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DEVELOPMENT OF REGIONAL COOPERATION TO ENSURE WATER QUALITY IN CENTRAL ASIA

Diagnostic Report and Cooperation Development Plan

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Economic Commission for Europe
in cooperation with
Regional environmental centre for Central Asia

TOWARDS DEVELOPMENT OF REGIONAL COOPERATION IN ENSURING WATER QUALITY IN CENTRAL ASIA

Diagnostic Report and Cooperation Development Plan

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FOREWORD

The Diagnostic Report was prepared within the framework of the United Nations Economic Commission for Europe (UNECE) “Water Quality in Central Asia” project, which is implemented in cooperation with the Regional Environmental Centre for Central Asia (CAREC). The project aims at enhancing the development of an efficient and coordinated policy on improvement of water quality in the framework of integrated water resources management in Central Asia.

The Report contains the following information:

- A review and an assessment of management systems, and legislative and regulatory frameworks in the countries of Central Asia;
- A review of monitoring systems and water quality regulation mechanisms in Central Asia;
- A review of international practice in water quality management;
- Recommendations on the introduction of applicable water quality management models in Central Asia;
- Recommendations on the organization of water quality monitoring and data exchange;
- An assessment of the current status of cooperation among the countries of the region on issues of water quality regulation;
- An action plan for regional cooperation in Central Asia.

The Diagnostic Report represents a synthesis of numerous reports by the following national and regional experts: A. Jumagulov, M. Burlibaev, I. Petrakov and R. Kaidarova (Kazakhstan); T. Neronova and A. Jailoobaev (Kyrgyzstan); A. Tyuryaev and I. Saidov (Tajikistan); S. Aganov and B. Ballyev (Turkmenistan); and G. Bensitova and Z. Yarullina (Uzbekistan), with the participation of K.Valentini, S. Ahmetov and E. Orolbaev.

The action plan for regional cooperation to ensure quality of surface water resources in Central Asia and the review of international practice in water quality management were prepared by R. Melian and V. Mosanu, project consultants. Recommendations on monitoring and data exchange on water quality indicators were developed by M. Lindenlaub.

A draft of the report was discussed in December 2010 and April 2011 in Almaty, and in May 2011 in Bishkek, with proposals for improvements made by A. Shamshieva, S. Ibraev, M. Mamanazarov, A. Golotyuk, L. Nyshanbaeva, E. Sahvaeva, H. Ibodzoda, B. Rahmonov, S. Samiev, B. Gozieva, A. Sufiev, R. Milibaeva, J. Alimjanov, R. Bespalova, S. Yanova and other participants of the working meetings.

From the United Nations, general management of the project was carried out by B. Libert (UNECE). The work of national experts and consultants on the project was coordinated by E. Strikeleva, A. Nikolaenko and I. Mirkhashimov (CAREC).

The authors hope that dissemination of the report will facilitate cooperation on and improvement of water quality management systems in Central Asia.

ABBREVIATIONS AND ACRONYMS

BOD	Biological Oxygen Demand
BWA	Basin Water Organization
CAC	Central Asian Countries
CAREC	Regional Environmental Centre for Central Asia
CIS	Commonwealth of Independent States
COD	Chemical Oxygen Demand
EC	European Commission
EC IFAS	Executive Committee of the International Fund for Saving the Aral Sea
EECCA	Eastern Europe, the Caucasus and Central Asia
EU	European Union
FWUA	Federal Water Users Association
GIS	Geographic Informational System
GNP	Gross National Product
GOST	State Standard
ICSD	Inter-State Commission for Sustainable Development
ICWC	Inter-State Commission for Water Coordination
IFAS	International Fund for Saving the Aral Sea
IPPC	Integrated Pollution Prevention and Control
IWRM	Integrated Water Resources Management
MAC	Maximum Allowable Concentration
MACL	Maximum Allowable Concentration Level
MAD	Maximum Allowable Discharge
NGO	Non-Governmental Organization
OECD	Organization for Economic Co-operation and Development
OSCE	Organization for Security and Co-operation in Europe
PAH	Polycyclic Aromatic Hydrocarbon
PIL	Permissible Impact Levels
RWG	Regional Working Group
TMDL	Total Maximum Daily Load
TSS	Total Suspended Substances
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
USSR	Union of Soviet Socialist Republics
WFD	Water Framework Directive
WPI	Water Pollution Index
WQS	Water Quality Standard
WUA	Water Users Association

