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WATER

CRITICAL RESOURCE FOR UZBEKISTAN'S FUTURE

Uzbekistan

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Foreword

Deputy Minister of Agriculture and Water Resources of the Republic of Uzbekistan

Water is fundamental to human survival and development. The world's fresh water supply is under increasing pressure. Water scarcity has become a serious global challenge and has led to environmental degradation, damage to people's livelihoods, and increasing population morbidity. Today more than 2 billion people in over 40 countries are affected by water shortages.

Water scarcity is one of the main factors constraining the future development of Uzbekistan. Already today the country faces many problems related to water shortage, pollution and exhausting of water sources. That is why the publication of this review is so opportune. The review aims to inform a wide audience, including scientific and state institutions, about the growing water crisis and the threat this presents to the region, as well as the efforts of five Central Asian states to jointly manage their water resources and restore the disturbed natural ecosystem of the area surrounding the Aral Sea.

All aspects of the economic and rational use and protection of water resources in Uzbekistan are comprehensively considered in the review. The existing provision of water for economic purposes, for the population and for the ecosystem is described in detail. The issues of water probability and quality of water resources are analyzed as well as the problems of water users and water consumers. Possible solutions to these problems are suggested which could meet the demands of both the rapidly increasing population and the ecosystem. Attention is also paid in the report to the institutional basis of water management and public involvement in decision making on water issues.

The present review focuses the attention of the public, governing institutions and communities on the importance of using water carefully and effectively at all levels, in order to provide sustainable agricultural development and environmental protection.

The review outlines the main activities which must be undertaken in Uzbekistan to adopt the principles of integrated water resource management and make it possible for people and the environment to exist together in harmony.

We hope this present review will help mobilize the efforts of all interested parties to solve the water problems of the Republic of Uzbekistan and attract the attention and involvement of the international community in water management issues and the conservation of the environment for future generations.

Sh. Khamraev

Foreword

UNDP Resident Representative and UN Resident Coordinator

Degradation of water resources and related salinization of arable land and mineralization of water has been identified by UNDP as one of the priority areas of environmental concern. Uzbek economy and its environmental sustainability significantly depend on availability and quality of the water resources. As with many countries in Central Asia, there are three major challenges related to water supply: (i) ensuring that the usage fully reflects the value of water as a scarce resource; (ii) rising of water table, leading to land degradation; and (iii) pollution of drinking water sources.

The fundamental reason for rural and urban water problems is the failure to recognize it as a precious resource. Among the Central Asian countries, Uzbekistan is the most dependent on irrigation water as the country has the largest arable land, the biggest rural population (over 16 million) and the highest population density. Hence, the proper use of water in agriculture is essential for Uzbekistan.

Given that the overwhelming percentage of water is used in agriculture, and that 80% of agricultural runoff waters contain high amounts of salts and pesticides, we can see the adverse effects of irrigated agriculture on the environment. Due to the long-periods of intensive irrigated agriculture during the Soviet period, and the excessive use of agro-chemicals, productivity of arable lands has decreased and rural population faces health hazards. As this report shows, addressing those issues has become a critical condition for the successful development of the country.

Globally, the shrinking of the Aral Sea and its delta is recognized as one of the largest man-made environmental disasters. That impacts on the northern regions of Uzbekistan. The ongoing unsustainable practices in water management and agriculture, coupled with the local population's intensified demands on the already denuded natural resources, have made life very difficult for the people of Karakalpakstan and Khorezm.

The report proposes that time has come to use ***integrated water resources management*** to face the challenges. It is worth pointing out that Central Asian countries have made some efforts in collectively addressing regional water problems. However, their different water endowments, different seasonal demands and continuing overdependence of their economies on Soviet era products and processes prevented active cooperation did not yield tangible results. Effective regional cooperation over water resources, as well as proper national water management practices, are likely to await sustained growth with economic diversification and deepening.

Fikret Akcura

List of Abbreviations

ADB	Asian Development Bank
ASBP	Aral Sea Basin Program
BAIS	Basin Administration of Irrigation Systems
BVO	River Basin Water Management Organization
CAC	Central Asian Cooperation
CACENA	Global Water Partnership in Central Asia and Transcaucasia
CARNet	Central Asian Network on Environment Protection and Sustainable Development
EBRD	European Bank of Reconstruction and Development
EUWI	European Union Water Initiative
FAO	Food and Agriculture Organization of United Nations
GEF	Global Environment Facility
GWP	Global Water Partnership
HPS	Hydropower Station
IBRD	International Bank for Reconstruction and Development
CACILM	Initiative of Central Asian Countries on Land Resources Management
ICARDA	International Center For Agricultural Research in the Dry Areas
ICWC	Interstate Commission for Water Coordination
IFAS	International Fund for Saving the Aral Sea
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
MAC	Maximum Allowable Concentration
MAWR	Ministry of Agriculture and Water Resources of the Republic of Uzbekistan
MDG	Millennium Development Goals
NCSA	National Capacity Needs Self-Assessment for Global Environment Management
NEAP	National Environmental Action Program
NGO	Nongovernmental Noncommercial Organization
NSWMP	National Salt and Water Management Plan
RIOD	International Network of NGOs and Local Organizations for Coordination of Actions to Combat Desertification
SCO	Shanghai Cooperation Organization
SIPLS	Mid-Term Strategy for Improvement of Population Living Standards
SIWI	Stockholm International Water Problems Institute
SLRM	Sustainable Land Resources Management
SPECA	Special UN Program for Economy of Central Asia
SRAR - CDD	Sub-Regional Action Program to Combat Desertification and Drought in the Central Asian Republics
UN CCD	UN Convention to Combat Desertification
UNDP	United Nations Development Program
UN ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UN FCCC	UN Framework Convention on Climate Change
UNEP	United Nations Environmental Program
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WARMIS	Water Resources Management Information System of WARMAP
WB	World Bank
WDI	World Development Indicators
WEMP	GEF “Water Resources and Environment Management Project” in the Aral Sea Basin
WUA	Water User Association

CONTENTS

SUMMARY

Water is fundamental to human survival and development. Both people and ecosystems depend on common water resources and so it is important to protect their mutual interests, especially the productive functions of ecosystems, which are the basis of public welfare. Recent estimates of the increasing demand for water show clearly the scale of future problems and threats and the need to be well-prepared for “life in a changing world”.

Water is the key factor in the socio-economic and environmental well-being of the Central Asian countries, which in recent years have faced the problem of shared *water resources management* in conditions of frequent drought, natural disasters, dust storms, flooding, and other especially dangerous phenomena. All the Central Asian countries experience shortages of water but Uzbekistan is the most vulnerable because it has the largest demand for water in order to meet the socio-economic and ecological requirements of its growing population, natural ecosystems, and sustainable development.

The main priority of the Republic of Uzbekistan in all stages of the current economic reforms is to ensure reliable social security for its population and measures to protect the environment.. In order to do this the Government pays special attention to liberalization and deepening of economic reform through institutional reorganization, development of WUAs, and expansion of the rights and economic independence of the agricultural producers.

Society already recognizes the need to take drastic steps for the solution of water problems and the mitigation of water shortages. Rethinking outdated water use principles and searching for acceptable and adequate measures and actions for overcoming worn out stereotypes in natural resources management is an ongoing process. It is noteworthy that the water shortages of recent years have increased people’s sense of the value of water and forced them to think what they can do to improve the situation themselves without outside support. In many respects the shortages have ensured a return to the traditions of the past.

The national programs and planned measures in the area of water resources management and environment protection are not limited to the national framework alone. They envisage integration into regional strategies for cooperation and strengthening of mutually beneficial partnerships in the Aral Sea basin on the basis of experience and achievements from elsewhere in the world.

This publication aims to familiarize the general public with the problems associated with water resources use in Uzbekistan. It also introduces them to some ways of solving water and energy problems that will allow sustainable development in the country, ensure regional and national security and help people to live harmoniously together in a changing environment.

The review comprises a summary, five chapters and five annexes.

Chapter 1 focuses on: (i) the facts behind the imminent global water crisis, regional problems and future threats causing serious concern; (ii) analysis of the international and regional agreements, initiatives and partnerships in the area of joint water and energy resources management and measures aimed at eliminating the negative impacts of the Aral Sea crisis; (iii) a brief review of the principles and approaches of integrated water resources management (IWRM).

Chapter 2 provides a general overview of the geographical location of Uzbekistan, its environmental and climatic characteristics and available resources, and describes the current problems associated with water resources use, including: (i) distribution and variation of river flow and water availability by region; (ii) use of water by sectors of the economy and river basins; (iii) quality of the surface, underground and collector/drainage waters and the staus of water resources monitoring; (iv) priority measures, mechanisms and action plans by sectors of the economy and future demands for water in changing conditions.

Chapter 3 is devoted to an assessment of: (i) progress in the development of reforms and reorganization in the water and agriculture sectors and a brief review of action plans in the area of water and energy resources management; (ii) institutional and legal aspects of water resources management, including analysis of factors limiting its integration into sustainable environment management and protection; (iii) participation and contribution of civil society in water use and conservation and its role in forming an ecological ideology, and promoting the ideas of IWRM and sustainable development.

Chapter 4 covers problems associated with transboundary water resources management and includes analysis of: (i) activities of the regional management bodies responsible for interstate water resources and the current status and infrastructure of BVOs; (ii) joint measures and actions undertaken by the five countries to restore the disrupted natural ecosystems in river deltas and the desiccated Aral Sea bed; (iii) transboundary problems in the Syrdarya and Amudarya river basins, and the status of monitoring, water use control, and decision support systems in the region; (iv) regional cooperation in joint use of water and energy resources in the Aral Sea basin, perspectives on the export of electrical energy and associated possible risks; (v) the role of tools and the possibilities presented by the Rio conventions for synergy and harmonized management of transboundary water courses and a review of progress towards fulfillment of the global commitments to the development of IWRM and efficiency plans.

Chapter 5 is devoted to: (i) analysis of experience and lessons learned in Uzbekistan and Central Asia in introducing IWRM; (ii) assessment of the key objectives of creating an enabling environment for IWRM through the improvement of the legislative basis, strengthening of intersectoral coordination, broad public participation and institutional development, as well as improvement of management tools; (iii) review of the main IWRM dimensions and vision of the national IWRM strategy in Uzbekistan; and (iv) analysis of the international experience associated with the introduction of IWRM in the future.

Materials from governmental and international programs and plans, outputs of national and international projects, research carried out by scientific institutions, statistical data and official materials from ministries and agencies of the Republic of Uzbekistan were used in the preparation of this publication.

The authors greatly appreciate the materials, consultations and valuable comments and amendments provided by the national specialists, and experts from UNDP and other institutions that have made this review possible.

Chapter 1. WATER IN GLOBAL AND REGIONAL CONTEXT

1.1. Water in Global and Regional Perspective

1.1.1. Global Water Crisis

Water is fundamental to human survival and development. However, the world's fresh water supply is under increasing pressure, and in many countries it is inadequate to satisfy the basic needs for food and sustainable ecosystems (Box 1).

The Global Water Partnership (GWP) summarizes the conclusions of many international sources about the looming water crisis with the following facts [75, 94]:

- Only 0.4 % of the world's water is accessible to people
- Currently more than 2 billion people in more than 40 countries have a lack of water;
- 263 river basins are shared by two or more countries;
- 2 million tons of waste are disposed of in water bodies every day;
- 90 % of natural disasters in 1990, were associated with water .

The recent UN (2004) assessments confirm that currently: (i) around 1.1 billion people have no access to safe drinking water; (ii) approximately 2.4 billion people use water without proper sanitary control; (iii) every year around 2 million children die of sea water-borne diseases alone; (iv) over the past decade many more people have died as a result of polluted water than from AIDS or as a result of military conflict [90].

In the subsequent decades increasing changes in landscapes are expected as a result of population growth, economic globalization, industrial development and measures to reduce poverty and hunger. This modification of landscapes brings about changes to ecosystems which runs contrary to efforts to preserve them as they are. Population growth and rising incomes will increase the demand for irrigation dependent food production, as well as domestic and industrial water consumption.

Box 1.1

WATER Facts

70-90%
the amount of fresh water used to grow crops in developing countries;

50 liters
the water needed per person to meet daily needs (Dublin Principles, 1992)

3,000 liters
the amount of water traditionally needed to grow one kilo of rice

58 kg
the average amount of rice eaten by one person each year

50%
the reduction in water use targeted by Future Harvest researchers producing new rice varieties

550 liters
the amount of water needed to produce enough flour for one loaf of bread (400 grams)

1,500 liters
the approximate amount of water used to produce 100 grams of beef in a developing country

7,000 liters
the approximate amount of water used to produce 100 grams of beef in a developed country

25%
the portion of India's harvest threatened by unsustainable groundwater use.

Source: IWMI

Mark W. Rosegrant et al (2002) point out that the success of irrigation in ensuring food security and improving rural well-being has been impressive, but past experience also indicates that inappropriate management of irrigation has contributed to environmental problems including, excessive water depletion, water quality reduction, waterlogging and salinization [50]. According to the World Resources Institute over the past 50 years, around 66 % of agricultural land has been degraded to varying degrees by erosion, salinization, nutrient depletion, compaction, biological degradation, or pollution (WRI, 2000). In fact, about one tenth of global irrigated lands are affected by soil salinity and could be threatening 10 % of the global grain harvest (FAO, 2002). Moreover, water and the ecosystems it supports are under increasing threat, leading to a deterioration in the quality and quantity of ecosystem functions. It has been estimated that half the world's wetlands have been lost as a result of agricultural drainage. In addition to wetland loss, deforestation – which can lead to excess erosion and sedimentation of rivers and storage reservoirs – is occurring at an accelerated rate. Although increasing slightly in developed countries since the 1980s, the area under forest declined by an estimated 10 % in developing countries. The majority of forest depletion is caused by agricultural expansion, logging and road construction [50].

By 2050, there may be significant changes as a result of the increasing food production needs of the growing population (9 billion) and ecosystem sustainability. As result of the need to provide people with food (through the development of irrigation or the improvement of rain-fed agriculture) water demand is expected to increase by more than three times in Africa and more than two times in Asia. (Box 1.2). Changes may also affect the industrially developed countries which, may be involved in the virtual export of water, i.e. the export of products to developing countries which experience water shortages. The extent to which future water needs can be met through irrigation development and the "yield from every drop" system, expansion of arable land area or virtual water with import of products will vary significantly in different regions of the world. These estimates of the increasing demand for water from the Earth's population show clearly the scale of the problems facing the integration of water, land, and ecosystems management, as well as the need to be well-prepared for "life in a changing world" [94].

In order to adapt ourselves to the changing conditions, we must consider the dynamics of natural processes together with the social ones which effect the environment. These social and environmental processes have evolved simultaneously. It has been shown that compared with other species the reaction of people to a change of habitat is less pronounced, and therefore, society should realize changes before it reacts to them consciously [94, 95].

The recent studies of environment degradation in the Mediterranean region during 20,000 years of human economic activity, conducted by Van der Leeuw et al contribute significantly to the new thinking [94]. The studies cover poor lands, droughts, abrupt flooding in Spain, soil salinization and water mismanagement in the southern part of Greece, the combined impact of tectonic processes and human economic activities on vegetation cover in the north-western part of Greece and seven thousand years of economic activity in the Rhone river valley in France. Excessive exploitation of natural resources by earlier civilizations for thousands of years has led to degradation of the environment. Sometimes this degradation was serious enough to cause the fall of civilizations (Box 1.3).

Box 1.2

The growing global demand for water to combat starvation

According to estimates by Rockstrom (2002)today's human diet requires evapotranspiration of on average 1,200 m^3/year which in terms of food production represents 7,000 km^3/year. The demand for water from food producers will increase up to 1,300 m^3/year (FAO). With predicted growth of the world population by 2050 (9 billions), an additional 5,600 km^3/year should be found for food production in order to ensure there are no shortages. Out of this volume 2,200 km^3/year is required to eliminate malnutrition, and the remaining 3,400 km/year to feed the growing population. Improved irrigation methods may save up to 800 km^3/year, and development of the system "yield from every drop" could represent an estimated 1,500km3/year. The remaining 3,300km^3/year should come from arable land reserves (existing meadows and forests), as well as from new arable land. *(M. Falkenmark, 2003, on the basis of the* Rockstrom,2002, *data)*

Box 1.3

The rise and fall of Easter Island civilization in the Pacific Ocean

The centralized and well-organized society of the Easter Islands, motivated by a desire to demonstrate its power to the neighboring clans and headed by a leader who was trying to outdo his predecessor, reduced the natural forest ecosystem virtually to a desert. The main reason for deforestation was the cutting of wood for transporting huge stone statues from inland stone-pits to their installation platforms on the seashore. Two hundred huge statues still stand there while the other seven hundred were left unfinished surrounded by the devastated ecosystem. Deforestation, most likely, had led to the intensification of wind activities and water erosion, which in turn disturbed the viability of the ecosystem. *(Van der Leeuw, 2000; Redman, 1999).*

"Six billion people, the current population of our planet, should reach a joint decision on how they will use water. The final result will depend on their good will" thinks Marc M. Brown, a member of the UN Commission on Environmental Issues [90].

1.1.2.Regional Water Problems and Future Threats

The Main Dilemma

Central Asia is located in the center of the vast Eurasian continent at the meeting point of trade routes. Currently it is the focus of increased international attention due to its geopolitical and economic importance, the wealth of its natural and human resources, and possibilities for transboundary trade and transportation. The peoples of Central Asia are united by a common history, culture, languages, religion, and traditions. However, without access to the sea the region to is highly dependent on its nearest neighbors and the international community for access to markets, security and support for socio-economic development. Water and energy also link the Central Asian countries. The highland countries (Kyrgyzstan and Tajikistan), located in the upper reaches of the rivers, possess one of the world's largest fresh water supplies and considerable hydropower capacity. The countries of the middle and lower river reaches (Uzbekistan, Kazakhstan, and especially Turkmenistan) have very significant reserves of fossil fuels, but depend on their upstream neighbors for the supply of water to their populations who rely directly or indirectly on irrigated agriculture (Figure 1.1).

Water is the key factor in the socio-economic and environmental well-being of the Central Asian countries. Practically all water resources of the region originate from the year-round snows and glaciers in Kyrgyzstan and Tajikistan. Irrigated agriculture is concentrated in the populous valleys of the Amudarya and Syrdarya rivers which carry their water to Uzbekistan, Kazakhstan, and Turkmenistan.

For two decades already the Central Asian countries, especially in the lower reaches of the

Figure.1.1. **Location of Central Asia**

Syrdarya and Amudarya rivers, have suffered from a lack of water and its socio-economic consequences. Uzbekistan is the most vulnerable because it possesses the largest irrigated land area (4.3 million ha), a large rural population (more than 16 million people), and the highest density of population (54.6 people/km^2 with a maximum of 520.5people/km^2 in the Andijan oblast) [107]. Despite the high demand for water, Uzbekistan has limited possibilities to directly influence the regime and volume of water flow across its borders, because the country is located in the middle reaches of rivers.

Water resources are to an increasing degree the key limitation on food production. They are of equal, if not greater significance than the availability of land. Irrigated agriculture already consumes more than 95% of the total intake and demand for water will grow in response to the need to ensure food security for the rapidly growing populations. Therefore, in the medium-term a serious conflict of interests will arise over the distribution of water between irrigated agriculture and other sectors of the economy, as well as at local level. Improving water use efficiency and conservation, managing demand on the basis of equitable distribution, achieving compromises between consumers and ecosystems along the upper and lower river reaches, are vitally important issues for Uzbekistan and the other countries of the Aral Sea basin.

Growing Concern

Although providing people with adequate supplies of drinking water is a priority for Central Asia, the population of the Amudarya and Syrdarya river basins has restricted access to safe drinking water. This affects first of all low-income groups and women. Water for municipal and drinking needs is drawn directly from rivers and canals. Consumers in the middle and lower river reaches and especially in the Amudarya delta are supplied with water which is unfit to drink (with a mineral content of 1.6 g/l to 2.3 g/l in some months[1]). These people have no alternative sources of water. Pollution of water by heavy metals, phenols and the other toxins is posing an increasing threat to people's health, lives and environment. Besides the current situation in the river deltas, there are serious threats in the Fergana valley (the radioactive pollution of the Mailisu river), the Zarafshan river valley and in the upper reaches of the Amudarya river (air pollution and environment by a Tajik aluminium plant, located 10 km from the border with Uzbekistan). Although desalination of mineralized water is relatively simple, all these processes are expensive to install and operate and would be a heavy burden for rural consumers. Low-income groups within the population are the most vulnerable. They have restricted access to water supply, as well as to other services [66]. The most serious problem facing cities and, especially, rural areas in the immediate future is how to meet the requirement for water and sanitation.

From the Soviet Union the region inherited an extensive water infrastructure, constructed during the early 1960s. This infrastructure is the regional public welfare [33]. During the Soviet period all operation and maintenance (O&M) expenses for this infrastructure, consisting of large dams, pumping stations, canals and other structures, were almost completely covered from the union budget. At independence, the management and operation became the responsibility of the republics themselves. However, they were unable to ensure proper O&M due to lack of funds and mechanisms for regional cooperation. This led to the growing deterioration of the infrastructure that in turn has increased the threat of waterlogging and soil salinization[2], pollution and degradation of the natural ecosystems, as well as significant water supply outages. According to some estimates the region loses USD 1.7 billion (or 3% of GDP) annually due to inefficient water resources management, and the annual decrease in agricultural production is estimated to be USD 2 billion [27, 33, 63,88,100]. Failure to improve the efficiency of the O&M system will present a threat to the safety of the whole regional water infrastructure and increase the risk of economic and ecological disaster.

[1]According to requirements of WHO and American Agency for Nature Protection, as well as standards of the Republic of Uzbekistan, the maximum quantity of the total soluble salts is 1.0 g/l.

[2]During the period 1990-2000 land area with high groundwater tables was increased from 25% to 35% from the total irrigated area; saline land area was increased by 57% (Amudarya river basin) and 79% (Syrdarya river basin); around 51% and 97% of agricultural land area are subjected to erosion in Kyrgyzstan and Tajikistan respectively.

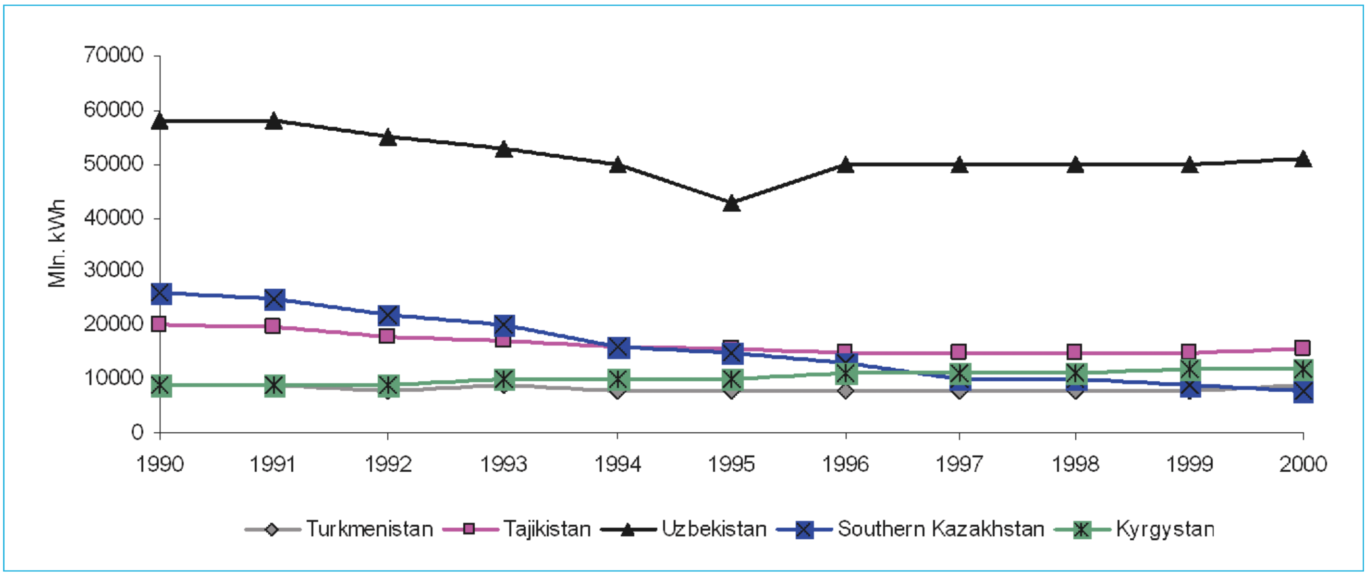
Energy is also an important regional issue, since the power grids, electric power stations, and oil and gas pipelines in the various republics are all interconnected. The energy system of Central Asia was conceived as a regional one, based on the export of hydropower from Kyrgyzstan and Tajikistan, and the sharing of energy carriers amongst all the countries. In the first half of the 1990s, there was a 20% decrease in energy consumption in all the republics. With the exception of southern Kazakhstan all the countries have managed to stabilize this situation (Figure 1.2). The reduction in energy consumption was accompanied by a 75% decrease in the volume of electric energy exchange amongst the republics that over the last 6-7 years accounted for 4-8% of total consumption. Various forecasts indicate that over the next 25 years energy consumption will increase by 35-80%. Demand will vary within the range of 5,300-12,000 megawatts by 2025. However, precise forecasting of the increase in electricity consumption volumes is very difficult in the current economic climate with outdated existing capacities requiring renovation and development. Despite this, according to UNDP estimates (2005) Central Asia has the possibility to become a major world energy supplier in the near future, especially in the oil and gas sector [33].

The critical state of water and energy systems in Central Asia threatens future economic development and environmental and social stability in the region. The most obvious example of this threat is the Aral Sea disaster and its consequences. The current crisis in the natural ecosystems of the Aral Sea zone symbolizes the key problem resulting from national water use and agriculture management in the countries of region. These ecological problems include deforestation, overgrazing and a decrease in the nutrition value of forage, loss of biodiversity and other processes disturbing the structure and functions of ecosystems and biogeochemical cycles crucial for the life support systems and safety of people and the environment.

Many millions of people in Central Asia and the life support systems which they rely on are subject to the impact of natural disasters such as earthquakes, flooding, and other dangerous phenomena. These threats continue to grow due to ill-conceived human activity which is causing irreversible damage to extremely vulnerable ecosystems. According to some assessments based on different climate scenarios, the Syrdarya and Amudarya river basins may see a reduction in water volume of 30% and 40% respectively [33]. Other forecasts suggest that such a substantial reduction in volume is unlikely. However, in all the models the demand for water grows faster than its supply. The expected growth in economic activity will cause increasing pressure on river runoff and global climate and moisture circulation, and problems associated with water deficiency in the arid and semi-arid regions of Central Asia will become more and more critical [73, 97].

UNDP analysis (2005) shows that national bodies are still poorly prepared to deal with natural disasters and their aftermath. The severity of the possible impact necessitates a better understand-

Figure 1.2. **Consumption of Electricity in Aral Sea Basin**



Source: GEF/WB WEMP Project, Report of the NWG of Uzbekistan, 2002 ing of the problem, assessment of vulnerability and the improvement of the system for monitoring water resources at the regional level. Only the combined efforts of all the Central Asian countries can achieve this extremely important task of ensuring reliable water management within changing ecosystems [33].

Over the past decade the Central Asian countries have made some progress towards cooperation in transboundary water management. They have managed to avoid interstate conflicts and are participating in ongoing negotiations and various initiatives on the joint use of water and energy resources. Although the current situation in the water/energy complex of the Syrdarya river basin is not critical, the implementation of the annual agreements on the Naryn-Syrdarya cascade, concluded in accordance with the new framework agreement, remains unsatisfactory. This endangers the life support system, income and safety of the whole Syrdarya basin population. The problem is complicated by the fact that the sectoral approach and "top-down" management system which dominated in the past, still remain at the national level. This is reflected in the preference for short-term economic benefit over sustainability, and for quantity rather than quality [99].This leads to fragmentary and uncoordinated development, hampers water management and use, and aggravates the growing competition for the depleted resource.

Today, Uzbekistan as well as the other Central Asian countries, must find ways to minimize and possibly prevent problems related to water and the environment. Both human beings and ecosystems depend on common water resources and so it is important to protect their mutual interests, especially the productive functions of ecosystems, which are the basis of public welfare. The ecological function of water is being constantly undermined by economic activity resulting in land resource use, production of biomass and pollution and deterioration of water which in turn affects the biotic interrelationship between circulating fresh water and ecosystems. Compromises must be found between the various uses to which water is put. This is a more complicated issue than supplying water to people, industry, and for irrigation. The problem is aggravated by a lack of coordination and consistency in prioritising water use and water and in compliance with agreements. This escalates tension and conflicts at the local level, especially in times of drought.

Clearly, consolidation of efforts, responsibilities, and cooperation amongst all the participating countries is urgently required if we are to achieve environmentally and socially acceptable compromises and the introduction of integrated water resources and environment management. In order to ensure that the social compromises are acceptable it is important to promote public participation in the processes of planning and decision making. This will help avoid future conflicts and contribute to stability in the region.

1.2. Global Conventions and Regional Agreements

1.2.1. Global Conventions

The Republic of Uzbekistan, as well as the other Central Asian countries which have experienced the impact of the Aral Sea disaster, recognizes the need to participate in global environmental protection activities. Currently the Republic of Uzbekistan is party to three Rio Conventions: the Framework Convention on Climate Change, the Convention on Biological Diversity, and the Convention to Combat Desertification, as well as a number of other international conventions, protocols, agreements, and memorandums of understanding in the area of environment conservation and sustainable development.

Cooperation amongst the Rio Conventions maximises benefits for the Parties from activities conducted within the framework of each agreement, and helps avoid duplication of effort. Although each of them has its specific objectives, tasks and commitments, they are all interrelated and interdependent, just like the components of natural ecosystems - water, land and other resources. All three Conventions complement and enhance each in connection with measures and actions, and also contain common commitments to capacity building, such as comprehensives studies, training,

[3]According to the recent assessments of SIC ICWC carried out jointly with the Mountain Unlimited & Scientific Information, (2003), as a result of the Aral Sea crisis the direct and indirect socio-economic costs for Uzbekistan is $ 144 millions per year (that is equal approximately to $ 5.7 per capita or 1.8 % of GDP).

strategic measures, monitoring and exchange of information.

Amongst the other important agreements in the context of global environment management, Uzbekistan is a Party to the following environmental conventions under the UN aegis:

- the Vienna Convention on the Protection of Ozone Layer (18.05.1993);
- the Montreal Protocol on Substances that Deplete the Ozone Layer (18.05.1993) and its London (1998) and Copenhagen (1998) Amendments;
- the Convention on the Prohibition of Military or Any Aggressive Destructive Actions on the Environment (26.05.1993);
- the Basel Convention on the Control of Transboundary Movements and Disposal of Hazardous Waste (22.12.1995);
- the Convention on the Protection of the World's Cultural and Natural Heritage (22.12.1995)
- the Convention on International Trade in Endangered Species of Wild Fauna and Flora (01.07.1997);
- the Bonn Convention on the Conservation of Migrating Species of Wild Animals (01.05.1998);

The Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitats (30.08.2001).

Uzbekistan is not a Party to the Convention on the Protection and Use of Transboundary Water Courses and International Lakes and the Convention on the Right for Unnavigable Use of Transboundary Water Courses. Among all countries of the Aral Sea basin currently only the Republic of Kazakhstan has joined these Conventions. Representatives of Uzbekistan participate as observers in the Conference of the Parties as well as regional meetings and discussions on these Conventions.

The participation of Uzbekistan in the above mentioned global environmental conventions opens broad possibilities for bilateral and multilateral cooperation with the participating countries in the area of environment protection, rational water and land use, combating desertification and mitigating the consequences of drought through the relevant national, sub-regional and international institutions. The representatives of Uzbekistan actively participate in the work of the Conference of the Parties to the conventions, as well as in international seminars and symposiums on problems of natural resources use, desertification and drought. They also interact with the Secretariat of the Convention, UNDP missions and other international and regional organizations and programs.

1.2.2. Regional Agreements

As was mentioned above, the water problem in Central Asia is of huge importance and is becoming more serious year by year. Variations in the seasonal demand for water resources along with imbalanced distribution creates preconditions for conflicts and may have a significant influence on the future economic position countries in the region.

All the Central Asian countries are faced with the problems of shared water resources management. These include:

- deterioration of the irrigation system and inefficient management and rapid growth of infrastructure maintenance costs;
- irrational and uneven distribution of water leading to waste and shortages;
- growth of tension between the upper and lower river reaches and an increase in intersectoral conflicts, particularly between hydropower and irrigated agriculture, both of which are of great importance to the national economy.

Since independence the republic has been a party to bilateral and multilateral agreements and a participant in regional initiatives in the area of joint water and energy resources management. A number of intergovernmental agreements have strengthened dialogue and cooperation amongst the Aral Sea basin countries (Annex 1).

In 1993, in order to address the ecological crisis and improve the socio-economic situation in the Aral Sea basin, the heads of the Central Asian countries established the International Fund for Saving the Aral Sea (IFAS). This organisation acts on the basis of the following intergovernmental agreements:

- The Concept of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan for solution of the problem of Aral Sea and its littoral zone taking into account the socio-economic development of the region (the main provisions developed in 1991-1992);
- The Agreement on joint actions for solution the problem of the Aral Sea and its littoral zone, ecological enhancement, and ensuring of the socio-economic development of the Aral Sea region (Kzyl-Orda, 26 March, 1993)
- The Agreement on status of the International Fund for Saving the Aral Sea (IFAS) and its organizations (Ashgabad, 9 April, 1999).
- The Provision on the International Fund for Saving the Aral Sea (IFAS), (Dushanbe, June 2002);

Since the establishment of IFAS existence the heads of state and the governments of the Central Asian countries have adopted a number of strategic decisions on the current and future tasks of the Fund, aimed at stabilizing environmental conditions and improving the management of water and land resources in the Aral Sea basin. In particular, the heads of state have adopted the Nukus (1995), Almaty (1997), Ashgabad (1999), and Dushanbe (2002) Declarations on the Aral Sea and other problems. The "Program of Specific Actions on the Improvement of the Ecological and Socio-economic situation in the Aral Sea basin" was jointly developed in close cooperation with the international community and submitted on behalf of the five states at the meeting of donors in Paris in 1994.

One of the most important IFAS structures is the Interstate Commission for Water Coordination which deals with water management issues at the interstate level. Decisions on the use of river water and discharge of water into the river deltas and the Aral Sea are adopted at the regional level. These decisions are binding for Central Asian countries. The existing status, functions and authority of the ICWC and its executive bodies, the BVO Amudarya and BVO Syrdarya, and problems associated with transboundary water resources management are discussed in Chapter 4.

Regional training centers (such as SIC ICWC, BVO Amudarya, and TIIM, etc) make the significant contribution to capacity building. These centers were established with support from international institutions and donor countries. A number of publications have been issued periodically including ICWC bulletins, abstract reviews, information digests, digests of scientific and legal reviews, IFAS bulletins, as well as materials from seminars, symposiums conferences, reports and brochures which reflect the results of activities in the region. Participation of decision makers (leaders, and water management specialists) in international study tours plays a very important part in enriching their experience.

1.3. International Cooperation and Donor Activities

Central Asia is currently the focus of increased attention and an arena for international cooperation. This is proving helpful in the coordination of efforts to improve the situation in the Aral Sea disaster area and ensure security and stability in the region.

Since independence Uzbekistan has established diplomatic relations with more than 100 countries and is a Party to more than 150 international multilateral conventions and protocols. Since 1992, the Republic, as well as the other Central Asian countries, has been a member of the Commonwealth of Independent States (CIS). In 1992, Uzbekistan became a member of the UNO and cooperates with a number of its programs and specialized institutions of the UN system. It is also a member of the UN Commission on Sustainable Development. More recently the Republic joined to the Eurasian Economic Community, as well as other regional initiatives – the Central Asian Cooperation Organization (CACO), the Shanghai Cooperation Organization (SCO). In the context of regional water resource management, Uzbekistan is a member of key regional bodies, such as the Economic Cooperation Organization (ECO) and the Central Asian Regional Economic Cooperation.

1.3.1. Global and Regional Partnership

In February 2002, the Republic of Uzbekistan became a member of the Global Water Partnership (GWP). The Regional Water Partnership of Central Asia and Transcaucasia (CACENA) unites on a voluntary basis the organizations involved in water use and management (government departments, local and regional organizations, professional associations, scientific and research institutes, as well as the private sector and NGOs) for sharing of experience and information and capacity building. The current activities of this regional organization in introducing the GWP approaches, experience and lessons learned are discussed in subsequent chapters.

The Republic of Uzbekistan also participates in the Water Initiative of the European Community (EUWI). The activities of EUWI provide a platform for the implementation of the action program for sustainable development (APSD) and contribute to the achievement of the Millennium Development Goals in Water. Within the framework of this initiative the EC strives for close cooperation with partners in order to: (i) strengthen the political will and commitment to action; (ii) make water management structures more efficient and build institutional capacity; (ii) improve coordination and cooperation; and (iv) increase the efficiency of the existing EC financing.

The political support for the initiative is strengthened by the EU's commitment to achieve the key tasks associated with water;

- reducing the number of people without access to safe drinking water and sanitation by 2015;
- developing integrated water resources management (IWRM) and efficient water use planning in all countries by 2015.

The EC initiative aims to provide a base for the development and implementation of this chain of actions. It proposes various mechanisms for promotion of current and future activities on cooperation and coordination, improving efficiency and ensuring an intersectoral approach.

In 1998, Uzbekistan and the other CA republics and ESCAP jointly declared their intention to begin implementation of the Special UN Program on the Economy of Central Asia (SPECA) with the support of donor countries. One of the priorities of this program is the rational and efficient use of the region's energy and water resources. With support from UNEP the Central Asian Regional Ecological Center was established together with regional and national offices in each of the five republics.

In 2004, the Republic of Uzbekistan joined with the other member states of the Organization "Central Asian Cooperation" (CAC) and EBRD representatives in adopting the concept of an International Water and Energy Consortium in the area of joint water and energy resource management. The Consortium reflects the agreed viewpoint of all member states on the creation of favorable economic and legal conditions for water management, fuel and energy, and other sectors of the CAC member states. Consortium activities are carried out under the leadership of a Board (oversight body) of plenipotentiary representatives from the participating countries, which has an equal number of members from each CAC state. In decision making each Party has an equal number of votes. Decisions are taken only with the complete agreement of all Parties.

In the area of hydrology and meteorology Uzbekistan participates in almost all programs of the World Meteorological Organization (hydrology, meteorology, climate, information, training, and organization of the international decades on hydro-meteorological safety). It is also a member of the UNESCO international hydrological program and the scientific programs of the interstate council on hydro-meteorology of the CIS.

Partnership between the international water and agricultural institutes (IWMI, ILRI, ICARDA, etc.) help to strengthen the scientific capacity of Uzbekistan. The advisory center CGIAR, financed by the WB, FAO, UNDP and International Fund for Agricultural Development (IFAD), unites 15 scientific and research institutions, known as of Future Harvest Centers. CGIAR aims to improve the living standards in drought affected regions through scientific research and training, to increase the production, productivity and quality of foodstuffs, and to protect and conserve water and land resources.

The Republic of Uzbekistan is also a full and active member of the International Commission on Irrigation and Drainage. A separate working group on the Aral Sea basin (ST-Aral) has been created within the ICID and representatives of Uzbekistan participate in ICID congresses and conferences.

Within the framework of the UN CCD the Republic of Uzbekistan participates in the 2003-2008 Regional Action Program for Asia and the Sub-Regional Action Program to combat desertification and drought for the Central Asian countries (SRAP-CDD), Havana, 2003. It is worth mentioning, that as far back as 1994, the Republic joined the international NGOs and local organizations network coordinating actions to combat desertification (RIOD) (Box 1.4).

A good example of multi-lateral and multi-donor partnership is the Central Asian Countries Initiative for Land Management (CACILM). The objectives of this program are to combat land degradation and reduce poverty in the CA countries by helping to develop a comprehensive and integrated approach to the sustainable management of land and water resources. CACILM is carried out with the participation of the Strategic Partnership (SPA) within the framework of the UN CCD. SPA comprises the GEF Global mechanism, the ADB, the International Fund for Agricultural Development (IFAD), GTZ (Germany), the Swiss Agency on Development and Cooperation (SDC), SIDA, the International Center for Agricultural Research in the Dry Areas (ICARDA) and UNDP.

Box 1.4

RIOD – Central Asia

RIOD was established in November 1994, at an international conference in Ouagadougou, Burkina Faso. Currently, RIOD unites NGOs from more than 100 countries of the world. RIOD consists of coordinating bodies at several levels (from local to national and sub-national regional and sub-regional). Since January 1996, Central Asia has been one of these sub-regions. The Chair of the coordination committee of RIOD – Central Asia is also a member of the RIOD global coordination committee. He current Chair is Mr. Oleg Tzruk of – Ecocenter BIOSTAN, Tashkent / and Ecoclub Catena, Ashgabad-ots@uzsci.net.

1.3.2. Donor Activities

Since independence Uzbekistan has cooperated closely with a number of international financial institutions, including the World Bank (WB), the European Bank for Reconstruction and Development (EBRD), ADB, the International Monetary Fund (IMF), the Global Environment Facility (GEF), and others. These institutions help gain access to international investment, world experience and green technologies.

The main source of finance for international projects in environment protection is the Global Environment Facility (GEF) (Box 1.5). One example of a nature protection partnership is the UNDP Program "Atrof Mukhit" 2001-2005, which lays the foundation of cooperation between UNDP and the Government of Uzbekistan in a number of environmental projects dealing with issues of sustainable development.

The efforts of international organizations and institutes are aimed at supporting the reform and institutional development of various sectors of the economy. They also aim to help develop a technically acceptable, economically reliable, and ecologically safe system for the management of the environment and natural resources and the improvement of living standards in the country. Around 78% of all donor funding was provided to the water and health sectors (Figure 1.3).

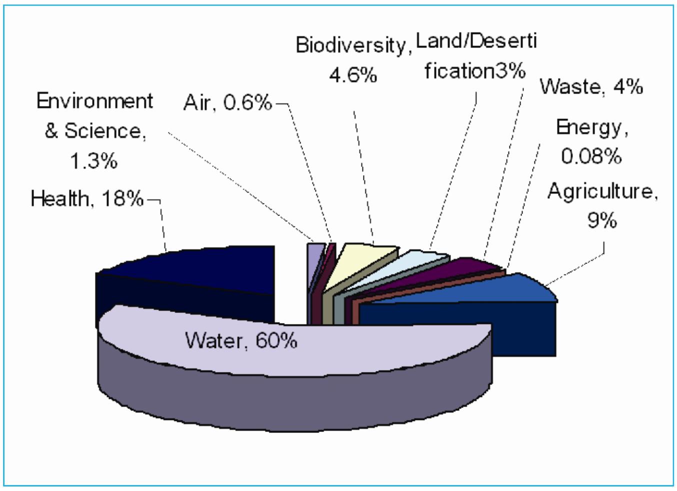
Box 1.5

Global Environment Facility

This is an international trust fund established to help protect natural environments of global importance and to promote environmentally safe and sustainable economic development.

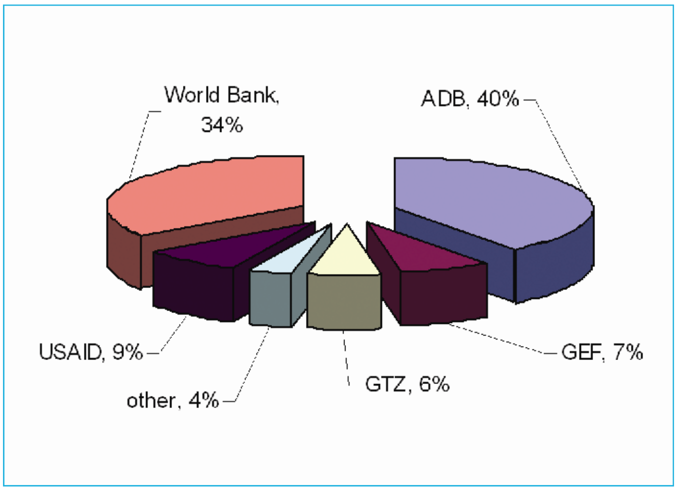
The program activities of GEF are concentrated in the following thematic areas: biological diversity, international water bodies, climate change and ozone layer depletion, and desertification problems. Three executive agencies have the right to administer GEF resources: the UN Development Program (UNDP), the UN Environment Program (UNEP) and the World Bank.

Figure 1.3. **Donors' Assistance by Sectors in Uzbekistan (2001-2005)**



Source: CACILM, 2006. NPF of Uzbekistan

Figure 1.4. **Donors' Contribution to Uzbekistan (2001-2005)**



Source: CACILM, 2006. NPF of Uzbekistan

According to CACILM (2006), the total contribution of donors to the development of the main sectors and support to reform in the country over the last five years is around $ 686 million. The contributions of specific donors is illustrated in Figure 1.4 [55].

Over the past decade national strategies, action programs and plans directly or indirectly associated with degradation of natural resources and the environment have been developed with support from donors. A wide range of projects are being carried out in various sectors and fields. This helps create a favorable environment for reform and cooperation and provides a platform for joint natural resources management and the achievement of stability in the region. Their efforts in capacity building and demonstration of benefits and advantages of the integrated water resources and environment management are of the special importance (chapter 5).

