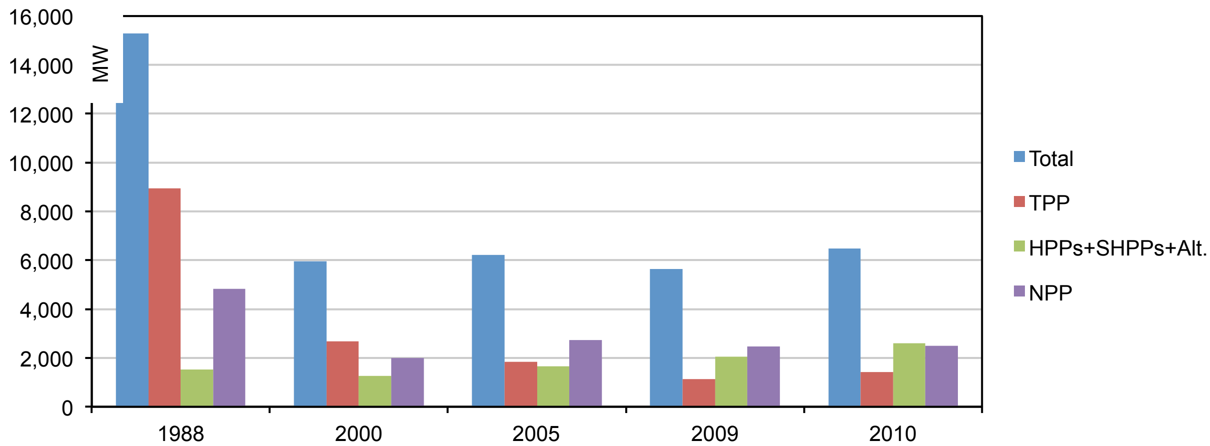
6.3.2. Hydroelectric and industrial water use

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

Armenia

The energy sector in Armenia suffered through a period of reduced availability, due to the economic crisis, the earthquake impacts on the Metsamor NPP, and unreliable gas supply. Since 1996 however the country is able to satisfy its internal needs, despite the overall production being at only 42% of that during the late 1980s. The period of independence also shows a shift from nuclear (-57%) and thermal power (-84%) towards hydropower (+70%) (Figure 6.3.2.1). In 2011, the total in-country energy production amounted to 7,432.7 GWh, of which about 15% was exported, the remaining 6,351.0 GWh for in-country use (ArmStat, 2012). Before 1990 hydropower generation depended mainly on large HPPs, namely the Hrazdan and Vorotan Cascades, still in operation today, with a total capacity of about 1,000 MW. Construction of small HPPs started after 2000. At present, 129 SHPPs are operational, with a total capacity of 210 MW.

Figure 6.3.2.1 Power generation trends in Armenia in 1988-2010 (in MW).



Source: International Atomic Energy Agency (2011).

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

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

The National Program on Energy Saving and Renewable Energy (2007) provided for a cross-sectoral assessment of the energy saving and renewable energy potential in Armenia and recommended actions for its cost-effective utilization. The assessment included an in-depth examination of all large and energy intensive enterprises as well as end-use consumption. This allowed revealing trends and making projections for development of the Armenian energy sector. According to the Program, the future development of the sector is planned through: 1) construction of medium size HPPs (with the capacity of 250-300 MW); 2) construction of additional small HPPs with the total capacity up to 250 MW; 3) rehabilitation of the thermal power plants and construction of modern cogeneration steam-gas power units; 4) continuous enhancement of the safety level of the existing NPP and development of new nuclear units based on modern technologies; 5) investing in renewable energy units, using wind (up to 200 MW), solar (up to 1,750 KWh/m^2/yr) and geothermal sources.

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

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

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

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

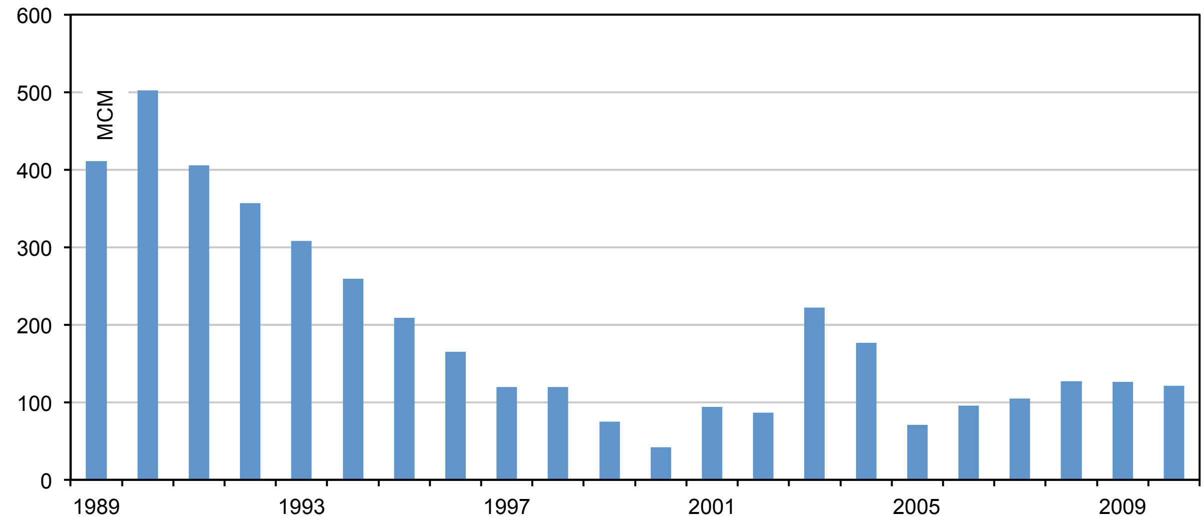
Industrial water use in Armenia significantly reduced since independence, following the economic crisis and the related sharp decline in the industrial production (Figure 6.3.2.2). The current share of the industry in overall water use in the country is less than 5%, obtained from both surface water as well as groundwater sources, either from private sources or through the municipal water supply network.

At present no national level forecast for the industrial water use trends is available. It is expected that along with development of the river basin management plans these trends will be identified.

Azerbaijan

In 2011, electric energy production in Azerbaijan amounted to 20,294 mln KWh, of which 85% was generated by thermo-electric stations and 13.2% by hydro-electric stations. Currently existing HPPs in Azerbaijan are listed in table 6.3.2.1.

Figure 6.3.2.2. Industrial water use in Armenia, 1989-2010.



Source: National Statistic Service.

Table 6.3.2.1 Existing hydropower stations in Azerbaijan.

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

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

In addition, it has been planned to build three hydropower stations on Shamkirchay water reservoir which is currently used for irrigation and energy production (AWE JSC, 2010). Installed capacity of the existing HPP on the Shamkirchay reservoir is 24.2 MW, with annual energy production of 50 GWh. The total volume of the reservoir is 160 MCM, useful volume – 135 MCM. There are two HPP stations under construction currently. A 25 MW HPP station is being built on the main Mil Irrigation Channel taking its beginning from the Ara(k)s River. The construction is planned to be finished in 2013. In addition, a small, 1 MW HPP station is being built on Goychay River, a left tributary of the Kura River. The construction has to be finished by the end of 2014.

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

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

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

Industrial water consumption significantly declined following independence and the related economic and political crisis, which resulted in the closure of ferrous and non-ferrous metallurgy, textile and other industries within the basin. However, after opening of the Gadabay and Dashkasan gold-copper deposits, the Silk Factory of Sheki, as well as the expansion of TPPs, the overall industrial water consumption increased again. In 2011 industrial water abstraction reached 1,760 MCM, still below the 2,280 MCM in 1980. Meanwhile in the Kura Ara(k)s basin water consumption has increased by 184.2 MCM. Industrial water use in the Kura Ara(k)s river basin comprises 73.6% of the total industrial water use in Azerbaijan, largely accounted for in the Aran economic region (98.7%), due to thermal power plants located there (AzerStat, 2012).