PART I. ASSESSMENT OF THE WATER QUALITY MANAGEMENT SYSTEM IN CENTRAL ASIA

INTRODUCTION

Guaranteed access of the world's population to safe drinking water is one of the key targets of the Millennium Development Goals proclaimed by the United Nations. Achievement of this objective is essential for Central Asia, where, owing to the geography and climate, the social and economic development of each of the five countries in the region is heavily dependent on the good status and efficient use of their water resources. The effects of global climate change, population growth and the development of water-using economic sectors, however, along with the continued practice of unsustainable water use, have led to an increasing scarcity and deteriorating quality of water resources in the region.

Upon their recent independence, the Central Asian states were compelled to tackle vital internal political and social problems, combat poverty and ensure food and energy security. Under such circumstances, the issues of environment and health, including water quality improvement were given lesser importance. Consequently, the region has recently seen a vast degradation of its water monitoring systems due to abrupt reductions in budgeting for pollution prevention and mitigation programs. The consumption of poor-quality water has led to a marked deterioration in human health in the region. In addition, there has been a reduction in the biodiversity of water ecosystems and agricultural productivity as a result of soil salinization and over-mineralization of irrigation water. Such threats require adequate countermeasures, including the overhaul and modernization of the approach to water management and protection at national and regional levels.

CHAPTER 1: WATER RESOURCES IN CENTRAL ASIA

The climate of the region is sharply continental and dry. Considerable differences in elevation (reaching more than 7,500 m, extremely non-uniform territorial distribution of precipitation (from less than 100 to more than 1000 millimetres of rain per year), locations proximate to sea and mountainous zones, and particular features of local landscapes all contribute to substantial differences in water reserves and water use conditions in the countries of the region. Kyrgyzstan and Tajikistan are zones of run-off formation, and most of the territories of Kazakhstan, Turkmenistan and Uzbekistan are zones of water flow dispersion.

KAZAKHSTAN is mainly a flat country with the exception of mountains in the eastern and south-eastern part of the territory. The total area of glaciers is approximately 2033 km^2. The current freshwater reserves in the mountain glaciers are estimated at 85 km^3. There are 85022 rivers and intermittent streams in the country, including 84694 rivers with a length of up to 100 km and 305 up to 500 km, and 23 rivers longer than 500 km. The rivers and watercourses are attributed to eight water basins: Aral-Syr Darya, Chu-Talas, Balkhash-Alakol, Irtysh, Ishim, Nura-Sarysu, Tobol-Torgai and Ural-Caspian. The largest transboundary rivers are the Irtysh, Ishim, Tobol, Ural, Syr Darya, Ili and Chu. In an average year, the total annual run-off is 100.5 km^3. Over half of the total river flow is formed within the country's territory, while the rest comes from the neighbouring states. The average annual return flow is about 9 km^3. The volume of drainage waters does not exceed 4 km^3/year. The reserves of fresh, low and highly saline water resources in the 48000 lakes are estimated at 190 km^3.

Table 1

Area and population in Central Asia

	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Total population (in millions)	16,4	5,3	7,6	4,9	28
Area (in millions of km^2)	2,724	0,198	0,143	0,491	0,448

Among the largest inland lakes are Balkhash, Alakol, Zaisan, Sasikkol, Markakol, Kurgaldzhino and Tengiz. Part of the Caspian and the Aral Sea are also under the jurisdiction of Kazakhstan. There are 626 underground freshwater deposits. Confirmed reserves of these waters are estimated at 16 km^3/year, and explored reserves are approximately 45 km^3/year. Kazakhstan contains seven wetlands declared to be of international significance, with the total area of more than 1626 thousand ha. Kazakhstan currently exploits 200 reservoirs with a total storage capacity of more than 95.5 km^3. The largest reservoirs are the Bukhtarma, Kapshagay and Chardara water reservoirs. The maximum rates of water intake (24.8 km^3/year) and water use (21.4 km3/year) were observed in 1980s-1990s. In recent years, however, water withdrawal rates have dropped to 19-20

km^3/year. The use of groundwater has also decreased from 2.0 km^3/year to 1.7 km^3/year.

