RER/03/G41/A/1G/31: Reducing Trans-boundary Degradation of the Kura-Aras River Basin

Kura-Aras River Basin
Transboundary Diagnostic Analysis

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EXECUTIVE SUMMARY

The Kura-Aras river basin is an internationally significant river system, which is seriously degraded and continues to be threatened. The basin covers almost all of Armenia and Azerbaijan, and a sizeable part of the populated and urbanized parts of Georgia. These countries together with Iran and Turkey rely heavily on the Kura-Aras river system as a principal source of water for all sectors and users: industry, agriculture, energy and residential uses.

Integrated, inter-country efforts are urgently required to evaluate the degree of ongoing degradation of these river ecosystems and to take action to halt and reverse damaging trends where necessary. Awareness of this fact has promoted the development of a UNDP-GEF project titled "Reducing Trans-boundary Degradation of the Kura-Aras River Basin" among four of the riparian nations (Armenia, Azerbaijan, Georgia and Iran). A cornerstone of this project is the Kura Aras River Basin Transboundary Diagnostic Analysis (TDA). This document is the result of the collaborative effort of leading specialists of the Armenia, Azerbaijan, Georgia and Iran, assisted by many international experts. It represents the first-ever attempt to produce an in-depth and comprehensive Transboundary Diagnostic Analysis of the Kura-Aras River Basin.

Information gathered by the TDA Technical Task Team (TTT) from the four riparian countries and thematic reports produced within the framework of the Project are unique, both in terms of their wealth and depth of analysis. This material has covered a broad range of economic, environmental, institutional and other activities, as well as their environmental consequences.

The TDA 'fact-finding' process employed the GEF 'Best Practice' approach and the experiences of other GEF projects to date. This document is an objective, non-negotiated analysis using best available verified scientific information and examines the state of the environment and the root causes for its degradation. It will provide the factual basis for the formulation of a Kura-Aras River Basin Strategic Action Programme (SAP).

The TDA for the Kura-Aras River Basin identified four priority transboundary environmental problems, namely: variation and reduction of hydrological flow; deterioration of water quality; ecosystem degradation; and flooding and bank erosion. Underlying regional causes of these transboundary problems include poor law enforcement and compliance, inadequate development planning, undeveloped civil society and public awareness and inadequate pricing policies.

Each transboundary problem and the key governance issues that underpin the problems are described below.

Variation and Reduction in Hydrological Flow

Variation in hydrological flow has been caused by numerous human interventions including direct water abstraction from surface and groundwater bodies, increased evaporation due to impoundments, urbanization and deforestation. This has significant transboundary

consequences and it has been calculated that 40 % of the natural runoff of the Kura and 27 % of the Aras runoff is lost to the Caspian Sea. Severe water deficit has not occurred in the basin to date and consequently shortages of water have not presented any serious threats to the population. However, population growth and rapid economic development in the basin countries will impose increased pressure on surface and groundwater resources. Climate change could also have a catastrophic impact in the medium and long term with potential scenarios indicating flow reductions of 50% as a consequence of increased average temperature and decreased precipitation. Variation and reduction of flow has already impacted fish species such as sturgeon in the Kura-Aras river basin and affected terrestrial ecosystems such as tugai forests. The construction of new reservoirs is likely to further alter flows. Non-rational use of water is a widely spread practice throughout the basin. Agriculture (and in particular irrigation activities) is the major consumer of water in the basin and water loss (through wastage, leakages and failures), particularly from domestic and municipal water use, is an acute problem for the South Caucasus countries. Currently, the underlying causes can mainly be attributed to low capital investments in operation and maintenance (due to alack of finance and historical economic difficulties), a lack of investment in developing new irrigation schemes and water supply systems, and a lack of a knowledge base of the hydrology and usage of the basin upon which to construct an integrated water resource management and river basin management policy and regulatory framework. This is compounded by the low awareness of the population which currently has little regard for water efficiency and is often careless with its use. Furthermore the lack of an integrated approach in water resources management is a major problem in all the basin countries where ground and surface water are dealt with separately, and land and forest management often fails to take into account management issues relating to water resources. This creates many of the problems outlined above. If present trends of water use are maintained, the impacts on the flow regime will continue to increase. In order to ensure the equitable use of water, coordinated actions between the basin countries are needed in order to avoid negative consequences in downstream countries occurring due to increased water consumption upstream.

Deterioration of Water Quality

Deterioration of water quality in the Kura-Aras river basin has significant transboundary consequences in the down stream countries. This can be confirmed by the presence of chemical compounds of anthropogenic origin in the transboundary sections of the basin as well as in bottom sediments of the Kura Delta in the Caspian Sea. Water pollution in the Kura basin comes from a number of land based sources including industrial and mining sites, agricultural lands, households in rural areas and municipalities. Wastewater treatment facilities are absent in many municipalities and enterprises, and are available only in some locations in the Aras basin in Iran. Most of the wastewater treatment facilities were built 20-30 years ago and are currently non-operational. The application of fertilizers and pesticides has been significantly reduced in the basin over the last two decades. Furthermore, the usage of persistent chlorine-organic pesticides, such as DDT, hexachlorcyclohexane (HCH) and aldrine, etc has been prohibited in the region. However, recent studies indicate that there is strong evidence that the illegal application of banned chlorinated pesticides in the region is occurring. The unregulated use of fertilizers results in diffuse pollution of both surface and ground water resources. Nutrient loading also comes from direct point source discharges of animal slurry from cattle and pig farms. These incidents have greatest impact in early spring during the snow melt, when waters wash out nitrates and phosphates from previous autumn applications. There is little information that can directly attribute water quality to specific environmental impacts in the Kura-Aras river basin. However, it is likely to be a contributing

factor and certainly increases the pressure on already stressed ecosystems. Industrial development and the construction of industrial wastewater treatment facilities are not coordinated. The only exception is enterprises which have local wastewater treatment facilities. However, it should be noted that most of them are currently not operating. Of particular danger are wastewaters from the mining industry and tailing lagoons and dumps.

Ecosystem Degradation

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, due to a large extent by habitat fragmentation and degradation. There has been a remarkable decline in several bird species, small mammals and several plant species. Forest degradation in the Kura-Aras basin has intensified during the last two decades. Boundaries of the mountain forests remained more or less stable until the beginning of the 1990s, but since then, the situation has changed as a result of extensive logging, both illegal and authorized by government institutions. Desertification and land degradation is a critical problem in the Kura-Aras basin. The main forms of degradation are salinization (especially in desert and semi-desert areas) and soil erosion (washing out of fertile soil). The most important reason for land degradation appears to be deforestation and overgrazing. Increased demand on timber for commercial purposes is one of the major drivers of ecosystem degradation. This includes timber logging for use in the construction business nationally and for export, and has consequently resulted in a reduction in deciduous forest areas. The energy crisis that has taken place during the last decade in the South Caucasus countries has also put great pressure on forests in the basin. The acute energy deficit in these countries, accompanied with poverty problems has resulted in excessive logging as the population has been forced to use wood for heating and cooking. The causes are related to weak legislation and regulations, institutional complexities, poor law enforcement and low public awareness on the importance of biodiversity and ecosystem act together with financial constraints to create unfavorable conditions for protecting ecosystem integrity and biodiversity. The absence of integrated water resources management also contributes to this process.

Flooding and Bank Erosion

Flooding and bank erosion in the Kura-Aras river basin has significant transboundary consequences. Anthropogenic interventions in the natural flow regime including river training and changes in land cover (intensive deforestation) combined with the degradation of natural floodplains as a consequence of urban development and agriculture, increases the risk of floods and mudflows in downstream countries. Deterioration in the flood protection infrastructure throughout the basin has worsened the situation. It is likely that climate change will further increase the risk. Flooding and mudflow events in the Kura-Aras basin have adverse economic and social implications for the basin countries. Despite extensive investments in flood control schemes in the past, significant damage and occasional loss of human life still occurs. High floods have been reduced by the construction of a number of dams and reservoirs on the Kura and Aras rivers. However, Lack of flood protection reservoirs is listed as one of the main underlying causes of floods in the basin. There are insufficient financial resources for the construction and maintenance of flood control and defense schemes. This is compounded by the lack of a proper monitoring and flow forecasting system that would allow effective early warning. The lack of integrated flood management is another other issue that needs to be addressed in the basin and approaches

restricted to flood control using only hard engineering solutions have to be revised, especially when the financial and environmental costs of such solutions are considered.

Governance

After the collapse of former Soviet Union environmental legislation has undergone significant changes in Armenia, Azerbaijan, and Georgia. Although the legal frameworks are relatively new, innovative and dynamic, a major concern is the coherence and consistency among the many legal documents. This has led to some confusion with regard to the institutional arrangements. Consequently, water management in the Kura-Aras basin is fragmented and there are duplications in the various water resources management bodies at the national level within each country. This is compounded by regular and sudden structural changes in the Environmental Ministries in Armenia, Azerbaijan and Georgia after the collapse of former Soviet Union which has destabilized these institutions. Analysis of various donor funded projects shows a lack of integrated environmental management. As a result, duplications of efforts frequently occur. In addition to this, there is a lack of institutional structures in the different economic sectors for planning, coordinating and supporting environmental activities. In the Kura-Aras basin countries one of the technical tools to promote more effective allocation of water resources and collection of corresponding fees are water use permitting systems. A number of regulations exist in Armenia, Azerbaijan, Iran and Georgia that define water use permitting procedures. Despite a comprehensive legal and regulatory framework, gaps still exist, which prevent the full and efficient implementation and enforcement of the water use permitting and associated payment system. The analysis of payments associated with water use permitting shows that the current water resources fees system does not provide incentives in most of the Kura-Aras basin countries for the permit holders to meter water use, conserve water, or to reduce pollution. The current system of water resources fees also does not provide any incentives for the agencies charged with the implementation and enforcement of the system. The Kura-Aras basin countries recognize the importance of transboundary cooperation and are trying to address priority transboundary issues with neighbouring countries.

Stakeholder involvement

Stakeholder involvement and participation was a cornerstone of the Kura-Aras TDA. Consequently detailed Qualitative and Quantitative Stakeholder Analysis was conducted in the riparian countries. The Qualitative Stakeholder Analysis was conducted in order to directly attain the opinions of the residents throughout the river basin about water quality and quantity issues, to ascertain their perceptions of water management challenges, and to identify the region wide concerns for the TDA/SAP process. In order for the public stakeholders to be active participants in environmental governance, it was important that their common and transboundary priority concerns were included in a larger scale Quantitative Stakeholder Analysis within the TDA/SAP process.

The most notable finding of the stakeholder analysis was the high level of concern among all stakeholders regarding the deterioration of water quality. Among all stakeholders surveyed, this was the highest priority concern by a significant margin. The second highest priority set of concerns were the variation and reduction of hydrological flow. The third highest priority set of concerns were ecosystem degradation in the river basin and decline in bioresources. The lowest priority concern was increased flooding and bank erosion.

The Kura-Aras Stakeholder Advisory Group (SHAG) finally provided detailed feedback and recommendations on further project development based on the findings of the TDA (refer to Appendix 1 for details).

1. INTRODUCTION

The Kura-Aras river basin is an internationally significant river system, which is seriously degraded and continues to be threatened. The basin covers almost all of Armenia and Azerbaijan, and a sizeable part of the populated and urbanized parts of Georgia. These countries together with Iran and Turkey rely heavily on the Kura-Aras river system as a principal source of water for all sectors and users: industry, agriculture, energy and residential uses. Notably, many of the region's poorest communities live within the Kura-Aras river basin and depend upon its waters.

The Kura and Aras rivers are important to regional cooperation as they cross and form many of the borders between the riparian states. Both rivers are seriously degraded in places. Water quality is impaired by the dumping of untreated municipal, industrial, medical and agricultural wastes, and by high sedimentation loads resulting from upstream deforestation and land degradation. Water quantity is constrained by use of water for domestic, agricultural and hydropower purposes, which impacts upon the river ecosystem in places. Finally, the rivers run into and impact the Caspian Sea, affecting the ecosystem and biodiversity of the region, particularly that of Iran and Azerbaijan.

As past experience has shown, single sector oriented management of water resources does not solve the problems of transboundary water resources and only integrated planning of water resources at the basin level can address the environmental and social-economic development needs in the basin. Consequently, integrated, inter-country efforts are urgently required to evaluate the degree of ongoing degradation of these river ecosystems and to take action to halt and reverse damaging trends where necessary.

Awareness of this fact has promoted the development of a UNDP-GEF project titled "Reducing Trans-boundary Degradation of the Kura-Aras River Basin" among four of the riparian nations (Armenia, Azerbaijan, Georgia and Iran). This PDF-B funded project aims to ensure that the quality and quantity of the water throughout the Kura-Aras river system meets the short and long-term needs of the ecosystem and the communities relying upon the ecosystem. The project is expected to achieve its objectives by: fostering regional cooperation; increasing capacity to address water quality and quantity problems; demonstrating water quality/quantity improvements; initiating required policy and legal reforms; identifying and preparing priority investments and; developing sustainable management and financial arrangements.

A cornerstone of this project is the Kura Aras River Basin Transboundary Diagnostic Analysis (TDA). This document is an objective, non-negotiated analysis using best available verified scientific information and examines the state of the environment and the root causes for its degradation. It will provide the factual basis for the formulation of a Kura-Aras River Basin Strategic Action Programme (SAP), which will embody specific actions (policy, legal, institutional reforms or investments) that can be adopted nationally, usually within a harmonized multinational context, to address the major priority transboundary problems identified in the TDA, and over the longer term enable the sustainable development and environmental protection of the Kura-Aras river basin.

2. METHODOLOGY

2.1 Background

Historically, advice on TDA and SAP approaches given by GEF has been rather limited. However, the experiences of senior IA portfolio managers, IW Chief Technical Advisors (CTAs) and practitioners from a number of IW projects, together with GEF IW Focal Area Programme Study, provided an opportunity to develop more formal guidelines to assist with the preparation of TDAs and to ensure inter-regional comparability.

Consequently a GEF guidance document was developed to provide a road map for best practice in formulating a TDA and a SAP as part of a GEF IW project. It was prepared on the basis of discussions between specialists from UNDP, UNEP and the GEF Secretariat, together with practitioners who had completed the process in freshwater and marine systems. The final document reflected the experience obtained in conducting TDA/SAPs between 1996 and 2003 but was not intended as a prescriptive formula, merely a guide that should be adapted to the cultural socio-economic and political realities of each region.

The GEF IW TDA/SAP "best practice" approach underpins the methodology used in the development of the Kura-Aras River Basin TDA. Consequently the methodology for the TDA consists of the following steps:

- **Identification and initial prioritisation** of transboundary problems
- Gathering and interpreting information on **environmental impacts** and **socio-economic consequences** of each problem
- **Causal chain analysis** (including root causes)
- Completion of an **analysis of institutions, laws, policies and projected investments**

It 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.

2.2 Kura-Aras TDA Methodology

2.2.1 Identification of the priority transboundary issues

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

The TTT, made up of 16 experts[1] from the Riparian countries brainstormed the list of 23 common GEF transboundary problems shown in Box 1 below in order to determine their relevance and transboundary nature in the context of the Kura-Aras River Basin.

Box 1: Common transboundary problems

Major Concern I. Freshwater Flow Modifications

1 Excessive withdrawals of surface and/or groundwater for human uses
2 Changes in freshwater availability
3 Changes in flow regimes from structures

Major Concern II: Pollution

4 Pollution of existing drinking water supplies
5 Microbiological pollution
6 Nutrient overenrichment
7 Hydrocarbon pollution
8 Heavy metal pollution
9 Radionuclide pollution
10 Suspended solids/accelerated sedimentation
11 Excessive salinity
12 Thermal pollution

Major Concern III: Habitat and community modification

13 Loss of ecosystems or ecotones
14 Modification of ecosystems or ecotones
15 Invasive Species

Major Concern IV: Exploitation of fisheries & other living resources

16 Over-exploitation
17 Excessive bycatch and discards
18 Destructive fishing practices
19 Decreased viability of stocks through contamination and disease
20 Impact on biological and genetic diversity

Major Concern V: Fluctuating Climate

21 Freshwater flow fluctuations such as drought and floods
22 Fluctuating ocean circulation patterns
23 Sea level change (including saltwater intrusion)

This priority transboundary problems were identified by assigning a score to each problem of between 0 (no importance), 1 (low importance), 2 (moderate importance) and 3 (high importance) to determine the relevance of the problem from the perspective of the *present day* and *15-20 years in the future*. When examining future change the TTT were asked to consider the effects of climate change. The scoring activity was based on the following suite of criteria:

- Transboundary nature of a problem.
- Scale of impacts of a problem on economic terms, the environment and human health.
- Relationship with other environmental problems.

[1] A full list of the TTT experts is shown in Appendix 3.

- Expected multiple benefits that might be achieved by addressing a problem.
- Lack of perceived progress in addressing/solving a problem at the national level.
- Recognised multi-country water conflicts.
- Reversibility/irreversibility of the problem

This initial meeting of the TTT also served as a project planning exercise. The expertise for the subsequent stages of the process can be discussed, as well as the availability of information. Agreement on a preliminary contents page for the TDA is a useful way of ensuring that the entire process has been thoroughly discussed.

2.2.2 National TDA Reviews and Thematic Reports

National TDA Reviews and Thematic Reports were drafted by selected consultants from the TTT and project team. The list of the Thematic Reports is shown below:

- Socio-economic situation in the Kura-Aras River Basin
- Legal and institutional framework for the water sector in Armenia, Azerbaijan, Iran and Georgia
- Change of climate and evaluation of environmental vulnerability in the Kura-Aras Basin
- Biodiversity and ecosystems in the Kura-Aras River Basin
- Water quality
- Assessment of land based sources of pollution
- Non rational use of water
- Irrigation and drainage
- Flooding
- Aquifer systems in the Kura-Aras river basin
- Impacts on Caspian Sea
- 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 Thematic Reports constituted the main sources of information for the TDA. All the Thematic Reports are presented in the Annexes associated with this TDA document, together with other key supporting information (e.g. UNDP/SIDA Reports[2]).

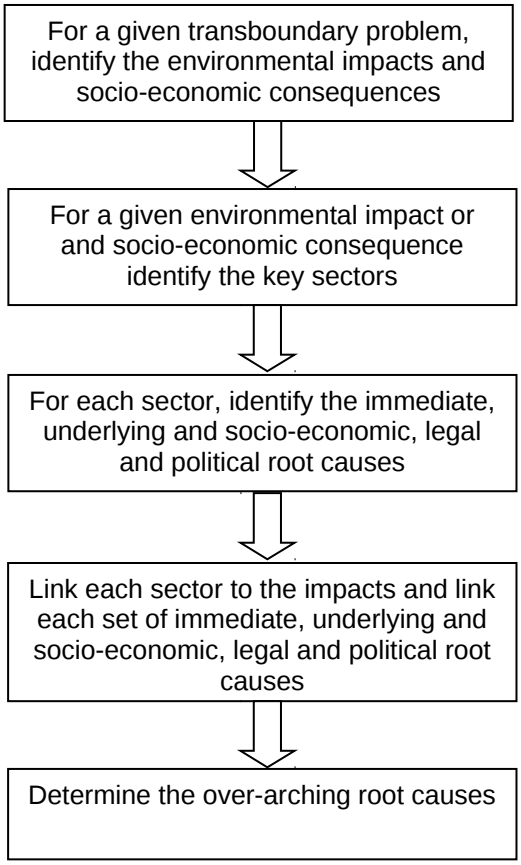
2.2.3 Development of causal chains for the priority transboundary problems

Causal Chain analysis (CCA) is one of the most useful aspects of the TDA for the development of future corrective actions. The causal chain should relate the transboundary problems with their impacts, immediate physical causes and their social and economic underlying root causes.

[2] UNDP/SIDA refers to the reports prepared under UNDP/SIDA component of this project. SIDA is the Swedish International Development Cooperation Agency

The CCA methodology developed for this TDA was based on the approach used by the Global International Waters Assessment (GIWA) and the Dnipro River Basin TDA. However, previous approaches only linked the causes to the transboundary problem, and failed to focus on why a particular cause results in a given impact. The Kura-Aras methodology aims to bridge this gap by linking the sectors and causes of a given transboundary problems with the impacts of the problem. The advantage of this approach, together with the Causal Loop Diagram methodology, is that it aids in the identification of well-targeted interventions that can address both institutional and technical solutions to problems. This is in contrast to existing approaches in which the interventions in the SAP do not address the findings outlined in the TDA. A simple step by step guide to the process is shown in Figure 2.1.

Figure 2.1: Stepwise sectoral analysis approach to developing a causal chain



2.2.4 Development of causal loop diagrams for the priority transboundary problems

Causal Loop Diagrams (CLDs) conceptualise transboundary problems in a different way to CCA. Here complex problems are presented in a dynamic way that shows not only simple cause-effect relationships but a complex system of feedbacks were impacts act as causes. It gives the opportunity to observe the behaviour of the whole system and how sub-systems interact. Impacts of interventions introduced at one point into the system can be followed throughout the chain. The need for an integrated approach to develop solutions for

transboundary problems is also very clearly demonstrated in CLDs which help better focus on more appropriate interventions.

After the priority transboundary problems have been identified, a team of experts developed a dynamic model for each problem getting by initially listing all exogenous and endogenous components that have contributed to the transboundary problem. The next step was to identify causality between the different system components: linking effects and causes and identifying feedback relations. Arrows with plus or minus signs are used for demonstrating these causalities and the character of the changes that one system component triggers in other. Analyses of all the impacts of each transboundary problem were carried out, helping to identify the most critical variables in each system. Along with CCAs, CLDs were used to identify potential areas of interventions.

2.2.5 Stakeholder analysis

The Kura Aras Stakeholder Analysis involved both qualitative and quantitative surveys of stakeholders in the region. These complimentary analyses provide insights into the concerns, priorities and perceptions of stakeholder groups throughout the region. They also identify 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 in summer 2005. The interview process involved traveling throughout the region with local experts familiar with the riparian communities and local language abilities. Stakeholder interviews were conducted with individuals in these communities. Initial questions were posed regarding water management concerns in the communities, with follow-up questions posed by the stakeholder analyst. Approximately 150 people were consulted in this process and included 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.

Following the Qualitative Stakeholder Analysis the Quantitative Stakeholder Analysis was conducted. This survey based analysis was conducted in all four South Caucasus countries among 36 different stakeholder groups. Surveys were translated into local languages and were administered by local and national level stakeholder consultants throughout the river basin. A total of 512 surveys were collected and statistically analyzed for trends among and between groups. Areas of notably high and low priority concern or high levels of variation within groups were detailed and analyzed for the potential causality and significance of these trends. Issues which showed potential for conflict between groups were highlighted. The full methodological approach can be found in the Annex 12.

3. DESCRIPTION OF THE BASIN

This section provides an overview of the Kura-Aras River Basin, covering the geographical characteristics of the basin, its ecological status, a summary of the socio-economic situation and an introduction to the institutional arrangements within the basin.

3.1 Geographical Characteristics

3.1.1 General characteristics

The basin of the rivers Kura and Aras covers the territory of Armenia, Azerbaijan, Georgia, Iran, and Turkey. The total area of the Kura-Aras basin is approximately 188,400 km^2, occupying the greater part of the South Caucasus[3]. Table 3.1 shows the distribution amongst the five countries.

Table 3.1: Distribution of the riparian countries in the Kura-Aras River Basin

Country	Total Country Area (1000 km^2)	Area in the Basin (1000 km^2)	% of the country area	% of the basin area
Armenia	29.8	29.8	100.0	15.8
Azerbaijan	86.6	55.1	63.6	29.2
Georgia	69.7	36.4	52.2	19.3
Turkey	771	28.9	3.7	15.3
Iran	1648	38.2	2.3	20.3
Total	**2605.1**	**188.4**	**7.2**	**100.0**

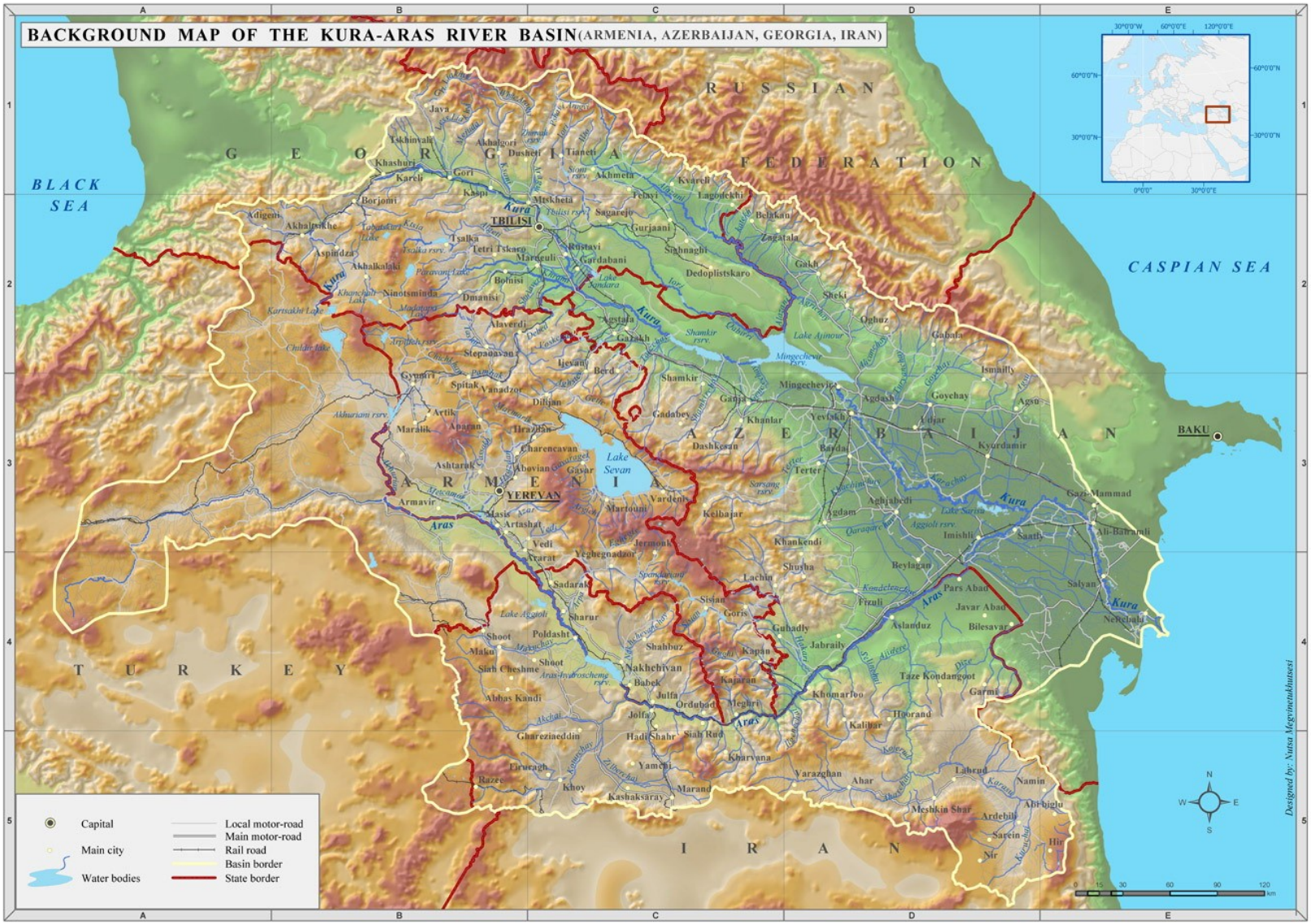
The basin spreads over the major part of eastern Georgia; over 60% of Azerbaijan, excluding the northeast of the country and the Lenkoran region; the entire area of Armenia; the northwestern part of Iran and territories of northeast Turkey. A map of the Kura-Aras Basin is shown in Figure 3.1.

The Kura is the main water artery of the Caucasus. Its total length is 1,364 km. It originates at a height of 2,700 m in the Anatolian highland of Northeast Turkey in the Kizil-Giadik mountain range, winding its way through mountainous regions in Turkey, Georgia and Azerbaijan into the Caspian Sea. It is fed by snow (36%), ice melt water from glaciers (14%), underground sources (30%) and rain (20%). The main tributary of the Kura is the Aras.

The altitude of the Kura watershed ranges from 4,500 m to the Caspian Sea (-27 m). The flow in the spring flood periods makes up 58-64% of the total annual discharge with 19-22% of the total discharge during the summer-autumn period and 17-20% in winter (JRM Final report 2004).

[3] South Caucus refers to Georgia, Armenia and Azerbaijan

Figure 3.1: Map showing geographical features of the basin of the Kura and Aras rivers



The Aras River originates in Erzurum province in eastern Turkey. It flows along the Turkey-Armenia border, the Iran-Armenia border, and the Iran-Azerbaijan border, before flowing into Azerbaijan where it joins the Kura near the Caspian.

The Aras divides just before meeting the Kura, and one branch flows directly into the Caspian. The total length of the river is 1,264 km with a total watershed area of 102,000 km^2 (of which 18,740 km^2 relates to Azerbaijan, 22,556 km^2 to Armenia and 60,704 km^2 to Iran and Turkey).

The Kura and the Aras contribute about 66% and 34% respectively to the total runoff. There are more than 10,000 rivers in the basin including many small shallow rivers.

The water regime is characterized by high spring flows from snow melt and low flows during the autumn and winter period. In the plains, the river meanders and the water of the Kura is characterized by high turbidity as the result of mobilization of erosion products along the bank, exacerbated by deforestation and flooding.

3.1.2 General status of the waters

Human activities in the second half of the twentieth century have had a drastic effect on the quality and quantity of the water in the rivers. A range of factors, including industrial pollution, domestic waste, agricultural pesticides, large-scale irrigation/flood control/hydropower schemes and watershed degradation have affected the basin. All the riparian countries have contributed to this situation. However, as many countries in the region experienced a significant economic decline in the last decade, the stress on water quality in some parts of the river has decreased temporarily. In the future, as the economies in the region grow, and as some industrial activities are restored, a likely scenario is that the threats to the water quality will again grow. Water quantity problems have generally not decreased in the past decades, with increasing droughts and floods. A good example of how mismanagement can cause irreversible damage to the ecosystem is the disappearance of the Tugai forest in Azerbaijan and Georgia. Inefficient upstream irrigation systems used the water needed by forest ecosystems, and consequently they were unable to survive.

A number of off-channel and on-channel reservoirs have been constructed for irrigation, drinking water supply, energy generation or regulation of uneven annual flow of rivers in the Kura-Aras river basin which indirectly serve as pollution control mechanisms. Though the reservoirs have a significant role for socio-economic development in the region, in some cases they have had a negative environmental impact through changing the natural hydrological flow of the rivers and the related ecological consequences such as degradation of floodplain forests, reduction of fish stock downstream, bank erosion, etc.