Georgia

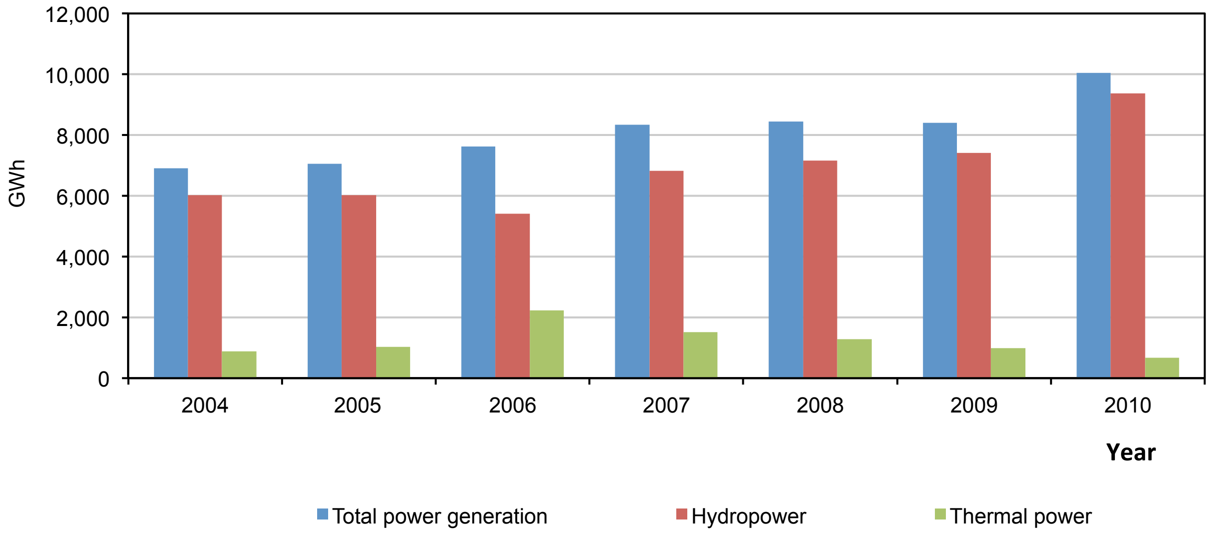
Hydropower is the only domestic energy resource available in significant volumes in Georgia. The total hydropower potential in the country is estimated at 80 TWh, of which 27 TWh is considered to be economically viable.

Following independence from the Soviet Union, Georgia suffered severe energy crises, as the country largely depended on imported electricity, because the local power generation was low due to deteriorated infrastructure. Since 2000 significant investments have been made, in power generation as well as transmission and distribution networks. Consequently, from a net importer, Georgia has become a net exporter of electricity. Total power generated in Georgia amounted to 10,046 GWh in 2010 (Figure 6.3.2.3). From this hydropower generation is accountable for 9,368 GWh (93%) and thermal power generation for 679 GWh (7%). The mean annual growth rate in hydropower production from 2004 to 2010 amounted to 6.7% (EBRD, 2012). The share of TPPs has been gradually reduced, currently used for covering peak demands, a consequence of increase gas prices. Currently 51 HPPs are operational, of which 29 located in the Kura basin. Existing HPPs vary in size from large (3,800 MW, Inguri HPP) to very small (<1 MW). The majority of HPPs are run-of-river types with dams not exceeding 10 m., while about 20% of all HPPs consist of larger dams (up to 100 m – Zhinvali HPP) with corresponding reservoirs.

Currently Georgia plans to significantly expand hydropower generation in the near future. Already throughout the country 36 more hydropower development projects are planned of which 9 are to be constructed in the Kura Basin (Table 6.3.2.2).

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

Figure 6.3.2.3. Power generation in Georgia in 2004-2010.



Source: National Statistic Service.

Table 6.3.2.2 Overview of hydropower generation in Georgia.

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

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

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

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

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

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

6.3.3. Municipal Water development

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

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

Armenia

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

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

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

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

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

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

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

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

Azerbaijan

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

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

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

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

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

Georgia

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

Starting from 2004 the optimization of drinking water resources management was started, funded from the state budget with support from international donors. Extensive reconstruction-rehabilitation works had been carried out in Tbilisi in the period of 2005-2007. Most central water supply pipelines have been rehabilitated and all major drinking water quality monitoring laboratories have been refurbished and equipped with modern computerized systems (ECBSea, 2009). Currently Tbilisi is provided with an up-to-date high-quality water supply service ensuring delivery of good quality drinking water without significant interruptions 24 hours a day to 400,000 customers, of which about 2,000 are public and state organizations, about 15,000 commercial enterprises and the rest are in the residential sector (GEO-Cities, 2011).

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

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

6.3.4. Literature cited

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Zerkala Newspaper, 17 November 2012

7. FUTURE TRENDS AND SCENARIOS

In line with GEF International Waters Best Practices the TDA has provided a detailed baseline description of the situation in the basin, as well as an analysis of the priority transboundary issues, including a causal chain analysis for each issue. The linkages chapter and the chapter on regional development trend in relation to water management, including climate change, extend to new information and analyses within the TDA.

However, in order to examine the challenges that the countries are facing, it is imperative not only to consider the sectoral historical developments that have led to anthropogenic deterioration of the basin ecosystems, but also to consider these within the context of intersectoral future development in the basin.

Accordingly, the current chapter presents an assessment of socio-economic development trends as they impact on water use, based on empirical evidence, in order to examine the future challenges to development. This includes examination of both short term and long term development plans for all sectors and an assessment of the implications for water resources and riverine ecosystem health with in the countries and across the basin.

The information for the assessment is drawn from UNFCCC National Communications, social historical and economic development trends, as well as sectoral development strategies and plans for each country, collected by the Project Team. It represents the best information on hydropower development, municipal water development and agricultural development currently available.

The chapter concludes with a discussion of two potential scenarios for water resources development in the basin, including the potential costs and benefits for “Business as Usual” and for “Regional Coordination of Water Resources Management”.

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

7.1. Assessment of observed trends

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

7.1.1. Hydro power generation

As described in chapter 6.3.2 for each individual country and the Kura Ara(k)s basin area within the country, the hydropower sector is envisioned to expand significantly in the nearest future. Table 7.1.1.1 presents an overview of all short- and long-term development plans defined by the responsible sectoral authorities in the countries Armenia, Azerbaijan and Georgia.

Table 7.1.1.1 Overview of hydropower development plans in the South Caucasus.

Sector HPP generation	Armenia	Azerbaijan	Georgia [c]	Total
Current installed (MW)	1,201	1,232	525	2,958
Licensed/under construction (MW)	418	150	201	769
Short-term total (MW) [a]	1,619	1,382	726	3,727
Short-term planned increase (%)	34.8	12.2	38.3	26.0
Country contribution to total short-term regional increase (%)	54.4	19.5	26.1	100.0
Long-term planned - increase [b] (MW)	370	175	170	715
Long-term planned - total (MW)	1,989	1,557	896	4,442
Relative increase - long-term national (%)	65.6	26.4	70.7	50.2
Country contribution to long-term regional increase (%)	51.7	24.5	23.8	100.0
Country contribution to overall short & long-term regional increase (%)	53.1	21.9	25.0	100.0

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

Based on table 7.1.1.1 the following conclusions can be drawn on regional hydropower development in the Kura Ara(k)s river basin until 2025:

- The currently installed hydropower capacity in the Kura Ara(k)s basin is 2,958 MW.
- Approved & licensed plans or ongoing construction works on expanding the hydropower capacity in the basin amount to in total 769 MW, a 26% increase compared to the current capacity.
- The largest absolute short term increase in MW capacity is planned in Armenia, increasing by 418 MW, compared to 201 MW in Georgia and 150 MW in Azerbaijan.
- At country-level the relative short-term envisioned increase in hydropower capacity is the largest in Georgia (38.3%) followed by Armenia (34.8%) and Azerbaijan (12.2%). The relative contribution of the individual countries to the overall short-term regional increase shows that Armenia contributes relatively more (54.4%) than Georgia (26.1%) or Azerbaijan (19.5%).
- Existing long-term plans envision an additional expansion of hydropower generating capacity of 715 MW, equal to an additional 19.2% increase on top of existing and ongoing short-term developments. Accordingly, by 2025 the total hydropower capacity in the Kura Ara(k)s basin is envisioned to increase by 50.2% compared to currently installed capacity. This potential increase will include 769 MW in short term ongoing activities and 715 MW in long-term plans.
- The largest overall relative increase in hydropower capacity is envisioned to occur in the Georgian section of the Kura Ara(k)s basin, planning to increase its current capacity of 525 MW to 896 MW, an increase of 70.7%. Armenia closely follows with 65.6%, and Azerbaijan plans an extension of 26.4%.
- Meanwhile the largest absolute long-term increase is planned in Armenia – 788 MW, followed by Georgia (371 MW) and Azerbaijan (325 MW).
- The largest contribution to the overall short- and long-term expansion of hydropower in the Kura Ara(k)s basin comes from Armenia (53.1%), followed by Georgia (25.0%) and Azerbaijan (21.9%).
- Most plans focus on installing small and medium-sides HPPs, based on the run-of-river approach. Although this approach does not use large dams and reservoirs, the environmental impacts still can be significant if proper environmental flows are not maintained. Potential impacts include a longitudinal disruption of flow and sediments, decrease or destruction of river biodiversity, including fish, both in quantity and quality, and a resulting loss of ecosystem functions. Also the geomorphological characteristics of rivers may be affected, due to the redirection of river water away from its current path.
- Installing run-of-river HPPs may affect the water availability to other water users along the piped pathway, including municipal, agriculture and industrial users.

