# Implementing the UN Millenium Development Goals in Central Asia and the South Caucasus:

## Goal 7: Ensure Environmental Sustainability

# Conserving Ecosystems of Inland Water Bodies in Central Asia and the South Caucasus

This report was prepared with financial and technical support from GWP CACENA, the Government of Finland, EC, and IUCN

Almaty - Tashkent, 2006

**Conserving Ecosystems of Inland Water Bodies in Central Asia and the South Caucasus (Part 1 – English)**

Editorial panel: B.K. Yessekin, M.J. Burlibaev, V.P. Bogachev, E.A. Kreuzberg, and V.V. Sadomsky, V.I. Sokolov

Authors of the National Reports:
Azerbaijan: M. Asadov and M. Adigezalova
Armenia: E. Pirumyan
Georgia: T. Cholokava, M. Makarova, and G. Dzamukashvili
Kazakhstan: K. Duskaev
Kyrgyzstan: A. Jaloobaev
Tajikistan: Ya. Pulatov.
Turkmenistan: P. Esenov and U. Saparov
Uzbekistan: N. Gorelkin, E. Kurbanbaev, and A. Kreuzberg.

Translation into English: N.I. Goroshkov

**TABLE OF CONTENTS (English Part)**

# Acronyms and Abbreviations

ADB – Asian Development Bank
AOS – Academy of Sciences
Bonn Convention - the Convention on Migratory Species of Wild Animals (CMS)
ASB – the Aral Sea Basin;
WB – the World Bank (the International Bank for Reconstruction and Development)
GDP – Gross Domestic Product
WSSD – the World Summit on Sustainable Development («Rio+10»)
IHE – Institution of Higher Education
Glavvodkhoz – the Central Water Directorate of the MAWR
SSIAM – the State Specialized Inspection for Analytical Monitoring
GEF – the Global Environmental Facility
EBRD – the European Bank for Reconstruction and Development
EC – the European Commission
UNECE – the UN Economic Commission for Europe
IDB – the Islam Development Bank
EC IFAS – the Executive Committee of the International Fund for the Aral Sea
IWRM – Integrated Water Resources Management
RFZ – a Runoff Forming Zone
IRCZ – an Intensive Runoff Consumption Zone
UN CCD – the UN Convention to Combat Desertification
UN CBD - the UN Convention on Biological Diversity
MP – Meetings of the Parties
EF – Efficiency Factor
UNCSD – the UN Commission on Sustainable Development
WBRD - the International Bank for Reconstruction and Development
IMF - International Monetary Fund
IWMI – International Water Management Institute
ICWC – Interstate Coordination Water Commission
ISDC – Interstate Sustainable Development Commission in Central Asia
CA – the Agency for Scientific and Technical Co-operation
IM EPAP – Implementation Measures for Environment Protection Action Plan
MAWR – the Ministry of Agriculture and Water Resources
IFAS - the International Fund for the Aral Sea
SRI – Scientific-Research Institute
NGOs – Nongovernmental Organizations
NBSAP –National Biodiversity Strategy and Action Plan
LA – Legal Act
NAPB – National Action Plan on Biodiversity
NAPEP - National Action Plan on Environment Protection
NAPCD – National Action Plan to Combat Desertification
SPA – Scientific and Production Association
SPC – the Scientific and Production Center
NAAR – the National Agency for Agricultural Research
НСУР – the National Strategy for Sustainable Development
OSCE – the Organization for Security and Cooperation in Europe
EIA – Environment Impact Assessment
UN– the United Nations
EP – environment protection
PA - a protected area
CACO – the Central Asian Co-operation Organization
MEA – the Millennium Ecosystems Assessment
ASBP – the Aral Sea Basin Program
GG – greenhouse gases
APEP – Action Program for Environment Protection
окружающей среды Agenda 21 – Agenda for the 21st century
PEBLDS – the Pan-European Biological and Landscape Diversity Strategy
UNDP – the United Nations Development Program
Ramsar Convention – the Convention on Wetlands of International Importance especially as Waterfowl Habitat
UNFCCC – UN Framework Convention on Climate Change
RAPEP – Regional Action Plan for Environment Protection
RoK – the Republic of Kazakhstan
RoU – the Republic of Uzbekistan
RFNP – Republican Fund for Nature Protection under SCNP
CAREC – Central Asian Regional Ecological Center
CASRHI– Central Asian Scientific-Research Hydrometeorological Institute
SANIIRI – Central Asian Scientific-Research Irrigation Institute
CITES – the UN Convention on International Trade in Endangered Species of Wild Fauna and Flora
MM – mass media
CIS – the Commonwealth of Independent States
POP – persistent organic pollutants
SAP PSL – the Strategy and Action Plan for Preserving Snow Leopard in Uzbekistan
TNR – Third National Report on CBD
TF – Trust Fund for CBD
Uzgidromet – Uzbek Hydrometeorological Center under the Cabinet of Ministers of the Republic of Uzbekistan
UZS – the Uzbek Zoological Society
CAMIN – Central Asian Mountain Information Network
CAISD – Central Asian Initiative on Sustainable Development «Sub-Regional Agenda -21»
CAMCP – Central Asian Mountain Cooperation Program
CAR – Central Asian Region
CATP PBWTS – Central Asian Transboundary Project on Protecting Biodiversity in Western Tian Shan
CAEC – Central Asian Economic Community
STC - Science and Technology Center under the Coordination Committee of Science and Technology for Development
MDGs – Millennium Development Goals;
ESCAP – the Economic and Social Commission for Asia and Pacific
UNCED – UN Conference on Environment & Development
UNEP – the United Nations Environment Program

## FOREWORD

This report considers the current challenges of preserving ecosystems in two regions, the South Caucasus (Azerbaijan, Armenia, and Georgia) and Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan), within the framework of the specific program of the Global Water Partnership.[1] The report follows up the analytical studies earlier performed by the Central Asian Regional Ecological Center (CAREC) with respect to commitments for achieving the MDGs[2] adopted by Central Asian countries. The report also expands the reviews earlier prepared by the CAREC: «The Information Support for Public Monitoring of Central Asian Initiative's Objectives» (2004), and «Problems and Prospects of Developing the Water Quality Legislative Base in Central Asia and the Caucasus» (2005).

An aim of this report is the analysis of current conditions of **inland waters' ecosystems**[3] (referred to hereinafter as aquatic ecosystems) and developing the proposals on their preservation and protection against the increasing devastation processes. The report focuses on the most important factor for preserving aquatic ecosystems – meeting their needs in freshwater resources (referred to hereinafter as water resources), or in other words, **available water supply to ecosystems.** It is presumed that other aspects of preserving aquatic ecosystems will be considered in the follow-up publications.

Actually up to now, all methods of planning water resources and nature use and protection, and developing and placement of productive forces did not consider the utmost abilities of ecosystems and their requirements. At the same time, the neglect or insufficient consideration of ecosystem-defined limitations has resulted in the crisis practically in all river basins of subregions in Central Asia and the Caucasus. To present day, society perceives the preservation of ecosystems as a minor task concerning only the agencies responsible for nature protection. There are not still the legal status of the term "preservation of ecosystems" in normative documents of countries of the Caucasus and Central Asia (CACENA), and agencies responsible for the preservation and maintaining of ecosystems within the framework of the state governance were not specified as well. The Ministries of Nature Protection are responsible for many aspects related to nature protection (from the wastes disposal control to collection of penalties for non-observance of ecological laws), but functions directly related to the preservation of ecosystems were not exactly specified. Therefore, the agencies responsible for nature protection do not still solve the matters related to specifying the utmost abilities of ecosystems and their water requirements. The report reveals that one of the basic causes of degrading aquatic ecosystems in the subregions is inefficient management and lack of public awareness concerning the major functions being implemented by ecosystems with respect to the preservation of the global environmental sustainability and supporting welfare of nations.

The introductory part of this report contains information on the general problems of preserving ecosystems of inland waters and adumbrates governing concepts, methods, and principles

[1] The Global Water Paertnership (GWP), established in 1996, is an international network open to all organizations involved in water resources management. The GWP was established for supporting, introducing, and developing the concept of integrated water resources management (IWRM) by means of establishing the public forum both at the global, regional, and national levels. The GWP CACENA Secretariat promotes introduction of IWRM into the regional and national programs with involving all stakeholders.

[2] The Central Asian Initiative. UNECE Document «Invintaion to Partnership» http://www.unece.org/env/proceedings/html/Item7b.e.html

[3] with the exception of marine ecosystems of the Caspian Sea and Black Sea

employed in this field, as well as it includes the analysis of the status of water resources and ecosystems and management issues related to commitments of countries with respect to achieving the MDGs[4]. The second part prepared by national experts contains information on the status and problems of aquatic ecosystems in countries, available mechanisms for protecting ecosystems, basic conclusions and recommendations for each country. The third part contains the general conclusions and recommendations.

The progress in moving towards sustainable development, first of all, depends on abilities of ecosystems to support environmental parameters vital important for human being (favorable climate, optimal composition of atmospheric air, safe water, and foodstuffs) and the resource environment that is the basis for economic and social development. Aquatic ecosystems (AE) play an important role in maintaining welfare of nations and in preserving biological diversity in subregions of Central Asia and the Caucasus, providing along with groundwater the integrity of river basins and supporting their normal functioning under conditions of arid climate. However, the resources-consuming approach that prevails in economic activity and insufficient considering of ecosystems' value causes the destruction of regulatory, supplying, and supporting functions of AE. On-going degradation of the Aral, Black, and Caspian seas, reducing biodiversity and biological resources, and adverse changes in transboundary river flows are universally known. "These processes result in deteriorating drinking water quality and health of the population, in decreasing land productivity and crop yields, and in the growth of poverty, unemployment, and migration"[5]. The vulnerability of aquatic ecosystems in Central Asia and the Caucasus becomes the major limiting factor for sustainable social and economic development.

The States of CACENA face the acute need in developing and implementing the integrated actions aimed at settling the increasing problems of destruction of AE. The UN Declaration on Environment and Development (Rio Declaration), UN Sustainable Development Program "Agenda 21", UN Millennium Declaration and other international documents consider the protection and preservation of ecosystems as the integral part of the developing process. The UN Millennium Declaration adopted by 147 Heads of State and Government and 189 nations at the UN Millennium Summit, sets forth the principles of sustainable development and declares the firm intention to adopt in all our environmental actions a new ethic of conservation and stewardship. The Millennium Ecosystem Assessment Report confirms that on-going degradation of ecosystems is the major obstacle on the way of achieving the Millennium Development Goals. At the All-European Ministerial Conference held in Kiev (2003), the preservation of aquatic ecosystems was declared as the priority subregional goal (Goal 1) in Central Asia[6]. In accordance with these goals, the CAREC under supporting by the Global water Partnership has studied the status of aquatic ecosystems in Central Asia and the South Caucasus based on available information. It is expected that this report will promote public awareness with respect to the degradation of aquatic ecosystems in the subregion, as well as formulating the topical tasks in the field of preserving aquatic ecosystems in Central Asia and the South Caucasus, and development of efficient strategies and mechanisms for regulating their vital functions.

[4] MDGs – Millennium Development Goals adopted by the world community for preserving environment sustainability and welfare of the world population (UN World Summits: 2000 and 2002)
[5] http://www.unece.org/env/documents/2003/ece/cep/ece.cep.106.rev.1.e.pdf
[6] http://www.unece.org/env/proceedings/html/Item7b.e.html

*«Water is a critical factor for the archebiosis on the Earth, and it remains the key element for surviving. Preserving inland waters is the basis for supporting all-important goods and services supplied by aquatic ecosystems».*
*(«What is a Water?...» The official publication of the Secretariat of the Ramsar Convention, 2005).*

## INTRODUCTION

Two geopolitical regions - the South Caucasus (Azerbaijan, Armenia, and Georgia) and Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) - have similar natural conditions. First of all, one of the largest mountain systems in the world (Caucasus, Elbrus, Tien Shan, Altai, Pamir-Alay, Hindukush, and Kopet-Dagh) had been formed in these regions. Their diverse watersheds are the sources of streams that supply water for agricultural, industrial, and domestic needs in lowlands. Specific geographical conditions coupled with arid and continental climate in most of districts determine the high social and economic value of inland water resources for development of nations. The countries of these regions have ancient traditions of natural resources use, and the great historical experience in the field of water resources management and water saving. Joint use of transboundary rivers is one of important characteristics of both regions, where developing the nations is directly depends on efficient water resources management.

The preservation of aquatic ecosystems in tow regions under consideration is the key task that actually provides putting the principles of sustainable development into practice. To present day, ecosystems' needs defining their ability for sustainable functioning are insufficiently taken into consideration adversely affecting the environment protection sector in the regions of South Caucasus and Central Asia. This report puts therefore special emphasis on analyzing the status of water resources from the point of view of the preservation of aquatic and water-related ecosystems for sustainable development.

## PART I. THE REGIONAL ANALYSIS

### 1.1. General Information on Sub-Region

***The South Caucasian Region*** occupies the vast mountainous region (the Greater Caucasus) between the Black Sea and the Caspian Sea. South Caucasia covers an area of about 186,300 sq km with the total population of 15,800,000 people (2002) and includes three countries – the Republic of Azerbaijan, the Republic of Armenia, and the Republic of Georgia. South Caucasia is remarkable for amazing-diverse and contrasting nature. The diversity of natural conditions is caused by the location of this region in two climatic zones (temperate and semitropical zones) at the meeting-point of mountains of South Europe, Asia Minor, and Central Asia, as well as by the alteration of valleys and high-mountain systems. Landscapes are changing with an altitude from subtropical forests to the glacier landscape, and in a west-easterly direction from humid subtropical swamp-forest landscapes in Colchis to arid subtropical and semi-desert landscapes of the Kura-Araks lowland.

***The Central Asian Region*** is located in the center of the Eurasian continent and occupies the area of 3,882,000 sq km with the population of 53,000,000 people. It includes such

States as Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. As a whole, the physical and climatic zoning is well marked in Central Asia. An aridity that predetermines vulnerability of ecosystems is the distinguishing feature of this region. Countries of the region are situated in the single environment areas of closed basins of the Caspian Sea, Aral Sea, Lake Balkhash, and Lake Issyk-Kol that have not connections with the so-called world ocean, and under combination with the arid climate, this aspect put ecological restrictions on economic activity and trade.

### 1.2. The Current Status of Aquatic and Water-Related Ecosystems in the Subregions

The status of aquatic ecosystems on the greater part of the subregion is far off from optimal one. Because of economic activity, most of aquatic ecosystems were transformed, and factors supporting them are under a tough anthropogenic press. Changes are observed in all natural-climatic zones, and are gradually strengthening towards lower reaches of rivers and the most essential in the zone of river flow consumption.

The Suram Ridge divides the river network of South Caucasia into two unequal parts: eastern and western one. River ecosystems (RE) in the eastern part belong to the Caspian Sea basin, and RE in the western part to the Black Sea basin. Three main groups of RE having common hydrographical characteristics can be distinguished here: (i) rivers on the southern side of the Greater Caucasus with their sources in the areas of glaciers and eternal snows, which flow through deep and narrow canyons, and have the considerable hydropower potential; (ii) rivers of the Lesser Caucasus Mountains where a surface runoff is comparably negligible, and the river network is not so dense (here rivers are mainly fed by springs or water from swampy depressions, and are characterized by slow flows and meandering channels); and (iii) rivers of the Kura-Araks lowland that has also the rare river network consisting of typical steppe watercourses with intensive water diversion for irrigation. The largest rivers are Rioni, Kura, Debed, and Araz.

Extremely intensive erosion processes and high sediment load are peculiar characteristics of most rivers in the South Caucasian region. Mudflows take place in the eastern part of the Southern Caucasian region and in the southwestern part of the Armenian plateau.

In Central Asia, water resources formed in mountain regions are used for irrigation and water supply to lowland territories that are located far off from mountain areas. Particularly large irrigated areas are concentrated along the middle and downstream reaches of rivers Amu Darya, Syr Darya, Zeravshan, Talas, Naryn, Ili, and Chu, as well as on foothill plains. Natural conditions are favorable to cattle breeding on grazing lands, and, at the same time, the dense river network and plenty of man-made water bodies create conditions for developing commercial fishery. In the region, since the second half of the 1990s the growth trend in the agroindustrial complex is observed (in Kyrgyzstan – by 9 percent; in Tajikistan – by 4 percent; in Turkmenistan – by 26 percent; and in Kazakhstan – by 29 percent); as well as a crop pattern is being changed (in Turkmenistan the area under grain crops is increasing; in Uzbekistan – areas under orchards, melons and gourds, vegetables). Growing the main kinds of cattle breeding produce became evident in Kyrgyzstan and Uzbekistan.

The sustainability of river ecosystems in the subregion mainly depends on the natural equilibrium in upper watersheds (mountain systems of Pamir-Alai, Tian Shan, and the

Greater Caucasus). Along with the growth of urban population and developing tourism and recreation industry, use of mountain areas for recreational purposes is increasing. Therefore, the need to control recreational loads on mountain ecosystems is very topical. The processes of deforestation, soil erosion, degradation of pastures, and pollution by wastes in mountain areas of both regions are strengthening. Destruction of mountainous ecosystems results in loss of their regulatory functions and the increase in risks of natural disasters (first of all, floods). Rise in air temperatures and contamination of precipitation cause intense reducing of glaciers. As a result, disturbance of the hydrological regimes, depletion of water resources, and degradation of aquatic ecosystems, especially in the so-called "runoff dissipation zone", are in progress.

A considerable part of aquatic and water-related ecosystems is located in foothill areas and on adjacent valleys. Developing of mining, processing and chemical industry, as well as urbanization of these territories entailing the disposal of insufficiently treated industrial and domestic wastewater into water bodies are the threat to functioning of ecosystems. Polluting the territories and watercourses by wastes is the largest problem in both regions that results in enormous economic and ecological losses. According to data of monitoring, 6 to 8 percent of water bodies in the area adjacent to the Aral Sea refer to dirty and much polluted water bodies with poor ecological conditions, 25 percent - polluted water bodies, 44 percent - moderate polluted, and 23 percent - clean and slightly polluted water bodies.

Irrigation and developing of plain areas in Central Asia and the Caucasus have caused the considerable transformation of aquatic and water-related ecosystems. Not only loss of some components of biodiversity (species of flora and fauna) but also the extinction of whole ecosystems took place. As a result of transformation of aquatic and water-related ecosystems and direct exploitation, more than 50 species of fish, about 40 species of birds, 20 species of mammals, 4 amphibians many of which were included in the IUCN List are referred to threatened species.

Construction of reservoirs made their contribution to destruction of ecosystems in lower reaches of rivers and affected long-term prospects of economic development of countries and regions. River flow regulation has resulted in the following consequences: i) decrease in volumes of biological active sediments; ii) changes in the hydrological regime of downstream reaches of watercourses; iii) strengthening sedimentation of riverbeds; and iv) disturbance of migration ways for migratory and semimigratory fish. More coarse sandy sediments bury silty bottom sediments downstream from reservoirs. Aquatic pelophilic organisms fail and perish because they cannot properly feed and build their shelters on unaccustomed bottom sediments. A situation in deltas of Amu Darya, Kura, Syr Darya, Razdan, and Ural is evaluated as the emergency one. There take place a reduction in volumes of intra-delta water bodies, increase in their water salinity, and decline in biodiversity and bio-productivity of deltas as a whole, as well as loss and reducing the number and diversity of natural habitats. Fishery conditions in the Syr Darya delta have changed: 97 percent of spawning grounds became inaccessible for barbel sturgeon (*Acipenser nudiventris*), 95 percent - for barbel *(Barbus barbus)*, and 60 percent – for asp (*Aspius aspius*) and white-eye (*Abramis sapa*). The area of fishery lakes in the Syr Darya River delta has decreased dozen times in comparison with the 1960s. Last ten years, fish catches from natural water bodies have reduced more than by 60 percent in the Central Asian region as a whole.

Intense sedimentation, transformation of coastlines, and changes in the hydrological

regime resulting in a decrease of self-purification capability of aquatic ecosystems occur in reservoirs of the plains themselves. Intense eutrophication and secondary pollution of the shallow zone are the typical problem for many in-channel reservoirs in the zone of the plains due to negligible depths and large areas. Cleaning of silted riverbeds due to regulation of river flows causes considerable budget expenses. For example, the Government of Azerbaijan has funded construction of a new branch of the Kura River channel (2003 to 2005) in order to improve the ecological conditions in its delta.