Annually, out of total domestic water use in Kazakhstan ~57 per cent goes to regular irrigation; ~1.6 per cent to 'liman'irrigation[1]; ~33 per cent to industrial purposes; <5.0 per cent to municipal water supply; ~2.6 per cent to the needs of rural water supply; and 0.8 per cent to irrigation of pastures. These data clearly show that in Kazakhstan the share of water resources used for industrial and household needs is much higher than in other countries of the region. The agricultural sector is the second largest in the national economy after industry. In the agricultural sector, rain-fed farming dominates over irrigated farming. The area of irrigated land represents 1.38 million ha.

Most water bodies in Kazakhstan are assessed as moderately polluted, however water bodies in mountainous and submontane zones of run-off formation are rated as clean, and a number of rivers, reservoirs and lakes in the zones of water-flow dispersion are assessed as polluted and extremely polluted. During 1990-2000, the discharge of pollutants into natural water bodies was observed to drop, but after 2001 the volume of water pollution started to increase. The main sources of water pollution are industries, including mining, agricultural enterprises, municipal sewerage systems and municipal wastes.

KYRGYZSTAN is a mountainous country with 94 per cent of its territory situated in more than 1000 meters above sea level. The country ranks second in Central Asia for its water reserves per capita. The total area of glaciers is more than 8000 km2, or 4.2 per cent of the country's territory. Current freshwater reserves in the mountain glaciers are estimated at 650 km3. In Kyrgyzstan, there are more than 3500 rivers belonging to the water basins of Syr Darya, Amu Darya, Chu, Talas, Ili, and Tarim Rivers and Lake Issyk-Kul. The major transboundary rivers are Syr Darya, Naryn, Kara-Darya, Chu, Talas, Chatkal, Sary Jaz and Jong-Isen-Gibush. The total annual runoff varies between 44 and 50 km3 (including return waters), depending on different water years.

Although, a vast amount of surface waters is formed in the country, not more than a quarter of the annual river runoff is used for national water consumption, the rest being supplied to neighbouring states. The amount of drainage water (1.3 km3/year) is estimated as insignificant.

Reliable data on annual volume of return flows for the past 20 years in Kyrgyzstan is not available. Reserves of fresh and slightly saline water resources of lakes, mainly those of Lake Issyk-Kul, are estimated at 1 745 km3 and make up approximately 71 per cent of the national water resources.

There are 626 underground freshwater deposits. Confirmed reserves of these waters are estimated at 16 km3/year, and explored reserves are approximately 45 km3/year.

There are 106 underground freshwater deposits in the country, of which only 44 were studied. Useful reserves of these resources are estimated at 6.1 million m3/day, and probable reserves are approximately 11-13 million m3/day. The total groundwater potential in Kyrgyzstan is insufficiently studied. The total area of waterlogged areas, which are mainly concentrated in the areas with higher groundwater levels, is less than 0.5 per cent of the territory.

At present, numerous reservoirs (with a total storage capacity of over than 22 km3) are operational in Kyrgyzstan. The largest reservoir is the Toktogul Hydropower Station, followed by Ortho-Tokoi, Kirov and Papan reservoirs for irrigation purposes. The maximum water intake rates (13.93 km3/year) and water use (10.05 km3/year) were observed in 1988. However, in recent years, water withdrawals decreased to 7.5-10 km3/year. The use of groundwater has also decreased from 1.0 to 0.2-0.3 km3/year.

The structure of domestic water consumption is fairly stable; on average 90 percent of water is used for irrigated agriculture, about 6 per cent for industry and less than 3 per cent for municipal needs, including drinking water supply for urban and rural populations. Forestry, fishery, energy and other water-using sectors and services use less than 1 per cent of total domestic water consumption. The agricultural sector, including irrigated agriculture, is the leading sector, with irrigated areas accounting for 1.02 million ha.