- Potential HPP development in upstream areas may significantly impact on the return on investment for HPPs in downstream areas, if not planned and managed in a coordinated manner. This includes potential impacts on current developments including the Iranian/Armenian shared HPP at Meghri.
- A shared view exists on climate change as an ongoing process in the South Caucasus. An increase in temperature together with a decrease in precipitation is envisioned to cause an overall reduction in river flow. While forecasts are based on generalized, regional models, the heterogeneous topography and relief of the South Caucasus region will provide for significantly more spatial variation in actual climate change at any specific location. This will have significantly consequences for any tributary's capacity to generate hydropower, reliable assessments of which are currently unavailable as no suitable hydrological flow forecast models exist.
- In the event that larger scale HPPs are developed, additional issues of reservoir filling & release schedules, seasonal energy requirements, and seasonal needs for irrigation as well as downstream ecosystems must be taken into consideration. The failure to coordinate this can have significant impacts on food security, water security and environmental security within the basin.
- Impacts of hydropower development are not only transboundary but national as well. These include:
  - While the largest hydropower development is planned in **Armenia**, also other water use development plans exist, including the further increase of water levels in Lake Sevan (by 2025: +3.5 m; +6 BCM), the increase in irrigated lands (+200%). These will also impact on available water resources, to be more acutely felt nationally, in addition to their transboundary impact.
  - In **Azerbaijan**, any increase in hydropower generation in upstream areas may impact on the seasonal availability of water resources to cover irrigation needs, increasing due to the planned expansion, as well as climate change impacts. Meanwhile, the development of irrigation together with climate change may impact on opportunities to generate hydropower in downstream areas.
  - In **Georgia**, any expansion of hydropower in the Kura basin may impact on the amount of water available for an envisioned expansion of irrigation, especially in the Alazani basin where commercial irrigated vegetable production already exists and is projected to expand.
- Additional studies should be undertaken to take energy transmission potential, type of hydropower being used, impacts on environmental flows and potential for coordination between sectors within and between countries into account, to maximize the positive impacts and minimize the negative impacts of hydropower development.

7.1.2. Municipal water use

As described in chapter 3.2 and chapter 6.3.3 there are opportunities for improving and expanding municipal water supply in the individual countries of the Kura Ara(k)s basin. While limited specific information is available for this sector, a preliminary assessment of the joint impacts of envisioned development plans for the Kura basin has been undertaken.

Table 7.1.2.1 Water consumption by sector in three South Caucasus countries in 2011.

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

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

From the features on sectoral water consumption, presented in table 7.1.2.1, one can observe:

- The highest consumer of national water by far is agriculture, using almost 77% in Azerbaijan, 71.1% in Armenia, and 23.7% in Georgia. Overall, agriculture in the Kura Ara(k)s basin accounts for 69.8% of all water consumption. Any expansion of the sector (see below) therefore will have important impacts on both water quantity and water quality. Volumetric water use in agriculture depends on irrigation method applied, crops varieties grown with specific crop water requirements and drought tolerance, cultivation methods, soil types, as well as the efficiency of water transportation in the distribution system. Water quality depends on the chemical composition of agricultural discharges into the surface and groundwater. Via agricultural drainage or seepage water potentially land-based sources of pollution, including harmful agrochemicals, salts and other contaminants may enter the rivers.
- According to the Trend Analysis Desk Study, industrial water consumption has increased only in Azerbaijan since the collapse of the Soviet Union. In both Armenia and Georgia the industrial sectors and related water use have declined, but as economies are recovering, it is likely that there will be an increase in industrial water use. The current data shows that 21.5% of consumption in Armenia, 20.1% in Azerbaijan, and 34.3% in Georgia is used in industrial processes, with the overall basin level consumption at 22.0%.
- Increased rates of industrial water use have significant potential to negatively impact on water quality, if insufficient attention is paid to minimizing pollution outflows. This becomes the more important as water resources are forecasted to become more limited, reducing the rivers' capacity to dilute pollutants entering the system.
- Municipal water consumption is relatively low in Armenia, at only 7.4% of total consumption. In Azerbaijan, where significant water resources are redirected to surplus Baku's available resources, municipal water use amounts to 13.6% of total abstraction, of which roughly one fifth is withdrawn for use inside the Kura Ara(k)s basin. In Georgia, where consumption overall is much lower as there is less need for irrigated agriculture, municipal water use accounts for 42.0% of total water withdrawals. Accordingly, for the Kura Ara(k)s basin municipal water use accounts for 8.2% of water consumption to date.
- Municipal water use is expected to increase significantly in the near future, related to an ongoing increase in population numbers, increased welfare levels of the population, as well as the expansion of municipal water supply services and wastewater treatment capacities in the three basin countries. The rate of increase in municipal water supply should not exceed the rate of strengthening wastewater treatment capacities, both in volume as well as geographical coverage. This is a common feature in municipal water development, because less investment is required to improve water supply services compared to the sanitation services. The availability of municipal water services without proper sanitation services will increase overall consumption, which in turn will increase the volume of polluted sewage wastewater released directly into rivers and waterways, if expanding the wastewater treatment capacity is lagging behind. This will have a serious impact on water quality, especially also in light of declining water resources as a result of climate change.
- Specific developments of importance at the national level include:
  - In **Armenia**, the impacts of expanded hydropower, see above, and increased agriculture, discussed below, will have impacts on water availability for industrial and municipal water use, both annual volumes as well as seasonal availability. Also, the quality of water within the country could jeopardize human health, if wastewater treatment facilities for municipal and industrial water are not updated, and polluted water is used downstream for agriculture, or if agricultural drainage water is used for either municipal or industrial purposes.
  - For **Azerbaijan** the water consumption from surface water sources in the Kura Ara(k)s basin is much higher than either Armenia or Georgia. Main factors include the larger population, the more arid climate and the higher dependency on river water as the major source for water consumption. A significant portion of the water abstracted for consumption meanwhile is "exported" outside the Kura Ara(k)s basin, to support consumptive needs in the Baku area. Accordingly, the availability of water of sufficient quantity and quality will be a concern at the national level, especially if growth rates in industrial, municipal and agricultural uses will continue, taking the forecasted impacts of climate towards more scarcity of water in the region into account. The inter-basin transfer of water for municipal use to Baku will likely increase as the population in Baku continues to grow, a trend observed also within the Kura Ara(k)s basin of Azerbaijan. As the most downstream country, the most arid one, and the most dependent on the Kura Ara(k)s as the main

source of water, Azerbaijan may face water scarcity that has the potential to create significant water insecurity and food insecurity if not addressed through inter-sectoral and transboundary coordination.

- For **Georgia**, the total water consumption is much lower than either Azerbaijan or Armenia, due to its climatic and geographical features. The municipal water consumption is less of an immediate concern within Georgia, with supplies largely originating from groundwater sources, however wastewater disposal must be considered for downstream impacts, including impacts on communities in eastern-most Georgia. For example, an increase in water consumption in the Iori basin, where water scarcity is already an issue during dry seasons, would create challenges for an increased outflow of polluted wastewater into decreasing water volumes. This has potentially significant negative impacts on ecosystems as well as the health of Georgian citizens, as well as on transboundary relations.

7.1.3. Agricultural water use

Chapter 6.3.1 described the developments in the agricultural sector during the last two decades, as well as the national development plans in the countries. A quantitative overview of the current expansion plans for irrigated agriculture is presented in table 7.1.3.1, including an assessment of the impact of agricultural water use on river flow.

Table 7.1.3.1 Overview of current and future agricultural water use in relation to river flows across national borders.

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

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

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

- Each basin country is planning for a significant increase in irrigation.
  - In Armenia, where significant international investments are being made in restoring and improving irrigated agriculture, the plans are to increase from 154,000 ha to 454,000 ha within 15 years. This is equal to a relative increase of 195%, for which an additional 1.41 BCM needs to be abstracted from the country's rivers. Accordingly the outflow from Armenia's rivers to downstream Azerbaijan and Iran reduces by 17.8% to an average 6.5 BCM. While some irrigation water may return to the river system, either through groundwater seepage or via drainage canals, information on this issue is not readily available. As noted above, irrigation development in Armenia may significantly decrease water resources availability – total and seasonal - for downstream HPPs.
  - In Azerbaijan, highly dependent on irrigation for farming and food security, current plans anticipate a 25% (350,000 ha) expansion of irrigated lands, increasing the annual water consumption in agriculture by 1.22 BCM. The result would be an 8.6% decline in river outflow from Azerbaijan into the Caspian Sea. This will likely impact fisheries and ecosystem health, especially taking into account that also river flow will decrease due to expanding upstream abstraction as well as climate change, anticipated to be significant in the lower Kura basin.
  - In Georgia a drastic expansion in irrigation of 784% is envisioned, which will significantly increase water use to 0.96 BCM. Although the percent change to the total outflow from Georgia into Azerbaijan is limited to 5.9%, locally on tributaries the impact may be larger. For example, if a significant expansion in irrigation is planned in the Alazani and Iori tributary basins, the only mechanism to ensure sufficient water supplies may be to rely on inter-basin transfers from the main Kura basin within Georgia.
- The envisioned 8.6% decrease in river flow from Azerbaijan into the Caspian Sea will be exacerbated by planned increased irrigation abstractions in upstream countries - 1.41 BCM in Armenia, 0.96 BCM in Georgia, to an overall 3.59 BCM. As such the outflow to the Caspian Sea will reduce by 25.1%.
- According to FAO (2012) all three countries have a far larger land area suitable for irrigation than currently being used, or plan on using in the nearby future. If all suitable lands would be brought in use for irrigation, the total volume of water assessed to be needed increases to 17.7 BCM. This would indicate that no more water will flow from the Kura river into the Caspian Sea, if the countries continue to manage and utilize water with the same efficiency as today. Accordingly, this should stimulate the basin countries to take urgent measures on improving the water use efficiency across the basin, and reduce losses in all sectors, as well as on realistic planning for future developments in the agricultural sector. The countries should also take measures to improve water quality and reduce pollution loads from other water use sectors. This will allow expanding the reuse of drainage water in agriculture, to partly meet the future increasing demands for water.
- It should be noted that the figures presented are based on assessed actual water use at the farm level, and as such do not take losses in the irrigation distribution system into account. Considering that the percentage losses is considered to be in the order of magnitude of 30-40%, the actual abstraction volume to satisfy planned irrigation needs would be 6-7 BCM. Accordingly the relative reduction in flow to the Caspian Sea would reduce by 40-50%, based on unchanged irrigation approaches.
- However, the project countries are aware of the importance of reducing losses throughout the water management sector, towards improving economic productivity, and making the best use of limited resources. An observed trend in agricultural developments in Georgia includes the in-migration of commercial farmers from South Africa and other countries, bringing BAT knowledge of farming in semi-arid areas, including operational management of commercial farming, knowledge that will help in initiating modernization of farm approaches, including the reduction of water losses in irrigation.
- The numbers presented above do not provide fully accurate information on changes in water use in the irrigation sector, as the actual abstractions will also depend improvements in water use efficiency There are potential gains from applying less water intensive irrigation and agricultural methods, including improved distribution canal efficiency, drip irrigation, sprinkler irrigation, no-till farming, drought-tolerant crops, and natural soil enhancement techniques. The current analysis indicates the level of impact in water resources to be expected in relation to investments in irrigated agriculture.