The further downstream, the greater the deterioration in water quality and the increase in water quantity challenges. This progression downstream is due to increasing levels and aggregation of pollution emissions, increasing demands for water, and the fact that the downstream areas are naturally drier The Kura-Aras Rivers also have an impact on the Caspian Sea. At present, the river is the second largest flowing into the Caspian, providing approximately 10% of the total inflow. It is possible that it provides an even greater share of

the Caspian's pollutants[4]. In order to sustainably manage the Caspian Sea, it will be necessary to manage the quality and quantity of the inflow from the Kura-Aras.[5]

3.1.3 Water quantity and water sharing agreements

Surface and groundwater quantity also has been a subject of significant change during last century. Accelerated economic development in the region during last century (the extension of irrigated lands, growth of industrial activities, urbanization and improved provision of drinking water) has increased water withdrawals from surface and groundwater bodies. Trends in water withdrawal have changed over the last 15 years as a result of economic recession in the South Caucasus countries. This has resulted in a significant decline in water consumption, especially in upstream countries (Georgia and Armenia). However, assuming this is temporary process, future economic revival and improvements in the life quality of the population may result in further increases in water consumption. Moreover, water consumption might increase significantly if the present unsustainable use of water resources in the basin remains. Currently, according to different sources from 31 to 40% of the Kura's natural runoff and 27% of the Aras runoff is not discharged to the Caspian Sea[6]. From a transboundary perspective, Azerbaijan is most vulnerable to water resource issues, as it is a downstream country heavily dependant on the Kura and Aras rivers due to its arid climatic conditions and growing population and development.

Water allocation between the riparian countries in the Kura-Aras river basin is regulated according to bilateral treaties made during last century. Below are listed several agreements reached between the USSR and Turkey and Iran. The Independent States of Armenia and Azerbaijan as successors of the USSR inherited these State Agreements in accordance with the international convention on State Succession. These treaties are:

- The convention between the USSR and Turkey on the Regulation of the Use of trans-boundary Waters signed in Kars on January 8, 1927. Under this convention the waters of the Boundary Rivers are shared 50/50 between the parties. The parties were obliged to set observation stations and form a joint commission providing two representatives from each side, which would determine twice a year the amount of water passing through these stations.
- The convention between the USSR and Turkey on the Utilization of Trans-boundary Streams signed on April 8, 1927, which included several provisions for the protection of water quality.
- The agreement between the Government of the USSR and the Shakhinshakh Government of Iran on Establishing the Regime on the Soviet-Iran Border and the Procedure of Settlement of Boundary Disputes and Incidents signed in Moscow on May 14, 1957. Under this agreement the parties would take the responsibility to "ensure preservation of the boundary waters in due condition of purity and protect the resources against pollution" (Article 10). The parties were also responsible to

[4] Until recently, the Volga was by far the largest pollution source. However, economic decline along the Volga has led to major reductions in the pollution load.

[5] The Caspian Sea covers 422,000 km^2 and provides a livelihood for 12 million people in five countries. GEF is providing support for the protection of the Caspian through the Caspian Environment Programme (CEP) with the involvement of the five riparian countries UNDP, World Bank, UNEP and EU-TACIS.

[6] According to data presented in book Water Resources of Azerbaijan (1989) around 40 percent of the Kura runoff is not discharged into the Caspian Sea. Studies of Russian Scientist Georgievski (2005) estimate runoff decrease of the Kura River by 27-31%.

"exchange information on a regular basis regarding the quantity and volume of water in the trans-boundary rivers and notify each other on the possibility of emergencies, like, floods" (Article 14).

- The agreement between Iran and the USSR on the Joint Utilization of Trans-boundary Waters of the Rivers Aras and Artak for Irrigation and Power Generation Purposes signed in Tehran on August 11, 1957. Under this agreement the waters and energy resources of the rivers Aras and Artak were shared 50/50 between the parties. The parties agreed to develop a common draft project on the joint utilization of waters and to conduct a mutual investigation of the streams for planning irrigation and power generation activities with the aim that the minimal stream rate did not fall below 10% as measured at the border.

There are agreements between Armenia, Azerbaijan and Georgia:

- The agreement of 1974 entered between the Soviet Socialist Republic of Armenia and the Soviet Socialist Republic of Azerbaijan on the joint utilization of the waters of the river Vorotan (concerning the diversion of the Vorotan-Arpa-Sevan), which predetermines allocation of 50% of these waters to each party.
- The Memorandum of Understanding between the Ministry of Environment of Georgia and the State Committee of Ecology and Nature Management of the Republic of Azerbaijan (currently the Ministry of Ecology) on cooperation in the development and implementation of pilot projects for monitoring and assessment of the status of the Kura River basin (1997).
- The agreement between the Governments of Georgia and Azerbaijan on cooperation in Environmental Protection (1997).
- The agreement between the Governments of Georgia and Republic of Armenia on cooperation in Environmental Protection (1997).

3.1.4 Climate in the region

There are a wide range of climatic conditions and landscapes in the Kura-Aras basin. Consequently, average air temperatures and precipitation rates vary greatly across the region. (Table 3.2).

Table 3.2: Average annual air temperature and precipitation for different stations in the region

Station	Height (m.)	Average annual air temp (^{o}C)	Average annual sum of precipitation, (mm.)
Krestoviy Pereval	2,395	-0.2	1,503
Gudauri	2,197	2.5	1,473
Tbilisi	404	12.7	524
Nakhichevani	875	12.8	271
Salyan	-21	14.5	283
Yerevan	900	11.6	339

Eastern Turkey and north-west Iran are mountainous and dry. The climate of Armenia is typically continental with hot dry summers and cold wet winters. The annual rainfall ranges from 1,000 mm in the mountains to less than 300 mm in the Ararat valley. Temperatures regularly exceed 35 ºC and can drop to a minimum of -35 ºC. Azerbaijan has a partly Alpine climate, and a very dry steppe climate with permanent lack of precipitation. In Georgia there is a wide range of climatic conditions ranging from Alpine in the north and the west (with up to 4,000 mm of rain) going down to dry steppe in the far south-east with less than 300 mm rain/year.

3.2 Ecological Status

3.2.1 Status of natural ecosystems and biodiversity

The ecosystems of the Kura-Aras basin, similar to the entire Caucasus Ecoregion, are highly diverse and include a broad range of landscapes, from semi-deserts and arid shrublands to mesophylic relic broadleaf forests and alpine grasslands. A map detailing the floristic regions of the Kura-Aras basin is shown in Figure 3.2. These ecosystems harbour a variety of plant and animal species representing a mixture of Mediterranean, Eastern European, and Near Eastern floras and faunas, combined with a high proportion of regional endemics (reaching 20-30% of the total species number in certain taxonomic groups). A detailed description of the ecological status can be found in Annex 4.

The Caucasus Ecoregion has been identified by Conservation International (CI) as one of the world's 25 biodiversity hotspots due to high species diversity and significantly threatened local ecosystems. The area identified by CI corresponds closely to the Kura-Aras river system. This demonstrates the ecological importance and fragility of this area. Notably, the Aras is home to one of the last natural sturgeon breeding grounds, there are important and unique dry-land riparian forests along the Kura, and the delta where the Aras and Kura rivers flow into Caspian contains many important wetland sites.

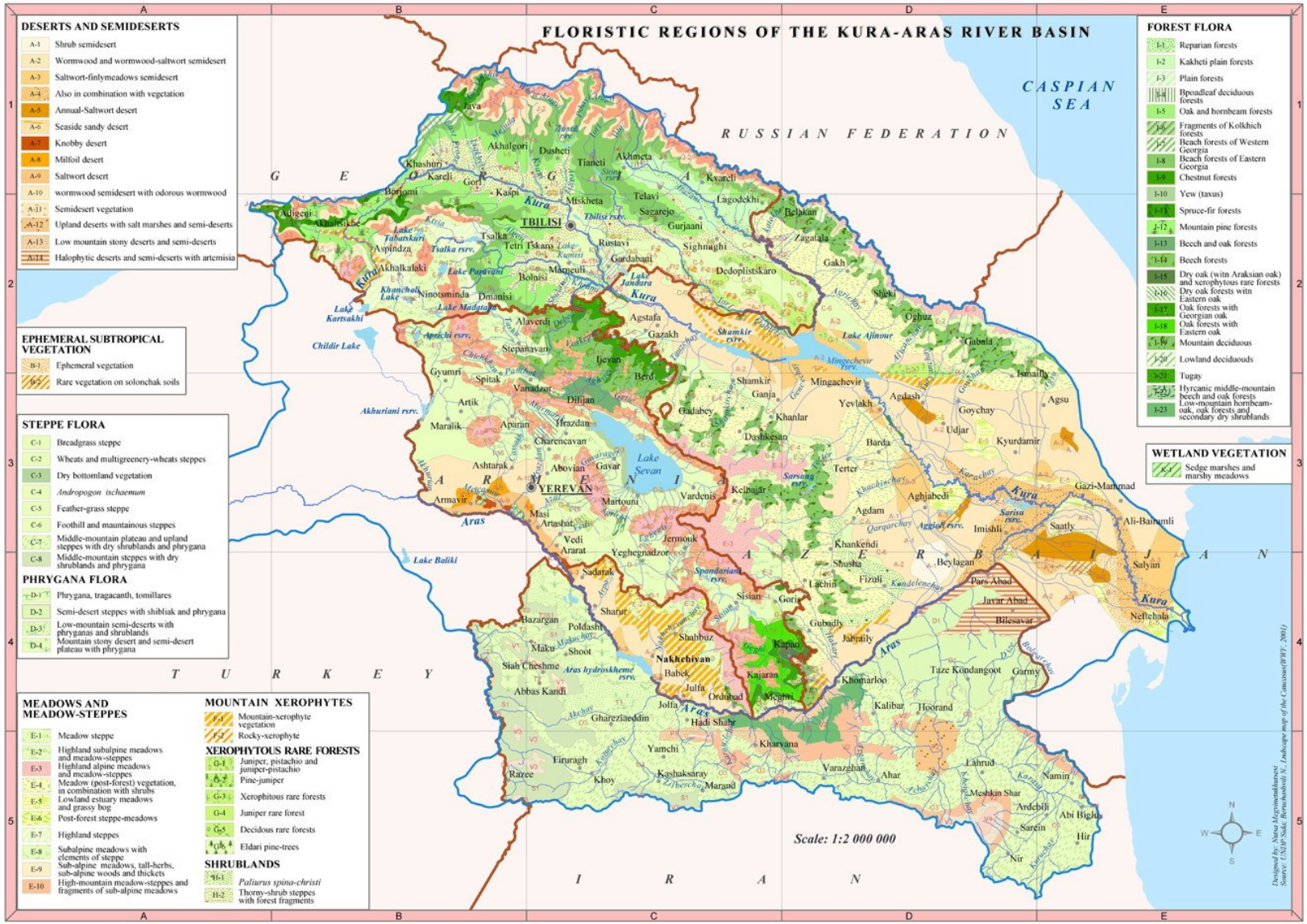
Over the last decades, the biodiversity in the basin has been affected by extensive anthropogenic activities. Major impacts on the basin biodiversity include loss of species and habitats. Many flora and fauna species have become endangered or threatened and have been listed in IUCN, former USSR and National Red Books, and recently, the Ecoregional Conservation Plan for the Caucasus (2006). Some species have also become extinct.

The major threats to the biodiversity and habitats are:

- Uncontrolled harvesting of flora and fauna, including poaching.
- Habitat destruction as a result of the development of agriculture, industry, tourism and recreation activities, and the development of infrastructure and urbanization etc.
- Climate change.

The threats and their impacts are described and analyzed in more detail in Section 4.5 which describes the transboundary problem of Ecosystem Degradation.

Figure 3.2: Map showing key floristic regions in the basin of the Kura and Aras rivers



To protect the unique biodiversity, the basin countries have developed various categories of protected areas. The first protected area in the basin, the Lagodekhi Strict Nature Reserve, was established in Georgia in 1914. At present there are over 60 protected areas in the basin (see Figure 3.3). The largest protected areas located in the basin are presented below in Table 3.3.

Despite the existence of protected areas, proper protection of the territories is rarely provided due to weak enforcement mechanisms. The major reasons for this are poor financing and poor institutional capacities to develop management plans and apply modern nature conservation procedures.

There are a number of internationally supported projects already implemented, ongoing or planned for implementation in the basin aimed at assisting the basin countries in improving conservation and the sustainable use of biodiversity. The financial contribution from the GEF is the largest so far. However, much more needs to be done by both the international community and the governments of the basin countries in order to protect and rehabilitate globally significant ecosystems and species diversity in the Kura-Aras River Basin.

Figure 3.3: Officially established protected areas in the Kura-Aras basin (modified)[7]

[7] Source: Ecoregional Conservation Plan for the Caucasus. 2005. WWF Caucasus Office

Table 3.3: Largest protected areas located in the Kura-Aras River Basin

Protected area	Country	Coverage (ha)
Sevan National Park including lake Sevan	Armenia	150,100
Marakan protected area	Iran	92,715
Agel National Park	Azerbaijan	17,924
Kiamaki protected area	Iran	84,400
Agri Mountain National Park	Turkey	80,908
Arasbaran Biosphere Reserve	Iran	72,460
Borjomi-Kharagauli National Park	Georgia	57,963
Shirvan National Park	Azerbaijan	54,373

3.2.2 Forest resources and deforestation

Forest ecosystems cover more than 2.3 million ha within the region, excluding the Iranian and Turkish portions of the basin (Figure 3.4), of which 54% lies in Georgia. A proportion of the forest cover in the basin is a result of recent or historical afforestation, the greatest area being in Armenia (75%). Largely these are mountain and foothill deciduous, broadleaf, and mixed forests (over 80 %) with only ca. 2-3 % as natural floodplain forests. The reserve of timber in the mountain forests of the Georgian part of the Kura basin constitutes 1000-1200 m^3/ha for the deciduous forests (the greater part of mountain forests of the region), and 1800-2000 m^3/ha for mixed forests.

Figure 3.4: Distribution of forests in the Kura-Aras basin[8]

[8] Source: Ecoregional Conservation Plan for the Caucasus. 2005. WWF Caucasus Office

Degradation of the forests of the Kura-Aras basin has been occurring since the second half of 20th century, the most vulnerable of which are the floodplain forests. Fragmentation of floodplain forests as a result of deforestation is the most likely reason for the extinction of the Near Eastern tiger.

The boundaries of the mountain forests remained more or less stable until the beginning of 1990s. Since then, the situation has deteriorated as a result of extensive logging, both permitted and illegal. The greater destruction has occurred in areas that are relatively easy to reach, located in the foothills of the Great Caucasus and throughout the lesser Caucasus. Logging for fuel affects all forest ecosystems throughout the countries of the region, whereas logging for commercial purposes applies first of all to the high-stem broadleaf forests of Georgia and, partly, Azerbaijan. In contrast logging for fuel, commercial timber harvesting has continually increased since the early 1990s and has accelerated in the second half of 1990s.

3.2.3 Land degradation

Land degradation is an important environmental and socio-economic problem in the Kura-Aras basin. The main forms of degradation are deforestation, desertification, salinization and soil erosion. The reasons of land degradation are unsustainable agricultural practices (including improper irrigation, land cultivation on slopes, etc.), unsustainable timber logging and overgrazing. In addition, the construction of large reservoirs (i.e. Mingechavir in Azerbaijan, Arpylych in Armenia, Tsalka, Sioni, Dali, and Tbilisi in Georgia) has also caused bank erosion and landslides.

Overgrazing is probably the most important reason of degradation of pasture quality throughout the uplands of the entire region. The most important and well-documented erosion is observed along the southern slopes of the Great Caucasus, especially in the easternmost part of the range in eastern Azerbaijan and in the Aragvi valley in Georgia.

In Armenia, extensive tree-cutting for fuel purposes (where the annual quantity of firewood in the Republic varies from 0.7 to 1.0 million m^3) intensifies the soil erosion and degradation processes. Consequently, about one-fifth of arable land in Armenia is unusable. A similar problem occurs in Georgia.

In Georgia, deforestation is the main reason of land degradation. Intensive deforestation, in the Trialeti Mountains, has caused increasing erosion along the northern and western slopes of the mountains.

Land salinization is wide-spread in Azerbaijan, north-eastern Iran and the southern part of Armenia with 500 thousand hectares affected in these countries. The major reason for land salinization is over-irrigation with ineffective drainage system. This leads to water logging and excessive soil mineralization. More details on the biodiversity and ecosystems of the Kura-Aras river basin can be found in annex 4.

3.3 Socio-Economic Situation in the KA Basin

Social and economic changes within the Kura Aras Basin have not only impacted the ecosystem but have also been affected by many of the environmental changes that have been

brought about during the last century. The historical socio-economic conditions of the Kura Aras Basin have largely shaped practices that continue to date, however, the shift from the Soviet economic system to a more free market system in the FSU states, and the increased agrarian reform in Iran have altered the impacts on the river basin.

Since the end of the Soviet Union the human population has experienced changes in demographics movements, transitional economic conditions and more localized social welfare that are reflected in the shifting environmental situation. The increases in urbanization, agricultural irrigation, and industrialization within the basin, have both impacted and are *impacted by* conditions within the river basin system. The indicators presented here illustrate these changes, as they pertain to the anthropogenic impacts on the Kura Aras, as well as how the changes and conditions of the Kura Aras are impacting human development conditions. The demographic trends indicate where human are settling, and the impacts of those settlements. The economic data highlights trends in national macro-economic development in the past 15 years in the region, pertaining to water use, development and government investment strategies. Finally, the social welfare data provides a snapshot of human conditions that are impacted by water conditions. Further details on the socio-economic situation in the Kura-Aras river basin can be found in Annex 1.

3.3.1 Demographic trends

The estimated population of the Kura-Aras River Basin for 2003 was approximately 13.1 million people, or about 16% of the total population of Armenia, Azerbaijan, Georgia and Islamic Republic of Iran[9].

The average population density in the Kura-Aras Basin is 82 people per km^2 (Figure 3.5). Table 3.4 shows the division between the urban and rural populations and population density in each riparian country.

Table 3.4: Population of the Kura-Aras River Basin (2002-2003)

Country	Population in the basin (mln.)	Urban Population (mln.)	Urban Population (%)	Rural population (mln.)	Rural Population (%)	Population Density (per 1km2)
Armenia	3.2	2.1	65	1.1	34	107
Azerbaijan	4.8	1.7	35	3.1	65	87
Georgia	2.7	1.1	41	1.6	59	74
Iran	2.4[10]	na	na	na	na	63
Total in the Kura-Aras Basin	**13.1**					**82**

[9] For the purpose of analysis this report does not include socio-economic, geographic or other data on Turkish part of the Kura-Aras River Basin

[10] For Iran the data is for 2000.

Figure 3.5: Map showing population density in the basin of the Kura and Aras rivers

Migration in the Kura-Aras river basin increased in the last decade of the 20th century, largely determined by the political and socio-economic developments in the region. In Armenia, in 1992 alone, more than 200,000 people left the country and although the level of emigration slowed by the end of 1990s, the negative migration balance continues to affect population growth in the country. Azerbaijan has experienced substantial migration within and across its borders over the last two decades and many of the internally displaced people (IDP) that make up 10 % of the population are settled in tent camps along the lower Aras and Kura rivers. Georgia continues to experience increased urbanization with IDPs, now making up approximately 5 % of the country's population. Within Iran, there has been an increased effort on behalf of the state to develop agricultural settlements within the Aras River Basin which depend on significant irrigation.

3.3.2 Economic indicators

Throughout the region, the social and economic systems have been in flux since the fall of the USSR, and the conflict between Armenia and Azerbaijan has exacerbated this. Economic development is uneven throughout the river basin, both between and within countries. Major urban areas are increasingly crowded, and some are thriving, while most rural areas slide further into economic dislocation due to the shift from a centralized economy to a market driven economy.

Following the dissolution of the former Soviet Union in the 1990s, the economies of Armenia, Azerbaijan and Georgia experienced dramatic economic decline in large part due to civil strife and conflict. For example, between 1990 and 1993, the average annual decrease of Gross Domestic Product (GDP) was around 18% in Armenia and 13 % in Azerbaijan. In Georgia, GDP declined by 70-75 % between 1991 and 1994. This was a result of economic dislocation, closing down of state owned industries and development of new land tenure systems for agriculture.

However, economic reforms and political stability in the second half of the 1990s have revived the economies of these countries and they are currently growing rapidly. Between 2002 and 2004 the average grown rate in GDP has been 9.66 % in Armenia, 10.60 % in Azerbaijan, 5.88 % in Georgia, and 5.62 % in Iran.

While these rates show positive trends the economies of the Basin countries remain in a period of transition with very low per GNI per capita[11] rates. Further, the rates of income distribution are concentrated tightly in urban centers and are generally in the hands of a minority of the population, while the significant majority of populations remain in poverty. See Table 3.5 for details.

Despite the drastic decline in economic production in Armenia, Azerbaijan and Georgia during the early 1990s, the Kura-Aras River basin remains a region with relatively well developed industry and agriculture (see Figure 3.6 and Table 3.6 for details).

[11] Definition: GNI (Gross National Income formerly GNP) GNI per capita (formerly GNP per capita) is the gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population.

Figure 3.6: Map showing key industrial sectors in the basin of the Kura and Aras rivers

Table 3.5: National GNI and GNI Per Capita for Kura Aras Countries 2000 - 2004

Country	2000	2003	2004
GNI (Current US $)			
Armenia	2.0 billion	2.9 billion	3.2 billion
Azerbaijan	4.9 billion	6.8 billion	7.8 billion
Georgia	3.3 billion	3.9 billion	4.8 billion
Iran	106.6 billion	134.0 billion	155.3 billion
GNI per capita Current US $)			
Armenia	666	960	1,060
Azerbaijan	610	820	940
Georgia	700	860	1,064
Iran	1,670	2,020	2,320

Table 3.6: Economic Sector Development Trends for Kura Aras Countries 2000-2004

Country	2000	2003	2004
Agriculture, value added (% GDP)[12]			
Armenia	25.5	24.1	23.4
Azerbaijan	17.1	13.5	12.3
Georgia	21.9	20.6	17.8
Iran	13.7	11.3	10.8
Industry, value added (% of GDP)[13] ***including mining***			
Armenia	35.4	37.7	37.1
Azerbaijan	45.5	52.6	55.4
Georgia	22.2	25.6	25.4
Iran	36.7	41.2	41.5

It should be noted that oil and gas extraction (mostly in Azerbaijan and Iran) and its transport are fast growing sectors in the basin. The Kura-Aras river basin is the corridor for the Baku-Tbilisi-Supsa and Baku-Tbilisi-Ceyhan oil and gas pipelines (put in operation in 1999 and 2006, respectively) which could impact the health of the river systems in the event of accidents. Furthermore, agriculture continues to play an important role through out the region, through both commercial and subsistence farming.

In the FSU states, the shift from collective state farms with assured markets to a market based economy for agricultural goods produced on privately owned plots of land have significantly impacted this sector. The high costs of farming equipment, renovation of irrigation schemes and agricultural chemicals has resulted in a short term decline in environmental impacts on the river basin. However, the precipitous decline in the quality of agricultural infrastructure including irrigation channels, and drainage systems has resulted in increased soil salinization, decreased soil fertility and increased demand for water to compensate for that lost in leaking degraded systems.

[12] Agriculture corresponds to International Standard Industrial Classification (ISIC) divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. Source: World Bank national accounts data, and OECD National Accounts data files.

[13] Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. Source: World Bank national accounts data, and OECD National Accounts data files.

In Iran the agricultural development in the Aras basin is expected to have impacts on the region. Water will be needed to irrigate these fields and it is expected that this will have an impact on the water regime in the basin. Additionally, planned hydroelectric dams to be built in partnership between Iran and Armenia (the Meghri hydropower plant), and between Iran and Azerbaijan, (the Khoda Afarin dam, currently under construction) are also expected to impact the regime. The need for both electricity and water reservoirs for agricultural development will be met through these projects, however these schemes are both in the planning stage at this point and construction has not yet begun.

3.3.3 Social indicators

While the economic situation appears to be improving, without a healthy functional workforce economies will not reach their potential. Further the health of the population can also be informative about the conditions within and across the region. Unfortunately, it is difficult to draw causality when gauging social indicators that will either impact or are directly impacted by river basin conditions. However the overall health of populations can be inferred by relying on several major indicators that are readily available. These are infant mortality rates, life expectancy at birth and prevalence of malnourishment. See Table 3.7 for details.

Table 3.7: Social Welfare Indicators in the Kura Aras Basin for 1990 - 2004

Country	1990	2004
Mortality Rate, infant (per 1,000 live births)		
Armenia	52	29
Azerbaijan	84	75
Georgia	43	41
Iran	54	32
Life Expectancy at Birth (years)		
Armenia	68	71
Azerbaijan	71	72
Georgia	70	71
Iran	65	71
Prevalence of Undernourishment (% of population)		
Armenia	52*	29
Azerbaijan	34*	10
Georgia	44*	13
Iran	4	4

*measured for 1993

Between 1990 and 2004, these have shown very favorable trends throughout the region, which could be interpreted to be indicative of an overall improvement in conditions. Indeed these trends may be a result of lower pollution loads in the river, as agriculture and industrial sectors have undergone transition, and more locally produced agricultural products are available. However, the loss of access to free medical care and low economic conditions suggest that the improvements would have been more notable. It should also be noted that the 1993 measure for malnourishment prevalence shown in Table 3.7 above, was probably low due to the tremendous social and political changes in Armenia, Azerbaijan, and Georgia during the years around this. Nonetheless the improvements portend positive trends for human populations.

One issue of significant concern is the high rate of infant mortality, especially in Azerbaijan. As a down stream country relying on the Aras and Kura rivers as the main source of drinking water for this population, infants become very susceptible to water borne illnesses. Further, birth defects due to maternal ingestion of some water borne pollutants can lead to higher rates of infant mortality (please refer to stakeholder analysis section for more details on perceptions different stakeholders.)

Other health and poverty related indicators are either not currently available or are not standardized for comparison across the region.

3.4 Climate Change

Changes in climatic conditions in the Kura-Aras river basin are likely to be complex and diverse[14]. During the last century, a significant area of the territory had seen air temperature increase by an average of 0.03-0.06 ^{0}C per 10 years. The most significant warming within the basin has occurred in the Borjomi Gorge, Lower Kartli, Great Caucasus, Kura-Arak lowlands and the Nakhichevan Autonomous Republic (Azerbaijan). The rate of warming in these regions (0.10-0.13 ^{0}C per 10 years) exceeds the global estimations (0.05-0.07 ^{0}C per 10 years).

A significant reduction of precipitation (up to 2-12 mm of the annual total per 10 years) has been observed in west Azerbaijan, with less significant changes in east Georgia, the Kura-Aras lowlands and in the territory of Iran (up to 3%). In the Lesser Caucasus and in the Nakhichevan Autonomous Republic the precipitation regime has not changed.

According to existing global climate change scenarios, warming is expected in the basin with the average annual temperature increasing by the middle of the 21st century by 1.5-2.0 ^{0}C compared to the average temperature of the 20th century. The annual amount of precipitation is expected to slightly decrease.

Analysis of hydrological data has shown a statistically significant reduction of annual flow in the main rivers and channels on the Kura-Aras basin. Conversely, an increase in flow has been observed in mountain rivers with significant glacial feeding. This is due to intense melting of glaciers as a result of temperature increases in the watershed. Currently, evaluation of trends and other statistical calculations does not distinguish between natural and anthropological causes of these changes.

According to the most probable climatic scenario, it has been calculated that an increase in temperature of 0.5-1 ^{0}C in the Basin will result in flow reductions even if the level of precipitation remains the same. For example, in the vicinity of Tbilisi, flow rates will be reduced by 5-10 % in the Kura River. However, the extreme scenario would see an increase of 2 ^{0}C and a 10% reduction in precipitation has been calculated, resulting in a 50% flow

[14] Possible variations of climate in the region were analyzed on the basis of global climate change scenarios proposed by the World Meteorological Organization and the results of mathematical modeling of total atmospheric circulation, from the laboratory of hydrodynamics, Preston University, USA. The evaluation of the change of river flows has been performed on the basis of statistical analyses of hydrological lines of observation, as well as by means of mathematical modeling of river flows.

reduction. This would have a dramatic effect on the environment and socio-economic development in the region and the implications would be impossible to forecast.

An increase in average annual temperature of 1.5-2.0 ^{0}C will result in two significant ecosystem changes in the Kura-Aras river basin: shifts in vertical zonation and significant changes in the typological structure. In the areas where precipitation is expected to decrease, the re-occurrence and frequency of droughts will increase. This will lead to a lessening of areas of woodlands, a reduction in the diversity of dendro-flora, and an increase in drought-resistant plants. These processes in the central and east regions of the Great Caucasus and some regions of the Lesser Caucasus are likely to cause significant degradation of alpine pasture.

There are a number of studies indicating that climate change has already affected biodiversity in the basin. This is especially true for plants and animals with small body size. In 1999-2000, a comparative study was carried out between amphibians and reptiles in Georgia originally described in the first two decades of 20th century with those currently observed. The study showed that species dependent on arid shrubby habitats had declined significantly, compared with species living in humid and forest habitats. The range of a number of reptile species, including the Levantine viper (*Vipera lebetina*), collared eirenis (*Eirenis collaris*) and the Montpellier snake (*Malpolon monspessulanus*) have been displaced 30-50 km south-eastwards during the last several decades. Altitudinal distribution of three species of green lizards (*Lacerta agilis, L. media, L. strigata*) have been displaced downwards in the Tbilisi area whereas the range of the Syrian spadefoot (*Pelobates syriacus*) has declined and undergone fragmentation. One plausible explanation of these events is the increase of humidity in southeastern Georgia (and possibly western Azerbaijan) recorded after the 1950s, perhaps as a result of the construction of the Mingechavir reservoir and several smaller impoundments along the Kura River.

There is also likely to be an impact on agricultural practices and cropping patterns. The most vulnerable crops are wheat, maize, sunflower, tobacco, sugar-beet, potato which will be affected by decreases in precipitation, an increase or re-occurrence of droughts and decreases in soil humidity etc.

In conclusion, climate change has to some extent already affected more sensitive and vulnerable biodiversity and ecosystems in the basin over the last decades. However, if global warming continues to follow more pessimistic scenarios, then the effect will be much more dramatic and will have significant impacts on the hydrological regime, ecosystems, agriculture and the national economies in the basin. Further information on climate change can be found in Annex 3.