Despite the high proportion of the international donor funding devoted to the country's water sector, it is still well short of the amount required for improvement of water and energy resource use and environmental protection. Mechanisms for coordinating joint activities to improve the legal and institutional basis, and build capacity for joint management and decision making should be improved. This will create a reliable basis for development of integrated water and energy resource management at national level and ensure its harmonious integration at the regional and global level.

The current activities of international organizations aimed at improving regional cooperation in water use are insufficient to meet the above mentioned environmental challenges and threats and need to be enhanced. According to recent UNDP (2005) assessments, no one organization among the main international bodies (in particular, CAREC and SCC) has the explicit mandate to formulate and develop a unified regional approach to combating natural disasters and drought. However, according to the recommendations of the Kobe international conference, such an approach is required to promote regional programs, develop methodologies and standards, facilitate information exchange, mobilize resources, conduct major regional assessments and publish findings and reports. Finally, the international donor community has not yet realised the importance of ensuring that people are prepared for natural disasters and of carrying out preventive measures. Up until now it has not managed its own programs effectively [33].

Overcoming the existing constraints and barriers at all levels of management and planning requires donors to work more closely with the national partners to improve the consistency of their activities and create a strong alliance for the management of water and energy resources and environmental protection in the region.

1.4. Principles of Integrated Water Resources and Ecosystems Management

Since 2000 the principle of IWRM in practice of water resources management has been applied in practice by the Global Water Partnership (GWP) and its regional and national subdivisions, such as GWP in Central Asia and Transcaucasia (CACENA). Training materials produced by GWP CACENA, SIC ICWC and other bodies help facilitate advocacy and build the capacity of organizations and beneficiaries to plan and implement IWRM at various levels [74, 75]. On the basis of these materials, as well as UN and CARNet documents, the main principles and definition of the integrated water resources management system, as guide to action at the local and national levels, are briefly outlined below. The experience of water management in the region and lessons from international projects which support the IWRM philosophy and approach, will be discussed in subsequent chapters of this report.

1.4.1. Why IWRM?

The preconditions for the development of IWRM are serious and inarguable. The problem which Central Asia faces, along with the majority of the world's countries, is it's the fact that the various sectors of the economy have always developed in isolation.

The GWP (2005) defines IWRM as the process and philosophy supporting coordinated development and management of water resources, ensuring maximum and equitable economic and social benefits, and avoiding threats to the sustainability of vital ecosystems. IWRM provides a balance between the use of water resources for life support and the conservation of resources for future generations, and thus facilitates economic development, environmental sustainability and social equality.

"IWRM challenges the accepted practice, relationships and professional approaches. It opposes rooted sectoral interests and requires integral water resource management for the benefit of all. Nobody claims that the introduction of IWRM will be an easy task, but it is vitally important to commence this process now in order to prevent a worsening of the crisis " GWP, 2002

The main requirement of IWRM is the attempt to change the way organizations currently function, taking into account their operating environments, and understanding that they may operate independently from one another. IWRM also strives to introduce decentralized democratic water resource management with an accent on the participation of beneficiaries and decision making at the lowest level. This all implies change that may bring both threats and opportunities.

The introduction of IWRM is a lengthy process that requires reform at all stages of planning and management. It also requires development of regional cooperation that build confidence and mutual understanding and ,at the same time, reduce the likelihood of conflict, and ensure regional stability.

Analysis of recent reviews shows that due to the efforts and activities of GWP to advocate and introduce IWRM principles, considerable experience has been gained and useful lessons learned in 64 countries of the world. This confirms the real advantages of this management system for all beneficiaries [102,103]. There are three outstanding examples of the successful realization of the IWRM philosophy and approach to the joint management of water resources: (i) the Murray Darling river basins in Australia; (ii) the Seine – Normandy region of France; and (iii) the "Everglades" complex in Florida, USA. The lessons learned in the management of water resources in the Murray Darling river basins, as well as in other countries will be discussed in Chapter 5.

1.4.2. IWRM Approaches

At the 1992 conference in Dublin four principles were proposed which have become the basis for future reforms in water management [51]:

Principle 1. Fresh water is an exhaustible and vulnerable resource which is important for the maintenance of life, economic development, and the environment.

Fresh water is a natural resource that must be protected in order to ensure the vital services which it can provide. This principle says that water is required for various purposes so its management should be integrated and take into account both demands for the resource and threats to its security.

The integrated approach to water management requires the coordination of various types of economic activity, and identification of the demand for water, land use, and volume of waste water. According to this principle, the river basin or watershed should be considered as the unit of water management.

Principle 2. Development and management of water resources should be based on a comprehensive approach involving users, staff of planning organizations, and political decision makers at all levels.

Water is a resource and each user is a beneficiary. Real participation takes place only when the beneficiaries participate in decision making. An approach involving all beneficiaries is the best way of achieving long-term and broad agreement. Participation means accepting responsibility, recognizing the impact of this particular sector of economy on other water users and aquatic ecosystems, as well as making a commitment to improve efficiency of water use and its sustainable development. Participation does not always lead to consensus. Arbitration or other mechanisms for resoving conflicts are also required.

Possibilities for participation should be provided to all beneficiaries, especially women and other vulnerable social groups. Decentralization of decision making down to the lowest required level is the only strategy for strengthening participation.

Principle 3. Women play the central role in the providing management, and protection of water resources.

It is universally recognized that women play the key role in the collection and protection of water for municipal needs and, in many cases, for agricultural use. However, in comparison to men they are insufficiently involved in the processes of management, analysis of problems and decision making in regard to water resources.

The IWRM requires recognition of the role of women. There is an important interrelationship between the equality of men and women and sustainable water resource management. The participation of men and women, who play influential roles at all levels of water resources management, may help bring about stability. At the same time an integrated approach to water resource management will make a significant contribution to achieving gender equality by improving access for women and men to water and associated services and meeting their day-to-day demands.

Principle 4. Water has economic value in all its competing uses and should be recognized as an economic commodity, as well as a social commodity.

According to this principle it is, first of all, important to recognize the fundamental right of all people to have access to clean water and normal sanitary conditions at acceptable prices. Managing water as an economic commodity is important for the achievement of social objectives like efficient and equitable water use, and conservation and protection of water resources. Water has a value as an economic commodity, as well as a social commodity. The majority of water resource management failures in the past are due to the fact that the real value of water was not appreciated.

Value and payment are two different things and we should clearly distinguish one from another. The value of water for alternative use is important for the rational distribution of scarce resources. This may be done through regulation or by economic means. Demanding payment for water (or providing it free of charge) is using water as an economic tool for supporting vulnerable groups in the population, influencing their behavior regarding the saving and efficient use of water, and ensuring incentives for demand management, payback of services and readiness of some consumers to pay for additional water services.

Recognition of water as an economic commodity is the important means for deciding how water should be distributed amongst various sectors of economy and various water users within each sector. This becomes especially important when a further increase in the volume of supply is impossible.

Chapter 2. WATER – A CRITICAL RESOURCE FOR UZBEKISTAN

2.1. Water and Land Resources of Uzbekistan

2.1.1. General Information

The Republic of Uzbekistan is one of the key Central Asian countries in the Aral Sea basin in terms of its size, location, the wealth of its natural resources, and historical heritage.

Uzbekistan is a cultural mosaic with its roots in the ancient Sogdian, Bactria, Margelan, Shash, Khorezm and Turan civilizations. At different times it has been influenced by Persia, Arabia, China, Greece, and other countries. Today it is an independent state with more than 130 ethnic, tribal, and linguistic groups in its population. The indigenous people are Uzbeks, making up more than 3/4 of the total population.

Figure 2.1. **Location of Uzbekistan**

General Information about the country

Location:	Central Eurasia: $37^{0}11´$- $45^{0}36´$N; $56^{0}00´$- 73^{0} 10´E.
Area	447.400 km^2
Comparable Area	Germany and Portugal all together
Administrative Division	The Autonomous Republic of Karakalpakstan, 12 Oblasts, and 175 Rayons
Population	26,021 mln. people, including 16,6 mln. people of rural population
GDP (US$)	13,666,860,000 (WDI database, 2005)
Gini Index (%)	26.08 (UNDP, 2005)
Capital City	Tashkent (2.2 mln. people)
Historical Cities	Samarkand, Bukhara and Khiva

Landscape

The landscape of Uzbekistan is extremely diversified. There are plateaus, lowland plains, piedmont plains, mountain spurs and ridges (Figure 1.1).

The north-western part of the country is occupied by the Ustyurt plateau and lowlands of the Aral Sea littoral zone. Adjacent to vast Kzyl Kum desert are flat plains known as steppes (Golodnaya, Karnabchulskaya, and Karshinskaya). These are wedged between mountain ridges far to the east. At their peripheries these steppes merge gradually into inclined piedmonts, linking the desert plains of the west and the highland spaces of the east. The main highland areas of the country are the mountain spurs and ridges of the western Tien Shan and Pamir Alay. The ratio of highland to plains in the republic is 1:5.

Climate

The climate of Uzbekistan (marked continentality, aridity, plenty of light and heat) is determined by its southern location within the vast continent and by its great distance from seas and oceans [97]. From May to October there is significantly more sunshine than in the Mediterranean or California.

According to the UNEP[4] aridity index (from 0.05-0.20 to 0.65) the territory of Uzbekistan (with the exception of the piedmont and highland areas) is classified as an arid zone which is subject to air and soil drought and is therefore susceptible to degradation and desertification.

The average monthly air temperature for January ranges from +3^{0}C in the south (Termez) to -8^{0}C in the north (Ustyurt plateau); the maximum air temperatures in the summer months (July) reach 45-49^{0}C, with the soil surface reaching 60-70^{0}C. The average precipitation in the desert zone of the country is less than 200 mm/year, while in the piedmont and highland zones it varies from 400 to 800 mm/year with a maximum in the high mountains of up to 2,000 mm/year. Annual precipitation varies significantly in all zones and in some years it may be half the average. The country's territory is divided into two agroclimatic provinces (plains and piedmont/highland), and 10 agroclimatic zones which differ from each other in terms of natural moisture content, sum of the effective temperatures, duration of the frost-free period and other factors important for agriculture (Figure 2.2).

Soils

The soils of Uzbekistan vary according to the latitude and altitude zonality that is associated with climatic conditions and vegetative groups [55].

The soils of the desert zone, occupying 14 millions ha (32%), are formed in the most arid and harsh conditions. They all have low fertility, humus content (< 1%) and absorption capacity, high calcareousness and are subjected to salinization. These desert soils include the automorphic soils (gray-brown desert, sandy, and takyr soils), as well as their hydromorphic subtypes.

The soils of the sierozem belt (light, typical and dark sierozem) with an area of 6.7 millions ha (15%) are common above the lower margin of piedmont plains from 200 to 700-900 metres above mean sea level. The sierozems have a higher humus content (up to 2-3%) than desert soils and are less subject to salinization (with the exception of light sierozems). The typical sierozems are valuable for rainfed and irrigated agriculture. The dark sierozems are similar to the typical ones, but with a broader distribution area of shallow, stony and leached soil types.

The hydromorphic soils (meadow desert, and meadow alluvial types) occupy 3.8 millions ha (7% of total area). They are subject to natural and secondary salinization and water erosion and distributed in all regions of the country, although most are concentrated in the middle and lower river reaches, the Aral Sea littoral zone and isloated depressions.

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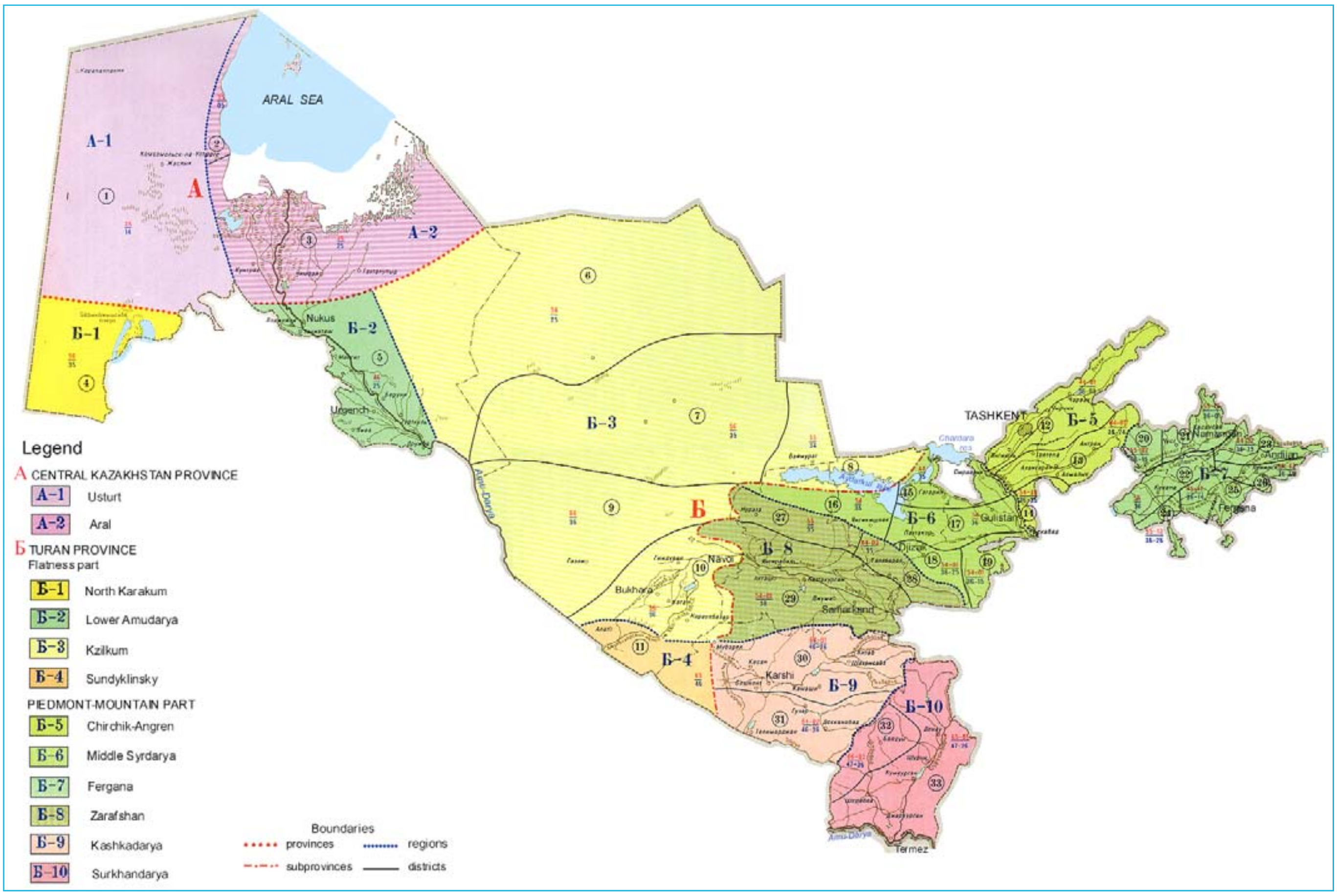
[4]According to the UNEP aridity index (the ration of total precipitation to the potential evapotranspiration) the droughty regions of the world are subdivided into three regions: *arid* 0.05-0.20, semi-arid 0.20-0.50, dry sub-humid 0.50-0.65

Figure 2.2. **Agroclimatic Map**



Source: CACILM, 2006

The chestnut, brown, and light brown soils of various depths occupy altitudes from 1,200 to 1,600 metres above mean sea level. The soils of the mountain slopes are characterized by their high humus content (from 1.5 to 8%) and various degrees of erosion: up to 70% of brown soils are classified as moderately or severely eroded. The slopes are used as pasture due to their highly dissected and steep nature.

Saline soils (residual, crust-puffed, puffed, etc.) with a total area of 1.3 millions ha (3% of the total land area) prevail in the local depressions located in lowland plains, lake basins and between mountains. Within the saline soils only meadow and swamp soils have a humus horizon reaching 1% of humus content.

Sands cover more than 12.1 million ha (27.6% of the total territory), including more than 0.5 millions ha of blown sands.

Vegetation

The flora of Uzbekistan is made up of not less than 4,800 plant species, which represent 659 genus and 115 families. The floristic composition of the country's south-western part includes many species peculiar to the Mediterranean. The xerophytic plants, which are specially adapted to severe environmental conditions, are common across vast areas of the deserted north-western part of the country. The main plant groups are psammophytes ("sand plants"), halophytes (saline soil plants), and gypsophilas (stony and gypsum desert plants). Currently natural vegetation covers not more than 25-30% of the total area [60].

The floristic composition of tugai vegetation comprises 285 plant species, representing 105 genus and 35 families. Human activity has caused significant damage to these species. The juniper forests of the country's highland territories are also characterized by degradation and comprise three juniper species: Juniperus seravschanica Komar, J. semiglobosa Rgl., and J. turkestanica Komar.

Cultivated vegetation occupies the special place. A combination of field crops (such as cotton, alfalfa, melons and gourds) together with trees planted beside roads, canals and along field boundaries and household gardens creates a landscape unique to oases.

Hydrography

Within the country's highlands the hydrographic network consists of a large number of permanent water courses, which form river systems of various sizes. In the piedmont zone the temporary water courses have created a rather dense hydrographic network. There are 6,500 rivers with a total length of 2,800 km on the slopes of Fergana depression [40,97]. The density of the river network here varies from 0.28 to 0.95 km/km^2. The average density of the river network in the Surkhandarya river basin is 0.52 km/km^2.

Significant variations in the density of river networks is observed in other of river basins and tributaries: in the upper reaches of the Zarafshan river its value is not more than 0.15 – 0.20 km/km^2, while in the lower reaches it is as high as 2.3 km/km^2; in the Kashkadarya river basin the average density of the river network is 0.32 km/km^2, and with its tributaries this value varies from 0.43 to 1.47 km/km^2. In comparison: the average density of the river system in the European territory of the CIS is 0.37 km/km^2, while that of the Ukraine is 0.27 km/km^2.

Lakes

Natural Lakes. The largest natural lake is the Aral Sea. The drying up of this large water body has led to significant disruption of the ecosystems and is considered one of the 20th century's global ecological disasters (Box 2.4). Within the valleys of local rivers natural flood-plain and delta lakes are found. Highland lakes are usually of the dammed or glacier/morainal type with water storage capacity of around 50 km^3.

Artificial Lakes are created as a result of human activity. They include the chain of lakes along the periphery of the Khorezm oasis and numerous lakes in the north-western part of the country and in the Kzyl Kum desert, which are used for disposal of waste waters (Figure 2.11).

269 lakes and desert depressions filled with water with total area of 739 km^2 have been identified in the middle and lower reaches of the Amudarya river (Table 2.1). Some of these have no outflow; others (such as Sichankul, Dengizkul, Salty, and Karateren) are seasonally regulated in conjunction with the Amudarya river or with other lakes.

The largest lake system in Uzbekistan is the Arnasai system located in the middle reaches of the Syrdarya river. It combines the Aidarkul, Tuzkan, and Upper-Arnasai lakes. The total water surface area of this system is 3,491km^2 (2004). However, its constant growth due to winter releases from the Chardara reservoir is having a serious ecological and socio-economic impact (Box 2.2).

Internal Wetland Ecosystems

Uzbekistan has a rather unique combination of desert and wetland areas of both natural and man-made origin.

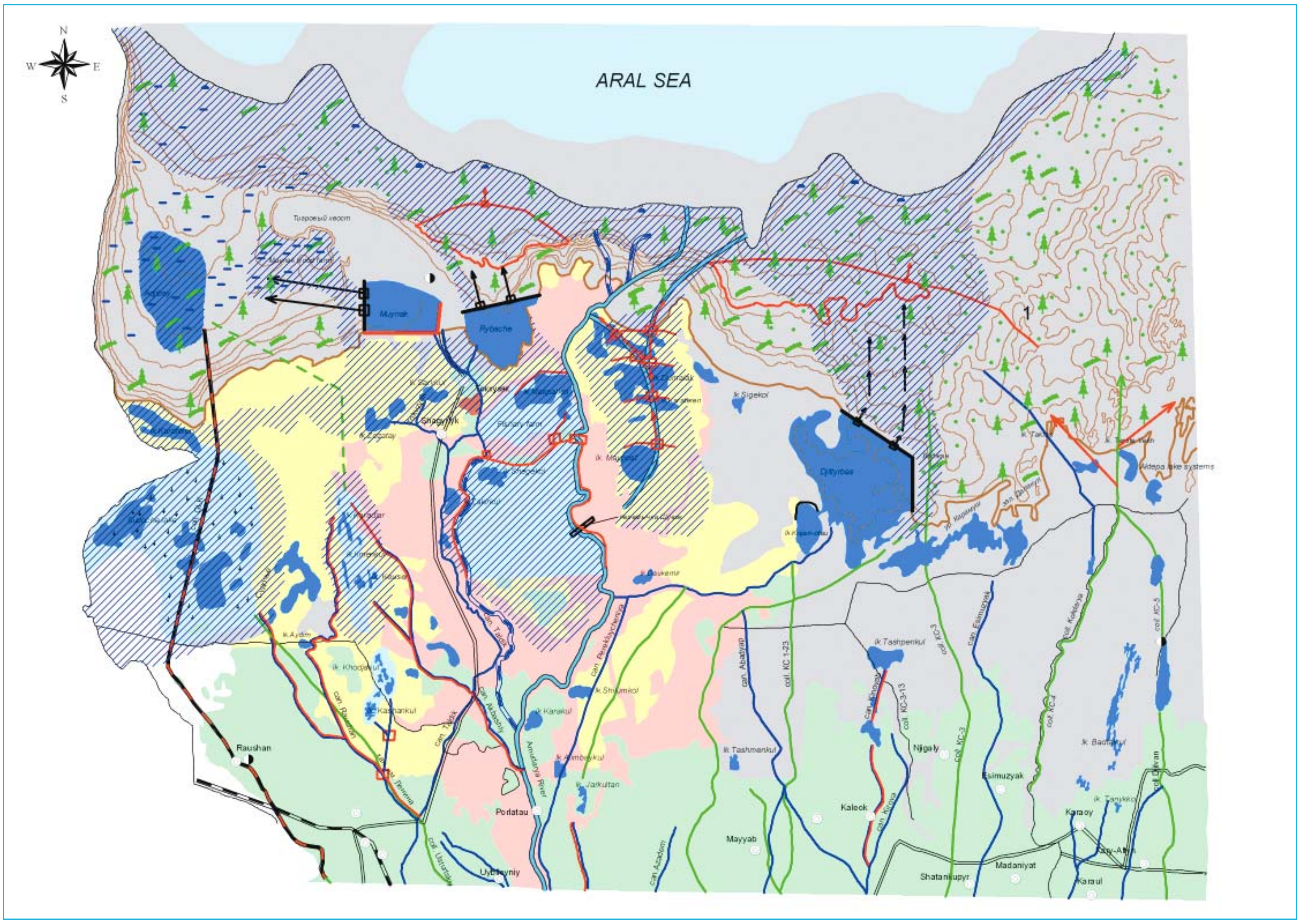
The Natural Wetland Ecosystems. The Amudarya river delta with an area of 700,000 ha (Figure 2.3) is a natural wetland system but one which has been significantly changed. The reduction of water inflow to the delta and recession of the Aral Sea from the coast line had caused irrecoverable damage to the ower reaches of the river which is a

Table 2. 1. **The Desert Depressions of Uzbekistan**

Oblast	Depression	Water Level Elevation, м	Volume km³	Surface Area km²
Kashkadarya	Atchin	272.30	0.08	15.61
	Sichankul	247.50	1.30	69.00
	Deukhana	250.00	0.20	23.00
Bukhara	Dengizkul	184.00	3.50	310.00
	Khadicha	226.00	0.15	26.00
	Tudakul	223.50	1.20	210.00
	Salty	183.40	0.21	48.00
	Ayakagitma	187.00	7.60	870.00
	Karakyr	184.00	0.28	170.00
Karakalpakstan	Ayazkala	100.00	0.67	60.00
	Karateren	47.00	0.63	21.00
Djizak, Navoi	Arnasay system	247.00	42.8	3,491

Source: Uzgipromeliovodkhoz, 2003

Figure 2.3. **The Natural Wetland Ecosystems of the Aral Sea Littoral Zone**



Source: CEF/WB, 2002

traditional nesting place for water-fowl and the habitat of many mammals and reptiles.

Wetlands located within the valleys of large rivers, at the periphery of debris cones and depressions are very often difficult to distinguish from small lakes because during wet periods they are filled with water. During dry periods some of these lakes dry up and turn into wetlands. There are not many wetlands in the highlands and they are usually small.

The Man-made Wetland Ecosystems. These systems are created mainly by artificial water bodies, which appeared as the result of drainage water disposal from irrigated lands or reservoirs constructed for regulating river runoff.

All the existing wetlands are used for fishing. The ecological problems of wetlands are due mainly to the unstable regime of water inflow and the fact that they are poorly protected. As a result of this there are only limited possibilities to conserve the habitat and biodiversity of this ecosystem.

2.1.2 The Available Resources

The Main River Basins

The main water resources of Uzbekistan are the surface runoff, formed by the transboundary rivers the Amudarya and Syrdarya with their tributaries and also the Kashkadarya and Zarafshan rivers. The main flow of the Amudarya and Syrdarya rivers is formed in Tajikistan and Kyrgyzstan respectively.

The surface water resources of the Amudarya and Syrdarya rivers are calculated from data collected at the river gauge stations located close to where the rivers come down from the mountains. However, each of these river basins has a so-called unaccounted flow that is formed by insignificant but numerous inflows from small streams, groundwater from mountains and piedmont areas and precipitation infiltration, which is not taken into consideration by the hydrometrical methods of flow estimation. The volume of surface water resources of the rivers calculated from the Uzhydromet river flow data for the period 1932/33-1998/99, and adjusted to the natural conditions is presented in Annex 2 [92].

The Syrdarya River Basin

The total area of the Syrdarya river basin is approximately 345 thousand km^2. The main Syrdarya river is formed by the confluence of the Naryn and Karadarya rivers. It is 2,8 km long, about 2,000 km out of the territory of Uzbekistan [40, 62, 87, 97].

The Syrdarya and its tributaries are glacier/snowmelt fed rivers. The water resources of the Syrdarya average 41.6 km^3. Approximately 70% of the main flow volume is formed within the upper watershed down to the river's exit into the Fergana valley. Most of tributaries join the river along its right bank in the eastern part of the Fergana valley. Numerous small streams with insignificant total flows join the river along its left bank.

The total surface inflow to the Fergana valley from the highland area of 94 thousand km^2 is on average 25,5 km^3/year, including the Naryn river (45%), the Karadarya river (16%), and the right and left bank tributaries (39%).

The Syrdarya river flow is characterized by significant annual and long-term variability. The long-term average volume of inflow to the Chardara reservoir is 34.3 km^3. In a dry year this value decreases to 24.3 km^3. The natural river flow is significantly distorted by the diversion of water for irrigation and disposal of drainage water, as well as by reservoirs. These factors disturb the hydrodynamic and hydrochemical balance of river.

The Chirchik river is the biggest right bank tributary of the Syrdarya river. It is formed by the confluence of the Pskem, Ugam, and Chatkal rivers. The river watershed is 14,240 km^2 in area The maximum discharge (581 m^3/s) of this glacier/snowmelt fed river is in June, and the minimum in February (69.1 m^3/s). Water from the river is diverted for irrigation into big canals (Bozsu, Karasu, Parkent).

The Amudarya River Basin

The Amudarya river is the largest in terms of runoff which accounts for 2/3 of the total water resources of the Aral Sea basin. The length of the Amudarya from the source of the Pyandj river to the Aral Sea is 2,540 km, including about 1,000 km within the territory of Uzbekistan. The basin covers a vast territory (approximately 1,327 thousand km^2). After the confluence of the Pyandj and Vakhsh the river is called the Amudarya. Then the river flows along the border between Afghanistan and Uzbekistan, crosses Turkmenistan, returns again to Uzbekistan and disgorges into the Aral Sea, creating at the approaches to it a huge delta up to 300 km wide. Two large right bank tributaries (Kafirnigan and Surkhandarya) and one left bank one (Kunduz) flow into the river in its middle reaches. Then there are no any tributaries on the way down to the Aral Sea. Over its course the river crosses deserts and semideserts flowing between the Karakum and Kzylkum deserts. While flowing through the plain from Kerki to Nukus, the river loses most of its runoff through evaporation, infiltration, and irrigation. The waters of the Amudarya river are the most turbid of any in Central Asia and among the most turbid in the world [40,62,84,97].

The Amudarya river is the glacier/snowmelt fed type of river and its water resources are 68,63km^3 on average. The main flow volume (85%) is formed by the Vakhsh and Pyandj tributaries. The share of the Surkhandarya, Kafirnigan, and Kunduz rivers is only 15%.

The total calculated surface inflow from the watershed is more than 80.5 km^3. The long-term variability of the annual runoff is not so high (the variation coefficient is 0.15), but its uneven distribution through the year is well pronounced with 77-80% and 10-13% of total runoff in April-September and December-February respectively. Such runoff distribution is very favourable for irrigated agriculture.

The Zarafshan River Basin. The total area of the Zerafshan river basin is 143 thousand km^2, including 131 thousand km^2 within Uzbekistan. Runoff of the highland part of river basin is formed by the Zarafshan river (51%) and its tributaries (Fandarya and the others). The total length of the river is 576 km.

The long-term average runoff of the Zerafshan river is 5.91 km^3. Only 0.76 km^3 of runoff is formed in Uzbekistan. The Zarafshan river basin is the region on the right bank of the Amudarya river with the lowest available water supply. It urgently requires replenishment of its own water resources and improvement of water quality.

The Kashkadarya River Basin. The Kashkadarya river, flowing from the western spurs of the Zarafshan and Gissar mountain ridges, is 310 km long with a watershed area of 8,780 km^2. The rivers Aksu, Yakkabag, Tankhaz, and Guzar contribute most to the Kashkadarya river runoff in the reaches between the mountains and the Karshi oasis. The Guzar river that flows into the Kashkadarya river immediately before the Karshi oasis is characterized by its negligible water supply and extremely unstable annual runoff.

The long-term average runoff of the Kashkadarya river is 1.0 km^3. Due to the intensive diversion of water for irrigation, not all rivers of the Kashkadarya river basin have constant transit flow along all their length after leaving the mountains.

Underground Water

Underground water forms a significant part of the country's water resources and plays an important role in supplying water for drinking, as well as for agriculture, including pasture irrigation. Underground water of the Aral Sea basin, which lies within territory of Uzbekistan, is formed by precipitation and filtration from water bodies, river beds, canals, lakes, and irrigated territories.

The total volume of natural underground water in Uzbekistan is 24.35 km^3. Out of this amount 20.79 km^3, 2.92 km^3, and 0.46 km^3 lie in the Quaternary, Upper Pliocene-Quaternary, and Upper Cretaceous deposits respectively (Table 2.2).

The regional replenishable underground water supply is 24.02 km^3. Out of this fresh water accounts for 8.95 km^3 (up to 1 g/l). The available underground water supply by aquifers is presented in Annex 2 [62].

Table 2. 2. **Underground Water Resources of Uzbekistan**

River Basin	Natural Underground Water Resources	Used Underground Water	
		Total	With mineralization up to 1 g/l
	km^3	km^3	km^3
Amudarya	10.73	9.93	3.11
Syrdarya	13.62	14.09	5.84
Total	24.35	24.02	8.95

Source: Uzbekhydroingeo, 2001

To date 357 underground fresh water aquifers (with the exception of mineral and thermal waters) with a total supply of 0.021 km^3/day have been explored. Out of this volume 0.010 km^3/day is potable water. Only 267 aquifers out of the total number explored are currently in use leaving large reserves for the future development of drinking water supply in rural areas. Since 1965, the underground fresh water supply has reduced by 5.05 km^3 (36%). This is due to extensive work on redistribution and diversion of the large water volumes from and disposal into the surface water courses, polluted return waters and untreated wastewaters.

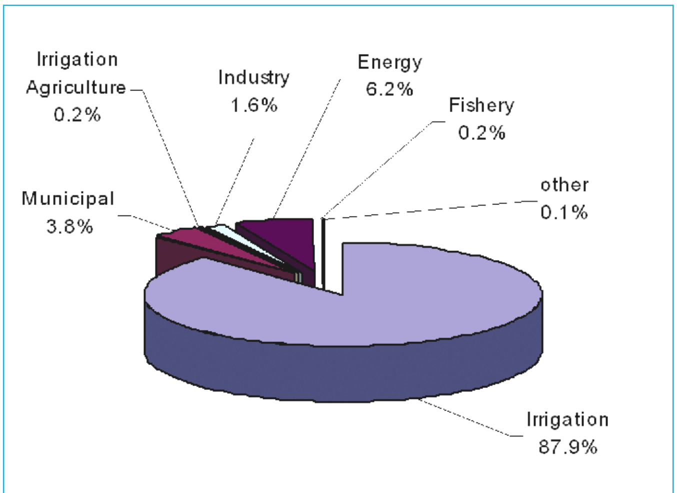
Return Waters

According to the latest assessments the total volume of return waters for the period of 1990-2000, varies on average from 28.0 to 33.0 km^3/year [62,77,98]. The total volume of return waters from various water consumers is 28.3 km^3/year, including 20.1 km^3/year and 11.5 km^3/year in the Syrdarya and Amudarya river basins respectively (Figure 2.4). These high volumes of return waters are associated with high infiltration losses from canals and irrigated fields.

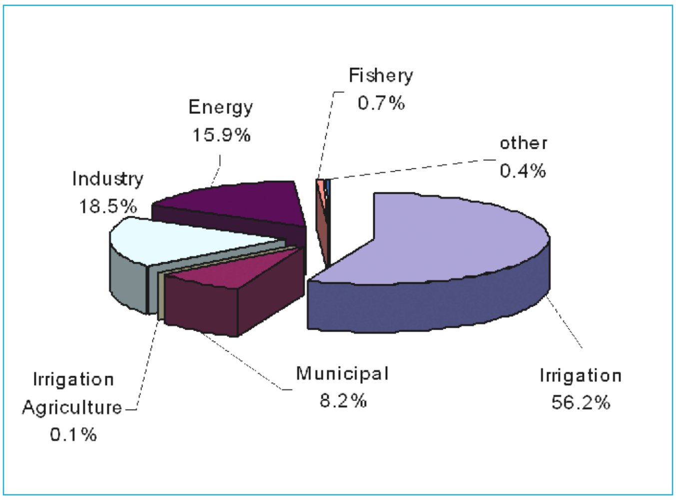
Irrigation water forms a significant part of the available water resources because more than half of it returns to rivers. However, the poor quality of this water is a serious threat to water resources and terrestrial ecosystems. The level of the average collector and drainage water quality (CDW) mineralization varies in the range from 1.5 - 2.5 g/l (the Central Fergana valley and Southern zone of Surkhandarya oblast) to 5.0 – 6.0 g/l (middle reaches of the Amudarya river).

Figure 2.4. **Distribution of Return Water Volumes by Various Water Consumers and Users**

Amudarya River Basin



Syrdarya River Basin



Source: GEF/WB WEMP, 2002

2.1.3. Water Resource Available for Use

The long-term average volume of Uzbekistan's internal rivers is 11.5 km³/year, or around 18% of the total water demand (Table 2.3).

Around 82% of total water demand is covered by the transboundary water resources of the Amudarya and Syrdarya rivers. The total surface runoff of these rivers is estimated as 123.08 km³ for the years with 90% probability (Figure 2.5). On the basis of this value and by the mutual agreement of the Aral Sea basin countries, limits on water consumption and sharing of water amongst the states of the region have been established (Chapter 4).

Although the estimated value of the available surface runoff (123.08 km³) was adopted as the legal basis one for allocating transboundary water resources, other values are also currently available such as those produced by SANIGMI (132.7 km³), SIC ICWC (116.6 km³) and component A1, 2001 (123.08 km³). This suggests that additional studies are required to assess the total surface runoff within the Aral Sea basin [72].

Table 2.3. **National Surface Water Resources of Uzbekistan**

River	Long-Term Average Runoff, km³
Anudarya River Basin	4.82
Surkhandarya	3.25
Kashkadarya	1.06
Zarafshan	0.51
Syrdarya River Basin	6.65
Rivers of Fergana Valley	1.50
Rivers of Middle Reaches	0.36
Chirchik, Angren	4.79
Total:	11.47

Source: Uzhydromet, NWG RUz, 2001

According to the interstate agreement the volume of available water resources for Uzbekistan is 63.02km³. This is based on seasonal Amudarya river flow regulation and long-term Syrdarya river flow regulation and takes into account 11.5 km³ of runoff from Uzbekistan's own rivers (Table 2.4).

Table 2.4. **Approved Volumes of Available Water Resources for Uzbekistan, km³**

River	Main Course	Tributaries	Total	Underground Waters	Collector-Drainage Flow	Total
Syrdarya	10.49	9.2	19.69	1.59	4.21	25.49
Amudarya	26.92	6.98	33.9	1.00	2.63	37.53
Total	37.41	16.18	53.59	2.59	6.84	63.02

Source: Integrated Water Master Plan for Syrdarya river basin (1983) and Amudarya river basin (1984), Sredazgiprovodkhlopok

2.1.4. River Flow and Its Regulation

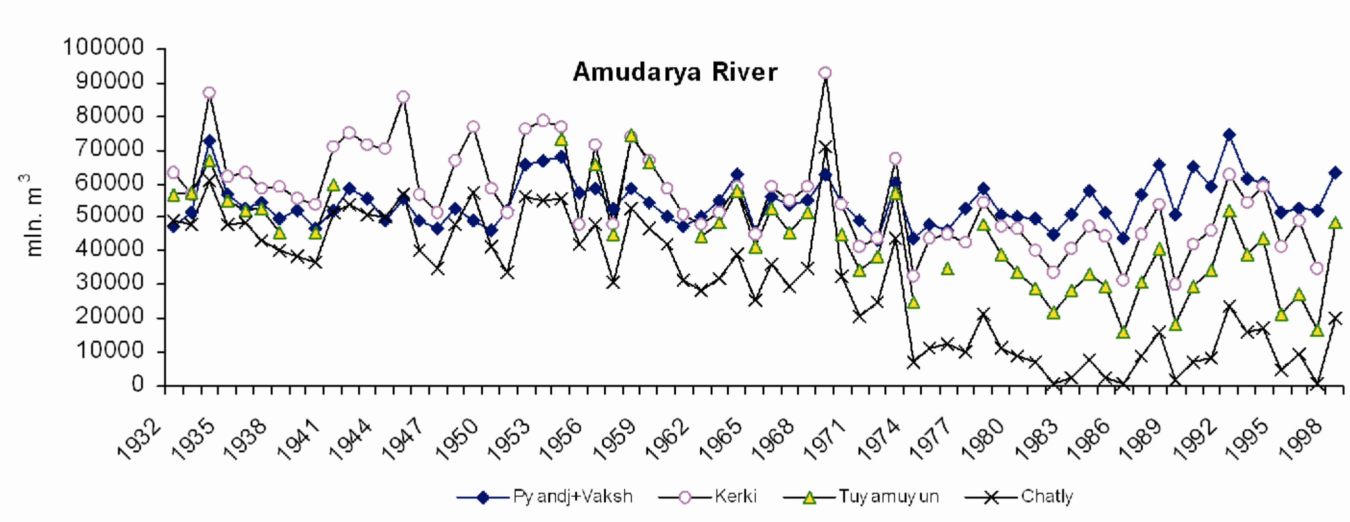
River Flow

River flow is characterized by the significant short-term and long-term variability. In dry years (with a 90% probability) it is 23 km³ less than in an average year. Wet periods (2-3 years long) occur every 6-10 years. Dry periods occur every 4-7 years and they are typically lengthy (up to 6 years) [62,73].

Variation of flow within these cycles is rather significant. During a dry period of 8 years (1960/61-1967/68) the Amudarya river flow was only 90% of its normal volume. During a 2 year wet cycle (1968/69-1969/70) it exceeded the average volume by more than 30% (Figure 2.5.). Variation of annual river flow is measured by the coefficient of variation: the higher the value of this coefficient, the bigger is the variation in flow (Table 2.5).

The cyclical nature of river flow variation and the occurrence of long dry periods complicates the use of water sources in the national economy and makes it necessary to regulate flow using a system of reservoirs.

Figure 2.5. **Long-term Trends of River Runoff Variations for 1932-1999 (GEF/WB, WEMP, 2002)**



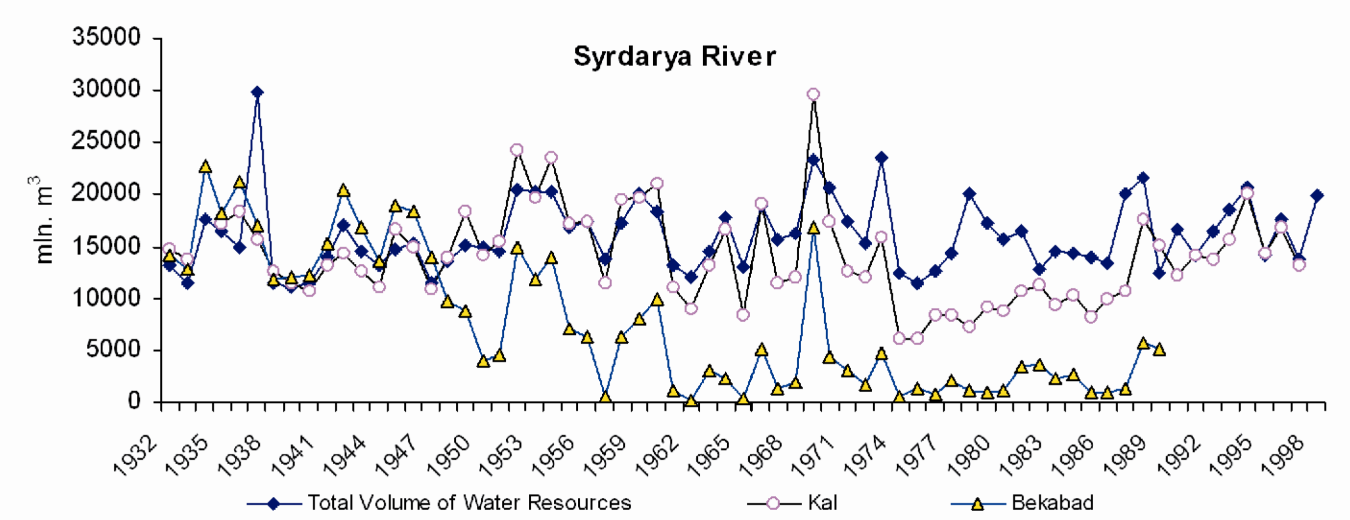


Table 2.5. **River Runoff of Various Probability, km³**

River - Site	Probability			C_v
	50%	75%	90%	
Amudarya river basin	**73.69**	**66.68**	**61.41**	
Vakhsh-Tutkaul	20.17	18.44	17.00	0.13
Pyandj-Lower Pyandj	33.84	30.92	28.50	0.12
Kafirnigan-sum of rivers	5.56	4.91	4.38	0.18
Surkhandarya-sum of rivers	3.72	3.22	2.89	0.19
Kunduz river, down stream	4.11	3.57	3.57	-
Kashkadarya- sum of rivers	1.04	0.85	0.70	0.29
Zerafshan-Dupuli +Magiandarya-Sudji	5.25	4.77	4.37	0.14
Syrdarya river basin (down to Chardara res)	**34.32**	**28.86**	**24.62**	
Nary-Toktogul	13.76	11.75	10.18	0.23
Fergana valley rivers	11.61	9.69	8.22	0.25
Chirchik, Angren, Keles	6.59	7.11	5.95	0.27
Rivers of middle reaches	0.36	0.31	0.27	0.21
Total	**108.01**	**95.54**	**86.03**	

Source: GEF/WB WEMP Project, Glavhydromet data, 2001

Flow Regulation of the Amudarya and Syrdarya Rivers

The main channel reservoirs for the regulation of the Amudarya and Syrdarya river flows are located beyond the boundaries of Uzbekistan, with the exception of the Andijan, Tuyamuyun, and South Surkhan reservoirs (Table 2.6). This system of reservoirs was designed for use in irrigation and energy production. Currently, only seasonal flow regulation is carried out in the Amudarya river basin (by the Nurek and Tuyamuyun reservoirs with a total capacity 10.5km^3 and 7.3km^3 respectively) [62,92].

The Syrdarya river flow is regulated within a volume of 34 km^3 provided the Toktogul reservoir is operated in irrigation-energy production mode. The Kairakkum reservoir in Tajikistan in the middle reaches of the river has a small available storage capacity of 2.5 km^3. The Chardara reservoir in Kazakhstan with a storage capacity of 4.7 km^3 operates in irrigation mode for water users in the lower reaches.

The Toktogul reservoir located in the Kyrgyz Republic provides long-term regulation of the Syrdarya river flow. Although the Toktogul reservoir controls only 1/3 of total flow of the Syrdarya river, it has a significant storage capacity of 14 км^3 and if it is functioning properly allows the whole Naryn-Syrdarya cascade of reservoirs to operate efficiently. Together with the other reservoirs (Kairakkum and Chardara), Toktogul draws down up to 4.5-5.0 km^3/year during the designed probability year (90%), including approximately 1 km^3 for hydropower generation.