- Data on river flow volumes presented do not take any forecasted alterations in flows due to climate change into account, which are expected to be significant at the basin level but still unknown for specific tributary basins.

7.1.4. Conclusion and recommendations

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

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

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

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

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

7.2. Future Scenarios

The previous chapters of the TDA reviewed currently identified major transboundary issues, the primary, intermediate and root causes based on factual information. Also the linkages and commonalities between the transboundary issues were discussed, as well as the currently envisioned development of water resources use in the basin. Merging available information, expected developments and envisioned impacts two general future scenarios for river basin development can be considered:

- "Business as Usual", without intersectoral and transboundary coordination.
- "Regional Coordination of Water Resources Management", taking on pro-active action towards improved intersectoral and transboundary water resources management, based on applying the principles of sustainable development.

It is important to consider the costs and benefits of each of these scenarios to most effectively understand the strength of the recommendations laid out in chapter 8.

The overarching assumptions for both scenarios are equal: the forecasted climate changes in the basin will be significant; and socio-economic developments will continue in all three riparian countries. As discussed in chapter 6 and chapter 7-1, according impacts on water resources availability are expected, and management responses needed. Overall envisioned impacts include:

- Increasing temperatures which will lead to reduced soil moisture, and melting of glaciers.
- Overall decreasing precipitation, although some areas may note significant but sporadic increases in rainfall.
- Rising irrigation demand, related to increasing demands for food by a rising basin population as well as increasing crop water requirements due to increasing temperatures and related rise in evapotranspiration rates.
- Increased occurrence of extreme events, including flooding and drought, as well as heat waves and periods of frost.
- Changes in available water quantity, as flows decrease and demands increase in relation to growing sectoral demands.
- Shifts in the existence, quality, extent and spatial distribution of natural ecosystems, including riverine and aquatic ecosystems, and related changes in species occurrence and abundance, including endemic, rare and endangered species, as well as the services provided by species and natural ecosystems.
- Water quality: as the quantity declines, pollution concentrations increase, with consequences for its suitability for irrigation and consumption, as well as ecosystems.
- Increased disease vectors and water borne illnesses.
- Increased water insecurity as upstream and downstream demands, as well as groundwater withdrawals increase.
- Potential energy insecurity as water resources available for hydropower reduce.
- Increased environmental insecurity from anthropogenic stresses.

7.2.1. Scenario 1 – Business as Usual

The "Business as Usual" scenario, within the environmental management and socio-economic development scenario outline in the Trend Analysis, suggests that there may be a continuation of current policies, and current trends in segmented development. The hallmarks of this scenario:

- **Food insecurity.** Continued population growth throughout the basin, most significantly in its lower part. This will lead to an increased demand for potable water, food as well as the related irrigation water of acceptable quality to be used for increasing crop production. Limited availability of water resources from surface or groundwater resources may lead to food shortages and food insecurity, most notably within the lower basin. This is forecast for both national and regional impacts.

- **Increasingly insufficient water resources for all sectoral development plans.** Continued economic development in sectors without coordination leads to increased demands for finite water resources within countries and between countries. The lack of sectoral coordination will mean that there is a high likelihood for water resources to be insufficient available to meet all demands. The independently planned expansion of hydropower development, increase in municipal water use and the anticipated increases in areas under irrigation likely will sum up to overall demands that may surpass available resources, if not coordinated. As a result the segmented plans cannot be fully realized and costs will be incurred.

- **Further increased demand for water treatment and water insecurity**. As water resources decline due to over-abstraction, and pollution levels increase from municipal, industrial and agricultural sources, also the need for treatment of increasingly polluted water will increase, resulting in additional costs. Water insecurity will result, as water of poor quality cannot be used for many purposes and to meet the many needs it may be able to serve.

- **Continued irrational use of water resources.** As long as the real value of water resources and related ecosystem services is not realized, and realistically included in economic valuation procedures for development planning, imbalances in resources uses will become evident sooner, creating more intersectoral stresses and possibly regional tensions.

- **Increased strains on national budgets due to more severe events and marginalization of populations, including labor force health**. As addressed in the causal chain analysis for deterioration of water quality, as water resources become more stressed this will result in a decline in human health, putting increased strains on national budgets for health care. Additional migration of population can be expected as extreme climatic events push populations to seek improved conditions. The risk of regional non-coordination may increase the deterioration of water quality, decline human health, and decline able populations securing improved living conditions.

- **Continued ecosystem degradation.** Increasing pressures on natural ecosystems – fragmentation, degradation, destruction as well as overuse of their natural resources – will result in a decrease of ecosystem services provided, including water cleansing, flood mitigation, groundwater recharge, and a wide array of providing services for subsistence livelihood support. In addition to human impacts, ecosystem services will likely significantly be affected by climate change impacts.

- **Continued flood events without effective management**. Insufficient attention and response to natural features of flooding, and considering the upward trend in the occurrence of extreme events will result in the loss of life and property, and increase in government resources required to repair and replace losses.

- **Continued transboundary deterioration of water quality.** In addition to the decline in human health and the loss of income due to outmigration, discussed above, there is a need for improved water quality management at the transboundary level. Without a balanced coordination mechanism, water quality within the river basin can be expected to deteriorate further, especially as upstream countries insufficiently treat wastewater before its outflows across borders. While there are incentives to curtail this, these cannot be fully realized without some regional coordination mechanism. Accordingly, the risk of continued deterioration of water quality will remain high .

The benefits of maintaining the “Business as Usual” approach to water governance do exist and may be attractive to some decision makers who are not expecting to be in positions long enough to be accountable for actions, or the lack of them, or to deal with the consequences. These include:

- **Short-term political gains.** The benefits for a domestic decision maker to being risk adverse are well documented and relatively well understood, as domestic decision makers are frequently most interested in protecting their own, short-term interests and the interests of organizations they serve. This is observed in all societies and political spheres. The greatest benefit for non-coordination, taking into account the costs and benefits outlined above, is the benefit derived from short-term gains for decision makers. A decision maker who will risk little is often more secure in his or her position in the long term. The tenure of a decision maker is correlated with the acceptability of the decisions he or she makes. Coordination between sectors and coordination between countries can be full of risks for any decision maker, therefore often decisions are made based on short-term gains because those are less costly and often come with the highest gains. These gains are in the short term though. In the longer-term interests it is difficult to sway decision makers to act. Therefore those providing tools to support decision makers must always consider the position of the decision maker rather than only the position that is being advocated.

- **Increased development potential for short-term water availability.** In the short term, priorities are often to attract financing for development, focusing on short-term gains and assuming the specter of the future will not yet be a problem, as water resources still seem ample at hand. In development plans energy resources are understood to be limited and therefore planning strategies include a finite supply at any given time, despite multiple sources of energy. Water has not been given this same status in resource planning yet, and as a result there appears to be the assumption that water resources will be plentiful for all future demands, when clearly that cannot be the case.

- **National and sectoral autonomy maintained**. While water and the environment do not know political boundaries, the challenges that will be faced as a result of coordination are very real for decision makers. By maintaining the "Business as Usual" approach, national and sectoral autonomy can be maintained which can be very beneficial to decision makers who currently benefit from established water management practices, regardless of future costs or challenges.