3.5 Institutional Setting

For Kura-Aras basin countries, ensuring the proper institutional setting is one of the key elements in successfully managing the basin's water resources. Institutions in most of the basin countries have a Soviet legacy. However, during the last several years some basin countries have made substantial progress in the improvement of the institutional framework of the water sector, supported by major changes in the legal framework.

Table 3.8 below summarizes the main functions of the water sector management authorities in the Republics of Armenia, Azerbaijan, Georgia and Iran. The table includes a description of the agencies responsible for water resources management and protection, tariff regulation, and management of water systems and infrastructure. The main functions of those agencies are also described together with the existing tools and enforcement mechanisms for implementation of those functions.

More details on the legal and institutional setting can be found in Annex 2.

3.5.1 Armenia

The Water Code and Law on Fundamental Provision of the National Water Policy of Armenia put into force an institutional framework that includes the following principal implementing entities: the National Water Council and its Dispute Resolution Commission; the State Authorized Body for Water Resources Management and Protection; Basin Management Authorities; the State Authorized Body for Management of State-Owned Water Systems and its technical commission for hydro-technical structures; and the Regulatory Commission for the regulation of various water using sectors, such as municipal water supply, irrigation and hydropower.

The *National Water Council* (NWC) is a high level advisory body, chaired by the Prime Minister. The NWC is responsible for providing guidance on the National Water Program, and other areas of responsibility that are given to it by regulation. *The Dispute Resolution Commission* (DRC) is established under the National Water Council. By using mediation, the Commission may resolve disputes that relate to water use permits.

The *State Committee on Water Systems* (SCWS) under the Ministry of Territorial Administration is responsible for management of water systems. It is also responsible for management and operation of state-owned drinking water supplies, irrigation water supplies, drainage structures and public wastewater collection, treatment and disposal facilities.

The *Public Services Regulatory Commission* (PSRC) is an independent body, responsible for developing water tariff policy and issuing water system use permits to non-competitive water suppliers.

The *Ministry of Nature Protection* (MNP) has a broad natural resources management protection mandate, which is fulfilled through various agencies of the MNP.

The *Water Resources Management Agency* (WRMA) is the state authorized body for water resources management. WRMA is charged with assessing water availability and ensuring water use efficiency, through the permitting and planning processes. It is also responsible for the management of competing water uses and for ensuring that environmental needs are met.

The *Basin Management Organizations* are involved in developing water management plans at the river basin level, recording copies of water use permits, ensuring water resources protection, assuring compliance with conditions set in water use permits, developing extraction regimes, and participating in the development of water allocation plans for each of the established five primary basin management areas.

Table 3.8: Main functions of water sector management authorities in Kura-Aras Basin Countries

	Country	Water Resources Management and Protection	Tariff Regulation	Management of Water Systems
Responsible Agency	AM	Water Resources Management Agency	Public Services Regulatory Commission	State Committee on Water Systems under the Ministry of Territorial Administration Ministry of Energy
	AZ	Azerbaijan Amelioration and Water Economy Joint-Stock Company Ministry of Ecology and Natural Resources	Ministry of Economic Development	Azerbaijan Amelioration and Water Economy Joint-Stock Company
	GE	Ministry of Environmental Protection and Natural Resources, Local Governance bodies (for water areas of local importance	Ministry of Economic Development Local Administrations	Ministry of Agriculture Ministry of Energy Ministry of Economic Development Local administrations
	IR	Ministry of Energy Regional Water Authorities	Ministry of Energy	Ministry of Energy
Main Functions	AM	Water resources monitoring and distribution; Strategic water management and protection	Protection of consumer rights and tariff regulation for non-competitive water supply and wastewater treatment in drinking, household and irrigation sectors	Management of water systems under the state ownership; Assistance to development of water user associations and water user federations, organization of tenders on transfer of water systems' management; Management of water systems of energetic importance, that are under the state ownership
	AZ	Water resources distribution and management; Monitoring and protection	Protection of consumer rights and tariff regulation for non-competitive water supply and wastewater treatment in drinking, household and irrigation sectors	Management of irrigation water systems; Assistance to development of water users associations; Management of water systems use for energy sector
	IR	Coordination and management of water resources; Monitoring coastal areas, marsh beds, natural rivers, streams and public canals	Protection of consumer rights and tariff regulation for non-competitive water supply and wastewater treatment in drinking, household and irrigation sectors	Development and exploitation of urban water distribution system, collection and transfer as well as treatment of urban sewage within the legal city limits in each province
	GE	Regulation of water use through providing permits; Monitoring of pollution and quality of water resources; Insuring compliance with legislation related to water pollution and water use.	Protection of consumer rights and tariff regulation for non-competitive water supply and water treatment in wastewater drinking, household and irrigation sectors	Water systems are in state ownership and are managed national or local governments; Except tertiary irrigation canals managed by Water User Associations and small hydro power stations managed by private companies.
Enforcement tools/ mechanisms	AM	Water use permits	Water system use permits	Management contract
	AZ	Water use permits	Water system use permits	Management contract
	IR	License	License	Regional Water Authorities
	GE	Water use permits including permits for water extraction and water discharges; Water quality standards	Water system use permits	Management contract

The *State Hydrometeorological and Monitoring Service* (ASH) is responsible for monitoring of river flows and levels of lakes and reservoirs. Through its 92 observation points and 7 regional hydrological centers, ASH monitors the quantity of surface waters of Armenia. Monthly measurements are sent from observation points to the appropriate regional stations, where annual data are maintained in the Annual Reference Books.

The *Environmental Impact Monitoring Center* monitors ambient surface water quality, including rivers, lakes, and reservoirs, in addition to air parameters. The current water quality monitoring network covers 54 water resources with 131 observation points.

The *Regional Geological Fund* is a repository of data on groundwater resources. Today the Fund mainly provides official groundwater availability letters to the applicants of water use permits, which are based on out of date information.

Compliance, assurance and enforcement of water and environmental legislation are conducted by the *State Environmental Inspectorate* of the Ministry of Nature Protection through its 11 local inspectorates. According to the legislation of Armenia, the Inspectorate supervises the implementation of water resources (including intake) and protects water users (e.g. from pollution in wastewater discharges).

The *Ministry of Agriculture* is the state authorized body for the development of agricultural policy and strategies, including irrigation and drainage policies. The Ministry also develops irrigation standards and regimes for agricultural crops.

The *Ministry of Energy* develops and implements policy and strategies in the energy sector, including the hydropower sub-sector.

The *Ministry of Health* through its *State Hygiene and Anti-Epidemiological Inspection* 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.

The *Ministry of Finance and Economy* is responsible for the organization and realization of auditing of financial-economic activities in Government agencies, state non-commercial organizations, and commercial organizations with Government participation. It conducts inspections in the sphere of water systems and environment, coordinates loans and grants from international financial organizations and donors, and monitors the implementation of programs funded by loans.

3.5.2 Azerbaijan

The main organization of Azerbaijan for the control of water use for irrigation purposes is the *Joint-Stock company for Amelioration and Water Economy of the Ministry of Agriculture*.

The basic functions of the Joint Stock company relate to: providing economic sectors of the Republic with water and controlling the rational use of water resources; providing drainage systems on irrigated land; operating water supply and land-reclamation facilities that are the responsibility of the Company; carrying out anti-mudflow activities; directing budgetary

funds for capital construction and design; providing development of the sector using current scientific, engineering and technological approaches.

The Ministry of Ecology and Natural Resources is responsible for the conservation and protection of water resources from pollution. It makes an inventory of water resources and controls their quality. It carries out permanent hydrometric, hydro-geological and hydro-chemical observations; compiles water balances; evaluates ground water yields; and deals with the issues of rational use and the regeneration of water resources. It establishes and approves standards of minimal allowable discharges (MAD) of wastewater and controls them through regional offices.

The Division of Ecology and Environmental Policy defines the main policy directions relating to the conservation and protection of water resources from pollution. The *Department of Environmental Protection* coordinates activities relating to the monitoring and implementation of environmental normative acts. It also examines the compliance of planned activities.

National departments of the *Ministry of Ecology and Natural Resources* are concerned with hydro-meteorology and environmental ambient monitoring, and monitoring of the quantity and quality of surfacewater run-off. Monitoring of ground waters is carried out by the *National Geology-Exploration Service*. The *Center for Environmental Pollution* in the *National Department for Environmental Monitoring* undertakes water quality analysis.

At present, three main water quality laboratories are functioning in the Ministry. These are *the Laboratory for the Management of Integrated Monitoring of the Caspian Sea*, the *Laboratory of the National Geologic Exploration Service*, and *the Laboratory of Monitoring of Pollution of Land Surface Waters*.

The Ministry of Health through the Centre of Epidemiology and Hygiene is responsible for setting standards and monitoring drinking water quality. In the regions there are corresponding subdivisions of the Ministry for monitoring and control of quality of water etc.

Prior to July 2004, water supplies in the cities of Baku and Sumgait were managed by the Absheron Joint-Stock Company. In July 2004 the water supply and sewerage services of other regions of the country were also given to this Company (before these were managed by the State Committee on Architecture and Civil Engineering) and the *"Azersu" Joint-Stock Company* was created. The focus of this company is the operation and rehabilitation of water supply and sewerage systems.

The Ministry of Fuel and Energy is involved in issues of water use for energy purposes.

The Ministry of Justice participates in the adoption and implementation of normative acts, which represent the legal basis for water resources.

Local Executive Bodies execute policies of water-intake and water-supply. They are responsible for supplying the population with treated, good quality drinking water and coordinating the development of standards for water use.

3.5.3 Georgia

The *Ministry of Environment Protection and Natural Resources of Georgia* is responsible for the regulation, inventory, licensing and issuing permits and efficient use of surface and ground waters, together with pollution control and water quality and quantity monitoring. Within the Ministry, the *Water Resources Protection Division* of the Department of Integrated Environmental Management ensures the implementation of state water protection policy.

The *Ministry of Labor, Health and Social Security of Georgia* supervises the compliance and control of water born diseases.

The *Ministry of Economic Development of Georgia* is responsible for the preparation of indicative plans, proposals for financing state programs (including those concerning the water sector), and tariff policy in the water sector. At present, the Department of Analysis and Monitoring of Sectional Programs deals with water resources. In addition, the Ministry has to define policy for municipal water supply and sewerage.

The *Ministry of Finance of Georgia* is responsible for the allocation of finances for the implementation of state programs and investment projects in the water sector

Tax Inspectorate (its sub-divisions existing in all administrative regions) being under the Ministry of Finances carries out the collection of taxes for water extraction from enterprises.

The *Ministry of Agriculture and Food of Georgia* is responsible for carrying out policy in the field of agriculture, including water use for irrigation purposes. Until 2004 the Department of Irrigation and Water Management was under the Ministry. It has now been reorganized into the Department of Melioration System Management. The Ministry is also responsible for the supervision of drinking water quality.

According to the law on Self Governance (2005), *Local Authorities (municipalities)* can carry out management of water resources of local importance. They are responsible for providing high quality, uninterrupted drinking water supplies. Furthermore, they prepare proposals concerning the establishment of tariffs for water-supply and sewerage, organize the water-supply and sewerage systems and allocate subsidies within certain budgetary constraints.

Water User Associations have been established in the South Caucasus. These associations are non-commercial entities, responsible for the management and operation of irrigation infrastructure of local importance; the provision and distribution of water amongst farms; and the collection of fees for services provided.

3.5.4 Iran

In Iran the *High Council on Water Affairs* was recently established, chaired by the President of the Republic. It comprises of the *Ministries of Energy and Agriculture Jihad (MoE and MoAJ respectively*), the Head of the *Management Planning Organization* and other experts. The Council provides broad policy guidance on the future of water security for the nation and acts as the final arbiter on matters dealing with water.

The *MoE* is legally responsible for water and the supply and development of its resources. The main duties of the Ministry in the water sector are: to supply and transfer water for agriculture, industry and urban purposes; the development of projects on surface and underground water resources; coastal and river engineering; urban potable water treatment and distribution; and the urban sewage disposal system. Irrigation and drainage development/management is placed under two ministries, the *MoE and MoAJ* while at the national planning level, the *Management Planning Organization* also plays a role.

The construction and development of dams, reservoirs and all main irrigation and drainage systems, and improvement of traditional schemes, is the responsibility of the *MoE*. It conducts and operates its responsibility through the deputy of Water Affairs, the *Water Resources Management Organization (WRMO),* its affiliated 15 *Regional Water Authorities (RWAs)* and other holding companies. These *RWAs* are organized by watershed and administrative approaches.

The Operation and Maintenance of the main irrigation and drainage systems is mostly entrusted to *MoE* affiliated companies, known as *Operation and Maintenance Companies*, 22 of which have been established to date. The O&M of the storage dams and water energy plants is also entrusted to 4 official *MoE* companies.

Since July 2004, all activities relating to the study, planning, development, supervision and coordination of O&M of water energy plants was entrusted to the deputy of the water energy plants of the *WRMO*.

The *MoAJ* is responsible for all planning and development activities below secondary canals. Its Deputy of Soil and Water has recently reorganized the three directorates acting as supervisory/executive agencies. These are: the *Office for Irrigation Development and on Farm Development;* the *Office for Agricultural Water Resources Development and Use Optimization;* and the *Office for Irrigation methods, Improvement and Development.*

The *MoAJ* conducts its responsibility through *Provincial Agricultural Organizations (POAs)* or affiliated companies. The *PAOs* mainly operate through country level offices which provide farmers and farmer group with technical and financial assistance.

4. PRIORITY TRANSBOUNDARY PROBLEMS

This Chapter identifies the priority transboundary problems in the Kura-Aras River Basin, and then describes each transboundary problem in detail. In particular each section describes the problem and justifies its transboundary importance; details the environmental impacts and socio-economic consequences of each problem; highlights the linkages with other transboundary problems; and analyses the immediate underlying, and socio-economic, legal and political root causes.

4.1 Key transboundary problems and priority scores

23 common GEF transboundary problems were assessed by the 16 members of the Technical Task Team (TTT) in order to determine their relevance and transboundary nature in the context of the Kura-Aras River Basin. The group was asked to brainstorm and identify the major water related transboundary problems. Consequently, the GEF list was narrowed down to 4 major transboundary problems in the Kura-Aras River Basin that required further detailed analysis:

1. Variation and reduction of hydrological flow
2. Ecosystem degradation in the river basin
3. Deterioration of water quality (e.g. pollution)
4. Increased flooding and bank erosion

A further cross-cutting problem of global climate change was also identified.

This list was further refined by assigning a score to each transboundary problem of between 0 (no importance), 1 (low importance), 2 (moderate importance) and 3 (high importance) to determine the relevance of the problem from the perspective of the *present day* and *15-20 years in the future*. When examining future change the TTT were asked to consider the effects of climate change. The scoring activity was based on the following suite of criteria:

- Transboundary nature of a problem.
- Scale of impacts of a problem on economic terms, the environment and human health.
- Relationship with other environmental problems.
- Expected multiple benefits that might be achieved by addressing a problem.
- Lack of perceived progress in addressing/solving a problem at the national level.
- Recognised multi-country water conflicts.
- Reversibility/irreversibility of the problem

The outcomes of this activity are presented in Table 4.1.

Table 4.1: Major transboundary problems and transboundary justification for the Kura-Aras River Basin

	Present day		Future (15-20 years)*	
Transboundary Problem*	**Median Score**	**Priority**	**Median Score**	**Priority**
Variation and reduction of hydrological flow	3.0	High	3.0	High
Deterioration of water quality (e.g. pollution)	3.0	High	3.0	High
Ecosystem degradation in the river basin	2.0	Moderate	3.0	High
Increased flooding and bank erosion	2.0	Moderate	2.0	Moderate

* Including the effects of global climate change

4.2 Key environmental impacts, socio-economic consequences and sectors

The key environmental impacts and socio-economic consequences of each priority transboundary problem were identified, together with the economic sectors that cause them. Each impact and sector was ranked according to its relative priority. The results are presented in Tables 4.2 (a) to (d). In all cases, 1 denotes the highest priority.

Table 4.2: Priority environmental impacts, socio-economic consequences of each transboundary problem in the Kura-Aras River Basin and the contributing economic sectors

(a)

Transboundary problem	Environmental impacts and socio-economic consequences	Rank	Sector	Rank
Deterioration of water quality (e.g. pollution)	Risk to public health through contaminated drinking water, agricultural products and increases in potential of water-borne diseases	1	Urbanisation	1
			Industry	3
			Agriculture	2
	Degradation of aquatic ecosystems leading to decreased recreational value of ecosystem	2	Urbanisation	2
			Industry	3
			Agriculture	1
	Decline in bioresources (e.g. reduced fish stock) leading to loss of income from fisheries	3	Urbanisation	2
			Industry	3
			Agriculture	1

(b)

Transboundary problem	Environmental impacts and socio-economic consequences	Rank	Sector	Rank
Variation and reduction of hydrological flow	Shortage of irrigation water resulting in: low productivity of land and desertification leading to low income from agricultural activities	2	Agriculture	1
			Industry	3
			Urbanisation	2
			Natural causes	4
	Shortage of safe drinking water leading to poor sanitation, disease and gender related problems	1	Urbanisation	3
			Industry	1
			Agriculture	2
			Natural causes	4
	Shortage of water for industry leading to a decline in production, and a decreased capacity for hydro energy production	3	Industry	3
			Agriculture	1
			Urbanisation	2
			Natural causes	4

Table 4.2: Continued

(c)

Transboundary problem	Environmental impacts and socio-economic consequences	Rank	Sector	Rank
Ecosystem degradation in the river basin	Deforestation resulting in soil erosion	1	Forestry	1
			Natural causes	2
	Losses in species and ecosystem integrity leading to: loss of species, reduction of recreational value and loss of income from fisheries	3	Fisheries	3
			Natural causes	4
			Agriculture	2
			Urbanisation	1
	Desertification and land degradation including salinization and soil erosion	2	Agriculture	1
			Natural causes	2

(d)

Transboundary problem	Environmental impacts and socio-economic consequences	Rank	Sector	Rank
Increased flooding and bank erosion	Damage infrastructure, agriculture losses (loss of crops) and loss of fertile land resulting in damage to national economies; Damage to households; Loss of human life	1	Urbanisation/industry /energy	3
			Forestry/Agriculture	1
			Natural causes	2

4.3 Variation and Reduction of Hydrological Flow

4.3.1 Description of the problem and justification of its transboundary importance

The hydrological regime in the Kura-Aras river basin is influenced by a complex of natural and anthropogenic factors. The natural fluctuations of river flow due to climatic variables such as precipitation and temperature and are discussed in more detail in Section 3.4 (Climate Change) and Section 4.3.4 below.

Variation in hydrological flow is caused by numerous human interventions including direct water abstraction from surface and groundwater bodies, and increased evaporation due to impoundments, urbanization and deforestation. This has significant transboundary consequences. At the confluence of the Aras River the natural annual discharge of the Kura River is approximately 32.3 km^3, while the natural discharge from the Aras at the same point is 12.3 km^3. However, at present, the discharge of the Kura River is about 19.6 km^3, while the discharge from the Aras at the same point is 9.0 km^3. It is calculated that 40 % of the Kura's natural runoff and 27 % of the Aras runoff is lost to the Caspian Sea (SIDA Technical Analysis, 2005). Figure 4.1 details the main hydrological features in the Kura Aras River basin.

Severe water deficit has not occurred in the basin to date and consequently shortages of water have not presented any serious threats to the population. However, population growth and rapid economic development in the basin countries will impose increased pressure on surface and groundwater resources. Water resources are most limited in Azerbaijan, which compared to Georgia has approximately 8 times less water measured in terms of both per km square and per person. As a result, the country is considered to be a region with a limited water supply (SIDA Technical Analysis, 2005). The most arid areas are in the Aras sub-basin, where more than half of the whole basin population lives. The Kura-Aras plain in Azerbaijan is also very arid and Azerbaijan's dependence on surface water resources from this is high (Regional Study on Irrigation and Drainage, 2006) making upstream water abstraction in the Aras sub-basin a very sensitive issue from a transboundary perspective.

4.3.2 Environmental impacts and socio-economic consequences of the problem

The main socio-economic consequences of variation and reduction of hydrological flow are water shortages in the various economic sectors, causing:

- Low productivity of agricultural land due to inadequate and poor irrigation;
- Low income from agricultural activities;
- Poor local sanitation and increased incidence of water-borne diseases – infection of shallow groundwater potable sources;
- Loss of groundwater resource due to over-extraction;
- Loss of commercial anadromous fish populations due to impoundments blocking access to spawning grounds
- Decreased capacity for hydro energy generation downstream.

Figure 4.1: Map showing the hydrology of the basin of the Kura and Aras rivers

The main environmental impacts of variation and reduction of hydrological flow can be summarized as follows:

- Ecosystem degradation including: degradation of habitat, losses of species and reduced biodiversity;
- Temporal changes in flow affecting biological processes such as fish spawning;
- Reduced natural pollution assimilation capacity of rivers, increased pollutant concentrations and reduce flux.
- Increased desertification due to lowering of groundwater tables

Socio-economic consequences

Significant increases in consumption of water in upstream countries will have a negative impact on the availability of water for economic activities and domestic needs in downstream states, potentially limiting development and affecting ecological functioning. Water shortage problems in the agriculture sector have already taken place in Georgia during the last 15 years although principally as a result of the deterioration of the existing irrigation supply network. Large areas of agriculture lands have not received irrigation water for many years leading to a decline in production and increased poverty levels in rural areas. A similar trend has occurred in Armenia. Water shortage problems in Azerbaijan have resulted in insufficient levels of water for water intensive crops: often they are irrigated only twice instead of 6-7 times (Regional studies on Irrigation and Drainage, 2006). This scenario is likely to develop in downstream countries if water availability is affected due to reduced hydrological flows[15]. In Iran where energy is heavily subsidized pumped irrigation schemes are common and the demand for water to irrigate uplands in the lower Aras basin is high.

There have been cases in the basin where excessive withdrawals of water have resulted in small and medium sized rivers drying out. Flow reductions from intensive water withdrawals for economic activities are relatively easy to determine, but the impacts of other human activities on river flow will only be revealed over time. Deforestation is one of them. It has a significant impact on the ratio of ground and surface waters and is one of the main causes of increased peak runoffs and decreased runoff during hydrological droughts.

Climate change could also have a catastrophic impact in the medium and to long term with potential scenarios (see section 3.4) indicating flow reductions of 50% as a consequence of increased average temperature and decreased precipitation.

Water shortages are likely to accelerate soil erosion and desertification in the basin. There are already acute environmental and social problems associated with these issues, especially in the South Caucasus countries. At present, 600 thousand ha of arable land are heavily eroded in Azerbaijan whereas in Armenia 44 % of land is subject to various levels of desertification. In south east Georgia around 3000 ha are subject to desertification and 11.5 thousand ha are heavily eroded.

[15] However it should be noted that much of the land previously irrigated by pumped systems in the Soviet period would be uneconomic to restore.

Environmental Impacts

Variation and reduction of flow has already impacted fish species composition in the Kura-Aras river basin. Statistical data shows that in Azerbaijan in 1932 (i.e. before the implementing major water projects in the Kura river basin) valuable anadromous and fluvial anadromous fish catch reached 30.5 thousand tonnes per annum. In 1982, after construction of the various flow control structures the fish catch was 15 times lower at 2 thousand tonnes.

Another cause for decreases in fish catch is the altered annual distribution of river runoff due to the construction of hydropower and irrigation impoundments such as the Mingechavir and Shamkir reservoirs. Although the reservoirs have provided favourable conditions for increasing certain fish stocks, they have had an adverse effect on the habitat and reproduction of downstream populations of silver fish (Cyprinids) as well as anadromous and fluvial anadromous fish.

The large abstraction of water from surface and groundwater bodies (predominantly for irrigation) has also affected terrestrial ecosystems. For instance, 5000 ha of floodplain tugai forests in the Iori River valley (a Kura River Tributary) located on the border of Georgia and Azerbaijan have been heavily impacted by reduced surface flows. One of the major causes of degradation of the forest was the construction of a 50 m tall dam on the Dali reservoir which impeded water flow. The Dali reservoir, occupying 3 km^2 was initially constructed for irrigation purposes in Georgia and Azerbaijan but no irrigation network has been put in place. Consequently the reservoir has lost its function and has been non-operational since its construction (WWF Report, 2005). There are similar examples throughout the lower basin.

4.3.3 Linkages with other transboundary problems

Flow variation and reduction is closely linked ecosystem degradation (Section 4.5) and water quality (Section 4.4). Unfortunately there is not much data available in the basin as no multidisciplinary studies have been carried out in this field. However, it can be assumed that decreased flow in rivers has a negative effect on aquatic ecosystems if they are below a certain threshold. At the same time decreased flow in rivers decreases the dilution of pollutants reducing carrying capacity. If discharge standards are not met this can cause further adverse effects on the environment and humans.

4.3.4 Natural causes of variation and reduction of hydrological flow

The generation of river flow is stochastic and fluctuates with in time. The natural fluctuations of river flow are predominantly due to climatic factors such as precipitation and temperature, driven by regional and global factors.

At present, research into climate change carried out in the Kura-Aras river basin countries, shows that in Azerbaijan temperature is increasing but the annual precipitation rate has remained unchanged. Consequently, it is presumed that with increased evaporation, river flows in the Azeri part of the basin are decreasing. In Armenia there is a reduction of precipitation which also negatively affects river flow. In the Georgian part of the basin there has been an observed increase in temperature and a reduction in precipitation. Although the Khrami river basin (a tributary of the Kura river), shows no significant change in precipitation (0.1 % annually) or changes in annual river flow, most of the other sub-basins of the Kura River in Georgia have shown an increase in temperature with an accompanied

reduction in precipitation and annual flow. In the Iranian part of the basin, slight changes have been observed in precipitation and annual river flow. Figure 4.2 shows the downward trend of total annual flow in the Kura-Aras river basin since 1927.

Please refer to Annex 3 for more details on changes in climate and an evaluation of environmental vulnerability in the Kura-Aras basin.

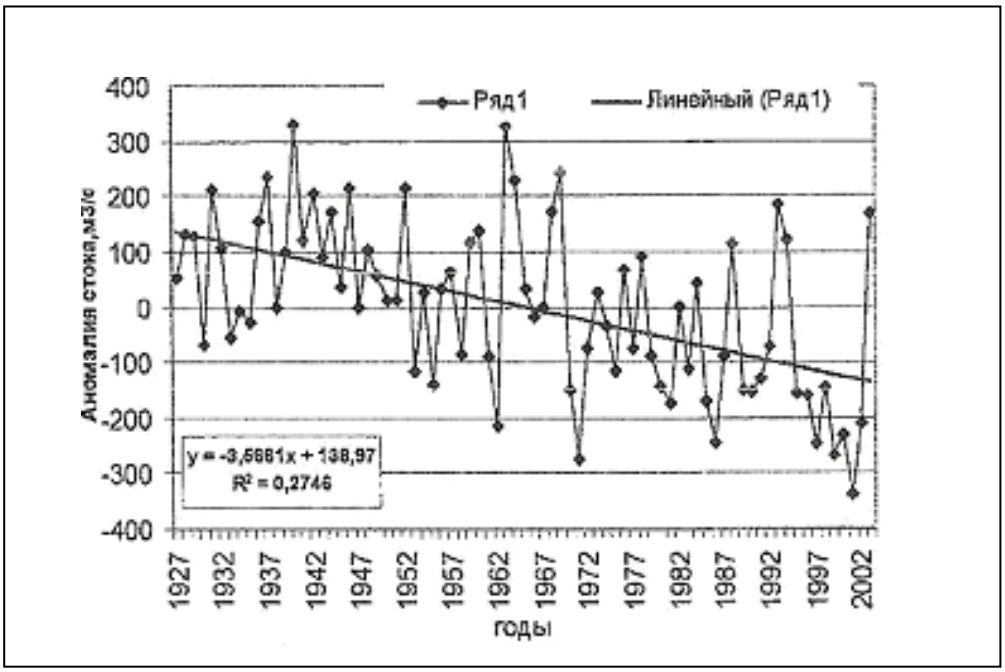


Figure 4.2: Changes in the annual flow rates at the mouth of the Kura River (1927-2002)

4.3.5 Immediate anthropogenic causes of variation and reduction of hydrological flow

The casual chain for Variation and Reduction of Hydrological Flow is presented in Figure 4.3. The sectors that have contributed to this problem are energy, agriculture, industry and urbanization (see Table 4.2).

Increased demand on water resources due to accelerated economic activities in the basin during last 50 years has led to increased abstraction of water from rivers and aquifers resulting in variation and reduction of hydrological flow. Although economic recession in the South Caucasian part of the basin during the last 15 years has slowed down this process and the recorded water use in Armenia, Azerbaijan and Georgia has significantly dropped. For example in Georgia actual water use in the basin has decreased by 69 % over the last 20 years and in Armenia by 44 %. Nevertheless, the current revival of the national economies and need to improve life quality in the basin will put greater pressure on the water resources if present water management trends remain. Figure 4.4 shows location of major water users in the basin such as energy and agriculture. Current water withdrawal from Kura-Aras river basin by countries is shown in the Table 4.3. The biggest water users in the basin according to the data presented are Azerbaijan and Iran.