Natural lakes of the subregion contain the considerable reserves of fresh water, and their ecosystems have a regulatory influence upon climate and functioning of other ecosystems in the basin. The largest of them are the following: the Aral Sea, Lake Issyk-Kul, Lake Balkhash, Lake Sevan, Lake Sarez, Lake Tabatzkuri, and Lake Sarisu. As a result of reducing river flow, many rivers, especially small rivers, have brackish water. Decrease in habitats of colonial-nesting species of water-related birds (herons, cormorants, and pelicans) is in progress, and conditions for adaptation of enormous number of waterfowls during their migration from the North Europe, Siberia, and Kazakhstan to wintering grounds on the Caspian Sea, in India, Pakistan, and Africa are deteriorating.

Due to developing the irrigation schemes, an area of desert sinks that accumulate enormous reserves of drainage water has increased in Central Asia. According to data of remote sensing (space images), more than 300,000 hectares of desert grassland were flooded with drainage water in Central Asia in the 1970s and 1980s, and 800,000 hectares in 2005 only in Uzbekistan.

The percentage of largest desert sinks – Lake Sarikamish and the Arnasay lake system – makes up 70 percent of the area of such water bodies. New-formed aquatic ecosystems play an increasing role in the water balance and landscapes of desert areas. However, ecological effects are different here. Desert sinks became the peculiar ecological oasis – the zones for supporting biological diversity, and at the same time, they are involved into the socio-economic sphere and are used by the population for recreation, fishery, hunting, harvesting reed etc. However, such processes as their intense overgrowing with wetland vegetation, shallowing, gradual salinization, and hydrogen-sulphidous contamination of near-bottom (benthic) layers occur here. In water-related ecosystems, valuable forage plants are replaced by low-valuable ones (over an area of about 530,000 hectares).

There is the need to manage water quality of desert sinks with the purpose of increasing their biological productivity. Unfortunately, up to now, these aquatic ecosystems do not have the economic and ecological status, and the legislative documents establishing the basis for their management were not adopted. Fishery and recreational value of these water bodies, resources for hunting, animal breeding, and other kinds of economic use of their biological resources should be assessed. The problem of return water and numerous water bodies that were created owing to return water disposal needs to be also considered both at the national and regional level. It is necessary to specify and legally fix the social and ecological status of desert sinks.

Ecosystems of man-made watercourses (irrigation and drainage canals) play an important role in functioning of the river basins. In countries of the subregion, their command area makes up hundreds of thousands of square kilometers, and their length come to many thousand kilometers. For instance, only in Uzbekistan, the total length of main irrigation (about 450) and drainage (400) canals makes up 156,000 km, and their total command area

amounts to about 1,100 sq km. Water delivery and use are often became complicated due to the following biological drawbacks: i) overgrowing of canals decreases their carrying capacity, algae blooming deteriorates water quality and sanitary conditions, fouling can fail a navigation and operation of hydraulic structures. Therefore, developing of measures for controlling biological drawbacks in man-made watercourses has the high practical value and is one of the most important issues of hydrobiology.

The lack of agreements with respect to water sharing among countries and economic sectors (basically between irrigated and hydro-power generation sectors), as well as nonobservance of signed agreements result in decreasing water availability for economic sectors in downstream districts, irrigated areas and output of agriculture, and in deterioration of ecological situation in lower reaches of the rivers. Irrevocable excessive water consumption for irrigation in the middle parts of river basins causes the shortage of water resources supplying to aquatic ecosystems in lower reaches. The general problem for both regions is inability of the existing management system and water infrastructure to provide the ecological flow for supporting of spawning grounds and ecosystems in river deltas. In many countries, the rates of ecological flow, sanitary and sanitary-ecological water releases are not estimated and depend on annual water availability. In practice, water supply for maintaining ecosystems is often formed according to the residual principle especially in the drought periods. In dry 2000-2001 years, there was even the problem of drinking water supply in lower reaches of the Amu Darya River. During the period between the consecutive surveys of lakes (since 1936 until 1985), an area of lakes hydraulically linked with rivers has decreased from 380,000 to 30,000 hectares in the flat part of the Aral Sea basin as a whole, and in the Amu Darya delta their area has reduced 7 times. Aquatic ecosystems support vital functions of other ecosystems in the delta and also functioning the delta as an integral natural complex, especially under arid conditions. The regime of water delivery into river deltas existing last years is ineffective for supporting biological productivity of their aquatic ecosystems. Prevailing of winter water releases cause the problems of winter floods in the deltas and abatement of their fauna. The destruction of aquatic ecosystems in the deltas has affected not only biological diversity but also the local population whose incomes mainly depend on usage of biological resources. Deteriorating the environmental condition in the Amu Darya River delta has affected the interests of 1.5 million people living here. Risks of undermining the food independence and safety are increasing in countries of the subregion.

Alien species, for example, ctenophores (*Mnemiopsis ieidyi*) that were brought with ballast water of oil tankers and disastrously invaded the Caspian Sea adversely affect the marine ecosystems. Sustainability of aquatic ecosystems and their self-purification ability are defined by the condition of phyto- and zoocenosis, whose composition and structure directly depend on hydrological and hydro-chemical regimes. Insufficient studies of aquatic biocenosis and lack of routine monitoring of surface water pollution do not allow presenting the in-depth analysis of reaction of the biological component of aquatic ecosystems on the increasing pollution in the subregion. This matter requires additional researches and establishing the biological monitoring system.

Water pollution is the general problem for countries of the subregion. Drainage water disposal, discharging of agricultural and industrial enterprises' wastewater, and placement of objects-pollutants within the water protection zones along rivers contribute to increasing chemical and bacterial pollution of water resources. River water quality in the zone of intense water consumption varies mainly from Class III to Class IV (polluted water), and

in the zone of large-scale industrial and urban complexes, from time to time, water quality can drop to Classes V and VI (dirty and very dirty waters) when water is ecologically hazardous with clear degradation of aquatic biota and cannot be used for any purposes. Due to pollution of water sources, increase in morbidity of the population and deteriorating the quality of agricultural output are observed. The major watercourses of Uzbekistan became practically unfit for drinking water supply due to lack of freshwater sanitary and ecological releases. The largest problem in the Caspian region that results in enormous economic and ecological losses is pollution of coastal-marine ecosystems by oil products. Lack of both urban (rural) and local treatment facilities and low efficiency of existing ones are evident. The need in regulating the technologies of industrial production and treatment methods for wastewater should be met, but economically feasible solutions are very often ecologically unacceptable.

The environmental problems such as water resources shortage, pollution and degradation of aquatic ecosystems directly affect economic development and social issues including poverty, forced migration, deterioration of life quality and health of the population in the CACENA region. Medical surveys conducted in the 1990s in Central Asia have revealed obvious increase in incidences of diseases of the following organs: endocrine and urino-genital system, digestive apparatus, blood and hemopoietic organ, circulatory system, as well as oncological diseases due to deteriorating quality of natural waters. Evaluating dynamics of health of the population in areas adjacent to the Aral Sea according to such nosologic forms as morbus hypertonicus, stomach ulcer, and duodenal ulcer confirms a leading role of general water salinity and its salt content composition in their etio-pathogenesis. For example, under increasing the concentration of chlorides up to 50 mg/l, the sickness rate related to cholelithiasis and cholecystitis rise 3 times, and to stomach ulcer – almost 4 times.

All countries recognize that the top-priority task for settling key problems of the safety of water resources and the environment is water supply to the population, production, and ecosystems of necessary quality and in sufficient amounts.

### 1.3. Interaction of Aquatic Ecosystems and Society

The preservation of water bodies and wetlands and their resources is especially important for nations in Central Asia and the Caucasus. Aquatic ecosystems were supporting the traditional economic activity under arid conditions in the subregion over the centuries, providing clean drinking water and food (fish and game) to the local population. Fish providing the development of fishery and fish industry played a special role among resources/goods of these ecosystems. Water-related birds and waterfowl were traditionally the objects of hunting and trade in river deltas and coastal-marine ecosystems.

In second half of the 20$^{th}$ century, degradation of aquatic ecosystems and abrupt reducing their goods and services adversely affected the living standard of the population, especially its socially vulnerable groups. The expert assessment of 24 kinds of ecosystems' services supporting vital activity of the population in the subregion reveals on-going decrease in the efficiency level of 15 of them. Two kinds of ecosystems' goods – fish stock and drinking water – do not correspond to the level that can meet the needs of the present generation, let alone the needs of future generations. At the same time, "any progress achieved in addressing the goals of poverty and hunger eradication, improved health, and environment

protection is unlikely to be sustained if most of the ecosystem services on which humanity relies continue to be degraded" (The Millennium Ecosystem Assessment Synthesis Report, 2005). Unfortunately, understanding of the role and functions/services of ecosystems and their direct and indirect value is yet lacking in modern society. There are not quantitative criteria for interrelations of the living standard of the population and the status of ecosystems.

***At the conference held in Kiev, Ministers responsible for nature protection have recognized that biological and landscape diversity is critically important not only due to its essential value but also due to goods and services provided to the humanity, including their social and economic role.***

The recent analysis of aquatic ecosystems in European countries (Belgium, the Netherlands and others) reveals that in the process of decision-making and "cost benefit analysis" of planned economic activity it is necessary to consider the following function/services of aquatic ecosystems:

- Productive (providing) functions - supplying of goods: fresh water, fish production, aquaculture, genetic resources, and game;
- Informative (regulative) functions - supplying of services: the protection from floods or climate changes;
- Cultural services (inestimable values): esthetic, recreational, and educational value;
- Conditional functions – the internal processes within ecosystems that enable the support to vital activity and production of goods and services; and
- An indirect form of using goods: reuse of nutrients under utilization a clean water of ecosystems and fish production.

Under influence of human activity upon ecosystems, so-called "construction services" occur, namely: construction of dams, water intakes, and other water infrastructure within aquatic ecosystems. Scientists have to solve a task of developing a method for selecting optimal variants of governance reorganization when benefits from the preservation of aquatic ecosystems exceed profits from economic activity. It is necessary to develop and implement the program of evaluating aquatic ecosystems in the subregion of the Caucasus and Central Asia within the framework of the Millennium Ecosystem Assessment.

### 1.4 Developing Efficient Strategies and Mechanisms for Ecosystems Management

One of the basic causes leading to abovementioned problems of aquatic ecosystems degradation in the subregion is inefficient management and lack of public concern. In the different periods of the Soviet epoch, the integrated water resources use and protection plans, integrated nature protection plans, municipal economy development plans, and water infrastructure and land reclamation construction plans were prepared according to the standard methodology. They did not sufficiently considered sustainable, equitable, and wise meeting the water requirements of water users and nature, as well as water balance over different natural and economic zones.

At the same time, the neglect or insufficient consideration of ecosystem-defined limitations has resulted in the crisis practically in all river basins of the subregion. Society perceives the

preservation of ecosystems as a minor task referring only to activity of nature protection agencies. There is not still the legal status of the term "preservation of ecosystems" in normative documents of countries of Central Asia, and agencies responsible for the preservation and maintaining of ecosystems within the framework of the state governance were not specified as well[7].

***«Governance of the water sector should be modernized in order to equally present the interests of irrigation, hydropower generation and other stakeholders under observing the priorities of drinking water supply, water-saving etc. and ensure the principle of equality of rights and responsibilities of all water users»*** (The invitation to the partnership for implementing of the Central-Asian initiative on sustainable development, 2003). Such a modernization is possible under integrated water resources management (the Global Water Partnership) based on the following principles of the ecosystem approach:

- Water resources management within hydrographic boundaries;
- Managing all water resources: surface water, groundwater, and return water under considering their interaction;
- Integration of the interests of all economic sectors, water users, and water consumers;
- Integration of the different levels of management hierarchy;
- Public participation in the decision-making process; and
- The priority of nature as a water user.

The grave obstacles for putting the basin management approach into practice are the following:

- The priority of short-term tasks in the governmental and territorial planning and in activity of the private business;
- Lack of the programs for integrated development of regions comprising the economic component;
- Inefficiency of enforcement of existing environmental laws;
- Limited financial and institutional capabilities of ministries;
- Weakness of civil society and NGOs for defending an opinion of local communities and the needs of ecosystems;
- Insufficient efficiency of available mechanisms for settling disputes between different water users comprising the transboundary level;
- Lack of incentives for water saving;
- Lack of an ecological-economic assessment of the current status of aquatic ecosystems;
- Neglecting the protection of ecosystems under developing recreational areas;
- Lack of efficient incentives for the application of the resources-and-energy saving technologies; and
- Lack of the national monitoring systems to control the status of ecosystems and resources.

[7] The Ministries of Nature Protection are responsible for many aspects related to nature protection (from the wastes disposal control to collection of penalties for non-observance of ecological laws), but functions directly related to the preservation of ecosystems were not exactly specified. Therefore, the agencies responsible for nature protection do not still solve the matters related to specifying and control of water releases for the needs of ecosystems.

### 1.5 Measures for the preservation of aquatic ecosystems

In countries of the subregion, the following projects and programs aimed at improving the environment were implemented or are in progress: «The Regional Environmental Program for Nature Protecting in the South Caucasus» under support of the Ministry of Co-operation and Development of Germany; the national program of Azerbaijan «Environmentally Sustainable Social and Economic Development», The Integrated Water Resources Management Plan and the Lake Sevan Ecological Balance Rehabilitation Project (Armenia), the Concept of Water Sector Development and Water Policy of the Republic of Kazakhstan up to 2010 (Kazakhstan), Kyrgyzstan Integrated Water Resources Use and Protection Plan up to 2005, Irrigation and Water Supply Infrastructure Rehabilitation Programs (Republic of Tajikistan), the National Environment Action Plan of the President of Turkmenistan Saparmurat Turkmenbashi.

In the programs adopted in countries of the subregion, the preservation of aquatic and water-related ecosystems is the top-priority task for national sustainable development. The following actions are planned to implement:

- Improving the legislation and strengthening the control for observance of laws;
- Developing national action plans in the field of integrated water resources management (including the ecosystems supporting them);
- Introducing the water-saving technologies and achieving the minimum level of available water resources losses;
- Specifying the scientifically-grounded rates of ecological river flows and measures for improving the condition of aquatic ecosystems;
- Control of river water pollution and water-related disasters;
- Development of activities aimed at accounting, reproduction, and the growth of biological resources;
- Rehabilitating a vegetation cover in the zones of runoff formation and consumption;
- Mudflow and flood control by means of construction of protective levees and cleaning of silted riverbeds;
- Maintaining activities related to the protected areas;
- Establishing the water protection zones along rivers and other water bodies;
- Improving management of the coastal zones;
- Enhancement of the water quality monitoring system and the control for discharges of pollutants into aquatic ecosystems;
- Developing the methods for evaluating damage of aquatic ecosystems and the rates of compensations for polluting and depleting water resources of transboundary rivers in line with the international standards;
- Developing well-founded quantitative criteria for evaluating the interrelations of living standard of the population and the status of ecosystems;
- Definition of social, economic, and ecological value of water resources; and
- Public awareness and public participation.

Assessment of the health of aquatic environment is recently introduced into the practice of nature protection, and its further developing is necessary. A forecast of aquatic

ecosystems' status and development of the scenarios of their modifications are extremely important for long-term planning of water bodies' exploitation.

Taking into consideration the experience of activity within the framework of the Ramsar Convention (1971), the tasks related to the protection of biodiversity of aquatic ecosystems in the subregion should integrated the following aspects:

- To facilitate the sustainable water resources use in all economic sectors including optimization and introduction of new systems of irrigation and water supply (the Millennium Development Goal 7, Target 10: Indicator 30 - Proportion of population with sustainable access to an improved water source, urban and rural);
- Developing the system of measures for management and protection of aquatic ecosystems with establishing the protected areas presenting the optimal network for supporting biodiversity based on auditing of all aquatic ecosystems and specifying the key sites, as well as on routine monitoring and managing of such a network (the Millennium Development Goal 7, Target 9: Indicator 26 - Ratio of area protected to maintain biological diversity to surface area); and
- Strengthening public awareness with respect to values of aquatic ecosystems and their biodiversity by means of the methods of economic incentives for enhancing commitments of the local population and authorities regarding the preservation of biodiversity.

Protection and rehabilitating of forests, overgrazing control, measures for the prevention of mudflows, landslides, catastrophic floods due to breaches of mountain lakes, control of chemical and biological pollution, and quantitative depletion of water resources are the basic directions of activity related to the preservation of terrestrial and aquatic ecosystems in the runoff formation zone. It is necessary to develop and introduce the legislative and institutional measures for controlling tourism in order to regulate the recreational load on the vulnerable mountainous ecosystems for preventing pollution of water sources and decline in biological diversity by campers.

The basic shortcoming of the existing integrated water resources use and protection plans, integrated nature protection plans, municipal economy development plans, and water infrastructure and land reclamation construction plans is that they do not take into consideration sustainable, equitable, and wise water delivery to ecosystems. Some actions in this direction were already undertaken – the Aral Sea is recognized as a water user equal in rights, however, it is necessary to implement this resolution in practice. The integrated aquatic ecosystem use and protection plans with considering ecosystems of the Aral, Caspian, and Black Seas should be developed for the protection of aquatic ecosystems of transboundary rivers. In many national and international experts' opinion, the process of preparing the agreements concerning specific problems of interstate water relations can be speeded up in case of adopting the general strategy of efficient use and protection of terrestrial and aquatic ecosystems, as well as establishing and strengthening the status of the subregional co-ordination commissions.

Implementing the pilot projects for rehabilitation and sustainable management of aquatic ecosystems in different natural and climatic zones with wide dissemination of their outcomes and experience seems useful.

*Legislation.* Some actions for improving the water legislation were for the first time undertaken in countries of the subregion. The new Water Codes (Armenia, Kazakhstan, and Kyrgyzstan), the law of Armenia "On the foundations of water policy" (2005) that initiates developing the national water program and basin management plans were adopted last years. In line with the Water Code of Azerbaijan (1997), "Regulations for the Governmental Monitoring Water Bodies Use and Protection", "Regulations for Ranking of Water Bodies as Special Protected Objects", and "Regulations for Specifying Sizes, Limits, and Uses of the Water Protection Zones and Their Safeguard Strips" were developed and adopted. At the same time, there is a discrepancy between normative documents and legislative norms that causes the conflicts between water management bodies and water users and adversely affects the procedure of water resources management. Society perceives the preservation of ecosystems as a minor task referring only to activity of nature protection agencies. There are not still the legal status of the term "preservation of ecosystems" in normative documents of countries of Central Asia and Caucasus.

**Box 1. Participation of the CACENA countries in the international conventions related to environment and water resources management**

| Convention | Countries of Central Asia and Caucasus | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | AR | AZ | GR | KZ | KG | TJ | TM | UZ |
| UNFCCC | 1993 | 1995 | | 1995 | 2000 | 1997 | 1996 | 1993 |
| The Kyoto Protocol | 2005 | 1995 | | 1999 | 2003 | | | 1999 |
| CBP | 1993 | 2000 | | 1994 | 1996 | 1997 | 1996 | 1995 |
| CBD | 1997 | 1998 | | 1997 | 1999 | 1997 | 1996 | 1995 |
| The Convention on the Conservation of the World Cultural and Natural Habitats | 1993 | 1993 | | 1994 | 1995 | | | 1995 |
| CITES | | 1998 | | 1999 | - | | | 1997 |
| The Bonn Convention | | | | | - | | | 1998 |
| The Ramsar Convention | 1993 | 2000 | | | 2002 | | | 2001 |
| The Basel Convention | 1999 | 2001 | | 2003 | 1996 | | | 1996 |
| The Convention on the Transboundary Effects of Industrial Accidents | 1996 | 2004 | | 2000 | 2000 | | | - |
| The Arhus Convention | 2001 | 1999 | | 2000 | 2001 | | | - |
| The Convention on the Protection and Use of Transboundary Watercourses and International Lakes | 1999 | 2000 | | 2000 | - | | | - |
| The Convention on EIA in a Transboundary Context | 1996 | 1999 | | 2000 | 2001 | | | - |
| The Stockholm Convention on Persistent Organic Pollutants | 2001<br>2003 | 2003 | | 2001 | 2003 | | | - |
| The Protocol on Water and Health | | 2002 | | | | | | |

Taking into account the requirements of the international conventions, further improving of the normative and legal base of water relations and harmonization of the legislative base are necessary. The process of ratifying and executing UN Conventions and Protocols (The

Convention on the Protection and Use of Transboundary Watercourses and International Lakes *[the UNECE Water Convention]*, the UNECE Convention on EIA in a Transboundary Context etc.) and signing the basin agreements and memoranda needs to be proceeded.