7.2.2. Scenario 2 – Regional Coordination of Water Resources Management

The previous section provided an outlined overview of the scenario for "Business as Usual". The alternatives to this involve coordinated water resources management, between sectors and nations, taking climate change adaptation needs into account. This would assume that national IWRM plans are prepared – coordination of sectors - and that the common priorities have transboundary implications – coordination of nations. There are points that must be considered when advocating regional coordination, both positive and negative. Attention to the benefits alone does not strengthen the case, because the negative risks are the reality as well and must be addressed to justify coordination between sectors and across the region for improved and sustainable water resources management.

Risks of coordination

Coordination includes a degree of risk at any level and any situation, even if arrangements are mutually beneficial. The main risks of coordination in transboundary water resources management are:

- **Loss of perceived autonomy due to consideration and consultation with upstream and downstream users.** This includes sharing information that may historically be considered sensitive, consulting with other water users, both within and between sectors in national and regional settings. This may increase sensitivities especially when there are unresolved distribution issues between sectors in the individual countries.

- **Domestic political costs due to potential rationing of water resources.** In order for regional basin-wide water management to work effectively with finite and declining resources, it may become necessary to reduce activities and withdrawals in one (upstream) sector or country in order to provide sufficient quantities to any (downstream) sector or country, where also limitations to withdrawals apply. In the event that this can happen there is often a (national) political cost that must be realized by all parties. Whenever possible, institutional mechanisms could be established to ensure equitable use and fair distribution to meet the needs of all parties.

Benefit of coordination

There are many benefits to coordination that can be realized with complimentary and nested institutions. The complimentary institutions assume that no structure in one country will contradict that in another country. The nested institutions suggest that the management systems are complimentary and can be scaled larger or smaller. The EU WFD defined River Basin Management Organizations (RBMO) function in this manner, and creating such institutions in the wider Kura Ara(k)s river basin may become an anticipated vision for the future. The main benefits of coordination are:

- **Climate change adaptation and regional IWRM will enable improved sustainability for future generations.** The scenarios without adaptation, based on "Business as Usual" do not forecast a sustainable future when viewed within the challenges for the Kura Ara(k)s river basin in the coming years. Through regional coordination for IWRM and coordinated adaptation strategies there is a far greater likelihood that the rich but finite resources of the Caucasus will be managed in a way that will enable current and future generations to survive in sustainable and less stressed conditions than today, and will certainly improve conditions compared to the situation should there be no future coordination.

- **Increased regional cooperation will increase markets for agricultural goods, as well as other trade.** The "regional cooperation" scenario can also serve to improve food security in the event that there are severe conditions resulting from climate change. Regional cooperation based on shared and mutually dependent natural resources have been the hallmark for the long-term resolution of strains between countries. The European Coal and Steel Community was designed to allow for resource sharing between France and Germany after World War II. That same institution has now evolved into the European Union. This is not to say that regional peace will evolve from coordinated water resources management in the Caucasus, but it will serve to improve relations, including trade in agricultural goods, especially in times of crisis, and could potentially create relationships that would protect against increasing tensions in a time of crisis from external sources such a climate change.

- **Improved regional food security and decreased hunger induced conflict.** As noted above the opening of markets regionally could significantly improve regional food security and reduce conflicts resulting from lack of water resources and hunger among populations.

- **Improved water security.** The water resources of the Kura Ara(k)s basin and tributary basins are finite and the challenges of water resource management, if addressed at the basin level, has much greater potential to improve water security for all users and all sectors, including the environment.

- **Improved energy security.** Throughout the basin the issue of energy security has been keenly felt in the past decades. The planned expansion of using hydropower for energy generation is beneficial, increasing the countries' energy security, but it risks reducing water available for irrigation at key moments during the vegetation season, because the energy is needed in other seasons. Linking the energy resources between countries can increase the coordination so that energy is available when it is needed in and irrigation water is also available.

- **Improved environmental security.** Throughout this TDA there is reference to the environmental degradation of the Kura Ara(k)s river basin. The need to reduce transboundary degradation is based on improving the quality of life for inhabitants in the region and ensuring healthy ecosystem functions. If the countries of the basin act only to improve their own national interests and allow development to continue without intersectoral coordination the environmental will suffer and deterioration will have cumulative effects throughout the region.

7.2.3. Overview of scenario costs and benefits

A comparative overview of the two scenarios elaborated above is presented in table 7.2.2.1.

In the near future the defined scenarios should be examined in more detail, towards proving an important set of tools for understanding the needs and priorities for water use and distribution within the Kura Ara(k)s basin with the potential trade-offs between sectors measured and gauged not only nationally but also in transboundary basins. The use of the 'Water Nexus", which employs a multisectoral approach to examining these relationships, has good potential to serve as a very useful and informative framework tool for future decision making with regards to the challenges to be faced in each of the countries, the Kura Ara(k)s river basin and its transboundary tributary basins as well as the wider Kura Ara(k)s basin region in the coming years.

The application of this approach may offer a strong set of viable options for improving national and regional water security, food security, energy security and environmental security across the Kura Ara(k)s basin. This initial review of these scenarios combined with the planned water use assessment provides a baseline starting point for this approach and may be considered in future national and transboundary efforts, especially as the challenges of climate change become more intense and the need for concerted action becomes more apparent.

Table 7.2.2.1 Comparative analysis of water management scenarios for the Kura Ara(k)s basin.

	Scenario 1 **"Business as Usual"**	**Scenario 2** **"Regional Coordination of Water Resources Management"**
Costs/ Risks	• Food insecurity • Increasingly insufficient water resources for all sectoral development plans • Further increased demand for water treatment and water insecurity • Deteriorating water quality, including transboundary, and environmental insecurity • Continued irrational use of water resources • Increased strains on national budgets due to more severe events and marginalization of populations, including labor force health. • Continued ecosystem degradation • Increased severity of flood events	• Loss of perceived autonomy due consideration and consultation with upstream and downstream users • Domestic political costs due to potential rationing of water resources
Benefits/ Incentive	• Short-term political gains. • Increased development potential for short-term water availability • National and sectoral autonomy maintained	• Climate change adaptation and regional IWRM will enable improved sustainability for future generations • Increased regional cooperation will increase markets for agricultural goods, other trade • Improved food security and less hunger induced conflict • Improved water security • Improved energy security • Improved environmental security

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. Conclusions

Ideally a transboundary river basin should be managed at the regional level. However, at this time in the South Caucasus, establishing a regional water management body is premature. At the same time it is obvious that individual countries cannot contribute effectively to a regional coordinating body unless they have full capacity to manage the water resources within their own boundaries. Therefore it is recommended to build the water resources management capacity through implementing national IWRM plans, sharing common linkages at the transboundary level wherever possible. This includes consideration of responses to transboundary issues, being both upstream and downstream countries. This, and the recommendations outlined below, serves as the basis for the development of the SAP, which will facilitate a more coordinated approach to transboundary river management.

The TDA provides an overview of the baseline situation in the Kura Ara(k)s river basin, including the physical setting, the human-oriented socio-economic setting and the institutional setting in the three project countries relevant to water resources management. The identified main transboundary issues are explored in detail, based on the available factual evidence. The main transboundary issues describe the relevant transboundary aspects of the issue, the existing perceptions, the verifiable factual information and the gaps in evidence. A causal chain analysis is presented, which discusses the environmental and socio-economic impacts of the problem, as well as its primary, intermediate and root causes. Each section concludes with a set of recommendations to address the issue at hand. The current chapter presents a consolidated overview of these recommendations, including those for addressing the cross cutting issue of climate change adaptation. The linkages between the main transboundary issues have been discussed in a separate chapter. In a separate chapter also the development trends in the basin, including anticipated changes from climate change, social development trends and economic sectoral development trends impacting the water sector were discussed. Trends were then compiled to examine future scenarios for water use and the environmental consequences, based on business as usual and an alternate coordination-based future.

8.2. Recommendations

Below a summary overview of the compiled recommendations proposed for addressing the identified transboundary issues, as well as those for climate change adaptation. These recommendations have been provided to the Project Steering Committee for review and possible consideration in the Strategic Action Program, targeted for implementation in a future phase of the project. The recommendations are categorized to fit the Water Resource Objectives (WRO) agreed between the countries in 2007 during the preliminary SAP development.

WRO I To achieve sustainable utilization of water resources to ensure access to water and preserve ecosystem services

Specific targets and activities to make this possible include two key objectives: “To achieve improved management of existing quantities of groundwater and surface water resources”; and “To achieve reduced losses of water resources”. These will involve both national and regional level efforts to maximize the basin wide management approach.

1.1 Achieve improved management of existing quantities of groundwater and surface water resources

Update hydro-meteorological data collection systems with improved national and transboundary stations including the use of online real time monitoring techniques and established data information exchange mechanism to make information regionally available: The hydrological and meteorological monitoring equipment across the region has deteriorated in the past 20 years. While some updates have been initiated, in order to improve water resources management it must be possible to reliably gauge flows. Updating the data collection systems with improved national and transboundary stations can employ real-time monitoring techniques that reduce travel costs, and enable establishing data information exchange in support of sustainable management of shared basin resources.