Figure 4.3: CCA Diagram for the Transboundary Problem: Variation and Reduction of Hydrological Flow in the Kura-Aras River Basin

Please See attached file for CCA

Figure 4.4: Hydropower plants and irrigation network in the Kura-Aras river basin

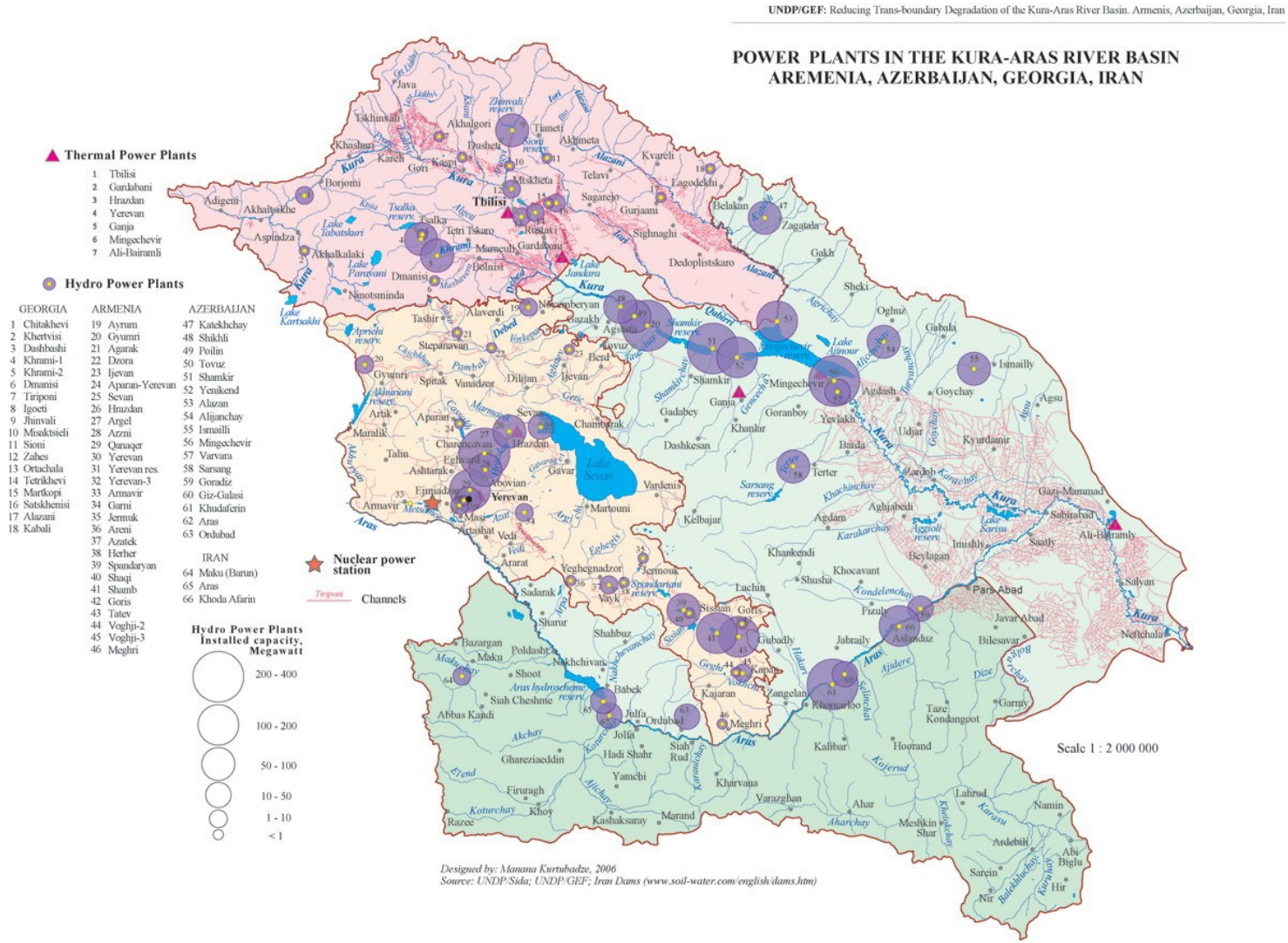


Table 4.3: Total water withdrawal by countries of the Kura-Aras river basin[16].

Kura-Aras Basin Countries	Total water withdrawal (surface and groundwater) in million m^3
Armenia (in 2004)	1 700
Azerbaijan (in 2000)	3 911
Georgia (in 2003)	1 067
Iran (In 2005)	3 000
Total	**9 678**

There are two other major immediate causes of flow reduction and variation in addition to water abstraction. These are:

- Non-rational utilization of water resources, mainly attributed to low efficiency rates and high losses
- Deforestation

Each of these is discussed in detail below.

Non-rational use

The non-rational use of water is a widely spread practice throughout the basin. As agriculture is the major consumer of water in the basin (see Table 4.4) the main challenges lay in this sector.

Irrigation efficiency in the South Caucasus countries is low (35-40 %), mainly due to low efficiencies in transmission. In Iran, in the Aras basin, irrigation efficiency is slightly higher (~ 43 %) (National TDA, Iran, 2006). Most irrigation canals in Armenia, Georgia and Azerbaijan are open and unlined with high filtration rates and therefore water losses are significant, reaching 40-60 % (Technical Analysis, 2005).

It should be noted that transmission losses do not necessary translate into water consumption since a percentage of the water will return either to groundwaters or surface waters. Unfortunately no studies have been carried out to assess the water consumption associated with these losses.

Table 4.4: Present water use by sectors[17]

Water users	Armenia (2004)		Azerbaijan (2000)		Georgia (2003)		Iran (2005)	
	Actual use (mil m^3)	Share in total use in %	Actual Use (mil m^3)	Share in total use in %	Actual use (mil m^3)	Share in total use in %	Actual use (mil m^3)	Share in total use in %
Agriculture	1 200	71	3 418	87	533	50	3000	90
Industry	100	6	73	2	170	16		
Domestic	400	23	420	11	361	34		

[16] Table 4.3 does not include water withdrawal figures from the Turkish part of the basin and water use for hydropower generation.
[17] This table 4.4 does not present data on other water users such as thermal power plants, fisheries etc.

In Armenia 1.2 million m^3 of freshwater was abstracted for irrigation purposes in 2004 and in Georgia 533 million m^3 was abstracted in 2003. The level of water consumption in agriculture in both countries has reduced considerably during the last 15 years and in Georgia the present consumption of water in agriculture is around a third of that in 1993. This is predominantly the result of the deterioration of the irrigation infrastructure. A consequence of this has been a significant reduction of irrigated land area (in 1989, there were 300,000 ha of irrigated land in Armenia while at present only 135,000 ha remains). In Azerbaijan, irrigated land area has not changed to any great degree. It has actually increased slightly, although water consumption trends are downward mainly due to alterations in cropping patterns, with a decrease in the production of water intensive crops. Since 1999, water use has stabilized.

Water loss, particularly from domestic and municipal water use, is an acute problem for the South Caucasus countries. A large share of water resources allocated for this sector, defined by legislation as a priority user, is wasted. Water extracted for drinking water purposes in cities, towns and rural areas is lost to leakages and failures in the supply network. High losses of between 20-40 % have been identified in the distribution networks and in Armenia, where extensive investigations have been undertaken, the level is as high as 72 % in some locations. The water distribution network in the South Caucasus part of the basin was constructed over 30 years ago and major parts of it are in urgent need of rehabilitation and reconstruction. For example in Armenia, during 2003, 21,949 failures and accidents were registered in the water supply system, including 2,376 in the capital, Yerevan. The total water supply network in Georgia is around 9500 km, 5000 km of which is outdated and requires replacement. In Tbilisi consumption of water per capita reaches a surprising 850 liters; half of which is wasted to leakage in the distribution system (Technical Analysis, 2005).

High losses of water impact on the operating costs and in some areas supply is often reduced to a few hours per day because of the cost of pumping. High levels of capital investment are needed to rehabilitate the systems which are not readily available from the central budgets of the Riparian countries. In fact revenue generation barely covers the cost of repairing and maintaining the existing systems.

Poorly maintained supply systems can also lead to secondary infection of treated water with contaminated groundwaters entering at low pressure points causing public health problems. Armenia has made considerable efforts to improve their water supply system and manage water demand, including the introduction of compulsory water metering.

It should be noted that there is a large inter-basin transfer in the lower Kura basin, with the main water supply for the city of Baku being abstracted from below the confluence of the Aras. This water is lost to the Kura basin and therefore every effort should be made to minimize losses from this supply system in order to conserve the river flows.

Deforestation

Deforestation is a further immediate cause that contributes to the variation and reduction of hydrological flow. Forests and the soil structure which they support retain and regulate the subsurface flows. The deforestation processes that have taken place in Armenia, Azerbaijan and Georgia are likely to have serious consequences as cleared lands can no longer store water. Unfortunately no studies have been carried out in the basin to estimate the potential

impact of deforestation on flow regime. Deforestation and its causes are discussed further in detail in Sections 4.5 and 4.6 and in the regional study on biodiversity (Annex 4).

4.3.6 Underlying causes of variation and reduction of hydrological flow

Currently, the underlying causes can mainly be attributed to low capital investments in operation and maintenance and the lack of investment in developing new irrigation schemes and water supply systems. In Azerbaijan, for example, only 30-40 % of the required financial resources are allocated from the state budget for the water industry (Regional Studies on Irrigation and Drainage, 2006). Insufficient funding ultimately results in further deterioration of the water supply infrastructure.

A major underlying cause is a lack of a knowledge base of the hydrology and usage of the basin upon which to construct an integrated water resource management and river basin management policy and regulatory framework. There is no clear picture of the sustainable yield of existing surface and groundwaters taking into account the ecosystem needs and other water uses such as hydro-power, navigation, and fisheries. There is no data on existing and forecast demand and supply in the region and no information on actual compared to licensed abstraction volumes.

The lack of investment and incentives in water saving technology in industry is another major underlying cause. These technologies often are not accessible or too expensive for small size enterprises which are a major segment of the industry sector in the basin.

Low incomes do not allow the rural population of the basin to apply modern irrigation technologies such as drop and sprinkler irrigation. Because the majority of farms in the basin are quite small[18] this becomes a limiting factor for the application of new, expensive irrigation technologies.

The underlying causes of deforestation are discussed in Section 4.5 on Ecosystem Degradation.

Future increased demand is a potentially important underlying cause of over abstraction In the basin there is a potential for expansion of irrigated lands, improvements in water provision to the population (if financially affordable), increases in energy production, development of industrial activity and navigation, which will put further stress on the hydrological flow in the basin. Currently though, little is known about the acceptable resource use limits within in the Kura-Aras basin and the wider Caspian basin, taking into account the balance between consumptive and non-consumptive use.

Demand is likely to rise in the future due to expected economic development. As living standards increase, the demand for water for domestic use will rise. However at the same time, with increased economic prosperity, investment in supply infrastructure will increase and losses should decrease which could bring about an overall reduction domestic water supply.

According to the Ministry of Economic Development of Azerbaijan, by 2015 the population will have increased by 18 % and subsequent water use in households and municipal services

[18] For more information please refer to Technical Analysis, 2005

will increase 3 fold. At present, in the major cities in Azerbaijan, daily consumption per person is 250-300 l (compared to 150-200 l in Europe), while in rural areas this figure is only 70-100 l. In Georgia and Armenia the populations are declining and in Iran there is a migration to the big cities and it is unclear what the basin population growth trend is likely to be in the medium to long-term. In all basin countries the indices of access to drinking water, especially in rural areas, are low (see Section 3.3 socio-economic situation in the basin) and there is consequently great potential for improving drinking water provision and its supply throughout the riparian states of the Kura-Aras river basin (Technical Analysis, 2005).

It is unclear whether demand for irrigated water will increase significantly in the Kura-Aras and much will depend upon the markets for agricultural products in the region which have declined considerably with the break-up of the Soviet Union. Improved supplies of irrigation water in terms of volume and efficiency of supply will help increase productivity, but it is unclear how long it will take, if at all, to establish the supply chain to get the products to market. However, reclamation and rehabilitation of existing irrigated areas will reduce water usage through improved supply delivery. There plans to develop new irrigated areas with a mix of gravity and pumped systems in both Iran and Armenia in the Aras basin. The area of irrigated land in the Aras basin in Iran is planned to expand from 237 thousand ha up to 440 thousand ha by 2021 with a subsequent growth in water withdrawals of up to 4026 million m^3 (Country Review, Iran, 2005). At present, withdrawals for irrigation in Armenia are around 1200 million m^3 but current estimations expect withdrawals to reach 3664 million m^3 by 2020, (Technical Analysis, 2005).

In the South Caucasus countries after the collapse of the Soviet Union water use in industry decreased drastically. For example, the index of water consumption for Georgia in 2003 was nearly 9 times lower than that of 1980. With the resumption of production in Armenia, Azerbaijan and Georgia, water consumption has risen slightly. At this stage it is difficult to make any forecast with respect to water use in industry as it depends on many factors (e.g. the type of industrial activity, expansion of production, effectiveness of water use, etc). Nevertheless, all basin countries expect that water use will rise significantly but a commitment to demand management measures, such as metering and strict pricing policy, will encourage the introduction of water saving technologies and should reduce demand.

In Georgia and Armenia energy resources are limited and development of cheap renewable energy sources such as hydro-power will be a priority in the future. Hydropower generation is one of the main competitors for water use in the Kura-Aras river basin, especially in upstream countries. Hydropower generation is considered a non-consumptive water user[19] but, in spite of this, the sector creates specific temporal problems. For example, during the summer months water requirements for irrigation significantly increase, whilst at the same time water is being stored for electricity generation in the winter months. This situation has been observed in Georgia and Azerbaijan in recent years. Hydropower generation significantly alters the flow regime and where water is intensively used for irrigation, can increase the risk of conflicts over water.

The construction of new reservoirs for hydropower generation and irrigation purposes is planned in the basin. In Armenia, 47 dams with a total capacity of 5 million m^3 are planned for the next 4 years. Armenia plans to increase power generation capacity with the construction of 3 large Hydropower Stations producing a total of 205 MW in the Aras basin

[19] Non-consumptive uses do not cause any significant reduction in net-stream flow. Examples of non-consumptive uses are reservoir storage, fish habitat, passive recreation (Lee & Dinar, 1995)

(Shnokha, Lori-Berd and Megri), and 350 small HPS with a total capacity of 257 MW. These stations will consume approximately 2.25 billion m^3 of water (Technical Analysis, 2005).

On the Aras, Iran is planning to construct the Khoda Afarin dam (capacity 1612 million m^3), the Giz-Gale diversion dam with Azerbaijan (capacity 62 million m^3) and the Megri hydropower plant with Armenia with a capacity of 140 MW (In Country Reviews, Iran 2005).

In Georgia there are plans to construct a number of small hydropower stations on the tributaries of the Kura River (including the small Liakhvi, Khrami, Tergi, Aragvi, ChelTi, Faravani and Borjomula). The capacity of these hydropower stations will be from 5 to 65 MW (Ministry of Energy of Georgia, 2006). However, these stations do not require the construction of reservoirs and therefore there is not expected to be any significant change in flow due to these activities.

4.3.7 Socio-economic, legal and political root causes of variation and reduction of hydrological flow

The main socio-economic, legal and political root cause of the problem is a lack of finance at all levels (state, regional, household, and enterprise). Economic difficulties and tight state budgets prevent the riparian states from fully funding the operation, maintenance and regulation of water systems. Full cost recovery is politically inconceivable until large capital investments necessary to improve the system and the service have been made. In a number of the countries a significant part of the budget expenditure is spent on water subsides, trying to target social goals and make water affordable for all. Unfortunately, low tariffs on water and the absence of other incentives for the introduction of new water saving technologies encourages the wasteful use of this valuable resource. Because of a lack of funds, water systems continue to deteriorate resulting in higher losses and lower efficiency rates.

This is compounded by the low awareness of the population which currently has little regard for water efficiency and is often careless with its use. For example, drinking water is often used for cooling streets during hot summers, watering gardens and washing cars. Furthermore, there is no incentive for repairing damaged taps and flush toilets which often remain faulty for months, if not years. Demand management controls including compulsory metering and public education is an important part of any water resource strategy. The public perception of the value of water needs to be changed.

The lack of an integrated approach in water resources management is a major problem in all the basin countries where ground and surface water are dealt with separately, and land and forest management often fails to take into account management issues relating to water resources. This creates many of the problems outlined above.

4.3.8 Knowledge gaps

Due to the economic and financial difficulties in Armenia, Azerbaijan and Georgia since the 1990s, the number of hydrological observation sites has drastically decreased. For example, in Georgia during the last 15 years, stream flow rates have been obtained using calculations alone. This has resulted in issues relating to data reliability and availability. With regard to

groundwater observations the situation is even worse. The financial resources required for processing hydrological data and creating reliable data bases are not available.

No exact and reliable data is available on water use in the South Caucasus countries in the different economic sectors. In most cases, state statistical accounting is based on approximate calculations. The majority of enterprises submitting applications to obtain permits for water withdrawals also calculate water use based on technological norms rather than actual measurements.

The minimum ecological flows in the basin are calculated based on criteria developed during the Soviet period and are not necessarily consistent with current knowledge and practice. As part of any integrated water resource management plan there is a need to review the minimum required ecological flows throughout the Kura-Aras basin as a first step to evaluating the reliable yields.

4.3.9 Summary and recommendations

Anthropogenic activities are the main drivers of this transboundary problem. Climatic variations and signs of climate change contribute to the reduction of flow but for the present are less significant. Future population growth in the basin and the need for economic development in the basin countries is likely to put increased pressure on surface and groundwater resources. Currently, the water infrastructure is in a very poor state with enormous losses and very low efficiency rates, especially in the South Caucasus countries. If present trends of water use are maintained, the impacts on the flow regime will continue to increase. In order to ensure the equitable use of water, coordinated actions between the basin countries are needed in order to avoid negative consequences in downstream countries occurring due to increased water consumption upstream.

The possible interventions include:

- Development of a regional water cadastre to record and register licensed ground and surface water abstractions throughout the basin. This will be a major input into any water resource model to be developed. This is a major task and one for which the countries will need considerable support.
- Harmonized permitting and inspection procedures. This intervention is linked to the development of the water cadastre. Any new procedures should take into account the budgetary constraints on the regulatory authorities.
- Improved hydrological monitoring network for both ground and surface waters. This is a long-term intervention which will require considerable investment. The support from the international community has yet to be matched by the countries.
- Development of a stochastic model for integrated water resource management. This will be an important tool in helping to determine the available resources within the basin and linking the management of ground and surface resources.
- Introduction of demand management control measures including metering, leakage control and public awareness programmes. Much work has been done in Armenia on demand management and this experience should be transferred and applied to other parts of the basin.
- Setting of new minimum ecological flow limits at strategic points in the river system, including minimum spring releases.

- Rehabilitation of irrigation infrastructure to improve transfer efficiency. This work is on-going in Armenia, Azerbaijan and Georgia, as part of major irrigation rehabilitation programmes supported by loans from the World Bank and other IFIs
- Introduction of water user associations in irrigation areas.
- Development of incentives to encourage the introduction of water saving technology by industrial users.
- Rehabilitation of water supply networks. This is a long-term intervention requiring large investments. In parallel to these investments water charges need to be raised and subsidies removed to achieve full cost recovery.

4.4 Deterioration of Water Quality

4.4.1 Description of the problem and a justification of its transboundary importance

Deterioration of water quality in the Kura-Aras river basin has significant transboundary consequences in the down stream countries. This can be confirmed by the presence of chemical compounds of anthropogenic origin in the transboundary sections of the basin as well as in bottom sediments of the Kura Delta in the Caspian Sea.

Water pollution in the Kura basin comes from a number of land based sources including industrial and mining sites, agricultural lands, households in rural areas and municipalities. Wastewater treatment facilities are absent in many municipalities and enterprises, and are available only in some locations in the Aras basin in Iran. Most of the wastewater treatment facilities were built 20-30 years ago and are currently non-operational. Those that are working provide mechanical treatment only. Moreover biological and chemical treatment of wastewaters is absent in most regions of the basin.

The lack of functional wastewater treatment plants in Georgia, particularly in Tbilisi and Rustavi, results in a significant discharge of untreated municipal wastewater into the Kura River, causing contamination of downstream irrigation reservoirs in Azerbaijan. In the Kura River a short distance below the Mingechavir dam, vigorous growth of aquatic grasses, covered with epiphytic algal growth have been observed. This anecdotal evidence suggests that the nutrient level in the water released at the dam, remains high despite any nutrient trapping by the reservoirs.

Downstream of the city of Mingechevir, the concentration of phenols in the Kura exceeds the sanitary norm by 5 times, the concentration of metals is 4 times higher, and the concentration of mineral oil and sulphates in water is twice the sanitary norm (USAID/DAI 2004)[20].

The upstream sections of the Aras River form the border between Armenia and Iran whereas the downstream sections form the border between Azerbaijan and Iran. The Aras is polluted by urban areas, agriculture, and industry and mining in both Armenia and Iran, although a major concern is pollution from certain heavy metals from metallurgical and mining sites located in Armenia and Turkey. Although chromium, copper and nickel undoubtedly have

[20] It should be noted that this pollution originates from Mingechevir city as well as other upstream sections of the Kura (UNDP/SIDA 2005).

high natural background values in this mineral-rich region, anthropogenic activities, notably mining, have further enhanced the metal content of water and sediment in the Aras River.

At the confluence of Aras and Kura, the concentration of metals in water exceeds permissible levels by up to nine times, while the concentration of phenols is six times higher, and mineral oil and sulphates are two or three times higher (USAID/DAI 2004).

The small tributaries in the Kura-Aras river basin are also affected by pollution. The river Alazani (Ganykh), a transboundary tributary of the Kura, has recorded concentrations of phenols 5-7 times above the permissible level, while the concentration of metals is 6-8 times higher and mineral oil is 2-3 times higher (USAID/DAI 2004). To a lesser extent the transboundary river Iori (Gabyrry) is also polluted, with measured concentrations of phenols and metals in water exceeding the maximum concentration limit by 2-3 times, while mineral oil and sulphates are twice the permissible level.

4.4.2 Environmental impacts and social-economic consequences

The main environmental impacts of surface and groundwater contamination can be summarized as follows:

- Land contamination by polluted waters including accumulation of heavy metals in soil and in plants
- Degradation of aquatic ecosystems
- Degraded fish stocks.
- Pollution of water-marsh ecosystems and wetlands
- Pollution of the coastal zones

The main socio-economic consequences of surface and groundwater contamination are:

- Contamination of drinking water supply (surface and ground water supplies) and consequently population health hazards
- Increase in potential water-borne diseases
- Reduced water availability and product quality in the aquaculture sector
- Reduced land productivity and agriculture products quality due to the use of polluted irrigation water
- Reduced attraction of the territories for recreation and the tourisms.

Environmental impacts

There is little information that can directly attribute water quality to specific environmental impacts in the Kura-Aras river basin. However, it is likely to be a contributing factor and certainly increases the pressure on already stressed ecosystems. For example, as a result of the deterioration of the sewage network in Armenia, more and more pollution incidents are occurring every year (in 2003, 21839 accidents were registered in Armenia, over 25% of which occurred in Yerevan). In 2006, a documented accidental release of waste water resulted in a significant fish kill in the Vachagan River in Southern Armenia (ARKA News Agency, June 2006).

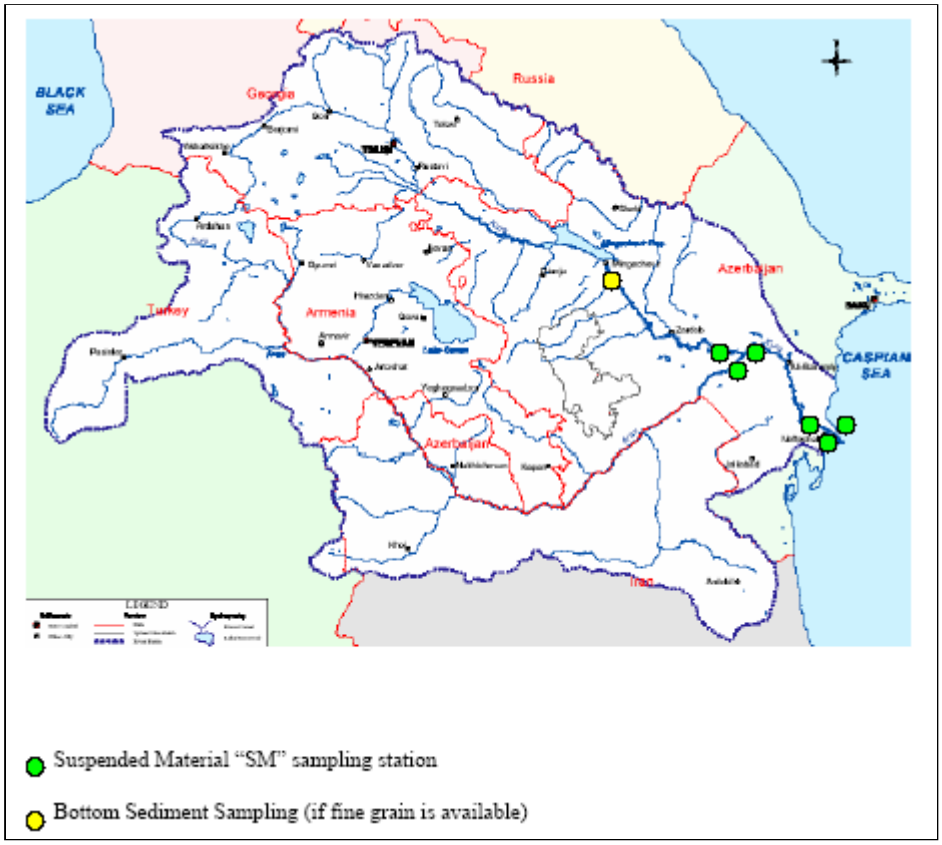
Untreated household and industrial wastewater discharged into the surface waters of the basin can contain epidemiological bacterial and poisonous substances, which alter the

chemical composition of water, enrich the water with biological elements and reduce dissolved oxygen levels. This can have a negative impact on natural activities of the water ecosystem and on the fauna and flora equilibrium. For more details on the causes of ecosystem degradation refer to Section 4.5 below, and Annexes 1 and 4.

Industrial effluents including waste from mining and its activities causes the greatest ecological damage in the Kura-Aras basin. The impact of industry on the environment is shown in the contamination of water and land resources. Disposal of contaminants into water bodies and onto land poses a serious threat to the aquatic and terrestrial ecosystems and creates a risk to human health. For example industrial wastewaters discharged in Armenia along with municipal wastewaters were a major cause of eutrophication in Lake Sevan. In Georgia, contamination of surface and groundwater resources from copper mining in Bolnisi has resulted in the contamination of water used for irrigation which has caused an increase in concentrations of heavy metals in soil. In some regions of Azerbaijan average concentrations of lead, cadmium, nickel, zinc and copper in soil exceed permitted levels by 3-60 times.

The application of fertilizers and pesticides has been significantly reduced in the basin over the last two decades. Furthermore, the usage of persistent chlorine-organic pesticides, such as DDT, hexachlorcyclohexane (HCH) and aldrine, etc has been prohibited in the region. However, recent studies indicate that there is strong evidence that the illegal application of banned chlorinated pesticides in the region is occurring. Figure 4.5 shows sampling stations in Azerbaijan from which bottom sediments and suspended mater were analysed for persistent organic pollutants and radionuclides.

Figure 4.5: IAEA sample stations on the Kura River in Azerbaijan.



Recent investigations in the vicinity of the Kura river delta along the coastal zone of Azerbaijan has indicated that bottom sediments were heavily contaminated with DDT-related compounds, with maximum concentrations of between 6600 pg/g to 13400 pg/g (de Mor*a et al*., 2004c). Concentrations of DDD (12.5 ng/g) and DDT (5.88 ng/g) in suspended matter samples were also observed at Naftechala. Levels of DDT compounds in the samples also showed the presence of aged DDT associated with fresh application of DDT in the region. Dieldrin, endosulfan sulphate, endosulphan II, endrin and b-BHC were also found on Kura River, indicating the application of these chlorinated pesticides in the region. Lindane, and possibly heptachlor epoxide, was also of concern in some parts of the marine environment of Azerbaijan.

High levels of PCBs were found in the main stream of the Kura River and at the river mouth than in the Aras branch. The highest concentration of PCBs (20 ng/g) were found in suspended material at Naftechala, close to the Kura river mouth. The level of total PCBs in the bottom sediment of the Kura River downstream from the Mingechavir reservoir was above 23 ng/g indicating inputs of PCBs from the upper watershed. For more details on the problems associated with Persistent Organic Pesticides in the Kura-Aras basin refer to chapter 4.4.5.

Radionuclides are another group of transboundary pollutants which have been an area of concern in the Kura Aras river basin. However, the values in the sediments collected in the Azeri part of the Kura-Aras basin are relatively low, and in most cases below the detection limit[21]. Caesium activity measured in the sediment was mainly attributable to atmospheric fallout from nuclear weapons tests and in part to Chernobyl-derived caesium. Caesium activity in aquatic plants collected at two locations were low and ranged from the detection limit to 3.5±0.6 Bq kg^{-1} dry weight. The results indicated that the main source of radioactive contamination in the study area were historical nuclear weapon tests carried out during the Soviet period. Samples were also taken from the upper watershed of Azerbaijan and the results indicate that the contribution of the upper Kura watershed in Georgia, Armenia and Iran is minimal in terms of radionuclides substances.

A proportion of the contaminants that are discharged into surface waters or infiltrated into groundwater are transferred to the Caspian costal area resulting in increased contamination in these sensitive ecosystems. Analysis of coastal sediments has indicated that PCB levels in the Kura-Delta are at the same concentration as those measured in the suspended material of Kura River. High concentrations of chlorinated pesticides were also detected at some sites in the Kura Delta. For example, concentrations of Lindane in sediment ranged between 680-1060 pg g^{-1}, exceeding permissible levels. The concentration of HCB in costal sediments was also high and varied from 430 to 630 pg g^{-1}. Coastal sediments in the Kura delta also contain elevated levels of copper, the sources of which are mining sites located in the Kura catchment area (De Mora et al., 2004). Mercury levels in sediments from the Kura delta were also high at a number of sites, sometimes exceeding permissible levels (Long et al., 1995).

Socio-economic consequences

The pollution of water resources either directly or indirectly (e.g. through local food) can have a significant impact on human health. In many places wastewater treatment networks are in disrepair or not functioning and as a consequence there is a high risk of drinking water

[21] IAEA 2005, Radiological Survey of the Aras and Kura Rivers Azerbaijan, IAEA Technical Cooperation Project AZB/9/004.

contamination through secondary infection. For example in Armenia, 18 infectious outbreaks were recorded between 1999 and 2002, affecting 5,690 persons whereas no infectious outbreaks related to drinking water quality were reported between 1984 and 1991 (SIDA Report).

In Georgia, the absence of even the most primitive waste water treatment at general medical establishments, infectious disease hospitals and tuberculosis clinics is alarming. The main "hot spots" where there is a high risk of contamination of soil and groundwater are:

- the Kvabliani river and its influx Otskhe below Abastumani
- the Kura river and its tributaries Borjomula and Gujaretistskali in the Borjomi region;
- the Kura river and its tributary Ksani in the Mtskheta region.

In certain areas, irrigated waters are polluted with heavy metals. The worst cases are the Kazretula and Mashavera Rivers in the Bolnisi mining region of Georgia, where waters locally used for irrigation are heavily polluted from copper mining activities. According to recent studies, the copper concentration in the Kazretula and Mashavera Rivers exceeds Maximum Allowable Concentrations (MAC) by 12-168 times, Zinc by 5-12 times and Cadmium by 2.5 times. On irrigated lands close to the mine, the concentration of heavy metals such as Copper and Zinc is 3000 mg/kg, while on non-irrigated lands the concentration is 33-89 mg/kg. For Cadmium the figures are 17 mg/kg on irrigated lands and 0.1-0.45 mg/kg on non-irrigated land[22]. Increased cases of cancer and other diseases are observed in this region.