All basin agreements related to water resources must form mutual relations and behavior of riparian countries promoting the preservation and protection of ecosystem, integrated water resources management, and reducing of diseases caused by poor water quality. They should fix the commitments of riparian countries with respect to unilaterally planned water use, procedures of transboundary environment impact assessment, and distribution of responsibilities in case of floods, droughts or emergencies. In addition, the agreements should established the order of consultations and effective mechanisms for notification, control, and mitigation of transboundary impacts, including detection of pollution sources, measures for reducing water pollution, and monitoring water quality. At the same time, the agreements have to include the mechanisms for reducing any risk for health and of morbidity caused by poor water quality, and mechanisms for providing public awareness and participation, as well as obligations with respect to caused damage and dispute settlement mechanisms.

*Institutional base.* A governance system of in the water sector in countries of the subregion comprises the large number of ministries, departments, and organizations with the extremely complicated framework for co-ordination and obstructs establishing and developing integrated aquatic ecosystems management. The responsibility for the status and preservation of ecosystems is not exactly specified in the system of state governance in countries of the regions[8]. The system of basin governance is at the initial stage of development (Kazakhstan, Kyrgyzstan, and Uzbekistan).

Water supply, protection of water resources, and preservation of aquatic ecosystems are not only national problems but also largely depend on the coordinated relations of riparian countries in the subregion. An experience gained in Central Asia shows that despite energetic activity of the Interstate Coordination Water Commission (ICWC) at the regional level and adopted political resolutions and agreements in the field of efficient natural resources use and nature protection, such problems as the insufficient legal and institutional base for regional co-operation, lack of political and financial obligations, and insufficient participation of riparian countries in tackling the regional challenges are still topical. A number of programs, declarations, and agreements adopted by Heads of Central Asian States with respect to developing the strategy of water sharing acceptable for all riparian countries and the economic mechanism for transboundary water resources management were not still actually realized.

The common interests and targets regarding the preservation of aquatic ecosystems and improvement of water resources quality are the base for the further inter-sectoral and inter-state co-operation. Central Asian countries have proposed the partnership initiative for sustainable developing of the region ("Agenda 21") that was included into the resulting documents of the UN Conference on Environment and Development (UNCED). This initiative provides for the integration of real processes and strengthening the mechanisms

[8] The Ministries of Nature Protection are responsible for many aspects related to nature protection (from the wastes disposal control to collection of penalties for non-observance of ecological laws), but functions directly related to the preservation of ecosystems were not exactly specified. Therefore, the agencies responsible for nature protection do not still solve the matters related to specifying and control of water releases for the needs of ecosystems.

for the co-operation between economic sectors, countries, and donors for achieving general development goals including the goal "Ensuring sustainable functioning of aquatic ecosystems important for vital activity of human beings (Preventing the degradation of aquatic ecosystems in river basins that support vital activity in Central Asia)." This goal can be also recognized as a priority-driven one by countries of the Caucasian region.

*Economic mechanisms.* The countries in the subregion do not have the well-grounded assessment of an actual value of aquatic ecosystems. Therefore, there is not also sufficient information and the ecological-economic ground of the need for ecological flows providing optimal functioning of natural and man-made ecosystems. However, recent years, the natural complexes in most of countries of the region received water in volumes earlier specified by the basin water management plans and other project studies, but only due to temporary economic depression, especially in the agricultural sector, and to considerable natural water availability.

Under market relations, when the economic mechanisms play a basic role, the efficiency of water resources use and indicators of water saving will be mostly depend on the economical assessment of the cost of ecosystems' services and the payment for water resources and services, and at the same time, the economic mechanisms defining water saving and efficient water use will prevail over other ones. The economic and ecological status of aquatic ecosystems including ecosystems of man-made water bodies and watercourses will have to be established.

*Public participation.* An extent of public participation in decision-making concerning water resources management is negligible due to the lack of awareness of existing problems, limited access to information, and insufficient possibilities for stakeholders to participate in the decision-making process. In line with the 12th principle of the ecosystem approach[9] and the provisions of the Arhus Convention, all interested groups of society and representatives of all branches of science should be involved in water resources management. Measures for building-up of public opinion and support to implementation of the IWRM principles and the preservation of aquatic ecosystems should be arranged.

Participation of water users, local communities, and NGOs in water resources management and the preservation of ecosystems are possible through the Basin Water Councils that should be established within the framework of the basin agreements including the international conventions. One of the first Basin Water Councils was established in the Balkhash-Alakol River Basin (Kazakhstan). However, the considerable work has to be still implemented to enable it to carry out abovementioned tasks.

*Information and monitoring.* The existing monitoring system for ecosystems' control in countries of the subregion is not sufficiently effective and does not meet the needs of comprehensive assessment of the status and dynamics of aquatic ecosystems in order to make objective-management decisions.

The efficiency and objectivity in the process of management decision-making will promote the extension of works related to establishing the unified accessible expert-information system comprising not only data on the status of aquatic ecosystems and driving factors but also data on the entire complex of economic, social, technical, cultural, and other processes that affect developing of the basin. Such a system will

[9] http://www.biodiv.org/decisions/default.asp

provide the decision-makers with an effective and science-based instrument for developing the options of administrative and legal decisions aimed at ecologically sustainable development of river basins and improving the living standard of the population in the subregion, as well as the prevention of water conflicts.

# PART II NATIONAL REPORTS

## CHAPTER 1 THE PRESERVATION OF ECOSYSTEMS AND RESOURCES OF INLAND WATER BODIES IN COUNTRIES OF THE SOUTH CAUCASUS

### 1.1. Analysis of the Status of Aquatic Ecosystems in the Republic of Azerbaijan

#### 1.1.1 Aquatic and Water-Related Ecosystems

The distinctive characteristics of water resources in Azerbaijan in comparison with other riparian States of the Kura River basin are the following: (i) uneven distribution of water resources over the territory, and (ii) formation of about 70 percent of surface water resources on the territories of upstream countries. In years with the average availability of water, the total water resources in the country make up about 28.5 to 30.5 cu km, and in dry years, they decrease up to 22.6 cu km.

Table 1.1.1 Surface water resources in the Republic of Azerbaijan

| River Basin | Total water resources, $km^3$ | Transboundary water resources, $km^3$ | Local water resources, $km^3$ |
|---|---|---|---|
| Kura (as far as the confluence with Araks) | 17.765 | 11.744 | 6.021 |
| Ganykh (Alazan) | 3.942 | 1.826 | 2.116 |
| Gabyrry (Iory) | 0.501 | 0.487 | 0.014 |
| Khram | 1.851 | 1.851 | - |
| Aksfatachay | 0.416 | 0.356 | 0.060 |
| Akhyndjachay | 0.176 | 0.150 | 0.027 |
| Araks | 9.157 | 7.836 | 1.321 |
| Arpachay | 0.747 | 0.684 | 0.063 |
| Okhunchay | 0.315 | 0.310 | 0.005 |
| Bazarchay | 1.211 | 0.694 | 0.063 |
| Samur | 2.36 | 0.889 | 0.065 |

*The status of river ecosystems in the runoff formation zone.* In the Kura-Araz plain, forest ecosystems promote natural recharging of groundwater that, in their turn, feed rivers in the period of low flows (in summer and winter). Devastation of forests results in decreasing underground inflow into rivers and in their further degradation. During the last decade, floods and mudflow activity have considerably increased in river basins of Kura and Araz.

*The status of lacustrine and river ecosystems in the zone of regulated flow:* Owing to regulating flows of the Kura and Araz rivers practically all water-related ecosystems, lakes, and oxbow lakes have lost flood waters and become transformed with loss of biological productivity. In particular, the hydrological regime of lakes Aggel, Mekhman, Sarisy, and Ajikabul has considerably changed; and at the same time, lakes Shilyan, Bostanchala,

Karasy, Makhmudchala, Agchala and others have dried up or become transformed into waterlogging areas.

*Deltaic ecosystems.* Irrevocable water diversion and regulation of Kura river flows, and banking of riverbed have adversely affected fish reproduction and fishery in the Caspian-Kura region: 90 percent of spawning grounds of sturgeon and salmon located upstream Mingechaur and Bagramtap dams have lost their fishery value because of reducing discharges and diminishing the freshwater zone. A rise in the Caspian Sea water level considerably affects aquatic ecosystems in estuaries and radically changes the conditions for natural reproduction of sturgeon fish.

### 1.1.2 Meeting Water Requirements of Aquatic Ecosystems

The Mingechaur Dam Project specified an ecological flow at the rate of 150 to 175 m3/sec. At the same time, this design parameter is not currently observed, and operating the Mingechaur reservoir radically transforms the sediment load pattern adversely affecting fish spawning and wintering. The same situation with respect to supporting ecological flows is observed in the Araks River basin where water diversion for irrigation in Iran, Azerbaijan, and Armenia is its basic cause.

Table 1.1.2 Ecological flows for the needs of Aquatic Ecosystems

| Basin | Ecological/sanitary flows, cu km | | | | |
|---|---|---|---|---|---|
| | Actual Flows in 2004 | | | | |
| | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total |
| **1. The Caspian-Kura Basin** | | | | | |
| The Kura River upstream from the confluence with the Araz River | 1.58 | 2.72 | 2.74 | 3.04 | 10.1x |
| | 1.36 | 1.36 | 1.36 | 1.36 | 5.44 |
| The Araz River upstream from the confluence with the Kura River | 0.272 | 1.52 | 0.272 | 0.71 | 2.77x |
| | 0.272 | 0.272 | 0.272 | 0.272 | 1.09 |
| The Alazan River upstream from the Mingechuar Dam | 0.65 | 1.39 | 0.63 | 0.75 | 3.42x |
| | 0.23 | 0.23 | 0.23 | 0.23 | 0.92 |
| The Iory River upstream from the Mingechuar Dam | 0.006 | 0.018 | 0.016 | 0.012 | 0.053x |
| | 0.020 | 0.020 | 0.020 | 0.020 | 0.080 |
| The Kura Delta and the Caspian Sea | 1.46 | 3.15 | 1.89 | 2.42 | 8.92 |
| | 1.63 | 1.63 | 1.63 | 1.63 | 6.52 |
| Lake Aggel | n/d | n/d | n/d | n/d | 0.16 |
| | 0.016 | 0.054 | 0.062 | 0.019 | 0.15 |
| Lake Sarisu | n/d | n/d | n/d | n/d | xx |
| | 0.020 | 0.031 | 0.043 | 0.019 | 0.113 |
| Lake Mekhman | n/d | n/d | n/d | n/d | xx |
| | 0.001 | 0.019 | 0.015 | 0.001 | 0.036 |
| Lake Ajikabul | n/d | n/d | n/d | n/d | xx |
| | 0.001 | 0.002 | 0.004 | 0.002 | 0.009 |
| **2. Rivers of the Caspian Basin** | | | | | |
| The Caspian Sea and the Samur River Delta | 0.050 | 0.27 | 0.19 | 0.047 | 0.56 |
| | 0.031 | 0.126 | 0.096 | 0.032 | 0.285 |
| The interfluves of Samur River – Kusarchay River | 0.03 | 0.047 | 0.054 | 0.039 | 0.171 |
| | 0.03 | 0.047 | 0.054 | 0.039 | 0.171 |
| The sea – the Kusarchay River | 0.001 | 0.010 | 0.002 | 0.002 | 0.075xxx |
| | 0.002 | 0.016 | 0.017 | 0.006 | 0.041 |
| The sea – the Kudialchay River | 0.016 | 0.032 | 0.022 | 0.016 | 0.086 |

| Basin | Ecological/sanitary flows, cu km | | | | |
|---|---|---|---|---|---|
| | Actual Flows in 2004 | | | | |
| | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total |
| | 0.007 | 0.022 | 0.021 | 0.009 | 0.059 |
| The sea – the Velvelichay River | 0.002 | 0.12 | 0.003 | 0.003 | 0.020xxx |
| | 0.005 | 0.017 | 0.010 | 0.004 | 0.036 |
| The sea – the Vilyashchay River | 0.003 | 0.003 | 0.007 | 0.007 | 0.020 |
| | 0.006 | 0.006 | 0.006 | 0.006 | 0.024 |
| The sea – the Lenkoran River | 0.065 | 0.030 | 0.060 | 0.223 | 0.38 |
| | 0.016 | 0.005 | 0.005 | 0.016 | 0.042 |
| The sea – the Tangeryu River | 0.062 | 0.002 | 0.006 | 0.003 | 0.013 |
| | 0.005 | 0.003 | 0.005 | 0.005 | 0.018 |
| **Total:** | Actual – 3 | | | | |
| | Water requirement – 7.5 | | | | |

x - the total ecological flow of the Kura River is pointed only for its delta
xx - (visually) drying up of the lake is in progress
xxx - occasional measurements

The field researches conducted in Azerbaijan on some mountain rivers in order to specify the rate of ecological flows have shown quite essential differences in approaches to determining ecological flows[10] but, at the same time, they enable us to obtain the more reliable methodical base for their calculating. However, an application of given values in the water sector practice requires additional accurate definitions.

It is necessary to note that since 2002, there were wet years, and problems with maintaining of ecological flows did not arise.

### 1.1.3 Available Mechanisms for the Preservation of Aquatic Ecosystems

*Legislative Base.* The water sector of Azerbaijan is managed in line with the Water Code (1997), as well as with the following laws: "On Sanitary-Epidemiological Safety" (1992), "On Land Reclamation and Irrigation" (1996), "On Water Supply and Sanitation" (1999), "On Hydrometeorological Services" (1998), "On Environment Protection" (1999), "On Ecological Safety" (1999), "On Public Participation in Decision-Making on Nature Protection and Open Legal Procedures" (1999), "On Municipal Water Supply" (2001), "On Waterworks Safety" (2002), and others. These laws mainly meet the modern requirements. For successful tackling of water-related challenges, 30 specialized normative documents were adopted, including "Regulations for Drawing up the Water Cadastre", "Regulations for the Governmental Monitoring Water Bodies Use and Protection", "Regulations for Ranking of Water Bodies as Special Protected Objects", and "Regulations for Specifying Sizes, Limits, and Uses of the Water Protection Zones and Their Safeguard Strips".

*The Institutional Framework*: Different organizations are engaged in water resources management, monitoring, maintenance, and scientific researches at the national level.

Ministry of Environment and Natural Resources (MENR) monitors the quantity and quality of surface waters, as well as is responsible for use and protection of groundwater.

[10] There is not the efficient algorithm for calculating an ecological flow and the utmost permissible water diversion in the Guidelines on Drawing up the State Water Cadastre.

The Ministry of Public Health (its Sanitary-Epidemiological Service), on the whole, is responsible for the quality of drinking water.

The State Agency of Land Reclamation and Water Resources under the Ministry of Agriculture (former the Committee of Land Reclamation and Water Resources) is responsible for water resources management, use, and protection, as well as for the maintaining of water protection zones, operation and maintenance of irrigation and drainage systems, and flood and mudflows control.

However, the more efficient co-ordination of these agencies' activity is necessary at both the national level and local level, as well as establishing the platform for the wide participation of all stakeholders.

### 1.1.4 Measures for the Preservation of Aquatic Ecosystems

At present, the developed framework for ecological management that allows to make efficient decisions and to improve the mechanism of wise nature management is established in Azerbaijan. In an effort to tackle ecological issues the following national programs and action plans were developed:

- The national program for poverty eradication and economic development;
- The national program for social and economic development of regions in the Republic of Azerbaijan for 2004 to 2008;
- The national program for rehabilitation of forests and afforestation;
- The national program for the efficient use of summer and winter pastures, grassland, and desertification control;
- The national program for ecologically sustainable socio-economic development;
- The strategy for management of hazardous wastes; and
- The national program for use of alternative and renewable sources of energy; and other programs.

At present, the economic methods of the preservation of aquatic ecosystems in which introducing payments for natural resources plays an important role are under realization; and in addition, an appropriate agency for controlling water charging was established.

### 1.1.5 Basic conclusions and recommendations

*Conclusions:* Current water deficit and its expected growth due to climate changes and anthropogenic impacts require developing the urgent measures for improving water resources management, river flow regulation, irrigation system efficiency, application of water-saving methods, and reuse of drainage and return water. These measures can be implemented combining activities in two directions: developing the integrated water resources management plan taking into consideration the status of water bodies and water infrastructure, as well as Reducing the current water deficit, using additional water sources, regulating runoff, cleaning riverbeds, etc. At the same time, the major objectives are the following: operative assessment of available water resources and water limits depending upon water consumption, and developing strategies for integrated water supply to all economic sectors taking into account the ecological status of water bodies in line with the following principles:

- Satisfying the needs in water resources of especially important economic sectors;
- Reducing damage related to water shortage;
- Profitability of water resources use by a specific water user;
- Minimizing losses of available water resources;
- Assessment of ecological flows in rivers and developing measures improving the ecological status of water bodies and the environment as a whole;
- Controlling of affects related to rising the Caspian Sea level and its impacts on aquatic ecosystems;
- River water pollution control and prevention water-related catastrophic events;
- Recovering a vegetation cover within the runoff formation zones; and
- Flood and mudflows control by means of construction of levees and cleaning of silted riverbeds.

*Recommendations:* Taking into consideration abovementioned, the following measures for improving the status of aquatic ecosystems are recommended:

- To establish the water quality monitoring network at rivers Kura and Araz in each riparian country. According to data of monitoring and in line with the international regulations, the extent of damage to aquatic ecosystems and compensations to be paid by the States that deplete and pollute transboundary rivers should be specified;
- To develop the unified mechanism for protecting the transboundary rivers against pollution and depletion of their water resources;
- For protecting aquatic ecosystems of transboundary rivers and specifying scientifically-based rates of ecological flows it is necessary to develop the Integrated Water Resources Use and Protection Plan for the Kura River Basin taking into consideration the status of the Caspian Sea's ecosystems; and
- To expedite joining of all riparian countries in the Kura River basin to the Helsinki Convention in order to maintain sustainable use and protection of transboundary water resources.

Implementation of these measures allows strengthening the capacity building, and finally to provide wise and efficient use of available water resources.

## 1.2 Analysis of the Status of Aquatic Ecosystems in the Republic of Armenia

### 1.2.1 Aquatic and Water-Related Ecosystems

Armenia is a mountainous country that is important for the whole South Caucasian region since many of rivers originate on its territory. Surface water resources amount to 7.15 cu km, including 0.94 cu km of transboundary water resources. Transit outflow from the country together with local runoff makes up 1.12 cu km per a year (from the upper part of the Kura River's catchment area to riparian countries (Georgia, Azerbaijan, and Iran) – 0.7 cu km per a year).

Table 1.2.1 Surface water resources in the Republic of Armenia

| River basin | Surface, $km^2$ | Runoff, $km^3$ | Volumetric runoff rate |
|---|---|---|---|
| Debed | 3,895 | 1,203 | 0.309 |
| Agstev | 2,480 | 445 | 0.205 |
| Small inflows of Kura river | 810 | 199 | 0.106 |
| Akhuryan | 2,784 | 391 | 0.140 |
| Kassakh | 1,480 | 329 | 0.222 |
| Metsamor | 2,240 | 711 | 0.317 |
| Razdan | 2,565 | 733 | 0.286 |
| Sevan lake basin | 4,750 | 265 | 0.056 |
| Azat | 952 | 232 | 0.244 |
| Vedi | 998 | 110 | 0.111 |
| Arpa | 2,306 | 764 | 0.331 |
| Vorotan | 2,476 | 725 | 0.293 |
| Vokhchi | 1,341 | 502 | 0.374 |
| Megri | 664 | 166 | 0.250 |
| *TOTAL* | *2,9741* | *6,775* | *0.228* |

*The status of river ecosystems.* There are about 9,480 streams and small rivers (of 23,000 km in total length) in Armenia. The river network density varies over the wide range of 0 to 2.5 $km/km^2$. The most dense river network is observed on territories belonging to the Zangezur Ridge and the Kura River basin. Some territories have no any runoff and a river network including northwestern areas adjacent to Lake Sevan and between rivers Gavaraget and Razdan.