Table 2.6. **Channel Reservoirs within Amudarya and Syrdarya River Basins**

Reservoir	Useful volume, mln.m^3	River
Amudarya River Basin		
Nurek	4,500	Vakhsh
Tuyamuyun	4,500	Amudarya
Southsurkhan	700	Surkhandarya
Syrdarya River Basin		
Toktogul	14,000	Naryn
Chardara	4,700	Syrdarya
Kaurakum	2,500	Syrdarya
Andijan	1,750	Karadarya

Source: NWG RUz, 09.2002

2.1.5. Water Supply and Balance

Based upon the availability of its own water resources Uzbekistan is among those countries which experience serious water shortages that significantly hinder economic development and the improvement of people's living standards. Schemes to transfer water for use within the Amudarya and Syrdarya river basins and current water use in Uzbekistan are presented in Annex2.

The rough water balance of the Syrdarya and Amudarya rivers for dry year conditions (90% probability) is shown in Figure 2.6 [62,84,85].

Currently the available water limit for a year of 90% probability does not actually exceed 59.2 km^3. In years with an increased water supply Uzbekistan consumes up to 63 km^3, including 59 km^3 for irrigation. In the years with a reduced water supply this index drops to 54.2 km^3, including 49.0 km^3 for irrigation. This is significantly below the established limit for possible water consumption, adjusted to the actual situation. The deficiency of water intake during drought years is illustrated in Figure 2.7.

The Syrdarya River Basin. Water availability in the Syrdarya river basin has dropped in recent years since the Toktogul waterworks changed its operational mode to hydropower generation (the total capacity of the reservoir is 19.5 km^3). The hydropower generation mode of Toktogul reservoir envisages an increase in water release from 180 m^3/s to 360 m^3/s. These changes in the operational mode of waterworks within the Syrdarya basin has led to a reduction in guaranteed water supply volumes during the growing period of 4.5-5.0 km^3/year. Uzbekistan's share of this reduction is up to 2.5 km^3/year, including a water deficit in the Fergana valley of up to 1.5 km^3/year.

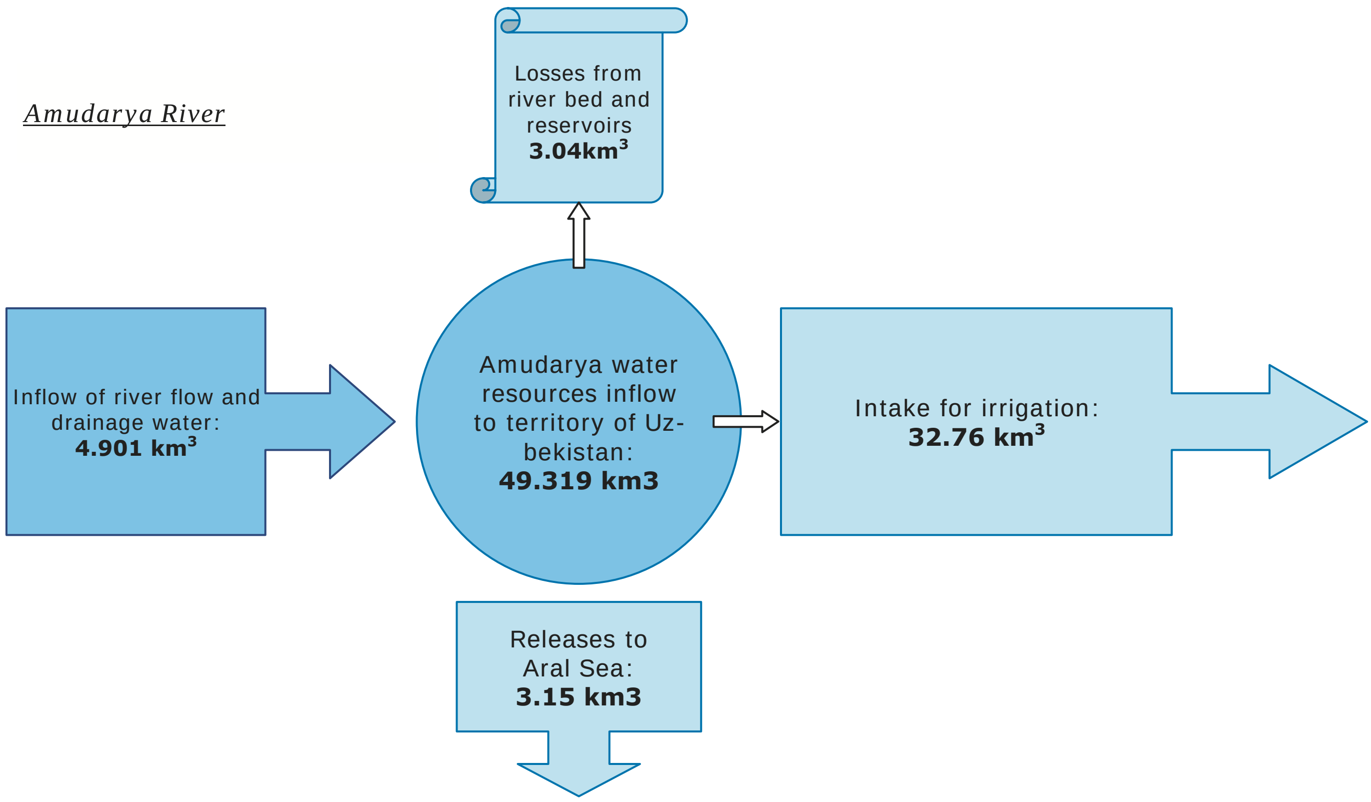
Further downstream in Syrdarya and Djizak oblasts the situation is similar. The discharge capacity of the main water course, the South Golodnostep canal, is 330 m^3/s which is insufficient to meet demands for irrigation of 450 thousand ha land in the Golodnaya and Djizak steppes. Currently not more than 65-70% of this area is supplied with water.

The Amudarya River Basin. Guaranteeing water delivery for irrigation in the Amudarya river basin is also problematic. For example, water is delivered to the irrigated lands of the Karshi steppe and Bukhara oasis by the pumping stations of the Karshi and Amu-Bukhara cascades. However, the head intake structures of these cascades are located in Turkmenistan. Out of the total intake limit from the Amudarya river allocated for this zone (10 km^3), only 8 km^3 is being taken. This represents an annual deficit of 2 km^3 of water.

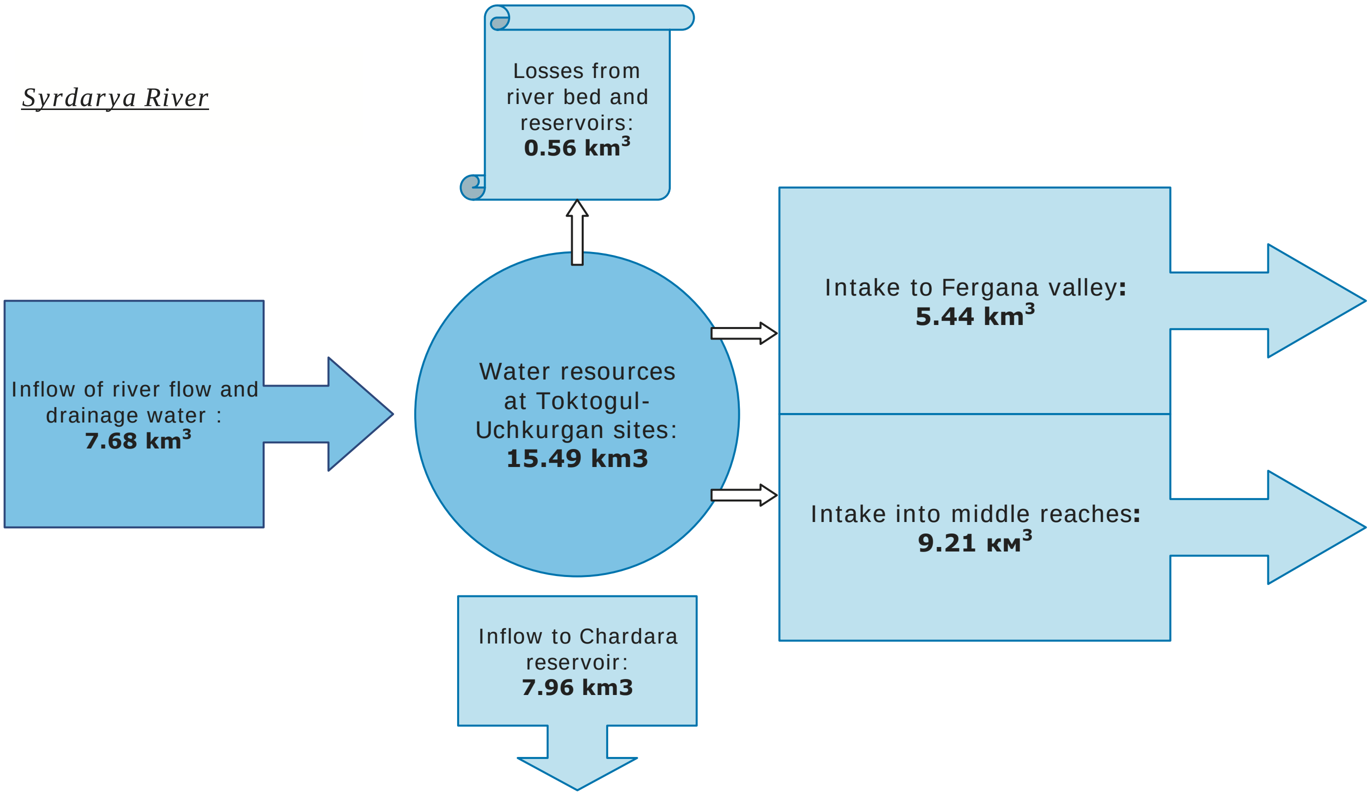
The following situation is in the downstream of the Amudarya river - the system of Tuyamuyun barrage, consisting of three consequently located water reservoirs (Kaparas, Sultansandjar and Koshbulak) has useful capacity of 4,5 km^3, as the filling is provided consequently, reaching of design capacity is not possible. This is because the Kaparas reservoir with a storage capacity of 0.55 km^3 provides water only for municipal and drinking purposes, and the dam of the Sultansandjar pond (with an available storage capacity of 1.65 km^3) is in a very poor state of repair. In addition, the long exploitation of the Tuyamuyun reservoir has led to silting of 1 km^3 reducing its available storage capacity to 3-3.5 km^3. This limits the guaranteed water delivery to the irrigated lands of Khorezm and the Republic of Karakalpakstan. The current deficiency of water is estimated at between 1.5 to 3.0 km^3 depending on water availability in a given year.

Thus, the total water deficit in the Republic of Uzbekistan is an estimated 2.5 km^3/year in the Syrdarya river basin, and between 1.5 to 3.0 km^3 in the Amudarya river basin. depending on water availability in a particular year.

Figure 2.6. **Rough Water Balance of the Syrdarya and Amudarya Rivers for Dry Year Conditions (90% probability)**

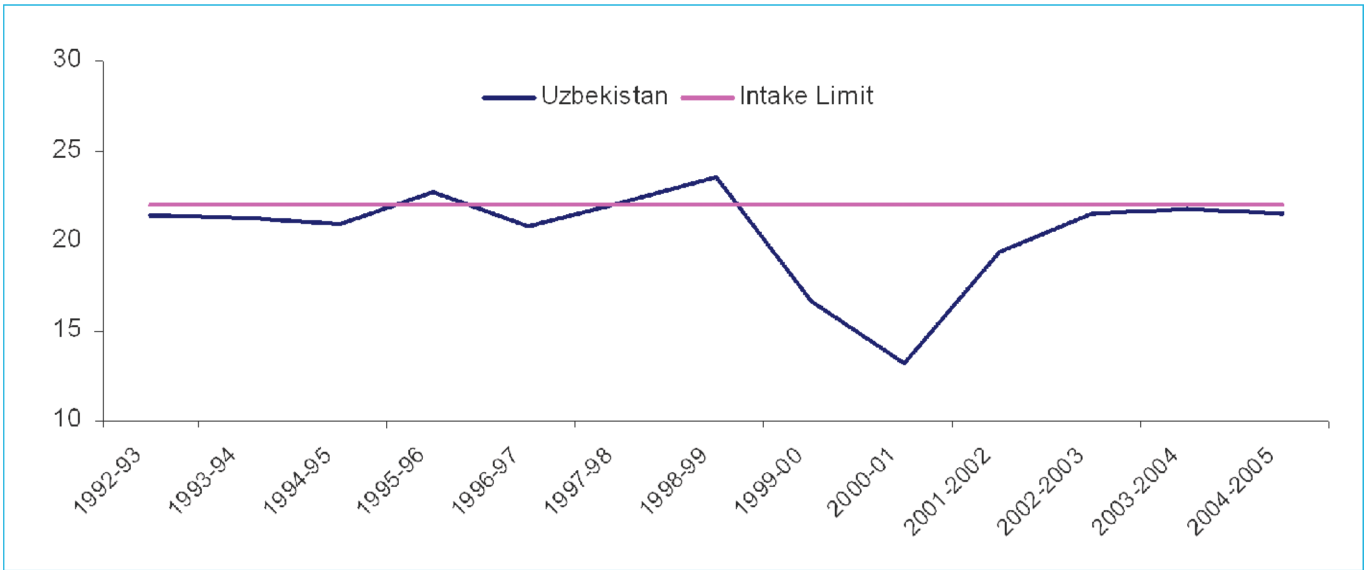


Syrdarya River



Source: Integrated Water Master Plans for Amudarya (1984) and Syrdarya (1985) river basins [84,85,87]

Figure 2.7. **Actual Use of Water and Intake Limits from the Amudarya River by Uzbekistan (1992-2005)**



Source: BVO Amudarya, 2006

2.1.6. Irrigation and Drainage Infrastructure

Uzbekistan, the birthplace of irrigation possesses a huge irrigation infrastructure. Having passed through the stages of direct irrigation from streams without dams and oasis irrigation, by the end of the 20th century the water infrastructure of Uzbekistan consisted of a huge complex of irrigation and drainage networks, hydropower facilities, and municipal and drinking water supply systems[5].

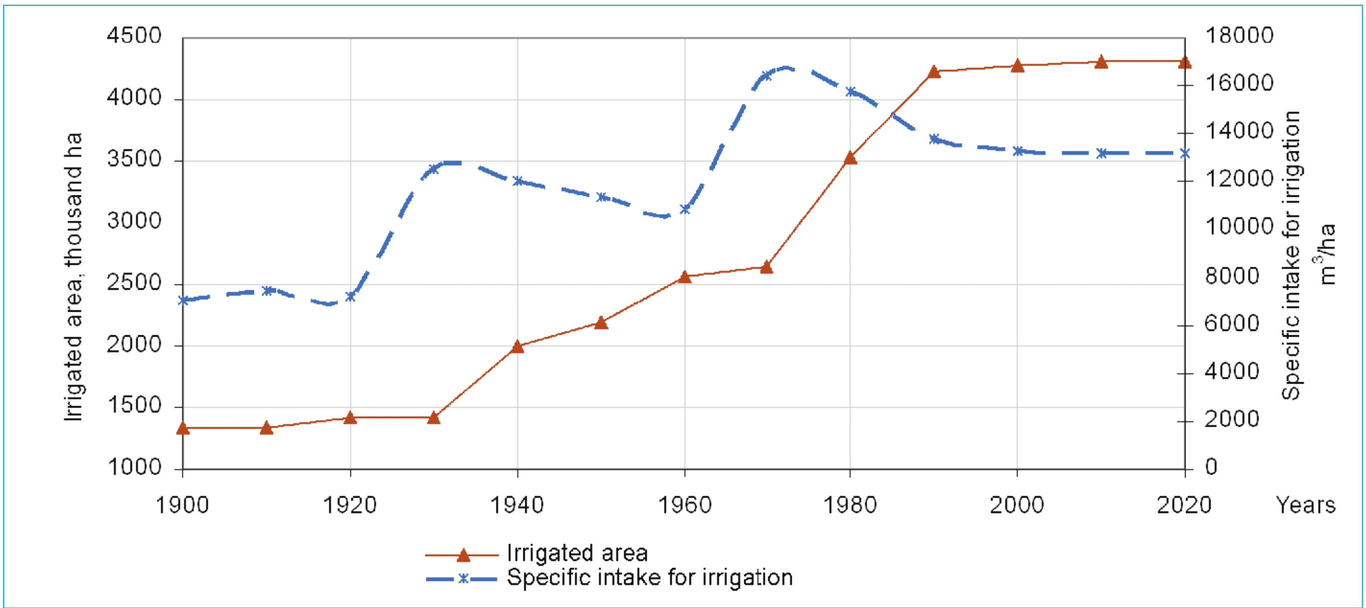
Irrigation in Uzbekistan Before Independence

The water management policy of tsarist Russia, and subsequently the Soviet Union, was aimed at making Uzbekistan the largest center of cotton production. The extensive development of virgin lands (the Golodnaya, Djizak and Karshi steppes, among others) took place in the period from the 1960's to 1985-86. From an engineering viewpoint the technical level of construction of these irrigation systems was very high. In addition the managerial and technical basis for the operation of large water complexes and an irrigation and drainage infrastructure (I&D) network, was being established through the training of qualified local staff and the development of essential infrastructure.

All these activities produced highly impressive results. The area of irrigated land was increased from 2.57 million ha in 1960, to 4.22 million ha by the mid 1980's. (Figure 2.8). Raw cotton production increased from 2.95 to 5.37 million tons [38]. Performance of the constructed systems and water use productivity was high: the overall efficiency of irrigation canals in the new irrigation zones reached 0.80-0.85; the technically perfect systems were maintained in proper operational condition.

However, the issues of sustainability and disturbance of the ecological balance were often ignored during the process of wide-scale development of

Figure 2.8. **Trends in Irrigated Area and Water Intake in Uzbekistan from 1900 - 2020**



Source: SANIIRI, 2005

[5]The beginning of the main canal construction is attributed to the early 20-th century. The oldest canal (Zang) was constructed in 1912 from the Surkhandarya river. Large scale construction work for irrigation of the Fergana valley was carried out in the 1940's (SFC, NFC and BFC). At the same time the Tashsaka and Suenli canals in the lower reaches of the Amudarya river were commissioned. Construction of canals began in the 1960-70's (Ecki Angar, Karshi, South Golodnostep canals), as and the irrigation infrastructure in the Fergana valley continued to expend (BAC and BNC). Amongst the first reservoirs was the Kattagurgan off-river reservoir on the Zarafshan river (1941) and the Kamashi reservoir on the Kashkadarya river (1945).

irrigation, although at the beginning of these activities scientists drew attention to possible future impacts. The future development of the water sector had been outlined in the "Integrated Water Master Plans" of river basins (IWMP), taking into account the interests of water users, consumers and the requirements of sanitary water releases to the Syrdarya and Amudarya river deltas. At that time these solutions were based on the possibility of transferring water from the Siberian rivers (Ob and Irtysh) to the region. This was already expected to have happened by 1990-95.

With the beginning of perestroika in the USSR (1985), achievements in the area of land irrigation and amelioration, as well the whole program for development of irrigation and the construction of water infrastructure in the Aral Sea basin were criticized. This led to negative attitudes of government and society towards the water sector. As a result, many water management organizations were closed down, and capital investment in the sector was reduced. The funds allocated from the state budget for maintenance of the I&D infrastructure were sharply reduced causing its rapid deterioration.

Problems of Irrigation and Drainage during Transition Period

At independence, Uzbekistan inherited not only a huge water infrastructure comprising large structures, pumping stations, dams, canals, etc., but also a number of urgent problems associated with its deterioration, worsening performance and the breakdown of the water delivery and distribution system. This contradictory combination of good and bad, modern and old, improved and outdated systems characterized the irrigation and water management situation in Uzbekistan at the moment of independence [76].

Since the mid 1980s, the development of new lands was suspended, with the exception of small on-farm increases in cultivated area. However, the area of irrigated land per capita decreased by approximately 25%, from 0.23 ha to 0.16 ha. As a result of land degradation and lack of water, the productivity of arable land decreased by 23% while agricultural inputs and labor costs increased by 23%.

Such a complicated inheritance proved difficult to improve during the first stage of reform. For economic reasons, the Government could not provide adequate support to the water sector that required substantial investment.

From 1991 to 2001, the state share of investment in agriculture was reduced from 27% to 8%, and capital investment in the water sector was reduced by almost 5 times. At the same time payment for electricity consumed by pumping stations increased from 13.6% to 48% [72,88,93]. Around 20% of the total energy consumption in the country and 70% of the MAWR budget is spent on electricity used for pumping stations and drainage. Allocation of recurrent funds for the operation and maintenance of the I&D infrastructure were sharply reduced, the volume of repair works and desilting of collectors and drains decreased, and works on the reconstruction of canals and water structures stopped. Financing for the maintenance of the water infrastructure was reduced from 191 (2000) to 184 billion sum (2003) in real terms [100].

To date, deterioration of the fixed assets of the irrigation system is 30-50%; the level of reliability of irrigation services for one ha per year with an average water supply probability is around 30-31%. This indicates that there are major problems with the functioning of irrigation systems. According to WB assessments (2003) deterioration/loss of the resource base for agricultural production costs the country approximately $1.0 billion annually.

The total requirements for the rehabilitation of the water management infrastructure can be summarized as follows:

- 32.1% of the total length of the inter-farm and main canals (22,300 km) require reconstruction, and 23.5% are in need of repair;
- More than 42.1% of the on-farm irrigation network (149,500 km) requires reconstruction, and 17.4% needs repairing;
- Out of 42 intake structures with discharge capacities in the range of 10 to 300 m^3/s, 18 require replacement and modernization of the hydro-mechanic equipment, and 5 require reconstruction;

- The majority of pumping stations supplying water to more than 2.1 million ha have already worn out. Out of a total of 1130 stations, 76 are large (>100m³/s), 496 are medium (up to 10m³/s), and 561 are small (less than 1m³/s). In general, 80% of large, 50% of medium, and 30% of small pumping stations require repair and reconstruction;

- Unfortunately, the sharp increase in prices for energy carriers and in equipment costs means that gravity irrigation is now a priority;

- Out of the 27 inspected reservoirs, 11 are almost completely silted up, and at 5 other reservoirs the silt has almost reached the level of the outlet structures [72].

- Around 19 thousand km of the open on-farm drainage system require desilting, 11,500 km of open and sub-surface drains require reconstruction and repair, and up to 50% of the sub-surface horizontal drainage system is operational [93].

In the current situation the operational life of the infrastructure will further decrease and may reach critical limits.

2.2. Water Use and Water Resources Protection in Uzbekistan

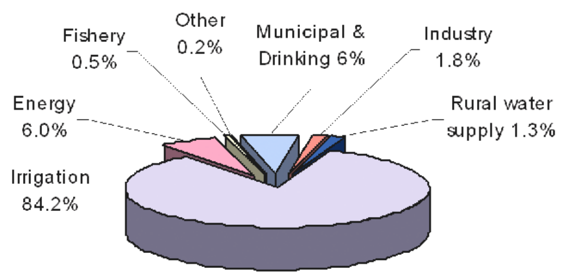
2.2.1. Use of Water Resources by Sectors of the Economy

In the current conditions Uzbekistan has at its disposal 11.5 km³ of surface runoff from internal rivers and 42.0 km³ from transboundary rivers, as well as 9.43 m³ of return and underground water. Fig. 2.9 below shows the use of water in 2000, by economic sector measured.

The largest user of water resources is irrigated agriculture which accounts for 84% of the total volume used.

Figure 2.9. **Use of Water by Sectors of Economy, MAWR,2000**

Sectors	km³	%
Municipal & Drinking Water Supply	4.05	
Industry	1.20	
Rural Water Supply	0.91	
Irrigation	57.00	
Energy	4.07	
Fishery	0.37	
Other	0.10	
Total:	**67.70**	



The use of water by consumers is based on the principle of equal water supply. Priorities in water delivery amongst the sectors of the economy are as follows:

- Drinking and municipal water supply;

- Industry;

- Agricultural and rural water supply

- Water users approved by special government decision;

- Sanitary releases to irrigation systems and small rivers.

Drinking and Municipal Water Supply. The distinctive feature of municipal water use is the strict requirements for water quality, especially drinking water. Amongst non-irrigation water users this sector is ranked first in terms of volume of intake, consumption and disposal of sewage water from cities and settlements. For drinking and municipal needs 4.05 km^3 are used annually. This is half of the total water consumption by all the non-irrigation sectors of the economy. The municipal sector consumes 1.97 km^3 of water annually.

A significant proportion of municipal and drinking water supply is provided by underground water. Out of 6.205 km^3/year of underground water extracted for all economic purposes, municipal and drinking water supply for urban areas accounts for 1.142 km^3/year. Supply to rural areas totals 1.423 km^3/year.

Although significant efforts have been made to improve drinking water supply, one third of the republic's population still drink water which is below acceptable standards [63]. Survey results indicate that 34.4% of the total samples taken in 2000, from all sources of surface water in Khorezm oblast was below the national standard for microbiological safety, and 15% showed the presence of cholera vibrios [83]. As a result of human activity, 40% of explored sources of underground fresh water had become unsuitable for drinking purposes [63]. Due to the uneven distribution of underground fresh water reserves, some regions of the republic have a shortage of drinking water (e.g. Karakalpakstan, Khorezm, Bukhara, western rayons of Samarkand, Kashkadarya, Djizak and Surkhandarya oblasts).

Water by Industry. Uzbekistan's industry withdraws 1.2 km^3 of water annually, of which only 0.58 km^3/year is consumed. Almost half of the withdrawn water is returned in the form of industrial effluent that poses an ecological threat to the environment. 502 industrial enterprises dispose into surface water bodies around 0.14-0.17 km^3/year of poorly purified effluent containing heavy metal salts, fluorides, phenol, petrochemicals, all nitrogenous groups, biological and other pollutants specific to particular industries.

Water for Agricultural and Rural Supply. The agricultural and rural water aims to meet the drinking and municipal water demands of the rural population and the productive demands of agriculture (not including irrigation). Many of the problems faced by rural water users are similar to those encountered by urban municipal users, but more sensitive. For agricultural and rural supply purposes 0.906 km^3 of water are used annually, almost 90% of which is consumed. Therefore, this sector produces only a neglible volume of effluent.

Water in Irrigated Agriculture. Out of the total volume of water consumed irrigation accounts for more than 84%. Taking into account the importance of agriculture to the national economy and the fact that 16.579 million people in rural areas are directly dependent on it, for their livelihood, incomes and welfare, ensuring an adequate water supply to this sector is extremely important.

In the current conditions the irrigation of 4.3 million ha of land requires an average of 57 km^3 of water annually. The specific water consumption in the Syrdarya river basin is 10.4 thousand m^3/ha, while in the Amudarya basin it is 12.5 thousand m^3. The irrational and inefficient use of water are the main factors restricting the development of irrigated agriculture. The main reasons for low efficiency is the significant loss through infiltration from the main canals, on-farm irrigation networks and directly from field irrigation water application. Only a small fraction of water withdrawn from its source is used purposefully (Table 2.7).

Table 2.7. **Water Losses in Irrigation Application**

Losses/Use	Volume ('000 m^3/ha/year)	% of Total Intake from Source
Losses from canals	2.68	20
Other inter-farm losses	650	5
On-farm canals:		
Transportation losses	3.10	24
Operational losses	3.10	24
Field water application:		
Leaching	770	6
Irrigation	2.70	21
Total	12.90	100

Source: GEF, WEMP, Component A1, Final Report, 2001

Over recent years the Government has adopted a number of measures aimed at increasing the efficiency of the main canals, improving water delivery, and so on. Optimal approaches to irrigation and water management mechanisms at various levels and in various regions of the country are being demonstrated by international organizations and donor countries (Chapters 1 and 5). However, the introduction of the results of these activities on a wide scale is limited by the lack of funds and problems in the existing agriculture system. Meanwhile, pollution of water and its consequences are growing. This hampers the transition to sustainable development and the achievement of food security.

Ecological Releases and the Aral Sea Demand. Before the early 1990's the demands of the Aral Sea were met in accordance with the residual principle (delivery of water volumes which remain after all economic needs are covered). With the adoption of intergovernmental agreements the Aral Sea and its littoral zone are now independent water consumers (Chapter 4) [101]. The dynamics and pattern of ecological releases and water delivery to the Aral Sea are illustrated in Figure 2.10.

Water in Hydropower Generation. The country's energy system is a component of the Integrated Power System of Central Asia (IPSCA) with 42% of the total installed capacity of the system. Operation of the IPSCA is carried out on the basis of the agreement "On parallel operation of the power system of Central Asian countries", as well as in accordance with agreements concluded with neighboring countries.

Uzbekistan's power system is based on 9 thermal and 28 hydro power stations. The total installed capacity of this sector is 11.58 million kWh, including 9.8 million kWh from thermal power stations, and 1.4 million kWh from hydro power stations. The electric power sector is in fact a water user. Out of 4.1 km^3 used for hydropower generation, only 0.15 km^3 is consumed.

However, only 11.3% of the total capacity of Uzbekistan's rivers is currently used. The 28 operating hydropower stations are located on rivers and large canals. Some 10 small scale hydropower stations with a total installed capacity of 26 MW were taken out of service due to problems with outdated equipment and lack of spare parts. This situation represents a serious problem for economic development. Significant inputs and investment will be required to restore the existing energy capacity and develop future capacity in order to meet the needs and improve the living standards of the 26 million population.

Water for Fisheries. One of the serious consequences of the Aral Sea disaster is the loss of the country's largest fishery that once provided 20 thousand tons of fish annually. The relocation of the fishery from the sea to the lake system of the Aral Sea littoral zone has not prevented a steady decline in the region's fish catch.

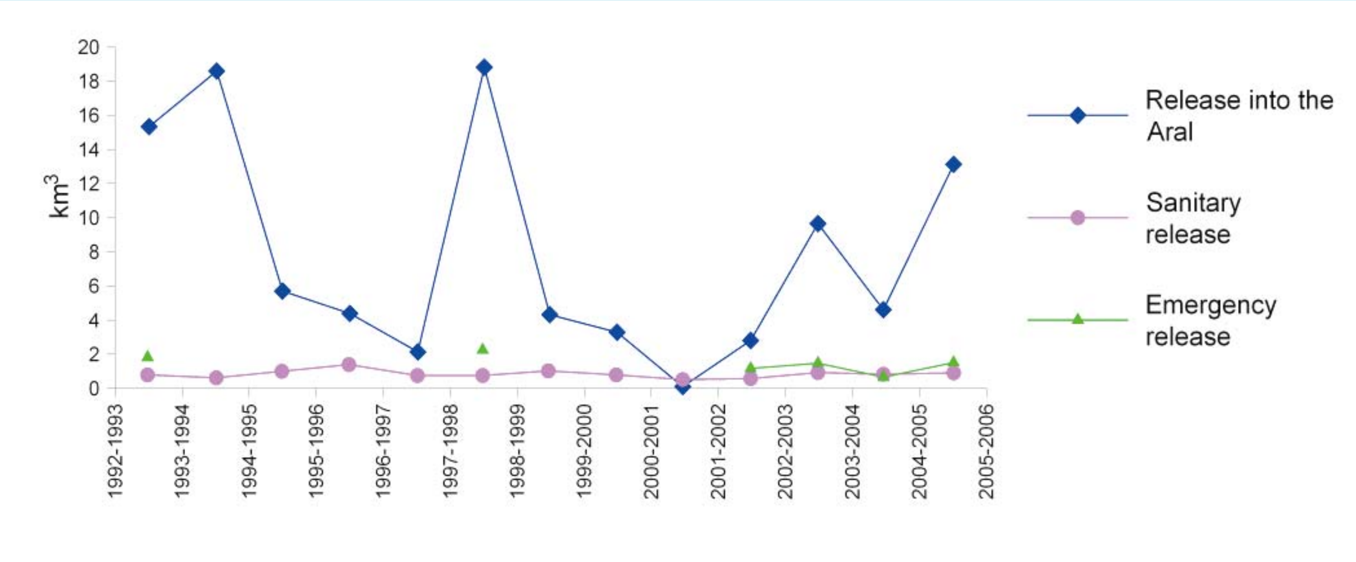
As a result of this relocation the fishery has been reoriented to pond fish breeding and all the suitable water bodies are now used for this purpose, particularly the Aidar-Arnasai lake system. At the same time there has been a change in the roles of fishing and fish breeding. A significant decline in fish production (51%), occurred between 1992 and 1995, due to the economic difficulties. The droughts of 2000-2001, aggravated the situation. The most catastrophic losses in the history of fisheries in the Aral Sea littoral zone were observed in 2003, when the fish catch decreased to 131.6 tons.

The increase of water mineralization and pollution by the toxic substances resulting from the disposal of irrigation return waters and industrial effluent into water bodies has a significant effect on fisheries. Despite the fact that the fishery sector is considered a water user rather than a consumer, it does consume around 60% of the 0.368 km^3 of annual water intake.

Water for Recreation. Recreational water use is based on the natural and artificial ecosystems, which include the piedmont and highland regions, floodplains of the large rivers, and shores of reservoirs and canal banks. Water bodies are among the most attractive landscapes for recreation purposes. However, their natural conditions are of little use for the recreation purposes and require the significant volume of works for recreational development and nature protection.

The main recreation areas are the Amudarya (the floodplain, reservoir shores, and canal banks), the Zarafshan (the entire length of the river), Tashkent (Chatkal and Chirchik rivers, shores of the Charvak reservoir), Karadarya (Karadarya and Syrdarya rivers and shores of the Kairakkum reservoir), and Fergana (piedmont and highland reaches of small rivers). The potential recreational capacity is 45 thousand people and this could increase to 170 thousand with further shoreline development. Practically all the recreational facilities are water users with only negligible consumption for drinking and municipal purposes.

Figure 2.10. **Satisfaction of the Aral Sea Needs and Ecological Water Releases for 1992-2005**



Source:: BVO Amudarya, 2006

2.2.2. Water Resources Quality

The current quality of the country's water resources remains extremely unsatisfactory. The highest level of mineralization and pollution is observed in the middle and lower reaches of the main rivers. This presents a serious threat to the life and health of the population and to the conservation of habitats. The main polluter of surface and underground waters is agriculture. Industrial effluents are slightly smaller in volume, but due to the level of their toxicity they are more dangerous and harmful.

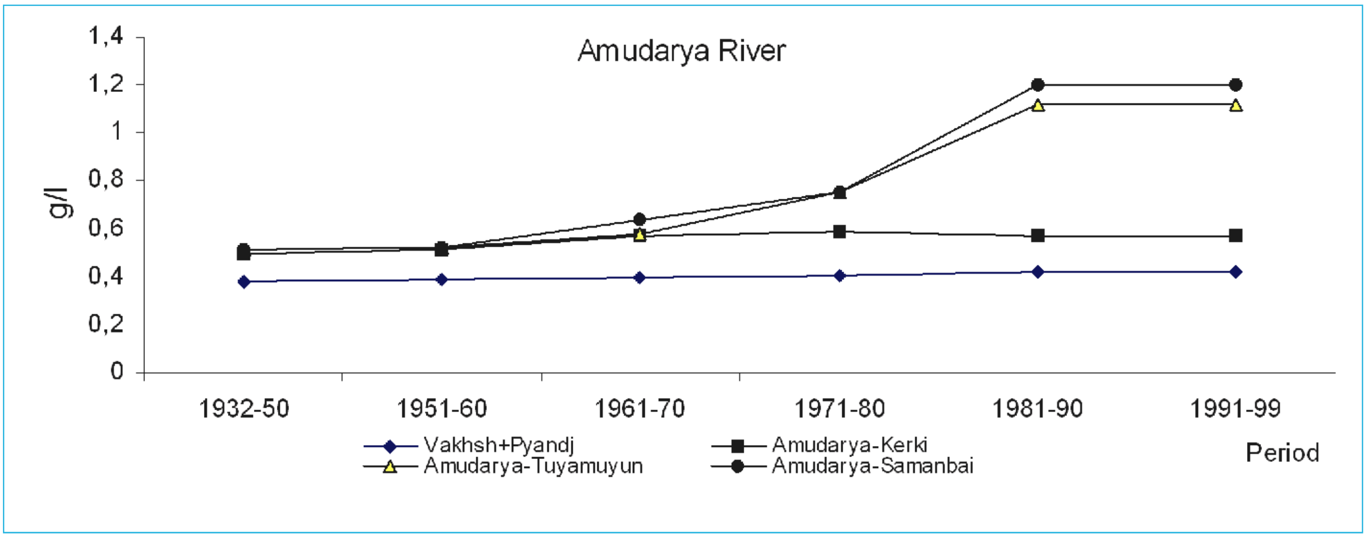
For the integrated assessment of water quality the water impurity index (WII) is used. This calculates the arithmetic mean value of six hydrochemical indices expressed as fractions of the maximum allowable concentration (MAC). These indices are the content of dissolved oxygen, biochemical oxygen demand (BOD) and any other four pollutants with the highest above average concentrations). There are seven classes of water quality by the WII [107]. A brief assessment of water quality based on the data of the State Statistics Department is provided below (2001).

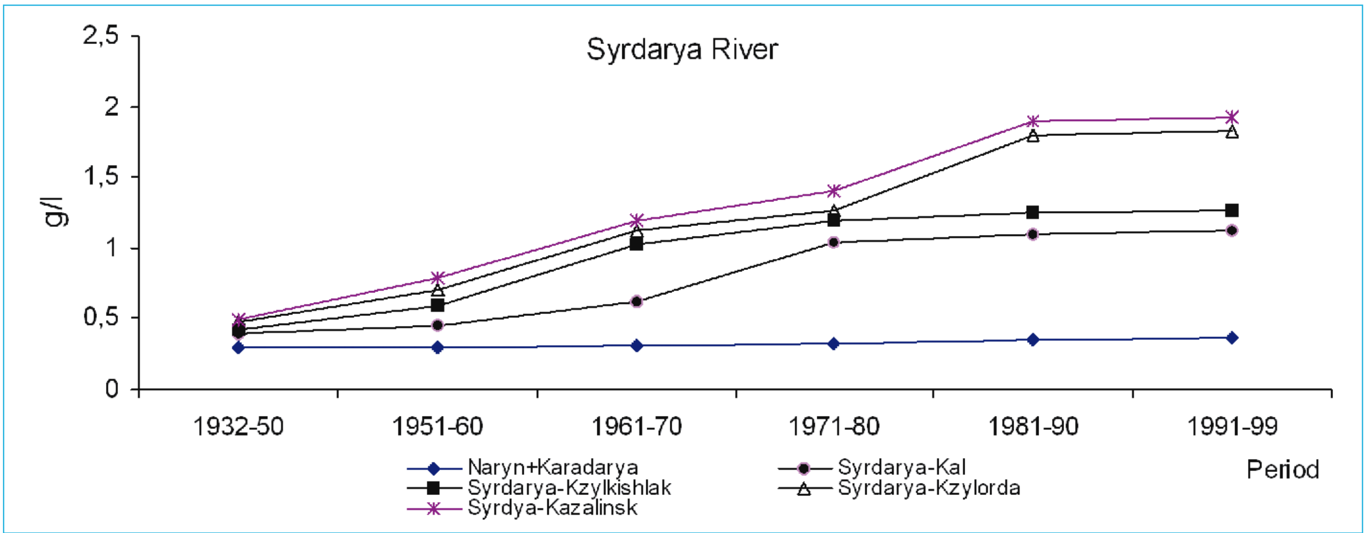
Surface Water Quality

The hydrochemical regime of rivers is influenced by the natural and anthropogenic factors. In the upper watersheds the regime of river water mineralization is determined by water availability, duration of high and low water periods and the other natural peculiarities of the water sources.

The surface runoff of rivers has changed significantly under the influence of human activity. Intakes into irrigation canals and losses from river beds cause a reduction in river runoff, and the disposal of collector and drainage waters worsen its quality. Analysis of data indicates that over the period 1932-1999 water mineralization increased significantly in the lower reaches of the Amudarya and Syrdarya rivers and is 1.2-1,9 g/l on average (Fugure 2.11).

Figure 2.11. **Long-term Trends of River Runoff Mineralization by Their Sites (GEF/WB, 2002)**





In 1996, WII class I (clean) water was observed in the Amudarya river at the Termez site. At the rest of the sites the water quality corresponded to the class III (moderately polluted). By 2000, predominately class III water was found by the WII along the entire length of the river. Water from the Surkhandarya river from its source to its estuary was also evaluated as moderately polluted (class III). Water mineralization in the Kashkadarya river increases along its course from 0.19 g/l in the upper reaches to 1.22 g/l in the lower reaches. The level of pollution by petrochemicals ranges from 0.4 to 8.2 of the MAC.

The quality of water at Syrdarya river sites is also class III (moderately polluted). Some improvement in water quality is observed at the site upstream from Bekabad city where the WII indicated class II water.

The chemical composition of water in the Zarafshan, Kashkadarya, Chirchik and others rivers is heavily dependent on wastewater from industrial enterprises and the municipal sector. According to the WII, the quality of water in the Akhanagaran river falls to class III. Environmental protection measures have improved the situation somewhat in the Chirchik river. At the site downstream from Chinaz town the water quality is class II on the WII.

Analysis confirms the steady increase of surface water mineralization along the river courses from source to estuary and pollution of river water by the industrial effluents, especially in the large industrial zones.

Underground Water Quality

In the east of Uzbekistan, 60% of the total reserves are underground. In all but a few areas this water meets the Uzbek State Standard (O'z DST) 950 for "Drinking Water" (2000).

Reserves of underground water in the western part of the country (in the lower reaches of the Zarafshan river and the western part of the Kashkadarya, Syrdarya, Amudarya and Central Kzylkum basins) are highly mineralized and hard. The fresh underground water lenses formed along the large watercourses (Amudarya and irrigation canals) and used to supply drinking water to the Khorezm oblast and Karakalpakstan are below standard due to an increase in mineralization and hardness. This is a cause of serious concern and necessitates urgent decisions and measures, because the population of the lower river reaches has restricted access to other sources of water.

Around 50% of the total volume of underground water extraction in the republic takes place in the Fergana Valley. However, here, as in the other regions, depletion of underground reserves and degradation of its quality due to unbalanced water consumption and environmental deterioration is typical. Aquifers in the lower part of the Sokh alluvial cone are practically unusable. As a result of economic activities and pollution of water sources associated with these activities, out of a total fresh underground water reserve of 20 m^3/c, only around 10-12 m^3/s concentrated in the central part of the Sokh alluvial cone. In order to improve protection of the current and potential sources of drinking water in the country, the status of area of national environmental importance has been given to eleven zones of fresh underground water formation (including the Sokh aquifer).

Collector and Drainage Water Quality

From irrigated areas of the Karshi steppe on average 1.2 km^3/year of drainage water (with mineralization up to 8 g/l) are disposed through the Southern and Sichankul collectors into the Amudarya river. From irrigated areas of the Bukhara oblast up to 1,5 km^3 of the CDW with mineralization of around 4 g/l are disposed into the Amudarya river (Table 2.8).

The content of nutrients (nitrogen and phosphorus) and pesticides in the collector and drainage water is significantly higher than in the surface water, and concentration of trace elements is in the same range (Annex 2).

To prevent pollution of the Amudarya river a package of measures on drainage flow management along the right bank of the river has been developed within the framework of the Drainage Project (Box 2.3).

Table 2.8. **Mineralization of Drainage Water by the Main Collectors on the Right Bank of Amudarya River**

Collector	Discharge Capacity, million m^3	Mineralization, g/l	Water Disposal Point /Body
Dengizkul	*429.80*	*5.30*	*RBDC (existing section)*
Southern	*26.40*	*8.00*	*Dengizkul*
Main Karakul	*75.50*	*7.10*	*RBDC (existing section), Amudarya*
Central Bukhara	*286.10*	*3.50*	*Salty lake, Amudarya*
Western Romitan	*80.20*	*3.90*	*Salty lake, Amudarya*
Northern	*343.50*	*3.40*	*Karakyr lake*
Ayakagitma	*120.80*	*2.30*	*Ayakagitma depression*
Karaulbazar	*109.40*	*9.00*	*Khodicha depression*
Parsankul	*367.90*	*5.10*	*Amudarya*
Dul-dul	*117*	*2.50*	*Ayakagitma depression*
Central	*50*	*1.80*	*Zarafshan river (used for irrigation)*

Source: WB, 1998. Drainage Project. MMTU-Uzgipromeliovodkhoz

2.2.3. Water Problems by River Basins

Shortage of water and degradation of water and land resources are apparent throughout the country. A significant proportion of irrigated land suffers from salinization, waterlogging and water erosion, agricultural biodiversity losses and other especially dangerous processes[6]. This restricts development of agriculture and other sectors of the national economy and aggravates the problems faced by the rural population with low incomes. Various studies conducted in the rural areas (WB, 2002; ADB, 2005) show that the percentage of the population with low incomes is clearly associated with the unreliable supply of water for irrigation and land degradation (i.e. soil salinity and waterlogging). The annual loss of agricultural production in Uzbekistan due to land salinity/degradation is estimated at $31 million, and losses caused by land abandonment (due to its high salinity) are approximately $12 million [65].

There is a close interrelationship between water quality, health, and the percentage of the population with low incomes. Almost a quarter of the population (more than 6 million people) over many parts of the country are effected by polluted water [27]. These problems cover large enough groups of population in many parts of the country. The most vulnerable people are those in the regions where natural phenomena (droughts, and desertification) and anthropogenic factors associated with improper water and land resources management, overlap. A summarized assessment of the current problems associated with water use and water availability in the Syrdarya and Amudarya river basins is provided below.

Syrdarya River Basin

Fergana Valley

The Fergana valley is an ancient oasis called "The Golden Valley" because of its favorable environmental -climatic conditions and fertile lands. This is the most populous region not only of Uzbekistan but within Central Asia (6.8 million people): the density of population in Andijan oblast is ten times higher than the national average.