4.4.3 Linkages with other transboundary problems

Deterioration of water quality is close linked to the other three identified priority transboundary problems in Kura-Aras River basin: Flooding and Mudflows (Section 4.6), Ecosystem Degradation (Section 4.5), and Variation and or reduction of hydrological flow(Section 4.3).

High sediment loads in the Kura river are common which significantly increase during high flow and flooding periods. At normal flow rates at the confluence of Kura-Aras (Sabirabaad) suspended material has been measured between 0.5 and 0.2 g/l (CEP Kura Survey 2005). This compares with maximum sediment loads of 196 g/l at times of high flow rates[23].

During floods nutrients, pesticides and herbicides are washed out from agricultural lands and a cocktail of contaminants can occur in the rivers following flooding of industrial contaminated land sites located along the river banks.

Variation and reduction of hydrological flow can result in increased concentration of pollutants in specific sections of the river with deleterious effects for the aquatic

[22] The figures are taken from study report carried out by the University of Gissen together with the Institute of Agriculture (Georgia): Narimanidze, E., Wichmann, L., Felix-Henningsen, P., Steffens, D., Schubert, S., Urushadze, T., Mishveladze, B., Kalandadze, B. 2005. Bergbaubedingte Schwermetallbelastungen von Böden und Nutzpflanzen in einem Bewässerungsgebiet südlich von Tiflis/Georgien - Ausmaß und ökologische Bedeutung. Zentrum für internationale Entwicklungs- und Umweltforschung der Justus-Liebig-Universität Gießen. Discussion Paper. N 21 Giessen, August 2005.

[23] LAR Consulting Engineers 1999. Assessment of Water and Sediment Budget in Aras Watershed) Water Research Center, Ministry of Energy).

environment and humans. In addition, soil erosion and mineralization also contribute to the deterioration of water quality.

4.4.4 Immediate causes of the deterioration of water quality

The casual chain for Deterioration of Water Quality is presented in Figure 4.6. The major immediate causes of this transboundary problem are:

- Discharge of wastewater from mining enterprises
- Municipal Discharges
- Solid waste disposal along riversides and in rivers
- Run-off from urban areas
- Pollution of drinking water in the distribution network
- Discharge of untreated and not fully treated wastewater from industry
- Land contamination from accidental spills and hazardous waste
- Diffuse pollution from improper application of fertilizers, pesticides and herbicides
- Point and diffuse pollution of manure/slurry from stock farms

The Aras River is affected by a number of point and non-point (diffuse) sources of pollution. The main sources of pollution are mining wastewaters, which contribute large quantities of various heavy metals, particularly Copper (Cu), Molybdenum (Mo), Magnesium (Mn) and Iron (Fe).

In the case of the Kura River, hazardous pollution comes mainly from a limited number of mining, metallurgical and chemical industries. The major pollutants are: heavy metals (Cu, Zn, Cd) from mining and the leather industry; ammonia and nitrates from the fertilizer industry; and a number of contaminants (including and acetyl-vinyl) from the chemical industry. Figure 3.6 (Section 3) and Table 4.5 present the key industries and main suspected hotspots of pollution in Kura-Aras River basin.

4.4.5 Underlying causes of the deterioration of water quality

The main underlying causes for the deterioration of transboundary water quality in the Kura-Aras basin can be summarized as follows:

- Absence of waste water treatment or non-operational treatment facilities in urban settlements
- Degradation of drinking water supply systems due to poor maintenance allowing secondary contamination
- Inadequate municipal waste management (lack of landfills, storage facilities)
- Lack of treatment of run-off from urban areas
- Lack of separate of storm and waste water collection systems
- Absence of or outdated treatment technology
- Absence of cleaner production practices
- No incentive for pollution prevention and control
- Inefficient agricultural practices

Figure 4.6: CCA diagram for Deterioration of Water Quality

Please See attached file for CCA

- Intensive livestock production
- Low awareness of farmers on sound land management
- Lack of "Best Management practices" in agriculture

Wastewater treatment: The coverage of sewage systems is relatively low in the region with most located in cities and bigger towns. Rural areas rarely have sewage systems. In addition, waste water treatment (WWT) facilities exist in only certain cities, were built 20-30 years ago and due to poor maintenance are in a very poor condition. Consequently, only a few WWT facilities operate currently, and even fewer provide biological treatment. Normally, industrial and domestic wastewaters are discharged into the same sewage systems.

Unfortunately, industrial development and the construction of industrial wastewater treatment facilities are not coordinated. The only exception is enterprises which have local wastewater treatment facilities. However, it should be noted that most of them are currently not operating. Of particular danger are wastewaters from the mining industry and tailing lagoons and dumps.

In Armenia the sewerage system of the republic covers 60-80% of the municipal territories and 9% of the rural territories. Excluding Yerevan which has a coverage of 97% the average coverage of municipal systems is 55.5%.

At present, the sewerage system is in crisis, with 63% of the network being more than 20 years old, and 22% requiring immediate renewal. As a result of this, more and more accidents are occurring each year. In 2003, for example, 21,839 accidents were registered, of which 5,839 (or 26.7%) occurred in Yerevan.

There are 20 wastewater treatment plants in Armenia with an aggregate capacity of 1,120 thousand m^3, as well as 18 quality control laboratories. The wastewater disposal and treatment volumes during 1994-2003 are given in Table 4.6.

In Azerbaijan large towns and cities have simple mechanical sewage treatment facilities, most of which were constructed in the 1970s. However sewerage systems are not present in the majority of small towns and settlements. The absence of sewerage systems and the long-term discharge of untreated sewage have led to pollution of both surface and ground waters. Until recently, maintenance of collection and treatment facilities in the Republic had been neglected and consequently, most are now decrepit, badly damaged and/or non-operational.

In Georgia, in the Kura basin, water treatment facilities were built and put into operation in 13 cities between 1972 and 1986 with a total capacity of 1 million m^3 per day. In eleven cities biological treatment was installed with a total capacity 100,000 m^3 per day. In the remaining two cities, facilities with mechanical treatment only were installed (total capacity of 8 000m^3/day). At present, due to poor maintenance, none of the treatment facilities can provide full biological treatment. Furthermore, in Tbilisi and Rustavi only mechanical treatment is currently available. The most polluting municipalities are those of Tbililsi, Rustavi, Gori and Borjomi.

Table 4.5: Major suspected hot spots of pollution in the Kura-Aras River basin[24]

Type of pollution	Country	City	Source	Expected pollutants
Organic	Georgia	Tbilisi Gardabani	Sewage Treatment Facilities (STF)	BOD
Organic	Armenia	Yerevan	STF	BOD
Heavy metals	Georgia	Bolnisi, village Kazretula	Mining Metallurgy	Cu, Zn
Heavy metals	Armenia	Kapan/Zangezur	Mining Metallurgy	Cu, Zn, Se, Mb
Heavy metals	Armenia	Alaverdi	Mining Metellurgy	Cu, Zn, Mn
Heavy metals	Azerbaijan	Denkacan	Mining Metallurgy	Cu, Zn, Mn
Heavy metals	Azerbaijan	Mingechavir	Leather	Cr
Hazardous substances	Armenia	Vanadzor	Chemical	Ph, PAC
Hazardous substances	Georgia	Rustavi	Chemical	Ammonia
Hazardous substances	Armenia	Yerevan	Chemical	CI, PAC
Hazardous substances	Armenia	Yerevan	Tire Industry	S, PAK
Hazardous substances	Azerbaijan	Mingechevir	Oil Industry	Oil, S
Hazardous substances	Georgia	Tbilisi	Thermal power station	Oil, S
Hazardous substances	Georgia	Gardabani	Tbilgres	Oil
Hazardous substances	Georgia	Rustavi	Chemical and Metallurgy	Ammonia, Oil
Hazardous substances	Agricultural regions	Agricultural regions	Irrigation areas	Cu, DDT
Organic, Hazardous substances	Iran	Moghan Agro-Industry	Irrigation Area and Agro industry	Nutrients, BOD, Metals, Pesticides *

[24] Source: EU-TACIS Joint River Management Programme – Kura Basin Final Report, February 2004.

Table 4.6: Disposal and treatment of the wastewater in Armenia during 1994-2003, million m^3 per year

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total disposal	647	636	632	620	630	362	375	208	237	349
Including:										
Without purification and satisfactory treatment	232	294	276	280	300	212	237	94	91	177
The water purified to standard quality (without purification)	171	130	130	130	150	12	14	15	18	29
The wastewater treated to standard quality	244	212	226	210	180	138	124	99	128	142
Including those purified:										
Biologically	236	200	213	175	145	101	99	98	97	106
Physically/Chemically and mechanically	8	12	13	35	35	37	25	1	31	36

In recent years the recreation and tourism industry has grown in Georgia parallel with the development of the economies of the Kura-Aras basin countries. However, sewerage systems and sewage treatment plants to cope with the increased wastewaters are largely absent.

Agriculture: The unregulated use of fertilizers results in diffuse pollution of both surface and ground water resources. Nutrient loading also comes from direct point source discharges of animal slurry from cattle and pig farms. These incidents have greatest impact in early spring during the snow melt, when waters wash out nitrates and phosphates from previous autumn applications.

Pesticides are also a significant threat in the South Caucus countries. The main threats for water pollution from pesticides in Georgia mainly are attributed to the use of banned pesticides and in particular persistent organic pollutants (POPs) such as DDT, HCCH, hexachloran, treflan, etc. Inventories carried out in Georgia in 2004-2005 showed that approximately 3,057 tonnes of banned, obsolete pesticides were still being stored, 99 % of which were located in the Kura basin. Approximately 2,700 tonnes of expired pesticides alone were stored at the Ialghuji mountain pesticide terminal, 66 % of which were POPs.

The state of banned pesticide storage facilities is poor. Many contain pesticides that are poorly packed or not packed at all and have consequently become a source of contamination for the surrounding environment and communities through atmospheric transport and infiltration into groundwaters. In most cases, the direct contamination of rivers has not observed. However, the river Potskhovi, a tributary of the Kura, has been the subject of direct contamination from a storage facility of near the town of Akhatsikhe where four tonnes of obsolete chemicals are stored.

The use of banned pesticides is also suspected. In particular, communities in close proximity to pesticide storage facilities are likely to have used banned or obsolete pesticides during the period of economic downturn during the 1990s. (UNDP/GEF project Preparation of the National Implementation Plan on Persistent Organic Pollutants, 2006).

Similar situation is observed in Azerbaijan

Industry/Energy: Polychlorinated Biphenyls (PCBs) from dielectric fluids used in capacitors and transformers are a significant threat to the environment. Approximately 430 tonnes of PCB containing oils are located in the Georgian part of the Kura-Aras river basin. In Azerbaijan this figure reaches 660 tonnes[25]. Much of the material is contained in old and obsolete equipment and there depreciated. Concern is over its storage, disposal and destruction. For example, PCBs have never been collected and safely disposed because the relevant storage facilities do not exist (UNDP/GEF, National Implementation Plan on Persistent Organic Pollutants, 2006 and UNDP/GEF, POPs in Azerbaijan, Review of existing situation, 2004).

Landfills: The Majority of official landfill sites located in the Kura-Aras basin do not meet environmental requirements. Often they are not lined and have simple drainage systems for collecting leachate, but it is not treated and may cause contamination of soil, surface and groundwater with heavy metals and toxins. Due to complete absence of monitoring no data is available to judge the extent of pollution. There are also cases of disposing medical and hazardous waste in landfills.

Currently most settlements in the Kura-Aras basin do not have access to solid waste landfills. As a result, solid waste collected from these settlements, is disposed on river banks or into the rivers, causing potentially significant damage to river water ecosystems and reducing the sanitary conditions.

4.4.6 Socio-economic, legal and political root causes of the deterioration of water quality

All the above mentioned causes which drive the deterioration of transboundary water quality have identifiable socio-economic, legal and political root causes and can be summarized as follows:

- Weak national policy and regulations related to municipal wastewater treatment
- Lack of financial recourses for rehabilitation and maintenance of drinking water supply systems
- Ineffective management of wastewater treatment facilities
- Absence of or inadequate laws, legislation and regulations related to municipal waste management
- Lack of the finances for dividing storm and municipal wastewater
- Absence or poor monitoring of surface and ground water quality
- Weak environmental policy and regulations related to industrial pollution prevention and control
- Absence or poor regulation and inspection of pollution discharges
- Lack of permitting regulations, linked to inability to set discharge consent standards without flow measurements
- Lack of regulatory enforcement
- Low levels of public awareness and public participation in decision making
- Poor knowledge of benefits of cleaner production and best practices

[25] This figure does not reflect the real situation, as no inventories have been carried out in Azerbaijan (POPs in Azerbaijan, Review of existing situation; International POPs Elimination Project, 2004).

- Weak policy and regulations related to application of fertilizers, pesticides and herbicides
- Low awareness of farmers on the negative impacts of application of fertilizers, pest and herbicides
- Lack of administrative framework to manage and evaluate diffuse sources of pollution from agriculture.

There are currently few skilled professionals working in the water sector and there is generally a lack of training, with little introduction to new technologies, and insufficient exchange of experience and knowledge.

Public awareness is low on the impacts of transboundary water quality deterioration, and the level of public participation is insufficient.

Another key root cause of the problem is related to the monitoring of surface and underground water resources both ambient and pollution discharges. In Armenia, Azerbaijan and Georgia practically no groundwater monitoring has taken place since the early 1990s. Ambient monitoring of surface waters is done irregularly, in different seasons, and thus it is difficult to compare and identify any pollution trends.

4.4.7 Knowledge gaps

At present, there is virtually no groundwater monitoring occurring in the basin and in some countries there is no responsible legal entity

The existing historical analytical data is limited and unreliable and there are only a few agencies, which are repositories of historical groundwater resource data. Water quality monitoring has just restarted in the basin countries after more than ten years of inactivity. The results from current short-term monitoring programmes (2 to 3 years) are useful but in order to conduct statistical and comparative analysis there is a need for longer time-series of water quality information. Although it is widely believed that pollution in the basin has declined since the break up of the Soviet Union there is no quantifiable evidence of such a trend.

Routine biological monitoring of rivers has never been undertaken. Consequently, there is no data on which to base ecological quality objectives and little or no capacity to acquire such data in the short to medium term.

In addition, in most of the basin countries an inventory of water bodies and related structures has not been conducted in the last two decades.

Improved transboundary information on water quality in combination with more intensive monitoring and data exchange between the riparian countries is required to achieve more effective water resource management.

4.4.8 Summary and recommendations

The lack of an effective regulatory framework to manage water resource pollution in some riparian countries is currently a major shortcoming. Consequently, to reduce the pollution of water resources in the Kura-Aras basin it is recommended that the riparian states apply

measures to improve environmental policy, legislation and regulations relating to wastewater management.

More financial investments are required for new wastewater treatment facilities and management systems. The installed systems should be simple to operate, energy-efficient and adapted to local conditions. The maintenance and operating costs should be low to allow for full-cost recovery. Reed-bed treatment and other low technology solutions for waste water treatment should be investigated whenever and wherever possible.

There is a need for capacity building and institutional strengthening within government institutions in a number of riparian countries. Increasing the level of public awareness and participation in water resources management and protection is an important task in the process of resolving this issue.

The following recommendations are also suggested in order to respond to the issue of transboundary deterioration of water quality in Kura-Aras River basin:

- Establishment of a basin wide water quality monitoring programme
- Introduction of common discharge standards and permitting procedures
- Promotion of public awareness for environmental quality conservation
- Establishment of an inter-state ministerial mechanism for quick response to emergency situations
- Strengthening of cooperation between the riparian countries on water quality issues
- Adoption of a transboundary environmental impact assessment for developing transboundary projects in the region
- Introduction of cost effective waste water treatment strategies for urban and rural areas
- Reducing pollution through "Best Practice" methods.
- Development of a network of farmer support services for rising awareness in application of fertilizers and sound land management
- Implementation of pilot projects on sustainable land management
- Development of policy and regulations related to application of fertilizers, pest and herbicides
- Build capacity of environmental authorities for enforcing regulations
- Assist industry (and mining enterprises) in developing Environmental Management Systems and undertaking Cleaner Production Activities
- Develop economic incentives for reduction of industrial pollution
- Provide industry with tax credits and grants to assist in the installation of wastewater treatment plants and new wastewater treatment technologies

4.5 Ecosystem Degradation

4.5.1 Description of the problems and a justification of its transboundary importance

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, due to a large extent by habitat fragmentation and degradation. There has been a remarkable decline in several bird

species, small mammals and several plant species. Though the decline in plant species is not so well documented, there is an obvious link with the reduction of valuable timber in recent years, in particular chestnut and oriental beach.

Forest degradation in the Kura-Aras basin has intensified during the last two decades. Boundaries of the mountain forests remained more or less stable until the beginning of the 1990s, but since then, the situation has changed as a result of extensive logging, both illegal and authorized by government institutions. The most vulnerable and rapidly degrading forest ecosystems are the floodplain forests.

Desertification and land degradation is a critical problem in the Kura-Aras basin. The main forms of degradation are salinization (especially in desert and semi-desert areas) and soil erosion (washing out of fertile soil). The most important reason for land degradation appears to be deforestation and overgrazing. Other reasons include construction of large reservoirs that cause bank erosion and landslides.

Further details on biodiversity and ecosystems can be found in Annex 4.

4.5.2 Major environmental impacts and social-economic consequences

The major environmental impacts can be summarized as follows:

- Losses in species and ecosystems integrity (including a decline in fish stocks)
- Desertification and land degradation (Including salinization, soil erosion)
- Deforestation

The main socio-economic consequences of ecosystem degradation are:

- Low productivity of agricultural land;
- Low income from agricultural activities;
- Losses of income from fishery
- Reduction in water quality

It should be noted that the environmental impacts and socio-economic consequences of Ecosystem Degradation are closely linked to the other transboundary problems identified in this TDA and in many cases ecosystem degradation is a significant driver of the other transboundary problems.

For example, deforestation increases peak or maximum discharges of floods, and decreases minimum discharges during hydrological droughts. Floods and mudflows cause significant damage to infrastructure (roads, bridges, pipelines). Deforestation also causes increased soil erosion, which in turn washes out fertile soils layers and covers irrigated lands with mud, considerably reducing the productivity of agricultural lands. Floods and mudflows also increase water turbidity, which has a negative impact on water quality. As a result there are increased costs for human health and decreased access to clean water. Deforestation also causes drought, drying out springs and small rivers, again limiting access to safe and clean water. Soil erosion reduces the productivity of agricultural lands and salinization decreases areas available for farming, a major source of income in most of the rural areas of the Kura-Aras basin.

For more details on the environmental impacts and socio-economic consequences of the problem, please refer to Variation and Reduction of Hydrological Flow (Section 4.3), Water Quality (Section 4.4) and Flooding and Bank Erosion (Section 4.6).

It is important to recognize the environmental impact of ecosystem degradation in the region on the decline and extinction of several species, including a number of large mammals during the 20th century.

The Near Eastern tiger (*Panthera tigris virgata*) became extinct throughout the entire Near East in the first half of 20th century, most likely as a result of fragmentation and degradation of its habitat. At the beginning of the century the tiger, ranged as far as SE Georgia along floodplain tugai forests but by the 1950s individuals were only occasionally recorded in the extreme SE of Azerbaijan. A number of large mammals strongly declined, and their range has been severely fragmented, during the 2nd half of 20th century.

The decline of red deer, goitred gazelle, and bezoar goat (primarily as a result of hunting pressure) are well-documented. Habitat loss and overgrazing are the most likely causes for the decline of the leopard during the 20th century, although there are no recorded negative trends since the late 1950s. Regular studies conducted by Georgian NGOs during the last 15 years have revealed a significant decline in bear and tur (mountain goat) populations, primarily as a result of poaching.

In the lower reaches of the Kura, there has been a significant decline in sturgeon species (Acipenseridae) which enter the river from the Caspian during the last 50 years. At its peak, the Caspian is said to have held up to 90 percent of the world's sturgeon. In recent years, however, landings have decreased dramatically: from 30,000 tonnes in 1985 to only 5,672 tonnes in 1995 (Caspian TDA, 2002).

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-Aras region itself.

One general trend is recorded for herpetological fauna in the region. The range of several amphibians and reptiles declined in the extreme north-western range of their distribution, in SE Georgia, in the second half of 20th century. The list of the species with declined ranges includes the Syrian spadefoot (*Pelobates syriacus*), the Montpellier snake (*Malpolon monspessulanus*), the collared eirenis (*Eirenis collaris*), and the Levantine viper (*Vipera lebetina*).

Declines of plant species are not so well documented. There is an obvious (although not accounted) decline of valuable timber species with in recent years, in particular chestnut (*Castanea sativa*) and oriental beach (*Fagus orientalis*).

4.5.3 Linkages with other transboundary problems

As described above, Ecosystem Degradation is closely linked with Variation and Reduction of Hydrological Flow (Section 4.3), water quality (Section 4.4) and Flooding and Bank Erosion (Section 4.6).

Flooding is directly connected with the causes of the ecosystem degradation. In particular, deforestation and land degradation causes increased runoff and strengthens the impact of flooding on local communities. Conversely, river bank strengthening, to limit the consequences of flooding transforms and degrades riparian landscapes (see Section 4.6 on Flooding and Bank Erosion).
The effect of irrigation on land quality is also linked to ecosystem degradation. Currently, irrigation in the countries of the region is undertaken almost exclusively through surface channels. Because of the poor condition of the canals, leaking water causes erosion and water-logging (see Section 4.3 on Reduction and Variation of Hydrological Flow and Section 4.6 on Flooding and Bank Erosion).

Changes in hydrological flow through the construction of dams and reservoirs have also caused ecosystem degradation (see Section 4.3 on Reduction and Variation of Hydrological Flow).

The underlining causes of surface and ground water pollution are the same as those causing land degradation throughout the region. They include poor agricultural practices, and more specifically the inappropriate application of fertilizers, pesticides and herbicides, including banned substances (see Section 4.4 on Water Quality).

4.5.4 Immediate causes of ecosystem degradation

Ecosystem degradation is manifested through deforestation, desertification, land degradation and species loss. The immediate causes discussed below are grouped according to these impacts. Please also refer to the CCA diagram for Ecosystem Degradation (Figure 4.7).

Immediate causes of deforestation
Extensive timber logging has been observed since the beginning of 1990s in the South Caucasus part of the Kura-Aras river basin. The foothills of the Great and the Lesser Caucasus are the areas that have been affected the most. Trees are cut for household use and commercial purposes. Logging for fuel affects forest ecosystems throughout the basin countries, whereas commercial logging mainly targets the high-stem broadleaf forests. Commercial timber harvesting has continually increased since the early 1990s (Regional Studies on Biodiversity, 2006).

In Azerbaijan, approximately 710 thousand ha is covered with forest within the Kura-Aras River Basin. Here the reasons for forest degradation are more diverse and in addition to extensive logging, forest cover has been removed during the construction of large water reservoirs. For example, as a result of the construction of the Kurin cascade reservoirs more than 30 thousand hectares of tugai forest was flooded and destroyed (Regional Studies on Biodiversity, 2006).

Immediate causes of land degradation
Excessive timber logging is also a main immediate cause of land degradation in the basin. The Trialeti Mountain region in Georgia has particularly been affected, intensifying erosion processes along the northern and western slopes of the mountains. Deforestation is also an important problem in the Aragvi valley in Georgia.

In addition to extensive timber logging, improper land and pasture management is a main driver of desertification, erosion, land salinization and soil contamination. Over-irrigation,

particularly, where there has been an absence of effective drainage systems, has led to water logging and soil salinization. Salinated soils in Azerbaijan are distributed mainly within the Kura-Aras lowland where the total area of affected land is approximately 500 thousand ha.

Figure 4.7: CCA Diagram for the Transboundary Problem: Ecosystem Degradation in the Kura-Aras River Basin

Please See attached file for CCA

The areas of greatest salinization are Kyurdamir (40 thousand ha), Agjabed (38.4 thousand ha), Salyan (32 thousand ha.), Agsuin (21.4 thousand ha), Imishlin (26.6 thousand ha), Saatlin (32 thousand ha), Sabirabad (40 thousand ha). Currently, about a fifth of the arable land in Armenia is out of use due to soil impoverishment (Technical Analysis, 2005). High production rates during the Soviet period were mainly achieved by the extensive use of pesticides and fertilizers which has created an historical legacy of land degradation.

Overgrazing is a major cause of land degradation in the sub-alpine, and to a lesser extent, the alpine grasslands of the Great Caucasus, especially in eastern Azerbaijan and in Aragvi valley in Georgia. Overgrazing causes habitat loss for several endemic Caucasian rodents, such as long-clawed mole vole (*Prometheomys schaposchnikowi*) and the birch mouse (*Sicista spp.*). Moreover, overgrazing strongly affects the suitability of habitats for ungulates and birds, including the besoar goat, the Daghestanian tur, and the Caucasian black grouse (all these species are included in the IUCN Red List). Overgrazing causes degradation of plant cover, 25-30% of which is represented by endemic flowering plants. Plant cover is then replaced by secondary plant communities with lower species Diversity (Regional Studies on Biodiversity, 2006).

Over 20 years ago, major areas of hayfields and pastures were considered to be overstocked causing soil erosion and lowering the productivity of hayfields and pastures. According to the Centre for Conservation of Species the situation has worsened with time, especially in the transboundary territories of the Kura, Iori and Alazani Rivers (NACRES). Agricultural lands in this region are under strong anthropogenic pressure since they are intensively used as traditional winter pastures (Conservation of Ecosystems, 2002).

A relatively minor cause of land degradation is the construction of large reservoirs in the Kura-Aras river basin (for instance Mingechavir in Azerbaijan, Arpylych in Armenia, Tsalka, Sioni, Dali, and Tbilisi in Georgia) which cause bank erosion and landslide problems.

Immediate causes of species loss

Hunting is the main cause of the decline of some big game species, including red deer, the bezoar goat, and the brown beer, as well as a number of bird species, in particular the aboriginal population of pheasant (*Phasianus colchicus*). Over hunting is the main cause of the drastic decline of deer in the Lagodekhi and Borjomi Conservation Area in Georgia. The number of deer here has been reduced from 1450 in 1990 to 160 in 2003 (NACRES). The impact of hunting has been exacerbated by deforestation which has reduced and fragmented the habitat of these vulnerable species (Regional Studies on Biodiversity, 2006).

As already mentioned above, fragmentation and degradation of ecosystems caused extinction of the Near Eastern tiger from the region in the beginning of the last century, the almost complete extinction of red deer, and a considerable decline of other large mammals and carnivores, including wild boar and jungle cat.

Logging in mountain forests, especially broadleaf forests dominated by oriental beach (*Fagus orientalis*), has caused possibly the most dramatic biodiversity loss, because this type of forest maintains an especially high proportion of habitats for endemic animals and plants, some of which are Pliocene and Miocene relicts (Regional Studies on Biodiversity, 2006).

Illegal fishing, especially unsustainable fish harvesting using destructive methods such as explosives and electro fishing, poisoning with chlorine, etc is a major threat for river fish fauna throughout the entire Kura-Aras basin. Poaching and fishing of sturgeon (particularly in the lower reaches of Kura in Azerbaijan) has already resulted in a considerable decline in the sturgeon population (Regional Studies on Biodiversity, 2006). The construction of the Mingechavir reservoir changed the composition of fish species in the middle and upper currents of the Kura after the 1940s. In particular, 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 west of the reservoir. In contrast, the Kura roach *(Rutilus rutilus caspicus)* and two species of bream (*Abramis brama orientalis* and *Abramis sapa bergi)* colonized the middle currents of the Kura after construction of the reservoir, along with a number of exotic fish species from the Russian Far East (Regional Studies on Biodiversity, 2006).

Water contamination also causes ecosystem degradation, the most vulnerable of which are aquatic ecosystems. Please refer to chapter 4.4 on Water Quality for detailed information.

Finally, local climatic changes (some of which may also be anthropogenic) are likely to intensify ecosystem degradation. According to studies carried out in 1999-2000, amphibians and reptiles living in arid and shrubby habitats in Georgia were subject to drastic decline, compared with these species living in humid and forested habitats. Reptile species including the levantine viper (*Vipera lebetina*), the collared eirenis (*Eirenis collaris*) and the Montpellier snake (*Malpolon monspessulanus*) have been displaced 30-50 km south-eastwards during the last several decades. In addition, the altitudinal distribution of three species of green lizards (*Lacerta agilis, L. media, L. strigata*) has been displaced downwards in the Tbilisi area. The range of the Syrian spadefoot (*Pelobates syriacus*) has also declined and undergone fragmentation. This is most likely due to increased humidity in southeastern Georgia (and possibly western Azerbaijan) that occurred after the 1950s, probably as a result of the construction of Mingechavir and several other smaller reservoirs along the Kura River (Tarkhnishvili et al. 2002).

In summary, the major anthropogenic factors causing biodiversity loss in the Kura-Aras River Basin at present are: deforestation, overgrazing (most importantly in sub-alpine and, partly alpine landscapes), illegal fishing and hunting and poor land management practices.

4.5.5 Underlying causes of ecosystem degradation

Underlying causes of deforestation

Increased demand on timber for commercial purposes is one of the major drivers of ecosystem degradation. This includes timber logging for use in the construction business nationally and for export[26], and has consequently resulted in a reduction in deciduous forest areas. Broadleaf forests harbor a critical part of the regional biodiversity, with the highest proportion of endemic and threatened animal and plant species. Recovery of this type of forests is extremely slow, and local clear-cutting causes irreversible landscape degradation, transforming ecosystems as a result of natural succession.

As mentioned above, the main targets of commercial logging are high-quality, old forests, mostly broadleaf (beach, chestnut, Caucasian hornbeam), and to a lesser extent, coniferous

[26] Demand on timber is often met at the expense of increased forest logging in other basin countries. This is case in the Artvin area of Turkey, a traditional timber-harvesting region, where logging activity decreased in recent years as a result of imports of relatively cheep timber from Georgia (Regional Studies on Biodiversity, 2006).

species (spruce, fir). The age of harvested trees varies between 50-100 years, and the therefore recovery of these woodlands will need many decades, particularly taking into account that in many areas over 30% of the mature trees are already logged. The most dramatic changes have been observed in the Georgian Lesser Caucasus (Trialeti and eastern Meskheti ranges) although the extent of deforestation and reduced forest quality as a result of commercial logging still has to be studied in detail.

The energy crisis that has taken place during the last decade in the South Caucasus countries has also put great pressure on forests in the basin. Georgia and Armenia have been especially vulnerable to this crisis as they have no reserves of oil, gas or coal. The acute energy deficit in these countries, accompanied with poverty problems has resulted in excessive logging as the population has been forced to use wood for heating and cooking. Low income levels and a lack of alternatives prevent the rural population from purchasing other sources of energy and they still continue to fully rely on firewood cut in surrounding forests. For example, in Armenia, extensive tree-cutting for fuel purposes annually reaches 1.0 million m^3.