*The status of lake systems.* In 1978, the Government has established the National Park covering the territory of Lake Sevan and declared about its plans to rehabilitate Lake Ghilli as well. For this purpose, the Arpa-Sevan tunnel (conduit) was built and commissioned in 1981 for transferring 0.250 cu km of water per a year from the Arpa River to Lake Sevan. Over the period of 1996 to 1998, the Program on Rehabilitation of Environmental Balance in Lake Sevan supported by the World Bank was developed for improving the ecological condition of Lake Sevan. In 2004, construction of the second Vorotan-Arpa tunnel had been completed. Owing to these measures, the law "On Sevan Lake" adopted in 2001 as well as several other by-laws, since 2002, a water level in Lake Sevan has increased up to its initial elevations.

### 1.2.2 Meeting Water Requirements of Aquatic Ecosystems

A basic river flow is mostly formed in mountainous regions where total atmospheric precipitation exceeds evaporation. Maximum flow rates are observed during a spring high flow. At the same time, the maximum flow of rivers belonged to the Kura River basin sometimes occurs during the period of summer-autumn low water resulted from storm rainfalls. Most rivers have two distinct periods of low water – summer-autumn and winter ones. During the intermediate period, rivers are mostly fed by the ground waters (however, in winter they are completely fed by ground waters).

Table 1.2.2 Water releases for the needs of aquatic ecosystems

| River basin | Actual state/water demand for 2004, cu km | | | | | | |
|---|---|---|---|---|---|---|---|
| | Ecological flow and sanitary water releases | Ecological flow and sanitary water releases* | 2004 | | | | |
| | | | Mean annual discharge | Q1 | Q2 | Q3 | Q4 |
| Debed | 0.008 | 0.28 | 1.18 | 0.22 | 0.55 | 0.26 | 0.15 |
| Akhstev | 0.05 | 0.06 | 0.43 | 0.07 | 0.28 | 0.05 | 0.03 |
| Kassakh | 0.02 | 0.05 | 0.05 | 0.004 | 0.02 | 0.02 | - |
| Razdan | 0.06 | 0.07 | 0.17 | 0.05 | 0.08 | 0.02 | 0.02 |
| Azat | 0.03 | 0.05 | 0.10 | 0.02 | 0.04 | 0.01 | - |
| Arpa | 0.02 | 0.15 | 0.43 | 0.07 | 0.28 | 0.03 | 0.04 |
| Vokhchi | 0.03 | 0.04 | 0.37 | 0.04 | 0.26 | 0.06 | 0.01 |
| Vorotan | 0.06 | 0.15 | 0.89 | 0.19 | 0.34 | 0.19 | 0.17 |

* the estimate of the Agency for Water Resources Management of the MNP of RA

As a whole, the volume of ecological water releases required for preserving the integrity of aquatic ecosystems are also sufficient for their rehabilitation.

### 1.2.3 Available Mechanisms for the Preservation of Aquatic Ecosystems

*Legislative base*: Water use in the Republic of Armenia is regulated by the following legal documents: the Water Code (2002), the resolution "On the approval procedure for ecological water releases and maximum permissible unrecoverable water offtake out of surface flows for every water bodies», the law "On the concept of water policy" (2005), the resolution "On controlling impacts on water resources over catchment areas and wetlands" (2003), and the decree "On the procedure for reservation of groundwater resources".

Institutional framework: the Water Code of Armenia clearly delineates functions of agencies responsible for water resources and water infrastructure management:

Government is responsible for the policy development including decision-making on budgeting rehabilitation of irrigation infrastructure and water releases from Lake Sevan.

The Water Commission approves the tariff policy in the water sector and authorizes the water systems operation.

The Ministry for Nature Protection is in charge of exercising economic mechanisms (water use fees and penalties for pollution), legal regulation (drafting environmental legislation), environmental studies and water use, pollution control and environment monitoring, environment impact assessment, and public relations.

The Water Resources Monitoring Agency under the Ministry for Nature Protection coordinates activity under the National Water Program as well as implements measures for protecting and controlling water resources.

The State Water Committee under the Government of Armenia is responsible for operation and maintenance of state water infrastructure.

The Ministry of Power is managing water releases from Lake Sevan pursuant to the approved rates.

Ministry of Finances and Economy is in charge of financing of governmental

agencies and institutions needs.

Water Users Associations (WUAs) are responsible for O&M of irrigation infrastructure and irrigated farming, as well as collect fee for water services.

### 1.2.4 Measures for the Preservation of Aquatic Ecosystems

In view of rehabilitation of aquatic ecosystems and adversely affected streams, in 2003 the Government of Armenia has issued the Resolution "On EIA Procedures." In 2004, the project for the preservation of river deltas and providing their rigorous water-protection regime was initiated. Within the frameworks of this project, rehabilitation of the Masrik River and Lake Gili is planned. In addition, over the period of 1986 to 2004, the works related to rehabilitation of the Razdan River delta and improving ecological conditions of Lake Sevan were implemented. At the same time, within the frameworks of this project, measures for strengthening the protection of the runoff formation zones and maintaining the rigorous water-protection regime within these areas. The following large-scale programs already accomplished or still being implemented in Armenia with the assistance of international donors:

- The Integrated Water Resources Management Plan (1999 to 2000, the World Bank);
- The Program on Rehabilitation of Environmental Balance in Lake Sevan (01.09.1995 to 15.05.1998, the World Bank);
- TheNational Environment Action Plan (01.06.1997 to15.05.1998, the World Bank); and
- The National Action Plan to Combat Desertification (05.07.1999 to 30.05.2002, UNEP).

### 1.2.5 Basic conclusions and recommendations

*Conclusions:* At the current stage, the basic problems in the field of integrated water resources management taking into consideration the needs of aquatic and water-related ecosystems are the following:

- Lack of integration of aquatic ecosystems' needs into the water resources management system and their degradation resulted from water pollution and economic activity;
- Poor water quality resulted from industrial, agricultural and municipal pollution;
- Natural disasters: floods, high waters, soil erosion;
- Conflicts among different water users related to water sharing including at the transboundary level;
- Lack of incentives for water savings and reducing water reserves due to inefficient water consumption and deteriorating the environment; and
- Neglect of ecosystems protection under establishing recreational zones.

At the same time, water resources management faces intersectoral conflicts to be settled by means of the co-ordination of departmental, intersectoral, public and private interests as well as water protection and sustainable management, including the following:

- Making a compromise to meet the needs of the power, industry, irrigation sectors in water resources, including water quality and water management issues as well as reserving fresh water of Lake Sevan;
- Demand and supply management, in particular in arid areas, meeting water requirements of ecosystems, minimal environmental flows as well as strategic reserves of fresh water and water desalinization; and
- Solving the political and institutional issues, including development of the efficient mechanism for water allocation and establishing water use rights.

*Recommendations:* Drawdown of groundwater table, pollution, silting, erosion, salinization and other processes most crucially affect water resources, aquatic and water-related ecosystems. Taking into consideration the above-stated provisions, the following recommendations related to water conservation issues had been developed:

*In the field of environment protection*:

1. Developing the criteria for specifying a minimal rate of ecological flow;
2. Establishing the improved monitoring system for water quality management;
3. Establishing the water protection and developing the management system for coastal zones;
4. Improving the territorial planning and land use planning system; and
5. Protecting the potable water sources.

*In the field of water resources monitoring*:

1. Providing the routine monitoring of the quality and quantity of surface and ground water resources; and.
2. The routine assessment of the status of surface and ground water resources.

## 1.3 Analysis of the Status of Aquatic Ecosystems in the Republic of Georgia

### 1.3.1 Aquatic and Water-Related Ecosystems

Mean annual runoff formed on the territory of Georgia amounts to 56.5 cu km. Transit inflow from adjoining territories makes up 9.3 cu km.

*The status of river systems in the runoff formation zone*. Waters accumulated in glaciers, lakes, and wetlands refer to slowly renewable ones. The distribution of water resources over the territory is uneven. The Tushet-Alazan basin is the most abundant in water resources, and the least water availability is observed in the Terek River basin.

Table 1.3.1 Water releases necessary to meet the needs of aquatic ecosystems *

| River basin | Ecological and sanitary runoffs (km3) | | | | | |
|---|---|---|---|---|---|---|
| | Actual runoff/Water requirements | | | | | |
| | 2003 | 2004 | | | | |
| | | Total | Q I | Q II | Q III | Q IV |
| The Kura River basin: Alignment at Tbilisi | 1.78/ no | 1.76/ no | 0.26/ no | 1.0/ no | 0.3/ no | 0.2/ no |

| | | | | | | |
|---|---|---|---|---|---|---|
| Khrami River delta | 0.63/ no | 0.57/ no | 0.14/ no | 0.19/ no | 0.1/ no | 0.14/ no |
| Alazani River delta | 1.6/ no | 1.8/ no | 0.2/ no | 0.9/ no | 0.3/ no | 0.4/ no |
| Iori River (g.s. Paldo) | 0.1/ no | 0.123/ no. | 0.022/ no | 0.04/ no | 0.04/ no. | 0.021/ no |

* Note: 1. All data are estimated ones.
2. no – not defined.

Almost all ecosystems suffer from heavy anthropogenic impacts. Economic activity drastically damages and reduces the areas of arid ecosystems of semi-deserts and open woodlands, as well as the areas of plain and mountain forests. Therefore, the protection of water bodies against pollution is one of the most important problems needed to be urgent solved. It is necessary to solve the following tasks: extending and improving the monitoring network for controlling quality and quantity of sewage disposed into the rivers; reducing solid and liquid wastes in the industrial sector; providing sewage dilution and self-purification process in each stream; and developing and practical use of efficient apparatuses and structures for intensification of water mixing and aeration. The last two positions are very important for small streams and densely populated areas in Georgia where water use has the complex nature.

### 1.3.2 Meeting the Water Requirements of Aquatic Ecosystems

During last 15 years, water balances for rivers in Georgia are not drawn up causing severe difficulties for water resources management and use. Only information for some gauging alignments where observations are performed in sufficient scopes is given in Table 1.3.1.

### 1.3.5 Available Mechanisms for the Preservation of Aquatic Ecosystems

*Legislative base:* The basic legal instruments in the field of water resources management are the following: the law "On the Preservation of Environment" (1996) and the Forest Code (1999). The bilateral agreements on co-operation in the field of the protection of the environment with Azerbaijan (1997) and Armenia (1997) are also important.

*Institutional Framework*:
Since 2004, the early independent institution – the State Department for Protected Areas – was merged with the Ministry of Nature Resources and Environment. Thus, three Georgian institutions engaged in the protection of ecosystems (the Ministry of Natural Resources and Environment, State Department of Forestry, and State Department for Protected Areas) are now under general management. The Hydrometeorological Service, Department of Geology, and some other organizations are also an integrated part of this ministry.

### 1.3.3 Measures for the Preservation of Aquatic Ecosystems

In 1996, Georgia has ratified the Ramsar Convention (1971). Two territories were specified as wetlands of international importance to be included into the Ramsar List namely: wetlands of Kolkheti Lowland and the Ispani region. In the 1920s, the intense drainage works were initiated in the Kolkheti lowland in order to use this territory for needs of agriculture. As a result, natural wetlands' ecosystems were destroyed over the large portion of the lowland. After including this territory into the Ramsar List,

rehabilitating the natural ecosystems is being implemented here.

Implementing the Regional Program on Nature Protection in Southern Caucasus is planned. Azerbaijan, Armenia, and Georgia participate in implementing this program. In particular, establishing of the National Park on the territory of Georgia along the boundary with Turkey and Armenia (about 20,000 hectares in area) and four protected wetlands (Khatchali, Bugdasheni, Madatapa, and Sagamo) is envisaged. It is expected that the National Biodiversity Strategy and Action Plan will be adopted in the nearest future in Georgia. One of the goals of this strategy is to create the network of protected natural areas including new Ramsar Sites.

Table 1.3.2 Measures for the preservation of river deltas and maintaining their proper water-protection regime

| **Georgia** | **Region** | **Budget USD million** | **Period** | **Output** | |
|---|---|---|---|---|---|
| | | | | **As of 2004** | **Planned** |
| The Forests Development Project | Over the country | 21.34 * | 2000-2008 | Afforestation of 8.8 ha | Reducing the area of degraded land |
| The Protected Areas Development Project | Eastern Georgia (Vashlovani, Lagodekhi, Tusheti) | 10.29 ** | 2001-2006 | Field study of biodiversity | Developing three protected areas |
| Mitigating Degradation of the Transboundary Kura River Basin | Eastern Georgia (the Kura River Basin) | 0.6496 *** | 2003-2005 | Analysis of the situation within the | Improving the ecological situation in the basin |
| Integrated Management of the Black Sea Coastal Strip | The Black Sea coast | 3.2 **** | 1999-2006 | The Management Plan for Kolkheti National Park, the plan for rehabilitation of wetlands | The Management Plan for Kolkheti National Park, the plan for rehabilitation of wetlands |
| Establishing Borjomi-Kharagauli National Park | Central Georgia | 5 ***** | 1998-2005 | The park developing program | Developing infrastructure of the park |

*) US$15.67 million – the International Development Association, US$5.67 million – The Ministry of Finance of Georgia **) GEF and USAID; ***) Swedish International Development Agency; ****) GEF, the International Development Association, the Government of the Netherlands, the Government of Georgia; *****) – the Government of Germany

### 1.3.4 Basic Conclusions and recommendations

*Conclusions:* Current problems in the water sector are evidence of incapacity of the current water policy. Institutional and legislative reforms are necessary for forming the efficient water policy by means of settling the following matters:

- Specifying roles and responsibilities of the Government, water agencies, and other stakeholders with regards to water resources management, use, development and protection;
- Implementing the principles of integrated water resources management at the river basin level and the ecosystem approach;
- Clear-cut defining social, economic, and ecological values of water resources;

- Restructuring political powers, privatization of water infrastructure, strengthening the role of institutions of local governing and public participation; and
- Clear-cut specifying the water rights, as well as regulations and mechanisms of the inter-sector co-ordination.

*Recommendations:* For implementing the principles of integrated water resources management at the river basin level and putting the ecosystem approach into practice, it is necessary to provide the following:

- Launching the campaign to provide public awareness and the political support by the population and policy makers to implementing the IWRM principles.
- Providing the support of international financial organizations for developing a new water legislation (the Water Code) of Georgia.
- Implementing one or two pilot projects to demonstrate the methods of conservation of ecosystems with the technical assistance of appropriate international experts;
- Rehabilitating the monitoring system and conducting of hydrological observations in order to draw up the adequate water balance and the Water Cadastre of Georgia;
- Implementation of target scientific researches in the field of hydrology to specify the science-based rates of ecological flows for country's water bodies; and
- Developing and implementation of the program of hydropower resources use taking into consideration the sustainable development of the country.

# CHAPTER 2 THE PRESERVATION OF ECOSYSTEMS AND RESOURCES OF INLAND WATER BODIES IN COUNTRIES OF CENTRAL ASIA

## 2.1. Analysis of the Status of Aquatic Ecosystems in the Republic of Kazakhstan

### 2.1.1 Aquatic and Water-Related Ecosystems

One of the hydrological features of Kazakhstan is that its territory is mainly located within the zones of river flow transit and use including deltas of the large river basins (Syr Darya, Ili, Ural, and Irtish). Total water resources in an average year make up 100.5 cu km; of them, only 56.5 cu km form on the territory of the republic, and the rest volume of 44.0 cu km comes from neighboring states. The total area of glaciers in mountains makes up about 2033.3 sq km, and their total water resources reserves - 95 cu km (this volume is close to an annual discharge of all rivers in Kazakhstan).

Table 2.1.1 Surface water resources in the Republic of Kazakhstan

| Basin | Mean annual runoff, km³ | | Runoff under water probability, km³ | | Available water resources, km³ | |
|---|---|---|---|---|---|---|
| | Total | Including transboundary water resources | 75% | 95% | 75% | 95% |
| Aral-Syr Darya | 17.9 | 14.6 | 14.7 | 14.2 | 9.8 | 9.3 |
| Balkhash-Alakol | 27.8 | 11.4 | 22.8 | 17.8 | 7.0 | 5.4 |
| Irtysh | 33.5 | 7.5 | 26.6 | 19.7 | 10.8 | 8.0 |

| Basin | Mean annual runoff, km³ | | Runoff under water probability, km³ | | Available water resources, km³ | |
|---|---|---|---|---|---|---|
| | Total | Including transboundary water resources | 75% | 95% | 75% | 95% |
| Ishim | 2.6 | - | 1.1 | 0.3 | 0.4 | 0.1 |
| Nura-Sarysu | 1.3 | | 0.4 | 0.1 | 0.3 | |
| Tobol-Turgay | 2.0 | - | 0.8 | 0.3 | 0.3 | - |
| Shu-Talas | 4.2 | 3.0 | 3.5 | 2.8 | 3.0 | 2.3 |
| Ural-Caspian | 11.2 | 7.5 | 6.2 | 3.0 | 1.0 | 0.3 |
| Total | 100.5 | 44.0 | 76.1 | 58.2 | 32.6 | 25.5 |

Source: the Committee for Water Resources of RK

Table 2.1.2 Reducing an ice field area in the Zailiyskiy Ala Tau over the period of 1959 to 1990

| Basin | Ice area, sq km | | | Reducing an ice field area, sq km | | | % of the 1955 area |
|---|---|---|---|---|---|---|---|
| | 1955 | 1979 | 1990 | 1955 to 1979 | 1979 to 1990 | 1955 to 1990 | |
| Great Almatinka River | 33.9 | 25.25 | 21.938 | 8.65 | 3.312 | 11.962 | 35.2 |
| Small Almatinka River | 9.3 | 8.12 | 0.353 | 1.18 | 1.767 | 2.947 | 31.7 |

The territory of Kazakhstan may be conditionally subdivided into eight water management basins: Aral-Syr Darya, Shu-Talas, Balkhash-Alakol, Irtysh, Ishim, Nura-Sarysu, Tobol-Torgay and Ural-Caspian.

Kazakhstan belongs to the countries with insufficient surface water resources. Owing to the climatic peculiarities, up to 90 percent of annual runoff of steppe rivers occurs during the spring period and up to 70 percent of annual runoff of mountain rivers during the summer period. In particular, the total volume of mandatory water releases to meet environmental and sanitary requirements of the rivers Syr Darya, Ural, Ili, Tobol, Irtysh, Ishim, Turgay and Shu makes up about 29 cu km per year.

Water resources deficit is caused by the natural factors (irregularity of surface waters distribution over the country, time-related variations of river runoff over years and seasons) and by significant use of transboundary river flows by neighboring countries. Intensive use of water resources accompanied by their substantial pollution has resulted in degradation of aquatic and water-related ecosystems in the runoff formation and transit zones and especially in so-called “runoff dispersion zone.”

*Current condition of ecosystems in the runoff formation zone*: Kazakhstan glaciers substantially influence upon the hydrological regime of mountainous rivers, as thawing of glaciers in summer provides considerable river flows in the periods of especially high requirements of natural and economic systems in water: piedmont and lowland ecosystems and water users of the main economic sectors (irrigated farming and hydropower generation). Based on monitoring data it was established that during the 35-years period (1955 to 1990) the area and volume of the Zailiyskiy Ala Tau glaciers reduced by more than 25 percent.

Generally, the environmental status of mountainous territories of Kazakhstan is remarkable

for wide spread of increasingly active erosion processes and dangerous natural phenomena in mountains. The unavoidable consequences of these processes are profound changes in the hydrothermal regime of mountain surface, depletion of renewable water resources and increasing the probability of dangerous natural phenomena.

One of the topical problems in the runoff formation zone is prospects of development of recreational activities in the mountain areas. In this connection, the problem of regulating the recreational load on mountain ecosystems becomes increasingly keen, and therefore the uncontrolled tourism may pose a threat to mountain communities and the environment.

*Current condition of ecosystems in the transit flow zone*: is characterized by degradation of basic components of biota due to water resources shortage and polluting water sources. Anthropogenic impacts are observed in all basic river basins within the country.

Table 2.1.3 Water availability over river basins of the Republic of Kazakhstan

| No | Basin | Water availability, % | | |
|---|---|---|---|---|
| | | Wet year | Average year | Dry year |
| 1 | Aral-Syr Darya | 90 | 82 | 77 |
| 2 | Balkhash-Alakol | 98 | 80 | 61 |
| 3 | Irtysh | 100 | 100 | 100 |
| 4 | Ishim | 90 | 40 | 10 |
| 5 | Nura-Sarysu | 53 | 20 | 5 |
| 6 | Tobol-Turgay | 89 | 33 | 6 |
| 7 | Shu-Talas | 90 | 73 | 56 |
| 8 | Ural-Caspian | 100 | 35 | 10 |
| Total | | 97 | 76 | 60 |

Source: Water Resources Committee of MoA RK

*The Syr Darya River Basin* is characterized by the complicated situation, especially in lower reaches, which resulted from mainly developing irrigation in the middle reach of the river and increase in irrevocable water withdrawal for this purpose. Change in environment conditions has affected the existence of various groups and species of the Aral Sea fauna, their number and structure. The significant number of waterfowls and water-related birds have moved to other regions.