Irrigated lands with a total area of 907 thousand ha are the main source of livelihood and employment for the rural population of more than 4.5 million people. The area of irrigated land for each rural inhabitant is 0.19 ha, as compared with 0.27 ha in the rest of Uzbekistan. However, production of cotton and wheat from each unit of irrigated area here is 1.3-1.5 times higher then the national average.

A characteristic of the irrigation network in the valley is its high density and branching. The many large and small systems are crossed by connecting canals, which feed the systems with additional water from the Naryn, Karadarya, and Syrdarya rivers (Figure 2.12). The irrigation network is inefficient: more than 57% of the main and inter-farm canals and 90% of the on-farm canal network have soil beds and require reconstruction, repair and proper maintenance.

From 1994 the change in the Toktogul reservoir operational mode caused a sharp reduction in the summer irrigation water releases and an increase in winter releases. According to MAWR data (2005), in Namangan oblast alone there is a summer water deficit of 0.9 km^3. During a year with average water availability the water deficit varies from 57-61% (June-August) to 85% during the autumn. At the same time, the Naryn river flow during autumn-winter period is more than two times higher than its natural flow and 1.9 times smaller than its natural value during the summer months. The unbalanced water supply has a negative effect on the operation of canals and water structures, forcing them to operate continuously in extreme conditions which leads to their premature deterioration.

During the summer period intakes into the Northern Fergana Canal (NFC), Big Namangan Canal (BNC), Big Fergana Canal (BFC) and Akhunbabaev

[6]Currently around 53% of irrigated lands suffer from secondary salinization and more than 1.0 million ha of them are classified as moderately and severely saline. Around 0.8 million ha of land is subject to water erosion and more than 2.3 million ha suffer from wind erosion. Specific losses of humus layer over a season due to erosion reach 80 t/ha. The area of pasture subjected to degradation due to overgrazing and human activity is 7.4 million ha and losses of nutrition capacity are estimated as 21% on average. More than 5 million ha of pasture are subject to deflation of sands due to deforestation and loss of more than 15 % of the valuable species diversity. Around 54% of the surveyed soils are polluted by pesticides; more than 80% have increased content of magnesium chlorate, etc.

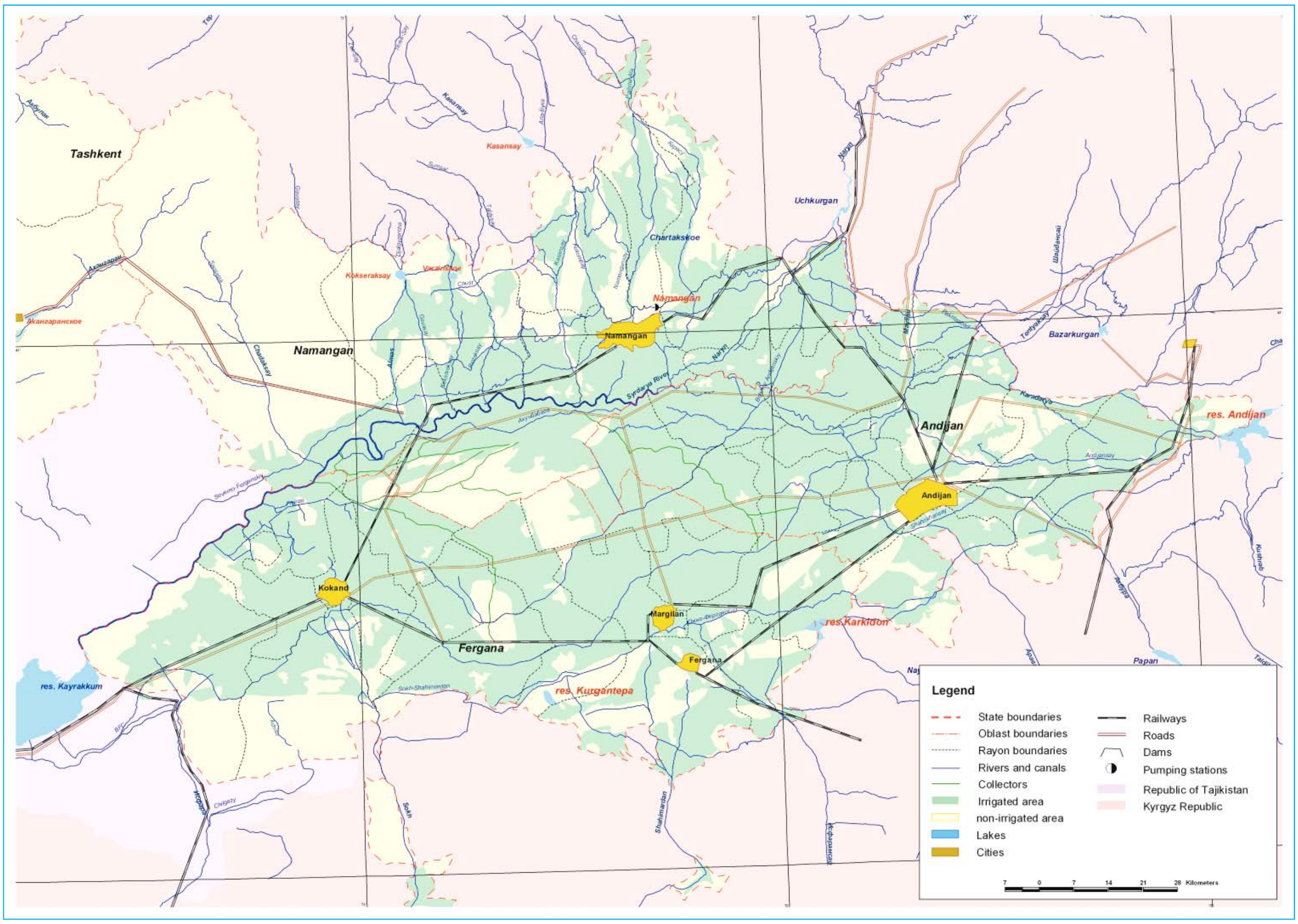
Canal are especially problematic. The total area with critical water availability during the growing period is 200 thousand ha.

As a result of low water supply, losses of wheat yield vary from 0.04 to 0.06 t/ha, and those of cotton from 0.07 to 0.1 t/ha; the income of farmers and dekhkan decreases, and orchards and vineyards become dry. Meanwhile, unsatisfactory supply of agricultural products and raw materials to meet the rapidly growing demands of the food processing industry causes serious socio-economic tensions. The economic problems make it difficult for the government to rehabilitate the existing I&D infrastructure which is already outdated and in need of significant investment. According to the BVO Syrdarya assessments (2001), the annual funding required for the operation and maintenance of the basin's infrastructure is $1.4 million on average. Restoration of the BFC will require $21.6 million, and there are around ten such canals in the Fergana valley. In order to stabilize the current situation, the Government is carrying out urgent engineering measures to increase water availability in Namangan oblast (Box 2.1).

The other serious problem for irrigated lands located on the right bank and central part of the valley is the rise of the groundwater table and associated processes of waterlogging and soil salinization. The main reasons for this are the high infiltration water losses from the adjacent higher lands (especially the Burgandin massif in the Kyrgyz Republic and adyr land in the Fergana valley), and the inadequacy of the existing water infrastructure. Due to continuous waterlogging agricultural lands are being abandoned and houses and other buildings destroyed. The situation is particularly bad in the Rishtan, Bagdad, and Altyaryk rayons, where during the growing period the groundwater table outcrops at the surface.

This causes significant pollution of fresh underground water and the disturbance of aquifers in the lower part of the Sokh alluvial cone. The negative impact on the central part of the alluvial cone, where fresh underground water remains, is growing. Mineralization and hardness of water have

Figure 2.12. **Irrigation Systems of Fergana Valley [88]**



increased here. The loss of many of the remaining aquifers limits the access of 1.5 million people to high quality drinking water. In addition, due to the expected growth in population the demand for fresh underground water from the Sokh aquifers for municipal and drinking water supply will increase 1.5-1.6 times.

This year at the request of the Government, the World Bank has begun implementation of the "Water Resources Management in the Fergana Valley" project. The strategic objective of this project is to develop technically reliable and cost efficient solutions aimed at improving water supply and water use practice in three rayons of the Fergana oblast and protecting underground water sources in the lower part of the Sokh alluvial cone.

Box 2. 1

"Construction of the Rezaksai Reservoir in the Namangan Oblast" Project

In order to mitigate the impact of the severe drought of 2000-2001, the Government of Uzbekistan commenced construction of a dam on the off-channel Rezaksai reservoir with a total capacity 0.2 km^3. This will be filled by the BNC. It also constructed two other outlets into the Syrdarya river and NFC (20-40 m^3/s), and other elements of infrastructure (maintenance roads, etc.). In perspective the volume of the reservoir will be increased up to 0.66 km^3 by filling up through the BNC and pumping stations cascade from the NFC. These technical measures will increase the level of water availability for irrigated agriculture and industrial and municipal water consumption, and therefore, mitigate economic and sanitary/epidemiologic tension in the Namangan oblast, especially during dry years. In addition, these measures will ensure the partial withdrawal from Naryn river winter releases of the Toktogul reservoir that will mitigate problems with their accumulation in the Chardara reservoir. The net benefit from the project interventions at the command area is an 76.6 billion sum, and also it will be commissioning the additional water management facilities (46.3 billion sum) and additional workplaces for over one thousand people. [Feasibility Study of the Rezaksai Reservoir, 2005].

The Middle Reaches

The middle reaches of the Syrdarya river include the Golodnaya and Djizak steppes on its left bank, and the piedmont plains and Tashkent oasis on its right bank. There are three large administrative oblasts in this territory: Tashkent, Syrdarya, and Djizak. The total area of irrigated land is 985 thousand ha, including 390.9, 293.6 and 300.5 thousand ha in the Tashkent, Syrdarya and Djizak oblasts respectively. The Syrdarya is the main source of water resources for the Golodnaya and Djizak steppes, with minor contributions from the mountain streams of the Djizak steppe. The sources of water for the Tashkent oasis are the Chirchik, Angren, Akhangaran, and Syrdarya rivers.

As was mentioned above, due to misuse over the years the water infrastructure of the Golodnaya and Djizak steppes has come to the end of its useful life and requires major renovation. As a result over 30% of irrigated land is waterlogged and more than 38% of land is classified as moderately or severely saline. Yields of cotton in the Syrdarya oblast have decreased two to three times from 3.2-3.6 t/ha to 1.4-1.6 t/ha. In some areas with high levels of land salinity and waterlogging cotton yields do not exceed 1.2 t/ha. Every year up to 8.8 million tons of salt is deposited in depressions and around 2.3 million tons are discharged into the Syrdarya river causing pollution and posing a significant ecological threat to the aquatic and terrestrial ecosystems [92].

Over recent years new ecological and socio-economic threats, associated with increased water releases from the Chardara reservoir into the Arnasai lake system, have arisen (Box 2.2).

To protect agricultural lands and rural infrastructure and to ensure human and ecological safety around the Arnasai lake system, the Government completed the construction of the Arnasai reservoir with a storage capacity of 600 million m^3 and a water surface area of 140 km^2. It has also built protective dams and structures. Management bodies within the oblast are also taking urgent measures to stabilize the situation.

International organizations, such as the Asian Development Bank, EC-TACIS, USAID and the French Government provide significant assistance to help solve the above mentioned problems and improve water management. The French Government has helped to improve drinking water supply and increase water availability for 405 thousand ha of irrigated land in the Syrdarya and Djizak oblasts. The "Modernization of the South Golodnostep Canal (SGC)" project, financed by credit from the French Board of Treasury, has completed its second stage. Adaptation of the SCADA system for the South Golodnostep canal has now been accomplished. Since 2003, with support from ADB the project "Development of Agriculture in the Akaltyn rayon of Syrdarya oblast" has been implemented. One of the main tasks of this project is "Support to the development of infrastructure and to restructured farms".

These investment projects and pilot programs, in various rayons of this region with support from donors will contribute greatly to the improvement of water management and development of the WUAs at both project area and national level. At the same time, it is obvious that the current inputs and investments are insufficient to cover the needs of the region for improvement of water management and the rehabilitation of infrastructure at the national and regional levels. According to assessments of the BVO Syrdarya (2001) the restoration of the Dustlik canal (former Kirov canal) alone which serves irrigated lands in both Uzbekistan and Kazakhstan would require $4.03 million.

Box 2.2

Problems of the Arnasai System of Lakes

The Arnasai system with an area of 2,000 km^2 , was formed in 1969, as a result of discharge of 21 km^3 of water from the Chardara reservoir, located in the Republic of Kazakhstan. By the beginning of the 1990s, inflow of collector and drainage waters stabilized the water level at 237 m above sea level, but from 1993, further releases from the reservoir caused a rise in the water level of 8.7 m. Today Arnasai is the largest system of lakes in the Republic of Uzbekistan comprising Aidarkul, Tuzkan, and Upper Arnasai lakes. By the summer of 2003, the total area of this lake system reached 3,491 km^2 with a volume of inflow of up to 3.0 km^3/year on average. As a result 180 thousand ha was flooded (2004) in the Djizak and Navoi oblasts The water covered paddocks and pastures, sheep-folds and insemination stations, wells and mineshafts, tens of kilometers of roads, electric power lines, gas pipelines and other installations. Parts of the Baimurat and Koshkuduk settlements with a total population of approximately 2,5 thousand people are threatened with flooding. The cost to Uzbekistan of the damage caused by this flooding is estimated at $700 million annually. *(Arnasai Feasibility Study, 2005, Uzhydromet, 2004)*

The Amudarya River Basin

There are more than 23.5 million ha of agricultural land in the Amudarya river basin, including 2.38 million ha which are irrigated. More than 11.4 million people (43% of the total population) live in this region, 70% of which live in rural areas. The ancient oases of Samarkand, Bukhara, Khorezm, Kashkadarya and the Republic of Karakalpakstan surrounded by the vast sandy deserts of Kzylkum and Karakum are located here. Irrigated agriculture and other economic activity in this region traces its roots back to 2000 BC, surviving many ups and downs. However, the ecological disaster of the 20th century may prove to be the heaviest burden for the present and future generations.

The Surkhandarya oblast with a total irrigated area of 0.33 million ha is located in the upper river reaches and consists of piedmont slopes and river valleys. Inefficient irrigation of the slopes with the excessive tail escapes and infiltration has led to waterlogging of lower land and the deterioration of surface and underground water.. In the south of the oblast 36-80% of the drinking water does not meet the State Standard (GOST) "Drinking Water". In the Saryassiya and Denau rayons the environmental situation is particularly bad due to harmful emissions from the Tajik aluminium plant. The level of infant mortality here is on average 54 / 1,000 people which is even greater than in the epicenter of the Aral Sea crisis (the Republic of Karakalpakstan and Khorezm).

The Middle Reaches

The country's large economic regions, the Samarkand, Navoi, Bukhara, and Kashkadarya oblasts, with a total irrigated area of 1.28 million ha are concentrated in the middle reaches of the Amudarya river. This river is the main source of water for the Karshi steppe and the Bukhara and Navoi oblasts. Other sources of water here are the Zarafshan and Kashkadarya rivers (Figure 2.13). The total population is around 9 million of which 73% are rural inhabitants.

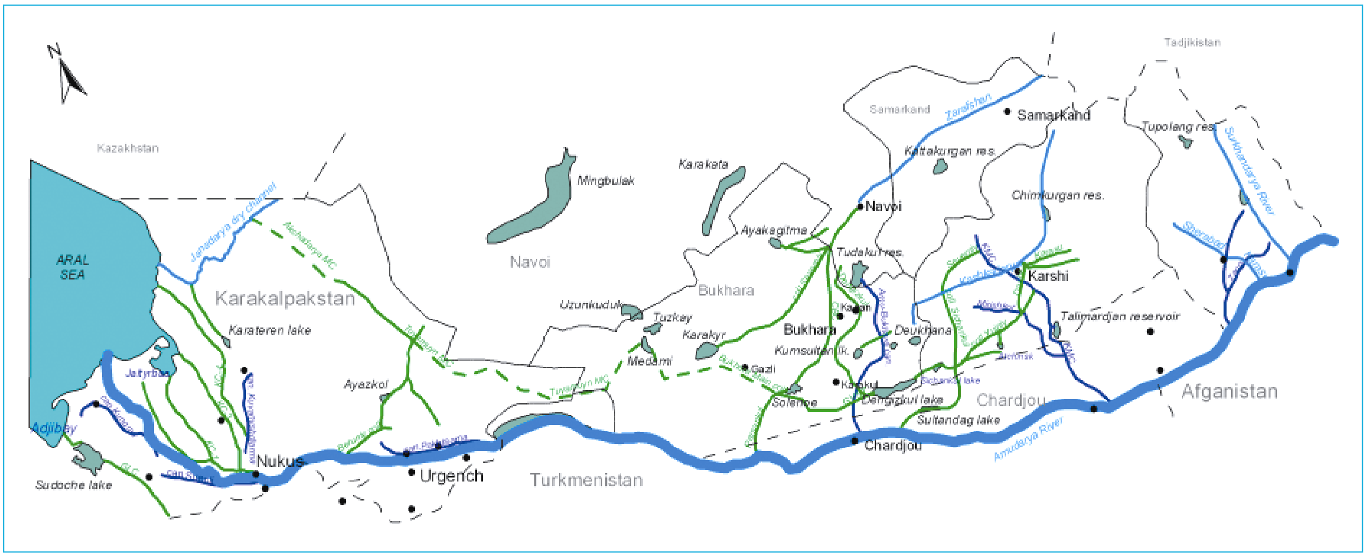
One of the main peculiarities of water delivery to the irrigation systems in these Amudarya reaches is the use of pumping stations or lift irrigation. The Karshi main canal (175 m^3/s) with a cascade of 6 pumping stations, and the Amu-Bukhara main canal (350 m^3/s) and pumping station are the largest lift irrigation systems. The intake structures of both canals are located in Turkmenistan. Both systems have off-channel reservoirs.

As in other regions of the country the I&D infrastructure, operated for more than 35 years without proper management and maintenance, and has now reached the end of its intended useful life. Operation and maintenance funds for the irrigation infrastructure cover only 55%-66% of the total requirement. Deterioration of pumping station equipment limits water intake from the Amudarya river by 2 km^3 during conditions of seasonal regulation. Deterioration of the network and water structures has led to significant water losses, poor irrigation water application and increased land degradation. In turn this has caused a considerable decrease in yields and farmer income. Cotton yields have fallen from approximately 2.7 t/ha (1992) to 2.4 t/ha (2004). Although the wheat yield has increased from 2.3 t/ha (1991) to 4.2 t/ha (2004), it still remains low for irrigated cultivation. According to ADB assessments (2005), it is expected that with further deterioration of the I&D network the irrigated area may be reduced by 20-25% over the next 30 years.

As was mentioned above discharge of collector and drainage waters into the Amudarya river pollutes river flow that is used by the delta population for drinking purposes and irrigated agriculture. The main regions, which discharge salt into the Amudarya river, are the Karshi steppe (6.43 million tons/year) and Bukhara oblast (5.6 million tons/year). Disposal of return waters into the desert depressions damages the fragile terrestrial and aquatic ecosystems of deserts. Dozens of water bodies of various volumes and sizes have appeared recently in this region. These include Dengizkul, Salty, and others (Figure 2.13). At the same time, the existing volume of water in desert depressions is very small and insufficient for long-term use. The infiltration losses and groundwater from irrigated lands contribute to the emergence of a large number of drainage lakes, which present a serious ecological threat.

In order to withstand the problems associated with the pollution of the Amudarya river, since 1990 the Government of Uzbekistan has taken steps to rehabilitate the existing drainage systems and construct off-take collectors (Box 2.3). From this year within the framework of the GEF Initiative of the Central Asian Countries on Land Resources Management (ICACLRM) the ADB credit funded project "Land Improvement in the Bukhara, Navoi, and Kashkadarya oblasts" will be launched (Chapter 5). However, this project does not address the problems associated with the main collectors and alter-

Figure 2.13. **Water Infrastructure and System of Lakes and Depressions on the Right Bank of the Amudarya River (WB, 1998)**



natives for withdrawal and/or decrease of collector and drainage water (CDW) discharge into the Amudarya river. Implementation of these measures is financed from the state budget. Donor support for improvement of water quality in the Amudarya river and regulation of the CDW within this region is extremely important.

The other regions under ecological threat are the Zarafshan and Kashkadarya river basins. The Zarafshan river provides water for irrigation, industry, drinking and municipal use for a population of more than 3 million 67% of which are rural inhabitants. The total water consumption by all sectors of the economy within the Zarafshan river basin is 6 km^3/year which exceeds the natural river flow into Uzbekistan. The shortfall is covered by using collector, drainage, and return waters in the downstream river reaches which leads to problems of water pollution.

According to the Statistics Department (2002), water in the upper reaches of the Zarafshan river has low mineralization, but is contaminated by nitrites and heavy metals (mercury and antimony) from ore mining and processing in Tajikistan. Mercury content in the surface flow of the Fanadarya river (Tajikistan) is 9 times higher than the MAC in some years. In its middle and lower reaches the Zarafshan river becomes a collector that receives industrial effluent, municipal wastewater, and collector and drainage water from the Samarkand and Navoi oblasts. Downstream from the Cheganok collector inflow, the content of ammonium nitrite and nitrate nitrogen increased by up to 19 times the MAC, and that of phenols and petrochemicals by up to 74 times the MAC). Along the entire river length the concentration of pesticides is up to 18-30 times the MAC.

The ecological load on the Kashkadarya river begins in the upper reaches. From its middle reaches the river turns into a collector that takes in up to 0.3 km^3/year of collector and drainage waters, and municipal wastewater polluted by nitrates, salts, phenols, petrochemicals and other harmful substances. The main source of river pollution is the left bank collectors –Shakarbulak and Karasu (Guzardarya) with a total annul flow of 67.4 million m^3 (1996) and average mineralization up to 8-9 g/l and more. As a result, water mineralization of the river downstream from the Karasu inflow reaches 2.0-2.2 g/l with a maximum of 3.0 g/l in some months, and the river is categorized as “dangerous” on the basis of its mineralization composition and content. This has a negative effect on the sanitary and hygienic situation in the settlements and in the areas adjacent to irrigated land. The problem is aggravated by a lack of water quality monitoring, although more than 50% of the oblast’s population is concentrated here.

Box 2.3

Right Bank Collector (RBC)

A detailed feasibility study for the Right Bank Collector was developed by the Sredazgiprovodkhlopok institute in 1990. This project envisaged that the RBC would intercept discharges into the Amudarya river from all collectors and divert them directly into the Aral Sea. Construction of the RBC commenced in 1993, but its implementation was slow due to lack of funds. In 1994, at the request of the Government, the World Bank provided financial assistance for the preparation of the feasibility study, including a preliminary economic analysis of RBC. The project identified several alternatives to the RBC, which had not been studied before. Subsequently, the MAWR initiated the project for assessment of all possible options and scenarios. Between 1996 and 1999, the World Bank financed Stages 1 and 2 of ecological assessment (EA) for the Preparation Study of Uzbekistan’s Drainage project. Implementation of the “Drainage, Irrigation and Improvement of Wetlands in the Southern Karakalpakstan ”project, which is funded by WB credit/loan, has recently begun. *(WB, DIWIP Project, 2003)*

Lower Reaches of the Amudarya River

The main water management problems are concentrated in the Amudarya river delta which is the centre of an ecological and economic disaster (Box 2.4). The Khorezm oblast and Republic of Karakalpakstan have a total irrigated area of 776 thousand ha and population of more than 3 million people (including 63% living in rural areas). The population of this region, located in the lower river reaches, uses water polluted by the upstream water users and suffers from acute

Box 2.4

Aral Sea and Its Littoral Zone: Some Facts

Up to the middle of the 20th century, the **Aral Sea** with an area of 66,085 km^2 and a volume of 1,061km^{3,} fed by the Amudarya and Syrdarya rivers, was one of the largest lakes in the world. The wide-scale development of new lands in the Aral Sea basin over the second half of the century drastically disturbed its hydrological regime and caused the onset of its gradual desiccation. Mineralization of water in the Aral Sea increased from 10 to 30 ppm making it an unsuitable habitat for the majority of endemic species. The Amudarya river delta (around 700 thousand ha) no longer functions as a normal delta ecosystem. As a result of the Aral Sea recession from the coast-line more the 50 freshwater lakes have dried up, the area of tugai has been halved and that of reeds and brushwood reduced by 6 times. Simplification of the vegetation cover pattern through halophytic (saltwort, sea-grass, etc.) vegetation overgrowth is taking place. The Aral Sea bed exposure and reduction of the natural vegetation cover has intensified wind activities, and aggravated aridity and continentality of climate. Wind blown salts and dust from the dried up bed threaten the Amudarya river delta and adjacent rayons of the Kzylkum desert. The mixture of salt and sand which settles on irrigated land aggravates the process of salinization. (NEAP,1999).

shortages of water, especially during dry years. The issues of coastal and aquatic ecosystems desertification, associated with the desiccation of the Aral Sea are presented in various assessments [47].

The Aral Sea disaster which threatens the life, health and habitat of the population is well-known all over the world due to the efforts of the region's countries as well as public, and international organizations, especially UNDP, GEF, GTZ, UNEP, WB, and others [33]. Although measures have been taken with support from international and regional institutions, all these efforts have failed to mitigate the ecological problems, improve water quality, correct the imbalance in water use/consumption and ensure the well-being of the population and the viability of the natural ecosystems in the region. Water which is unsuitable for agriculture and municipal needs with a mineralization of 1.5-1.8 g/l and hardness of 2 times the MAC, continues to be used by water user/consumers in the river lower reaches. At the Kuzyldjar site the concentration of calcium is more by 240%, magnesium 420%, hydrocarbonates 120% and sulphates 620% compared with the upper watershed. The population of these oblasts has practically no access to good quality drinking water that meets the State Standard (GOST) [97].

According to UNDP assessments (2005), the river water in the Republic of Karakalpakstan is unsuitable for drinking during 10 months in the year due to high mineral residues. The reserves of clear water in the sand lenses along the large canals have disappeared or become contaminated by agrochemical and other pollutants. However, part of the rural population continues to use lenses along canals, which lost drinking water quality, as the only source of drinking water. The proportion of drinking water with a quality below GOST standards varies from 30 to 100% in some rayons.

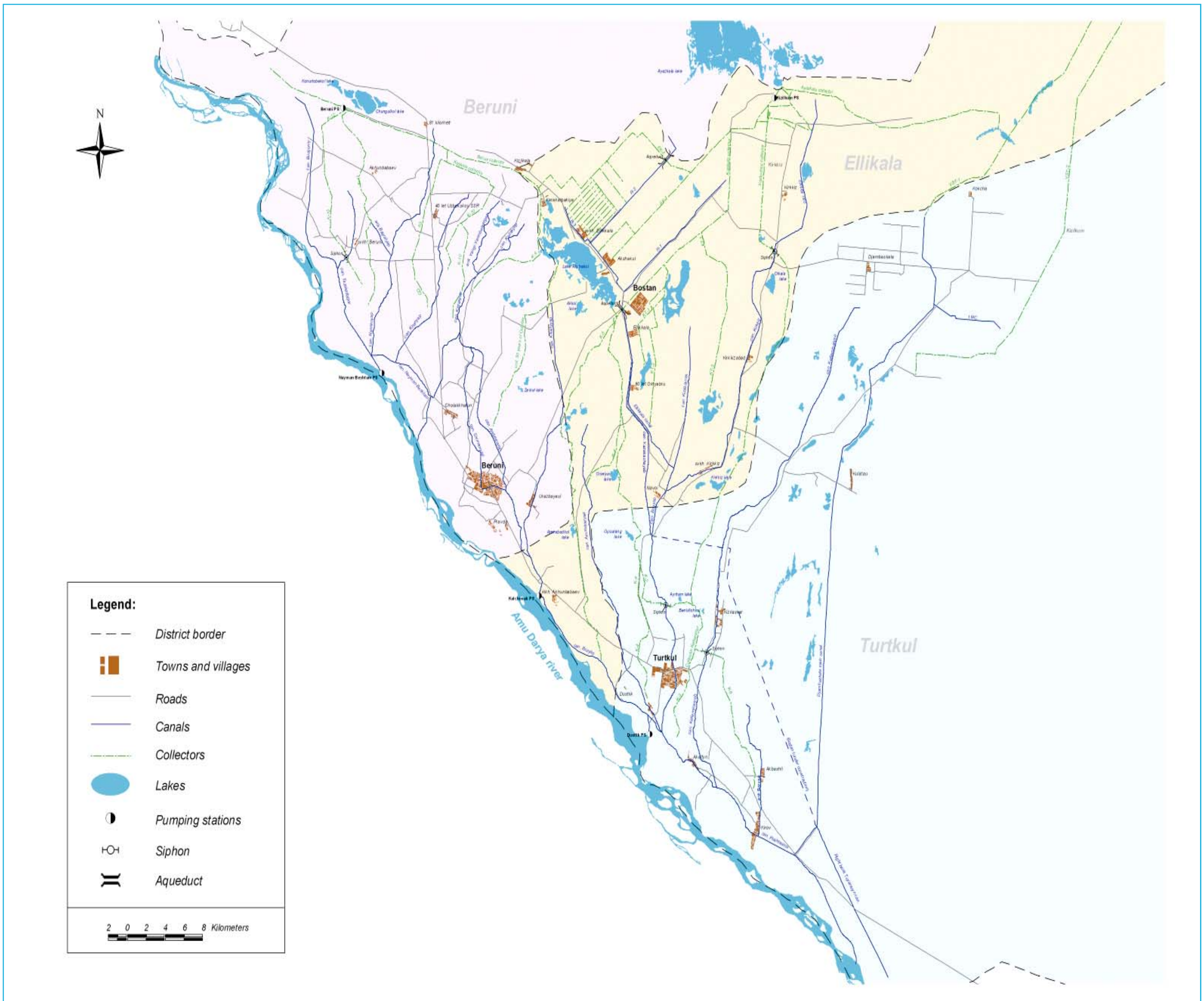
The inefficient irrigation network and inadequate drainage systems cause high infiltration from canals and irrigated fields and lead to soil water-logging and salinization. The situation is aggravated by the use of polluted collector and drainage waters (CDW) with levels of mineralization up to 3-4 g/l for leaching irrigation. Analysis shows that from 1995, the area of land with a groundwater depth of 0.5-1.5 m represented more than 75% of the total irrigated area in the northern zone of Karakalpakstan. In southern Karakalpakstan and Khorezm such lands are widespread (95%). The proportion of land with medium or severe salinity ranges from 41-48% (Karakalpakstan) to 55% (Khorezm). More than 95% of the irrigated area in southern Karakalpakstan suffers from soil salinity. Every year up 0.367 km^3 of the CDW is withdrawn from the irrigated zone of southern Karakalpakstan. Part of this volume (0,27km^3) is discharged through the Beruni collector into the Amudarya river, and the rest of it is disposed beyond the irrigated zone (Figure 2.14). In recent times this rayon, as well as others in the delta have experienced severe drought and water shortages. In 2001, the gross production of the three main crops – rice, cotton, and wheat, was reduced by 75%, 11%, and 52% respectively compared with 2000.

The "Drainage, Irrigation and Wetlands Improvement Project" (DIWIP) was launched in southern Karakalpakstan in 2003 with a total budget of $60 million, funded by a World Bank loan and IDA credit. This was the first stage of the general strategy for improving the efficiency of the extensive I&D infrastructure and stabilising the ecological and socio-economic impacts along the right bank of the Amudarya river. This project is implementing one of the technical alternatives from a package of measures aimed at improving water quality in the Amudarya River which are identified within the framework of the Drainage Project of Uzbekistan (Box 2.3).

The main tasks of the DIWIP are: (i) to increase irrigated agriculture productivity, employment, and incomes in Karakalpakstan, which has one of the Central Asian regions lowest per-capita incomes; (ii) to improve water quality in the Amudarya river through safe disposal of drainage flow and improvement of wetlands quality in the Amudarya delta; and (iii) to establish organizations for the improvement of water resources management, operation and maintenance of irrigation and drainage systems, as well as for the development of sustainable irrigated agriculture through integrated management.

One aim of this project is to close the Beruni pumping station that pumps mineralized drainage water into the river, and redesign the Beruni collector so that it disposes drainage water by gravity flow towards the Aral Sea. Water users and consumers and the natural ecosystems in the north and south of Karakalpakstan, as well

Figure 2.14. **Overall Location of the Project Area (WB, DIWIP, 2004)**



as the Aral Sea itself will benefit from the project interventions.

In implementing this project the Government of Uzbekistan is fulfilling the bilateral Agreement on the joint and rational use of the water resources of the Amudarya river, concluded between Uzbekistan and Turkmenistan on January 16, 1996. Article 9 of this Agreement specifies that both parties should have stopped disposing of drainage waters into the Amudarya river from 1999.

2.2.4. Water Resources Monitoring and Information Systems

Monitoring of the chemical composition and pollution of natural waters within of Uzbekistan is carried out by specialized departments in various agencies: Uzhydromet, Goskompriroda, MAWR, Goskomgeologia, and Minzdrav.

An extensive observation network existed in Uzbekistan before the end of the 1980s. This network was part of a unified system of hydrometeorological and climatic monitoring in the Aral Sea basin (Box 4.3). After independence Uzhydromet managed to retain the existing infrastructure, facilities, database and observation system. Uzhydromet's observation network comprises 78 meteorological, 131 hydrological, 89 agro-meteorological and 2 avalanche stations. More than 100 stations carry out observations on the condition of agricultural crops and pasture vegetation. Observations on air pollution are carried out in 38 settlements. They comprise 68 monitoring points in 26 cities and one station for background monitoring in the Chatkal reserve. Observations are also carried out at the high-altitude meteorological complex located on the TV tower in Tashkent.

Since 1996, due to economic difficulties there has been a steady reduction in the hydrometeorological observation network and scope of observations. The deterioration of equipment, instruments and other infrastructure has also led to problems. A similar situation exists with underground water monitoring, control over use of water and land, sources of pollution and other types of observation. Despite this Uzbekistan does have the capacity to develop a sustainable information system for the management and use of water, hydropower and land resources. The country's managerial structures are well developed (Ministry of Emergency Situations, Uzhydromet, MAWR, and other organizations). With support from international institutions (EC-TACIS, GEF/WB, USAID and others) the information systems WARMIS-WARMAP, WUFMAS, ISEAM have been adapted, and GIS and remote sensing technologies introduced. A number of interrelated simulation and optimization models have been developed at regional and national levels (Chapter 4). However, organizations at oblast and local levels lack management tools, efficient information systems and reliable databases.

The national organizations develop the specialized databases on water resources, but they do not relate to each other in terms of methodologies, systems and programs, and have been developed for specific tasks. The available WARMIS information system on water and land resources of the Aral Sea basin comprises a large volume of data (more than 100,000 data units). However, the limited time and funding for its development did not allow regular and reliable data collection or updating at the local level. Besides, access to this information for stakeholders is restricted, and complete information about the databases is not widely available

Introduction of GIS and remote sensing technologies within the above mentioned projects makes it possible to identify changes in ground cover and land use under the influence of the existing water use practice at various levels. However, lack of funds and poor coordination of studies impede the broad introduction of these technologies at oblast and local levels. A survey conducted by the NCSA (2004), in various regions of the country confirms that there is a lack of technical resources and qualified specialists, poor methodological basis and access to data, and insufficient awareness at the local level of the possibilities and advantages of GIS and remote sensing technologies for reliable impact analysis and assessments [46].

2.3. Future Water Supply and Demand

The "Millennium Declaration" adopted at the UN Millennium Summit in September 2000, identifies the action plan and target tasks for achieving sustainable development as a platform for building bridges between sectors and directions. One of the eight goals of the MDGs for Uzbekistan is the eradication of poverty and hunger. This defines the need to solve the urgent problems limiting human safety and the sustainability of environmental sustainability. The harmony of humans and nature is considered supreme wisdom in the Orient [56]. A change in the way of thinking and a restoration of the respect for water and land indigenous to the ancient civilizations are prerequisites for future progress. The Aral Sea disaster suggests that these changes are yet to happen.

The priorities for environmental protection activities in the mid- and long-term adopted by the national action programs and plans (NEAP, 1999, NSDS, 2000 and the others) are:

- creation of favorable living conditions for the population;
- rational use of natural resources;
- careful conservation of the biosphere.

NEAP envisages a complex of measures guaranteeing maximum socio-economic and ecological benefits at minimum expense. On this basis, priority actions aimed at eliminating unfavorable environment impacts on the health and well-being of the population (pollution of water, air and foodstuffs) were identified. The second priority task is the measures aimed at overcoming the economic consequences of land and water resources depletion, especially those associated with the reduction of fresh water reserves the increase in their mineralization, soil salinization and erosion, and others.

2.3.1. Future Water Demand

Development Approaches and Scenarios

Future water demand outlined within the framework of the "General scheme for development of irrigated agriculture and water management of the Republic of Uzbekistan for the period up to 2015", and the "National Plan for Water and Salt Management" (NPWSM, WEMP, 2002), meets the Millennium Development Goals (MDGs) for the harmonious management of water and energy resources and environment and the prevention of natural and man-made disasters [92]. The common task of these program documents is to meet the demand for water from the rapidly growing population, prevent ecosystem degradation, and overcome changes that may disturb the environment's capacity to regenerate biomass and sustain life. The programs and planned measures are not restricted by the national borders. They envisage regional strategies for cooperation and strong mutually beneficial partnerships in the joint management of water and energy resources in the Aral Sea basin, drawing upon existing experience and international achievements.

In the regional context of water and energy resource management the specific objectives of WEMP are to:

- Provide an approved set of policies, strategies and action programs for the basin in regard to: (i) protection of water resources and decrease of soil salinity; (ii) rehabilitation and improvement of the irrigation and drainage systems; and also (iii) improvement of the operation and maintenance of the main and on-farm systems.

Develop the conceptual basis for the preparation of international agreements in regard to: (i) mechanisms of water distribution and standards for river water mineralization, (ii) investment in the national and regional water infrastructure, and (iii) financing of organizations within the basin responsible for water resources and infrastructure.

In order to retain the long-term productivity of society and the ecosystems supporting life the National Plan for Water and Salt Management (NPWSM) has adopted three scenarios for the future development of the country's water sector interrelated with the other sectors of the economy:

- "Deterioration Scenario" “Minimum” (I)- low level of macro-economic development and reform, and minimum investment in the existing water infrastructure and agriculture;
- "Strengthening Scenario " “Optimum” (II) – accelerated stabilization and structural reform of the economy supported by external investments and measures for the maintenance of economic activity;
- "Restoration Scenario" “Maximum” (III) – maximum level of macro-economic development and structural reform of agriculture, irrigation and drainage, supported by substantial internal and external investment.

Taking into account the social needs of the population by 2025, (40 million people) and the need for sustainable development of all sectors, the future demand for water is an estimated 72.4 km^3. This corresponds to the total available water resources established by the Interstate agreement of 1992. The NPWSM is aimed at ensuring reliable water delivery and distribution of the available resources and economical and rational use of water at all levels of the irrigation system. This requires joint efforts and actions by all stakeholders in promoting reform and institutional reorganization.

Costs of Rehabilitation and Improvement of Water Use

According to the NPWSM (2002) assessments the required investments for the rehabilitation of the I&D infrastructure and the improvement of irrigated lands in the mid- and long-term is in the region of $24.5 billion, excluding the cost of developing new lands. According to the I&D strategy (World Bank), the value of investment is approximately $23 billions including $12 billion that should be covered by water users [88]. This strategy involves a two-stage implementation (“Consolidation and Urgent Actions” and “Reconstruction and Modernization”). Each stage is a combination of investment, institutional reform and strategic reform. It is clearly necessary and important to carry out the restoration of irrigation systems jointly with the local beneficiaries. However, the possibilities of private and dekhkan farms are very limited due to their low income levels.

According to ADB assessments (2005), at this stage that function should be taken over by the Government, considering that there are around 15 million rural inhabitants, farmers and dekhkan. Installation of effective water metering equipment in an area covering 4.3 million ha is also an expensive measure but one which is crucial if reform is to be achieved. It appears that the government agencies authorized to deal with the local communities, scientists and NGOs must work symbiotically to find optimal solutions to the problems and achieve the planned objectives. The end result of these actions would be the prevention of further environmental pollution, and more responsible water users with a better understanding of the economic value of irrigation water.

2.3.2. Water Use Perspectives by Economic Sectors

The measures planned by various sectors of the economy are described below. Implementation of these measures faces serious difficulties because progress in developing the approved set of strategies, mechanisms and international agreements on water management and sharing at the basin level within the framework of the WEMP project has been very slow. This impedes realization of the vitally important interventions aimed at reducing the socio-economic tensions and preventing the negative consequences of water shortages in the various regions of the country. At the same time the agreements mentioned above between the countries in the region and other Central Asian initiatives within the framework of EAEC, SOC, CACO, especially the establishment of the water and energy consortium in, Central Asia, provide the basis for the successful development of water relationships in the Amudarya and Syrdarya river basins.

Measures for Ensuring of the Guaranteed Water Supply

In order to ensure guaranteed water supply the Government of Uzbekistan has adopted a number of Decrees on improving the safety and reliability of operation of the large and most important water management facilities through their rehabilitation, repair and on the construction of new compensating reservoirs [9].

In Uzbekistan's Syrdarya river basin the Arnasai reservoir has been constructed with a maximum capacity of around 1.0 km³. The Rezaksai reservoir in the Namangan oblast with a capacity of 0.2 km³ is under construction. These compensating reservoirs can provide 1.0-1.2 km³ of water during the growing period. The current total deficit is 2.5 km³. In order to cover the remaining 1.5-1.3 km³ discussions must continue within the framework of bilateral and multi-lateral agreements on additional releases from the Toktogul reservoir.

In the upper watershed of the Amudarya river basin the Tupolang reservoir with a total capacity of 0.5 km³ is being constructed. To ensure a guaranteed water supply to the Republic of Karakalpakstan, including the demands of the delta systems, it is planned to construct the Shorbulak reservoir with a total capacity of 3.6 km³ in the lower reaches of the Amudarya river.

Realization of this complex of measures would increase the efficiency of water use within the established limits and possibilities for annual flow compensation but will not satisfy the total water demands. These problems have a regional dimension and should be resolved at interstate level. Experience of joint water resources management in other river basins of the world shows that in the short-term, regional cooperation in parallel with improvement in water use efficiency and guaranteed water supply at the national level, would bring significant benefits even in the current economic situation.

As was noted above, more than 2.1 million ha of irrigated land in the country use lift irrigation with water intake from the sources of local and transboundary importance. All systems urgently require staged rehabilitation and modernization of pumping stations and the auxiliary infrastructure. Rehabilitation of the Amu-Zang canal is being funded by ADB credit. Restoration of the Karshi pumping stations cascade with a total budget of $145 million that was supposed to be financed by World Bank and other donors credit has been suspended due to intergovernmental disagreements. In this connection, the Government has undertaken the reconstruction of 8 pumping stations (with small and medium capacities).

Irrigated Agriculture. Irrigated agriculture, remains the main user of water resources and one of the country's leading economic sectors providing people with employment and social security. Future water demands for irrigated agriculture according to the three development scenarios are provided in Table 2.9.

A combination of technical, water management and environment protection measures is envisaged in the sector of irrigated agriculture. These include the reconstruction and maintenance of the irrigation and drainage network in order to reduce losses from canals and irrigated fields, water conservation and increasing the availability of water to rayons with low supply. Under the "Optimum" scenario the efficiency of irrigation systems should be increased to 0.70 by 2010, and to 0.75 by 2025.

Table 2.9. **Development Irrigation and Water Demand for Irrigated Agriculture**

River Basin	Areas and Water Demands by Development Scenarios											
	2010						2025					
	Minimum		Optimum		Maximum		Minimum		Optimum		Maximum	
	mln.ha	km³	mln.ha	km³	mln.ha	km³	mln.ha	km³	mln.ha	km³	mln.ha	km³
Amudarya	2.3	37	2.6	34	2.9	33	2.3	27	2.9	35	3.9	39
Syrdarya	1.8	22	1.9	21	2.0	20	1.9	22	2.0	20	2.3	20
Total	4.1	59	4.5	55	4.9	53	4.2	59	4.9	55	6.2	59

Source: WEMP, A1 Component. NWG Final Report, 2002
Note: Scenarios do not consider changing of dietary habits

Special importance is attached to improving agronomic practice through crop diversification, improvement of land tillage, use of fertilizers and seed quality as well as through the introduction of water conservation, safe irrigation technology, and methods of soil moisture retention, and plant protection. Efficiency of the irrigation water application methods is planned to increase on average up to 0.69 in the nearest future, and up to 0.74 by 2025.

Activities aimed at the management of return flow and the reconstruction of the main collectors and disposal tracts, are important in combating land degradation and pollution of water and ecosystems. Resource saving (through conversion of diesel pumping station to electric power, transition to gravity irrigation, etc) is also of great importance.

At the same time, insufficient financing of measures for the "Minimum" scenario may lead in the coming 5-7 years to the loss of 200,000 ha of irrigated land and a reduction of farmers' income and a decline in their standard of living. These losses will be caused by, among other factors, increase of land salinity and the deterioration in the level of maintenance of the I&D infrastructure maintenance.

Drinking and Municipal Water Supply. The future task of this sector is to provide the entire population with good quality drinking water and meet the municipal water demands of cities and settlements through centralized water supply systems that differ only in their scale and methods of water supply to a particular settlement.