Increased demand on commercial timber and firewood is often covered by illegally logged timber. This has become an acute problem in the South Caucasus countries. In Georgia during the last 15-20 years the real volume of timber logging has exceeded the quota set many times over[27], mainly due to the illegal production of commercial timber. For example, in 1990 4.5 thousand m^3 of timber was cut illegally. By 2000 this figure had reached 43.0 thousand m^3 and in 2003, 54.5 thousand m^3 (Natural resources statistical collection, 1980, 1985, 1988, 2002). To compound this problem, 3485 reports on the violation of forest legislation were submitted to the law enforcement authorities, however, only 1955 reports or 58% were reviewed. Illegal logging has caused severe damage to the forest ecosystem of Armenia as well. In the past decade, up to 26.2% of the beech forests have turned into thickets and shaws and only 10.3% have retained their natural density (the figure for oak-forests is even worse at around 1.3%). A substantial part of the Armenian forests have already lost the natural ability to regenerate (Regional Studies on Biodiversity, 2006). Illegal logging is also a major problem in Azerbaijan. According to official data from the Ministry of Ecology and Natural resources of Azerbaijan, the volume of illegal cutting in 2002 reached 41110 m^3 (Technical Analysis, 2005).

Underlying causes of land degradation

Salinization in the basin is often caused by poorly operated irrigation systems and facilities, as well as the unavailability of new efficient irrigation technologies. High losses and the lack of drainage often leads to water logging and secondary salinization of lands. For more details on this issue please refer to Section 4.3 on Variation and Reduction of Hydrological Flow.

Increased livestock numbers on pasture lands is the main cause of overgrazing in the basin. Livestock pressure has increased over last 10-12 years because sheep have not been driven from Georgia to the north Caucasian Kizlar pastures (Conservation of Ecosystems, 2002). At present, according to estimations, each hectare of pasture land sustains approximately 35-40 sheep compared to less than 12 a few years ago. The effect of extensive sheep grazing is quite evident in the region: grass cover has disintegrated and been modified, erosive processes have been observed and fragments of the pistachio arid forest have almost disappeared (Technical analysis, 2005).

Underlying causes of species loss

[27] Annual registered cutting in Georgia should not exceed 0.15 - 0.20 million m^3

The reasons for overfishing (both legal and illegal) and over hunting are different: whilst fishing is an important source of income for riparian communities (especially in the lower currents of the Kura) and communities near large lakes, hunting is a wide-spread leisure activity throughout the region.

4.5.6 Socio-economic, legal and political root causes of ecosystem degradation

There are a number of socio-economic, legal, institutional and political root causes for transboundary ecosystem degradation in Kura-Aras River basin. These root causes are related to sectoral development, further extension of the infrastructure that serves as a backbone for economic development. Weak legislation and regulations, institutional complexities, poor law enforcement and low public awareness on the importance of biodiversity and ecosystem act together with financial constraints to create unfavorable conditions for protecting ecosystem integrity and biodiversity. The absence of integrated water resources management also contributes to this process. The institutional, legal and political causes are discussed in more detail in the chapter on Governance Analysis (Chapter 6).

The weak institutional capacity of environmental authorities means that fishing and hunting are poorly controlled. In general there is a lack of social responsibility for illegal hunting and fishing since in most of the Kura-Aras basin countries the level of fines for breaking laws is low. This also applies to illegal timber logging. In the South Caucasus countries the state has almost fully retained ownership of forests. However, the division of responsibilities between central and local government regarding forest management remains unclear, and local communities do not have authority to deal with this problem. Furthermore, the budget allocation for the forest sector has drastically decreased over the last decade.

A lack of financial resources for combating desertification and salinization, together with the low awareness of farmers on sound land and pasture management practices has intensified land degradation processes in the basin. Two further causes are a lack of adequate finances for introducing new technologies and the absence of corresponding incentives. In Georgia, for example, the approved budget for the State Programme on Combating Desertification in 1999-2005 was around 28.5 million GEL. However, between 1999-2002 only 0.36 million GEL was spent.

4.5.7 Knowledge gaps

In the basin countries, there is no current inventory on riparian and bank ecosystems, particularly wetlands and forests, and, in addition, there is lack of monitoring programs for these ecosystems. Existing historical data is inaccurate due to the intensive deforestation that has occurred in the basin since the early 1990s.

Key animal and plant species in the region are not monitored and there is an absence of complete biodiversity inventories. Though there are inspectorates in the Kura-Aras basin countries which control illegal hunting and fishing, there are no agencies responsible for regular monitoring of biodiversity.

Land use information is not widely available, and often does not include changes in land use patterns during the last decade.

Most of the basin countries have not established minimum ecological flows. In addition, information on establishing criteria and procedures for designating and maintaining ecosystem zones is lacking in most of the basin countries.

4.5.8 Summary and recommendations

The ecosystems of the Kura-Aras basin are highly diverse and include a broad range of landscapes, from semi-deserts and arid shrublands to mesophylic relic broadleaf forests and alpine grasslands. These ecosystems harbour a variety of plant and animal species representing an admixture of Mediterranean, Eastern European, and Near Eastern floras and faunas, combined with a high proportion of regional endemics (reaching 20-30% of the total species number in certain taxonomic groups). This diversity has resulted in the Caucasus ecoregion being included in a shortlist of global biodiversity hotspots.

The natural ecosystems of the Kura-Aras river basin are enduring significant and increasing threats which are causing degradation and decline. The most important cause is accelerated timber logging, linked to the historical and ongoing energy crisis, and increased commercial demands on timber. Other causes include unsound land and pasture management, pollution and over-exploitation of fish stocks. There are also some signs that climatic change is having an influence on the structure of local ecosystems and animal species.

Some efforts to prevent further degradation of ecosystems and species loss throughout the basin have been implemented. However, these efforts are insufficient and require better coordination at the inter-governmental level.

In order to prevent losses in species it is recommended to build capacity and provide finances for effective enforcement of corresponding regulations. An effective land-use planning system also needs to be developed to avoid fragmentation of habitats and degradation of ecosystems.

To address the issue of deforestation, measures should be implemented towards clearly defining the forest management institutions, introducing corresponding legislation and enforcement mechanisms, as well as developing incentives that would stimulate the generation of alternative renewable energy.

Land degradation can be addressed through the introduction of new water saving technologies, combating salinization and erosion, as well as regulating the use of pesticides and fertilizers.

Other recommendations addressing the issue of ecosystem degradation in Kura-Aras river basin include:

- Improvement in the management of protected areas, and development of new protected areas in critically important ecosystems and transboundary corridors. The Great Caucasus forest landscapes, along with floodplain forests and shrublands of Georgia and Azerbaijan are under-represented in the largest protected areas. There are many smaller protected areas, but their limited size and absence of legally protected corridors make them vulnerable. Only around 5% of the basin is protected at the moment. The ecoregional plan anticipates increasing this figure to 8% during the next

few years. It is especially important to ensure that the protected areas link-up with the eight transboundary priority areas[28] and the planned Javakheti national park will probably cover entirely or almost entirely one of those transboundary areas. Two transboundary areas (Lagodekhi-Zakatala and Iori-Mingechavir) have protected areas at both sides of the border, which should be conjoined into larger protected areas. Five others transboundary areas either do not have related protected areas or have sanctuaries of limited size that will require substantial improvement of the infrastructure.

- Increasing public awareness on the consequences of unsustainable fishing and hunting. Although in all countries of the basin, illegal hunting and fishing is punished, products of poaching are commonly freely available at local markets. In particular, river fish caught using destructive methods are freely available and the same is true for the horns of protected ungulates.
- Adjustment of the tax policy and subsidies to reduce valuable timber harvested for trade. An important problem in this trade is the difference in taxation for harvesting and use of timber in the neighboring countries of the region, in particular Georgia and Turkey.

- Strengthening of policing and enforcement of forestry regulation and legislation and providing finances for capacity building

- Provision of relatively cheap alternative energy sources, including biogas.

- Mobilization and empowerment of communities to manage common forests. There are sound traditions of community foresting in the region, in particular in the mountains of the Great Caucasus. These traditions need to be better studied and revived.

- Implementation of pilot projects on sustainable land management including a combination of studies on biodiversity, and social and economic impacts. It is important to develop a sustainable monitoring system on the state of regional ecosystems and species diversity.

- Ensuring sustainable (land-use) planning and an effective EIA system to avoid fragmentation of habitats and ecosystem degradation.

- Developing management plans and applying modern nature conservation procedures.
- Developing incentives for introducing new water saving technologies and developing sustainable schemes for financing, maintaining and developing irrigation (including

[28] Transboundary conservation areas located in Kura-Aras river basin are: 1) *Lagodeghi-Zakatala-West Daghestan* (transboundary Georgia-Azerbaijan-Russia; total area 498,706 ha); *2) Iori-Mingechavir (transboundary Georgia-Azerbaijan; 631,181 ha); 3) Alazani-Ganykh (transboundary Georgia-Azerbaijan; 51,230 ha); 4) Kura-Jandari (transboundary Georgia-Azerbaijan; 30,068 ha); 5) Maku and western Iranian border (transboundary Iran-Turkey; 486,479 ha); 6) Agri Dagi and Armash* (transboundary Turkey, Armenia, Azerbaijan, Iran; 271,669 ha); 7) *Javakheti* (transboundary Georgia, Armenia, Turkey; 322,994 ha); 8) *Igdir Plain and Armavir* (transboundary Turkey, Armenia; 403,170 ha). For more detailed information please refer to Annex 4: Regional Studies on Biodiversity and Ecosystems.

water use fees). For more detailed information on this recommendation, please refer to Chapter 4.1 on Variation and Reduction of Hydrological Flow.

4.6 Flooding and Bank Erosion

4.6.1 Description of the problem and a justification of its transboundary importance

Flooding and Bank Erosion in the Kura-Aras river basin has significant transboundary consequences. Anthropogenic interventions in the natural flow regime including river training and changes in land cover (intensive deforestation) combined with the degradation of natural floodplains as a consequence of urban development and agriculture, increases the risk of floods and mudflows in downstream countries. Deterioration in the flood protection infrastructure throughout the basin has worsened the situation. It is likely that climate change will further increase the risk.

Although flooding and mudflow events are observed throughout the basin, the magnitute and frequency of these events varies from place to place. Georgia and Azerbaijan are more susceptable to flooding, whereas in Armenia mudflows are of serious concern. In Iran the major concern is bank erosion as a consequence of flooding.

Flooding and mudflow events in the Kura-Aras basin have adverse economic and social implications for the basin countries. Despite extensive investments in flood control schemes in the past, significant damage and occasional loss of human life still occurs. The construction of reservoirs, dykes, and walls has provided protection from floods and decreased their severity but other human interventions such as channelization of rivers, streightening of river courses, and changes in land cover have increased the risks and uncertanties. Development and settlement in floodplain areas, some of which are flood risk zones, has also made many communities vulnerable to flooding. Figure 4.8 shows the geographic areas most susceptible to flooding and bank erosion.

Floods occur principally in the Spring with the snow melt. The potential for catastrophic flooding is dependent on the depth of the acumulated snow fields and the speed which the snow melts, together with sudden increases in temperature. The worse case scenario is when the peak floodwaves from the Kura and the Aras coincide in the lower Kura basin. Extensive drainage for agriculture in the 1950's onwards decreased the natural flood storage - attenuation capacity in the Kura-Aras basin increasing the flood risk, which was only partly offset by the construction of the large irrigation and hydro-power impoundments (Minchechavir and Shamkir) in the basin, which have a secondary flood control function. The situation is deteriorating with high sedimement loads in the rivers causing rapid siltation and a reduction of live storage in these impoundments, reducing flood storage capacity at critical times. In addition the effective control of reservoir releases to mitigate downstream flooding is severely hampered by poor information and communication on metoerological conditions, including snow field depth and timing of the snow melt. It is unclear whether control rules of the major reservoirs have been reviewed in recent times in light of increased threats from flooding. Finally, there is already stochasitic evidence of increased runoff and incidence of outlier events due to global warming and that the threat and extent of flooding in the basin is likely to increase. Please refer to Annex 8 for further details.

Figure 4.8: Geographic areas in the Kura-Aras river basin most susceptible to flooding and bank erosion.

4.6.2 Major environmental impacts and socio-economic consequences of the problem

The main socio-economic consequences of flooding and bank erosion are:

- Damage to infrastructure;
- Damage to water supply systems and water treatment plants;
- Agricultural losses;
- Land degradation: salinization of flooded lands due to rising ground waters;
- Sedimentation of reservoirs;
- Losses of land both temporary and permanent.

The main environmental impacts of flooding and bank erosion can be summarized as follows:

- Change in ecological condition of rivers through increased turbidity and contamination with solid waste and hazardous substances from flooded industrial sites;
- Wetland creation and preservation;
- Improved fish spawning and fry recruitment conditions;
- Soil enrichment.

Socio-Economic Consequences

The impacts of floods on the national economies of the river basin countries can be devastating, especially in the South Caucasus where the national economies countries have undergone serious decline. Infrastructure including roads, railways, communications, transmission lines, pipelines, water supply systems, etc that have deteriorated over last 15 years due to a lack of funds for their maintenance have been subject to further deterioration due to floods. Residential areas, industry and construction sites are heavily affected by these natural hazards in Georgia, Armenia and Azerbaijan.

The increased magnitude and frequency of floods occurring upstream of the Kura river has an effect on sediment load. Increased sediment load accelerates the siltation of reservoirs downstream in Azerbaijan (mainly in Shamkir and Mingechavir reservoirs) reducing the water storage capacity and diminishing their flood control function. For example, the maximum depth of the Mingechavir reservoir has dropped from 83 to 63 m since its completion in 1953 due to sedimentation (TACIS, 2004).

Since the construction of the Mingechavir reservoir on the Kura, and the Aras reservoir on the river Aras (in 1970) the magnitude of floods has been significantly reduced (TACIS, 2004). However, the heavily regulated flow does not relieve the population from danger. In Azerbaijan in the Kura-Aras river basin in 1967, 1969, 1976, 1979, 1982, 1997 and 2003 large areas of Salyan, Neftchala, Sabirabad, Saatli, Imishli, etc. were covered with floods affecting around 50 % of population. In addition, increased levels of ground water caused salinization of lands further damaging the national economy. (Regional Studies on Flooding, 2006)

The drinking water supply networks in the basin are very sensitive to flooding events. In Azerbaijan, for example, water treatment plants are not capable of performing mechanical

treatment and supplying drinking water to Baku for several days after a flooding event (Technical Analysis, 2005). Increased sediment load in water floods and mudflows often causes serious breakdowns of both water supply and sanitation systems potentially acting as a source of waterborne disease. More details on this impact can be found in Section 4.4 on Water Quality.

Losses in agriculture are also severe, especially when the social vulnerability of the rural population is taken into account. Often whole harvests and, sometimes if floods are especially severe, livestock are swept away by floods and mudflows. The impacts of floods are not only immediate; they can also have a significant effect on the agriculture sector over time relating to soil erosion, land salinization and desertification. Damage caused by floods and mudflows often extends and triggers the occurrence of other natural hazards such as landslides. According to estimates in 2003, the aggregate losses caused by the flooding in the downstream Kura basin (Azerbaijan) amounted to 65 million USD (TACIS, 2004).

Mudflows and floods cause catastrophic damage to settlements, major constructions and roads. Furthermore, many pastures and arable lands become totally unsuitable for agriculture. (National TDA, Armenia, 2006)

Armenia is particularly susceptible to catastrophic mudflows where around 1400 permanent and temporary beds and gullies are to some extent mudflow carrying. These lands are characterized by low humidity, sharp changes of temperature, poor earth-vegetative cover, high rates of weathering and are mainly located on the southern slopes of the Lesser Caucasus mountains. On the northern slopes, where dense forest and valley vegetation are present, the mudflows are much less prevalent.

Mudflow processes in Georgia take place in the highland zone of the Caucasus: Tbilisi, Kvareli, Telavi have frequently suffered from mudflows. Almost in all residential areas the great majority of the riverbeds and bridge passages are entirely or partially filled with mudflow sediments, building and household wastes. Rainwater gullies and canals are blocked and during the spring run-offs create a further risk of flooding (Root Cause Analysis, 2005).

In Iran, after construction of the Aras dam, flood effects have decreased remarkably, but flood dispersion can be still observed upstream of this dam. Construction of the Khoda-Afarin dam downstream of the Aras dam is likely to reduce flood risk further downstream. But the problem of bank erosion remains and moreover, has intensified. Invasion of the river, particularly in the plain regions has resulted in intense bank erosion. Observations have shown that the bed displacement has taken place in a number of areas[29]. Investigations have indicated that the displacement can be up to 1 kilometer causing significant erosion of lands on the Iranian side. Similar processes have been observed on the river Alazani (a Kura tributary) between Georgia and Azerbaijan (National TDA, Iran, 2006). The River Aras forms the boundary between Iran and Armenia and its displacement has political as well as economic consequences, with both countries seeking a stable river bed.

Unfortunately there are no data available to quantify the impact of deforestation on the flow regime but there are indications that deforestation and land irrigation over the last 30 years has increased sediment load drastically (TACIS, 2004) causing localized shoaling in the

[29] The river Aras is Border River between Azerbaijan and Iran and Armenia and Iran. Displacement of the river toward Iran causes loss of land on Iranian side.

rivers. As the discharge capacity of rivers decreases there is a danger that spring high waters in small or even dry river beds will cause flooding of surrounding territories.

Cases of mudflow events occurring due to deforestation are easier to identify. In the Pambak Ridge Mountains, for example, adjacent to Vandzor city, the removal of forest and converting the land to intensive pasture has resulted in the whole site within 13-15 km, becoming eroded. Consequently, after heavy rainfall the city is flooded with a water/mud/stone mixture (National TDA, Armenia, 2006).

Environmental Impacts

Flooding is a natural process which humans seek to control. An increased incidence and frequency of flooding expands and creates new wetland areas to the benefit of aquatic biodiversity, floodplain forests and fish spawning and recruitment. Through sedimentation flooding also enriches the downstream agricultural lands.

However, floods and mudflows also have a negative effect on the ecological conditions of the rivers. The consequences of improper solid waste management throughout the basin becomes particularly noticeable after floods when large volumes of waste are transported from illegal landfills mainly located on river sides and are deposited into reservoirs or to the costal zones (Technical Analysis, 2005).

4.6.3 Linkages with other transboundary problems

All the identified priority transboundary problems Kura-Aras are interconnected and this is particularly the case for flooding and mudflows, which link to all other problems to a greater or lesser extent. Flooding and mudflow have an impact on water quality through increased sediment load and solid waste load into rivers. During floods, nutrients, pesticides and herbicides are washed out from agricultural lands. Contaminants related to industrial sites located near river banks are also often discharged into rivers after flooding events. See Section 4.4 for more details.

Ecosystem degradation (e.g. deforestation, land degradation) has a magnifying impact on flooding, increasing its destructive power. Deforestation processes, throughout the basin, affects the capacity of forests to retain water, affecting peak flows in rivers through increased runoff. At the same time erosion processes enhanced due to deforestation augment sediment load in rivers and decrease the discharge capacity of rivers. See Sections 4.3 and 4.5 for more details.

4.6.4 Immediate causes of flooding and bank erosion

The casual chain for Flooding and Bank Erosion is presented in Figure 4.9. The sectors that have contributed to this problem are urbanisation, industry, energy, forestry, agriculture and natural causes (see Table 4.2).

The formation of floods is determined mainly by the geological, geomorphologic and hydro meteorological conditions of the basin. However, the main immediate causes dealt within this TDA focus on those of an anthropogenic nature. Thus, the major immediate causes of Floods and Bank Erosion are:

Figure 4.9: CCA Diagram for the Transboundary Problem: Flooding and Bank Erosion in the Kura-Aras River Basin

Please See attached file for CCA

- River training;
- Insufficient flow regulation (flood wave attenuation) ;
- Reduction of floodplain areas;
- Deforestation and changes in land use; and
- Increased runoff from urban areas.

4.6.5 Underlying causes of flooding and bank erosion

High floods have been reduced by the construction of a number of dams and reservoirs on the Kura and Aras rivers[30]. However, Lack of flood protection reservoirs is listed as one of the main underlying causes of floods in the basin. The possibilities of further extension of the reservoir network allowing better protection of settlements from flood and mudflow has not exhausted. However provision of this form of protection could exacerbate other transboundary problems and more non structural measures (NSMs), including managed retreat, should be considered.

Existing flood protection schemes are in a poor condition in the lower basin, predominantly due to a lack of financial resources for maintenance and rehabilitation of the infrastructure as a consequence of the economic recession over the last decade.

Over the last 50 years urbanization processes (such as construction and paving) have affected runoff (and in particular peak rates of flow). Consequently, the reduced permeability has contributed to a reduction in flood plain storage and attenuation of the flood wave.

A major driver of increased runoff in the basin is deforestation which significantly alters the long-term hydrological regime. The Kura-Aras river basin is rich in forest (see Section 4.5) and forested lands in the Caucasian part of the basin (where intensive deforestation processes are taking place) occupy 2,345 thousand ha. According to expert evaluations, timber logging during the last 10-15 years has reached alarming levels. For example, in Georgia in 2003, 54.5 thousand m^3 of timber were logged illegally and in Azerbaijan 41.1 thousand m^3 were logged in 2002 (Regional Study on Biodiversity, 2006). Furthermore, 25 % of forests were cut down in Armenia due to the energy crisis in the 1990s.

Changes in land use, the development of settlements and construction activities in hazardous areas also increase the scale of the damage. After the Spitak earthquake in the northern regions of Armenia in 1988, for example, whole cities and villages were constructed in undeveloped mountain areas susceptible to mudflows. This resulted in a subsequent sharp increase in damage from mudflow, erosion and landslide. (National TDA, Armenia, 2006) During whole 20^{th} century settlements expanded in the floodplain forest areas. Floodplain forest was cut down to clear land for agriculture. Transformation of floodplain forests into cultivated lands continues but to a lesser extent in the Kura and Alazani valley. Please refer to Annex 4 for further details.

For a detailed list of underlying causes please refer to Figure 4.9 (CCA Diagram).

[30] Detailed list of dams and reservoirs existing in the Kura-Aras basin are presented in UNDP/SIDA report Preliminary Technical Analysis (Armenia, Azerbaijan, Georgia) and in TACIS report (see reference list).

4.6.6 Socio-economic, legal and political root causes of flooding and bank erosion

A major socio-economic root cause of increased Flood Risk and Bank Erosion is insufficient financial resources for the construction and maintenance of flood control and defense schemes. This is compounded by the lack of a proper monitoring and flow forecasting system that would allow effective early warning. The lack of integrated flood management is another other issue that needs to be addressed in the basin and approaches restricted to flood control using only hard engineering solutions have to be revised, especially when the financial and environmental costs of such solutions are considered. There is a limit to the severity of flood event for which protection can be provided and may be less than was previously provided in the Soviet period because of economic and climatic changes. This is particularly pertinent in the Kura-Aras river basin where a number of the countries are experiencing economic problems. Further, the insurance industry in the region is in its infancy and the state is the only responsible institution providing compensation for property loss and damage to households, which also lays a heavy burden on the limited state budget of the Caucasus countries. A lack of planning and integrated river basin management was also identified as major cause (refer to Chapter 6, Governance Analysis) where there is also weak regional cooperation on flood control and risk management. No regional mechanisms exist for creating early warning systems to ensure better flood preparedness in downstream countries or the development of joint projects for flood risk management.

4.6.7 Knowledge gaps

Gaps in knowledge prevent the full assessment and comprehensive analysis of the impact and consequences of flooding and bank erosion. Major knowledge gaps include:

- A lack of data on the frequency and severity of floods for the last two decades as a result of failures in the hydrological monitoring networks, i.e. the affect of global warming cannot be verified;
- Insufficient automatic hydrological monitoring stations and data exchange among the riparian countries;
- No reliable and effective flood forecasting. Existing approaches fail to meet present requirements and use old techniques;
- No systematic data on bank erosion and available data is intermittent.
- No reliable data on the damage caused by floods and mudflows

4.6.8 Summary and recommendations

Floods and bank erosion are natural events and will continue to occur in the future, even if anthropogenic impacts are minimised. The only way to to deal with these risks is to have in place an appropriate preparedness system to reduce damage and mitigate the impacts of flooding and bank erosion.

Investment from the riparian states is vital to deal with flooding and its causes. Initially, allocated funds could be directed at rehabilitating existing flood protection schemes. In addition, it is recommended that regional plans for the comprehensive rehabilitation of flood protection and flood control schemes in whole basin need to be developed as well as flood risk management strategies.

In the countries of the basin there is existing experience on flood management through the application of structural measures and engineering constructions (reservoirs, walls, strengthening banks, etc). Unfortunately, very little attention has been paid to non-structural measures in the countries of the basin, especially Armenia, Azerbaijan and Georgia. The concept of non-structural measures (NSM) was first used in the context of flood control, as a means to reduce ever increasing damages, without expanding costly infrastructure. NSMs can be considered as complementary additions to the structural solutions of flood control, in order to reduce costs and enhance efficiency.

With respect to above, there is a need in the Kura-Aras river basin to put more emphasis on NSM, particularly on:

- An early warning system, which should be developed at the basin level. It would help prevent or avoid damage both nationally and regionally.
- Revision of reservoir control rules to maximize flood control
- Vegetation managment, as an important part of NSM for flood control. Planning interventions for protecting against floods without addressing deforestation can not be fully effective. Other measures with regard to vegetation include: terracing and horizontal ploughing inclined slopes, regulation of cattle pasture, surface flow regulation through water removal (channels, terracing, trenching,). In addition certain bed hydrotechnical measures could be applied in areas susceptable to hazardous mudflows.
- Disaster contingency planning, raising awareness, increasing preparedness and developing self-protection in affected communities.
- Limiting land uses and forbidding settlements in areas under threat of flooding.
- Developing flood damage insurance in flood risk zones.
- Long-term spatial planning, integrating land and water management, and building capacities both at national and local levels. This would help to prevent, manage and respond to floods and mudflows.
- Development of a sustainable flood control and risk management strategy. For this it is important to have a good database on: topographic data; imagery; administrative data; infrastructure data; environmental data; hydro meteorological data; economic data; and emergency management data. An estimation of the institutional, technical and cultural frameworks, both at the national, and basin level is another important activity for the development of a long-term flood management strategy.

4.7 Transboundary impacts of groundwater reserves

An analysis of the transboundary impacts of groundwater reserves has been undertaken under a separate component of the Kura-Aras project and project funded by ENVSEC (Project Titled). The full report for this project is presented as Annex**, attached to this document.

4.8 Overarching root causes

Beyond the underlying socio-economic, legal and political causes are a number of overarching root causes of environmental degradation which are common to all 4 priority

transboundary problems. These over-arching root causes are often related to fundamental aspects of macro-economy, demography, consumption patterns, environmental values, and access to information and democratic processes. Most of these are beyond the scope of a GEF intervention, but it is useful to document them for two reasons:

1. Some proposed solutions may be unworkable if the root causes of the problem are overwhelming.
2. Actions taken nearer to the root causes are more likely to have a lasting impact on the problem.

The overarching root causes of environmental degradation in the Kura-Aras river basin can be divided into the following categories:

- Economic instability in the south Caucus countries during the transition to a market economy
- Political instability (particularly in the South Caucus countries during the 1990s)
- Poverty as a result of political and economic instability after the collapse of the Soviet system resulting in a sharp decline in living standards, widened income inequalities and a deterioration in health conditions.
- Demographic change including population migration from rural to urban areas; outward migration particularly from the South Caucus countries; civil conflict resulting in internal displacement of people; reduced birth rates
- Lack of co-operation and suspicion between riparian countries
- Lack of awareness of the consequences of environmental degradation in government and civil society and a limited degree of motivation for environmental protection

5. STAKEHOLDER ANALYSIS

5.1 Introduction

In order to improve the conditions of the river basin, and address the needs of the many types of stakeholders, a stakeholder analysis was conducted in the Kura Aras basin in 2005-2006. The analysis involved identifying different types of stakeholder groups, asking stakeholders what their priority concerns are, and questions to gauge how they perceive issues pertaining to transboundary water management in the region. Open ended questions asked in the Qualitative Stakeholder Analysis focusing on river basin communities, and then structured surveys were administered to over 500 stakeholders from the region, representing 30 different stakeholder groups for a Quantitative Stakeholder Analysis. The results of these analyses provide a summary review of priority concerns and perceptions of stakeholders throughout the Kura and Aras basin.

The Qualitative Stakeholder Analysis was conducted in Armenia, Azerbaijan and Georgia in June- July 2005. The Kura Aras Qualitative Stakeholder Analysis (QLSA) was conducted in order to directly attain the opinions of the residents throughout the river basin about water quality and quantity issues, to ascertain their perceptions of water management challenges, and to identify the region wide concerns for the TDA/SAP process. The QLSA focused primarily on the concerns of those community members within the transboundary river basin because they are most directly impacted by water quality and water quantity challenges. Traditionally, perceptions of these stakeholders in riparian communities are under-represented in the national and regional water management strategies and yet they can play a key role in successful river basin management plan implementation. In order for the public stakeholders to be active participants in environmental governance, it is critical that their common and transboundary priority concerns are included in the larger scale Quantitative Stakeholder Analysis (QNSA) survey and within the TDA/SAP process.

The Quantitative Stakeholder Analysis survey was conducted during December 2005/January 2006 in Georgia and Armenia. In Azerbaijan and Iran the surveys took place later during 2006 and are still being finalized[31] . The 512 surveys collected from the region were compiled and statistically analyzed for trends across and within stakeholder groups. The QNSA provides a structured empirical gauge of a very wide array of stakeholders throughout the region. These groups and their priority concerns are presented in Table 5.1. The full survey is presented in the Annex 12.

The most notable finding of the SHA, both the QLSA and QNSA is the high level of concern among all stakeholders regarding the deterioration of water quality. Among all stakeholders surveyed, this was the highest priority concern by a significant margin. The top three concerns among all groups was the lack of sewage treatment, lack of potable drinking water and related health problems, and deterioration of water quality (e.g. pollution). The second highest priority set of concerns are the variation and reduction of hydrological flow, with concerns regarding the lack of water for irrigation, infrastructure decline, irregular water supply to households, and non-rational use of water including inappropriate and non sustainable water use.

[31] The analysis presented here is based on an unequal number of surveys. There are fewer available survey from Azerbaijan and Iranian and more from Armenian and Georgia. A weighted fully completed analysis is expected by the beginning of the year 2007.

Table 5.1: Stakeholder priority concerns from the Kura-Aras river basin Quantitative Stakeholder Analysis (QNSA) survey (2005-2006).