*In the Ural-Caspian basin*, water requirements substantially exceed actual capabilities to meet them, especially in dry years. As a result, the commercial reserves of migratory and semi-migratory fish in the Ural River of great fishery importance are drastically decreasing last years. Due to the Caspian Sea transgression, the coastal territories heavily polluted by oil products are threatened with inundation. Oil pollution of the territory is not only a severe environmental problem for Kazakhstan but also for the Caspian Sea region as a whole, resulting in enormous economic and environmental losses.

*The basins of the Central and Northern Kazakhstan rivers*: Over the overall territory of the basins, a stable trend to reduction of natural biodiversity is observable due to worsening of flora and fauna habitats conditions. The imperfect system of surface water pollution monitoring complicates the general assessment of water resources quality dynamics.

*The Irtysh River basin*, despite its considerable water resources, also experiences water deficit and severe industrial pollution. At present, the Irtysh River, its resources, flora and fauna are in threatening conditions, which require urgent actions for protecting and rehabilitating their natural potential.

*The Balkhash Lake basin* is one of the most problematic basins with respect to both water availability and the environment due to growing irrevocable water diversion from the Ili River by China and its intensive pollution resulting in deterioration of all natural environment components, drying up of the lake itself and the Ili River delta. Further degradation may result in irreversible consequences, and the Balkhash Lake region of 500,000 sq km may become another ecological disaster zone in the nearest future.

### 2.1.2 Meeting Water Requirements of Aquatic Ecosystems

Environmental flows into lower reaches of Kazakhstan rivers are substantially determined by water releases from reservoirs upstream the rivers, and by the water management situation at a specific water body and in the region as a whole. For example, the future status of Lake Balkhash may be significantly affected by growth of water consumption on an adjacent territory of the PRC. Investigations[11] have shown that replenishing the Kapshagay Reservoir must be limited in order to maintain the Balkhash water level enabling the restoration of natural within-year flow variations in the Ili River lower reach and stabilization of ecosystems' conditions.

Table 2.1.4 Water releases for aquatic ecosystems' needs

| Basin | Ecological and sanitary water releases ($km^3$) | |
|---|---|---|
| | Actual data as of 2003. | Normative requirement |
| 1. Aral-Syr Darya | 11.87 | no.* |
| including into the Aral Sea | 9.76 | 3.10 |
| 2. Balkhash-Alakol | 21.7 | no. |
| Lake Balkhash | 17.6 | 14.60 |
| including: Ili River | 13.06 | 12.20 |
| Lake Sasikol | 1.74 | no. |
| including Tentek River | 1.74 | 0.40 |
| Lake Alakol | 1.88 | no. |
| including Urjar River and other rivers | 1.84 | 0.15** |
| 3. Irtish | 23.0 | no. |
| including Irtish River outflow into RF | 23.0 | 13.00*** |
| 4. Ishim | 0.94 | no. |
| including Ishim River outflow into RF | 0.24 | 0.032 |
| 5. Nura- Sarisu | 0.55 | 0.10 |
| including: Nura River and other rivers | 0.42 | 0.074 |
| Sarisu River and other rivers | 0.13 | 0.01 |
| 6. Tobol- Torgay | 0.80 | no. |
| Tobol River outflow into RF | 0.50 | 0.016 |
| Torgay River with Irgyz River | 0.30 | 0.16 |
| 7. Ural-Caspian | 8.80 | no. |

[11] The Geography Institute of NAS RK has made a case study of potential increase of irrevocable water consumption by 1.76 $km^3$/year in the Chinese part of the Ili River basin by 2010.

| Basin | Ecological and sanitary water releases ($km^3$) | |
|---|---|---|
| | Actual data as of 2003. | Normative requirement |
| including Ural River and water release into the Caspian Sea | 8.10 | 6.50 |
| 8. Shu-Talas | 3.52 | no. |
| including: Shu River | 2.65 | 0.10 |
| Talas River | 0.68 | 0.034 |
| Total in Kazakhstan | 66.6 | 37.482 |

* no– did not specified , ** - 0.15 $km^3$ – through Urjar River, *** - 13.0 $km^3$ – integrated release: sanitary – 4.3 km3, for navigation – 8.7 $km^3$

At the same time, it may be stated, that in Kazakhstan there is no scientifically grounded assessment of actual importance of aquatic ecosystems at both regional and national level. At this stage, an environmental and economic substantiation of necessity and rates of ecological water releases to ensure optimal functioning of natural and economic systems are only being initiated to be substantiated.

### 2.1.3 Available Mechanisms for the Preservation of Aquatic Ecosystems

*Legislative base*: Water resources use is regulated by the Water Code (2003), Land Code (2003), and Forest Code (2003), and by the following laws: «On the environment protection» (1997), «On sanitary and epidemiological security of the population» (2002), «On emergencies due to natural and man-caused events» (1996), «On rural water user consumers»; as well as by the decrees «On subterranean resources use and protection» (1996) and «On land resources» (2001), and by the conceptions "Water sector development and water policy of the Republic of Kazakhstan by 2010" and «Ecological Security of the Republic of Kazakhstan for 2004-2015»; the national program «Developing rural areas of the Republic of Kazakhstan over the period of 2004 to 2010», and the National food Program of the Republic of Kazakhstan for the period of 2003 to 2005.

*Institutional Framework*:

The Ministry of Agriculture (MoA) is the major agency responsible for developing the sector of water supply and sanitation (WSS) and water resources protection. The Water Resources Committee (WRC) under the MoA is immediately responsible for WSS development programs and water management.

The Ministry of Health monitors water quality through its Sanitary and Epidemiologic Control Department.

The Committee for Geology and Mineral Resources controls exploitation of groundwater resources.

The Ministry of Environment Protection establishes the guidelines for control of water resources condition.

The Construction Committee of the Ministry of Transport and Communications, the Committee for Forestry, Fishery and Hunting Grounds, and the State Land Committee also play a certain part in water sector management and activities.

### 2.1.4 Measures for the Preservation of Aquatic Ecosystems

In January 2002, the Government of Kazakhstan has adopted the Concept of Water Sector

Development and Water Policy of the Republic of Kazakhstan until 2010, which aimed at the preservation of runoff formation zones and river deltas and maintaining their rigorous water-protective regime. In addition, a number of national and donor projects and programs related to the conservation and rehabilitation of water resources are implemented in the country. The list of the basic on-going and completed projects of the Kazakhstan water sector is given below.

Table 2.1.5 Projects are implemented in the water sector of the Republic of Kazakhstan

| # | Project title | Funding source | Project status |
|---|---|---|---|
| 1. Projects covering different basins | | | |
| 1 | The Northeast Kazakhstan Water Supply and Sanitation Project; water consumption and demand, distribution network, leakage management, analysis of productivity and methods of water treatment in cities Karaganda, Temirtau, and Kokshetau | World Bank | ongoing |
| 2 | Wastewater disposal studies for Karaganda, Temirtau, Kokshetau, and Atyrau | EC/TACIS | completed |
| 3 | The Farm Sector Restructuring and Development Program | Asian Development Bank | to be completed in 2005 |
| 4 | The Rural Water Supply and Sanitation Sector; Physical Infrastructure Improvement and Capacity Building | Asian Development Bank, Islamic Development Bank and Government of Kazakhstan | ongoing |
| 5 | Institutional Strengthening for the Rural Water Supply and Sanitation Sector Services | Asian Development Bank | ongoing |
| 6 | The Sector Program "Drinking Water" 2002-2010 | Government of Kazakhstan | approved by Government |
| 7 | The Concept for Water Sector and Policy Development of the Republic of Kazakhstan up to 2010 | Government of Kazakhstan | approved by Government |
| 8 | Developing a new method for specifying the utmost permissible impacts on water bodies | Government of Kazakhstan, CAREC | ongoing |
| 2. The Irtysh River basin | | | |
| 1 | The Action Plan for Improvement of Water Quality in the Irtysh River Basin | Government of France | completed |
| 2 | The Irtysh River Basin Transboundary Water Management Project | GEF and Government of France | ongoing |
| 3 | Proposals for the Remediation of Contaminated Groundwater and Hazardous Industrial Waste Sites in the Ust-Kamenogorsk Area, Kazakhstan | Government of Germany | completed |
| 4 | Study of Cost Efficient Methods for Decreasing Risks of Contamination by Heavy Metals in Industrial Centers by the Example of the Mercury Pollution at “Khimprom” Pavlodar (Study of Mercury Pollution at “Khimprom” Pavlodar) | EC | completed |
| 5 | Supporting Implementation of Environmental Policies and NEAPs in the NIS; Kazakhstan, Sub-Task 10g “Development of a Pilot Regional Financing Strategy for the Urban Water Supply and Sanitation Sector” | EC/TACIS | completed |
| 6 | The Ust-Kamenogorsk Environment Rehabilitation Project | Government of Japan | stage of preparation |
| 7 | The Semipalatinsk Region Rehabilitation Program | TACIS, DFID (UK) | stage of preparation |

| # | Project title | Funding source | Project status |
|---|---|---|---|
| 3. The Ishim River basin | | | |
| 1 | The Feasibility Study for Water Supply and Sanitation in Astana City of in the Republic of Kazakhstan | Government of Japan | completed |
| 2 | The Detail Design of Water Supply and Sewerage Systems in Astana City in the Republic of Kazakhstan | Government of Japan | completed |
| 3 | The Feasibility Study for Protecting of Astana against Esil River Floods | Government of Kazakhstan | completed |
| 4 | Infrastructure of Astana City: 2 parts | KFAED (Kuwait Fund for Arabic Economical Development) | completed |
| 5 | The Nura-Ishim River Basin Management Project | DFID (UK) | ongoing |
| 4. The Tobol-Torgay River basin | | | |
| 1 | The Joint River Management Programme on Monitoring and Assessment of Water Quality on Transboundary Rivers | EC/TACIS | ongoing |
| 5. The Ural-Caspian basin | | | |
| 1 | The Atyrau Pilot Water Supply and Sanitation Project | Akimat of Atyrau region and World Bank | completed |
| 2 | The Atyrau Municipal Infrastructure Development Project, Kazakhstan; Improvement of the Drainage System in Atyrau City | Akimat of Atyrau region and EBRD | ongoing |
| 3 | The Caspian Regional Environmental Programme | RK, EC/TACIS, UNEP, UNDP, WB, GEF | ongoing |
| 6. The Nura-Sarisu River basin | | | |
| 1 | The Nura-Ishim Basin Environment Management and Rehabilitation Project: Nura Riverbed Cleaning Project | World Bank | ongoing |
| 2 | The Kazakhstan Dams Safety Study, Intumak Reservoir | World Bank | completed |
| 3 | The Mercury Pollution Monitoring and Intumak Reservoir Study | Japan International Cooperation | stage of preparation |
| 7. The Shu-Talas River basin | | | |
| 1 | The Feasibility Study for “Vodokanal” in Taraz | Government of France | completed |
| 8. The Balkhash-Alakol basin | | | |
| 1 | The Almaty Potable Water Supply and Sanitation Project, Kazakhstan, Rehabilitation and Development of the Water Supply and Sewerage Network in Almaty (Almaty Sui) | EBRD and Government of France | ongoing |
| 2 | The Kazakhstan Mountain Agrobiodiversity Conservation Project | GEF | completed |
| 3 | Ili-Balkhash Basin Integrated Management Plan | EC/TACIS, CAREC | ongoing |
| 9. The Aral-Syr Darya basin | | | |
| 1 | The Feasibility Study: «Kazakhstan – Water Supply, Sanitation, and Health» | KFAED (Kuwait Fund for Arabic Economical Development) | completed |
| 2 | The Feasibility Study «Syr Darya Riverbed Control and Northern Aral Sea» | Government of Japan and World Bank | completed |
| 3 | «Kyzylorda – Pilot Water Supply Project» (Aralsk and Kazalinsk rayons) | World Bank and Government of Kazakhstan | completed |
| 4 | «Kyzylorda – Pilot Sanitation Project» (Aralsk and Kazalinsk rayons) | World Bank | completed |
| 5 | «Aralsk Water Supply Project» (Full-scale project) | KFAED (Kuwait Fund | ongoing |

| # | Project title | Funding source | Project status |
|---|---|---|---|
| | | for Arabic Economical Development) | |
| 6 | «Kazalinsk Water Supply Project» (Full-scale project) | KFW | ongoing |
| 7 | Syrdarya River Control and Northern Aral Sea Project. Phase 1 | World Bank and Government of Kazakhstan | ongoing |

Many of the above listed projects are not directly related to the conservation of ecosystems in runoff formation and river delta zones. Analysis shows that, in general, the activities for improving the status of aquatic and water-related ecosystems including donor arrangements are quite energetic in Kazakhstan. However, despite generally substantial resources involved, it should be considered that the progress made in rehabilitation of aquatic ecosystems is insignificant.

### 2.1.5 Basic conclusions and recommendation

*Conclusion:* Preserving the water balance and the condition of ecosystems in the transboundary river basins depends on settling water relations with other riparian states. At present, the rates of ecological flows and sanitary water releases mainly depend on water availability in a specific year and often do not meet the needs of ecosystems in lower reaches of rivers. Enormous water losses in excess of planned rate and lack of a management system promoting efficient use of irrigation water result in increasing a share of expenditures for irrigation within production cost and decreasing the competitiveness.

*Recommendations:*

- The governance within territorial units should be based on the ecosystem approach, and with respect to water resources on the basin principle i.e. within hydrographical boundaries of the river basins and by the basin authorities;
- Searching the compromises that enable, on the one hand, to maintain functioning of basin ecosystems and, on the other hand, generating economic benefits from water resources use;
- It is necessary to consider interrelations and unity of quantitative and qualitative characteristics of water resources;
- Putting the environment impact assessment into practice for any water-economic activity at all phases of its implementation (planning, design, construction, operation, and maintenance);
- Priority of scientific researches and integrated environmental monitoring;
- Forecasting in the course of developing any water management projects and arrangements;
- It is necessary to specify the needs and minimum requirement to ecological flows in lower reaches of the rivers; and
- Designation of agencies responsible for planning, maintaining, and monitoring ecological flows is one of the topical tasks.

## 2.2 Analysis of the Status of Aquatic Ecosystems in the Kyrgyz Republic

### 2.2.1 Aquatic and Water-Related Ecosystems

Kyrgyz Republic has abundant water resources consisting of river flows, groundwater, and water accumulated in glaciers and lakes. In average years, total water resources amount to 2,458 cu km. Glaciers and permanent snowfields cover 8,169.4 sq km or 4.2 percent of the national territory. Fresh water reserves in mountain glaciers are estimated at the rate about 650 billion cu m exceeding the river discharge in the republic more than 12 times.

Table 2.2.1 Distribution of surface water resources formed within the Kyrgyz Republic

| **Basin** | Estimated water resources formed within Kyrgyzstan, km³ | Distribution of water resources, km³ a year | | | | |
|---|---|---|---|---|---|---|
| | | Kyrgyzstan | Kazakhstan | Uzbekistan | Tajikistan | China |
| Chu River | 5.00 | 3.85 | 1.15 | - | - | - |
| Rivers Talas and Kurkureu | 1.74 | 1.00 | 0.74 | - | - | - |
| Syr Darya River | 27.40 | 4.88 | - | 22.18 | 0.34 | - |
| Amu Darya River | 1.93 | 0.42 | - | - | 1.51 | - |
| Lake Issyk-Kul | 4.65 | 1.56+3.09*) | - | - | - | - |
| Ili River (Karkara) | 0.36 | 0.18 | 0.18 | - | - | - |
| Tarim River (Sarijaz) | 6.15 | - | - | - | - | 6.15 |
| **Total km³** | **47.23** | **14.98** | **2.07** | **22.18** | **1.85** | **6.15** |
| % | 100 | 31.71 | 4.38 | 46.97 | 3.92 | 13.02 |

*) Note: *) 1.56 km³ formed in the Lake Issyk-Kul basin can be used for irrigation, communal and industrial needs, and 3.09 km³ should be annually supplied to Lake Issyk-Kul to meet ecological requirements

Excluding its high-mountainous part, the territory of Kyrgyz Republic is located in the semiarid zone where agriculture is based on irrigation. During the last decades, a number of factors affected ecosystems of the country and caused decline in the number of communities and species including species of commercial importance. At the same time, it is necessary to note that ecosystems within the runoff formation zone have insignificantly transformed, and Kyrgyz Republic plays an important role in providing water resources for all countries of the Central Asian region located in lowlands.

In different river basins of Kyrgyz Republic, the ratio in spreading zones of runoff formation and use is also different. For example, the predominance of the runoff formation zone over the zone of river flow consumption is typical for the basin of Lake Issyk-Kul. A major share of water resources (90 %) is used for irrigation. The irrigation canals, most of which look like natural watercourses, form the hydrographic network peculiar and typical for the zone of river runoff consumption.

### 2.2.2 Meeting Water Requirement of Aquatic Ecosystems

In 2004, ecological flows made up 32.69 cu km or 69.2 percent of all surface water resources formed within the republic. However, this indicator is conditional because it can change depending on economic development.

Table 2.2.2 Parameters of mean annual discharges of rivers in the Kyrgyz Republic

| Basin | River flow for years of different probability | | | |
|---|---|---|---|---|
| | Mean annual discharge, km³ | Probability - 50% | Probability - 75% | Probability - 95% |
| Syr Darya River | 27.4 | 26.7 | 23.2 | 18.7 |
| Amu Darya River | 1.93 | 1.92 | 1.79 | 1.62 |
| Chu River | 5.00 | 3.48 | 3.21 | 2.84 |
| Rivers Talas and Kurkureu | 1.74 | 1.51 | 1.35 | 1.13 |
| Ili River (Karkara) | 0.36 | 0.33 | 0.29 | 0.23 |
| Tarim River | 6.15 | 5.98 | 4.82 | 3.56 |
| Lake Issyk-Kul | 4.65 | 3.77 | 3.52 | 3.13 |
| Total | 47.2 | 43.7 | 38.2 | 31.2 |

Table 2.2.3 Water releases for the needs of aquatic ecosystems

| Basin (lakes, rivers at gauging stations) | Ecological flow and sanitary water releases (km³) | | |
|---|---|---|---|
| | Normative rate = 0.75*Qmin year of 95% probability | Actual data as of 2004 | 2005 |
| Amu Darya River | | | |
| including: Vakhsh River | 0.9 | 1.93 | |
| Syr Darya River –Kayrakum Reservoir. | 5.35 | 16.28 | |
| Ili River – estuary | 0.07 | 0.36 | |
| Assa River – estuary | 0.04 | 0.1 | no |
| Talas River – Kirov Reservoir | 0.25 | 1.14 | |
| Chu River - Tashatkul Reservoir. | 0.89 | 2.91 | |
| Tarim River (Sarijaz) | 0.98 | 6.15 | |
| Lake Issyk-Kul | 3.09 | 3.79 | |
| **Total for** Kyrgyz Republic | **11.57** | **32.69** | |

no – flows were not defined

### 2.2.3 Available Mechanisms for the Preservation of Aquatic Ecosystems

*Legislative base*: The basic principles of the state policy in the field of water resources use are set forth in the Constitution, Water Code (2005), and Law "On Environment Protection." Some aspects of water relations are regulated by the following legislative acts in force: the laws on licensing, water supply tariffs, drinking water; subterranean resources, land code etc.

However, dozens of by-laws (guidelines, standards, norms etc.) developed prior to 1992 that are inadequate to modern conditions and contain some antagonisms adversely affecting water resources management are still in force in the republic.

Transbountary water resources use is regulated by bilateral and multilateral agreements as well as international conventions and norms of international water legislation.

*Institutional framework*: The sectoral principle of water resources management when functions and responsibilities in the field of water governance are distributed among different ministries and departments is employed in the republic.

The State Water Administration is responsible for water resources governance and putting provisions of the Water Code into practice.

The Ministry of Agriculture, Water Resources and Processing Industry that is also the agency responsible for water resources management is exercising control of water resources protection and use.

The Ministry of Public Health is in charge for controlling implementation of water protection requirements, sanitation standards, and the established maximum permissible concentrations of pollutants in water.