Develop national and regional conjunctive use strategies for sustainable utilization of surface and groundwater resources based on future trends in water use for different sectors and the potential impacts of climate change, and using updated monitoring information for the groundwater aquifers in line with international BAT for national and transboundary aquifers: Incomplete information on available surface and groundwater availability increases the risks of overuse and damage to resource systems, especially as water stress is expected to increase due to climate change as well as the further development of water use. The development and implementation of national and regional conjunctive use strategies will enable the sustainable use of both surface and groundwater to meet demands for water security, food security and environmental security in periods of abnormal fluctuations and scarcity, ensuring minimal disruptions to social and economic welfare both nationally and regionally.

Assess water demands and sectoral net economic return to GDP per unit of water, applying the most appropriate and staged water nexus approaches to develop, and implement demand management mechanisms to optimize the utilization of available water resources, including allocations to environmental flows in sub-basins for subsequent use on the regional level: Without a clear understanding of the role that water resources play in the economy of the countries and the region, as well as the role of water for ecosystems, decisions are made on water allocations that may be suboptimal and on development plans that may be unsustainable, as water resource scarcity increases in line with increasing demands and increasing impacts of climate change. Conflicts between users emerge when there is resource scarcity and in areas as critical as the Kura Ara(k)s basin the threat of increasing scarcity and exacerbating tensions are significant. The economic valuation of services from water contribution to the GDP is an emerging field internationally, to support governments at local, national and regional levels making the best use of available water resources while continuing to support vital ecosystem functions. Use of the nexus approach in the basin for food security/water security/energy security/environmental security will enable decision makers to see the importance of tradeoffs for allocating available water resources and take steps towards improved sustainable management. A tailored best practices approach will be required in order to build on existing and new information, to build consensus on various scenarios and to develop a methodology that will support harmonization of water-dependent development for decades to come.

Provide support for capacity building to improve the sustained implementation of IWRM and ongoing assessments based on the water nexus and economic approaches: The UNDP/GEF project has identified many capacity needs for sustainable water resource management in the basin. Capacity building measures through the UNDP/GEF EU Kura Ara(k)s IWRM Academy initiated the process, yet additional efforts are needed to sustain future generations of water resource managers, especially as they work to address the competing demands of multiple sectors and employ international best practices. It will be critical to further harmonize the capacity building measures across the region so that future decision makers will be familiar with regionally specific conditions and share common understandings of the cause and effects of water scarcity and strategies for addressing those, including emerging natural resource economic approaches.

1.2 Achieve reduced losses of water resources

Adopt modern technologies to improve water use efficiencies in irrigation systems, using incentive structures for farmers based on the public/private partnership approach: The agricultural sector is the biggest water user across the wider Kura basin, with significant water losses emerging from the use of water intensive practices that fail to optimize yields while negatively impacting soil health and environmental conditions. The adoption of modern technologies in irrigation systems for improved water efficiency will be best realized through the creation of public/private partnerships to encourage farmers to adopt updated practices, though incentive structures, possibly provided through Water User Associations in areas where these exist and are functional. The implementation of such efforts has the potential to have a win-win-win outcome of reduced water use, increased crop yields and increased incomes for participating farmers and agricultural industries.

Improve public awareness and participation in decision making, among farmers, water end-users and other stakeholders, through among others Water User Associations, Basin Management Authorities and gender mainstreaming at local levels: All sectors of society in the region depend on the local and regional water resources. The loss of water due to outdated practices, beliefs and behaviors diminishes the overall amount of water available within the system, at great social and economic costs. These losses are also largely due to failure to understand the nature of water scarcity, the costs of water services, and the simple steps needed to improve water resource management at the household, community, and municipal levels. Building on experiences and lessons learned both regionally and internationally, implementing public awareness campaigns and increasing public participation in local water resource management through Water User Associations and gender mainstreaming will enhance local ownership of the problems and stimulate innovative solutions to shared challenges that have potentially deleterious impacts as demand for water increases, climate change impacts become more severe and water resources grow increasingly scarce.

Implement demonstration projects on alternative agricultural practices, including no-till rotations and low water use crop varieties, to increase yields and their reliability with public/private partnerships: Throughout the Kura Ara(k)s basin there are arid areas that suffer disproportionately from lack of water resources. In these areas, the challenges to successful water resource management and the costs of failure are significantly higher than in more water rich areas. There are strains of various crops, some endemic to the region, which have more resilience to harsher arid conditions that can be cultivated for increased yields and lower water demand. Additionally, no till agricultural practices enable to maintain soil integrity while decreasing erosion, lower water demand as well as the need for agrochemicals. The demonstration of uses of these technologies and commercial development of drought tolerant species of food crops has the potential to be extremely beneficial for public private partnerships while at the same time reducing water use, improving environmental conditions and improving the sustainable quality of life for residents in the most arid parts of the basin.

WRO II To achieve water quality such that it would ensure access to clean water for present and future generations and sustain ecosystem functions in the Kura-Ara(k)s river Basin

2.1 Improve monitoring programs

Adopt revised national physicochemical and hydromorphological monitoring programs for both surface and groundwater, including geographical coverage, sampling schedule and parameters measured in line with the EU WFD and international standards: There is a general recognition that suitable data of sufficient quality on which to build decisions are limited in the context of water quality and wastewater discharges in the Kura Ara(k)s river basin. The frequency, distribution, and location of monitored parameters are currently insufficient to identify the location and extent of pollution point sources or 'hot-spots' and non-point sources, including microbial pollutants from wastewater discharge. The national monitoring plans should provide steps needed to address these shortcomings: capacity needs, equipment needs. This should also include a staff retention plan to provide incentives for well-trained staff to remain working in monitoring laboratories, to reduce the high rate of staff turnover. The adoption of the EU WFD and international standards for best practices are a critical step towards making improvements in monitoring in support of alleviating pollution sources locally and regionally.

Adopt national bio-monitoring programs with shared databases on local taxonomy and water status indicators including environmental flows: Physicochemical analyses give a measurement which is valid only for the instance in time when the sample was collected, whereas biological methods reflect the effects of the physical and chemical conditions to which the organisms were exposed over a period of time. Biological monitoring should be widely expanded, including the establishment of appropriate reference conditions, to determine the ecological status of water bodies, and shared databases on local taxonomy and water status indicators.

Improve Quality Assurance & Quality Control in sampling & analytical practices: Currently there is a need to update and ensure quality control and accuracy in water quality monitoring & analytic procedures so that the data can be trusted and lead to best decision making. Each basin country should establish a national reference laboratory for water quality monitoring, responsible to provide technical support to other water quality laboratories in that country, and ensure the proper implementation of the Quality Assurance/Quality Control (QA/QC) procedures. The national reference laboratories will run regular proficiency tests of laboratory analyses for the main pollutants, and will evaluate the performance of other national laboratories in line with developing and implementing common procedures of the EU WFD.

Development of water quality information strategies and tools for improved decision making including improved inter-sectoral information exchange: Information collected by the monitoring agencies must be used to improve decision making, including the allocation of resources to reduce negative impacts and improve overall water management. The countries need to strengthen the national capabilities to interpret water quality monitoring data, towards developing decision support systems using mathematical models and GIS techniques as well as hot-spots maps. Efforts should be made to complete an emission inventory for the main sources of pollution in the Kura Ara(k)s river basin, to determine the exact location and contribution of each source to the pollution load entering the river basin, as well as areas where there is increase in pollution from non-point sources, so that targeted national and regional interventions can improve the conditions, especially in light of pending impacts of climate change, including increased water scarcity in the region.

2.2 Pollution reduction and prevention

Assess health risk from water borne diseases for local communities with emphasis on the gender dimension in the water sector, and conduct an economic valuation of the environmental and socio-economic impacts due to water pollution, including losses to GDP: Poor water quality impacts on communities, human health and the overall economic productivity, due to losses to the workforce, especially for women as caretakers for the young, infirm, and elderly who are disproportionately vulnerable to these illnesses. An assessment of health risk from water borne diseases for local communities, to include losses to GDP at local and national levels will provide a more complete understanding of these problems. Implementation of gender mainstreaming activities to empower women as stewards of local water quality will serve to improve local conditions and improve gender balance within water resources management, within communities and across the basin.

Reduce water pollution through development and implementation of integrated river water pollution abatement plans: Pollution in rivers is a serious challenge for water resource managers that must be addressed. Technical and financial support to all basin countries is needed to develop integrated regional river water pollution abatement plans that will include environmental compliance action plans for the main sources of pollution in the river basin, including an assessment of the estimated cost to implement these compliance plans, and the costs to governments of continued business as usual. These plans should encourage the use of Best Available Technologies (BAT) and Best Environmental Practices (BEP) in pollution reduction throughout the region for all sectors. Linking these plans regionally will significantly strengthen the impacts and increase opportunities for increasing benefits for the region.