Stakeholder Groups Prioritizations of Concerns **High Priority** **Medium Priority** **Low Priority**	**Lack of Potable H_2O**	**Lack of water for irrigation**	**Infrastructure decline**	**Lack of Sewage Treatment**	**Irregular Water to Home**	**Non ration Water use**	**Ecosystem Degradation**	**Pollution**	**Flooding/ Bank Erosion**	**Decline in Bioresource**
Survey question number:	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Transboundary Problem Area[32]:	**B**	**A**	**A**	**B**	**A**	**A**	**C**	**B**	**D**	**C**
Priority Level for All Stakeholder Groups:	**#2**	**#8**	**#4**	**#1**	**#7**	**#6**	**#5**	**#3**	**#9**	**#10**
1. Water, Hydro-meteorological Department										
2. Natural Resources, Ecology or Environmental Ministry										
3. Industry Ministry										
4. Energy Ministry										
5. Economic Ministry										
6. Foreign Affairs Ministry										
7. Defence Ministry										
8. Agriculture Ministry										
9. Forestry Ministry										
10. Fisheries Ministry										
11. Social Welfare / Public Health Ministry										
12. Labour Ministry										
13. Mining industry										
14. Transportation Ministries										
15. Parliamentary committees for environmental protection										
16. National NGO										
17. Scientists										
18. Heavy industry										
19. Light industry										
20. Agro-industry										
21. Regional government official										
22. District water management official										
23. Municipal Government										
24. Municipal waste manager										
25. Nature preserve staff										
26. Community based organization										
27. Educator/teacher										
28. Student										
29. Farmer										
30. Pastoralists/ animal husbandry										
31. Public health care provider										
32. Member of community near the river										
33. Tourism/Recreation industry										
34. Press and media										

[32] Transboundary Problem: A. Variation and reduction of hydrological; B. Deterioration of water quality; C. Ecosystem degradation in the river basin; D. Flooding and bank erosion

35. International Funding Inst										
36. Bilateral development agency										

The third highest priority set of concerns are ecosystem degradation in the river basin and decline in bioresources (e.g. fisheries). The lowest priority concern is increased flooding and bank erosion[33].

5.2 Variation and Reduction of Hydrological Flow

The variation and reduction of hydrological flow was a medium level problem for most stakeholders. There were several priority concerns that address this. The decline in infrastructure to support water delivery was the 4th highest priority among all stakeholders, and non-rational use of water was the 6th highest concern. Although some stakeholders ranked this concern as important (generally the Ministries and scientific community), within the survey there were varying levels of agreement amongst stakeholders pertaining to the availability of water. For example, farmers, fishermen and community groups all felt that non-rational use of water was a low priority issue.

There were some interesting and very informative trends in regards to issues of potential water scarcity. In response to the statement "There is enough water for everyone who needs it" only labour ministry groups agreed, while many groups either disagreed strongly or have division within the specific group. Upon close examination there was some geographic division with those living closer to the river tending to disagree, while those living further from the river and in urban areas generally agreeing. In contrast, almost all stakeholder groups agreed that "farmers need more water than they currently have". A notable exception was the District Water Management Officials, though those in areas further down stream tended to agree more readily than those further up stream. Over all rural stakeholders agreed more strongly than urban stakeholders. This suggests that overall stakeholders are aware of and concerned about availability of water throughout the region.

In response to the statement "each community should use the river any way they want to" there was strong disagreement among most stakeholder groups, with strongest disagreement among urban stakeholders compared to rural stakeholders. Light industry tended to agree with this statement though stronger agreement originated from among those in small industries further upstream than down stream. It should also be noted that there is almost unanimous consensus among stakeholder groups in response to the statement "economic development is the most important priority for my community". Tourism and recreation industry stakeholders were less adamant, as were public healthcare providers, farmers, educators, nature preserve staff, and natural resource, ecology and environment ministry officials. Members of communities near the river, regional government officials, municipal government officials, economic ministry representatives, and energy ministries agreed more strongly than the average stakeholder did.

These findings were supported by the QLSA findings. Within the QLSA, stakeholders were concerned about the lack of water delivered to homes and through the community. There was frustration about the lack of power to support pumps in areas where water was pumped into communities, and there was concern over the cost for irrigation waters. Several farmer stakeholders who were interviewed as part of the QLSA said that they pay for water, but often it is not provided or the amount that they pay is too high. This seemed to vary from one

[33] The lower number of surveys from Azerbaijan and Iran may impact the low status of flooding as a priority issue.

place to the next without clear trends. In communities with lower levels of economic development this concern was more apparent. When stakeholders were asked who was responsible the broad reaction was municipal government officials. Municipal government officials, when interviewed, agreed generally, however they also said that they have no budget for improving water delivery, and that the district officials do not pay them sufficiently to support current work or improve the infrastructure. All stakeholder groups agreed strongly that they are willing to pay to support a reliable supply of drinking water in their communities, with rural stakeholders, and those whose drinking water comes from the river agreeing more strongly than average.

The transboundary implications of this are that the stakeholders are largely aware of the issue of the variation and reduction of hydrological flow, however they perceive it from a localized point of view. This is to be expected as many stakeholders to not think of their water use from a basin wide transboundary perspective. The negative reaction of stakeholders to the question regarding unfettered use of the river by each community suggests that there is concern about how other communities use the resource within the river basin system, and a strong understanding of the impacts of water use from one community to another. However, it is not clear at this point if this pertains more immediately to pollution or to irrational water use.

5.3 Deterioration of Water Quality

The deterioration of water quality was by far the highest priority problem of the stakeholders. This was either as a lack of potable drinking water, lack of sewage treatment/municipal waste management and deterioration in water quality (e.g. pollution). Each stakeholder group listed at least one of these as a highest priority issue, and many listed all three. Of those whose drinking water came from river, deterioration of water quality/pollution was listed as the highest priority concern whereas for those whose water came from piped spring water, the lack of sewage treatment/ municipal waste management was the highest priority. For those whose water came from artesian wells, the lack of potable water sources and related problems was the highest priority concern.

Those stakeholder groups who classified themselves as rural indicated that the lack of potable water drinking sources and related health problems were the highest priority by a significant margin, whereas among urban stakeholders the lack of sewage treatment and/or municipal waste management was the highest priority issue. These findings were widely supported by the QLSA. In the QNSA, two main areas of concern were identified that relate to the deterioration of water quality: the impacts on public health and the impacts on river health.

Through the QNSA, concerns about water quality deterioration and impacts on public health were articulated by stakeholder groups though 5 statements. In response to the statement “the water in communities near the river is safe to drink” all stakeholder groups disagreed strongly. There was some division amongst ministry officials from industry, economic, public health and social welfare in upstream communities. Overall this statement drew the strongest level of disagreement from stakeholders of all statements in the survey.

In a related statement “people need to boil water before they drink it” those whose drinking water comes from the river agree with this statement very strongly, especially in downstream communities. Those who have other sources of water also tend to agree that the water should

be boiled before drinking it. District water managers disagreed with this statement overall, though those in upstream communities were more prone to disagree, whereas those from downstream communities agreed more strongly. This was also the trend for public health care providers who strongly agreed in downstream communities, and only mildly disagreed in upstream communities fed by mountain streams. Foreign Affairs Ministry officials and Public Health and Social Welfare Ministry officials agreed strongly with this as well, indicating an awareness of water problems among both of these groups.

In response to the statement "people in river communities have been ill from water related causes" there was a strong trend that those living in down stream communities who are dependent on the river for drinking water responded in strong agreement, where as those who had other sources of drinking water tended to disagree. Public health care providers from down stream communities supported this statement strongly, while public health care providers from upstream communities did not. District water managers tended to disagree with this statement. Light industry also disagreed with this statement. Other groups generally were more neutral about this, though this may be a result of incomplete data from downstream communities.

Also related with the above was the statement "people sometimes have skin problems after contact with water". Those that relied on the river for drinking water, and residents and public health care providers in down stream communities had much stronger levels of agreement than those upstream. During the QLSA this concern was highlighted by a number of those interviewed, especially in communities who were down stream from industries, mining and municipal centers. The overall perception of stakeholders from downstream communities is that they are ill as result of pollution from upstream, whereas those communities further upstream and in more urban areas consider the impacts of pollution on public health as less immediate.

The deterioration in water quality is also perceived to have other impacts. Most stakeholder groups responded with agreement to the statement "I worry about what is in the river water". The agreement with this did not vary significantly across countries or from upstream and down stream communities. Those groups that agreed most strongly with this were the Foreign Affair Ministries, and Public Health and Social Welfare Ministries, and the scientific community (such as environment and natural resource ministry officials, nature park staff, scientists and hydromet officials) who are those with access to scientific information.

There was a high level of disagreement among all stakeholders to the question "use of farming chemicals is safe for rivers and the environment" but especially among those who have access to scientific information. Farmers who lived closest to the river tended to agree with this statement, while those who live further from the river disagreed. This may be because those close to the river do not see immediate impacts of their individual agro-chemical use. It should also be noted that during the QLSA, those in farming communities said that they use less agro-chemicals now than during Soviet times because of the cost of these chemicals.

Despite these concerns, in response to the statements "Eating fish from the river is healthy" and "the water taken from the river is healthy for irrigation uses" stakeholders overall were in agreement and there was little variation between upstream and down stream communities. However, as noted earlier, those that had access to scientific information tended to be more inclined to disagree with this, while those without this information tended to be in stronger

agreement. This is mainly because of the belief that while the water is not safe to drink, mainly due to organisms within the water, use of river water for irrigation benefits crops by improving nutrients, the soils and the mineral content of the produce. The same belief is also the case for fish taken from the river.

The perception amongst stakeholders overall is that river water quality has significantly deteriorated, and in the QNSA, the belief that water quality was not safe or healthy either above or below the community in which they lived was pervasive. In contrast, during the QLSA, those stakeholders interviewed generally felt that the water coming into their community was much cleaner than the water leaving the community. This was largely in part due to the household trash, raw sewage and farm wastes dumped into the rivers, or disposed of on the flood plain next to the river.

The transboundary implications of the deterioration of water quality are found mainly in the variation in responses from upstream communities and downstream communities, especially pertaining to public health issues. Though most stakeholders do not seem to draw direct links to transboundary problems, there is some awareness of this. However, the lack of accessible scientific information available to the public has resulted in a lower level of awareness of transboundary pollution than might otherwise be expected. Anecdotal evidence suggests that there may have been intentional transboundary pollution, however, neither the QLSA nor the QNSA show any indication of this, nor of a perception that this practice is taking place.

5.4 Ecosystem Degradation in the River Basin

While ecosystem degradation in the river basin is a high level concern for those with access to scientific information and a high level of understanding of environmental degradation issues, among other stakeholders, this was not a priority concern. The problem of ecosystem degradation in the river basin ranked fifth among all surveyed, and the concern of decline in bio-resources ranked lowest. The QLSA found that while stakeholders are worried about river basin conditions, they are concerned mainly with impacts on their own health and the health and economic development of their communities, rather than longer term environmental aspects.

It should be noted that many of the issues addressed in the sections above regarding river health and pollution impacts would also be applicable to their beliefs about ecosystem degradation. However, in terms of the health of the river ecosystem, despite the perceived pollution levels, non-scientific stakeholders continue to perceive that the ecosystem continues to function.

In response to the statement “there are many fish in the river” there was a notable disconnect between the scientific community who believed that the number of fish was low and disagreed with this statement, and the other stakeholders who were more varied, but tended to be neutral regarding this. Further those in rural areas were slightly more likely to agree with this. Many fishermen were observed along the river banks during the QLSA, and the fish caught were predominantly for human consumption.

The response among stakeholders that economic development is the most important priority for communities could be seen as a threat to the ecosystem. However, the survey also signaled that the participants were open to information about environmental management which could have a positive impact on the ecosystem. For example, in regards to ecosystem

health, all stakeholder groups agreed that there was a need for more information on how to keep the river healthy, and that currently most information about river conditions is found via television. Though this does not directly have an impact on improving ecosystem health, it does signify an increased interest in the problems and a possible medium for making ecosystem awareness more pervasive and possibly meaningful to stakeholders.

5.5 Flooding and Bank Erosion

The QLSA found that flooding is seen as a challenge that harms local communities and threatens economic development. The overall concern was much lower than anticipated given the amount of flood damage caused over the past several years within the region. As noted above, this may be in part due to the lower number of surveys from downstream countries.

Problems with flooding for stakeholders include loss of life and property, loss of infrastructure and loss of economic opportunities. The stakeholder groups who listed this as a high priority concern included the environment and natural resource ministries, as well as forestry officials and those in the agricultural industry. Rural stakeholders ranked this slightly higher as a concern than urban residents. Furthermore, stakeholders who depend on the river for drinking water ranked this as their highest priority concern. This is to be expected as flooding events for these communities can contaminate drinking water supplies, and considerably impact living conditions. Members of this category also tend to live downstream or in rural conditions that are more strongly impacted by flooding events.

Beyond the immediate threats of flooding there are a number of long term impacts. For example, the presence of large pools of stagnant water following flooding events is a concern for stakeholders because of the prevalence of malaria in low lying regions. During the QLSA this was noted as a significant concern by rural communities living near the river or on the flood plains in all countries. In the QNSA, this issue was addressed with the statement “people in my community have had malaria”. Those who are dependent on river water for drinking water rated this much higher than those who have other sources of drinking water. Rural stakeholders ranked this somewhat higher than urban, but the lack of data from Iran and Azerbaijan may be weighting this. Also those stakeholders surveyed in Armenia tended to disagree with this statement strongly, while those in Azerbaijan strongly agreed with it. This is most likely because geographic variation and climate differences in the basin countries have an affect the presence of malaria.

6. GOVERNANCE ANALYSIS[34]

6.1 Introduction

This chapter provides analysis of governance in the Republics of Armenia, Azerbaijan, Georgia and Iran. Though some progress has been made in water sector governance in the Kura-Aras basin countries, there are still significant deficiencies in terms of legal frameworks, institutional frameworks and law enforcement, including the collection of fees/tariffs, and the implementation of transboundary agreements.

It should be noted that several national and regional projects related to the environment, and water in particular, have been implemented in the Kura-Aras basin countries, most of which have carried out an assessment of the legal and institutional frameworks to some extent. However, the focus of most projects has been at the national level, and even in those that have undertaken a regional analysis there is a heavy emphasis on the country-level approach.

This chapter compiles existing information pertaining to governance and assesses it from a regional perspective. An effort was made to emphasize the legal and institutional framework particularly related to the four identified transboundary problems: reduction or alteration of hydrological flow, deterioration of water quality, flooding, and ecosystem degradation, including bank erosion. In addition, transboundary cooperation efforts are a key aspect of this governance analysis.

6.2 Legal and Institutional Assessment

In the Kura-Aras basin countries virtually all of the water resources are considered to be part of the national wealth, with state agencies charged with their safe-keeping and management of their exploitation. National legislation in the basin countries stipulates the basic principles of management, utilization and protection of the water resources and water systems. In particular, they specify the principles of: satisfying the essential needs of present and future generations; preserving and increasing the volumes of the water reserves; encouraging effective utilization of water resources for the public benefit; establishing a coordinated and integrated management system of surface and ground water resources; reducing and preventing the pollution of water resources; and reimbursing the expenditure for the cleanup of polluted waters, amongst others.

After the collapse of former Soviet Union environmental legislation has undergone significant changes in Armenia, Azerbaijan, and Georgia. Currently in these countries the legal framework is relatively new, innovative and dynamic, and endeavors to be quite comprehensive, However, these laws are certain to be confronted with a number challenges as implementation moves forward. A major concern is the coherence and consistency among the many legal documents. This has led to some confusion with regard to the institutional arrangements. Table 6.1 shows the duplications, gaps and overlaps in the water resource oriented functions of the various government agencies in the Kura-Aras basin countries.

[34] Further information on Governance and the institutional setting can be found in Annex 2.

It can be seen from this table that water management in the Kura-Aras basin is fragmented and there are duplications in the various water resources management bodies at the national level within each country. Though this is not uncommon, it is a hurdle for successful transboundary river basin management.

Several donor-funded international projects[35] indicate duplication and gaps in water resources monitoring. For example in Armenia and Georgia[36], currently no organization is responsible for monitoring the quantity and quality of underground water resources. As for surface water quantity and quality, different agencies collect separate types of information, but there is very weak coordination among the agencies, and intra-country and inter-country data exchange mechanisms are virtually absent. Though compliance procedures for regulations and water use permits are in place, the institutions responsible do not have sufficient resources and capacities to enforce them appropriately.

Decentralized water resources management is a prerogative for the countries, but in reality it does not take place. Only Iran and Armenia have established basin management organizations which at this point, do not have enough capacity to undertake appropriate management of water resources at the basin level.

There are also gaps related to responsibilities for setting standards of water quality including: pollution discharges; development of procedures for compliance and enforcement of regulations and water use permit conditions; and the development and implementation of financially sustainable cost recovery incentive mechanisms.

A very important issue is that of funding. Inadequate funding is a significant impairment to progress in the irrigation and municipal sectors. There is also a lack of funding for water resource management and monitoring.

It should be noted that Armenia, Azerbaijan, and Georgia are currently working towards the harmonization of their institutional setting and legislation with the legislation of the European Union (EU), including the field of environmental protection, and in particular water resource management. Hence, the institutional structures of water resources management bodies are being organized to ensure the implementation of water protection policy in accordance with the requirements of the EU Water Framework Directive (N2000/60/EC, 2000). The introduction of basin management principles is a requirement of the Directive. Hence the directive is not only concerned with water quality but also with the equitable sharing of water at the basin level.

[35] USAID Project Water Management in the South Caucasus (2001-2004), EU TACIS Joint River Management – Kura River (2001-2004), USAID Program for Institutional and Regulatory Strengthening of Water Management in Armenia (2004-2007).

[36] Recently this task was assigned to the Centre for Monitoring and Forecasting of Ministry of Environmental Protection and Natural Resources of Georgia

Table 6.1: Duplications, gaps and overlaps in the water resource oriented functions of the various government agencies in the Kura-Aras basin countries

Functions/Tasks	Armenia	Azerbaijan	Georgia	Iran
Formulation of laws and regulations	MNP, sectoral ministries	MENR, sectoral ministries	MEPNR, sectoral ministries	DOE, MOE, Sectoral Ministries
Water resources management and policies	MNP	MENR	MEPNR	MOE,
Monitoring of surface water quantity and quality	ASH, WRMA, EIMC	HMEM	MEPNR	NMO, MOE
Monitoring of groundwater quantity and quality	None	NGES	None	NMO, MOE
Water resources classification	WRMA	MENR		MOE
Water quality standards	None	MH	MH, MEPNR	DOE, MOE
Standards for pollution discharges for classified water resources	None	MENR	MENPR	DOE
Monitoring of water use and pollution discharge	WRMA, BMO, SEI	MENR, AAWE	MEPNR	DOE, MOE
Monitoring of drinking water sources and quality, and recreational water quality	SHAEI	MH, MENR	MLHSS	DOE
Monitoring of meteorological conditions	ASH	HMEM	MEPNR	NMO
Maintenance of water resources databases	ASH, EIMC, WRMA, RGF, SEI, SHAEI	LMIMCS, LNGES, CMPNE, MH	MEPNR, MLHSS	MOE
Development of National Water Program	WRMA, SCWS	MENR	MENPR, ongoing	DOE
Development of Basin Management Plans	WRMA	None	None	MOE
Issuance of water use permits	WRMA	AAWE	MEPNR	MOE
Development of rules and procedures for compliance assurance	MNP	DEEP	MEPNR	IRI Parliament
Implementation of compliance assurance procedures for regulations and permit conditions	SEI, WRMA, BMO	DEEP	MEPNR, MLHSS	MOE
Supervision of payment of water withdrawal and water discharge fees	None	AAWE, MENR	TI	MOE
Application of penalties and fines	SEI	DEEP, MENR	MEPNR	DOE
Protection of drinking water sources	SHAEI	MH	MLHSS	DOE, MOE
Development of a policy and mechanisms for financing water management	MFE	MF, MENR	MED, MF	MOE
Formulation of agricultural policy and sector plan	MA	AAWE	MoA	MOAJ
Management of irrigation and drainage systems	SCWS	AAWE	MoA	MOAJ
Water system use license and tariffs	PSRC	AAWE, MFE	MEPNR, CRS	MOAJ, MOE
Formulation of municipal water supply policy	Local Self-Gov., MTA	AAWE, AZERSU	MED	MOE
Management of municipal water systems	SCWS and municipalities (for different systems)	Azersu, LEB	LM	MOE
Operation of municipal water systems	YWSC, AWSC, communities, private companies	Azersu, LEB	LM	MOE
Regulation (issuance of water system use permit and approval of tariffs)	PSRC	MED	MED, CRC	MOAJ, MOE
Training and capacity building	None	None	None	DOE, MOE, MOAJ

Note: The following abbreviations have been used for the agencies:

AAWE – Agency for Amelioration and Water Economy
ASH – ArmStateHydromet
AWSC – Armenian Water Supply Company
Azersu – "Azersu" Joint-Stock Company
BMO – Basin Management Organization
CRC – Central Regulatory Commission
DOE – Department of Environment
EIMC – Environmental Impact Monitoring Center
HMEM – Department of Hydro-Meteorology and Environmental Monitoring
LEB – Local Executive Bodies
LM – Local Municipalities
LMIMCS – Laboratory of Management of Integrated Monitoring of Caspian Sea
LMPLSW – Laboratory of Monitoring of Pollution of Land Surface Waters
LNGES – Laboratory of National Geologic Exploration Service
LSG – Local Self-Government
MAF – Ministry of Agriculture and Food
MED – Ministry of Economic Development
MENR – Ministry of Ecology and Natural Resources
MEPNR – Ministry of Environment Protection and Natural Resources
MF – Ministry of Finances
MFE – Ministry of Fuel and Energy
MH – Ministry of Health
MLHSS – Ministry of Labor, Health and Social Security
MNP – Ministry of Nature Protection
MOAJ – Ministry of Agricultural Jihad
MOE – Ministry of Energy
MTA – Ministry of Territorial Administration
NMO – National Meteorological Organization
PSRC – Public Services Regulatory Commission
RGF – Republican Geological Fund
SCWS – State Committee on Water Systems
SEI – State Environmental Inspectorate
SHAEI – State Hygiene and Anti-Epidemiological Inspection
TI – Tax Inspectorate
WRMA – Water Resources Management Agency
WUA – Water User Association
YWSC – Yerevan Water Supply Company

The Ministries of Environment (Nature Protection, Ecology) and Energy in each country are the key organizations that will ensure transition to a basin management approach. However, there is not enough capacity within these Ministries or a corresponding structure to ensure the implementation of integrated approaches in the field of water resources protection.

Environmental Ministries develop and enforce the state policy in the field of environment and rational use of natural resources in Armenia, Azerbaijan and Georgia. In Iran environmental issues are being coordinated by the Department of Environment. Environmental Ministries are responsible for formulation and implementation of state policy on conservation and sustainable use of natural resources, including atmosphere, water, soil, flora and fauna, as well as specially protected areas of nature and forests.

However, regular and sudden structural changes in the government bodies dealing with Environmental issues in Armenia, Azerbaijan and Georgia after the collapse of former Soviet Union have destabilized these institutions. The establishment of new structures, separations and allocations has also had a compounding negative impact.

Analysis of various donor funded projects[37] shows a lack of integrated environmental management. As a result, duplications of efforts frequently occur. In addition to this, there is a lack of institutional structures in the different economic sectors for planning, coordinating and supporting environmental activities.

6.3 Water Use Permits, Payments, Fees

In the Kura-Aras basin countries one of the technical tools to promote more effective allocation of water resources and collection of corresponding fees is a water use permitting system. Water use permitting can provide an equitable allocation of water among water users, while maintaining water quantity and quality standards necessary to satisfy basic human needs and environmental quality.

A number of regulations exist[38] in Armenia, Azerbaijan, Iran and Georgia that define water use permitting procedures. Under these procedures each new permit regulates the withdrawal and discharge of water from rivers, lakes and groundwater. Unless otherwise specified, a permit will not grant the right to the holder to modify the banks, bed or shore of the water resource. The permit conditions include measures to improve the efficiency of water use and water quality, as well as the monitoring and assurance mechanisms to comply with the permit requirements. The permit also defines the provisions for the payment of water withdrawal and discharge fees.

Though the Kura-Aras Basin countries employ different systems of payments associated with water use permits, these systems have common elements, including system of fees for the use of water resources and for the pollution of return waters.

Despite a comprehensive legal and regulatory framework, gaps still exist, which prevent the full and efficient implementation and enforcement of the water use permitting and associated payment system. These gaps are associated with: (i) deficiencies in permitting regulations, (ii) incomplete guidelines, (iii) insufficient cooperation amongst the agencies of the

[37] NATO, OSCE, EU TACIS.
[38] See Legal and Institutional Report (Annex 2)

Ministries of Environmental Protection/Energy in the process of the issuance of permits and the assurance of compliance with permit conditions.

The analysis of payments associated with water use permitting shows that the current water resources fees system does not provide incentives in most of the Kura-Aras basin countries for the permit holders to meter water use, conserve water, or to reduce pollution. If the abstracted quantity is less than the permitted quantity, the permit holder must still pay for the permitted quantity[39]. More importantly, water resource fees were set at a low level and have lost their real value over time, as they have not been adjusted to inflation. Furthermore, the fee structure for pollution discharges is complex and difficult to understand by the permit holder. The list of pollutants subject to pollution fees is long, and not tailored to the nature of the polluting industry and the function of the receiving water body. Moreover, most of the pollutants in the list cannot be effectively monitored by the controlling agencies, particularly in Armenia, Azerbaijan and Georgia. In Georgia the fee for pollution discharge has been abolished, and only pollution exceeding Maximum Allowable Concentrations (MAC) is now penalized. Discharge permit applicants are required to submit MAC discharge calculations for polluting substances to the Ministry of Environment. Calculations are carried out according to the rules adopted by the Ministry.

The current system of water resources fees also does not provide any incentives for the agencies charged with the implementation and enforcement of the system. In Armenia, Azerbaijan, Iran and Georgia any revenues from fees, penalties and fines are deposited into the State budget. For example in Armenia, less than 5% of the anticipated revenues are actually collected[40]. In general, water for domestic use is not covered by these payment schemes resulting in unreliable domestic water supplies, and poor potable water quality.

This analysis, supported by various donors[41], also shows that the structure of penalties and fines, in the case of non-compliance with permit conditions, is difficult to implement. As a result, few fines and penalties are being applied or paid, and virtually no legal action has been taken against those who have not pay their fines. Thus, there is little knowledge as to which organizations or persons are in compliance with permit conditions.

Tariff levels and collection rates are still below what is needed to cover full operation and maintenance (O&M) for water supply and wastewater treatment. A challenge remains to reduce water losses, which amount to 50-80%[42] in Armenia, Azerbaijan, and Georgia[43]. Another challenge is to improve rural water supply and sanitation, which has been given insufficient attention. Capital expenditures will continue to be unaffordable from utility revenue alone.

Long-term financing from subsidies and donors will remain necessary until the average income of the Kura-Aras Basin countries are a multiple of current levels, since much of the population will not be able to pay for waster supply and wastewater services if tariffs are increased to a level to cover O&M costs

[39] In Georgia water users pay permit fee and then resource fee according to extracted quantity of water.
[40] USAID Program for Institutional and Regulatory Strengthening of Water Management in Armenia.
[41] UNDP/SIDA, USAID, EU TACIS.
[42] UNDP/SIDA
[43] No corresponding figures are available for Iran.

6.4 Transboundary Cooperation

The Kura-Aras basin countries recognize the importance of transboundary cooperation and are trying to address priority transboundary issues with neighboring countries. A number of bilateral treaties bind Armenia, Azerbaijan, Georgia and Iran with respect to the development and use of international waters.

Though most of the treaties were adopted by the former Soviet Union, Armenia, Azerbaijan and Georgia consider themselves to be successor states of the Union and are thus bound by them.

An agreement exists between Armenia and Iran on the joint utilization of the frontier parts of the Aras River for irrigation, power generation and domestic use. This agreement from 1957 provides the legal foundation for the current preparatory work for the joint development of two hydropower plants on the Aras River. An agreement also exists between Iran and Azerbaijan, which distributes the use of the transboundary River Aras in equal proportions.

Before the break-up of the Soviet Union, water issues within the Soviet Union were dealt with centrally through decisions adopted amongst ministers of the Soviet states. Accordingly, decisions and agreements were made between Armenia and Georgia on the use of the Debed River and between Armenia and Azerbaijan on the use of the Arpa, Vorotan, Aghstev and Tavoush rivers. These decisions and agreements have generally been accepted by the former Soviet States and honored in practice.

One of the basic requirements for the implementation of international treaties is that proper monitoring and information exchange programs on water flows and water quality are in place. This basic requirement has not yet been met, despite various donor supported transboundary projects (UNDP/SIDA, USAID, EU TACIS, NATO, OSCE), which have supported workshops and legal, policy and planning activities. As a result, empirical quantitative information on water quantity and water quality issues between the countries is scarce.

The institutional deficiencies presented in Table 6.1 also refer to the implementation of transboundary agreements. There are no notable transboundary commissions in the countries, and even where they nominally exist they do not have support staff, technical equipment and appropriate capacity. For example, by the Decree of the Prime Minister of Armenia a transboundary commission on water resources was established in 2003, chaired by the Head of the Water Resources Management Agency of the Ministry of Nature Protection. However, from a technical standpoint, the Commission does not have office space, appropriate technical support staff and technical equipment to function more effectively.

Armenia, Azerbaijan, Georgia and Iran are also bound by international environmental agreements and conventions. Table 6.2 below shows that there are several conventions that all four countries have signed and ratified, which can be considered a good basis for transboundary cooperation.