The Ministry of Geology and Subterranean Resources Protection co-ordinates groundwater use and location of infrastructure and projects that can be sources of groundwater pollution.

The Water Cadastre is drawn up by departments of the following sectors: hydrometeorology, water management, geology, and nature protection.

The departmental dissociation in the water sector and lack of a united organization for management in river basins do not allow efficiently tackling tasks of integrated water resources use and protection in the basins.

### 2.2.4 Measures for the Preservation of Aquatic Ecosystems

The current situation in the country can be characterized by complete disintegration of the system for monitoring surface water quality that is conducted irregularly and only in some river basins.

Analyzing mean annual discharges of basic rivers under the current trend of increase in water availability allows making the following conclusions:

1. During last 30-year period, a considerable change in water availability of rivers occurred. The total water resources of rivers have increased by 6 percent, on average;
2. Forecasting water availability until 2020 for rivers with a glacial-snowy type of runoff forming has shown the increase in water availability by 14 to 16 percent on average;
3. In rivers with a snowy-glacial type of runoff forming, water availability will increase by 6.0 to 10 percent.
4. Further decreasing water availability of rivers with snowy and snowy-rainy types of runoff forming is expected (especially in closed depressions), as well as in those regions where degradation of glaciers takes place, for example, in the western part of southern slopes of the Kungley-Alatau Ridge;
5. Increase in water availability in the republic as a whole by 11 percent on average is expected; and
6. According to the forecast until 2020, the total water resources of rivers for internal demand are estimated at the rate of 1,441 m3/sec (45.4 cu km a year).

In 2000, the biosphere reserve “Issyk-Kul” covering 4,314,400 hectares (within the administrative boundaries of Issyk-Kul Province) and having the status of special protected area according to the legislation in force was established.

At present, implementing of the Germany-Kyrgyzstan Project that comprises a joint assessment of water resources of Kyrgyz Republic including studies of spatial distribution and dynamics of natural and anthropogenic landscapes, water bodies, glaciers, snow cover, precipitation, and river flows is under discussion.

### 2.2.5 Basic conclusions and recommendations

*Conclusions:* Two levels of institutional risks in the water sector can be distinguished: regional and national. Water sharing among riparian countries (water users) aggravated with contradictive water requirements of hydropower and irrigation sectors determines the risks at the regional level. Risks at the national level are caused by lack of a unified coordination organization in the water sector. Four departments whose activity are not coordinated and cannot withstand the growing degradation of aquatic ecosystems and other natural resources manage water resources.

Risks related to ecological and economic factors are determined by anthropogenic impacts on water resources and the environment.

Risks of natural and man-caused emergencies require tackling the task of wise water resources use and the preservation of sustainable aquatic ecosystems. It is necessary to maintain the monitoring system that should include the control parameters of changes in the environment in order to be capable to for forecasting undesirable natural events (mudflows, floods, etc.).

A number of the issues arising in the process of optimizing water use in Central Asia can be solved only based on joint regional efforts, including the following:

1. Insufficient knowledge with respect to aquatic and water-related ecosystems in the region, the processes of their forming, anthropogenic transformation, and spatial-temporal variations;
2. Developing the system of coordinated monitoring of the environment and ecosystems based on precise indicators and comparable information;
3. Lack of quantitative criteria for the correlation between living standards and the status of ecosystems. In particular, legible rules for specifying the minimum ecological flow and water quality indicators;
4. Difficulties related to cost estimate of damage due to degrading quality of ecosystems and decline in their services. Objective optimization of nature management requires developing an algorithm for defining a monetary equivalent for any changes in living conditions of the population and in ecosystems.
5. Lack of legible criteria for defining the quality of nature management, in particular, water resources management, as well as defining of objective and penal functions without which the concept of optimization loses its meaning.
6. Contradictory interests of different water users and consumers within the country and of riparian countries in Central Asia resulting in severe economic and political problems and in suppress developing and implementing an optimal strategy for water resources use.

*Recommendations:* Settling above problems based on objective economical estimates is possible only under availability of the following factors:

- Market prices for water taking into account its quality, reliability of water supply in different seasons, and expenditures for providing these conditions; and
- Sufficiently developed market of land plots purchase and sale whose cost would consider an ecological condition of these plots.

Modeling of operation of water supply systems can promote the assessment (in monetary equivalent) of the planned (probable or average) saving rate due to application of any strategy for water resources use and protection. In this case, the objective economic assessment will be given to any violation of requirements of the hydro-ecological safety or criteria of nature management including water resources management.

## 2.3 Analysis of the Status of Aquatic Ecosystems in the Republic of Tajikistan

### 2.3.1 Aquatic and Water-Related Ecosystems

Tajikistan, similar to Kyrgyz Republic, has abundant water resources. In average years, river runoff formed within the country amounts to 51.6 cu km, including 51.08 cu km or 99 percent of transboundary river flow. Considerable water reserves are accumulated in glaciers and snowfields that occupy 5.6 percent of the national territory or 8,500 sq km.

Table 2.3.1 Water Resources of the Republic of Tajikistan

| River basin | Mean annual runoff, km³ | Runoff formed within the country, km³ | Water withdrawal, km³ | Used water resources, km³ | Water losses, km³ |
|---|---|---|---|---|---|
| Panj River | 33.4 | 17.1 | 1.97 | 1.5 | 0.47 |
| Vakhsh River | 20.2 | 18.3 | 4.6 | 3.5 | 1.1 |
| Kofarnihon River | 5.1 | 5.1 | 2.5 | 1.95 | 0.55 |
| Karatag River | 1.0 | 1.0 | 0.64 | 0.38 | 0.26 |
| Zeravshan River | 5.3 | 5.1 | 0.43 | 0.4 | 0.03 |
| Syr Darya River | 15 | 0.8 | 2.96 | 2.6 | 0.36 |

The annual hydrological cycle of rivers formed within Tajikistan distinctly divides into two periods: spring-summer high water and low water. It is very difficult to delineate the periods of floods and high water for mountain rivers because during spring-summer rains simultaneously melting of snow cover also increases. Over the period of high water, from 70 to 90 percent of annual water volumes are flowing down through all rivers.

Table 2.3.2 Distribution of glaciers over river basins of the Republic of Tajikistan

| River basin | Number of glaciers | | Area of glaciers | |
|---|---|---|---|---|
| | Number | % | Sq km | % |
| Kofarnihon River | 380 | 4.0 | 85 | 0.3 |
| Zeravshan River | 1,225 | 14.0 | 575 | 7 |
| Vakhsh River | 2,595 | 26.0 | 3,150 | 57 |
| Panj River | 4,700 | 50.0 | 2,960 | 29 |
| Lake Karakul and. Marakansu River | 757 | 6.0 | 555 | 7 |
| TOTAL: | 9,475 | 100 | 7,325 | 100 |

In the process of moving from the glacial zone towards alpine meadows and the forest zone, biodiversity of aquatic and water-related ecosystems is increasing. In comparison with other territories, most of the upper watersheds preserve the high quality of water resources and sustainable condition of aquatic and water-related ecosystems, and they can be considered as background ones. In the zone of lower mountains, economic activity causes changes in hydrological and hydrochemical regimes as well as in hydro-biological

conditions of aquatic ecosystems in many of the areas.

### 2.3.2 Meeting Water Requirements of Aquatic Ecosystems

Developing the mountain areas with unstable and complicated geological conditions and application of conventional irrigation methods cause such adverse consequences as soil erosion, abatement of slopes' stability and landslides. In addition, the human activity results in quantitative and qualitative changes in surface water resources and in deteriorating conditions of aquatic ecosystems both in the runoff formation zone and along all stream.

Table 2.3.3 Ecological flows for the needs of aquatic ecosystems

| River basin | Ecological flows and sanitary water releases ($km^3$) | | | | | |
|---|---|---|---|---|---|---|
| | Actual situation | | | | | |
| | 2003 | 2004 | | | | |
| | | Total | QI | QII | QIII | QIV |
| Zeravshan River (Dululi) | 4.7/3.8 | 4.59 | 0.32 | 1.3 | 2.52 | 0.46 |
| Kzil-Su River (Somonchi) | 0.61/no | 1.30 | 0.11 | 0.73 | 0.36 | 0.11 |
| Varzob River (Dangara) | 0.59/0.1 | 1.61 | 014 | 0.89 | 0.48 | 0.10 |
| Syr Darya River (Kzil-Kishlak) | 17.2/1.2 | 20.0 | 5.60 | 4.54 | 4.28 | 5.58 |
| Vakhsh River (Nurek Dam) | 21.6/21 | 22.04 | 3.64 | 6.06 | 809 | 4.25 |
| Panj River (Lower Panj) | 41.0/39 | 39.21 | 5.43 | 1.,96 | 15.86 | 5.96 |
| Kofarnihon River (Tartki) | 3.5/2.7 | 3.63 | 0.39 | 2.05 | 0.77 | 0.42 |
| Luchob River (Putov Bridge) | 0.02/0.1 | 0.14 | 0.013 | 0.10 | 0.016 | 0.011 |
| Khanaka River (GS Gissar) | 0.03/0.01 | 0.27 | 0.044 | 0.134 | 0.067 | 0.025 |
| Ilyak River (GS Yanchi-Yul) | 0.21/0.1 | 0.47 | 0.072 | 0.19 | 0094 | 0.11 |
| Semikan River (GS Semigan) | 4.0/0.1 | 0042 | 0.012 | 0.02 | 0.004 | 0.006 |
| Obi-Es River (GS Isaev) | 0.33/0.1 | 0.33 | 0.02 | 0.23 | 0.04 | 0.04 |
| Surkhob River (GS Garm) | 8.6/7.9 | 9.40 | 0.77 | 2.34 | 5.16 | 1.13 |
| Obi-Khingal River (GS Tavildara) | 4.6/4.3 | 4.95 | 0.36 | 1.38 | 2.68 | 0.53 |
| Yavan-Su River (GS Khojakala) | 0.35/0.35 | 0.26 | 0.04 | 0.08 | 0.09 | 0.05 |
| Gunt River (GS Khorog) | 3.1/no | 3.07 | 0.19 | 0.7 | 1.86 | 0.32 |
| Bartang River (GS Shudjant) | 4.08/no | 4.20 | 0.47 | 0.84 | 2.19 | 0.7 |
| Vanch River (GS Vanch) | 4.0/2.3 | 1.66 | 0.098 | 035 | 1.052 | 0.16 |
| Total | 118.53/ 83.06 | 117.198 | 17.719 | 33.904 | 45.613 | 19.962 |

no – flows were not defined. Flow rates that were measured at gauging stations (GS) are given in this table.

### 2.3.3 Available Mechanism for the Preservation of Aquatic Ecosystems

*Legislative base*: The basic principles of the state policy with respect to water resources use and protection are set forth in the Water Code (2005), in laws "On the Environment Protection" (1999) and "On the State Sanitation Inspection" (1994), in Decrees of the President, and Resolutions of the Government. Some aspects of water relations are regulated by the following legislative acts: laws on licensing, water supply tariffs, drinking water; subterranean resources, land code, etc.

*Institutional framework*: The Ministry of Agriculture, Water Resources and Processing Industry that is also the agency responsible for water resources management is exercising control of water resources protection and use.

The Water Cadastre is drawn up by departments of the following sectors: hydrometeorology, water management, geology, and nature protection.

### 2.3.4 Measures for the Preservation of Aquatic Ecosystems

Glacial lakes are a permanent potential threat for high-mountainous areas. Breaking and rapid drawdown of such lakes very often result in catastrophic mudflows, which, in their turn, cause enormous economic damage and human victims. The existing regional network of hydrometeorological stations is insufficient for the exact forecast of river flows. There is not routine monitoring of the status of snowy-ice resources. In order to settle abovementioned issues, the Government has adopted and approved a number of programs that set forth the integrated approach to improving the environment over the whole region.

Table 2.3.4 Measures for efficient water resources use

| Region of CA | Total | Budget | Period | Output | |
|---|---|---|---|---|---|
| | | | | As of 2004 | Planned |
| 1. The Agricultural sector rehabilitation Program | Over the country | US$1.73 million | 2005-2010 | Restructuring farms and establishing private farms | Efficient use of water and land resources, food provision |
| 2. Program «Clean water and sanitation» | Over the country | US$1.32 million | 2003-2005 | Rehabilitation and construction of water pipes in settlements | Rehabilitation of water pipelines and pumping stations, and supplying of clean water |
| 3. Program «Public Health» | Over the country | US$6.17 million | 2003-2010 | Equipping of hospitals | Securing healthy population |
| 4. National program to combat desertification | Khatlon Province | US$4.35 million | 2003-2010 | Rehabilitation of irrigated infrastructure and land reclamation | Improving living standards of the population due to increase in crop yields |

### 2.3.5 Basic Conclusions and Recommendations

Apart from measures for rehabilitation of the irrigation schemes and improving of irrigation methods and technique, efficient water resources use requires implementation of some arrangements related to economic assessment of water resources and introducing of water charging both in the republic itself and outside its boundaries.

- Analyzing the current situation shows that the system approach is not still applied in the Republic of Tajikistan for water resources forming, management, use, and protection.
- The regional and national information systems do not fit with the world level, and therefore it is necessary to develop the database covering the water sector as a whole.

- Last 20 years, owing to deficit of funds and material resources, geological and hydrogeological surveys were not conducted, causing troubles in the process of developing projects for construction of levees, bridges, aqueduct, siphons and other water infrastructure.
- It is necessary to renew hydrogeological and hydrological survey to facilitate the scientific-based forecast of surface runoff formation and river flow patterns.
- The monitoring of the status of glaciers and mountain lakes needs to be established for long-term and medium-term forecasts of water resources formation.
- It is necessary to improve the legislative, economic, institutional, and engineering base for water resources management.
- Studies in the field of efficient use and protection of aquatic ecosystems are necessary as well.

## 2.4 Analysis of the Status of Aquatic Ecosystems in the Republic of Turkmenistan

### 2.4.1 Aquatic and Water-Related Ecosystems

The basic volume of surface water resources inflowing into Turkmenistan is formed in adjacent countries and amounts to 63.57 cu km per a year including 33.63 cu km per a year that are consumed by Turkmenistan.

Table 2.4.1 Surface water resources of Turkmenistan

| River basin | Total, $km^3$ | A share of Turkmenistan, $km^3$ |
|---|---|---|
| Actual basins | | |
| Amu Darya River at Kerki | 59.65 | 29.82 |
| Murgab River downstream from the confluence with the Kushka River | 1.75 | 1.75 |
| Tedjen River at Ata Village | 0.73 | 0.73 |
| Atrek River downstream from the confluence with the Sumbar River | 0.3 | 0.19 |
| Rivers, large water sources and kahrizes on the north-eastern slop of Kopetdag | 0.35 | 0.35 |
| Kugitang River at Kuytan Village | 0.02 | 0.02 |
| Sub-total: | 62.8 | 32.86 |
| Potential basins | | |
| Kopetdag within Turkmenistan (without the Sumbar River basin and western ridges) | 0.12 | 0.12 |
| External part of watersheds of Kopetdag that provides inflow into Turkmenistan | 0.03 | 0.03 |
| Western edge of Kopetdag | 0.02 | 0.02 |
| Big and Small Balkhans | 0.03 | 0.03 |
| Uplands Badkhiz and Karabil | 0.26 | 0.26 |
| Kugintangay and Gaurdak-Kugitan districts | 0.04 | 0.04 |
| Takyrs in lowland | 0.22 | 0.22 |
| Takyr-like catchment areas in lowland | 0.05 | 0.05 |
| Sub-total: | 0.77 | 0.77 |
| TOTAL: | 63.57 | 33.63 |

Source: IUCN Office for Central Asian – Ecological Legislation in Central Asia, Almaty, 2004.

Analyzing data on surface water resources of Turkmenistan shows that under estimate of water requirements of ecosystems it is necessary to take into consideration quality and quantity of available water resources. According to water quality, it is possible to distinguish the following groups: a) river water; b) drainage water; and c) marine water.

*Aquatic and water-related ecosystems* are represented by ecosystems of flood plains and valleys of the rivers Amu Darya, Murgab, Tedzhen, Sumbar, Chandyr, Atrek Rivers and small mountain rivers of the Kopetdag and Kugitang. Tugai forests grow along rivers (Amu Darya, Murgab, Tedzhen, Sumbar, and Atrek) and occupy 6 percent of the total area of the basic ecosystems of Turkmenistan.

*Marine and Coastal Ecosystems* occupy 2 percent of the total area of the basic ecosystems of Turkmenistan. Marine ecosystems cover the shelf zone of the Southern and Middle Caspian Sea. Wetlands of the Caspian Sea coast play a significant role in the preservation of biodiversity and game resources of both Turkmenistan and other Caspian countries.

*Ecosystems in the Anthropogenic Zones* are represented by the ecosystems of developed oasis areas (Lower Amu Darya, Middle Amu Darya, Murgab-Tedzhen, Kopetdag and Atrek-Sumbar) with abundant weed vegetations. Lake Sarygamysh that is the largest desert sink in Central Asia that occurred in the Sarygamysh Depression due to drainage water disposal from the irrigation schemes in Dashhowuz Province of Turkmenistan, Khorezm Province and Karakalpakstan (Uzbekistan) refers to these ecosystems.

Table 2.4.2 Impact of drainage discharges on water quality in the Amu Darya River

| Sampling date | Sampling place, characteristics of gauging stations | Mean daily flow rate of the Amu Darya River and drains in water sampling time, $m^3/s$ | Total salt content (dry residual), $mg/dm^3$ |
|---|---|---|---|
| 02.06.04 | Mukry Village, opposite of the regulator on the Kara Kum River, Koytendag District; 1,102 km from the Aral Sea. | 2,300 | 600 |
| 03.06.04 | Atamurat Town, downstream the pontoon road bridge; at 1,045 km of the Amu Darya River | 1,880 | 633 |
| 03.06.04 | Khojambas District; at 974 km of the Amu Darya River | 1,865 | 633 |
| 04.06.04 | Karabekaul District, at the intake of the Karabekaul Inter-Farm Canal; at 950 km of the Amu Darya River | 1,840 | 633 |
| 04.06.04 | Head structure of the Karabekaul Inter-Farm Canal; at 940 km of the Amu Darya River | 1,835 | 666 |
| 04.06.04 | Yapach site of the Farab District, 5 km upstream the outfall of the South Drain inflowing from Uzbekistan's territory; at 865 km of the Amu Darya River | 1,835 | 666 |
| 04.06.04 | Outfall of the South Drain, Farab District; at 860 km of the Amu Darya River | 30.0 | 5,700 |
| 04.06.04 | Sakar District, 10 km downstream the outfall of the South Drain; at 850 km of the Amu Darya River | 1,860 | 933 |
| 07.06.04 | Turkmenabad Town, downstream the pontoon road bridge to Farab | 1,850 | 733 |

| Sampling date | Sampling place, characteristics of gauging stations | Mean daily flow rate of the Amu Darya River and drains in water sampling time, $m^3/s$ | Total salt content (dry residual), $mg/dm^3$ |
|---|---|---|---|
| 07.06.04 | Seidi Town | 1,840 | 736 |
| 07.06.04 | Outfall of the Main Left Bank Drain, Deynau District | 23.4 | 1,400 |
| 07.06.04 | Outfall of the Farab Drain, Farab District | 3.0 | 1,766 |
| 07.06.04 | Kabakly Village, downstream the outfall of the Makhankul Drain inflowing from Uzbekistan, Birata District; at 697 km of the Amu Darya River | 1,835 | 1,433 |
| 07.06.04 | Birata Village, at 611 km of the Amu Darya River | 1,830 | 800 |

### 2.4.2 Meeting the Water Requirements of Aquatic Ecosystems

The Interstate Coordination Water Commission (ICWC) annually determines a rate of ecological flow through the Amu Darya River. Last years, according to the ICWC decision, water releases into the Aral Sea and its surrounding region has been recently established at the rate of 10 cu km per year.

In 2005, the Dostluk Reservoir with a storage capacity of 1,250 million $m^3$ was constructed (in cooperation with the Islamic Republic of Iran) on the Tedzhen River. Construction of the Dostluk Dam enables regular delivery of irrigation water to the intakes of Turkmenistan and Iran along the river section from the dam to the Dovletabad (about 89 km), thus providing stable functioning of ecologically clean systems. However, the Tedzhen River loses its water at the section from the Dovletabad to the outlet of the Oguzkhan Main Canal. Therefore, the joint operation rules of the Dostluk Dam envisage providing sanitary-ecological releases in order to maintain the ecological systems along this section.