Develop and implement a regional strategy for addressing point and non-point source pollution from contaminated sites and agricultural activities, including demonstration projects for BEP: The absence of lined landfill sites with leachate traps, the practice of co-disposal of both municipal and hazardous wastes in uncontrolled landfill sites, the existence of soil contamination at the former industrial complexes, and high levels of agricultural run-off all negatively impact on the health of river ecosystems. Strategies to address this should include: routine leachate monitoring at existing and former landfill sites and illegal dumps adjacent to the rivers; an improved mechanism to record and verify industrial and municipal waste sources and flows; oversight of agricultural water runoff; and an integrated solid waste management program. These should be in line with the EU Waste Directive and encourage the use of BAT and BEP in pollution reduction and treatment throughout the region for all sectors. Cost recovery mechanisms to induce polluters to bear the actual costs of monitoring and remediation should also be included within the strategy. Demonstration projects using BAT and BEP should be implemented in areas where there are high impacts from industrial pollution, including mining and historical industrial sites, as well as areas with high levels of agricultural discharge.

Implement demonstration projects on the use of the best available technologies in pollution prevention and treatment for municipal sources: Historically river systems have been used for waste disposal from industrial, municipal and agricultural sources. The improved understanding of ecosystem interdependence, combined with increasing impacts due to climate change, as well as the increased costs for treating water for consumptive uses will no longer support this approach. Demonstration projects must clearly show how measures can be taken to reduce waste discharges into the river system, with emphasis to the municipal wastewater. Many small communities throughout the region are often negatively impacted by the lack of connection to municipal water supply and sanitation. The costs to extend wastewater/sewage lines can be extremely high. Demonstration projects with constructed (engineered) wetlands for sewage water treatment in small villages can be implemented in the basin countries as a low-cost technology most suitable for small communities. The budgets will be based on the specifics of the pilot projects designed for demonstration in each country.

2.3 Harmonization of Water Quality Standards

Adopt harmonized national WQ standards in line with the EU WFD and international best practices: Currently the discrepancies between national water quality standards create significant challenges for comparison of the water quality status between riparian states. It is recommended to review and update water quality standards in all basin countries, towards designating common norms for the main water pollutants, and improved information sharing.

Introduce a unified water quality assessment system and harmonize methods and procedures for laboratory analysis for different polluting substances, including inter-laboratory testing: Different approaches in sampling and analysis of water quality in the basin may create discrepancies and incomparability in the information collected by different institutions. By defining a unified water quality assessment system and harmonizing methods and procedures for laboratory analyses for different polluting substances, including inter-laboratory testing, the countries can build the national and regional capacities, improve overall monitoring QA/QC procedures for better harmonization in water quality monitoring that goes in line with the approach advocated in the EU WFD.

Develop a common water quality index and related river basin status assessment criteria: Knowledge about the health of the river system is dependent on the quality of information and the assessment criteria. Incomplete information leads to incomplete measurement criteria and assessment and can lead to incorrectly targeted remediation efforts. In line with the EU WFD, the development of a common and inter-calibrated water quality index and related river basin status assessment criteria can be implemented in all basin countries, to evaluate the water quality in the river basin in a unified way, and bring each of the countries into closer approximation of the EU WFD, as well as benefit from appropriately targeted resources to river system health improvements.

Improve data sharing on water quality in regional technical task force(s): While there have been many international projects that have sought to bring regional technical experts together to share information on water quality, when these projects ended the information exchanges did not continue in a systematic manner. In order to improve sustainability, one of the mechanisms that could be applied is the establishment of a permanent taskforce for water quality monitoring information, which will define the transboundary stations to be monitored by each country, the number of parameters to be measured, the frequency of measurements, the reporting format for these data and the responsible authority in each country to collect and analysis these data. In the event that it is not politically possible to establish a single task force, two bilateral task forces could be developed to serve to harmonize efforts regionally. A key initiative of this/these task forces(s) is to evaluate the quality of the data and review regional indicators on the state of water quality including recommendations for decision makers. Efforts should be made to encourage other basin countries - Turkey and Iran - to cooperate in providing required information on water quality in their river basins, at the regional level as well as bilaterally.

WRO III To achieve and maintain ecosystem status whereby they provide essential environmental and socio-economic services in a sustainable manner in the Kura-Ara(k)s River Basin

Sub-objectives to achieve this long term objective are: “Monitoring and assessment of the status of the riverine and aquatic ecosystems”; “Improved sustainable use of natural resources”; and “Restoration of riverine ecosystems”, with accompanying targets.

3.1 Monitoring and assessment of the status of riverine aquatic ecosystems

Develop and implement national aquatic and riverine biological and environmental monitoring & assessment programs, interlinked at the regional level, including harmonized data collection, analysis and assessment, to be updated regularly: Without more up-to-date and complete information on the taxonomy on the flora and fauna of aquatic and riverine ecosystems specific to the South Caucasus region, it will be difficult to judge improvements and know where to target efforts for the long term sustainable management of riverine ecosystems. By taking steps to actively address gaps in current information on ecological processes, updating the biodiversity taxonomy specific to the basin, including a description of environmental preferences, and creating a shared database, the management of ecosystems at the local, national and regional levels can be significantly enhanced. This will enable ecosystem health and functions to be measured and improved upon. This will also contribute to the shared knowledge on impacts of developments interferences, to the economic valuation of ecosystems services, and to mainstreaming environmental impacts into sectoral planning processes.

Conduct economic valuation of ecosystem services in support of improved decision making and public awareness: Strengthening the mainstreaming of environmental protection into sectoral planning processes and expanding public interest in actively protecting the health of the ecosystem requires that information on how ecosystems function, the services they provide, and the economic benefits of these services are properly valued. State-of-the-art methodologies can guide how to more fully assess the value of the services, towards improving water management for multiple sectors. By conducting an economic valuation of ecosystem services for the riverine ecosystems in the basin, it will be possible to more accurately assess the actual impacts of development processes, and create positive incentives for protection of ecosystems.

Support the mainstreaming of aquatic and riverine ecosystem concerns into sectoral economic development (agriculture, hydropower, forestry etc.), by means of implementation support to National Biodiversity Action plans, intersectoral cooperation and planning, in line with the Water Nexus approach towards improved environmental security: Information on ecosystem functions and processes as well as the value of their services must contribute to the overall implementation of the sustainable development strategies targeting the improvement of the health of river systems, in line with international best practices. The use of the Water Nexus approach for multi-sectoral planning includes environmental security as one of four key elements, in addition to water security, food security and energy security. Improved resilience to the negative impacts of climate change, extreme weather events, water quality hazards, and variable flows can be addressed by the nexus assessment towards the development of basin strategy that mainstreams aquatic and riverine ecosystem management into multi-sectoral planning to ensure sustainable development.

3.2 Improved sustainable use of natural resources

Assessment and update of legal and policy mechanisms for the protection of areas of ecological significance to river system health: Protection of the ecosystems has not been a top priority for the region, as economic and political transitions have taken precedence for the past two decades. However, as these situations begin to stabilize and incentives for improved stewardship emerge both nationally and internationally, assessment and updating of these legal and policy mechanisms in line with the EU Directives will continue. Strengthening the protection of areas of ecological significance contributing to river system health will enable the countries to benefit from the services provided by these critical ecosystems.

Public awareness raising on the sustainable use of floodplain forest, wetlands, and riverine ecosystems, focusing on ecosystem services provided as well as the protection and use of endemic, migratory and rare flora and fauna species: Communities and decision makers at all levels can insufficiently appreciate the importance of the sustainable use of riverine ecosystems without a concerted effort to raise awareness of the benefits of services provided by ecosystems. Knowledge needs to be increased on means to sustainable manage resources at the community level with support from higher level governance institutions. A concerted awareness effort can highlight ecosystems services, their benefits and mechanisms for sustainable use with benefits to stakeholders for protecting them.

Strengthen EIA and SEA procedures towards a more complete, transparent assessment of development impacts on surface and groundwater, and aquatic and riverine ecosystem services and their values, for use in decision making processes on (sectoral) economic development: The best practices for implementation of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) in line the EU Directives and the Equator Principals applied by international financing institutions (IFIs) require that impacts on surface and groundwater resources and the riverine environment at large are considered in all decision making on development activities. Meeting these requirements is challenging when there is a lack of information, a lack of methodological procedures, and a lack of enforcement. Capacity building and improvement of formally endorsed assessment procedures at the national and regional levels will support improved understanding of and compliance with legislation, and support the long term sustainable management of resources.

Conduct demonstration projects on opportunities for mainstreaming river system biodiversity conservation and sustainable use of biological resources into economic development and production processes with public/private partnerships: Without incentives to change behavior, humans will continue to engage in unsustainable practices, unless they see clear benefits for adopting new behavior. It is critical to show incentives for improved mainstreaming of river system biodiversity conservation and the sustainable use of biological resources. These incentives can include economic development opportunities from sustainable production processes, using e.g. public/private partnerships. Demonstration projects may focus on local fisheries management, sustainable cultivation and harvests of endemic species following green industrial processing practices, as well as ecotourism development opportunities. These should include strategies for scaling up and replication based on sustainable use of natural resources, and economic costs and benefits, based on international experiences.