Table 6.2: International Environmental Agreements, which the Kura-Aras Basin Countries are Party to (R – Ratified; S – Signed; NS – Not Signed)

Name of Convention	Date	Status in Armenia	Status in Azerbaijan	Status in Georgia	Status in Iran
Roma Convention on Plant Protection	1951	NS	R	NS	NS
Ramsar Convention on Wetlands of International Importance	1971	S	R	R	R
Convention on the International Fund Establishment for Compensation of Oil Pollution Damage	1971	NS	NS	R	NS
Paris Convention for the Protection of World Cultural and Natural Heritage	1972	R	R	NS	R
International Convention for the Prevention of Pollution from Ships	1972	NS	R	R	NS
Convention on International Trade in Endangered Species of Wild Fauna and Flora	1973	NS	R	R	R
Geneva Convention on Prohibition of Military or Any Use of Environmental Modification Techniques	1977	R	NS	NS	NS
Geneva Convention on Long-range Transboundary Air Pollution	1979	R	R	R	NS
Bonn Convention on the Protection of Migratory Species of Wild Animals	1979	NS	R	R	R
Bern Convention on the Conservation of European Fauna	1979	NS	R	NS	NS
Vienna Convention for the Protection of Ozone Layer	1985	R	R	R	R
Montreal Protocol on Substances Depleting the Ozone Layer	1987	R	R	R	R
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	1989	R	R	R	R
Espoo Convention on Environmental Impact Assessment in Transboundary Context	1991	R	R	NS	NS
Rio Convention on Biological Diversity	1992	R	R	R	R
Framework Convention on Climate Change	1992	R	R	R	R
Convention on the Transboundary Effects of Industrial Accidents	1992	R	NS	NS	NS
Protocol on Water and Health of Helsinki Convention on Protection and Use of Transboundary Watercourses and International Lakes	1992	S	R	S	NS
Helsinki Convention on Protection and Use of Transboundary Watercourses and International Lakes	1992	NS	R	NS	NS
London Convention on Civil Liability for Oil Pollution Damage	1992	NS	NS	R	NS
Bucharest Convention on the Pollution of Black Sea and Other Issue	1992	NS	NS	R	NS
Convention on the Protection of Black Sea Against Pollution	1993	NS	NS	R	NS
Paris Convention on Combating Desertification	1994	R	R	R	R
Kyoto Protocol of UN Framework Convention on Climate Change	1997	NS	R	R	R
Aarhus Convention on Access to Public Information, Public Participation in Decision-making and Access to Justice in Environmental Matters	1998	R	R	R	NS
Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemical and Pesticides in International Trade	1998	S	R	NS	R
Stockholm Convention on Persistent Organic Pollutants	2001	S	NS	R	R

Note: S – Singed; R – Ratified; NS – Not Signed.

6.5 Conclusion

In general, progress towards the development of water resources management in the Kura-Aras basin countries has progressed slowly. In particular there are deficiencies in water resources monitoring, national water planning and coordination, integrated river basin

planning and management, water use permits, compliance assurance, and enforcement of permit conditions and regulations. The fulfillment of these activities has suffered from two principal root causes:

Lack of adequate budgets - Overall, water resources management authorities have been seriously under-funded during the last 10 to 15 years, particularly in Azerbaijan, Georgia and Armenia. The funding of these authorities will have to increase substantially to enable the responsible organizations to fulfill the responsibilities assigned to them according to legislation.

Institutional and legal deficiencies - Insufficient cooperation and lack of data exchange among the countries is a major issue that is contributing to performance shortfalls in water resources management. Cooperation of the agencies under the Ministries of Environment/Energy can and must be improved. International experience shows that regardless of the administrative structure of the water sector, water can be effectively managed as long as the government provides the support for cooperation and coordination among participants in the water sector. A second concern is fragmentation, overlapping jurisdictions and gaps in authorities among the various water sector organizations. Even with the current low budgets, there are opportunities for the Ministries of Environment/Energy to strengthen overall water resources management by streamlining their agencies and improving cooperation.

This chapter has reviewed existing information from a regional perspective pertaining to governance. The emphasis on the legal and institutional framework particularly related to the four identified transboundary problems has demonstrated that though initial steps have been taken thus far, significant strides remain to achieve effective, efficient national transboundary water management that will meet the demands of users and the ecosystem in a sustainable manner. In addition, transboundary cooperation efforts are a critical component of meaningful river basin governance strategies.

7. SUMMARY AND CONCLUSIONS

The Kura Aras River Basin TDA has been the result of the collaborative effort of leading specialists from Armenia, Azerbaijan, Georgia and Iran, assisted by many international experts. It represents the first-ever attempt to produce an in-depth and comprehensive analysis of the Kura-Aras River Basin.

Information gathered by the TDA TTT and thematic reports produced within the framework of the Project are unique, both in terms of their wealth and depth of analysis. This material has covered a broad range of economic, environmental, institutional and other activities, as well as their environmental consequences.

The TDA for the Kura-Aras River Basin identified four priority transboundary environmental problems, namely: variation and reduction of hydrological flow; deterioration of water quality; ecosystem degradation; and flooding and bank erosion. Underlying regional causes of these transboundary problems include poor law enforcement and compliance, inadequate development planning, undeveloped civil society and public awareness and inadequate pricing policies.

Summaries and conclusions for each transboundary problem and the key governance issues that underpin the problems are described below.

7.1 Variation in Hydrological Flow

- Variation in hydrological flow has been caused by numerous human interventions including direct water abstraction from surface and groundwater bodies, increased evaporation due to impoundments, urbanization and deforestation. This has significant transboundary consequences and it has been calculated that 40 % of the natural runoff of the Kura and 27 % of the Aras runoff is lost to the Caspian Sea.

- Severe water deficit has not occurred in the basin to date and consequently shortages of water have not presented any serious threats to the population. However, population growth and rapid economic development in the basin countries will impose increased pressure on surface and groundwater resources.

- Climate change could also have a catastrophic impact in the medium and long term with potential scenarios indicating flow reductions of 50% as a consequence of increased average temperature and decreased precipitation.

- Variation and reduction of flow has already impacted fish species such as sturgeon in the Kura-Aras river basin and affected terrestrial ecosystems such as tugai forests. The construction of new reservoirs is likely to further alter flows.

- Non-rational use of water is a widely spread practice throughout the basin. Agriculture (and in particular irrigation activities) is the major consumer of water in the basin.

- Water loss (through wastage, leakages and failures), particularly from domestic and municipal water use, is an acute problem for the South Caucasus countries

- Deforestation also contributes to the variation and reduction of hydrological flow.

- Currently, the underlying causes can mainly be attributed to low capital investments in operation and maintenance (due to alack of finance and historical economic difficulties), a lack of investment in developing new irrigation schemes and water supply systems, a lack of a knowledge base of the hydrology and usage of the basin upon which to construct an integrated water resource management and river basin management policy and regulatory framework. This is compounded by the low awareness of the population which currently has little regard for water efficiency and is often careless with its use.

- Furthermore the lack of an integrated approach in water resources management is a major problem in all the basin countries where ground and surface water are dealt with separately, and land and forest management often fails to take into account management issues relating to water resources. This creates many of the problems outlined above.

- Anthropogenic activities are the main drivers of this transboundary problem. Climatic variations and signs of climate change contribute to the reduction of flow but for the present are less significant.

- If present trends of water use are maintained, the impacts on the flow regime will continue to increase. In order to ensure the equitable use of water, coordinated actions between the basin countries are needed in order to avoid negative consequences in downstream countries occurring due to increased water consumption upstream.

7.2 Deterioration of Water Quality

- Deterioration of water quality in the Kura-Aras river basin has significant transboundary consequences in the down stream countries. This can be confirmed by the presence of chemical compounds of anthropogenic origin in the transboundary sections of the basin as well as in bottom sediments of the Kura Delta in the Caspian Sea.

- Water pollution in the Kura basin comes from a number of land based sources including industrial and mining sites, agricultural lands, households in rural areas and municipalities. Wastewater treatment facilities are absent in many municipalities and enterprises, and are available only in some locations in the Aras basin in Iran. Most of the wastewater treatment facilities were built 20-30 years ago and are currently non-operational.

- The application of fertilizers and pesticides has been significantly reduced in the basin over the last two decades. Furthermore, the usage of persistent chlorine-organic pesticides, such as DDT, hexachlorcyclohexane (HCH) and aldrine, etc has been prohibited in the region. However, recent studies indicate that there is strong

evidence that the illegal application of banned chlorinated pesticides in the region is occurring.

- The unregulated use of fertilizers results in diffuse pollution of both surface and ground water resources. Nutrient loading also comes from direct point source discharges of animal slurry from cattle and pig farms. These incidents have greatest impact in early spring during the snow melt, when waters wash out nitrates and phosphates from previous autumn applications.

- There is little information that can directly attribute water quality to specific environmental impacts in the Kura-Aras river basin. However, it is likely to be a contributing factor and certainly increases the pressure on already stressed ecosystems.

- Industrial development and the construction of industrial wastewater treatment facilities are not coordinated. The only exception is enterprises which have local wastewater treatment facilities. However, it should be noted that most of them are currently not operating. Of particular danger are wastewaters from the mining industry and tailing lagoons and dumps.

7.3 Ecosystem Degradation

- 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, due to a large extent by habitat fragmentation and degradation. There has been a remarkable decline in several bird species, small mammals and several plant species.

- Forest degradation in the Kura-Aras basin has intensified during the last two decades. Boundaries of the mountain forests remained more or less stable until the beginning of the 1990s, but since then, the situation has changed as a result of extensive logging, both illegal and authorized by government institutions.

- Desertification and land degradation is a critical problem in the Kura-Aras basin. The main forms of degradation are salinization (especially in desert and semi-desert areas) and soil erosion (washing out of fertile soil). The most important reason for land degradation appears to be deforestation and overgrazing.

- Increased demand on timber for commercial purposes is one of the major drivers of ecosystem degradation. This includes timber logging for use in the construction business nationally and for export, and has consequently resulted in a reduction in deciduous forest areas.

- The energy crisis that has taken place during the last decade in the South Caucasus countries has also put great pressure on forests in the basin. The acute energy deficit in these countries, accompanied with poverty problems has resulted in excessive logging as the population has been forced to use wood for heating and cooking.

- The causes are related to weak legislation and regulations, institutional complexities, poor law enforcement and low public awareness on the importance of biodiversity and ecosystem act together with financial constraints to create unfavorable conditions for protecting ecosystem integrity and biodiversity. The absence of integrated water resources management also contributes to this process.

7.4 Flooding and Bank Erosion

- Flooding and bank erosion in the Kura-Aras river basin has significant transboundary consequences. Anthropogenic interventions in the natural flow regime including river training and changes in land cover (intensive deforestation) combined with the degradation of natural floodplains as a consequence of urban development and agriculture, increases the risk of floods and mudflows in downstream countries.

- Deterioration in the flood protection infrastructure throughout the basin has worsened the situation. It is likely that climate change will further increase the risk.

- Flooding and mudflow events in the Kura-Aras basin have adverse economic and social implications for the basin countries. Despite extensive investments in flood control schemes in the past, significant damage and occasional loss of human life still occurs.

- High floods have been reduced by the construction of a number of dams and reservoirs on the Kura and Aras rivers. However, Lack of flood protection reservoirs is listed as one of the main underlying causes of floods in the basin.

- There are insufficient financial resources for the construction and maintenance of flood control and defense schemes. This is compounded by the lack of a proper monitoring and flow forecasting system that would allow effective early warning.

- The lack of integrated flood management is another other issue that needs to be addressed in the basin and approaches restricted to flood control using only hard engineering solutions have to be revised, especially when the financial and environmental costs of such solutions are considered.

7.5 Governance

- After the collapse of former Soviet Union environmental legislation has undergone significant changes in Armenia, Azerbaijan, and Georgia. Although the legal frameworks are relatively new, innovative and dynamic, a major concern is the coherence and consistency among the many legal documents. This has led to some confusion with regard to the institutional arrangements.

- Consequently, water management in the Kura-Aras basin is fragmented and there are duplications in the various water resources management bodies at the national level within each country.

- This is compounded by regular and sudden structural changes in the Environmental Ministries in Armenia, Azerbaijan and Georgia after the collapse of former Soviet Union which has destabilized these institutions.

- Analysis of various donor funded projects shows a lack of integrated environmental management. As a result, duplications of efforts frequently occur. In addition to this, there is a lack of institutional structures in the different economic sectors for planning, coordinating and supporting environmental activities.

- In the Kura-Aras basin countries one of the technical tools to promote more effective allocation of water resources and collection of corresponding fees are water use permitting systems. A number of regulations exist in Armenia, Azerbaijan, Iran and Georgia that define water use permitting procedures. Despite a comprehensive legal and regulatory framework, gaps still exist, which prevent the full and efficient implementation and enforcement of the water use permitting and associated payment system.

- The analysis of payments associated with water use permitting shows that the current water resources fees system does not provide incentives in most of the Kura-Aras basin countries for the permit holders to meter water use, conserve water, or to reduce pollution.

- The current system of water resources fees also does not provide any incentives for the agencies charged with the implementation and enforcement of the system.

- The Kura-Aras basin countries recognize the importance of transboundary cooperation and are trying to address priority transboundary issues with neighboring countries.

REFERENCES

Variation and Reduction of Hydrological flow

UNDP/GEF.2006. Initial TDA for Kura-Aras basin. Republic of Armenia.

UNDP/GEF.2006. Initial TDA for Kura-Aras basin. Georgia.

UNDP/GEF.2006. Initial TDA Report for Kura-Aras basin. Azerbaijan.

UNDP/GEF.2006. Initial TDA Report for Kura-Aras basin. Iran

UNDP/Sida, 2005. Preliminary Technical Analysis of the Kura-Aras River basin (Armenia, Azerbaijan, Georgia)

TACIS: 2004. Joint River Management Programme, Final Report

Financing Strategy for Water and Wastewater Sector in Georgia. 2005. OECD.

Lee J.D and Dinar, A. 1995. Review of Integrated Approaches to River Basin Planning, Development and Management. The World Bank. Policy Research Working Paper 1446.

WWF Norway and WWF Caucasus. 2005. Halting the extinction of the threatened tugai forest in the transboundary area of the Iori river in Caucasus

Report on Desertification/Land Degradation, Georgia, 2003, EUNDP/GEF. Georgia's Capacity Needs Self Assessment for Global Environmental Management

Ministry of Energy of Georgia, Small Hydropower Stations, http://www.minenergy.gov.ge (Accessed, July, 2006)

In Country Reviews, Iran. 2005, PDF-A,UNDP/GEF project report, Reducing Transboundary Degradation of the Kura-Aras river basin.

Deterioration of Water quality

ARKA News Agency, June 2006

Caspian Environmental Programme, Kura Survey 2005

de Mora, S., Sheikholeslami, M. R., Wyse, E., Azemard, S. & Cassi, R. (2004b). An assessment of metal contamination in coastal sediments of the Caspian Sea. Marine Pollution Bulletin 48: 61-77.

EU-TACIS Joint River Management Programme – Kura Basin Final Report, February 2004

IAEA 2005, Radiological Survey of the Aras and Kura Rivers Azerbaijan, IAEA Technical Cooperation Project AZB/9/004

LAR Consulting Engineers 1999. Assessment of Water and Sediment Budget in Aras Watershed) Water Research Center, Ministry of Energy

Long, E. R., MacDonald, D. D., Smith, S. L. & Calder, F. D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19: 18–97.

Narimanidze, E., Wichmann, L., Felix-Henningsen, P., Steffens, D., Schubert, S., Urushadze, T., Mishveladze, B., Kalandadze, B. 2005. Bergbaubedingte Schwermetallbelastungen von Böden und Nutzpflanzen in einem Bewässerungsgebiet südlich von Tiflis/Georgien - Ausmaß und ökologische Bedeutung. Zentrum für internationale Entwicklungs- und Umweltforschung der Justus-Liebig-Universität Gießen. Discussion Paper. N 21 Giessen, August 2005.

UNDP/Sida, 2005. Preliminary Technical Analysis of the Kura-Aras River basin (Armenia, Azerbaijan, Georgia)

USAID/DAI, Water Management in South Caucasus – Report Background Studies on Mingechevir Reservoir, 2004

UNDP/GEF project Preparation of the National Implementation Plan on Persistent Organic Pollutants, Final Report, 2005

UNDP/GEF, POPs in Azerbaijan, Review of existing situation; International POPs Elimination Project, 2004

Ecosystem Degradation

UNDP/Sida, 2005. Preliminary Technical Analysis of the Kura-Aras River basin (Armenia, Azerbaijan, Georgia)

Tarkhnishvili, D. N., Kandaurov, A. S. & Bukhnikashvili, A. K., 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. Regional Studies on Biodiversity and Ecosystems of the Kura-Aras River Basin

Conservation of arid and semiarid ecosystems in Transcaucasia. 2002. Press Release NACRES

NACRES, Press Release, 2006 March.

NAPCD. 2006. Third National Report on Progress of Implementation of National Action Plan on Combating Desertification.

Flooding and Bank Erosion

UNDP/GEF report.2006. Initial TDA for Kura-Aras basin. Republic of Armenia.

UNDP/GEF report.2006. Initial TDA for Kura-Aras basin. Georgia.

UNDP/GEF report.2006. Initial TDA Report for Kura-Aras basin. Azerbaijan.

UNDP/GEF report.2006. Initial TDA Report for Kura-Aras basin. Iran

UNDP/SIDA report. 2005. Preliminary Technical Analysis of the Kura-Aras River basin: Armenia, Georgia, Azerbaijan.

UNDP/SIDA report, 2005. Root Cause Analysis, Georgia.

UNDP/GEF report.2006. Regional Studies on Biodiversity.

UNDP/GEF report. 2006. Regional Studies on Flooding.

UNDP/GEF 2006. National TDA, Armenia, Azerbaijan, Georgia, Iran.

TACIS: 2004. Joint River Management Programme, Final Report

Под ред. Г.Сванидзе и В.Щ.Цомая. 1988 Водные ресурсы Закавказья.: Гидрометеоиздат. 264с

Мамедов М.А. 1989. Расчёты максимальных расходов воды горных рек(на примере рек Кавказа). Л.: Гидрометеоиздат. 184 с.

под ред. Г.Г.Сванидзе и Я.А.Цуцкиридзе. 1983. Опасные гидрометеорологические явления на Кавказе. Л.: Гидрометеоиздат. 263 с.

Appendix 1: Recommendations of the Kura-Aras Stakeholder Advisory Group

The Kura Aras Stakeholder Advisory Group (SHAG) convened in Gudauri Georgia in November 2006 to review the Transboundary Diagnostic Analysis (TDA) and provide comments on the project development and objectives. A group of 12 SHAG team members were carefully selected to facilitate broad representation of a wide array of stakeholders who had not been directly involved in the development of the project to date. These include: NGO representatives, a public health care provider, a community organizer, a municipal water manager, an agricultural input association representative, a farming technology expert, a rural sociologist, and an environmental journalist. Most lived in communities close to the Kura and Aras rivers. The members of the group were selected based on a broad spectrum of specialization, their understanding of transboundary water issues, and various interests while maintaining an equal balance of regional nationalities.

The recommendations of the SHAG Team included:
Irrational Use of Water:

- Introduce new methods for irrigation, such as drip irrigation instead of traditional canals and large scale flooding of fields
- Support construction of small scale community reservoirs to minimize impacts of seasonal variation in flows
- Create soaking wells and earthen berms around fruit trees, emphasize mulching
- Implement user fees for water based on flow rates to households and apartment flats
- Create farmers associations to work in different communities as a source of equipment and information technology regarding pesticides, new types of fertilizers and components of water usage
- Seek assistance in the agricultural sector from bilateral and international donors in coordination with the UNDP/GEF project to make improvements to water flow challenges. These should include alternate irrigation methods, water monitoring approaches, and public awareness building.

Flooding and bank erosion:

- Encourage and work with governments to limit domestic, agricultural or industrial construction in the flood zones to prevent loss of life and property
- Develop and implement a public awareness plan to address herdsmen grazing livestock in areas flood prone areas, where deforestation and soil erosion is especially problematic
- Endorse tree planting to reduce flooding impacts
- Design a flood prevention and emergency response manual for communities with alternative practices in local languages to distribute throughout the region

Water Quality Degradation:

- Teach farmers to proper agro chemical use, and application rates and timing
- Teach farmers impacts on water may reduce some of the problems

Ecosystem Degradation

- Include project focus on wetlands and link with other international efforts such as Ramsar
- Implement fish ladders in any new hydro electric dam construction
- Develop a concerted public awareness campaign on the importance of biodiversity would help increase attention to this issue
- Host a coordinated region-wide Kura-Aras River Day, with different communities/ groups going out to clean the local river banks

Appendix 2: Glossary of terms used in the TDA

Accidental spills: A transboundary issue in the Kura-Aras River Basin. Accidental spills refer to the adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities.

Causal chain analysis: Examines the sequence of events that cause environmental and socio economic impacts. The first step of the analysis examines the immediate causes of the issue. The next step studies the sectoral pressures that underlie the immediate causes including a detailed analysis of current governance structures that affect the sectoral or immediate causes (e.g. regulations, public participation, institutions).

Deterioration of water quality: A transboundary issue in the Kura-Aras River Basin. Deterioration of water quality refers to the contamination of water bodies as a result of human activities. Contaminants are here defined as compounds that are toxic and/or persistent and/or bioaccumulating.

Ecological system (ecosystem): A community of living organisms and the environment in which they live, interacting to form a whole functional system.

Ecosystem degradation: A transboundary issue in the Kura-Aras River Basin. Ecosystem degradation refers to anthropogenic interventions in ecosystem resulting in deforestation, land degradation and losses in species.

Environmental impact: The adverse effect of a transboundary issue on the integrity of an ecosystem. For example, loss of natural productivity and biodiversity as a result of the loss of an ecosystem or ecotone.

Flooding and bank erosion: A transboundary issue in the Kura-Aras River Basin. Flooding events refers to flooding of land in periods of high flow as a result of human activities or natural processes. Bank erosion refers to erosion of river banks caused by a rise of water level in a river due to flooding.

Forest coverage: The ratio between the area occupied by forests and the total area of a territory.

Governance: A response term embracing regulations, laws, policies, projects and institutions. The absence of effective governance is not regarded as the cause of pressure on the environment but as a failure to deal with a pre-existing cause.

Governance analysis (GA): describes the dynamic relations within political and social structures that underpin such aspects as legislative and regulatory frameworks, decision-making processes and budgetary allocations.

Hot spot: A source of pollution whose impact results in exceedance of the prescribed MAC limits in water bodies located within the boundaries of one administrative unit (District), thereby creating a greater threat for biodiversity and risk for human health, as well as areas of higher environmental danger.

Immediate causes: are the immediate technical causes of the issue. For example, in the case of eutrophication, the causes might be enhanced nutrient inputs, increased recycling/mobilisation or trapping of nutrients.

Institutional barriers to change: These are the barriers identified in the governance study. They include issues related to insufficiencies in current policy, legislation and its implementation, institutional capacity, public participation, etc.

International waters: International waters are those shared by one or more nation states. They are transboundary in nature but provide "free" goods and services to the economies of individual countries.

Landscape: A territorial system comprising natural and/or natural and anthropogenic components and groups of lower taxonomic levels that interact with each other.

Resource uses and practices: These are practices that contribute to a particular immediate cause and transboundary issue. They include such issues as land use, waste discharges, damaging or unsustainable practices, uses of water (diversion, storage etc). A typical agricultural practice contributing to eutrophication for example, would be the excessive application of fertilisers.

Root causes: Beyond the underlying social and economic causes and sectoral pressures are the root causes of environmental degradation. These underlying causes can be loosely divided into the following categories: population pressure and demographic change; poverty, wealth and inequality; public policies, markets and politics; development model and national macro-economic policies; social change and development biases.

Sectoral approach: The causal chain methodology uses a sectoral approach to examine the pressures that underlie the immediate causes. The seven sectors are agriculture, industry, urban development, transport, energy, fishing and recreation (including tourism).

Social and economic causes: The causes of resource uses and practices These include increased sectoral development, investment, operation and maintenance, waste minimisation procedures, demand and supply side management etc.

Socio-economic impact: The adverse effect of a transboundary issue on human welfare. For example, increased costs of water treatment, or illness due to pollution.

Strategic Action Programme: A negotiated policy document, endorsed at the highest level of all relevant sectors, which establishes clear priorities for action to resolve the priority transboundary issues identified in the TDA.

Stakeholder analysis: As a prerequisite for Full Project approval, a stakeholder analysis must be conducted. This goes much further than the initial stakeholder consultation. It seeks to verify the interest of groups and individuals in the project concept. The analysis must also include information on affected populations.

Technical task team (TTT): a regional body formed by the OP Focal Point to provide technical advice on the initial project formulation and subsequently to undertake the technical process of TDA formulation and proposals for long-term EcoQOs. The team should be broadly representative of stakeholders but entirely technical in nature.

Transboundary: the majority of GEF-funded IW projects are concerned with water-related environmental problems which transcend the boundaries of any one country, hence transboundary. Consequently, the environments include marine and freshwaters (including wetlands, lakes, rivers and aquifers) that are shared by different countries.

Transboundary Diagnostic Analysis: The TDA is an objective assessment and not a negotiated document. It uses the best available verified scientific information to examine the state of the environment, the root causes for its degradation. The analysis is carried out in a cross sectoral manner. It focuses on the transboundary issues without ignoring national concerns and priorities.

Transboundary issue: An environmental problem originating in one country and affecting another (e.g. Eutrophication, chemical pollution). The transboundary impact may be damage to the natural environment and/or damage to human welfare.

Underlying causes: Those causes that contribute to the immediate causes. They can broadly be termed as resource uses and practices and their related social and economic causes.

Variation and reduction of hydrological flow: A transboundary issue in the Kura-Aras River Basin. Variation and reduction of hydrological flow refers to an increase or decrease in the discharge of streams and rivers as a direct or indirect consequence of human activity.

Water monitoring: Regular observation and assessment of the state of natural waters.

Appendix 3: Abbreviations and acronyms

AAWEMA	Agency for Amelioration and Water Economy of the Ministry of Agriculture
AM	Republic of Armenia
ASH	State Hydrometeorological and Monitoring Service of Armenia
AWSC	Armenian Water Supply Company
AZ	Republic of Azerbaijan
BMO	Basin Management Organization
BOD	Biological Oxygen Demand
EU	European Union
CCA	Causal Chain Analysis
CEP	Caspian Environmental Programme
CLD	Causal Loop Diagram
CRC	Central Regulatory Commission
CTA	Chief Technical Advisor
DAI	Development Alternatives Inc.
DDD	Dichloro-Diphenyl-Dichloroethane
DDT	Dichloro-Diphenyl-Trichloroethane
DOE	Department of Environment
IA	Implementing Agency
IDP	Internally Displaced Person
IR	Islamic Republic of Iran
IW	International Water
IUCN	International Union for the Conservation of Nature and Natural Resources
EIMC	Environmental Impact Monitoring Center
FSU	Former Soviet Union
GEF	Global Environmental Facility
GEO	Republic of Georgia
GDP	Gross Domestic Product
GIWA	Global International Waters Assessment
GNI	Gross National Income
HCH	Hexachlor-Cyclo-Hexane
HMEM	Department of Hydro-Meteorology and Environmental Monitoring
LEB	Local Executive Bodies
LM	Local Municipalities
LMIMCS	Laboratory of Management of Integrated Monitoring of Caspian Sea
LMPLSW	Laboratory of Monitoring of Pollution of Land Surface Waters
LNGES	Laboratory of National Geologic Exploration Service
LSG	Local Self-Government
MAC	Maximum Allowable Concentration
MAF	Ministry of Agriculture and Food
MAD	Minimal Allowable Discharges
MED	Ministry of Economic Development
MENR	Ministry of Ecology and Natural Resources
MEPNR	Ministry of Environment Protection and Natural Resources
MF	Ministry of Finances
MFE	Ministry of Fuel and Energy
MH	Ministry of Health
MLHSS	Ministry of Labor, Health and Social Security
MNP	Ministry of Nature Protection

MOAJ	Ministry of Agricultural Jihad
MOE	Ministry of Energy
MTA	Ministry of Territorial Administration
NATO	North Atlantic Treaty Organization
NGO	Non Governmental Organization
NMO	National Meteorological Organization
NSM	Non Structural Measures
NWC	National Water Council of Armenia
O&M	Operation and Maintenance
OSCE	Organization for Security and Cooperation in Europe
PCB	Polychlorinated Biphenyl
POP	Persistent Organic Pollutant
PSRC	Public Services Regulatory Commission of Armenia
RGF	Republican Geological Fund
SHA	Stakeholder Analysis
SAP	Strategic Action Plan
SC	South Caucasus (Armenia, Azerbaijan, Georgia)
SCWS	State Committee on Water Systems
SIDA	Swedish International Development Cooperation Agency
SEI	State Environmental Inspectorate
SHAEI	State Hygiene and Anti-Epidemiological Inspection
STF	Sweage Treatment Facility
TACIS	Technical Aid to the Commonwealth of Independent States
TI	Tax Inspectorate
TTT	Technical Task Team
TDA	Transboundary Diagnostic Analysis
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
QLSA	Qualitative Stakeholder Analysis
QNSA	Quantitative Stakeholder Analysis
WRMA	Water Resources Management Agency
WUA	Water User Association
WWF	Global Conservation Organization/World Wildlife Fund for Nature
YWSC	Yerevan Water Supply Company

Appendix 4: List of participating experts

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Appendix 5: List of Annexes

Thematic reports

Annex 1: Socio-Economic Situation in the Kura-Aras River Basin

Annex 2: Legal and Institutional Framework for the Water Sector in Armenia, Azerbaijan, Iran and Georgia

Annex 3: Change of Climate and Evaluation of Environmental Vulnerability in the Kura-Aras Basin

Annex 4: Biodiversity and Ecosystems in the Kura-Aras River Basin

Annex 5: TDA Report on water quality in the Kura-Aras basin

Annex 6: Land based sources of pollution

Annex 7: Irrigation and drainage

Annex 8: TDA report on flooding in the Kura-Aras River Basin

Annex 9: CLD models of Transboundary Problems

Annex 10: Groundwaters

Annex 11: Impacts on Caspian Sea

Annex 12: Stakeholder analysis

National TDA Reports

Annex 13: National TDA Report for Armenia

Annex 14: National TDA Report for Iran

Annex 15: National study on groundwater resources in Armenia

Annex 16: National study on groundwater resources in Azerbaijan

Annex 17: National study on groundwater resources in Georgia

UNDP/SIDA Reports

Annex 18: Institutional Aspects of Water Resources Management in Armenia, Azerbaijan and Georgia

Annex 19: Water Policy of Armenia, Azerbaijan and Georgia;

Annex 20: Evaluation of Legislative Needs for Integrated River Basin Planning and Management

Annex 21: Preliminary Technical Analysis of the Kura-Aras River Basin (separate reports for Georgia, Azerbaijan and Armenia).

Annex 22: National Objectives for Integrated Management of the Kura-Aras river basin

Annex 23: Root Cause Analysis

Annex 24: Identification of Existing Data Bases, Data Collection and Management Techniques, Monitoring and Standards

Annex 25: Institutional Models for Management of Transboundary River Basin

Annex 26: Thematic GIS maps for Kura-Aras River basin (South Caucasus part of the basin)

Annex 27: Draft National Action Plan (for Georgia, Armenia, Azerbaijan)

Supplementary information

Annex 28: Public involvement and communication strategy

Annex 29: NGO forum reports

Annex 30: TDA and SAP TTT Reports