Fishery output and developing of recreation zones mainly determines the economic value of desert sinks, and, therefore, their ecological and economic status should be legally fixed.

### 2.4.3 Available mechanisms for the preservation of aquatic ecosystems

*Legislative base:* Water resources management, protection and use are governed based on the Water Code, the law "On Nature Protection", decrees of the President of Turkmenistan concerning the water sector and water resources use, as well as by bilateral agreements that regulates water resources use on transboundary watercourses (the agreement between Turkmenistan and the Republic of Uzbekistan signed in 1996, and the Soviet-Iranian agreement on rivers Arake and Atrek signed in 1957 and 1958).

*Institutional framework:* The Cabinet of Ministers of Turkmenistan and authorized state bodies govern activity in the field of water resources management, protection and use in line with the order established by the legislation:

The Ministry of Nature Protection co-ordinates activity in the field of wise nature

management and protection and actualizes the general scientific and engineering policy concerning reproduction and protection of natural resources.

The Ministry of Public Health and Medical Industry;
The Ministry of Water Resources;
The Ministry of Oil-and-Gas Industry and Mineral Resources;
The State Committee for Fishery; and
Hydrometeorological Service.

### 2.4.4 Measures for the preservation of aquatic ecosystems

During last 25-30 years, the desert sinks (man-made lakes for utilization of drainage water) were being formed due to drainage water disposal into natural depressions in the Kara-Kum Desert in the command area of the Kara-Kum Canal. According to the Turkmen Lake Project, these water bodies will be linked by the Main Drain system for accumulating drainage water in the Karashor Depression. A number of measures for preserving aquatic ecosystems and establishing the rigorous water-protection regime will be implemented within the framework of this program.

Table 2.4.3 Preserving ecosystems in the river basins

| **River basin** | **Water releases for the needs of ecosystems** | |
|---|---|---|
| | **Actual condition as of 2005 ('000 km³)** | **Planned outcomes** |
| Freshwater water bodies | | |
| Dostluk Dam on the Tedzhen Rive (a storage capacity of 1,250 mln. m³) | Release of one twelfth of an 5%-annual discharge during 8 months | Conservation of ecosystems downstream Dovletabad. |
| Kelif Lakes on the Kara Kum Darya River | 8,500 ha | Gradually lose their importance as wetlands for the preservation of ichthyofauna and ornithofauna diversity |
| Zeid Reservoir | Water area of 36,500 ha; a storage capacity of 1,144 mln. m³ | Forming a new wetland southward of the Kelif Lakes on the Kara Kum Darya River |
| Wetlands in the lower reaches of the Atrek River (including reservoirs Mametkol, Gyzylay, and Deleli) | Total area is 21,400 ha; a storage capacity is 889.6 mln m³ | Very important for the conservation of ecosystems; but it loses its importance as a sturgeon spawning ground |
| Desert sinks | | |
| Lake Sarygamysh, a storage capacity of 48 km³, a water area – 347,000 ha at water surface elevation – 4.68 m +BSL. | Annual inflow of drainage water:<br>from Turkmenistan – 1.5 to 2.0 km³;<br>from Uzbekistan – 3.5 to 4.0 km³;<br>in the future, after linking the lake by the Main Drain with the Turkmen Lake, inflow from the Daryalyk Drain is envisaged at the rate of 1.0 to 1.5 km³/year | The conservation of ecosystems of Lake Sarygamysh |

| River basin | Water releases for the needs of ecosystems | |
|---|---|---|
| | **Actual condition as of 2005 ('000 km³)** | **Planned outcomes** |
| The Turkmen Lake with a storage capacity of 134 km³ | A complex of structures is under construction. Estimated cost is Manat 10,173.2 billion | 2002-2010,<br>Drainage water disposal to the Turkmen Lake.<br>Cessation of drainage water discharges into Amu Darya.<br>Improving irrigated land.<br>The prevention of waterlogging of pastures, wells and roads, etc. |
| The Kernay (Aybugir) Lake in the Dashhowuz Province (desert sink) | A water area is 4,800 ha, a storage capacity of 152 mln. m³, an average salinity of 19 g/l | Valuable as a wetland for waterfowls, migratory and wintering birds |
| The Zengibaba Lake in the Dashhowuz Province (desert sink), located in the zone of the Dashhowuz inlet to the Turkmen Lake | A water area is 2,470 ha, a storage capacity of 140 mln. m³, an average salinity – 14 g/l | Important wetland for ornithofauna and ichthyofauna. In the future, its water area and storage capacity will be increased due to disposal of drainage water. |
| The Ulishor (Ketteshor) Lake – desert sink, where from the Main Drain of the Turkmen Lake starts | A water area is 2,600 ha; an average salinity – 2.0 to 2.5 g/l | The conservation of aquatic ecosystems |
| Marine water bodies | | |
| The Turkmenbashi and North-Cheleken Bays of the Caspian Sea (have the status of wetland of international importance since 1976) within the Khazar Reserve | 192,000 ha | Marine wetland for waterfowls, migratory and wintering birds on the Turkmen coast of the Caspian Sea |
| Esenguli portion of the Khazar Reserve (marine wetland) | 70,000 ha | Marine wetland for waterfowls, migratory and wintering birds on the Turkmen coast of the Caspian Sea |

Table 2.4.4 Current measures for efficient water use and the adequate water protection regime

| List of the most important investment environmental programs | | | | |
|---|---|---|---|---|
| Programs and activities | Executive agencies | Budget | Period | Planned output |
| Reuse of slightly brackish drainage water in the areas of their formation. Donors for implementation of the program are being sought. | MWR | Turkmen manat 130.0 billion | 2003 to 2010 | Increase in agricultural production |
| List of activities aimed at settling the key water management problems | | | | |
| Signing the interstate agreement on the Amu Darya River water quality management and cessation of discharges of drainage water, industrial and domestic wastewater. | Government, MFA, MWR | | 2003 to 2005 | Reducing disposal of pollutants into the Amu Darya River from neighboring territories |

| | | | | |
|---|---|---|---|---|
| Under development. | | | | (Turkmenistan, Uzbekistan, and Tajikistan) |
| Joining of Turkmenistan to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes.<br>Preparatory works are underway. | MFA, Ministry of Nature Protection, MWR | | 2003 to 2005 | Proposal on possible joining the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, aimed at ecologically sound and efficient management of water resources, environment protection (EP) and rehabilitation of ecosystems. |
| Drafting the regulations for water protection zones of major water bodies. | MWR, MNP together with EC IFAS | | 2003 to 2005 | Reducing the pollution level in watercourses. |

### 2.4.5 Basic conclusions and recommendations

*Conclusions:* Principal anthropogenic risks arise under conditions of water resources deficit, climate aridization, and drop in the water level of the Aral Sea, and the fluctuating water level in the Caspian Sea. These risks may be conditionally divided into direct and indirect threats. The direct risks include actions resulting in reducing of biodiversity and in changing of ecosystems such as felling of tugai forest, overgrazing, and poaching. The indirect risks affect the biological and water resources due to current transformations. They include the following: contamination by drainage water, industrial wastewater (the Caspian Sea by oil and oil products), and domestic wastewater; salinization, wind erosion and desertification of oases caused by unsustainable irrigation and land use methods; and transboundary pollution of rivers. All these causes lead to reduction and degradation of wetlands and their biological diversity. The national objectives for the protection of biodiversity of wetlands must integrate the following basic aspects:

- Promoting sustainable water resources use in all economic sectors including optimization and introduction of new irrigation and water supply methods;
- Developing measures for management and protection of wetlands with establishing the system of protected areas representing an optimal network for support of biodiversity and based on inventory of all wetlands and definition of key areas with permanent concentration of the numerous number of waterfowls and water-related birds during migration, wintering or nesting periods, and their legislative approval, as well as on regular monitoring and control of such a network;
- Improving public awareness concerning wetlands' importance in general and importance of the biodiversity, using the methods of economic incentives for increasing the motivation of local population and authorities in the preservation of biodiversity; and

- Establishing the economical and ecological status of desert sinks.

*Recommendations:* Monitoring surface water quality is insufficient to complete the picture of polluting water sources; the legislative base for protecting water resources is not adequate; and there are not economic mechanisms for managing of water quality. Therefore, it is necessary to strengthen the following activities:

- Developing the national information system for water quality monitoring;
- Unifying the standards for water quality; to establish the unified database and mapping unit;
- Assessment of the ecological status of groundwater and surface water;
- Improving the set of normative documents of Turkmenistan for controlling water resources quality;
- Remodeling the existing offtakes with the purpose of recharging freshwater groundwater in the lower reaches of the Amu Darya River based on using flood flows;
- Establishing the monitoring system for wastewater and measures for decreasing volumes and toxicity of wastewater of enterprises in Turkmenistan;
- Implementing measures for efficient use of water in municipal economy;
- Preparing the national program of phased introduction of ecologically-clean technologies at enterprises for reducing wastewater discharges; and
- Developing and introducing the water-saving methods.

In the process of implementing the National Environment Action Plan approved by the President of Turkmenistan Saparmurat Turkmenbashi (2002), joining of Turkmenistan to the Ramsar Convention can be recommended as an additional action for strengthening the international co-operation in the preservation of wetlands.

## 2.5 Analysis of the Status of Aquatic Ecosystems in the Republic of Uzbekistan

### 2.5.1 Aquatic and Water-Related Ecosystems

Uzbekistan is located within the basins of the two Central Asian rivers – Amu Darya and Syr Darya. A percentage of water resources forming on the territory of Uzbekistan makes up: for the Amu Darya basin – 6 percent, for the Syr Darya basin – 16 percent, and in total over the republic – about 8 percent of their cumulative flow.

Table 2.5.1 The percentage of available water resources of Uzbekistan by components (mln. m³)

| River basins | Rivers | | | Groundwater | Drainage water recommended for use | Available water resources |
|---|---|---|---|---|---|---|
| | Stem stream | Small | Total | | | |
| Syr Darya | 10,490 | 9,425 | 19,915 | 1,590 | 2,600 | 24,105 |
| Amu Darya | 22,080 | 10,413 | 32,493 | 301 | 2,310 | 35,104 |
| Total | 32,570 | 19,838 | 52,408 | 1,891 | 4,910 | 59,209 |

Drainage and return waters play an important role in supporting vital functions of aquatic

and water-related ecosystems on the territory of Uzbekistan. The cumulative volume of return water within the republic averages 28 to 33.5 $km^3$ a year. Of this return flow volume, nearly 13.5-15.5 $km^3$ are formed in the Syr Darya basin, and about 16-19 $km^3$ – in the Amu Darya basin. Numerous lakes (desert sinks) have occurred as a result of return water disposal into depressions. The largest lakes include Arnasay, Aydarkul, Dengizkul, Solenoe, Sudochye, Jyltyrbas, and some others.

Table 2.5.2 Formation of return waters ($km^3$/year) in Uzbekistan (1990 to 1999)

| River basins | Drainage water from irrigated areas | Industrial and domestic wastewater | Total return flow | Water disposal and utilization | | |
|---|---|---|---|---|---|---|
| | | | | to rivers | To depressions | Re-used |
| Syr Darya | 7.6 | 0.89 | 8.49 | 5.55 | 0.84 | 2.1 |
| Amu Darya | 10.8 | 0.80 | 11.60 | 3.37 | 6.23 | 2.0 |
| Total for Uzbekistan | 18.4 | 1.69 | 20.09 | 8.92 | 7.07 | 4.1 |

The status of aquatic ecosystems over the most part of Uzbekistan is not satisfactory, and the succession process affect most water bodies, and they requires the permanent control and implementing measures for their stabilization and improving.

*The Runoff Formation Zone:* In Uzbekistan, similar to most of mountainous territories in the region, an area of glaciers has reduced and goes on to reduce. This often entails developing small lakes with the unstable regime in the zone adjacent to glaciers, and some of them may cause disastrous floods and mudflows.

Complicated natural and socio-economic issues affect the current condition of mountainous ecosystems; of them, the following ones should be mentioned:

- Relatively low resistance of ecosystems against anthropogenic impacts;
- Exposure of the territory to adverse exogenous processes (over 20 percent of the territory is under impacts of soil erosion, landslips, collapses, avalanches, and mudflows);
- Low percentage of mountainous woodlands (below 15 percent) and high degradation of pastures; and
- Polluting part of catchment area and, consequently, of water resources with industrial wastes and refuse of recreational activity.

*Condition of Ecosystems in the Runoff Transit Zone*: Resulting from the change in river hydrological regime, the area occupied by freshwater and water-related ecosystems has reduced, and their status changes as well. In lower reaches and deltas of rivers, they are in depressed condition, and in low-water periods they completely dry up. Given the degradation of the Aral Sea, the total water area of lakes on the lowland territory has reduced by over 20 times. Moreover, rise in salinity of river water and deterioration of its quality has become another reason of decreasing the potential of bio-productivity of water resources. The proportion of brackish water lakes among lacustrine water bodies in Uzbekistan has increased. The number and areas of water bodies subjected to hydrosulphuric pollution has multiplied.

*Drainage water and desert sinks:* This component of man-made ecosystems needs to be considered as the newly created elements of the landscape that have the certain social and ecological status. Desert sinks have turned to peculiar ecological oases (biodiversity-maintaining zones) and at the same time, the population uses them for recreation, fishing, reed harvesting, etc.

*Condition of ecosystems in lower reaches and deltas of rivers:* The extant lakes underwent anthropogenic eutrophication due to increasing inflow of biogenic and organic matters to rivers and lakes together with drainage water. Different options of using additional water resources to stabilize the situation in the Aral Sea area have non-equivalent environmental and economic efficiency. The least costs are required for the projects of rehabilitation and support of former lakes and wetlands in the delta, and priorities are given to wetlands located near lakes Shegekul, Sudoche, and Kamislabish.

*Condition of Marine Ecosystems:* Drying up of the Aral Sea and reducing water inflow into the Amu Darya delta are caused by drastic anthropogenic impact on water resources in Uzbekistan. By 2005, the sea has lost four fifths of its volume, the surface area reduced by more than two thirds, water level dropped by 22 m, and water salinity increased 6 to 12 times.

### 2.5.2 *Available Mechanisms for Maintaining Ecological Flow*

*Legislative base*: The basic provisions concerning water resources management and protection at the national level are set forth in the following legal documents: the Constitution of the Republic of Uzbekistan (1992), the laws of the Republic of Uzbekistan "On Water Resources and Water Use" (1993), "On Nature Protection" (1992), and "On Protected Natural Territories" (2004), as well as the resolution of the Cabinet of Ministers of the Republic of Uzbekistan "On water protection zones of reservoirs and other water bodies, rivers, main irrigation and drainage canals, and other sources used for public water supply, medical and cultural-recreational purposes in the Republic of Uzbekistan" (1992) and by-laws and departmental instructions defining the activities of ministries and their agencies.

*Institutional framework*:

Departments of the Ministry of Agriculture and Water Resources monitor water infrastructure condition, operative regimes of irrigation and drainage canals and the status of agricultural lands.

The Ministry of Geology is responsible for monitoring of groundwater.

The State Committee for Nature Protection implements the ecological monitoring of the environment.

The Hydrometeorological Service is responsible for monitoring of natural water resources.

The Ministry of Emergencies and the Ministry of Health also performs some functions of monitoring the environment and man-caused emergency events.

However, the efficiency of the existing monitoring system with regard to aquatic ecosystems is insufficient and does not cover all aspects of this problem. Therefore,

operational decision-making for current management of aquatic ecosystems and unbiased assessment of long-term trends are difficult.

### 2.5.3 Measures for the Conservation of Aquatic Ecosystems

At the present-date stage, works related to rehabilitation of pre-existing freshwater lakes and wetlands are in progress. Most of the environmental projects being implemented in Uzbekistan also cover to some extent the issues of conserving biodiversity and aquatic ecosystems. The large-scale projects, jointly financed by international donors and the national budget, are the following:

- The Aral Sea Basin Program (ASBP), 1994 (the World Bank);
- TheAral Sea Program, 1998 (the World Bank/UNDP/UNEP);
- The National Environment Action Plan of the Republic of Uzbekistan (NEAP), 1997 (UNEP/GEF);
- The National Biodiversity Conservation Strategy and Action Plan of the Republic of Uzbekistan, 1998 (UNDP/GEF);
- The International Western Tien Shan Biodiversity Conservation Project, 2000-2004;
- The Action Plan for Sustainable Development of Tourism in Uzbekistan, 1995 (UNDP);
- The Uzbekistan National Environmental Information Grid, 1999 (UNEP/GRID-ARENDAL);
- The Subregional Action Plan to Combat Desertification in the Aral Sea Basin (SRAPCD), 2000 (GTZ, the UN Convention to Combat Desertification);
- Support to the Regional Environmental Action Plan in Central Asia (UNEP); and
- The UNDP and Uzbekistan Environmental Program.

Activity aimed at water saving in irrigated farming remains topical. Resulted from the implemented measures, some positive progress is achieved in terms of aquatic ecosystems' conservation, although so far there are many problems to be solved.

### 2.5.4 Basic conclusions and recommendations

*Conclusions:* The basic trends of on-going changes in the runoff transit zone, mouths and deltas of rivers result in the reduction of areas formerly occupied by freshwater ecosystems of rivers, lakes, wetlands, coastal and island tugai forests and riverside thickets of hydrophilous vegetation, and in the extension of water areas subjected to anthropogenic eutrophication and of areas occupied by halophilous species.

Topical directions for activity related to the preservation of terrestrial ecosystems and simultaneously aquatic ecosystems in the runoff formation zone are the following:

- The protection and rehabilitation of forests;
- Measures for preventing mudflows, landslides, and catastrophic floods owing to breaching of mountain lakes; and
- Chemical and biological contamination control.

*Recommendations:* Achieving the primary goal – sustainable ecosystems functioning – requires consideration of all levels of natural links and co-ordination of management systems including interstate agreements on transboundary water management based on water partnership with regard to supporting the aquatic ecosystems. The tools for solving these issues may include the following:

- Integration and more close co-operation of ministries and departments;
- The ecosystem approach in solving nature protection tasks;
- Introduction of integrated water and land resources management;
- Improving the national legislation;
- Improvement of the monitoring system;
- Scientific justification of operation rules for reservoirs and other water infrastructure;
- Developing procedures to define maximum permissible discharges and maximum allowable concentrations of pollutants in water bodies;
- Environmental impact assessment of large-scale economic projects.
- The conservation of native habitats and the gene pool of the whole range of species' diversity in aquatic ecosystems (from freshwater sections of rivers, lakes and wetlands to brackish desert sinks);
- The development and substantiation of ecological water requirements used for maintenance of natural ecosystems;
- Establishing the monitoring system adequate to current processes in aquatic ecosystems.

Strengthening of the supervision for observance of laws, regulations and rules of water use by all economic entities at the national, regional and local level is the precondition for the ecological sustainability of aquatic and water-related ecosystems. Involvement of NGOs and the local population will enhance the efficiency of this activity.

## CHAPTER 3 GENERAL CONCLUSIONS AND PROBLEMS

The integrated analysis of the problems of preserving ecosystems in the Caucasus and Central Asia reveals many causes of their origins and cause-and-effect relations that have general and specific characteristics/features at the national and regional level. The intensity and nature of adverse processes arising in aquatic ecosystems depend on their location within the river basin (upper watershed, the middle reach of a river or delta).

***Causes:***

- Lack of the awareness with respect to the significance and role of aquatic ecosystems for preserving the ecological sustainability and supporting welfare of the population;
- Lack of integrated water resources management;
- Neglecting the protection of aquatic ecosystems (the protection of aquatic ecosystem is not incorporated into the water use system and the appropriate laws and tasks of governmental bodies);
- Enormous water losses exceeding the standard rates in irrigated farming;

- Disregarding water requirements of ecosystems. The rates of ecological flows and sanitary water releases are not specified and mainly depend on annual water availability, not meeting the needs of ecosystems in lower reaches of rivers.
- Insufficient employing of the economic mechanisms, lack of economic evaluating the cost of ecosystems' services and a monetary equivalent of damage due to degrading quality of ecosystems;
- Lack of incentives for water-saving;
- Degradation of forests and pastures, reducing of glacial areas, a threat of breaching mountain lakes, as well as intense erosion over catchment areas;
- Untreated industrial, agricultural, and communal wastewater;
- Poaching and introduction of alien organisms;
- An underdeveloped analytical and research basis and insufficient knowledge with respect to the processes of forming, man-caused transformation, and spatial-temporal variability of aquatic and water-related ecosystems in the region;
- The system for monitoring of water quality and the status of ecosystems does not fit with modern requirements; and
- Regional and national information systems are underdeveloped and do not provide access to information for all stakeholders.