Future demands of this sector in the short and medium-term are as follows: 6.2 km^3/year (2010) and 8.1 km^3/year (2025

Agriculture Sector Water Supply. This sector will be mainly reoriented to meet the technical, agrochemical and other needs of agriculture and livestock production. Future demands are as follows: 1.5 km^3/year (2010) and 1.7 km^3/year (2025

Industrial Water Consumption. As part of the restructuring of the country's economy, industrial water consumption will be oriented to closed cycles of water use that will allow a reduction in consumptive water use by up 24-25%. Total intake for industrial needs will be increased by up to 1.4 km^3/year by 2010, and 1.6 km^3/year by 2025, from the current level of not more than 1.202 km^3/year.

Fishery. In the future the fishery sector of Uzbekistan will be oriented towards the development of pond fish breeding, and the active stocking with fish of the existing natural and artificial water bodies (reservoirs, drainage ponds and treated wastewater, etc,).

There are good prospects for fisheries in the use of water bodies within the Aral Sea littoral zone – the Mezhdurechenskoe (interfluve) reservoir together with the adjacent river bed, bays and lakes in the Amudarya river delta (Figure 2.3), as well as the Arnasai system of lakes in the middle reaches of the Syrdarya River. A number of water engineering and fish conservation facilities are planned for the regeneration and growth of stocks of commercially valuable fish species. An important direction for fishery rehabilitation is the creation of complexes for fishing, and storing, processing and marketing fish products. The expected catch and commercial fish production in Karakalpakstan for the period up to 2010, is 10,230 tons.

As a result of this increase in capacity, the total water demands of fishery will rise sharply. By 2010, demand will rise to 2.1 km^3/year, and by 2025 it will reach 2.4 km^3/year from the current level of 0.4 km^3/year.

Recreation. In the whole country around 18,000 km^2 or 4% of the land area is suitable for recreation. Approximately half of this area can be currently used for recreation without special development (i.e. availability of sites for construction, optimal environment, climate and landscape, good sanitary and other conditions). Ecological and recreational water needs are included in water supply to a number of non-irrigation and irrigation sectors.

Hydroelectric Power Sector. The future development of hydropower in Uzbekistan will be aimed at maximizing the capacity and efficiency of one of the most important renewable energy sources. The balanced operation of the country's energy system will be ensured through implementation of measures aimed at improving the efficiency of generating capacity, energy saving, etc. This will lead to an increase in the reliability and safety of the system which is vital for the support of communities and protection of the environment.

The plan in the near future is to restore and develop the existing hydro and thermal power stations. Amongst the hydroelectric power facilities planned for construction in the medium term is the Pskem hydropower station. This will have an installed capacity of 450 MW and a long-term average power generation of 0.92 billion kWh. Also envisaged is the design and development of 25-28 small-scale hydropower stations with a total installed capacity of 267 MW and power generation of 1.19 billion kWh. Thus, by 2010, use of the country's hydropower capacity will increase by up to 13.5%, and expected power generation may reach 60 billion kWh. It is planned to attract credit from the international financial institutions for the reconstruction of electric power facilities. EBRD credit has already been obtained for the reconstruction of the Syrdarya thermal power station.

In the long-term it may also be possible to construct three more hydropower stations on the Pskem River (the Karapchitugay, Upper-Pskem, and Mullalak hydropower stations) with a total installed capacity of 800 MW and a long-term average power generation of 2,135 billion kWh. The operation of these hydropower facilities will be coordinated with the irrigation-energy operation mode of the Charvak hydropower station. These measures will allow 35-40% of the country's hydropower capacity to be exploited by 2025, including the development of small-scale hydropower facilities generating up to 10 billion kWh. Total use of water resources by the hydropower sector by 2025 will be 4.04 – 4.15 km^3/year. The planned new hydropower generation capacities are presented in Table 2.10.

The system of measures aimed at reducing power consumption pays special attention to: (i) developing energy resources, (ii) expanding the combined cycle for generation of heat and electric energy, and the share of new and renewable energy sources, and (ii) creating economic mechanisms and incentive measures for streamlining power generation. on the aim is to achieve an energy saving of up to 30% by 2010.

The share of coal in energy consumption is planned to increase to 17% by 2010 compared with the current level of 4.5%. Gas and oil production will remain at the current level, but there is a plan to improve the quality of petrochemicals through the introduction of efficient oil-processing technologies and diversification of products. Successful implementation of these measures will help reduce CO_2 emissions in Uzbekistan.

Table 2.10. **Planned New Hydropower Generation Capacities**

	Capacity (MW)	Cost, mln. USD (at USD800,000 per MW)
Thermal Electric Power Stations (TPS)	3,930	3,140
Hydroelectric Power Stations (HPS)	1,250	1,000

Source: GEF/WB, WEMP, A1 Component. Regional Report 2, 2001

Ecological Demands of the Aquatic Ecosystems

Aral Sea and Its Littoral Zone Demands. The annual inflow of water to the Aral Sea and its littoral zone from transboundary water courses will be carried out within the approved water intake limits of not less than 14.5 km^3/year. This includes 10 km^3/year for the Amudarya River and 4.5 km^3/year for the Syrdarya River. Compliance with these limits depends on water availability in a given year as well as the ability to implement measures aimed at the rational use of water by water users.

To protect delta and coastal ecosystems from the threat of damage Uzbekistan envisages the creation of artificially regulated ponds to replace former littoral and intra-delta lakes and sea bays along with a set of forest amelioration measures. For this purpose it is planned to release up to 3.0 km^3 of the country's available water in an average year from the Amudarya river downstream from the Kzyldjar site.

Aquatic Ecosystem Demand. Ecological regulation, aimed at maintaining a sustainable interrelationship between communities and natural ecosystems, also means that internal and external rivers, lakes and other aquatic ecosystems need to be recognised as “water consumers”. Nature should be an equal partner in the use of water resources. If water is not released then the aquatic ecosystems will lose their essence and functions. The key priorities for decision makers and for society as a whole should be:

- Observance of ecological discharges from water courses to ensure their long term viability or ability to self-purify;
- Maintenance of flood discharges and acceptable river water quality;
- Observance of sanitary releases for the dilution of harmful ingredients,
- Satisfaction of river delta demands, etc.

Recognising the ecological demand for water also implies protection of aquatic ecosystems with rare endemic species, valuable biodiversity, and landscapes of special aesthetic importance. It is important that both small and large rivers are able to maintain their natural flora and fauna and at the same time keep their primordial beauty.

For the protection of local ecosystems special attention should be paid to the following measures:

- Maintaining flow in water bodies that are fed by drainage water only;
- Maintaining a water mineralization level not exceeding 5 g/l and a water depth in winter time not lower than 1.5m in lakes with important fisheries;
- Preventing sharp drops in water level during the spawning period and sharp rises in winter;
- Maintaining shallow water zones for growing canes, reeds and lake aquatorium which can provide fodder for fish, birds, etc.

2.3.3. Change of Water Demands due to Climate Change

The last decades have been characterized by global climate change and an increase in the number of extreme weather and climatic phenomena (droughts, heavy precipitation, floods, storms, etc.), causing serious damage to people, the economy, and habitats (Figure 2.15).

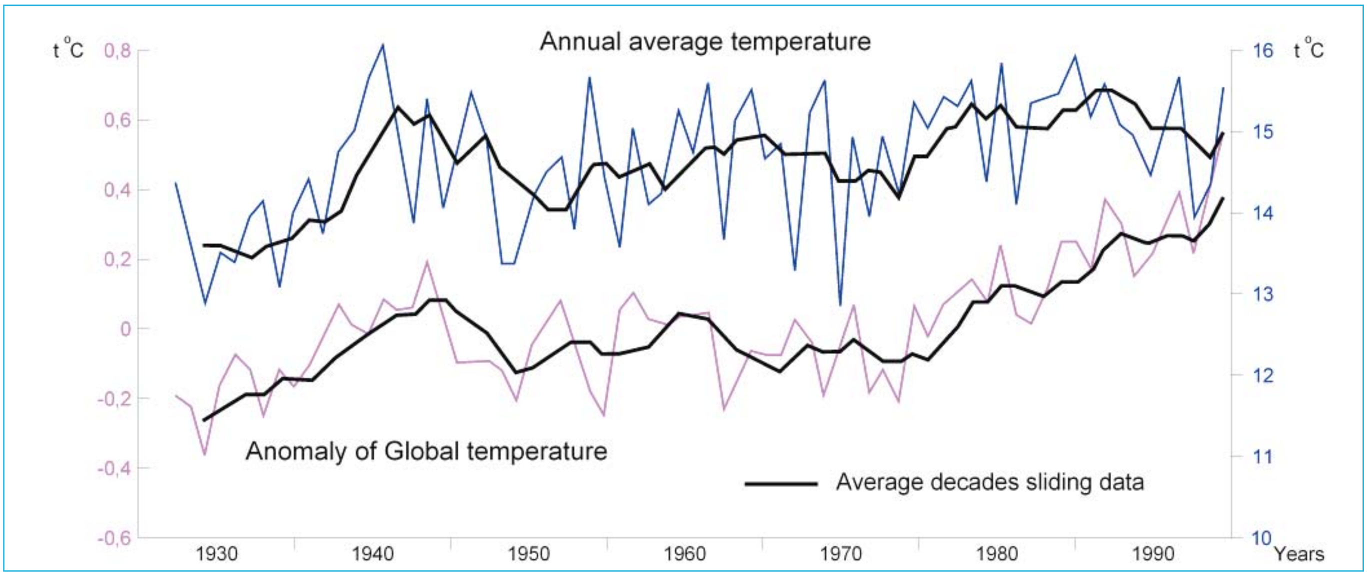
Assessment of the recent data shows that there has been a general reduction in glacier area. Glaciers have already lost 115.5 km^3 of their reserves (»104 km^3 of water). This is approximately 20% of the total reserve at the level of 1957. It is assumed that the current rate of reduction in glacier area approximately 1% per year) will continue in the future. Reduction of glacier area will lead to the creation of numerous moraine lakes that will in turn increase the probability of breakout floods and mudflows.

According to the research data in the near future variations of water resource volume within the natural range from +3% to -2-7% are expected [73]. A large proportion of the precipitation will be in the form of rain. The share of total annual precipitation which falls as rain will increase from 8-12% to 15-25%. This will lead to floods, increased mudflows and other degradation processes. In Uzbekistan the maximum discharge of mudflows resulting from rainfall will increase by 30-35% on average by 2030, compared to the current level[7].

Rising air temperatures will lead to changes in the time of spring flooding on rivers. This is not desirable either for agriculture or the operation of waterworks. The expected increase in total evaporation and water requirements of crops will cause a 5-10% increase in the normal levels of leaching irrigation and pre-irrigation water application. There will also be a 10% increase in net irrigation. The intensity of salt transfer processes within the zone of aeration will be also increased, especially in areas with high groundwater table. This will lead to an increase of soil salinization and land degradation. An increase in the severity of

[7]*According to ADB data (2004) out of total mudflows number in CAR, 75% occur in Uzbekistan.*

Figure 2.15. **Multi-Year Trend Change of Global and Average Air Temperature in Uzbekistan**



Source: Uzhydromet, 2000

droughts will lead to declining yields of the current varieties of agricultural crops.

Thus, with the expected growth of human activity and the increased use of water for irrigation, the development of irrigation should be based on the retention of soil moisture and the saving of the available water resources. This can be achieved through the adaptation of highly efficient technology and know-how, safe water and energy saving methods and efficient energy use, as well as in the area of agricultural production and food safety [73, 97].

2.3.4. Economic Incentives and Mechanisms of Efficient Water Use

Economic Mechanisms of the Natural Resources Use

Under the Government "Program for the introduction of scientifically sound economic and normative mechanisms for nature protection and the use of natural resources up to 2010" (1996) the staged development of the legal basis for a system of payments for environment pollution, within and outside agreed norms, is being carried out. Currently, in accordance with the adopted bylaws up to 80% of collected funds are directed to the state budget, and 20% to the nature protection funds [11,12]. A system of payment for irrational use of natural resources will be introduced by 2010.

The current mechanisms for nature protection management and the use of natural resources from the fund mobilization viewpoint are subdivided into the following categories:

- ecological payments: direct payment for emissions or disposals of pollutants into water, air or soil;
- user payments: payments for municipal services (water supply, wastewater purification and municipal solid waste utilization);
- taxes on production: payments for products, which pollute the environment in the process of their manufacture, consumption or disposal;'
- tax on water resources use;
- payment for the use of natural resources: extraction of mineral resources and fossil fuel, water intake or use of biological resources;

- a deposit system: a payment (deposit) is made when certain products are purchased and this is reimbursed when a used product or its container is returned;
- payment for violation of ecological legislation: penalties imposed for the contravention of certain laws;
- subsidies: all types of financial assistance to polluters or to natural resource users (grants, tax credits, tax exemption, etc.).

User Payments

User payments are directed at municipal services, i.e. water supply and wastewater treatment services and solid waste disposal service. The main purpose of these payments is to compensate recurrent and overhead costs, as well as the capital costs of these services. However, due to social considerations the amount of payments are kept below the level of complete pay back, charges are controlled by the local authorities and they are not fixed. The Decree of the Cabinet of Ministries of the Republic of Uzbekistan (No. 54, dated 7.02.94,) envisages a staged transition to self-sufficient municipal services with an average 10% annual reduction of the state subsidy level to home owners and flat tenants.

Tariffs for water use depend on the type of user and water body. Prices are established at a level that allows the recurrent costs to be covered, although in practice they are totally insufficient for this purpose. Social difficulties and the general economic situation impedes liberalization of prices. Profitability of the water supply organizations has decreased due to people's low income levels or their unwillingness to pay. As a result local authorities allocate subsidies from their budgets in order to cover the most urgent costs (staff salaries and urgent repairs).

Households and enterprises connected to the sewage system, pay the municipal water management organizations (Vodokanal) for wastewater treatment. Currently only 50% of the population has access to the sewage system.

Payments for Use of Natural Resources

Payments are made for water consumption and use, extraction and use of mineral resources, land and forest use, as well as for hunting and fishing.

Payments for the use of surface and underground water are mainly regulated by the Law on Water and Water Use and Decree on Limited Water Use. Tariffs depend on the source (underground and/or surface water) and water user. Tax rates for the use of mineral resources and prices for water are established every year in accordance with the Cabinet of Ministers' decree on the macro-economic indices and state budget prognosis.

The cost of delivering water to agricultural producers is included in the water tax that producers pay as part of the land tax. This procedure simplifies the work of tax agencies, but does not reflect either the cost of water or the real cost of operating and maintaining the water infrastructure.

Tax for Water Resources Use

Over the period 1996-2000, tax on the use of water resources made up around 5% of total resource taxes or 36% from the total income to the budget. Rates of this tax differ according to the economic sector. In 2001, they were in the range from 11 tiyin to 2.92 sum for 1m^3. According to the MAWR data, in 2000, tax was paid on only 10% of the water volume used by enterprises and the population. It is not paid by people or agricultural enterprises, which switched to a unified land tax, or by trade and public catering enterprises, which selected the simplified system of taxation.

Payment for water collected from the WUAs (from $0.5 to $4 per ha) is significantly lower than cost of operation and maintenance of the water delivery system. The infrastructure for servicing the agricultural good producers had not been created in rural system (procurement for the agreed prices of products produced by farmers and dekhkans, supply to them the necessary goods, tools, materials, etc.). In this context the economic incentives and mechanisms of efficient water use in the irrigated agriculture predetermine the necessity for improvement of the economic reforms in agriculture.

Studies of the WUAs operation experience in various countries, conducted by the World Bank, indicate that the legal basis of WUAs should be supported by distinct provisions, such as approbatory legislation, provisions of WUA charter and agreement on transfer of assets, etc. Therefore, WUAs should be considered as fully-fledged production and economic entities in the area of water use and agricultural activity with perspectives for development.

Mechanisms for increasing water use efficiency in the non-irrigation sectors of the economy are improved through tariffs for primary water users and system of the agreed obligations of water management organizations.

On the Issue of Charge for Water Delivery

Market reforms, carried out in Uzbekistan, have brought water charges to the fore as one the most important tools of rational water use in times of water shortage [72]. However, the existing scientific approaches and recommendations on water charges require improvement taking into account world experience and lessons learned in the region over recent decades [36,81].

Management of demand has huge scale in regard to the on-farm water use. As was mentioned above, privatization of agriculture and the establishment of WUAs, which are currently being introduced will lead to a fuller understanding of the relationship between water use and water charging. There is currently no special water charge, but a small fee for water use is included in the unified land tax.

According to ADB assessments (2005), in the current financial conditions it is estimated that the price of cotton and wheat should be increased by 25% - 30% to cover O&M costs of the on-farm I&D network, and by up to 75% to cover O&M costs of all elements of the I&D infrastructure, including pumping costs. It is also necessary to note that farmers will pay for irrigation water only if a satisfactory and efficient service can be ensured. Therefore, demand management will make sense only if agriculture will become profitable enough to be able to pay for water delivery and if this payment will not represent an unjustified financial burden.

Experience from other countries indicates that farmers with low income are ready to pay for a good quality water delivery services which will increase and stabilize their income. In the majority of countries the government subsidizes the cost of water management services for agricultural producers. The scale of these costs varies and depends on the natural, social, economic, technical and technological conditions of agricultural production.

In this connection, there is a need for a more detailed analysis of farm budgets under alternative scenarios of prices, yields, and type of crops, as well as reliable calculation of the O&M costs of the on-farm and inter-farm I&D network that may be covered by farmers, and also the level of government subsidies that required to cover the costs of the O&M and the whole I&D network. After identifying a procedure for the reimbursement of production costs, the program for the gradual introduction of a water charge system managed by the WUAs network can be prepared.

Special attention should be paid to the installation of metering instruments and other equipment in the irrigation system to measure the volume of water supplied to farms. From the on-farm management viewpoint, this equipment can also be used to measure volume of water supplied to every field. This process is not simple and requires significant human and financial resources, as well as support from the government.

In the course of time, adoption of market principles in irrigated agriculture should significantly improve the quality and efficiency of irrigation and drainage services. This initiative should also take into account the international experience on introduction of water use rights and the market principles in water use. The improved efficiency of water use may create a market for excess irrigation water that WUA can sell to those farmers wanting to expand their irrigated land. Creation of efficient, equitable and transparent mechanisms of the production costs reimbursement for financing of O&M with using both government and WUA/farmers funds is a prerequisite for the sustainable development of irrigated agriculture in Uzbekistan.

To ensure guaranteed water delivery from the transboundary water courses it is extremely important to strengthen mutually beneficial cooperation and develop sustainable mechanisms for joint water use at the regional level. Today the countries located in the upper watershed of transboundary rivers increasingly consider water as an economic commodity that has value and may be sold. What this concept implies and the problems associated with it will be discussed in Chapter 4.

Chapter 3. **WATER RESOURCE MANAGEMENT AND USE**

3.1. National Policy in the Area of Water Resources Management

3.1.1. Policy and Reforms in Water Sector

The main priority for the Republic of Uzbekistan at all stages of the on-going economic reform is to ensure reliable social guarantees and measures for social security and protection of the environment [54,56]. The environmental protection policy and the measures promoting rational use of natural resources and environment protection are based on the following main principles:

- *Integration of economic and ecological policy aimed at the conservation and restoration of the environment as the essential condition for improving people's living standards;*
- *Transition from an approach in which only certain elements of the environment were protected to one of general and integrated ecosystem protection;*
- *Responsibility of all members of society for protecting the environment, conserving its biodiversity and creating favorable living conditions.*

The main strategic framework for the successful development of reform and reorganization in all sectors of the economy is laid out in the Decrees of the President and Resolutions of the Cabinet of Ministers. These include, "*On measures for realization of programs for liberalization and deepening of reforms in the political, economic and cultural spheres of society, ensuring of the country's security*", as well as special laws, provisions, and norms.

The Government's agricultural policy is aimed at liberalization and encouraging economic reform through further institutional reorganization, development of Water User Associations (WUAs), and extending the rights and economic self-sufficiency of agricultural producers. Special attention is paid to the fundamental reform and accelerated development of private farms. In October 2003, the rapid creation of private farms by 2006 was approved by the Decree of the President of Uzbekistan "*On the concept of private farms development in 2004-2006*". This decree stressed the necessity for private farms to be legally protected and freed from interference by administrative bodies in their business. At the beginning of 2006, the number of private farms growing mainly cotton and wheat was already more than 120,000 and dekhkan farms numbered more than 3.5 millions.

The main aim of the Government's policy in the water sector is to promote the rational use of water and to protect water resources. It also aims to improve the efficiency and reliability of the country's water sector management, ensuring guaranteed water delivery and providing essential services both to society and natural ecosystems for the reconstruction, operation and maintenance of the existing infrastructure.

The main priorities of activities in the water sector are as follows:

- Water saving in all types water consumption and improving water quality;
- Development of systems for supplying the population with good quality drinking water;
- Restoration of soil fertility and maintenance of a favorable water-salt balance in the rooting zone of soil;
- Prevention of water and wind erosion of soil, and rational use and protection of the vegetation cover in the piedmont-highland and desert-pasture zones;
- Mitigation of the negative impacts of the ecological and economic crisis in the Aral Sea littoral zone through an integrated approach to decision-making on interrelated regional and national issues.

The process of water sector reform began with the adoption of the Decree of the Cabinet of Ministers on the transition from an administrative-territorial approach to a two level system of basin irrigation management involving the introduction of market relationships at all levels of water use:

- Decree of the Cabinet of Ministers of the Republic of Uzbekistan of 21.06.2003, No 290

"*On improvement of the activities of the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan*";

Decree of the Cabinet of Ministers of the Republic of Uzbekistan of 21.07.2003, No 320 "*On improvement of water sector management*".

The transition from the territorial principle of management with its strict centralized approach, to the more flexible systems approach based on hydrographic (basin) principles, is fundamental to these decrees. The creation of the two-level system of national water resources management through the establishment of the Basin Administration of Irrigation Systems (BAISs) and WUAs has become the most important component of the on-going reforms. The Main Department of Water Resources of the Ministry of Agriculture and Water Resources (MAWR) was established at the top of hierarchical structure (Annex 3).

The first WUAs in Uzbekistan were set up in 1999-2000, when the reform of the unprofitable collective farms led to the establishment of private farms, which in turn were integrated into farmers' associations. These associations formed the basis from which the first 13 WUAs emerged.

The development of the WUA saws further boosted by the Cabinet of Ministers Decree No 8 of 5 January, 2002, "*On measures for the reorganization of agricultural enterprises into private farms*", and also "*Procedure for regulation of water interrelationships on the territory of reorganized agricultural enterprises*". In accordance with this Decree the Ministry of Justice, MAWR, and the Association of Dekhkan and Private Farmers of Uzbekistan prepared a package of documents covering; (i) the procedure for establishment of WUAs on the territory of agricultural enterprises which are being reorganized; (ii) the management structure of the WUA; (iii) the standard agreement about water users integration and establishment of WUAs; (iv) the standard charter of the WUA; and (v) the standard agreement between the WUA and farmers for provision of chargeable water delivery services and works.

3.1.2. National Programs and Investments

The national policy and approach to transition to sustainable development is an integral part of the strategic programs and sectoral action plans (Box 3.1). The conceptual basis and approaches to transition to sustainable development are reflected in program documents of the Government[8].

In accordance with these documents, various programs and projects, financed by the national and local budgets, as well as by enterprises and foreign investment, bank loans and credits, are being implemented in Uzbekistan. The contribution of national programs and projects was assessed in the previous chapters and is also detailed in recently conducted reviews [55,56]. Therefore, here we will concentrate only on certain key documents in the area of water-land and energy resources use.

The "Master Plan for the development of irrigated agriculture and water management in the Repub-

Box 3.1

National and Sectoral Programs and Action Plans

The National Environmental Action Program of the Republic of Uzbekistan, 1999.

The National Strategy and Action Plan for Biodiversity Conservation, 1998.

The National Action Program to Combat Desertification, 1998.

The National Strategy for Reducing Green House Gas Emissiosn, 2001.

The First National Report on Climate Change, *1999, 2001.*

The Mid-Term Strategy for Improving Living Standards ,2003, and the others.

[8]Concept and National Strategy for Sustainable Development, A National Agenda for the 21st Century for the Republic of Uzbekistan; National reports at UN SDC Sessions (1997-2001) and the Millennium-2000, as well as reports and reviews evaluating the progress of the Government in sustainable development made to the Cabinet of Ministers and the UNDP Mission in Uzbekistan (1997-2001), the National review of progress made by the Republic of Uzbekistan in realization of the "Agenda for 21 st Century" and others

lic of Uzbekistan for the period up to 2015" (2001), and the "Draft governmental strategy for improvement of water resources management and water use in conditions of agriculture reform and establishment of water user associations" (2004) were developed to support reform in the nation's water and agriculture sectors.

The common objective of both program documents is to provide a rationale for the direction and scope of further development in irrigated agriculture with the aim of meeting the needs of the rapidly growing population and ensuring food security for all. As was mentioned Chapter 2.3, implementation of the planned package of measures aimed at conserving water and other resources in the medium-term will facilitate both increased agricultural productivity, growth of rural incomes and conservation of the environment. In order to strengthen the role of government in water management issues, the Master Plan envisages the establishment of the State Committee on Water Resources of the Republic of Uzbekistan (Goskomvod).

In 2000, the "Strategy of Irrigation and Drainage Development" was initiated by the Government of Uzbekistan with support from the World Bank and the Government of Holland. This strategy is aimed at preventing further degradation of natural resources and possible damage to the I&D infrastructure, and ensuring guaranteed water delivery and reliable water management systems in the short- and long-term [88].

The "National energy program for the period up to 2010" is aimed at reducing energy consumption and improving energy supply efficiency. The main priorities of this program are to explore and develop internal energy resources, reduce natural gas consumption and increase the share of domestic coal in electric energy generation, and expand renewable sources of energy. The main objectives of the "National program of energy saving for the period 2001-2010" are the efficient and rational use of energy and energy saving. Special attention is paid to realization of projects in the area of helioenergetics, mini-hydropower, geothermal energy, and the use of wind and biomass energy [52,53].

The "National "Strategy and Action Plan on capacity building for implementation of the global environmental conventions (GECs)", developed within the NCSA project (2006), identifies the country's further steps and actions aimed at strengthening capacity to comply with the common commitments to the GECs [32,56]. The action plan comprises three target tasks: (i) improvement of the system for coordination, cooperation, resource support, and incentive measures; (ii) development of the normative and legislative basis and implementation mechanisms with the aim of harmonizing it with the GEC requirements; (iii) increasing awareness, understanding, and involvement of the public in the implementation of the GECs. These key provisions have been identified as a result of multilevel analysis of common and cross-cutting capacity needs and extensive studies of and consultations with all stakeholders, independent experts, and local communities. The combined efforts of all stakeholders in implementing the national action plans will help them become part of the global effort to protect the environment.

Among the many programs and projects, already mentioned in previous chapters, the regional and national initiatives and interventions aimed at sustainable natural resource management and improvement of people's livelihoods and living standards are of special importance.

The "National Programming Framework of Uzbekistan" (NPF), developed within the framework of the CACILM multi-lateral and multi-donor initiative of the Central Asian countries, is aimed at combatting land degradation and reducing poverty [39]. It does this by promoting approaches to sustainable land management (SLM) that will increase the environmental integrity of vulnerable natural ecosystems and improve people's living standards. Assistance from GEF will cover three interrelated interventions: capacity building, on-the-ground project investments, and target studies at local, national and, interstate levels. Various approaches to the solution of legal, political, and institutional problems and programs aimed at expanding participation will be tested. The total value of Uzbekistan's NPF investment program is $516.6 million, including $377 million dedicated to the "Natural Resources Management" program area.

The "Project for the creation of local water bodies in the Amudarya river delta in Uzbekistan" (IFAS) identifies the ecologically important wetlands and flood plains in the Amudarya river delta, which are in need of urgent rehabilitation and where expansion and/or an increase in water level are possible. This project has formulated a long-term policy of water resource management on the basis of the advisability and technical feasibility of creating wetlands and restoring the Amudarya river delta.

In order to mitigate the impacts of the severe drought of 2000-2001, that caused more than USD 38-40 million of damage[9], the Government undertook a number of urgent measures in the seriously affected regions. In 2001, the Government of Uzbekistan allocated significant financial resources to implement a number of technical interventions and also sought assistance from the international community. With support from the UNDP, several projects have been implemented: the “Emergency measures for reducing the impact of drought in Uzbekistan”, “Assistance to the Government of Uzbekistan for mitigating the impact of drought”, and “Development of advisory services to the Government of Uzbekistan for drought prevention”.

At the same time, implementation of some projects, especially in the Syrdarya river basin, is the subject of discussion[9]. This is associated with construction of the Rezaksai reservoir in the Fergana valley and engineering measures on the Arnasai lake system (see Chapter 2.2). The main reason for the initiation of these projects was the problems associated with change of the Toktogul reservoir operational mode. These problems were even more serious in extremely dry years. Meanwhile, both direct and/or indirect benefits from the project interventions aimed at ensuring guaranteed water supply and redistribution of the Naryn and Syrdarya rivers runoff downstream to the Chardara reservoir will be felt by all water users as well as by the natural ecosystems in the Syrdarya river basin.

It is very clear that taking urgent action in one country alone cannot overcome the increasing threats to water in the river basins as a whole. There is an obvious need to consolidate the efforts of all Central Asian countries to improve water relationships and to develop strong, mutually beneficial partnerships and cooperation.

3.2. Institutional Aspects of Water Resources Management

3.2.1. The Governmental Management Bodies

Under current legislation the management of water resources at the national level is carried out by the Cabinet of Ministers, the State Committee for Nature Protection (Goscomprirodа), the Centre of Hydro-meteorological Service under the Cabinet of Ministers (Uzhydromet), the Ministry of Agriculture and Water Resources (MAWR) and local authorities under the guidance of the Oliy Majlis Commissions.

Responsibility for national water use and protection is shared by the local authorities, Goscomprirodа, the Agency for Supervision and Safety Management in Industry and Mining, the Ministry of Health Care, MAWR, and Uzhydromet according to the procedure laid down in the law. Sectoral management of land use is the responsibility of the State Committee on Land Resources, Geodesy, Cartography and State Cadastre (Goskomzemgeodezcadastr).

The Responsible and Management Structures

Water use and water protection at the national level is overseen by the Main Department of Water Resources of MAWR. Management of underground water is carried out by a body approved by Goskomzemgeodezcadastr. In 1999, Gosvodkhoznadzor was established with the main task of inspecting the country’s huge I&D infrastructure and making recommendations to the Government on how it can be renovated and improved.

The Ministry of Agriculture and Water Resources (MAWR) is the state body for water resource management. It plays the key role in implementing state policy on water (as well as forest resources) management and use, and coordinating the work of the water management bodies in Uzbekistan. As was mentioned above, from the beginning of reorganization in 2003, the total number of organizations in the MAWR system was reduced 2.5 times, and their roles and legal responsibilities towards water users were also changed.

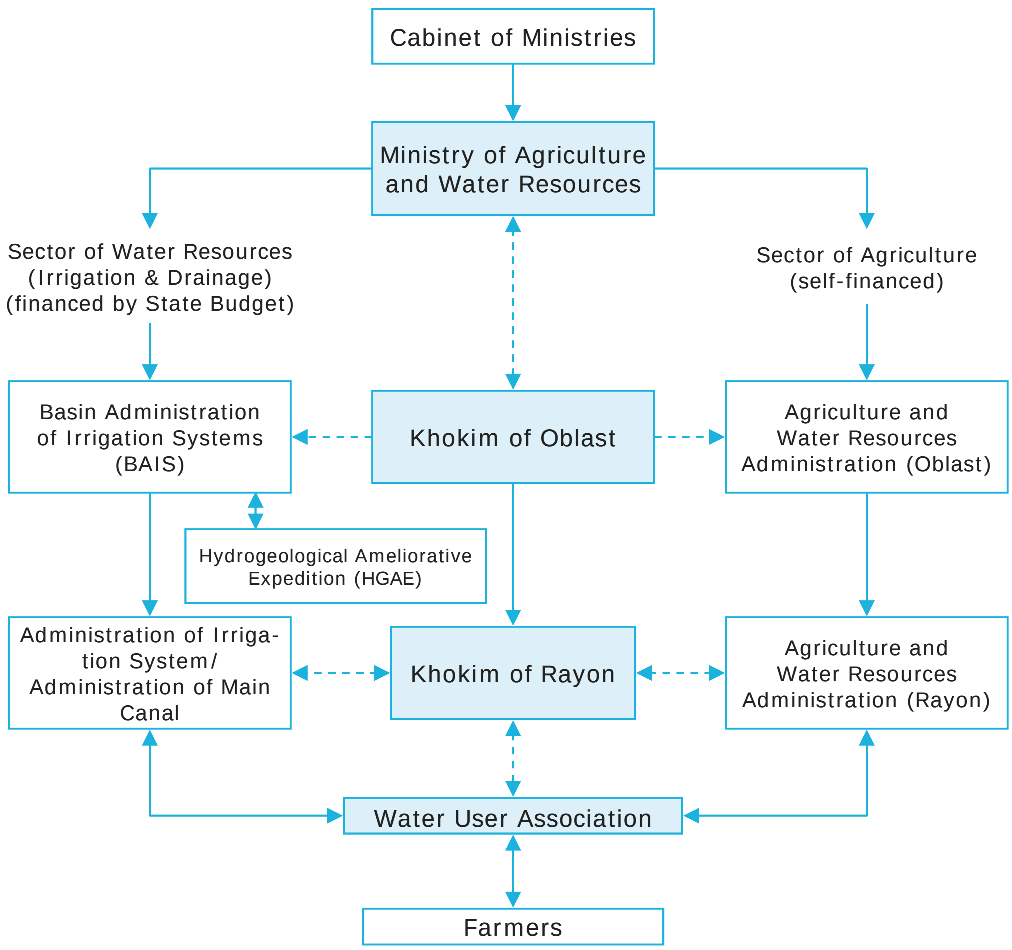
[9] CARNet, CARWATER info (2006); UNDP (2005); ADB, CEA (2004), et alia.

The main tasks of MAWR relating to water management are:

- Development of policy in the agriculture and water resources sector;
- Introduction and development of new technologies in the area of agriculture and water resources;
- Coordination of the activities of commercial service enterprises and organizations;
- Making investments in the irrigation and drainage systems to improve water resource management;
- Development of policies and procedures for the basin organizations;
- Assistance to development of WUAs;
- Introduction of integrated water resource management at the river basin level;
- Creation of strong research institutions and training courses for the improvement of on-farm irrigation.

Basin Administration of Irrigation Systems (BAISs) are regional bodies under MAWR which were established on the basis of existing structures (Annex 3). The main tasks of BAISs are: (i) managing the purposeful and rational use of water resources; (ii) implementing an integrated technical water management policy; (iii) ensuring uninterrupted and timely delivery of water to users; (iv) rational management of water resources within the basin; and (v) ensuring the reliable measurement of water use. The Irrigation System Administration in each region is a structural subdivision of the BAIS and MAWR (Figure 3.1).

Figure 3. 1. **Organizational Structure of Management**



In addition, financially independent and state financed enterprises and construction administrations, as well as design and scientific research institutes are subordinated to MAWR (Annex 3).

The State Committee on Irrigation and Drainage is the intersectoral and interregional body coordinating irrigation and drainage activities in Uzbekistan. Members of this committee are the heads of the large water management organizations, and deputy khokims of oblasts responsible for water management issues.

The "Uzkommunkhizmat" agency is the state management body responsible for the provision of municipal services to the population. It was established in 2000, to replace the abolished Ministry of Municipal Services. The main tasks of this agency are: (i) ensuring the stable and reliable operation of interregional water pipelines; (ii) designing and implementing an integrated technical policy on the exploitation and development of interregional water pipelines, and tendering for their construction; and (iii) developing the normative and legal framework and monitoring the technical and economic conditions affecting municipal services. The Regional Municipal and Exploitation Associations (RMEAs) are responsible for municipal services at the local levels, and are subordinated to the oblast khokimiayt and the Agency.

The State Committee for Nature Protection (Goskompriroda) is the main executive agency in the area of environment and the natural resources protection in Uzbekistan. Goskompriroda is responsible for the control and improvement of surface water use and compliance with the legislation in the area of nature protection. It develops and implements environmental protection measures. The Committee is directly subordinated to the Oliy Majlis.

A number of ministries and institutions are entrusted with the implementation of environmental protection measures, and have control over and responsibility for specific areas, namely:

- The Agency of Energy and Electrification manages the hydropower stations and their associated reservoirs;
- The State Committee on Geology and Mineral Resources is responsible for monitoring and controling underground water;
- Uzhydromet carries out observations on the hydrological regime of rivers, lakes and reservoirs, and is responsible for monitoring the quality of water within rivers, lakes and reservoirs. Uzhydromet has the status of a ministry.

These bodies are jointly responsible for the development and realization of specialized programs, strategies, and action plans in the area of water infrastructure and natural resources management, as well as environment and water monitoring and protection.

Other Concerned Organizations

The Sanitary and Epidemiologic Stations (SESs) ensure the epidemiologic safety of the population. At the state level the SESs are subdivisions of the Ministry of Health Care, and at the oblast and rayon levels they are subordinated to the relevant khokimiayt. The SESs are responsible for the regular monitoring of drinking, municipal and irrigation water quality in order to prevent contamination by harmful substances. SES directives are legally binding for all organizations and citizens using water for production, agricultural and municipal purposes, as well as for the commissioning of water supply facilities.

Departments of Labor, Employment and Social Security are simultaneously structural subdivisions of khokimiayts and the Ministry of Labor and Social Security in each region of the country. They are responsible for involving unemployed citizens in temporary public works, including the repair, restoration and cleaning of irrigation and drainage systems.

3.2.2. Major Water Users and Consumers

There are various categories and groups of water users in cities, kishlaks (villages) and other rural settlements. More than 16 million water users live in rural areas. These include dekhkans, farmers, owners of household plots, and other rural dwellers, as well as non-governmental organizations and other independent bodies, industrial and commercial enterprises, etc. There is an overlapping of interests amongst these categories: for example, private farmers often have household plots, and city dwellers can be employed by the water management organizations.

The Non-governmental Organizations Relevant to Water Use

Partnership of Housing Owners is a non-governmental noncommercial organization acting as an independent legal entity. It unites urban housing owners to ensure the joint management and safety of apartment buildings and houses. It also helps to identify the requirements of ownership and the use of shared amenities, as well as maintenance of proper sanitary, fire-prevention, and technical conditions.

Citizens' Councils in Uzbekistan represent people who live in settlements, kishlaks, auls (villages) and city makhallyas[10]. Citizens' Councils are the supreme autonomous bodies representing the interests of the population and making decisions on its behalf in their respective areas. These Councils are responsible for the solution of all issues associated with people's living environment, including improving municipal supply of drinking water and natural gas,organizing khoshars (community labor) for keeping the local environment clean and constructing or cleaning the water supply infrastructure.

The Republican Association of Dekhkan and Private Farms unites the dekhkan and private farms, and also small food processing enterprises and represents their interests in governmental and other organizations, including the water management services.

The Water User Associations (WUAs) are associations of the newly established private farms and other commercial entities providing services in water distribution and the operation and maintenance of the on-farm irrigation and drainage systems. The WUAs are a new type of non-governmental organization in the area of land and water use, but they already serve around 2.8 million ha (2005). The WUAs are now responsible for approximately 70,000 km of irrigation channels and 50,000 km of the drainage network.

The Vulnerable Group of Water Users

Although the whole of society is affected by the socio-economic and ecological impacts of water shortages, some population groups have proved to be especially vulnerable.

There are three types of agricultural producers who are extremely dependent on water: (i) families which work in the shirkats (agricultural cooperatives) and lease plots of land with an average size of 5 ha; (ii) dekhkans who cultivate small household plots (0.1 ha); (iii) private farmers with large land plots on long-term lease. Unreliable delivery of water for irrigation and land degradation (especially salinization and waterlogging) aggravates the problems associated with poverty. The social assessments of the WB (2002) and the ADB (2005), note the desperate needs for improving the quality of drinking and municipal water available to vulnerable groups in the population. At the moment they have to spend a significant share of their income on purchasing and stoing drinking water. Apart from the financial expense, the population incurs a significant social charge in terms of the serious threats to health, nutrition, etc.

The following groups of the population are extremely vulnerable to water shortages:

Women in cities and villages are the most vulnerable inhabitants. Taking care of the health and hygiene of the family, women are the primary users of municipal water supply and sanitation. Shortages of water and environment degradation significantly increase their vulnerability because women have to combine field work and the man-

[10]From the legislative viewpoint the makhallya is the independent self-administration body only in cities and other urban settlements while in the rural areas the legal bodies of self-administration are citizens' councils. Each of them usually includes several makhallyas, i.e. actually the rural makhallyas are unofficial self-administration bodies.

agement of land plots with housekeeping. Very often they are able to find only seasonal work in cotton weeding and harvesting. Women from low income families are more vulnerable. They can not pay for the delivery of water by transport and so buy bottled water. Pensioners, handicapped, single mothers, pregnant women, and many families with children are also vulnerable and find it very difficult to cope with water shortages.

Young Families. One of the most vulnerable groups among the rural population is young families who live apart from their parents. As a rule such families build houses in remote areas and their gardens are often initially without water. These families experience water shortages even if the general situation is favorable. During dry years the problems they face are much greater.

Agricultural Producers in Lower River Reaches. Agricultural producers, located at the tail end of the irrigation system or at some distance from it, especially those on river deltas and in lower reaches, suffer more from water shortages than those located in the upper river reaches or close to canals irrespective of their status as shirkat or WUA members or private farmers. The most vulnerable are the dekhkan farms with poor quality land and insufficient access to irrigation water.

Specialized Agricultural Producers Farmers specializing in horticulture and viniculture also add to the number of vulnerable land owners. Lack of water for irrigation of their plots has forced many of them out of business, orchards and vineyards have dried up, wasting years of work. Farmers engaged in livestock breeding are also vulnerable since it is the women and children who are usually responsible for watering cattle, and they are forced to cover long distances on foot in search of available water.

3.2.3. Gaps in Institutional Development

According to assessments of the ADB (2005) and others, the process of reform in the water management sector is faced with considerable technical, financial, and institutional difficulties [72,93]. There are several key limitations, namely:

- Lack of incentives for farmers and the restrictive purchasing and pricing policy;
- Legal and institutional weakness in the formation and development of private farms;
- Inadequate agricultural services for private farms;
- Lack of progress in privatization of agro-business;
- Lack of capability of the WUAs to manage and carry out O&M, in addition to their weak legal basis;
- Insufficient financing of the O&M of the I&D infrastructure, and weak mechanisms for cost recovery.

Nevertheless, since 2001, the Government has made some progress in implementing a market based agricultural and land policy, particularly in regard to pricing of goods according to international norms. Restructuring of collective farms and development of private farms has also gathered pace over the last three years. The Government has simplified taxation in agriculture with the introduction of the single land tax in some selected oblasts. At the macro-economic level the most important change for the agricultural sector was the significant devaluation of the exchange rate in September 2001 that led to a substantial increase in the price of cotton and wheat.

At the same time, the rapid transfer of functions and responsibilities from government management to farm management, changes in water relationships, and improvement in the system for metering, control and reporting on the use of water at national level are unrealistic due to the huge scale of the task and lack of adequate financial mechanisms. The situation is aggravated by the lack of experience and knowledge, and the poor coordination of activities which significantly constrains reform.

More than 75,460 private farms have already established 894 WUAs on a voluntary basis. However, a number of fundamental provisions concerning the relationship between WUAs and Dekhkan and Private Farms Associations

(DPFAs), and the coordination and approval of water use limits and plans by the regional authorities are missing in these documents [48]. In addition, issues on regulating water distribution at the local level still remain under the control of the oblast and rayon administrations, although their task is to provide legal assistance, and support to agricultural enterprises. This is clear evidence of the fact that the system of centralized management still remains and that decision making is not yet adequately decentralized. It also shows how difficult it is to change the way of thinking of a generation who grew up before the period of transition to the market economy and often lacks appropriate managerial skills.

The other significant factor restraining WUAs from providing services is that farmers and dekhkans lack finance for rehabilitation of the on-farm I&D infrastructure. This work requires large investment that individual farmers and dekhkans cannot afford. In a survey by the World Bank (2002) a large majority of respondents (90%) agreed that the Government should take over responsibility for investments in the irrigation and drainage system, as well as for its operation and maintenance. Taking into account the current income levels in the country this is hardly unexpected. Farmers are ready to invest if it is economically expedient and beneficial for them. Apart from this, people feel that they should participate in decision making on various aspects of water and land management.

Experience of similar reforms in the water management sector of Central Asian countries indicates that simple replication of institutional programs and management tools without taking into consideration the historical and socio-economic context of the country is unacceptable and inappropriate. Experience from other countries, such as Turkey and Mexico, shows that a key precondition for the successful transfer of management in irrigation is strong political will and a commitment to the privatization of water management.

3.3. Legal Aspects of Water Resources Management

3.3.1. Review of Water Legislation

The main legislative document identifying the rights, obligations and regulations of natural resources use and environmental protection, is the Constitution of the Republic of Uzbekistan, adopted in 1992. Water and nature protection relationships are regulated by a number of laws, adopted immediately after independence[11].