3.3 Restoration of Riverine Ecosystems

Assess, update and implement environmental flows in different sub-basins in line with international best practices, including flow assessment & design, legislative support, monitoring and enforcement: The use of bio-monitoring and rapid ecological assessment to assess environmental flows and impacts on ecosystem health has been tested in pilot sites by the UNDP/GEF project. The current approach in environmental flow calculations based on averaged information does not allow maintaining ecosystem health in line with international best practices and the EU WFD. Environmental flow monitoring and management, combined with rapid ecological assessment and bio-monitoring need to be expanded to additional sites and tributary basins to more fully document the state of river ecosystems and the relation to flow variation, to optimize aquatic ecological processes and improve river system health throughout the Kura Ara(k)s basin. Strengthening environmental flows is especially of importance as competing uses and trade-offs between sectors emerge, and climate change impacts become felt.

Implement river restoration plans at critical sites for improved ecosystem services, water supply and safety, to enhance surface and groundwater management in line with environmental security priorities: Degradation of riverine ecosystems at critical sites throughout the basin has significantly diminished the viability of many endemic, vulnerable and rare species, and devalued the services performed by these ecosystems. The loss of tugai forests, wetlands, floodplains and other unique riverine ecosystems may be repaired via a concerted effort to improve and revive ecosystem functioning, to the benefit of rare, endemic as well as migratory species, some of which may be commercially viable. Improved riverine wetland ecosystem functioning will also have positive impacts on water retention and flood peak reduction, improve water availability beyond the flood season and reduce flood hazards, As such, the design and implementation of river restoration plans will simultaneously encourage environmental security, food security and water security priorities for all countries throughout the basin.

WRO IV To achieve mitigation of adverse impacts of flooding on infrastructures, riparian ecosystems and communities

Based on the experiences and issues related to flooding events, especially in light of increasing severity of local and regional impacts due to climate change, the following recommendations have emerged for reducing the hazards of floods, to assess status and develop improved measures in line with the EU Floods Directive, link crisis response centers, demonstration measures for reduced impacts and empowerment of local communities.

Conduct a preliminary floods risk assessment for the South Caucasus, including flood hazard and flood risk mapping in line with the EU Floods Directive: Based on observed trends, increasingly severe flooding events are expected throughout the region, and the existing flood protection infrastructure is often in poor repair, putting communities at risk locally and potentially regionally if severe conditions persist. Knowledge on the current status of flood protection infrastructure needs to be updated throughout the region in order to most accurately target resources and minimize the most severe damages, and flood hazard maps and flood risk maps for the wider basin should be developed as a tool to best understand where actions are needed. The EU Floods Directive provides guidance on this and while working at the wider basin level, tributary basins should also be considered (Chapters 2 and 3, EU Floods Directive).

Develop flood risk management plans including early warning systems for national and transboundary areas in line with the EU Floods Directive: Flood risk management plans should include agreed objectives to reduce negative impacts on human life, human health, the environment, cultural heritage, and economic activities. They also should include cost and benefits calculations; descriptions of flood extend and flood conveyance routes as well as areas with the potential to retain flood water during high flows, such as natural floodplains; spatial plans for soil and water management, land use, and nature conservation. These should also address prevention, protection, preparedness, including flood forecasts and early warning systems (Chapter 4, EU Floods Directive).

Strengthen linked crisis response centers for flood hazard mitigation equipped with flood forecasting capacity and response equipment: Flooding in the wider Kura Ara(k)s basin results in significant transboundary impacts, including the loss of life, loss of property and isolation of communities, as communication and transportation infrastructure are damaged. Development of linked crisis response centers for flood hazard mitigation, equipped with the technical means for flood response, may be able to reduce the impacts of flood events and in extreme cases provide support to neighboring communities in transboundary areas. Linking these crisis response centers across the basin also increases the opportunity to share information, lessons learned, and best practices.

Develop community action plans for flood responses, and train the local communities in most vulnerable areas: In many remote areas of the region communities become isolated when severe flooding events occur, because of disrupture in infrastructure, communication and response capabilities. These communities often suffer due to this isolation, and commonly assistance is available only when the crisis has passes. Empowering local communities in high-risk areas to develop community action plans for flood mitigation and flood response, including training in basic medical practices, impact prevention, and community safety measures, and training residents on emergency procedures in case of a severe flood event creates a pro-active basis for self-support. As such, the local impacts of flooding will be reduced, the transboundary impacts will be increased resilience of vulnerable communities across the basin, with potential for sharing experiences, lessons learned, as well as for providing direct support to neighboring areas across borders.

Conduct demonstration projects to reduce flood severity by developing floodplain buffer zone rehabilitation plans, implemented at key pilot sites: The benefits of natural flood management strategies can be counterintuitive to those who have been negatively impacted by raging waters or sought to prevent the loss of life that can be associated with extreme events. However, using natural flood management can be beneficial as a way to work with nature instead of against it. The EU Floods Directive states “Flood risk management plans should focus on prevention, protection and preparedness. With a view to giving rivers more space, they should consider where possible the maintenance and/or restoration of floodplains, as well as measures to prevent and reduce damage to human health, the environment, cultural heritage and economic activity.” (Introduction, paragraph 14). A set of demonstration projects at key sites can serve as a model for this approach throughout the basin with benefits for local communities as well as regionally as flood risk management plans are developed, implemented and updated within the wider Kura basin.

Additional recommendations

Review of the suitability of the Nexus approach towards inter-sectoral, transboundary water management in the Kura Ara(k)s river basin. The scenarios outlined in Chapter 7 provide a glimpse of the future and pending challenges for sustainable water resource management in the basin. In the future a further examination of these scenarios into more detail will provide an important set of tools towards improved understanding of the needs and priorities for water use and distribution within the basin, including the potential trade-offs between sectors measured and gauged, not only nationally but also in transboundary basins. The use of the “Water Nexus” approach, which employs a multi-sectoral approach to examining these relationships, has potential to serve as a very useful and informative tool for future decision making with regards to the cross-sectoral challenges to be faced in each of the countries, tributary basins and the wider Kura Basin in the coming years and decades. The application of the Nexus approach may offer a strong set of viable options for improving national and regional water security, food security, energy security and environmental security across the Kura Ara(k)s basin. An initial in-depth review of realistic scenarios, supported by additional relevant information, will provide a baseline starting point for application of the Nexus approach to be considered in future transboundary water management efforts, especially as the challenges of climate change become more intense and the need for concerted action becomes more apparent.

Climate Change

The issue and impacts of climate change is cross cutting for all transboundary issues. These are addressed within chapter 5, as well as Chapter 6 on the linkages between the issues. It is recommended that additional actions related to adaptation for climate change be considered within the scope of the TDA and for potential use in the SAP. These are:

Implementation of climate change adaptation measures towards improved water resources management for food, water, energy and environmental security. At present, water resources, as well as ecosystems depending on them, within the basin are already stressed by the irrational use of water, including increasing demands. Trends for the future could indicate a continued lack of coordination within and between the countries towards addressing the sustainable use of the finite amount of available water resources. Meanwhile, climate change as a cross-cutting regional driver adds additional complexity to addressing human development activities towards the sustainable use of water resources. The development and implementation of climate change adaptation measures towards strengthening water resources management for food, water, energy and environmental security would put additional benefits to multi-sectoral water resources planning for improved security. Adaptation initiatives would support the national and regional response to climate change impacts, improve resilience to any future shifts in water availability and improve long term sustainable development within the region.

Improved knowledge and understanding of expected impacts of climate change of relevance to targeted stakeholder groups, towards strengthening sustainable climate change adaptation including annual regional meetings of decision makers and researchers to plan climate change adaptation measures in line with IWRM, and share results of tested mechanisms. In the past, water managers have been trained to expect some variations in water availability, however the specter of climate change suggests fluctuations in water availability will be more severe, and additional responses to adapt to these changes will be required. New thinking and approaches are needed at all levels from local communities to water management in all sectors. Strengthening improved knowledge and understanding of expected impacts of climate change of relevance to management decision making for targeted stakeholder groups, towards strengthening sustainable climate change adaptation, will enable more robust development, taking climate change into proper account. Additionally, organizing annual regional meetings of decision makers and researchers to plan climate change adaptation measures in line with IWRM, and share results of tested mechanisms will serve as an important mechanism on awareness raising and knowledge development, to enable stakeholders throughout the regional to learn from one another as well as provide a showcase for the wider global water management community.

Implement public awareness measures to highlight local adaptation strategies. Communities and households, especially in rural areas, will be directly impacted by climate change. It is critical that these citizens are informed about what the anticipated impacts could be, and are empowered to adapt to these impacts themselves. Many adaptation measures are envisioned to target the household and community level, so empowering the public will require awareness raising, to ensure participation in addressing the pending changes in climate. Adaptation measures at the local level largely target the variation in water availability for domestic use, for small scale agricultural use, as well as impacts on household infrastructure. Education and empowering citizens will required a concerted effort throughout the region, in order to reduce irrational water use, improve behaviors that are already negatively impacting on the environment and that will be made worse by climate change. This will also provide supportive public opinion to climate change adaptation and mitigation measures at the municipal, national as well as transboundary levels.