***Causes of regional nature***:

- Integrated water resources use and protection plans for transboundary river basins with considering the needs of ecosystems (management plans) were not developed;
- Insufficient capabilities of countries for harmonization of national water and environmental laws at the regional level, in particular, as applied to transboundary aquatic ecosystems;
- Contradictory interests of different water user and consumers (hydropower generation, industry, and irrigated farming) within a particular country and in countries located in the common transboundary river basin;
- Lack of administrative, economic, and institutional mechanisms for protecting aquatic transboundary ecosystems against pollution and depletion including the mechanism of administrative responsibility; and
- Lack of an accessible and integrated information system covering the entire water sector in the region.

***Problems:***

- Water pollution and decline in self-purification capability of water bodies;
- Reducing water reserves in ecosystems; the growth of water resources deficit;
- Decrease in biological diversity of aquatic ecosystems;
- Deteriorating features of bottom sediment – covering of biologically active silt by more coarse materials;
- Decline in the value of aquatic ecosystems and their role as sources of drinking water; the growth of water deficit and morbidity of the population; and
- Natural disasters: breaches of mountain lakes, mudflows, and floods.

## CHAPTER 4 RECOMMENDATIONS

Analyzing the status and causes of degradation of river basins in subregions enable us to formulate the following recommendations with respect to measures for preserving (rehabilitation and use) aquatic ecosystems in countries of the Caucasus and Central Asia:

- Definition of roles and commitments of the governmental bodies, water management organizations and other stakeholders in the field of protecting aquatic ecosystems;
- Specifying the needs of ecosystems and minimum requirements to ecological flows in lower reaches of rivers;
- Improving of the existing water resources management systems based on the principles of integrated river basin management;
- Developing the action plans for integrated water resources management (including measures for supporting their ecosystems);
- Improving and harmonization of the water legislation in countries of the region, and developing of by-laws of direct action;
- The legislative validating of ecosystems' entitlement for water and intersectoral procedures for the decision-making process;
- Adjoining of countries (Armenia, Georgia, Azerbaijan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) to the UNECE Helsinki Convention and other UN Conventions that play an important role in the preservation of aquatic and water-related ecosystems;
- The legislative validating of the economic and ecological status of desert sinks (the desert depressions used for disposal of drainage water from the irrigation schemes);
- Developing and putting into practice the procedures for estimating social, economic, and ecological values of goods and services provided by aquatic ecosystems;
- Developing the procedures for economic evaluation of water resources and introducing water charging;
- Estimating the damage to aquatic ecosystems and the rates of compensation for pollution and depletion of water resources of transboundary rivers;
- Introducing the international requirements to water quality control and maintaining minimum sanitary-ecological flows, as well as the protection of potable water sources;
- Rehabilitating forests and pastures, the measures for preventing breaching of mountain lakes in upper watersheds;
- Reducing water losses by means of remodeling the irrigation systems, improving of irrigation technique, employing the technologies for drainage water reuse and other arrangements;
- Establishing the water protection zones along rivers and other aquatic ecosystems;
- Public participation and support the IWRM principles, public awareness with respect to objectives and tasks of the preservation of aquatic ecosystems, and developing the special educational curriculums;
- Establishing the system of monitoring the environment with indicators of surface water quality and parameters for evaluating the status of aquatic ecosystems that has to be agreed by all riparian countries; and
- Developing and implementing of one or two pilot projects in each country concerning the preservation of aquatic ecosystems with follow-up dissemination of positive experience and development of the regional projects.

## CONCLUSION

A distinctive feature of Central Asia and the Caucasus is the vulnerability of ecosystems. The Central Asia is located within the single ecological area of land-locked basins of the Caspian and Aral seas, and this fact in combination with arid climate imposes additional and severe ecological limitations on economic activity and trade.

Development of irrigated farming in the Aral Sea basin unprecedented in the modern history according to its scales has exceeded the abilities of ecosystems and resulted in their destruction. Intense water diversion from rivers for irrigation has caused the drop in water level of the Aral Sea by 19 m and reducing its volume by 75 percent. By the end of 1980s, the sea has practically died, and this event caused a number of the following adverse consequences: drastic deterioration of water quality and health of local population, large-scale desertification, soil salinization and waterlogging, decline in biodiversity and intensification of adverse impacts on climate.

The cost-is-no-object approach that was formed as far back as in the period of arms race is as before prevailing in water-related activity in countries of the subregion. Despite a persuasive example of the Aral Sea disaster, use of water resources is basically planned to meet water requirements of agriculture and hydropower generation without consideration of other needs of economy and nature. As a result, drinking water quality and health of local population are deteriorating; land productivity and crop yields are decreasing; and poverty, unemployment, migration, and risks of conflicts are building up.

Welfare and future development of countries of Central Asia and the Caucasus mainly depend on the natural balance and the status of aquatic ecosystems. Authors of this report hope that the present study can help countries of the subregion, international community, and other partners to adjust their efforts and undertake the effective measures for the protection of ecosystems from degradation.

## DEFINITIONS

**Aquatic ecosystem** is the ecosystem with prevailing of water mass (hydro-mass) over mass of six other components.

**Biodiversity** means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD, 1992).

**Biological resources - g**enetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity (CBD, 1992).

**Ecosystem** means the aggregate of living organisms and their environment. A directive effect of links from environment factors at the major element – a host (biota, living organisms) is typical for the model of "ecosystem."

**Ecological flow** is river flow at the rates necessary for supporting the status of water body in line with the ecological requirements with taking into consideration the seasonal parameters.

**Ecological status** is the set of indicators reflecting quality and functioning of the aquatic ecosystems related to surface waters

**Ecosystem resources/goods and services.** A term "services" of ecosystems that is used in the report means conditions and processes by means of which the natural ecosystems create the conditions for life of human beings. Ecosystems' resources/goods accordingly mean benefits, which human beings receive, directly or indirectly, from functioning of ecosystems

**Ecological welfare of a water body** is the normal reproduction of basic functions of the ecological system of a water body.

**Health of the environment** is a state (quality) of the environment necessary for maintaining the health of human being, and other living organisms and a basic ecological indicator of sustainable development and the efficiency of environmental policy

**Lake** is a large, inland body of fresh or salty standing water

**Protected area - a** geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives (CBD, 1992).

**River basin** is a terrain over which surface runoff in the form of streams and rivers flows into a receiving water body (sea, lake) through a single river mouth, estuary or delta

**Runoff dissipation zone - a**ccording to outstanding hydrologist of Central Asia Prof. Shultz, this term means the zone where a river flow is depleted due to evaporation and

infiltration, as well as diversion for different human needs including irrigation and only is partially replenished by return water.

**Self-purification ability of an ecosystem** is natural ability of ecosystems to detoxify pollutants (toxic pollutants) by means of their destruction or fixation

**Sanitary water releases** are provided through rivers to prevent the deterioration of sanitary conditions and river water quality

**Sanitary-ecological water releases** are supplied into irrigation systems for maintaining minimum water volumes within the canals that are used for domestic and potable needs of the population

**Surface water** is water permanently or temporarily stored in surface water bodies

**Sustainable development** is a process of developing (land, cities, business, communities, etc.) that meets of the present without compromising the ability of future generations to meet their own needs (The UN Brundtland Commission, 1987).

**Sustainable management - m**anagement that meets the current needs without compromising the ability of future generations to meet their own needs (The UN Brundtland Commission, 1987).

**Sustainable use - t**he use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations (CBD, 1992).

**Wetlands** are areas of swamps, fens, peat grounds or water bodies: natural or man-made, permanent or temporary, closed or with flow-through, freshwater, brackish or high saline including marine water areas with a depth not exceeding six meters

**Water-related ecosystem** is ecosystem/hydromorphic land site located in the zone of aquatic ecosystems' influence

**Water resources** are reserves of surface water or groundwater stored in the water bodies that are used or may be used

**Water body** is an accumulation of water on land surface within its relief forms or subterranean aquifer having boundaries, volume, and specific features of the water regime

## REFERENCES


1. Abdirov Ch. A., Konstantinova L.G., Kurbanbaev E.K., and Konstantinova G.G. Surface water quality in lower reaches of the Amu Darya River under anthropogenic transformation of freshwater flow. FAN, Tashkent, 1996
2. Agaltzeva N. A. and Borovikova L.N. The integrated approach to assessing the vulnerability of water resources under conditions of climate change. // Scientific Proceedings, Bulletin No5: Assessment of climate change in the Republic of Uzbekistan - guidelines for evaluating the environment vulnerability. 2002, Tashkent, p.26-36.
3. Analyzing the efficiency of ADB water policy. Summary of national consultations in Kazakhstan. Water for All. 2005. 39 pages.
4. Babaev A.G. Assessment of drainage water's impacts on the environment. Scientific Proceedings: Improving the methods for monitoring irrigated land conditions and assessment of impacts of irrigation and drainage on the environment. Ashkhabad, 1987.
5. Bulletin of Hydrochemical Regime. The Hydrogeological Service of the Ministry of Water Resources of Turkmenistan, Year-Book, 1995.
6. The Water Code of the Republic of Kazakhstan, Astana, 2003.
7. Water Resources of Kazakhstan in the New Millennium. Review. UNDP, Almaty, 2004, 131 pages.
8. Gafurov E.Sh., Mirzaev U.T., Khegay V. N., Abduvaliev A.S. and Mirabdullaev I.M. Improving fish productivity in the Aydar-Arnasay lakes system. // Problems of efficient use of biological resources of water bodies in Uzbekistan: Proceedings of the Republican Scientific Conference. Tashkent. 2001. p. 26-29
9. The report on integrated water resources use and protection in the Republic of Kazakhstan over the period of 1997 to 2004. The Committee for Water Resources of the Ministry of Agriculture of the Republic of Kazakhstan.
10. Golubenko Yu. A. The status of fish stock in the Aydar-Arnasay lakes system and the forecast of fish catches. // Problems of efficient use of biological resources of water bodies in Uzbekistan: Proceedings of the Republican Scientific Conference. Tashkent. 2001. p. 31-34.
11. Gorelkin N.E. Changes in the pattern of lakes in the lowland area of Central Asia under influencing construction of water infrastructure. // Proceedings of the Uzbekistan Geographic Society. Tashkent: FAN, 1988, Volume 14, p. 25-31.
12. Gorelkin N.E., Goroshkov N.I., Nurbaev D.D., and Talsky V.N. Assessment of main drains and lakes on the right-bank of the Amu Darya River. The Problems of Developing Deserts, No2, 2002, p. 49-57.
13. Gorelkin N.E., Nurbaev D.D., Lukoshevich L.V., Zavyalova L.V., Agophonova O.A., and Gorban V.V. The content of chlorine-organic pesticides in environmental objects in the Amu Darya delta // Monitoring of the environment in the Aral Sea basin, Saint Petersburg. Gidrometizdat, 1991, p. 123-132.
14. Ten years of donors' activity in the Aral Sea basin. The report on the efficiency of projects implementation. UNDP, 2003, 38 pages.
15. The diagnostic report: "Rational and Efficient Water Resources Use in Central Asia". Tashkent-Bishkek, 2001.
16. The Report at the UN Conference on the Environment and Development. Rio de Janeiro, 3-14 July 1992, the United Nations, New York, 1993.
17. Dukhovny V.A. Advanced water resources management in the modern world: Central Asia. // Environmental sustainability and advanced approaches in water

resources management in the Aral Sea basin. Proceedings of the Central Asian International Scientific Conference. Almaty-Tashkent, 2003, p. 8-18.
18. UNECE: Document “Calling in the partnership for implementing the Central Asian initiative”.
19. The law of the Republic of Kazakhstan No 162-1 adopted July 15, 1997 “On special protected natural territories (with amendments adopted by the laws No 381-1 of 11.05.1999, No 151-II of 23.01. 2001, and No 276-II of 24.12.2001)”.
20. Information-Ecological Bulletin. The Ministry of Natural Resources and Environment Protection of the Republic of Kazakhstan, 1998-2001.
21. Information documents of “Kazgidromet”on the environment condition in the Republic of Kazakhstan. 1999-2004.
22. Kimensky Yu. A. and Sheynin L.B. Legislative aspects of water sharing on transboundary rivers. // Journal “Water Resources” No 3, 1986.
23. Kipchakbaev N.K. and Sokolov V.I. “Water Resources in the Aral Sea Basin – forming, distribution, and water use.” Proceedings of the Scientific Conference: “Water Resources of Central Asia”. Almaty. 2002.
24. Kogan Sh. I. The Karakum Canal. Ashkhabad, Ilim, 1991.
25. Kreuzberg–Mukhina E.A., Mirabdullaev I.M., and Talsky V.N. Basic outcomes of the ecological monitoring in the Sudoche Wetland. // The Environmental sustainability and advanced approaches to water resources management in the Aral Sea basin: Proceedings of the Central Asian International Scientific Conference. Almaty-Tashkent, 2003, p. 355-363.
26. Implementing the IWRM principles in countries of Central Asia and the Caucasus. GWP CACENA, 2004.
27. Transboundary watercourses. The Technical Document of the World Bank No 414, Washington D.C. USA, 1998.
28. Nazarbaev N.A. “Kazakhstan-2003. The President's message to People of Kazakhstan.”
29. The National Report on the Status of Environment and Natural Resources Use in the Republic of Uzbekistan (2001). Tashkent, 2002, 168 pages.
30. The National Environment Action Plan for Sustainable Development of the Republic of Kazakhstan. The Ministry of Natural Resources and Environment Protection, NEC, 1999.
31. The National Environment Action Plan of the President of Turkmenistan. Ashkhabad, 2002.
32. The National Integrated Water Resources Management and Saving Plan for Kazakhstan. Draft Document. The Government of RoK, UNDP. 2005, 27 pages
33. The National Strategy and Action Plan for Sustainable Development of Mountain Areas in Kazakhstan. Almaty. 2001. 31 pages.
34. Nikitin A.I. Water resources and balance of lakes and reservoirs in Central Asia. Proceedings of SANII, 1986, Issue 108 (189).
35. Nikitin A.I. Lakes of Central Asia (The hydrometeorological regime of lakes and reservoirs in the USSR). Gidrometizdat, 1987.
36. The report on outcomes of implementing the joint project of the Ministry of Nature Protection of Turkmenistan and UNDP “The assessment of impacts of the crisis in Afghanistan on water quality of the Amu Darya River within Turkmenistan.” 2004.
37. Rogers P. Hall A.. Effective Water Governance, the GWP(2003).

38. The Decree of the Cabinet of Ministries of the Republic of Kazakhstan of April 29, 1995 No 600 “On the Approval of the Regulation for the State Control of Water Resources Use and Protection.”
39. Rules for the protection of surface waters in the Republic of Kazakhstan (the Ministry of Ecology and Biological Resources of the Republic of Kazakhstan, Protocol No13 of June 1, 1994).
40. Regulations for joint operation of the reservoir “Dostluk” on the Tejen River (Gerirud), 2005.
41. The programme “Sustainable Development of the Balkhash-Alakol Basin for 2007-2009.” Astana, 2005, 33 pages.
42. Razakov R.M. The Aral Sea and Priaralie: Problems and Solutions. Tashkents, 1992.
43. Razakov R.M., Toryanikova R.V. and Talsky V.N. Methods for assessment of surface water quality: standards and criteria. // The Environmental sustainability and advanced approaches to water resources management in the Aral Sea basin: Proceedings of the Central Asian International Scientific Conference. Almaty-Tashkent, 2003, p.331-339.
44. The Central Asian Regional Ecological Center: “The decision-making system for environment protection in Central Asia.” 2001.
45. The Central Asian Regional Ecological Center: “The regional strategy for sustainable development of mountain areas in Central Asia.” 2001.
46. The Central Asian Regional Ecological Center: “The concept for sustainable development of the Ili-Balkhash river basin,” 2001.
47. The Central Asian Regional Ecological Center: “Central Asia: Progress in Implementing Agenda 21” 2002.
48. The Central Asian Regional Ecological Center: “Assessment of Mountain Ecosystems in Central Asia,” 2003.
49. The Central Asian Regional Ecological Center: “Information Support of Social Monitoring for Central Asian Initiative.” 2004.
50. The Central Asian Regional Ecological Center: “Problems and Prospects of Developing the Legal Base for Maintaining Water Quality in Central Asia and Caucasus,” 2005.
51. The Regional Report of Central Asian Statyes: “The Status of the Environment in the Aral Sea Basin.” UNEP/GRID-Arendal. 2000.
52. Reymers N.F. Nature Management, Moscow. “Misl”, 1990.
53. Reymers N.F. Ecology. Moscow, 1994.
54. Reteyum A.Yu. Glossary for some terms and concepts of sustainable development. The Moscow State University, 2002.
55. Rustamov E.E. The strategic aspects of the protection of wetland ecosystems as birds’ habitates in Turkmenistan. Proceedings: Ornithological Issues in Turkmenistan. Moscow, 2002.
56. Salnikov V.B. On bio-indication of toxic pollutants in water bodies according to morphologic-ecological features of fish (in lakes formed by drainage water in Turkmenistan). Proceedings: Hydrobiology of water bodies in Turkmenistan. Ashgabad, 1992.
57. Salimov T. Water quality management. Dushambe, 2001.
58. Sanin M.V. et.al.. Lake Sarakamish and Desert Sinks. Moscow, “Nauka”, 1991.

59. Saparov U.B. and Golubchenko V.G. The Turkmen Lake in the Karakum Desert. Journal "Problems of Deserts Development" No1, 2001.
60. Sarsibekov T.T., Nurushev A.N., Kojakov A.E., and Ospanov M.O. Transboundary Rivers Use and Protection in Countries of Central Asia. Almaty. "Atamura", 2004. 270 pages.
61. Sharing knowledge for equitable, efficient and sustainable water resources management, ToolBox, Version 2, GWP
62. Shultz V.L. Hydrography of Central Asia. Brief Review. Central Asian Stae University, Tashkent, 1958, 117 pages.
63. Talsky V.N. Problems of eutrophication of river ecosystems in the Central Asian region // Issues of the protection and wise use of biological resources of water bodies in Uzbekistan: Proceedings of Republican Scientific Seminar, Tashkent, 2001, p. 92-96.
64. Talsky V.N. Taraskin A.A., Abdullaeva L.N., Gerasimova O.D., and Mustafaev Z.A. The ecological status of natural watercourses in the Nurata Reserve.// Proceedings of Uzbekistan's Reserves. Tashkent, 2001, Issue 3, p. 5-17.
65. The transboundary diagnostic analysis of the Caspian Sea. Technical description and target indicators of the environment quality. Volumes 1 and 2, Baku, 2002.
66. Turkmenistan. The status of biological diversity. Review. Ashgabad. 2002
67. Sustainable Development of the Ili-Balkhash Basin: Problems and Their Solutions. CAREC, Almaty, 2002.
68. Sustainable Development of Turkmenistan. Rio+10. The National Report. Ashgabad, 2002.
69. Chub V.E., Toryannikova R.V., Kenshimov A.K., and Talsky V.N. Issues of transboundary water quality management in the Aral Sea basin. Journal "Problems of Deserts Development" No 1, 2001, p.28-35.
70. Chub V.E., Toryannikova R.V., and Talsky V.N. Optimization of the system for monitoring surface water quality in the Aral Sea basin. // Assessment of polluting the environment in the Central Asian region. Proceedings of SANIIGMI, Issue 155 (236), 1998, p. 5-18.
71. The ecological flows. Issue 1, Tashkent, 2003.
72. Esenov P. The ecological and meliorative condition in the irrigated area of Dashauz Province. Journal "Problems of Deserts Development" No 6, 1995.
73. Esenov P. Pollution of the environment in Dashauz Province. Journal "Problems of Deserts Development" No 1, 1997.
74. http://www.zakon.kz
75. http://www.worldwaterforum.org
76. http://www.un.org/russian/
77. http//www.carec.kz
78. http//www.carec.kz/water
79. www.ecopress.lorton.com
80. http//www.ecolife.org.ua/
81. http//www.ecoline.ru/
82. http://www.ecoportal.ru/
83. http://www.wild-natures.com/
84. www.climate.kz.
85. http://www.unece.org/env/proceedings/html/Item7b.e.html
86. www.johannesburgsummit.org/html/sustainable_dev/p2_partners_other_areas/central_asian.pdf