Currently, the country's nature protection legislation covers a broad spectrum and including the following main areas:

- Protection of the environment and its main components;
- Protection of ecosystems and regulation of natural resources use;
- Environmental impact assessment and ecological expertise;
- Regulation of compensation for damage to the environment (including economic and administrative aspects);
- Regulation of the rights to ownership of natural resources.

The law "On Nature Protection" (1992) is the fundamental legislative act regulating environmental protection. It provides the legal, economic, and managerial basis for the conservation and monitoring of natural resources, the protection of ecosystems and the rights of citizens to a favorable environment.

At the same time a series of laws was adopted that regulate protection and use of natural resources: the "Land Law" (1993), "Law on Water and Water Use" (1993), "On the Specially Protected Nature Territories" (1993), "On the State Sanitary Inspection" (1992), as well as mechanisms for their execution specified in Government Decrees [8].

In order to strengthen and develop the relevant legislative basis, further laws, associated with conservation, use, and management of natural resources with special attention to vulnerable com-

[11]During Soviet Times water relationships were regulated by the Law of the Union of the SSR of 10 December, 1970. "Basics of the water legislation of the Union of the SSR and the allied Republics".

ponents of environment, were adopted in subsequent years. Violations of the laws on the environment are dealt with under the Criminal Code, Administrative Code, Civil Code, and the Labor Code. In addition, the law on nature protection contains special provisions on ecological and legal responsibility which are not covered by the above mentioned laws.

The most important legal document is the "Law on Water and Water Use" signed by the President of Uzbekistan on 6 May, 1993. Some corrections and amendments to the law were made later. Article 3 of the law envisages that water resources constitute state property, and shall be rationally used and protected by the state. Article 49 specifies that land under reservoirs, interstate canals and water structures, and underground water intakes, irrespective of ownership and land use shall be the property of the state. It also specifies that on-farm structures will be the property of shirkats or WUAs, which took over their responsibilities and rights.

The tasks of the "Law on Water ..." are regulation of water relationships, rational use of water for the needs of the population and the national economy, protection of water from pollution and depletion, prevention and elimination of other negative impacts on water, improvement of the condition of water bodies, as well as the protection of rights of enterprises, institutions, organizations, private and dekhkan farms and citizens in relation to water[12].

The law "On safety of water structures" is aimed at ensuring safety in design, construction, commissioning, reconstruction, restoration, conservation, and demolition of water structures.

Many important aspects of the state management, use and protection of water resources are regulated by bylaws. There are a number of Decrees of the Cabinet of Ministries of the Republic of Uzbekistan, such as:

- On the approval of the Provision on State Ecological Expertise (No 491, 31.12.2001);
- On the approval of the Provision on State Environment Monitoring (No 49, 3.04.2002);
- On giving the fresh water aquifer formation zones the status of specially protected natural areas of national importance (No 302, 26.08.2002);
- On the improvement of the hydrometeorological service (No 183, 14.04.2004);
- On the approval of the Provision on the procedure for the cadastral division of territory of the RUz and formation of cadastral numbers for the land plots, buildings and structures (No 492, 31.12.2001)

The special Decree of the Cabinet Ministries of the Republic of Uzbekistan (No 276 of 01.08.2002r) "On additional measures for ensuring the stable development of agricultural production in the Republic of Karakalpakstan for the period 2003-2007" was adopted in order to support institutional reorganization, development of private farmer associations, and the extension of rights and economic independence of agricultural producers.

In order to overcome the limitations of the existing legal system, in November 2004, a Special Government commission working jointly with stakeholders took the following decisions in regard to the development of WUAs:

- To adopt the special law on WUAs and make the necessary amendments to the relevant laws and bylaws (stressing at the same time that at present the legal basis of WUA status and functions is insufficiently elaborated);
- To strengthen the role of WUAs in planning and managing the rational use of water resources on irrigated lands and the promotion of sustainable and integrated water resource management;
- To encourage WUAs to make better use of their own water resources through the introduction of advanced irrigation water application technologies which reduce the volume of water supplied per hectare;
- To develop a special program for the intro-

[12]Enterprises, organizations, and institutions, in coordination with the authorized management bodies, should carry out the measures aimed at preventing and eliminating negative impacts on water such as, floods, impoundments, collapse of banks, protective dams and the other structures, waterlogging and, salinization of land, soil erosion, formation of ravines, landslides, mudflows, and other harmful phenomena. As economic measures, the law envisages payments for specialized water use, pollution of and other harmful impacts on water bodies, and tax credits and other benefits for introduction of water saving technologies, water protection and other activities, etc. (Law on water and water use).

duction of modern irrigation water application technologies and a review of issues associated with financing of farmers; and

- To assist WUAs in introducing water meters for precise measurement and calculation of water volumes used by farmers.

The commission paid special attention to the following issues:

- Proceeding with the establishment of WUAs by the method "from start to finish" in order to promote participation of every farmer in offsetting up the association and to provide them with possibilities or incentives to be sure that they will be heard and can influence the operation of the system and decision making on its management;

- Creating within MAWR a specific bureau or department to support the management of the basin and to assist farmers in establishing the WUAs.

In line with Government priorities, the Commission of the Oliy Majlis together with governmental agencies and stakeholders are preparing the law "On Water User Associations", as well as a new version of the law "On Water and Water Relationship" and other bylaws.

The following Government directives were recently adopted in the sphere of drinking water supply:

- *"On* the approval of the Provision on accumulation of funds of the water supply organization of the Republic of Karakalpakstan and Khorezm oblast for the repayment of credits from the international financial institutions spent on improving the drinking water supply system", Decree of the CM No 252, 2005;

- "On some issues associated with realization of project 'Improvement of water supply system in Gulistan, Djizak and Karshi cities' with participation of the ADB", Decree of the CM No 6 of 17.01.2006.

The law "On the rational use of energy" regulates the use of energy resources. The objective of this law is to establish the general legal basis ensuring the conservation of the nation's energy resources and the efficient use of those resources and the existing production capacity. Financing of target programs is carried out according to the procedure established by legislation. For financial support of the state policy on the rational use of energy the Government has created an off-budget intersectoral fund for energy saving.

3.3.2. Gaps in Water Legislation

Analysis of recently completed reviews shows that the law on the use and protection of natural resources is not being effectively implemented. The issues of resource saving is insufficiently integrated into national strategies and other documents [55,56]. Approaches to and mechanisms for the implementation of the current laws and acts by the executive bodies are not coordinated and are mainly intended for sectoral use. The reviews indicate that there is practically no awareness of cross-cutting issues associated with access to safe technologies and their transfer, coordination and cooperation, strengthening of intersectoral relationships and capacity building.

Mechanisms to provide incentives and establish legal liability for damage to water resources and the environment are not envisaged in the current legislation. Although penalties for pollution of water bodies are imposed at all levels, the collection rate of these fines remains low due to inadequate financial mechanisms. The law "On water …" identifies the rights to check water quality, but does not establish requirements for observing the relevant standards and limits of water use, as well as the rights of users to receive water of proper quality. There is also no explicit regulation of issues associated with the calculation of volumes and registration of the quality of water being withdrawn by water users for irrigation and of tail escape water disposed from irrigated land. No specific mechanism for compensating people for the loss of irrigated land, agricultural infrastructure or homes due to water logging, is provided.

One of the constraints of the current water legislation is the poorly developed legal norms for water and other resource saving. The Decree of the

Cabinet of Ministers "On the temporary procedure for the limited water use" (No 385), adopted on 3 August, 1993, needs to be updated and relevant changes and amendments made.

The Government provides associations and citizens with the right to control how water resources are used and protected. However, the articles of law "On water …" do not contain provisions specifying that associations and citizens can and should participate in carrying out such control. The normative and legislative acts on water use and saving do not contain information about public management and control, and the issues of monitoring and impact assessment are not sufficiently considered.
In general, the aim of the normative and legislative basis is the rational management and use of natural resources, but the approaches and instruments used lack the flexibility which would allow them to form part of a sustainable natural resources management system. Consistent and appropriate use of international law, procedures and normative acts on use of water and energy resources in many cases is not yet common practice in Uzbekistan. Despite all these difficulties, however, acceptance of international law and global agreements will create a reliable legal platform for the harmonization of water relationships at all levels.

3. 4. Civil Society and Public Participation

3.4.1. Civil Society

There are some 362 specialised institutions from the spheres of scientific research and design which are responsible for the rational use and conservation of natural resources., The key activities of these organizations are directly or indirectly related to the solution of the water problems of Uzbekistan. These include the development of national strategies, action programs, plans and technical designs, as well as the scientific and applied studies in the field of ecology and nature protection. These activities contribute to the development of reforms and institutional reorganization, training, development of advanced technologies and methods of resource saving, etc.

Since independence 13 public organizations and 22 national charity and international foundations have been established in Uzbekistan. Their activities are aimed at supporting public health and environmental protection, as well as developing entrepreneurship, and establishing and strengthening cultural relations and intellectual capacity. Organizations such as ECOSAN, the Mercy and Health Fund, IFAS, the Soglom avlod uchun foundation, the Women's Committee, the Association of Business Women of Uzbekistan and others are all promoting public participation.

Non-governmental and non-commercial organizations (NGOs) play a special role in disseminating knowledge and involving the public. This helps ensure interaction amongst all stakeholders. All 49 NGOs and initiative groups which are concerned with environmental protection, have established the national program ECOFORUM. Of these 37 were ecological NGOs and the remaining 12 focused on water problems. The strategy of ECOFORUM activities covers the following directions:

- involvement of the public in the solution of water problems;
- public ecological expertise and monitoring;
- participation of NGOs in promoting the concept of sustainable development in society;
- conservation of biological and landscape diversity;
- ecological education and training;
- development of environmental journalism and information campaigns.

In June 2004, Goskompriroda and Ecroforum signed a Memorandum of Understanding and Cooperation[79, 89]. The first steps in implementing a number of ECOFORUM programs have already been taken. In particular, the following activities have been undertaken:

- implementation of small-scale projects in the Fergana valley, Samarkand, Surkhandarya and Tashkent, as well as a project for developing mechanisms for pollution control in the Amudarya, Syrdarya and Zarafshan river basins;

- involvement of environmental and water management organizations in the international conference "Public participation in the water deficiency overcoming in the Central Asia" (Tashkent, May, 2003);

- development of a national NGO and experts network and involvement of journalists from Uzbekistan in the Central Asian festival of environmental journalism, etc.

To raise awareness of environmental issues public organizations conduct TV and radio programs, round tables and discussions on water and other ecological problems with involvement of all stakeholders. The magazines "Water Resources" and "Ecological Bulletin" and others are published in the country. Environmental information is also presented on the websites of Goskompriroda, the "Atrof-Mukhit" program of UNDP, and various NGOs. Many newspapers and practically all magazines have played a role in various environmental campaigns and conferences.

International and regional organizations have helped facilitate capacity building of NGOs and public institutions. Various training programs, such as "Farmer to Farmer", "Farmer's Field Schools", etc. have been introduced within the framework of the technical assistance programs of international organizations such as FAO, GEF, ADB, WB, UNDP, and others.

International development agencies such as USAID, JICA, KOICA, and others provide support to development of WUAs and institutional reform in water and other sectors of the economy. Representatives of the NGOs and local communities are involved in seminars, conferences, and virtual discussions, regularly organized by the RIOD and CARNet network, CAWater-Info portal, SIC ICWC, UNDP, and others.

At the same time, analysis of NCSA (2006) and other program documents shows that the civil society capacity is underused, although it is crucial for the participation of local communities in water resources management. Participation of women in the activities of water management organizations is still very limited. Despite the fact that their participation has significantly increased, rural women still play little part in decision making on issues associated with water use and this remains a major obstacle to sustainable development.

Women's involvement in the water management process and their responsibilities to family members, society and the environment is an important catalyst for the improvement of sanitation and water supply at the local level.

3.4.2. Public Participation in Overcoming of Water Shortage

The need to take radical actions to solve water problems and mitigate water shortages is already widely recognized. The process of rethinking outmoded principles and outdated stereotypes in natural resources management has begun. This process is taking place against a background of dynamic sectoral reorganization and so it is very important to find the best solutions not only at the legislative level, but also through the development of joint efforts to achieve sustainable development and environmental safety.

Numerous assessments, conducted in various regions of the country, show that rural inhabitants (including women) have much higher social capital than city dwellers both in terms of their relationships with one another and their attitude and willingness to cooperate in order to maintain the water infrastructure in good working condition [67,93]. They already cooperate with management bodies at national and local levels in order to overcome the drawbacks of the water deliver system. In addition, they are ready to participate in this process through other types of activities: environmental protection, rational water use, change of water use volumes, water charging, and participation in the routine operation and maintenance of water delivery systems in the form of labor input.

Shortage of irrigation water, its irregularity and low quality forces all water users (especially households and farmers) to look for adequate solutions of their own (Figure 3.2). This includes searching for additional sources of water, using water saving measures and improving the irrigation and drainage network. All of these strategies require labour, energy, money, political influence and involve social and environmental risks.

During dry years water conflicts are not unusual. Conflict is not associated with particular ethnic groups but is the result of the water problem. One dekhkan from the Kasan rayon said: *"Conflicts over water have existed from the times of our ancestors".* Private farms located at the ends of irrigation canals strive to install water metering devices for control over the volume of water delivered. For farms located in the upper reaches (and/or upper sections of canals) installation of water meters is undesirable because it would allow them to fix excessive use of water so, as a rule, meters are not used on these farms. In most cases without alternative water sources, they aim to take water from the drainage collectors and/or from underground. This practice causes land salinization and degradation and associated yield losses as well as other economic and ecological damage.

It is noteworthy that recent water scarcity, along with insufficient state financing, has provoked a return to the traditions of an earlier time. When people have a very acute sense of the value of water, they are forced to think what they can do about it themselves without outside support. There are some other positive trends in the revival of public participation, especially at the level of local communities (Box 3.2).

The experience of centuries of water use may provide a simple but important lesson for today's inhabitants: "No matter to whom it formally belongs, whether it is ample or insufficient in any year, whether its supply to fields is paid fully by agricultural operators or by the state, water can only be used rationally and without conflict if collective decisions are taken at the level of ordinary users, as was done on this land from time immemorial."

Box 3.2

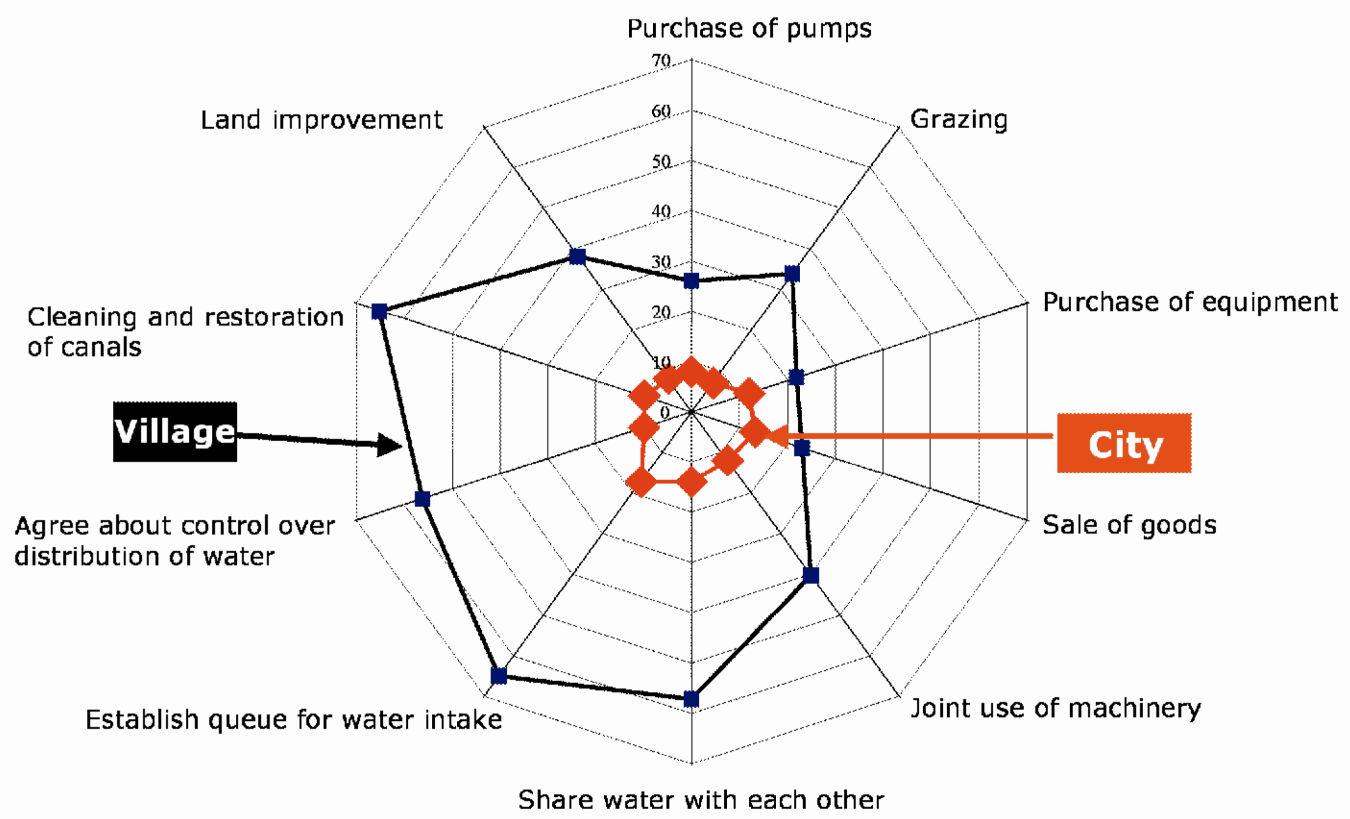
Strategies for Overcoming Water Use Issues: Farm Djeinau Case Study, Kaskadarya Oblast

The Historical Inquiry: The Djeinau settlement is 50 km west of Karshi city. The translation of "zhina" from Arabic literally means: "we arrived". This farm traces its roots back to the period of Arab migration to Central Asia (758-780). Since that period and up to the beginning of the last century the Arabs, Uzbeks, and the other inhabitants of the settlement were involved in livestock breeding and crop husbandry.

Since 1970, with the commissioning of the Mirishkor canal, the water supply situation in Djeinau was almost ideal: there was plenty of water, land was fruitful and yields were high. However, the Soviet slogan "golden hands create white gold (cotton)" and subsequent problems of the transition period led to land degradation and reduction of yields, incomes and livelihoods.

The Lessons Learned: The principles of water use, formed in this region, are the product of many centuries of cooperative living. Because the main task for people living here has always been how to survive in the conditions of water shortage, observance of the established rules was and remains obligatory for all people irrespectively of their origin: indigenous inhabitants or migrants, Uzbeks or Arabs. There are many bright examples of the informal cooperation in Djeinau: from cleaning of drainage ditches by the khashar (collective voluntary efforts of population) method and agreement between dekhkan about use of "avandos" to the joint "patrol" of canals and the public reprobation to those who steal water from their neighbors. (WB RKPSC Project, 2001)

Figure 3.2. **Rural and Urban Cooperation to Overcome Strategies of Water Shortage**



*** Area inside the lines shows cooperation with neighbors in each type of activities**

Source: WB (2001), RKPSC Project.

Chapter 4. TRANSBOUNDARY WATER RESOURCES MANAGEMENT PROBLEMS

4.1. Current Status and the Regional Management Structure

The existing water management complex (WMC) of the Amudarya and Syrdarya river basins to the great extent determines the conditions of economic development in the Central Asian region. The WMC is made up of natural and manmade structures providing water formation and conveyance, runoff transformation, intake and delivery of water to water uses, hydropower generation, and control and measurement of the quantity and quality of water resources. All the interstate (transboundary) water resources, including surface and return waters, are subject to management.

4.1.1. Development History

Issues of rational water resource use and management emerged as far back as in the 1970-80s (Box 4.1). Creation of the single Automated Management System (AMS) in the Amudarya and Syrdarya river basins has allowed certain functions of water management and distribution to be delegated to the Basin Water Management Organizations, BVO "Amudarya", BVO "Syrdarya", and BVO "Zerdolvodkhoz" (Zarafshan river basin). This brought certain benefits. Firstly, a proper system of measurement and control over the use of water resources was established. Secondly, the percentage of unaccounted for and lost water from rivers and interstate canals was reduced. The management system became more flexible, suited all the Parties, and helped ensure a certain level of mutual understanding and confidence amongst the region's countries. The share of water for each republic was determined in accordance with the quotas approved by Gosplan (State Planning Agency) of the USSR on the basis of general plans [84,85].

The two principles "to minimise *water deficiency* within the basin", and therefore, "minimise damage to the national economy from the shortages of water" were used as the basis for assessing the efficiency of water distribution [26,86]. Depending on hydrological forecasts, the BVO could decrease or increase water limits to each country by up to 10%. However, it was not responsible for water quality and water use in each country. In reality water discharge to the Aral Sea and its littoral zone was based on the principle "whatever remains".

Box 4.1

History of creation of the AMS for WMC in the Aral Sea Basin

The Ministry of Amelioration and Water Resources of the USSR initiated design studies for creation of a single AMS for the WMC in the Aral Sea Basin on the basis of the Decree of the Central Committee of the Communist Party of Soviet Union (CC CPSS)) and the Council of Ministries of the USSR of 17 March, 1986, No 430 *"On measures to speedup the economic and social development of the Karakalpak ASSR"* and others.

World experience of AMS establishment by the large WMC was used as the analogue for creation of the single AMS for WMC in the Aral Sea basin: (i) the centralized management of water supply system in California (USA) and water resources of the Sogami river (Japan); (ii) decentralized system of telecontrol in Provence (France); and (iii) the AMS of Saratov WMC (USSR), and the others.

The main objective of creation of the AMS for WMC of the Amudarya and Syrdarya river basins was the rational water delivery to all regions through the optimal distribution of water resources both in terms of volumes and time, taking into account requirements of all water users and consumers with observance of the ecological norms, for achievement of the maximum benefit for the national economy. The system would has ensured discharge of the sanitary water releases to the river deltas, without disruption of the leaching and vegetative irrigation water applications, as well disturbance of hydropower generation facilities. The main management criterion was the minimum deviation from the specified parameters (ToR for the "AMS of the Amudarya river basin", design institute Sredazgiprovodkhlopok, 1989, et alias).

4.1.2. Regional Management Structure

As was mentioned in Chapter 1, since gaining independence the Heads of five Central Asian countries have begun improving the regional structure for managing the interstate water resources in the Aral Sea basin

The first stage of coordinated action by the Central Asian countries was the establishment in 1992 in Almaty, of the Interstate Commission for Water Coordination (ICWC) with two its executive bodies the BVO "Amudarya" and the BVO "Syrdarya". The meeting of the Heads of five Central Asian countries in Kzyl-Orda (26 March, 1993), laid the foundation for the organizational and legal structure of management. The ICWC 'took over the baton' for water resource management in both basins directly from the former Ministry of Amelioration and Water resources of the USSR. The Charters of the BVOs were approved, and Provision on the ICWC and other fundamental documents were developed and approved.

At the Kzyl-Orda meeting decisions were taken on establishing, on the basis of parity, the Interstate Council for the Aral Sea (ICAS) with a permanent Executive Committee (EC). In addition the principle of of sharing water based on the "existing water use" as agreed under the Master Plans[1] was approved The Interstate Sustainable Development Commission (ISDC) and ICWC were also established under ICAS, and the "Provision on the International Fund for Saving the Aral Sea" was adopted. At the Tashkent forum (13 July, 1993), the Heads of five countries approved the provisions on the Interstate Council for the Aral Sea. This works under the EC and Interstate commissions (ICWC, and ISDC).

In January 1994, at the Nukus meeting of the Heads of the Central Asian countries, the World Bank's Aral Sea Basin Program (ASBP) was adopted. The first phase of the ASBP comprised a package of programs to protect the environment of the Aral Sea basin, including: (i) implementation of a regional system to monitor water resources and their use in the Aral Sea littoral zone; (ii) development of principles for water quality improvement and limitation of all types of pollution; (iii) implementation of the interstate programs "Clean Water" and "Health"; (iv) studies and implementation of measure to enhance environmental conditions in the upper watershed; (v) provision of technical facilities to the "Syrdarya" and "Amudarya" BVOs.

The second phase of the ASBP identifying the priorities for development of the region for the period up to 2010 was approved by the Heads of the states at the International Water Forum in Dushanbe in August, 2003. The main directions of the ASBP-2 activities are as follows:

- Development of coordinated mechanisms for integrated water resources management in the Aral Sea basin; rehabilitation of the water management structures and improvement of water and land resources use;
- Improvement of the environmental monitoring systems and implementation of a program for combating natural disasters and strengthening of the material, technical, and legal base of international organizations;
- Development of a series of projects aimed at solving the region's social problems and ensuring rational water consumption in different sectors of the economy in the Central Asian countries; realization of programs for environmental protection in the upper watersheds, sanitary and ecological enhancement of settlements and the natural ecosystems, etc;
- Development of the concept of sustainable development in the Aral Sea basin;
- Assistance to realization of the regional action program to combat desertification;
- Development of wetlands in the lower reaches of the Amudarya and Syrdarya rivers; and streamlining use of the mineralized collector and drainage waters.

As the part of the ASBP, the International Fund for Saving the Aral Sea (IFAS) was established as a high level organization with the task of coordinating ASBP implementation, attracting international attention to the environmental disaster caused by the recession of the Aral Sea, and mobilizing funds to help tackle the problems of the coastal lands identified as the disaster zone.

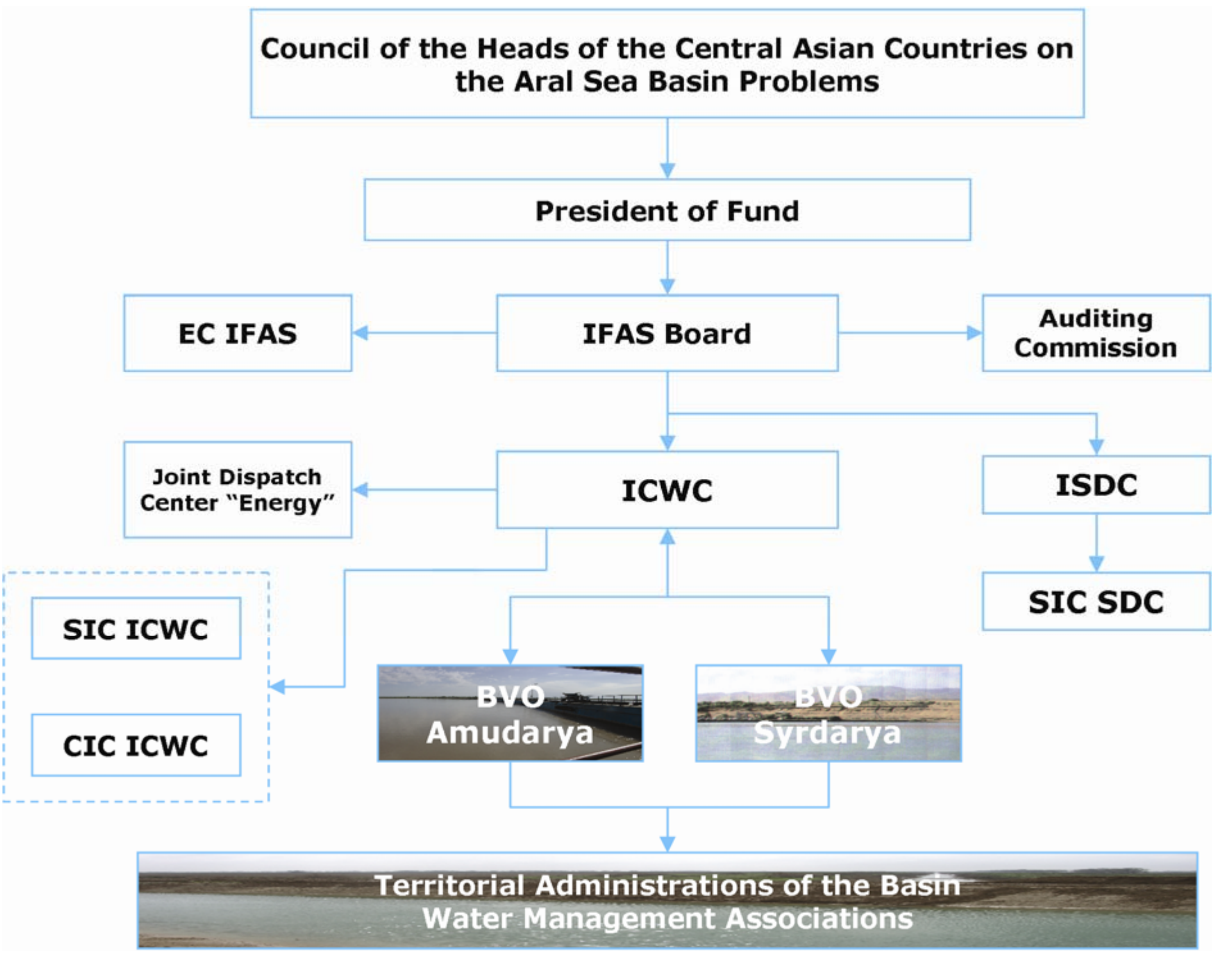
Although in the early stage of its existence the IFAS was a relatively dynamic organization (partly due to the direct support from the international community (EU-TACIS, UNDP, World Bank and the others), its activities at the regional level have significantly declined since the middle of 1999. This also coincided with a reduction in financial assistance from the international donor community. However, the Heads of the Central Asian countries some efforts to reorganize and revive the IFAS. A new IFAS and its Executive Committee (EC IFAS) have been established and the work of the ASBP is continuing. (Figure 4.1)

The new IFAS structure comprises the ICWC and ISDC and their subdivisions. According to this scheme the deputy prime ministers of the five countries are members of the IFAS Board. The Executive Committee of the IFAS (EC IFAS) is headed by the permanent chairman.

The ICWC is the collegiate management body, responsible for transboundary water resources management, water sharing, water monitoring and support to measures associated with water resources at interstate level. Its activities facilitate adoption of the decisions agreed by five countries and decrease the possibility of conflict. The ISDC coordinates the nature protection policy in line with for the goal of sustainable development and is responsible for the development and implementation of the national strategy and program of measures for achieving planned targets on sustainable use of natural resources and environment protection. The scientific and information centers provide data, analytical and metrological support to the relevant bodies, and facilitate capacity building, improvement of public awareness, and exchange of information amongst all the stakeholders, etc.

The establishment of the new structure of IFAS has been a positive move since its organizations are now legal entities with international status. This status also applies to the ICWC and its executive bodies, responsible for the basin's water resource management. These changes represent real progress towards strengthening and improvement of the managerial and legal basis of the ICWC and its organizations.

Figure 4.1. **Structure of the International Fund for Saving of the Aral Sea (IFAS)**



4.1.3. Current Status and Infrastructure of BVOs

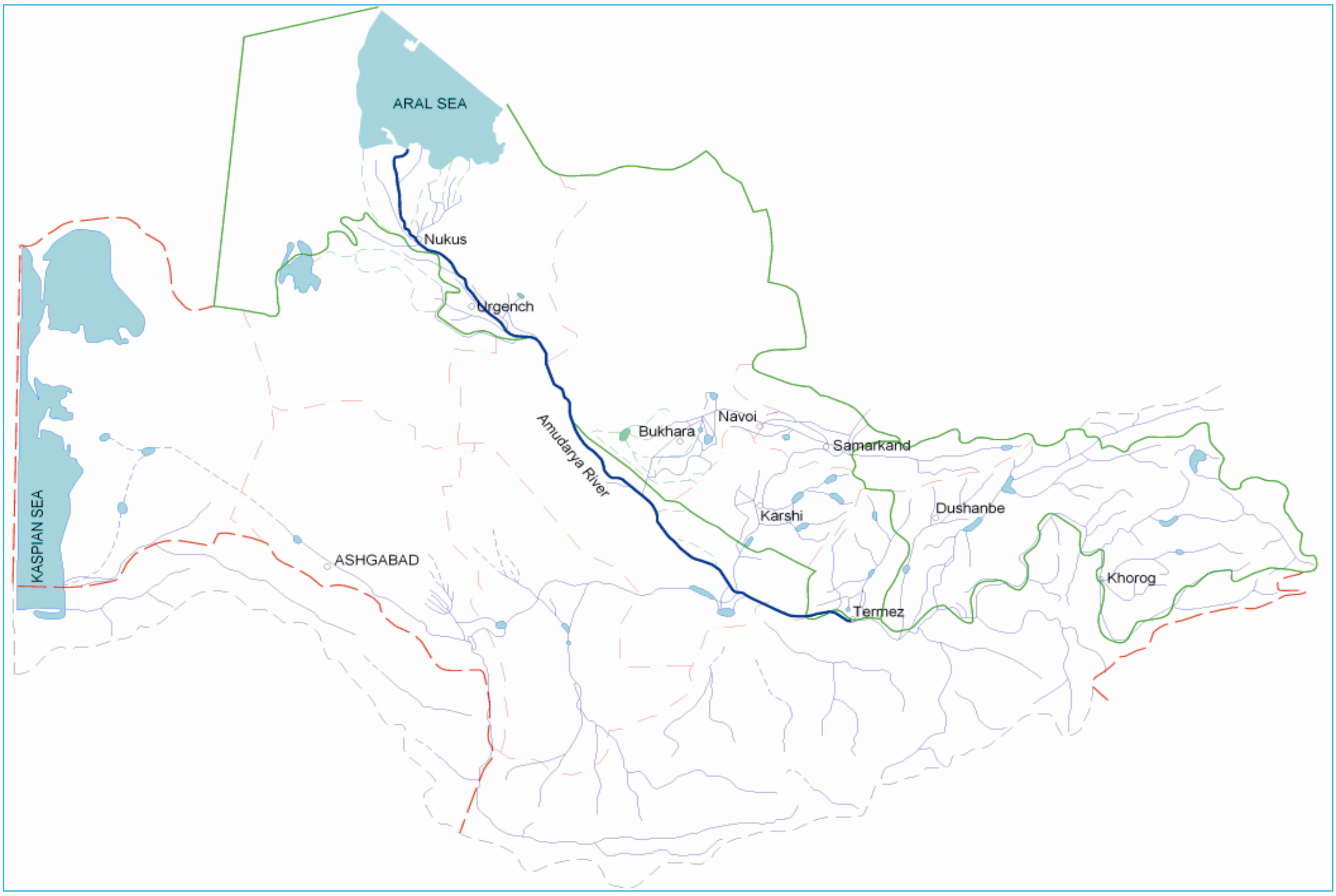
Rights of ownership and management of the Aral Sea basin's infrastructure are divided between the national Governments and BVOs. The main basin water management organizations are the BVO "Amudarya" and BVO "Syrdarya", which manage the interstate water sharing in the region under ICWC guidance. The regional infrastructure of BVOs was formed by the five republics through the temporary transfer of water structures, including the head river intakes, control structures, interstate canals, gage stations and other facilities. The remaining infrastructure, including the on-farm elements is attributed to the national infrastructure.

The BVOs have the relevant regional administrations for the operation and maintenance of intakes, control structures, and the interstate canals (Figures 4.2 and 4.3). They carry out their activities in accordance with the BVO charter, current legislation of the ICWC member countries and ICWC decisions, as well as agreements, protocols, and other normative acts.

The management of the WMC is very complex because different elements of the infrastructure are located over the whole area of the five Central Asian republics and far apart from each other (Annex 4).The specific features of WMC can be listed as follows:

- The large amount of information of different kinds showing the condition of the WMC;
- The large number and spatial dispersion of the management bodies and sources of information;
- The uncertain nature of the hydrological information;
- Inconsistency in the management modes of WMC participants;
- The lack of unified economic criteria for water resources use.

Figure 4.2. **Amudarya River Basin Scheme [96]**



In regulation and distribution of water resources amongst the republics the BVO Amudarya and BVO Syrdarya follow three main principles: (i) precise distribution of water resources in accordance with the established intake limits; (ii) maintenance of equity in all situations and strengthening of friendly relationships amongst all the participants and water users/consumers; (iii) recognition of water as the stabilizing factor in the region that brings together all the stakeholders and countries.

However, the effectiveness of the BVOs, as executive bodies dealing with interstate distribution of water, is restricted for the following reasons:

- Some intake structures of interstate importance, as well as the most important hydropower complexes with reservoirs are managed by national bodies;

- The BVOs do not control the volume and schedule of underground water extraction and discharge of return waters, or the quality of water resources;

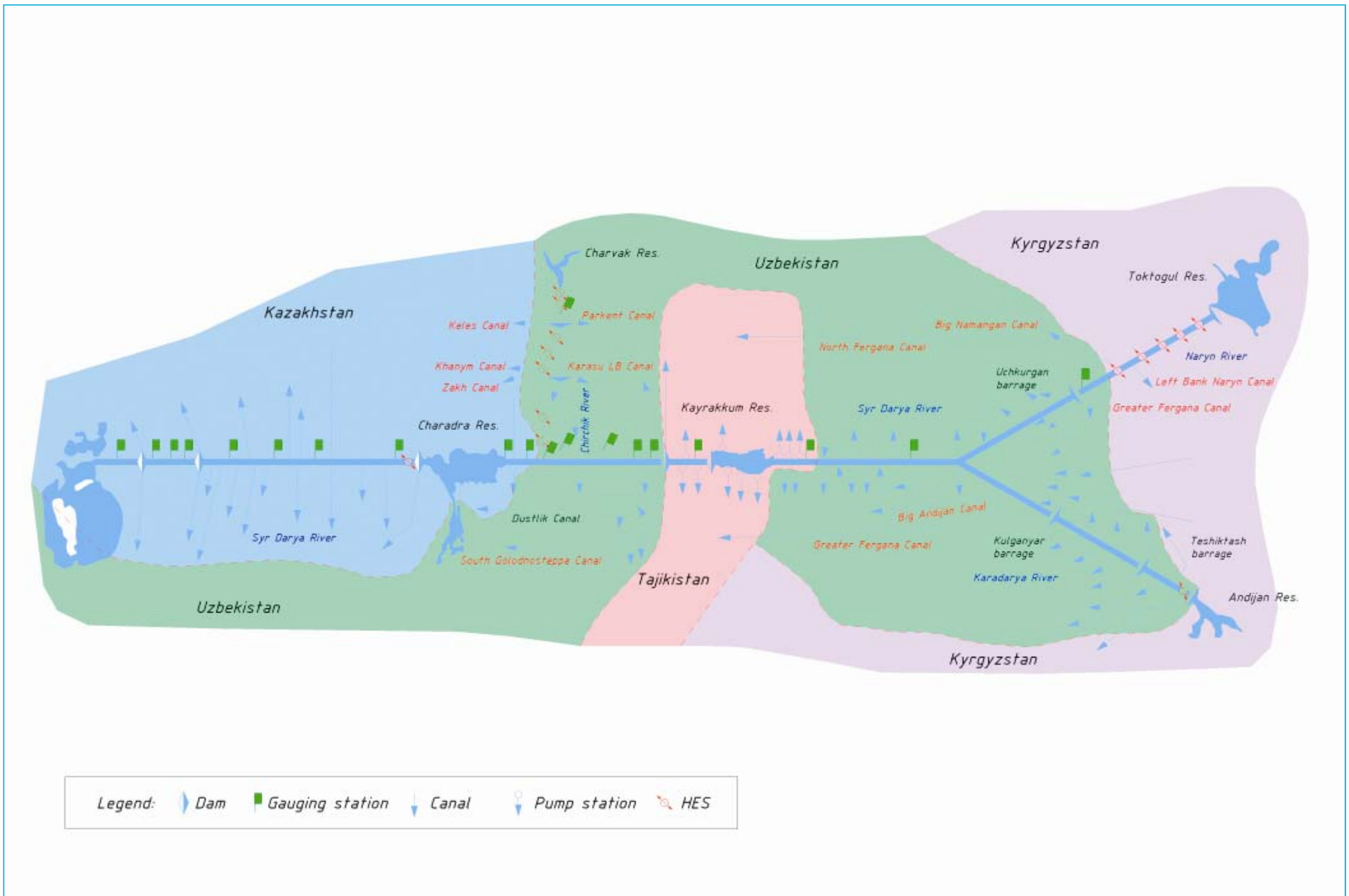
- The equipment and infrastructure of intakes and gage stations at the key points of rivers is in poor condition;

- The interaction between the BVOs and national hydro-meteorological services is inadequate;

- There is a lack of precise rules for the management and exploitation of river basins; protected zones on important interstate rivers importance have not yet been established, etc.

In the current conditions of limitations and change, the complexity of the WMC management requires the role, power and capacity of the BVOs to be strengthened. This would ensure the reliable exploitation and management of the WMC with the minimization of threats from floods, droughts, and other emergency situations.

Figure 4.3. **Syrdarya River Basin Scheme [72]**



4.1.4. Joint Activities to Stabilize the Situation in the Aral Sea Littoral Zone

The possibility for the coordinated management and use of water resources in the region, and the capacity of joint actions and initiatives for cooperation have been demonstrated by the measures adopted by the countries to restore the disturbed natural ecosystems of river deltas and the dried up bed of the Aral Sea.

All five Central Asian countries consider the Aral Sea littoral zone as an independent water user so its demand for water will be taken into account along with the demands from the countries. These water demands should be established on the basis of the intergovernmental concept for saving the Aral Sea littoral zone taking into account the annual variations in river runoff. At the same time, all countries admit the importance of coordinating demands in order to ensure both quality of water and conservation of the biodiversity and bioproductivity of the deltas.

All countries have recognized that restoring the Aral Sea up to the previous water level is unachievable in the foreseeable future (Box 4.2). According to estimates of the WB, and others, restoration of the sea within 25 years would require 75 billion m^3 of water annually (more than half of the total annual runoff of the Amudarya and Syrdarya rivers). This is unrealistic because it would require closure of the majority of irrigation systems in the Central Asian countries. For reduction of the catastrophic impacts of the falling water level in the Aral Sea the ASBP has recommended large scale but achievable interventions.

The IFAS and the region's countries are trying to improve the socio-economic situation in the littoral areas particularly health care and drinking water supply in the vicinity of Muinak and Aralsk cities. Part of this work has been supported by various donor organizations, notably the World Bank, but the major part was financed by the CA countries themselves. With GEF support, the Government of Uzbekistan has completed a project to restore the wetlands around lake Sudoche (see Chapter 5). In addition, the Government provides funding for the design and construction of water structures which create local ponds and regulate the water use system in the Amudarya river delta. Pilot activities, such as those of the GTZ agency aimed at creating forest shelter belts on the dry sea bottom, are also making a significant contribution.

Box 4.2

The Intergovernmental Concept for Saving the Aral Sea Littoral Zone

In the Intergovernmental Concept, adopted by the Heads of the Central Asian countries in 1994, it was admitted that in the current conditions it is impossible to restore the Aral Sea itself, and therefore, the task is not to restore the Aral Sea, but to save its littoral zone. Chapter IV of the Concept emphasizes: *"…to create the active zonal controllable ecosystem that ensure stability of restoration of the disturbed natural development in the Aral Sea littoral zone".* Activities aimed at creating artificial ecosystems in the deltas and on the dried bottom of the sea are of high priority from the viewpoint of nature protection and should include:

- Creation of a controllable pond system on the dried bottom of the Amudarya river and control over part of the Small sea for the Syrdarya river;
- Creation of a polder system on the dried sea bottom;
- Carrying out phyto - ameliorative works to fix the drifting sands;
- Discharge of the collector and drainage waters into the sea aquatorium through the scattered zones in sands.

In addition, the remaining water areas of the Aral Sea with increased salt concentration should be identified their salt and water balance and levels should be forecast. Measures to prevent the pollution of coastal areas should also be taken.

There is no doubt that all these contributions are insufficient to repair the damage caused by the Aral Sea disaster. According to some Muinak[13] inhabitants "…the *volume of water coming to us from the Amudarya river is in any case insufficient to restore the fishery".* Despite this, Uzbekistan and Kazakhstan, as the directly interested countries, are trying to identify their priorities and abilities to carry out protection work in the future.

The demand for water from the Aral Sea littoral zone is estimated at 8 km^3/year and 5 km^3/year for the Amudarya and Syrdarya river basins respectively. In the more distant future (by 2025) this inflow to the two basins should be increased as a minimum up to 11 km^3/year (Amudarya) and 8 km^3/year (Syrdarya).

To ensure the environmental sustainability of the aquatic ecosystems in the Aral Sea littoral zone, BVO "Amudarya" specialists recommend that the

[13]CAWater – Info based on materials from the CentrAsia.org, 20.07.2006.

intergovernmental agreements should specify optimal water sharing and the regime for its release to the river deltas in years with various water availability. This would guarantee water for conservation of fish and other species of flora and fauna in drought years [96]. To develop strategically important decisions about the future of the Aral Sea and its littoral zone, it is recommended that:

- A master plan and a feasibility study should be developed for the improvement of water-supply in the southern part of the Aral Sea littoral zone with an area of more than 2 million ha. The aim of this would be the restoration of the species diversity and ecological sustainability of the natural ecosystems in the Amudarya river delta.
- Studies of the future of the Aral Sea itself should be conducted, including the possibility of retaining one of its parts (in particular, the western deep-water section) as a biologically active environment. At the same time, the future of the remaining parts of the sea should be determined in order to prevent further threats and especially dangerous phenomena.

These multi-purpose measures would restore the Amudarya river delta as a delta complex of interstate importance. This complex will be also be of great environmental and socio-economic importance for the whole Aral Sea basin. In order to increase the efficiency and reliability of this complex operation a strong institutional and normative/legal basis must be created.

4.2. Main Transboundary Water Management Issues

The previous chapters stressed that Uzbekistan, as well as the other countries of the middle and lower river reaches, face not only ecological and socio-economic problems associated with impacts of the Aral Sea disaster, but also environmental degradation and severe water shortages. The total water demand of Uzbekistan is almost entirely met (82%) by the transboundary water resources of the Amudarya and Syrdarya rivers. For the population of the Fergana valley, and the middle and lower reaches of the Amudarya and Syrdarya rivers there are no alternative sources of supply. The underground water is insufficient both in quantity and quality to meet the demands of a population of 26 million (Chapter 2). Water deficiency is the main factor limiting the development of the country's economy, especially in the lower reaches of the Amudarya river.

4.2.1 Water Agreements and Joint Resources Use Issues

The current legal basis for the joint management and distribution of water in the Aral Sea basin is the intergovernmental Agreement "On cooperation in the area of joint management, use and protection of water resources of the international sources", signed by the Heads of five Central Asian countries in February 1992. In addition, over the last ten years the five countries have adopted a number of bilateral and multilateral agreements and acts on the basis of previously approved water sharing schemes and the 1992 Agreement (Annex 1). At the same time, the main principle of International Water Law, the *"obligation not to cause significant damage"* is still not observed by the countries, especially by those located in the upper watersheds. There is still no agreement between the countries on essential terminology and no shared understanding of the term 'transboundary water resources'.

Analysis of application of the water agreements shows that they have been very ineffective in solving the existing ecological, economic and social problems. The "Parties" to the current agreements do not always precisely comply with the adopted commitments due to the weakness of mechanisms for their execution. In some cases, since they are not practical, monitoring of their implementation is not carried out. The mechanisms for resolving disputes and ensuring that agreements are observed are missing.

It is worth mentioning that the problems in implementing the bilateral annual agreements and in solving the energy issues can be explained by the substantial differences in the economic structure of countries, as well as by the constraints and barriers typical of the transitional period. Market economy conditions exist, but not yet in all countries and all sectors. The recent changes (introduction of visas, creation of borders, strengthening of customs requirements, introduction of duties, etc.) also put constraints on joint activities to strengthen water relationships.

Naryn - Syrdarya Cascade of Reservoirs

The most serious disagreements have arisen in the Syrdarya river basin due to changes in the operational rules of the Naryn-Syrdarya cascade of reservoirs, which had a negative impact on its operation as a single water management complex as well as on the established water balance of the river.

The operational mode of the Toktogul reservoir in the Kyrgyz Republic is no longer coordinated with the operational modes of the other water management facilities of Tajikistan, Uzbekistan, and Kazakhstan, located in the middle and lower reaches of the Syrdarya river. The data in Table 4.1 confirms that the Toktogul reservoir with a total capacity of 19.5 km^3 now operates mainly to generate cheap electric energy both for internal needs and export. Consequently increased water releases from the reservoir are observed every year during the winter.

Table 4.1. **Trends in Changes of the Toktogul Reservoir Operation Mode, km^3**

	Inflow	Losses	Releases		Total	Annual Average Balance of Reservoir
			Non-Veget. Period	Vegetation Period		
Designed (1970)	11.83	0.30	2.80	8.50	11.30	0.20
Annual Average for 1975-1991 (16 years)	11.30	0.30	2.70	8.10	10.80	+ 0.20
Annual Average for 1991-2001 (10 years)	13.00	0.30	7.20	6.10	13.30	- 0.60
2000-2001	12.80	0.30	8.40	5.90	14.30	- 1.80

Source: BVO-Syrdarya, 2002

Changes in the operational mode of the Toktogul reservoir have led to a decrease in the guaranteed water supply in the Syrdarya river basin during the vegetation period of 4.5-5.0 km^3 per year. Within-year water deficiency in the Fergana valley in years with average water availability varies from 57-61% (June-August) to 85% in September causing serious losses and threats for the population and habitat (Chapter 2). Similar deterioration in the water management, socio-economic and ecological situation is taking place in the middle and lower reaches of the Syrdarya river (Box 2.2). Since 1992, around 27 km^3 (by 3 км^3/year on average) of water has had to be discharged into the Arnasai depression during the winter time due to the limited discharge capacity of the Syrdarya river bed downstream from the Chardara reservoir. The water discharged into the Arnasai depression is not only lost for further use, but also causes damage to the infrastructure, water logging of agricultural lands and settlements and other threats. The annual damage from this phenomenon to Uzbekistan alone is estimated at $700 million [55].

In the current economic conditions in Central Asia the Framework Agreement of 1998, on management of the Naryn-Syrdarya cascade of reservoirs is the best that might be expected. The countries agreed that electric energy generated in the cascade should be the basis for payment for services provided by the upstream countries. At the same time, this has led to the situation that already in April of 2002, the volume of water in Toktogul reservoir dropped down to a new critical level of 7.5 km^3. Moreover, the period 1989-1999, was characterized by increased water availability in the Amudarya river basin (114% of the norm). Selection of 1989, as the benchmark was not random. The initial filling of the Toktogul reservoir to the Normal Water Level (NWL) started in 1974 and was accomplished by August 1988, but in the other five regulating reservoirs in the Syrdarya river basin the designed storage capacity had still not been achieved by 1989.

The countries of the middle and lower river reaches have the historic right to use water from transboundary rivers. Construction of the Toktogul reservoir did not change this situation, but ensured that the guaranteed water supply could also be used to generate hydroelectric power. Having been faced with the necessity for more rational water use and adaptation to the changed operational mode of the Toktogul reservoir, the countries of the middle and lower river reaches now direct their efforts towards ensuring a guaranteed water supply and a decrease in water consumption. Uzbekistan has changed the cropping pattern with a significant reduction in the rice growing area. Measures aimed specifically at reducing specific water consumption in irrigated agriculture are also being undertaken.

The GEF WEMP assessment (2002) shows that the Kyrgyz Republic is increasingly considering water as an economic commodity with a value and therefore one which may be marketed[14]. It also considers that the downstream countries use "its water" for their own benefit. However, the natural hydrological cycle, rights of water users, and the fact that maximum profits Kyrgystan makes from electric power, generated by the Toktogul reservoir come at the cost of losses incurred by the countries of the middle and lower river riches, throw doubt on the validity of considering water as an economic commodity.

According to the recommendation of the GEF/WB WEMP (2002), the countries concerned should fix the operational mode of the Toktogul reservoir for a five year period in order to guarantee that annual releases would not exceed the annual inflow. This would allow reservoir volume to be maintained for long-term river flow regulation. The most beneficial option for the countries of the middle and lower river riches is summer water releases from the Toktogul reservoir of between 6.5 and 6.0 км^3, which would only be possible if winter releases were significantly reduced It is important that an agreement is reached on a level of supply which, although lower, will at least be guaranteed.

The Amudarya River Basin

At present the Amudarya river runoff is not highly regulated which leads to a delicate water balance and makes it difficult to use this source of water for economic purposes. Seasonal regulation of the Amudarya river runoff is provided by the Nurek and Tuyamuyun reservoirs. Currently Tajikistan is completing construction of the Sangtuda I and II hydropower dams (with a total designed capacity of 890 MW), and the Rogun I and II dams (with a designed capacity of 3,600 MW).

For Uzbekistan the water situation in the Amudarya river basin is less delicate because the bilateral agreement about joint and rational use of the Amudarya river water resources, signed by the Presidents of Uzbekistan and Turkmenistan in Chardjev (16 January, 1996), is being observed by both parties. Article 6 of this agreement specifies that the Parties have established equal sharing of water from the Amudarya river at the Atamyrat (Kerki) site. Before 1996, water sharing was carried out according to the same principle relying on the Intergovernmental agreement of 21 April, 1991.

At the same time, there are significant difficulties associated with ensuring a guaranteed water supply and the deteriorating water quality in the Amudarya river. As was mentioned in Chapter 2, water delivery to the Karshi steppe and Bukhara oasis, located on the right bank of the Amudarya river, is curried out by the Karshi and Amu-Bukhara pumping station cascades. The head intakes of these cascades are located in Turkmenistan. Deterioration of the equipment in these stations cut down the withdrawal of water from the Amudarya river by 2 km^3. Suspension of the "Rehabilitation of the Karshi Pumping Stations Cascade" project, financed by the World Bank and other donors, due to intergovernmental disagreements, is disrupting the water supply to more than 1.5 million people, whose livelihoods depend directly on this water source.

The problems associated with the deterioration of water quality along the entire Amudarya river course downstream from Termez are of special concern to the government and public. Water consumers in the middle (Bukhara) and lower reaches of the Amudarya river, who receive water with mineralization of 1.5-1.8 g/l and hardness of more than 2 MAC (Chapter 2) that is unsuitable for municipal and agricultural needs, are the most vulnerable. The population of Khorezm and the Republic of Karakalpakstan has almost no access to the good quality drinking water that meets the State Standard (GOST).

[14]Letter of the National Coordinator of the Kyrgyz Republic, Mr. B. Mambetov (26.10.2004, No 22-2229) to the OCAC about establishment of the system of interrelationships in use of water and energy resources on the partly market conditions.

Since adopting of the above mentioned bilateral agreement of 16 April, 1996, Uzbekistan has made the significant efforts to improve river flow quality through reduction of collector and drainage water (CDW) discharges from the right bank of the Amudarya river. The first stage in a general program of interventions is the recently commenced "Drainage, Irrigation and Wetlands Improvement Project" in Southern Karakalpakstan, funded by a WB credit/loan (see Chapter 2). On the left bank of the Amudarya river middle reaches, Turkmenistan is also carrying out large scale interventions to divert collector waters. Completion of these projects is planned for 2012. However, this complex of measures can not completely eliminate the growing pollution of the Amudarya river flow, and aggravation of the socio-economic and ecological situation. Until measures are taken to prevent, and reduce pollution of water sources and precise mechanisms are established to regulate the quality of water for drinking, irrigation and ecological needs, the current problems of river flow contamination and conflicts between the upper and lower river reaches will go on, threatening people's security and the integrity of ecosystems,

As was mentioned in Chapter 2, all water users and the natural ecosystems of river basins suffered from an unprecedented shortage of water in 2000-2001. The water users of the lower reaches of the Amudarya river (Khorezm and the Republic of Karakalpakstan), and the Dashkhovuz veloyat of Turkmenistan were most badly effected. The northern zone of Karakalpakstan experienced the most severe impacts, where apart from large agricultural losses huge environmental damage was caused to the Amudarya river delta and the Aral Sea littoral zone. Over the years of water shortage practically all water bodies including natural lakes dried up, most of the fish population perished, and flora and fauna was almost at the point of vanishing. In fact, the entire Aral Sea littoral zone was facing a new disaster.

All the above mentioned problems caused by water shortages entail serious threats and expense (Chapter 1). The expected revival of agricultural production in Northern Afghanistan and the respective growth of water consumption in this region may lead to a reduction in the already scarce supply of fresh water in the Amudarya river basin. There are several "hot spots" in water resources management which could cause catastrophes of regional importance. In particular, the breakthrough of the natural dam of Sarez lake in Tajikistan may lead to destructive floods endangering the lives of millions of people throughout the Amudarya river basin.

Therefore, without compromise and mutually beneficial cooperation in the area of joint use of water and energy resources, the socio-economic and environmental situation in the Central Asian republics will deteriorate further bringing new threats to the life and health of the population, and the viability of the natural ecosystems.

The Additional Reservoirs and Compensations

Even with the Toktogul reservoir operating in a mutually agreed and stable mode for instance, 5.5 km^3 and 6 km^3 of water releases in winter and summer respectively) about 2 – 3km^3 should be released through the Chardara dam without being used for economic purposes. At the same time, the Kyrgyz Republic uses water resources for generating cheap electric energy, 80% of which is being sold in the internal market. However, over recent years the Kyrgyz Republic, as well as Tajikistan and Kazakhstan have directed their efforts at expanding the foreign energy market (Box 4.6).

Since construction of additional dams on the main course of the Naryn and Syrdarya river middle reaches is impossible, Uzbekistan is creating an additional reservoir in the Fergana valley (Box 2.1), and is also considering options for more rational use of water in the Chirchik and Akhangaran rivers. Such an increase in the regulation of the Syrdarya river tributaries may be more effective if the operational regime of the Toktogul reservoir, which has changed over the last decade, will be compensated. To some extent, a change in the operational rules of the Kairakkum and Chardara reservoirs may help to overcome this problem, but this issue requires study. Implementation of such projects includes part of the costs associated with the change in the operational mode of the Toktogul reservoir, and this should be accepted by all countries [62].

The Republic of Kazakhstan is also carrying out studies on the use of the Koksarai depressions downstream from the Chardara reservoir for retention of the excessive winter flow that can be used for irrigation and ecological purposes. There will be no need for such a reservoir if the operation of the Naryn-Syrdarya system can be stabilised. Apart from this, this reservoir would bring additional losses due to evaporation (0.4 km^3). At the same time, the various options for creating additional reservoirs would not ease the problem in the short-term. It is extremely important that the regional institutions strengthen coordination of direct negotiations and multilateral consultations with all key Parties, with involvement of the regional and international communities in order to achieve a joint agreement on the sustainable use of the Toktogul reservoir.

According to the WEMP assessment (2002), the next ten years will see a transition from compensation for electrical energy to its free marketing with monetary clearing-off. It is expected that establishment of corporations in the energy sector of all countries will accelerate. During this transition period various energy companies will remain under governmental control, and stakeholders from the irrigation sector will be able to make agreements with these companies for the purchase of energy from Kyrgyzstan during the summer.

In the future, when free market principles and mechanisms will dominate, water and energy resulting from the use of hydropower resources, will presumably, be more and more separated both in the energy and agriculture sectors. Export/import of electrical energy will be separated from water delivery services. Energy companies will search for ways to maximize the level of services to their customers and, at the same time, to maximize their profits. In the agricultural sector this will strengthen the water user associations, which will further improve methods of water use , for instance, through the introduction of charges for water delivery services.

4.2.2. Monitoring and Water Use Control Issues

Observation and Monitoring of Water Resources

According to assessments by GEF (2001), et alias, a serious deterioration of the water resources observation and monitoring system is evident in all the Central Asian countries (Box 4.3) [55,92]. Due to deterioration of the technical equipment, instruments, and other elements of the infrastructure there has been a steady reduction in the hydrological and meteorological stations network and the volume of observations... The situation with snow cover observations in the mountains has worsened. Only some of the gage stations on lakes and reservoirs., which are not always representational, have remain in operation The Kairakkum observatory in Tajikistan has ceased its activities as a scientific and methodological center. Its role has been reduced to that of a standard lake station.

Box 4.3

Observation Network in the Aral Sea Basin

Before 1991, 400 meteorological stations, 475 hydrological posts and a large number of aerological, actinometric and agro-meteorological stations simultaneously operated within the Aral Sea basin. Observations on snow cover and accumulation in the mountains were carried out at 239 ground snow-depth gages and 988 gages of airborne observations, 6 water balance stations for observations on evaporation from open water surfaces. There were 11 points of observations on the Aral Sea regime, 49 posts and 6 stations for observations on lakes, and around 70 water gage stations on reservoirs. A wide spectrum of studies on reservoir banks transformation, sediment transfer, thermal and ice regimes, etc. was carried out (Uzhydromet, 2001).

As a result, large areas (some river basins or groups of basins, slopes of mountain ridges, and high elevation zones) have remained insufficiently covered by hydrological, meteorological and snow cover observations. A particularly bad situation regarding observations has developed on small rivers 10-25 km long. Serious gaps in the observation series and lack of data (as a result of reconstruction and/or replacement of stations) are hampering studies and evaluation of long-term river flow dynamics and forecasting. Along with this reduction in the water bodies monitoring network, snow cover surveys in mountains and observations with total precipitation gauges have been almost abandoned. This means that ambiguity in the hydrological calculations and forecasts remains a significant problem despite the introduction of computer technology, and access to remote sensing data, etc.

Water Use Control and Decision Support Systems

One of the main problems in water resources management is the poor equipping of the BVOs infrastructure with modern equipment and metering devices for measurement and calculation of water resources. The low level of automation and dispatching of the control structures and objects limits the information communication system, data processing and storage, and accuracy of river flow control along its course. The other limiting factor is the lack of accounting of the available underground and return water, and poor control and monitoring of river beds. There is still a lack of knowledge and experience, and well trained staff at all levels of management, which restrains introduction of the new technologies and management tools. All these gaps impede accuracy of water accounting, distribution, and operational decision making, especially in emergency situations.

Development of information systems in the Aral Sea basin (WARMIS, WUFMAS) began in 1996, within the framework of the ASBP with technical assistance from EC-Tacis. Development of models and DSS was conducted later on with support from USAID, GEF/WB, and others. As a result a flexible set of interrelated simulation and optimization models was created (Box 4. 4).

Introduction of decision support systems, such as ASBOM, into management practice is held back by technical, economic, and institutional limitations. Measures to overcome these barriers should focus mainly on strengthening the coordination, relationships, and cooperation amongst the regional management structures and responsible monitoring services, as well as creating favorable conditions for their integration into regional and global networks.

There is a need for international technical assistance and investment in modernizing the worn-out equipment, and automating and dispatching the BVOs infrastructure (head intakes, dispatch centers, and river gauge stations, etc.) with the introduction of SCADA systems. Capacity building and awareness improvement through the establishment of training centers, extension services, and distribution of decision support tools is also necessary.

Special attention should be given to the development of a joint action plan for optimizing the observation network and improving the forecasts and flow calculations provided by the BVOs gauge stations. There is also a need for “on-line” communication of information, creation of an early warning system for drought, protection from floods and pollution, and the introduction of a state of emergency in extreme situations. All countries should also to work on expanding the single information system and GIS/RS database, improving the system of indicators and regulating the disposal of pollutants into water courses, etc. Implementation of these measures would ensure operativeness, continuity and reliability of monitoring, and would allow precise control over the volume and quality of water at all levels of management.

Experience of the developed countries shows that ensuring free exchange of and access to information is the main precondition for the development of cooperation based on the principle of hydro-solidarity and mutual confidence, and taking into account the interests and needs of all countries and the region as a whole.

Box 4.4

Decision Support System of GEF/WB WEMP, 2002

The ASBOM optimization model of the GEF project combines technical, economic, ecological and agricultural aspects into a single logically coherent system. ASBOM is a useful tool for assessment of the benefits from various compromise situations, which may include electric power and/or water cross-flow between the countries or compensatory payments, as well as formulation of the general system for direct negotiation between countries and river reaches for water/energy issues.

The management model for the Aral Sea basin (ASB-MM) comprises the hydrological and socio-economic modules and includes two versions: ASB-MM – for increasing public understanding of the problems and threats faced by the region ; and ASB-MM-expert - for increasing understanding among politicians of various strategies and their impact. The model takes into account various patterns population growth, reforms in the economy and climate change. The Model of the Aral Sea basin salinization was developed for prediction of ground, underground, and drainage water mineralization. This model allows selecting and decision making under various hydro-geological conditions and alternative water management scenarios.

4.3. Regional Cooperation Issues and Perspectives

4.3.1. Regional Cooperation Issues

Despite the various views and opinions of the Parties, cooperation in transboundary water resource management in Central Asia has made significant steps forward over the last ten years [99]. A certain consensus on the principle of reasonable and equitable sharing of water in accordance with the adopted regional agreements has already been achieved. However, there is still a lack of coordination and inconsistency in water use priorities that lead to losses of the limited water resources, aggravation of tension and threat of conflict. Difficulties in coordinating interventions in the water and energy sectors significantly restrain the implementation of measures aimed at protecting transboundary water courses and implementing the national programs and plans for saving water and other resources. More efficient and rational water use at the national level would ensure reduction of tension and achievement of stability in the region. According to UNDP assessments (2005) it is impossible to determine the total cost of the lack of cooperation, but when it does exist the annual benefits are estimated at 5% of GDP on average. The corresponding figure for the upstream countries is twice as high.

Reaching mutually beneficial decisions and achieving compromise on the issues associated with water and energy resources use is difficult due to insufficient coordination of joint actions and lack of proper management mechanisms at the regional level. According to recent external assessments water resources management still suffers from control "from the top", inherited from Soviet times [70]. The ICWC did not take into account the changing political and economic relationships. Today the ICWC is a relatively closed intergovernmental body dealing almost exclusively with water sharing, and it x does not interact enough with the ISDC. There are no representatives of water users/consumers from agriculture, industry, the energy sector, or NGOs in this body. The Joint Dispatch Center "Energy" have no power or ability to ensure precise observance of intergovernmental agreements. There are almost no consultations on the majority of projects dealing with the expansion of irrigated areas or the construction of reservoirs and artificial lakes in the countries. This increases mutual suspicion.

Analysis of numerous discussions shows that the adoption and/or update of the bilateral and multilateral agreements listed below may stimulate constructive dialog and cooperation between the Parties [82]:

- *"On the joint use of water and energy resources of the Aral Sea basin's rivers and the mechanism for realization of the mutual supply of water and hydropower resources and energy carriers." It is proposed to prolong the current agreement of 17.03.1998, with relevant amendments on the mechanisms of realization, or to adopt a new one, taking into account regional and world experience;*

- *"On the legal status and operational regime of the interstate water and energy resources management body, executive organizations of the international bodies and their managing staff";*

- *"On the legal status of water management and energy objects of interstate importance, and also the Aral Sea and its littoral zone";*

- *"On the procedure and scope of observations on hydrological and hydrochemical indices of the transboundary water courses and on conveyance of the agreed flow volumes at the gauge stations on national boundaries";*

- *"On information exchange about the quantitative and qualitative conditions of the transboundary water resources, as well as operational regimes and conditions of water management and hydropower facilities";*

- *"On financing interstate organizations, joint activities on operation and maintenance of the interstate water management and hydropower facilities, interstate research, design and scientific work, as well as work on environment protection, etc ".*

However, in order to fully implement these agreements the countries involved must have confidence in each other and be prepared to compromise both in the area of their own interests and in the regulation of water relations and compliance with the social and environmental needs of the region. Regional legislation and the legal system should become for the key to the resolution of conflicts between the upper water shed and dissemination zones, and between all water users and the environment. Creation of a strong regional legal basis is a laborious process requiring the involvement of highly qualified specialists, national experts, the general public and politicians.

To consolidate the efforts to achieve understanding amongst the countries, the responsibilities, authority and capacity of the regional management structures need to be strengthened. The regional institutions should fulfill their obligations and commitments to the participating countries and be responsible to the regional community. They should be able to coordinate joint activities on developing regional solutions and reaching agreements between the countries on the basis of equality and mutuality. They should also monitor the execution of these agreements, and implement the relevant legal, economic and financial measures aimed at ensuring e equitable water sharing and protection of transboundary waters.

The numerous contradictions at regional and national levels should be solved through the use of the legal mechanisms of joint water resources management. Currently all countries of the Aral Sea basin urgently need assistance and support from intergovernmental and international organizations tor harmonize their national water law with international legal norms. This process should be based on the experience and achievements of developed countries in integrated water and energy resources management.

The Central Asian countries place great hopes in the establishment of the International Water and Energy Consortium (Box 4.5).

Consortium will operate in accordance with the framework agreement. Within the scope of this agreement second level agreements on water use, operation of reservoirs, the system for electric power transmission and marketing, and mechanisms for their execution will be developed[15].

Until adoption of the agreed concept for the Consortium within the framework of the organization for Central Asian Cooperation (CAC), countries should continue to be guided by the Framework agreement of 17 March, 1998, and the annual intergovernmental agreements on use of water and energy resources of the Toktogul hydropower complex.

The Special UN Program for Central Asia (SPECA) presents a great opportunity for strategic planning and development of regional cooperation. One important SPECA output is the development of a Cooperation Strategy on rational and effective use of water and energy resources in Central Asia. This has already been approved at different levels by the Governments of Kyrgyzstan, Kazakhstan, Tajikistan and Uzbekistan. This Strategy is a political platform for effective cooperation between the countries of Central Asia, and includes several guiding principles for such activity [104]. Now all stakeholders are considering how to ensure connectivity between this strategy and the national policies and action plans.

Box 4.5

Draft Concept for Establishment of the International Water and Energy Consortium

The Consortium envisages: (i) coordination of the current activities of its Entities within the power provided to the members of the Consortium, including preparation of international agreements and coordination of feasibility studies of regional projects funded from internal and external sources; (ii) ensuring harmonization of the relevant legislation and improvement of the international legal basis of the participating countries; (iii) ensuring interaction with international organizations and other concerned structures; (iv) development of measures for prevention of damage to the participating countries as a result of the activities of the Consortium entities; and (v) monitoring of practical implementation of the international agreements in the area of rational and efficient use of water, energy, and fuel resources by the Parties. The Consortium will also be responsible for other tasks, specified by the international agreements.

[15]Meeting of the intersectoral working group heads of the member states of the organization for "Central Asian Cooperation" with the representatives of the International Bank for Reconstruction and Development on the concept for establishment of the International Water and Energy Consortium, (Almaty, 30 July, 2004), Protocol of the Meeting.

4.3.2. Electrical Energy Export Perspectives

According to WB assessments (2004), the annual surplus of electrical energy in Central Asia in 2015, will be an estimated 43,663 GWh, with around 65% of this occuring during the summer. Kyrgyzstan and Tajikistan have the greatest potential for the export of electrical energy to neighboring countries. The bilateral agreements between the Kyrgyz Republic and the Republic of Tajikistan on the transmission of electric power through the Batken – Kanibodom line, and also between the Kyrgyz Republic and the Republic of Kazakhstan on the export of electrical energy from Kyrgyzstan to Russia have already been signed. Access to new markets in Pakistan and Iran is also beneficial for Kyrgyzstan and Tajikistan. Electrical energy demand from China comes mainly from its distant eastern regions and would require significant investment in power transmission lines (Box 4.6).

Kyrgyzstan, with help from Kazakhstan, is planning to construct an energy corridor that will link both countries with Russia and Pakistan. Kazakhstan is showing great interest in the energy sector of Kyrgyzstan, including the construction of the Kambarata hydropower stations and development of the hydropower capacity of the upper and middle reaches of the Naryn river. Nuclear power stations are planned in Kazakhstan, but Kyrgyzstan proposes to solve the problem of electrical energy supply by cheaper means. Energy transmission to Iran will be via Afghanistan, Turkmenistan, and Uzbekistan after the relevant agreements are concluded

The first phase of electrical energy marketing, coordinated by the WB[16], will include the import of 1,000 MW from the Republic of Tajikistan to Pakistan through Afghanistan and the creation of the necessary infrastructure. Surplus electrical energy from Kyrgyzstan Republic may be transmit-

Box 4.6

Planned Export of Electrical Energy from Central Asia

The Kyrgyz Republic is currently planning the construction of the Kambarata Hydropower Station - 1 (400 MW) and Hydropower Station-2 (1,200 MW) at a total cost of $2.5-2.9 billion. The Decrees of the Government “On organization of the investment tender for construction of the transformer substation 500/220 kV “Datka” and reconstruction of the electric power transmission line EPTL - 220 kV for southern Kyrgyzstan”, and “On construction of the hydropower stations cascade on the Sary-Djaz river” (Issyk Kul oblast) with a minimum total installed capacity of 750 MW, have been signed. China is intended as the main consumer of electrical energy generated by this cascade. Total estimated cost of this project is $2.5–3 billion. According to calculations, Kyrgyzstan will be able to sell electrical energy worth around $300 million annually. The ADB has allocated $0.8 billion to a feasibility study of supplying Afghanistan with electrical energy from Kyrgyzstan. The selling price of electrical energy supplied to Kabul is approximately 5-6 cents per kWh.

On 21 February, 2006 the heads of the energy bodies of Tajikistan, Iran, and Afghanistan signed a trilateral agreement on the construction of a 1.100 km long high-voltage transmission line from the Sangtuda to Meshkhed. This agreement also covers the transit of electrical energy from Tajikistan to these and other Asian countries. Another bilateral agreement was signed by Tajikistan and Afghanistan on the all-year-round supply of Tajik electrical energy, and on cooperation in the gas sector, as well as the realization of a joint project to construct a hydropower station on the river Pyandj. Currently, 120 thousand kWh per day of electrical energy is exported to Afghanistan.

The capacity of the Fuel and Energy sector of Kazakhstan is attracting the largest American and European multinational corporations, China, and India. Practically all the generating assets in the country have been privatized,and the high capacity hydropower stations handed over for concessions. To strengthen the connection between the energy-rich north and the energy- deficient south, construction of the second electric power transmission line North-South and EPTL from northern Kazakhstan to Aktyubinsk oblast is planned to be completed by 2008-2010. This will ensure Kazakhstan’s energy independence. A project to create an energy bridge between Kazakhstan and China with a total cost of $9.5 billion is at the stage of pre-feasibility study development. This energy bridge will be supported by the construction of a new State Rayon Electric Power Station with a capacity of 7,200 MW and a 3,800-4,200 km long electric power line extending to the center of China. Implementation of this project will significantly increase the capacity of Kazakhstan to export power to China (more than 6,000 MW). *(From the review of the energy sector status, Institute of Strategic Research of the RUz, 2006)*

[16]“The Times of Central Asia”, 1.07.2006; “Asia Analytics” , 2.07.2006. The Project is planned to be implemented in three stages. During the first stage an electric power line (EPL-220 KV) will be constructed from Tajikistan to Afghanistan. During the second stage another line (EPL -500 KV) will be constructed from the border of Kazakhstan through Kyrgyzstan, Tajikistan and Afghanistan to Pakistan, During the third stage two new hydropower stations in Tajikistan will be constructed. (D. Perri, Regional Director of the “AES” Corporation for Kazakhstan, Russia, and the Central Asia).

ted through these lines by installation of the new lines. Completion of this project, with a total cost of around $1 billion, is expected by 2010.

However, according to the UNDP assessments (2005), the export of energy faces a number of limitations associated with the inability of Afghanistan to pay, the need to construct electrical power transmission lines, uncertainty of pricing for power transmission, and, especially threats associated with political instability and security. Therefore, the expected growth of electrical energy sales beyond Central Asia will have some negative effects both on the exporting countries and transit states, and limit the development of mutually beneficial regional cooperation. To minimize the possible risks and prevent future threats to security, there needs to be an intensification of the activities of the key partners aimed at ensuring the effective coordination and development of mechanisms for joint energy and water resources management in the short- and long-term.

4.3.3. Commitments to Integration into the IWRM

In the Nukus Declaration of 20 September, 1995, the Heads of the Central Asian countries affirmed their support for the Convention on transboundary waters and emphasized the necessity for establishment of an International convention on sustainable development of the Aral Sea basin. The protocol of the ICWC meeting in Almaty (14-15 June, 2002) indicated: *"Members of ICWC should consider the issue on submission of proposals in accordance with the established procedure to their respective governments on the possibility for ratification of the Convention on protection and use of the transboundary water courses and international lakes* (Helsinki, 1992). There are also a number of other statements, and declarations of the Heads of the Central Asian countries which reflect the political objectives and willingness to further strengthen interstate cooperation.

Although as of now only Kazakhstan (2000) has acceded to the Convention *on protection and use of the transboundary water courses and international lakes*, all the Central Asian countries are parties to the UN Rio Conventions and have adopted explicit commitments for rational use of natural resources and protection of the environment. The possible synergy between these Conventions will allow more rational, efficient, and economical use of their tools and mechanisms for harmonized water resources management with observance of the main principles of the international water courses use, namely:

- Water resources are common property and the basis for future development, and their volumes are extremely limited;
- Water resources exist irrespective of state boundaries;
- The main objective of water resource management is the common welfare of people and countries;
- The interests of the whole basin should have precedence over particular interests, including those of the countries using the water resources;
- Observance of the principle of equitable and rational water resource use and the damage prevention rule should be obligatory.

The current efforts and contributions of Uzbekistan, as well as the other Central Asian republics, confirm its commitment to the observance of the main provisions on the equitable and rational use of the international water courses in regard to other upstream and downstream countries. In previous chapters it was mentioned that the urgent measures being undertaken by Uzbekistan to overcome the negative impacts of water deficiency and environment degradation will bring positive benefits at the national and regional levels.

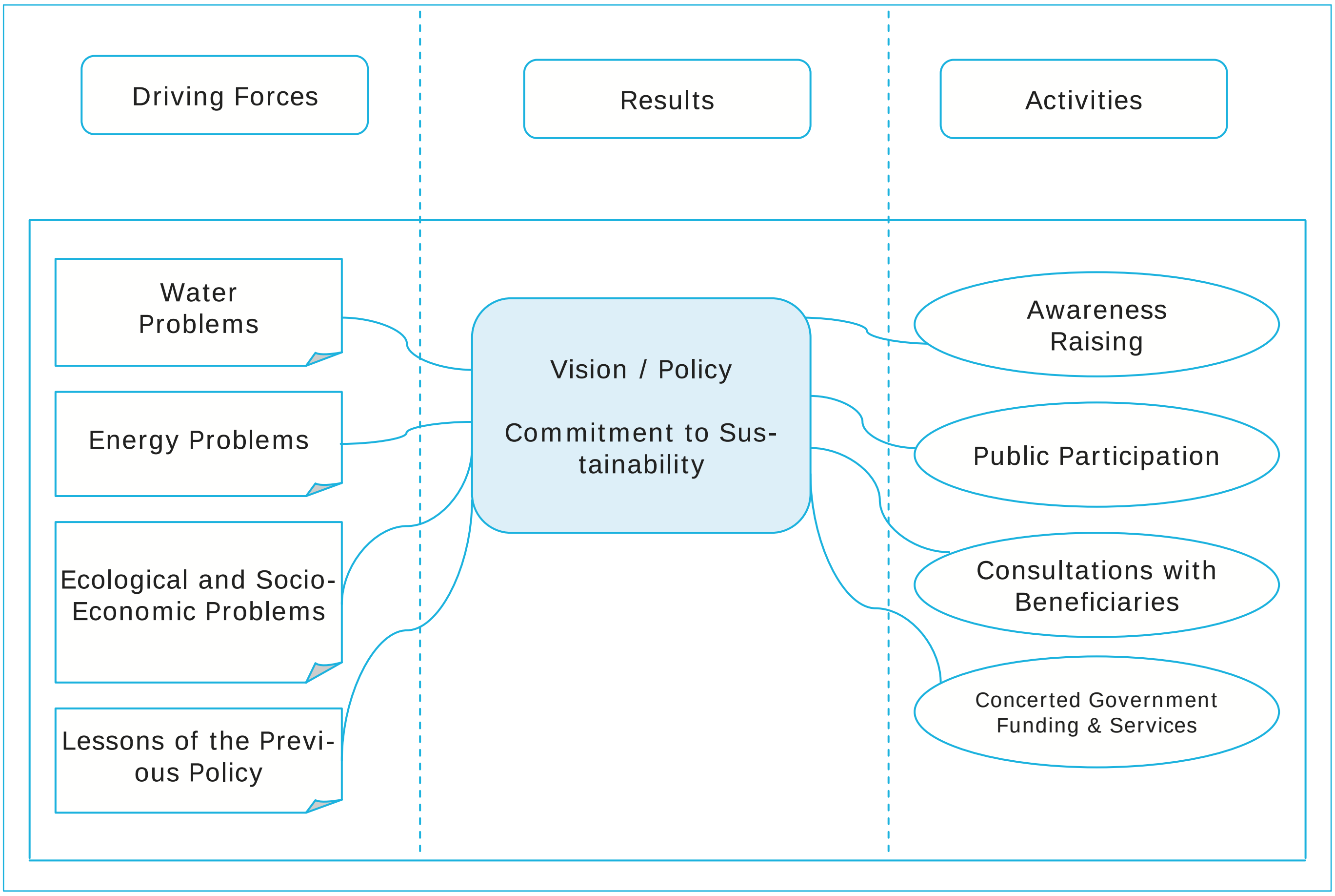
It is well-known that the world summit on sustainable development in Johannesburg (2002) called on all countries to develop integrated water resource management and efficiency plans by 2005. The summit recommended that countries *"develop and implement the national and regional strategies, plans and programs for the integrated management of river basins, watersheds, and underground waters; improve efficiency of water resource use and ensure their distribution in such a way that gives priority to the daily wants of people and achievement of a balance between the requirements for conservation and restoration of ecosystems, especially vulnerable ones, and municipal,* *industrial, and agricultural demands, including guaranteeing the quality of drinking water".* In a broad sense integrated water resource management (IWRM) involves integration of the three fundamental parameters: economic development, environmental sustainability, and social requirements in the political context.

The first step of the Central Asia integration into the IWRM processes has become the "Main provisions of the regional water strategy of the Aral Sea basin countries, developed within the framework of WB ASBP-1 (1997) [105]. As was mentioned above, since 2002, introduction of the IWRM principles and approaches in the five countries of the region has been carried out by the Technical Committee of GWP CACENA. In 2004-2005, development of the National IWRM strategy for Kazakhstan and the main provisions of the National IWRM Plans for the other republics were initiated with financial support from Finland and Norway. For strengthening integration of CA countries into IWRM further international support and assistance in developing national strategies and plans is required in order to achieve of security and stability in the Aral Sea basin. All national IWRM plans should be closely linked with the ESCAP Cooperation Strategy on rational use of water and energy resources.

Development of Uzbekistan's national IWRM strategy will help overcome the existing barriers and adaptation to the changes in water and land use associated with the expected demographic growth, migration and the growing demands of the population. The strategic vision of IWRM is illustrated in Figure 4.4.

Previous experience world achievements, and lessons learned by the country within the framework of programs and projects carried out with financial support from the international community will become the main preconditions for successful introduction of IWRM in Uzbekistan. The centuries-old history and shared fundamental interests of the Aral Sea region's nations also instill confidence that the declared objectives can be achieved.

Figure 4.4. **IWRM Strategic Vision: Driving Forces, Results and Activities**



Source: GWP (2002) updated by UNDP project team, 2006

Chapter 5. INTEGRATED WATER RESOURCES MANAGEMENT FOR UZBEKISTAN'S FUTURE

As was mentioned in Chapter 1, the developed world has considerable experience in implementing IWRM approaches. However, analysis of reviews shows that process of introducing IWRM in Uzbekistan and Central Asia, as well as in other developing countries, is not proving very successful. This is due to the different existing economic environment and possibilities, and also to a lack of understanding or misinterpretation of the main principles of IWRM [106]. This problem is complicated by the considerable vulnerability of arid lands and the high sensibility of their ecosystems to abrupt changes. Therefore, extreme care should be taken with the current human interventions, so that they are all technically, economically and environmentally acceptable in order to avoid repeating the mistakes of the past and increasing future risks and threats.

Water resource management requires a deep understanding of the special role of water for life on Earth, the importance of water resources for social and economic development, and the principles of interaction between people and the environment. Only if we have a profound understanding of the numerous interrelationships between human activities and the balance of nature, can we expect success in water resources management. The general objective is the coordinated and comprehensive management of water, land and associated resources in order to achieve equilibrium between water and energy resources, and the needs of society and the natural ecosystems, and to ensure social and environmental sustainability on which the livelihoods and welfare of the present and future generations must be based.

The experience gained and lessons learned in the region over the last ten years with support from the international community have helped increase the possibility of a successful transition to IWRM principles and approaches in Uzbekistan. Lessons learned from a successful example of IWRM in another part of the world are illustrated later in this chapter (5.3).

5.1. Main Dimensions and Strategic Objectives of IWRM

Of the challenges facing the water sector and the imminent crisis over fresh water require a strategic approach with sustainable water resource management as its corner stone. Development of a realistic and comprehensive strategy will depend on a clear understanding and analysis of the key management problems, an assessment of the acceptability and feasibility of decisions for all beneficiaries, compromises between the upper and lower river reaches and interaction between integrated water resources management and environmental services within the watershed. At the same time, it is important to guarantee human rights, justice and consensus between sectors and participants at national, regional and international levels so that people can maintain their livelihoods in the face of inevitable change.

The starting point for transition to the IWRM system is the strategic vision illustrated in Figure 4.4 that indicates the intentions and commitments of the country to sustainable management and development. The strategy should aim to tackle all the main economic, social and environmental issues involved in sustainable water and energy resources management. The strategy should be both comprehensive and achievable.

The IWRM strategy should be based on the following dimensions[17]:

- *Sectoral and Intersectoral Integration.* This is related to the planning and management of water resources taking into account the competition and conflicts between irrigated agriculture, hydropower, drinking and municipal water supply and sanitation, industry, etc;

- *Economic, Environmental, and Social Integration.* This means that not only the economic costs and benefits of specific decisions on water resources management but also the environmental and social ones should be taken into consideration,

[17]GWP Manuals (2002) and the national programs, concepts and main provisions, etc.

- *Administrative Integration.* This is related to the coordination of water resources management at all levels of government (national, oblast and local) and the interaction and interrelationship between these levels. Well-formed and explicitly declared legal and managerial structures are extremely important for the management of limited water and energy resources;

- *Geographical Integration.* *This* refers to the use of the hydrological units (i.e. watersheds and river basins) or hydraulic units (irrigation systems) as the main subdivision for water resources management. It also means that consideration of watersheds themselves and the interaction between the use of land and the water in rivers, lakes, and streams is part of the decision making for the development and management of all natural resources; and

- *Integration of International Donors.* This involves effective coordination of the external financial institutions that support and assist in the development and implementation of projects in order to ensure efficient and high quality water resources management even though funding may be limited (see Chapter 1).

The IWRM strategy should cover the following main areas:

In the International Context water resources should be managed with observance of all the international agreements, conventions, global values, and good neighborliness that ensure equitable joint use of water resources and benefits from transboundary water courses;

In the National Context water resources should be managed in a manner that would ensure achievement of the national development goals, such as poverty reduction, the Millennium Development Goals and sectoral objectives in food production, energy, industry, and environment protection;

In the Context of Population and Ecosystem Needs water resources should be managed so as to make them accessible to everybody and to satisfy the main needs of both people and ecosystems. In distribution of water resources priority should be given to the needs of the population and to environmental demands;

In the Context of Managerial Principles the most important principles include: decentralization of responsibilities to the lowest level; public participation in management and the decision making process, including the participation of women; joint management (intersectoral and various agencies); and management within the boundaries of hydrological units (river basins);

In the Context of Financial Sustainability water resources management benefits from the total reimbursement of production costs within the administration system, and water users and polluters pay for services. Payment for water and tariffs, subsidies, incentives, and limitations are the key issues.

5.2. Creation of Favorable Environment for IWRM Introduction

The experience and lessons learned in the region described above show that to introduce a sustainable and integrated approach to the management of water and energy resources will require changes in all spheres and at all management levels. To achieve the key objectives of IWRM fundamental institutional and legislative reform based on international water law is needed together with improved management procedures and tools.

Improvement of Legislative Basis

The general objective of the legislative reform process is to guarantee legal support for the key decisions and to ensure harmonization between laws and regulatory frames in all sectors of the economy which make use of water resources.

The key objectives for creation of the relevant conditions include:

- Compliance with global environmental conventions and accession to the international convention and protocols on transboundary water courses, etc;

- Development of efficient mechanisms for sharing the water of transboundary rivers , taking into account the priority of supplying drinking water as well as environmental and social requirements;

- Development of mechanisms for managing water quality and the environment as a whole in accordance with nature protection laws and regulations;

- Ensuring the legislative basis for institutional reforms and provisions on sanctions in case of violation of laws, as well as regulation of situation in cases of water deficiency, floods and emergency situations associated with pollutions;

- Creation of conditions for the recovery of production costs through water charges, as well as a system of incentives and financial measures ensuring sustainability.

DAI considers the development and implementation of the legislative norms as a type of control over stakeholder involvement and emphasizes five main elements for the reliable operation of the legal management model*: political program – problem analysis – decision makers/lawmakers - implementation – monitoring* [80]. These elements ensure close interaction between regulators and the regulated, as well as with independent observers.

Using information technology really helps to improve the regulatory framework and supervision of sectoral activities. Application of information technology facilitates: (i) encouraging wider and more effective participation in the development of regulations; (ii) improving the implementation of existing regulations, and (iii) introducing legal and regulatory knowledge systems.

Institutional Development

Helping to management at all levels is extremely important for the harmonious fulfillment of legal frames and strategic decisions. The first priority is the improvement of coordination of the activities of the existing institutions and/or the establishment of new organizations as necessary that will be able to implement the following key objectives:

- Separating the management of water resources from the provision of services (irrigation, hydropower, municipal water supply and sewerage) and consolidating their efforts in order to avoid conflicts of interest and to encourage economic self-sufficiency;

- Decentralizing regulation and service provision to the lowest level and ensuring participation of beneficiaries and the public in planning and developing managerial decisions;

- Improving the knowledge and professionalism of staff through a long-term program of capacity building and the implementation of an action plan;

- Broadening the involvement of the private sector and encouraging its potential contribution to financing and providing services (irrigation, hydropower, municipal water supply and sewerage, etc.)

One important element in the institutional development of IWRM is the establishment of the Advisory or Coordinating Committees of canals jointly headed by the local administration bodies (hakims) and representatives of the BVO, Goskompriroda and the relevant WUAs (i.e. with representatives of political, economic, environmental, and social institutions.) Setting up such committees in Uzbekistan (Boxes 5.3 and 5.4) has helped ensure that all participants contribute to joint decisions and take responsibility for their implementation.

Increasing rural community participation, will require accelerated development of independent WUAs that unite all farmers using a single irrigation system or part of it. These WUAs should have well-defined responsibilities, be free from state control over cropping and production (free from the state order) and be able to make decisions on the management, operation and maintenance of the system. As the number of private farms continues to increase, well-run WUAs will play a key role in the management, operation and maintenance of the I&D systems at the on-farm level.

Achieving the IWRM objectives will involve the following:

- Collection of comprehensive information and assessment of water resources (surface, underground and marginal) waters, and development of specialized monitoring and control services;
- Strategic planning and policy making at basin level, and the development and protection of water resources through the use of the decision support system;
- Development of water distribution mechanisms and identification of norms and rights for all types of water consumers and users;
- Resolution of any conflicts in regard to water resources (for instance, between water intake and disposal of wastewaters);
- Measures aimed at the management and protection of water bodies, such as rivers, and lakes; and
- Capacity building and human resource development, including training of specialists in the area of threats, environmental, social, and economic assessment and solution of institutional issues.

5.3. Experience and Lessons Learned

5.3.1. World Experience and Lessons for the Future

The experience of other countries may serve as a good lesson for the successful introduction of IWRM principles at the national and local levels. One of the best examples of the introduction of IWRM is the Murray-Darling rivers basin initiative in eastern Australia (Box 5.1).

The main factors in the success of this initiative were: (i) strong institutional frameworks; (ii) good knowledge base; (iii) integration of issues associated with natural resources, legal and researches / policy / realization; and (iv) strong community participation (Figure 5.1). Finding a solution to the conflicting needs to improve water quality in the lower river reaches and to discharge drainage waters from the upstream irrigated lands was one of the first tasks of the initiative. The joint program of works is unique in that it takes into account both river and land management and environmental effects. The upstream states contribute funds for the construction of facilities to intercept ground water along the river course (or divert the drainage flow), and the other states and/or polluters carry out the construction. They have the right to discharge salts into the Murray river only within the approved limits. Limitations in regard to discharge of salts into the river have led to a significant improvement in irrigation practice and water use efficiency.

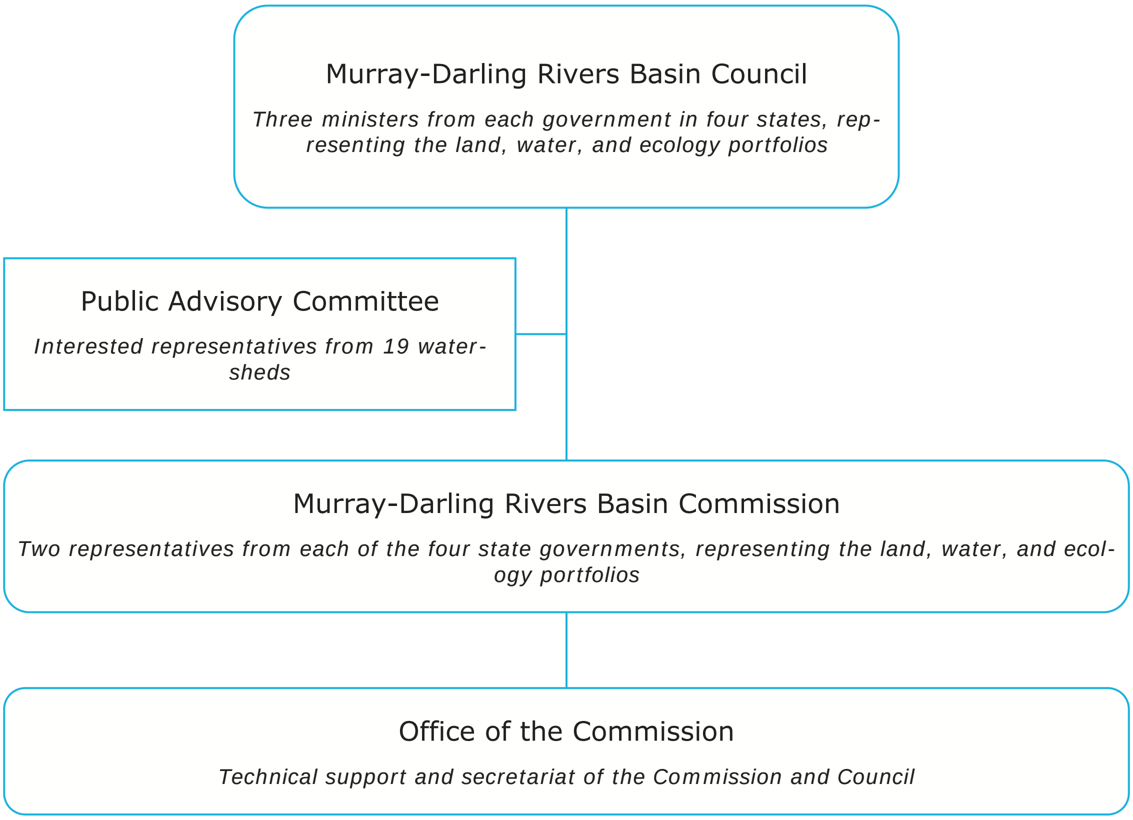
Box 5.1

Murray-Darling Rivers Basin Initiative

The total basin area is around 1 million km^2 (equivalent to the combined size of France and Spain). The Murray and Darling rivers (3,700 km long) cross four independent states: New South Wales, Victoria, South Australia, and Queensland. This is the main agricultural province of Australia producing 33% of agricultural production with a total annual value of AUSD 10 thousand million. The basin comprises 75% of the country's total irrigated area, and around 25% of livestock production.

To promote efficient planning, management and sustainable use of the basin's water, land and natural resources an agreement between the Federal Government and Governments of the four states on establishing a Council of Ministers and Commission for the Murray-Darling river basin was signed in 1988. The strategic program of this initiative involves community groups in the development of comprehensive plans for land and water resources management in all regions. A characteristic of these plans is the joint leadership by the community and the government that ensures support when the need arises. The strength of such plans is the separation of costs. The major part of these costs is met by the community *(M. Falkemark, 1999).*

Figure 5.1. **Management Structure of Murray-Darling Rivers Basin, Australia 1997**



Source: D. J. Blackmore. 1997

The Murray-Darling Rivers Basin example highlights a number of principles which are prerequisites for the successful management of an interstate watershed:

- *Government Leadership*. Mature and forceful leadership is required from the government. This may involve relinquishing some sovereign rights to other stakeholders. It also includes raising community awareness and providing the means for local communities to manage local environmental issues. The government must also define a framework which ensures that downstream impacts are considered in upstream management decisions.

- *Community Leadership*. Successful environmental management is much easier to achieve where the local community is demanding actions and is committed to developing and implementing action plans. Raising awareness of local communities of the need to act is a critical first step. Community-based monitoring of water quality and involvement of educational institutions and schools have been shown to be effective ways of expanding community awareness. Some features of successful public participation in land and water planning are: the commencement of consultation early on in the planning procedure; guidelines and planning procedures required at the outset; community awareness of the objectives of its involvement and the level of power being offered; efforts made to include all stakeholders; information available to everyone, and adequate administrative and technical resources available for the required tasks and meetings.

- *Technical Knowledge*. Impacts often occur distant from the site of mismanagement, but the symptoms of mismanagement are often treated rather than addressing the cause. For this reason, successful plans can only be built on a strong knowledge base and comprehensive studies ensuring profound understanding of the root causes, effects and impacts of the various management options. It is rare, however, for knowledge to be complex. Consequently, an assessment of the risks of incomplete information should be made and flexible plans must be adaptable and regularly updated on the basis of new information.

- *Use of Market Instruments*. It is necessary to estimate the total incurred costs of resources that users pay for. In particular, off-site costs and the costs of degradation which will not appear until some time in the future are rarely included in the costs of production. For this reason, the Government is well-placed to ensure that these costs are included in day-to-day decision-making as an incentive for resource users to find the most efficient and least costly management options. In the same way the Government extends subsides and tax-breaks to encourage certain activities

Analysis of the GWP reviews (2002) shows that the main problems facing engineers, scientists, and planners are not technical In nature. They are problems of reaching agreement on facts, alternatives, and/or decisions. In assessing the implementation of 121 projects concerned with the rural water supply systems in Asia, the World Bank (2005) stresses that "participation of beneficiaries" is the most important factor determining how well decisions are implemented [37]. It also helps improve access to and control over water resources. Involvement of the public often not only leads to an increase in public responsibility and steadfastness of judgment, but also assists in resolution of conflicts, building of confidence, and strengthening local communities for carrying out other activities. Therefore, public involvement and conflict management techniques are key in being able to introduce and implement innovations. Community involvement from the initial planning stage encourages 'joined up' decision making and innovations by individuals because they are not tied to the official status quo. However, this costs money. For instance, New-York City allocates a portion of its budget for major projects to "Citizen Advisory Committees", which involve citizens, environmental organizations, and industry [95] The planning and governing authorities involved in watershed management must perceive themselves as agents of change and innovation.

Innovations are encouraged if:

- management is integrated across the boundaries of a basin;
- integration exists between functional state sectors (agriculture, forestry, water resources, environmental regulations, nature conservation, land use-government level);
- integration exists between disciplines, common sectors and directions;
- integration exists between knowledge providers and knowledge users and no destructive tension exists between the scientific/ research communities, design and planners of resources.

Therefore, the successful model for changing poor management practices and adopting innovations involves: commitments, resources, a substantial knowledge basis, and a well-planned change process including attitude of land users, cost-sharing, and group activities. When one of these elements is missing, changes either will not occur or will take place in a direction that is not sustainable.

5.3.2. Experience and Lessons in Uzbekistan and Central Asia

As was mentioned in previous Chapters, since 2002 the Technical Committee of GWP CACENA and IFAS with support from international institutions and donor countries have been promoting the introduction of IWRM in Central Asia. The main elements and mechanisms of IWRM and the specific requirements for introducing these in the context of Central Asia have been formulated on the basis of experience gained from the NATO project in the Amudarya river delta and the SIDA "IWRM-Fergana" project in the Fergana valley [41].

Due to the efforts of the international community over the past decades, the development of comprehensive participatory approaches and methods of water resource and environment management has already begun in the country. These methods can be adapted to specific conditions and disseminated at the national and basin level. Some donor-funded projects and programs in the area of water/energy and natural resources management, have already been discussed in previous chapters. A complete list of projects is provided in Annex 5.

Projects Oriented to Integrated River Basin Management

The *"Drainage Project of Uzbekistan"* is an example of how IWRM principles can be successfully developed for equitable shared use of transboundary water courses. Within this project a package of technical interventions and all possible options and scenarios for CDW management on the right bank of the Amudarya River have been developed (Box 2.3) [77]. The process of environmental assessment (WB, 1998) identified potential projects from the integrated river basin management viewpoint and established explicit objectives for the management for each sector (Annex 5) [98]. These objectives complement one other, but at the same time they may come into conflict. Therefore, there is a need to search for compromises in order to reach consensus and achieve equilibrium of environmental and social needs. One of the best models for joint participatory management is the WB *"Drainage, Irrigation, and Wetlands Improvement Project"* (DIWIP) in Southern Karakalpakstan (see Chapter 2).

A successful example of IWRM principles being implemented to support the needs of population and ecosystems is the GEF pilot project *"Restoration of the Lake Sudoche Wetlands"* [30]. The main objective of this project is to demonstrate comprehensive approaches to management, conservation and restoration of the delta ecosystem biodiversity and provision of stable incomes for the local population (Box 5.2). One of the target tasks of this project is to qualify the Lake Sudoche lzone for protection under the Ramsar Convention.

Studies of the population in the project area have identified priority measures to improve employment and conservation of biological resources of Lake Sudoche. These include: (i) provision of local population with the rights to catch certain quantities of fish and muskrat, and to cut reeds for domestic use; (ii) involvement of the population in the management of wetland biodiversity and reproduction of biological resources; (iii) use of the experience of the local self-administration bodies (makankenesy) and the traditional institutions of local leaders (the so called "biy"), etc. Certainly, the CMLS, jointly with the supervisory public commissions, should carefully coordinate implementation of the Sudoche wetlands management plan developed during preparation of the detailed design. They should also carry out socio-ecological monitoring and implement mitigating measures to maintain the integrity and viability of the wetland.

Another successful example of IWRM in the context of human and ecosystems needs is the UNDP/GEF project *"Establishment of the Nuratau-Kyzylkum Biosphere Reserve"* which is located in the middle reaches of Syrdarya River. The main objective of this project is to demarcate the general boundaries and internal zones of the reserve, and to develop a long-term plan for the management of the Nuratau-Kyzylkum Biosphere Reserve based on normative, legal, environmental, and socio-economic criteria and principles of sustainable natural resources use. The management approaches and methods being demonstrated by

Box 5.2

Sudoche Wetland, with a total area of 500 km^2, is made up of the main lakes (open ponds) Akushpa, Karateren, Begdulla-Aidyn, and Big Sudoche in the Amudarya river delta. This is one of the best preserved ecological zones in the Amudarya river delta and a place where the biological diversitytypical of the region is being maintained.

In 1999, the Council of Ministers of the Republic of Karakalpakstan established the Committee for the Management of Lake Sudoche (CMLS). This comprised associate members (representatives of the responsible ministries, institutions, and organizations), and supervisory public commissions, established in the seven adjacent settlements. Implementation of the engineering measures for construction and rehabilitation of water structures and other infrastructure will ensure an annual water inflow volume of not less than 300 million m^3. Over a period of three years this will allow water mineralization to be reduced from 18 to 6-8 g/l. The area of wetland will be increased up to 200 thousand ha with a water depth of 3.0-3.5 m. The area of water surface free from reeds will reach 130 thousand ha. This will ensure favorable conditions for the mass movement of water and the improvement of the wetland oxygen regime. (GEF/IFAS WEMP project, Component E. Final Report, 2000) this project make a real contribution to achieving sustainable links and compatibility between land/water use and protection of the ecosystems within the watershed. In general implementation of the project will increase the area of reserves in Uzbekistan by up to 6%.

Projects Focusing on Integrated Water/Land Management in Agriculture

The various investment projects and technical assistance programs that are being implemented in the country demonstrate the integrated management and use of water and land resources (Box 5.3). The common objectives of these projects are to: (i) support the development of institutional reforms at all levels of water management with involvement of all stakeholders; (ii) implement technical interventions for reconstruction of the I&D infrastructure, measurements and control over distribution of water; (iii) promote a purchasing and pricing policy and agricultural services which encourage farmers; (iv) develop a policy for reimbursement of expenses through the introduction of a system of payments for delivery of irrigation water; (v) establish advisory services and develop training programs in order to raise public awareness and participation. One of the most important target tasks to be carried out within these projects is to support the development of WUAs that took over responsibility for the on-farm water management.

Box 5.3

Investment Projects that are being Implemented with Donors Support

ADB Project *"Rehabilitation of the Amu-Zang Main Canal and Pumping Stations" ($73 million);*

ADB Project *"Development of Agriculture in the Ak-Altyn Rayon" ($ 36 millions);*

WB Project *"Support to the Agricultural Enterprises" ($ 36 million);*

WB "*Irrigation, Drainage and Wetlands Improvement Project" ($ 40 million*);

ADB Project "Improvement of Grain Crops Productivity" ($ 26 million,) and others (see Annex 5).

Projects Focusing on Improving Water Productivity and Water Saving

The practical results of the on-going projects and programs show that the adaptation of IWRM principles in order to increase water productivity in irrigated agriculture is entirely achievable.

The regional project "IWRM-Fergana" introduces the main provisions of the IWRM concept into the existing water management systems in Fergana valley (Box 5.3) [35]. Experience of another ICARDA project - (*"On–farm management of water and land resources for maintenance of sustainable agricultural systems in Central Asia")* has shown how some effective and efficient water use techniques can be used in Uzbekistan. This includes the drip irrigation of vineyards and vegetables growing on steep slopes, the practice of bio-drainage and the creation of forest shelter belts. These techniques bring substantial economic and environmental benefits including the saving of surface water.

The results of other pilot projects such as EC-TACIS, WARMAP (a WUFMAS sub-project), CIRMAN-ARAL and others show that the priority measures for ensuring water saving are: (i) measures on improvement of water use discipline; (ii) measures on improvement of crop irrigation technologies and methods; and (iii) thorough field preparation and tillage. Although these measures come at a certain cost, they ensure efficient on-farm water use and make a significant contribution to water saving [76].

UN FAO supports projects which aim to demonstrate best-practice in on-farm land and water management on degraded land within the country's arid zones. Application of agriculture conservation system and bio-drainage in combination with drainage facilitates resources saving and transfer 30-70% of the expendable part of water balance to its ecologically clear transpiration part.

FAO experience also confirms that management methods in the system "rainfall water – soil – crop", such as rainfall harvesting techniques, and a combination of runoff farming with soil moisture management are important ways of ensuring security in livelihoods and food production for the growing population.

The revival of the active involvement of the population makes a special contribution to water saving, especially at local community Level. These issues are discussed in Chapter 3.

Box 5.4

"Integrated Water Resources Management in Fergana Valley" Project (2001-2005)

The project considers three levels of the water resources management hierarchy: "system (canal) – WUA – farm". The results of the first target task are as follows:

- *Increased field application efficiency of irrigation water from 42-51% to 69-81% due to a reduction in tail escape and infiltration losses;*
- *Increase in uniformity of water delivery by the South Fergana canal between outlets up to 70-95% as against 25-76% in 2003.*

Canal Water Committees (CWC) were established within this project. These comprise representatives of all parties interested in the use of water resources [35].

Projects Focusing on Improving Knowledge and Awareness about IWRM

In regard to advocacy and training in the IWRM concept the ICWC initiative, supported by the governments of the five republics as well as donors [35], has been significant. Since 1996, opportunities have been provided for training seminars, exchange of experience and participation in international forums. A network of training center branches and field seminars has enabled approximately 2000 people each year to upgrade their qualifications. It has also strengthened public awareness of IWRM. USAID, through its *"Natural Resources Management Program",* and other donors provide technical assistance to the responsible institutions in management and monitoring of water resource quality, automation of irrigation systems and capacity building in water supply and management.

IWRM also envisages broad involvement of rural communities, farmers, and vulnerable population groups, especially women, in water resource management and use, and environment protection. Therefore, training of farmers and dekhkans, who came to agriculture from other sectors of the economy and have insufficient knowledge and experience in the area, is extremely important.

The contributions of the international institutions in the development of farming have already been discussed in Chapter 3. The approaches to training and raising community awareness that were demonstrated within the FAO program *"Field Farmers School"* deserve attention. However, the absence of special departments and/or extension services as well as a lack of awareness within the Ministry of Agriculture and Water Resources and in other responsible organizations limits the wider introduction of best practice in water and land management at the national and local levels.

One of the best examples of interdisciplinary research and the training of young Uzbek scientists is the UNESCO/ZEF Bonn project *"Economic and Ecological Restructuring of Land- and Water Use in the Region Khorezm of Uzbekistan"* (2002-2012). The objective of this project is to elaborate a regional development concept based on the integration of natural resources management studies with economic and institutional research, and to suggest strategies for decentralized development which adhere to sound environmental principles.

ANNEXES

ANNEX 1

Annex 1.1. List of the Bilateral and Multilateral Agreements and the Regional Initiatives in the Area of Joint Management of Water and Energy Resources in Central Asia.

Agreement amongst the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, and the Government of the Republic of Uzbekistan about use of the fuel/energy and water resources, construction and exploitation of gas pipelines in the Central Asian region (Tashkent, 5 April, 1996);

Agreement amongst the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, and the Government of the Republic of Uzbekistan about use of the water and energy resources of the Syrdarya river basin (Bishkek, 17 March, 1998);

Protocol amongst the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, and the Government of the Republic of Uzbekistan about use of the water and energy resources of the Naryn-Syrdarya cascade of reservoirs in 2001;

Agreement amongst the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, and the Government of the Republic of Uzbekistan about cooperation in the area of nature protection and rational use of the natural resources (17 March, 1998);

Agreement amongst the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, the Government of the Tajik Republic and the Government of the Republic of Uzbekistan about cooperation in the area of hydro-meteorology (17 June, 1999);

Agreement amongst the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic, the Government of the Tajik Republic and the Government of the Republic of Uzbekistan about parallel operation of the energy systems of the Central Asian countries (Bishkek, 17 June, 1999);

Agreement between the Republic of Uzbekistan and Turkmenistan about cooperation in the water management issues (Chardjev, 16 January, 1996);

Agreement between the Government of Republic of Uzbekistan and the Government of Turkmenistan about the onerous land use (Ashgabad, 17 April, 1996).

Table 1.2. **List of the International Organizations to which Uzbekistan is a Member**

N	Abbreviation	Full Title of Organization
1	UNO	United Nations Organization
2	UNIDO	United Nations Industrial Development Organization
3	UN ESCAP	Economic and Social Commission for Asia and the Pacific
4	UNCITRAL	United Nations Commission for International Trade Law
5	UNDP	United Nations Development Program
6	UNESCO	United Nations Educational, Scientific, and Cultural Organization
7	UNCTAD	United Nations Conference on Trade and Development
8	UNECE	United Nations Economic Commission for Europe
9	WIPO	World Intellectual Property Organization
10	WHO	World Health Organization
11	ILO	International Labor Organization
12	ITU	International Telecommunication Union
13	IBRD	International Bank for Reconstruction and Development
14	IFC	International Finance Corporation
15	IDA	International Development Association
16	MIGA	Multilateral Investments Guarantee Agency
17	IMF	International Monetary Fund
18	OSCE	Organization for Security and Cooperation in Europe
19	EBRD	European Bank of Reconstruction and Development
20	EEC	European Energy Charter
21	ADB	Asian Development Bank
22	WCO	World Customs Organization
23	IDB	Islamic Development Bank
24	OECD	Organization of Economic Cooperation and Development
25	ICO	Islamic Conference Organization
26	ICAC	International Cotton Advisory Committee
27	IAEA	International Atomic Energy Agency
28	ISTCO	International Satellite Telecommunication Organization
29	ISO	International Standardization Organization
30	WTO	World Tourist Organization
31	FAO	Food and Agriculture Organization

Source: UNDP, 2003

ANNEX 2

Table 2.1. **Average Substances Concentration in the Amudarya River Near Nukus**

Parameters	Average Annual Substances Concentration (mg/l)				
	1991	1992	1993	1994	1995
Dissolved Oxygen	8.09	8.61	9.33	10.29	10.05
BOD	0.68	1.26	0.62	1.10	1.49
COD	16.3	12.8	19.0	9.6	8.5
Ammonium Nitrate	0.06	0.07	0.06	0.02	0.04
Nitrate	0.06	0.88	0.80	0.52	0.56
Nitrite	0.01	0.034	0.021	0.019	0.011
Fe (III)	0.03	0.03	0.02	0.03	0.02
Copper (II) (ug/l)	2.5	3.8	0.8	1.5	2.2
Zinc (II) (ug/l)	12.5	7.6	9.7	9.9	10.5
Phenols	0.006	0.002	0.002	0.005	0.003
Petrochemicals	0.04	0.06	0.04	0.06	0.03
Cr (ug/l)	1.0	2.7	1.6	0.7	0.5
MAC	0.04	0.01	0.01	0.01	0.02
Suspended Matters	101	435	277	260	136
DDT (ug/l)	0	0	0	0	0
-HCH (ug/l)	0.023	0.134	0.047	0.023	0.001
Fluorine	0.36	0.31	0.20	0.21	0.26
Arsenic (ug/l)	0.6	2.5	0.1	1.2	1.7
Mineralization	814	995	1,090	1,025	1,244

Source: WB, 1998 Ecological assessment of I&D in the Amudarya River Basin, IWACO and others

Table 2.2. **Reservoirs of Uzbekistan**

Oblast	Q-ty	Available Storage Capacity, km^3	Oblast	Q-ty	Available Storage Capacity, km^3
Amudarya River Basin			*Syrdarya River Basin*		
Khorezm	1	4.505	Andidjan	3	1.760
Kashkadarya	14	2.348	Tashkent	5	1.999
Samarkand	7	1.063	Fergana	4	0.255
Surkhandarya	4	0.902	Namangan	7	0.239
Navoi	2	0.845	Djizak	4	0.181
Bukhara	2	0.430	Syrdarya	2	0.012
		10.093			4.446

Source: GEF/WB WEMP Project, Report of the NWG of Uzbekistan, 2002

ANNEX 3

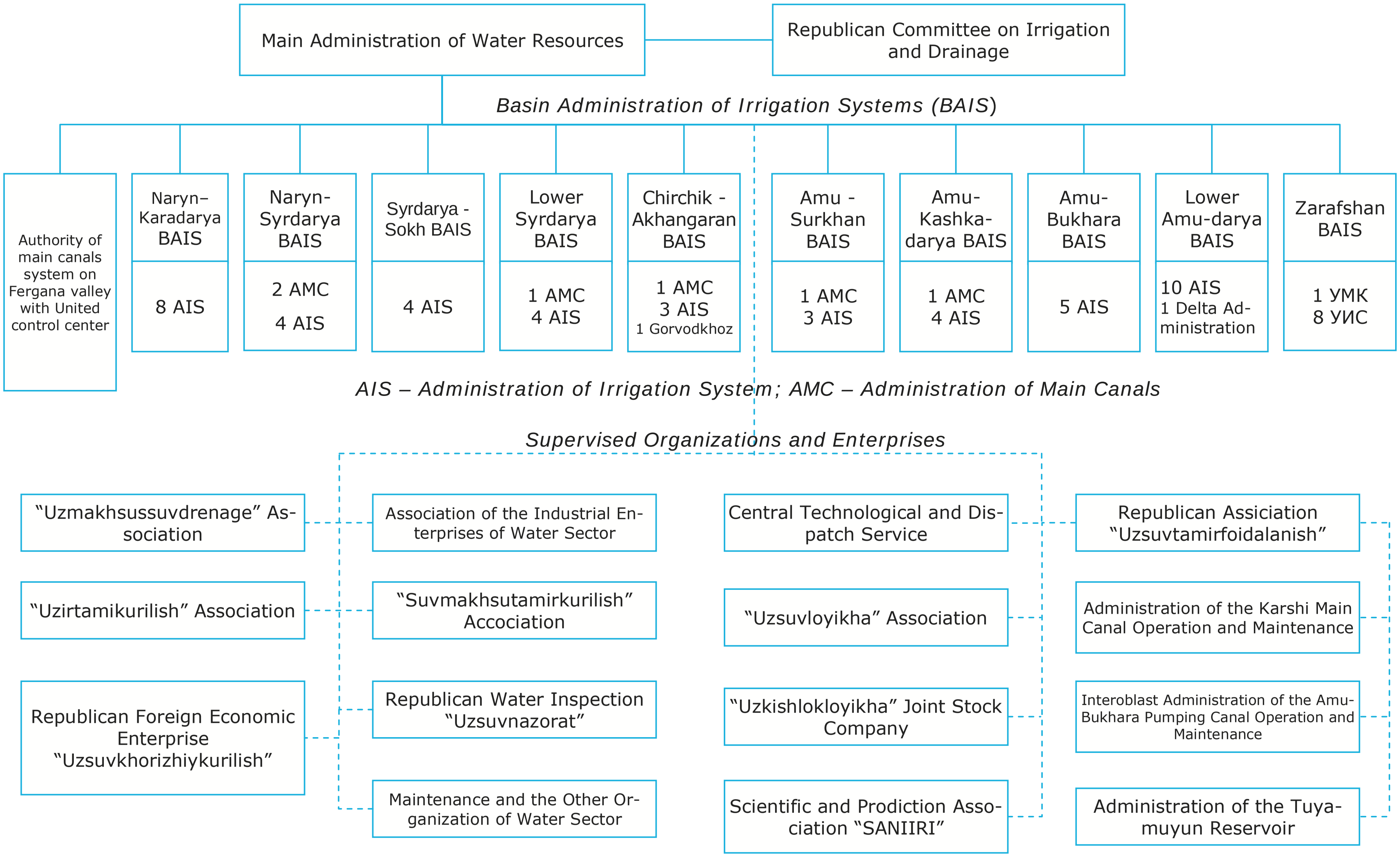
Table 3.1. **Structure of Distribution of the Republic's Oblasts and Rayons Amongst the Basin Administration of Irrigation Systems (BAIS)**

Ministry of Agriculture and Water Resources of the Republic of Uzbekistan

Main Administration of Water Resources

Lower Amudarya BAIS (Takhiotash)	The Republic of Karakalpakstan and Khorezm
Amu - Surkhan BAIS (Termez)	Surkhandarya
Amu - Bukhara BAIS (Bukhara)	Bukhara and Navoi (Kzyltepa, Navoi)
Amu –Kashkadarya BAIS (Karshi)	Kashkadarya, except for zone of the Eski-Angar canal (Chirakchi)
Zarafshan BAIS (Samarkand)	Samarkand, Djizak (Bakhmal, Gallyaaral, Djizak); Navoi (Khatyrchi, Navbakhor) Kshkadarya (Chirakchi)
Lower Syrdarya BAIS (village Uchtam Sardoba)	Syrdarya and Djizak (Arnasai, Dustlik, Zaamin, Zarbdor, Zafarabad, Mirzachul, Pakhtakor, Farish and Yangiabad)
Chrchik - Akhangaran BAIS (Tashkent)	Tashkent
Syrdarya - Sokh BAIS (Fergana)	Fergana
Naryn – Syrdarya BAIS (Namangan)	Namangan
Naryn – Karadarya BAIS (Andidjan)	Andidjan

Table 3.2. **Managerial Structure of Water Resources Administration of the Republic of Uzbekistan [72]**



ANNEX 4

Figure 4.1. **Amudarya River Scheme (GEF/WB, WEMP, 2002)**

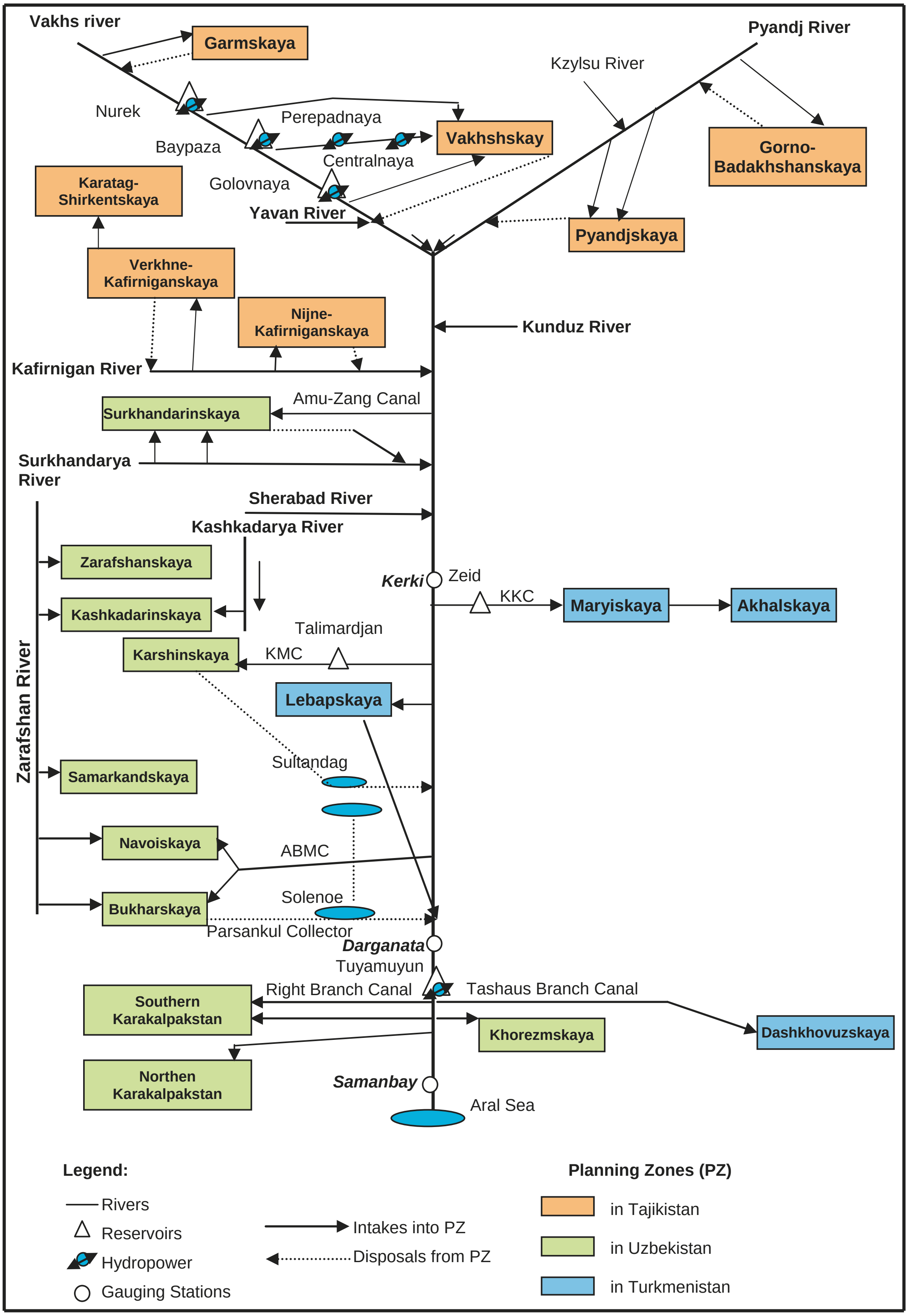


Figure 4.2. **Syrdarya River Scheme [72]**

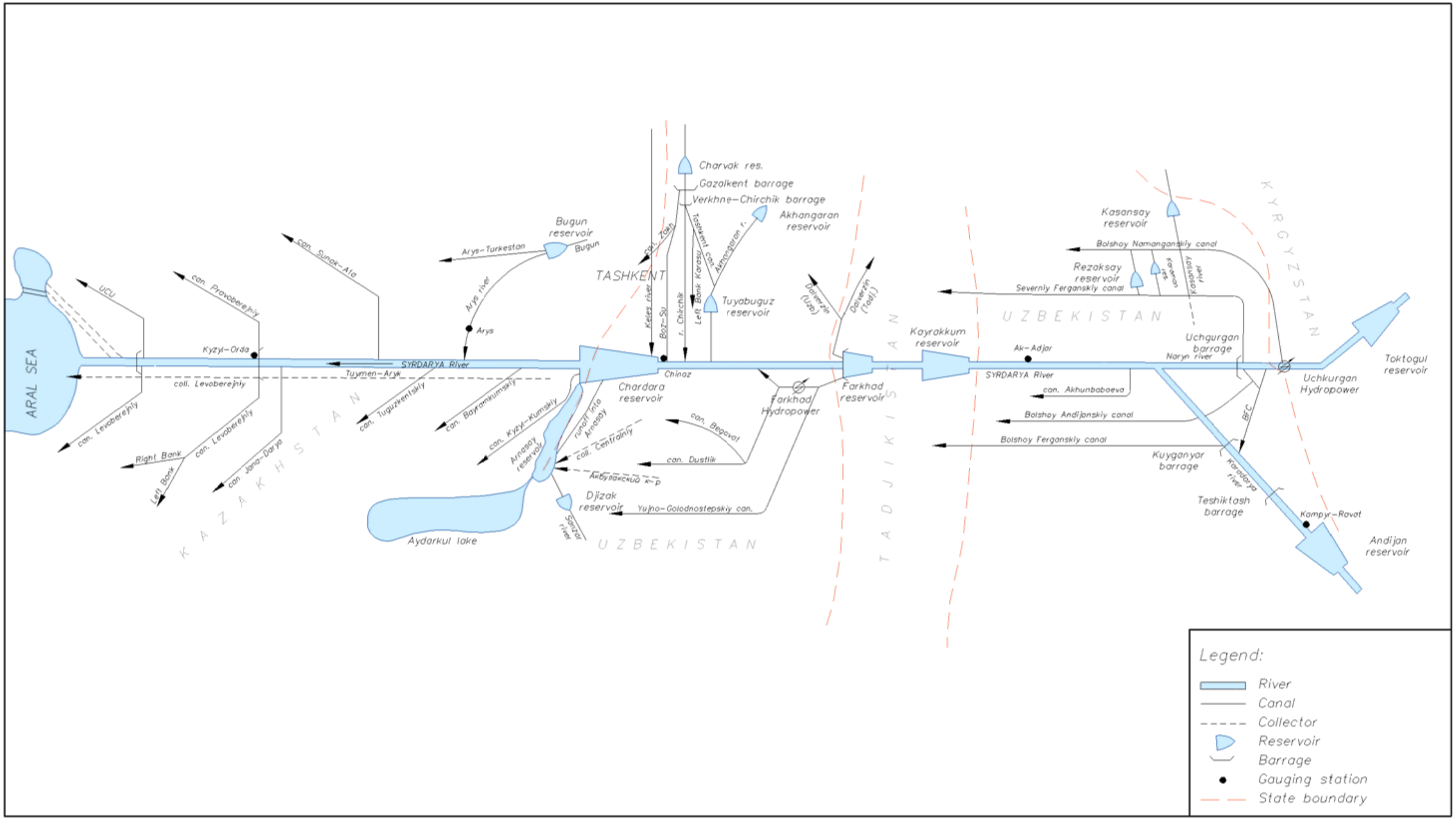


Table 5.1. **Preferable Projects from the River Basin Management Viewpoint, Right Bank of the Amudarya River (WB Uzbekistan Drainage Project, EA, 1997)**

Sector	Management Objective	Tasks to be Solved	Preferable Option	Compromise
Water Resources	Water Quality Management	Use of local depressions for salts accumulation; increase of irrigation systems efficiency	Connection of Sichankul - Sultandag - Dengizkul; Karateren pumping station	Creation of flowage and/or balance between confined and flow-through system of depressions for conservation of biodiversity
Land Resources	Salinity and Water Logging Reduction	Improvement of the on-farm irrigation and drainage systems; improvement of inter-farm collector and drainage network	Beruni collector	Serious improvement of irrigation practice and maintenance of stable regime of wetlands management
Biological Resources	Increase of Biodiversity	Compensation of biodiversity losses in the basin and creation of wetlands	Connection of Sichankul - Sultandag - Dengizkul; Beruni collector	Compromises are similar to the ones for the previous objectives. In addition, development of the Akhchadarya river wetlands and conservation of pastures for stockbreeders and households in project area.
Social Economy	Support to Economic Development	Capacity building for economic development	Beruni collector	Development of the Akhchadarya river wetlands and conservation of pastures for stockbreeders and households in project area.
Managerial Structures	Compliance of projects with managerial capabilities; development of managerial structures	Feasible development of managerial structures	Use of system of the preferable projects; Water resources management; Ecological resources management	Development of management structures for both water and biological resources.

Table 5.2. **Regional and National Projects Financed by the International Donors in Uzbekistan**

Project Title	Financing Agency	Implementation Period	Budget, mln. USD	Implementation Agency / Local Counterpart
Water / Irrigation				
Project on municipal water supply and improvement of sanitary conditions in Bukhara and Samarkand	WB; SECO	2002-2007	40.9	Water Supply Organizations (Vodokanal) of Bukhara and Samarkand
Rural Water Supply and Improvement of Sanitary Conditions	WB	1997-2005	75	State Statistics Agency (Goskomstat)
Drainage, Irrigation and Waterlogged Lands Improvement Project (Phase - I)	WB	2003-2010	60	MAWR; Mott MacDonald & Temelsu
Amu-Zang Irrigation System Rehabilitation Project	ADB	2004-2009	73	MAWR
Rural water supply Project in Western Uzbekistan	ADB	2002-2005	38	Ministry of Economy
Urban Water Supply	ADB	2001-2007	36	Agency of Municipal Services of the RUz
Rural Water Supply	SDC	2004-2006	1.7	International Secretariat on Water Issues
Assistance in Liquidation of Drought Impacts in the Aral Sea Region	ADB	2002	0.15	Ministry of Economy
Possible Services and Water Conservation for Indigent Urban Inhabitants	ADB	2004-2006	1.5	Ministry of Economy
Drinking Water Supply in the Khorezm Oblast. Improvement of Health Care in Various Regions	Germany / Creditunstal	1995-2005	13.8	Cabinet of Ministers, AIK Obi Khaet
Central Asian Regional Information Base on Water (CAREWIB)	SDC	2003-2006	0.29	SIC ICWC; GRID-Arendal;
Regional Center of Hydrology (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan)	SDC	2002-2003	1.5	SDC on water and geology
Canals Automation Project in Fergana Valley (Kyrgyzstan, Tajikistan, Uzbekistan)	SDC	2002-2005	1.3	BVO "Syrdarya"
Integrated Water Resources Management (Kyrgyzstan, Tajikistan, Uzbekistan)	SDC	2001-2005	2.3	SIC ICWC; IWMI
Project on Training in Water Resources Management in the Central Asia	CIDA	2000-2005	1.5	SIC ICWC; McGill University; Canada
Central Asia Natural Resources Management Program (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan)	USAID	2000-2005	35	PA Consulting
Water User Associations Support Program (Kyrgyzstan, Tajikistan, Uzbekistan)	USAID	2004-2007	25	Winrock Int., USAED; New Mexico
Integrated Water Resources Management in Low Lands and Deltas of the Aral Sea Basin (Kazakhstan, Turkmenistan, Uzbekistan)	US State Department	2004-2005	0.12	SIC ICWC
Regional Training Course "Assistance to Water User Associations "	JICA	2004-2008	0	IC Tsukuba, Japan

Economic and Ecological Restructuring of Land and Water Use in the Khorezm Oblast	BMBF	2002-2006	1.3	MAWR
Development of Program for Preparation of Indicators for Environment and Water Resources Management in the Central Asia (EWASIA)	EU TEMPUS	2003-2006	0.5	Wageningen University;ТИИМ
Water Resources Management and Agricultural Production in the Central Asian Republics (WARMAP)	EU TACIS	1995-2000	4.75	Aquater, DHV
Water and Environment Management in the Aral Sea Basin	GEF; EU TACIS	1998-2003	22.8	GEF Agency, IFAS
Special UN Program on Economy of the Central Asia (SPECA)	UNECE, UNESCAP		0	Governments of Central Asian countries
Improvement of Irrigation Water Use Efficiency and Water Quality in Uzbekistan	STCU	2003-2006	0.3	Scientific/Research Institute (SRI) of Cotton Production; SRI of Veterinary
Cooperative International Study of the Transboundary Rivers Pollution in the Central Asia	STCU	2003-2006	0.15	Institute of Nuclear Physics
Total on Water			436.86	
Agriculture				
Project on Support to Rural Industrial Enterprises	WB	2001-2006	36.14	MAWR
Ak-Altyn Agricultural Development Project	ADB	2001-2004	36	MAWR
Agricultural Development Project in Karakalpakstan	JICA	2005-2008	0	Council of Ministers of Karakalpakstan
Training for Professional and Senior Management Staff of Agricultural Sector in the Central Asian Countries	BMZ	2006-2014	2.2	Germany, TIIM and CAR Universities
Regional Network for Assistance in Wheat Growing and Seed Productivity in the Central Asia	BMZ	2002-2005 (accomplished)	1.6	MAWRs, Institutes of Selection jointly with CYMMIT.
Economic Development in the Selected Regions of Uzbekistan (Component: Sustainable Use of Land Resources in Karakalpakstan)	BMZ	2005 - 2011	1.2	Cabinet of Ministries of the RUz and Council of Ministries of the RK, MAWR
Total on Agriculture			77.14	
Land / Desertification				
Land Improvement Project in the Bukhara, Navoi, and Kashkadarya Oblasts	ADB	2004-2005	0.55	MAWR
Assistance to the private agricultural sector of Uzbekistan and improvement of forest plantations on the dried bottom of the Aral Sea	GTZ	1995-2006	0	Goskompriroda
Integrated management for sustainable use of saline and gypsiferous soils and Component Field Farmer Schools (FAO/TCP/UZB/2901	FAO	2002-2005	0.36	MAWR, Uzgipromeliovodkhoz
Sustainable agricultural practice in the droughty regions of Karakalpakstan (FAO/TCP/UZB/2903)	FAO	2003-2005	0.37	MAWR, SANIIRI / ICARDA
Increase of cotton and wheat productivity through adaptation of soil conservation farming system (FAO/TCP/UZB/3001)	FAO	2004-2005	0.36	MAWR, TIIM

Stabilization of the dried areas of the Aral Sea in Central Asia – Option for continuation from 2006 (continuation of the Aral Sea project in the RUz)	BMZ	2005 - opened	3.8	MAWR of RUz and Kzy-lorda, Kazakhstan
Regional Project "Support to implementation of the UN Convention to Combat Desertifica-tion (UN CCD) in Asia"	BMZ	2001-2007	5.2	GTZ in the countries of Asia
Sustainable management of situation associ-ated with locust in the Central Asia (Kazakhstan and Uzbekistan)	BMZ	2003-2007	2	MAWRs of KAZ and UZB
Combat desertification and amelioration of saline soils in the Aral Sea region (Kazakhstan)	BMBF	2001-2004		University of Bielefeld, Germany
Assistance to ecologically sustainable agricul-ture and from 2001: Recultivation of the dry Aral Sea bottom and assistance to the private sector of agriculture and business	BMZ	1995-2004 (accomplish ed)	8.8	MAWR
Initiative of the Central Asian Countries in Land Resources Management (ICACLRM) (Kazakhstan, Kyrgyzstan, Tajikistan, Turk-menistan, Uzbekistan)	GEF; Bilateral Governments	2005 (disap-proved)		ADB
Economic and ecological restructuring of land and water use in the Khorezm Oblast (Uzbekistan): Development study pilot project: Second Phase from 2002 to 2006, Approved	Government of Germany (BMBF)	2001-2011	1.3	MAWR, UNESCO; ZEF; DLR
Total on Land			22.74	

Sources: CACILM, NFP of Uzbekistan, 2006

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