In general, water resources of Kyrgyzstan are assessed as clean and very clean. There has been no significant trend in water quality deterioration over the last decade, however occasional exceedances of water pollution limits in the Chu basin and in southern parts of the country were observed, mainly in the vicinity of populated areas. The main sources of water pollution are agriculture, and to a lesser extent, industry, municipal sewerage systems and household waste. Potential hazards for natural water bodies and people's lives are dumps, including tailing dumps of the mining industry located in alluvial fans and floodplains of rivers, where radioactive waste and salts of heavy metals are buried.

A significant factor that has an adverse impact on quality of water resources is a disorderly type of economic activity in water protection zones and strips of surface water bodies, as well as the poor status of sanitary protection zones of groundwater deposits.

TAJIKISTAN is a mountainous country. By specific indicators of water reserves per capita the country ranks first in Central Asia. The total area of glaciers is more than 11 000 km^2, or 8 per cent of the country's territory. Current freshwater reserves in mountain glaciers are estimated at 845 km^3. The republic has more than 25 000 rivers within the river basins of the Syr Darya, Amu Darya and Zeravshan. The largest transboundary rivers are the Syr Darya, the Amu Darya, the Bartang and the Zeravshan. The total annual run-off varies between 25 km^3 and 68 km^3 depending on the water content of the year.

Most surface waters are formed in the country, though just a quarter of annual river run-off is used for national water consumption, the rest being supplied to neighbouring states. Average annual return waters reach 2.2 km^3/year. The amount of drainage waters is estimated as insignificant. Reserves of fresh and slightly saline water resources of 1 300 lakes make up about 46.3 km^3, the largest being Lake Sarez with a volume of 17.3 km^3. Useful underground freshwater resources are estimated at 6 million m3/day, with probable reserves of

1 The 'liman' system of irrigation consists of a temporary flooding of a certain area by the waters in the spring, by retaining it between embankments 'limans'. Duration of flooding of 'limans' depends on vegetation and irrigated crops, water-holding capacity of the soil and the depth of moistening (usually 10-20 days).

around 18 million m^3/day. Tajikistan is exploiting nine large reservoirs with a total storage capacity of 15.3 km^3. The largest is the Nurek reservoir. The maximum levels of water intake (~14 km^3/year) and water use (~11 km^3/year) were reached in 1980-1990s. Since then, however, water intake has dropped to 9.5-10 km^3/year. The structure of domestic water use has been significantly transformed recently: more than 97 per cent of water is used for irrigated agriculture, ~1.0 per cent for industry, ~0.43 per cent for household use and drinking water supply and 0.65 per cent for rural water supply. Altogether, other water-using economic sectors and services use about 0.2 of total domestic water consumption. Agriculture, including irrigation, is the key water-using sector of the economy, and the area of irrigated land exceeds 0.74 million ha.

On the whole, the water resources of Tajikistan are assessed as clean and very clean. There has not been a significant deterioration in water quality over the past decade. Moreover, the volume of pollutant discharges into natural water bodies has decreased by almost one third. Currently, the major sources of pollution are discharges of mineralized drainage waters and untreated sewage into rivers, as well as unplanned disposal of household waste in rural settlements close to watersheds.

TURKMENISTAN is mainly flat with the exception of the Kopetdag and Paropamiz mountain ranges and their foothills in the southern and south-western part of the country. Per capita water reserves of Turkmenistan are considered the lowest in the region. There are practically no glaciers in Turkmenistan. The largest transboundary river and the key source of water resources is the Amu Darya (88 per cent of average annual runoff). Among other comparatively large transboundary rivers are Murgab and Tedjen, and smaller rivers – Atrek, Sumbar and Chandyr. The total amount of water resources is estimated at about 25 km^3/year. The greater part of surface waters (95-98 per cent) is formed outside the boundaries of the country. Average annual return waters are estimated at about 6 km^3/year, of which the share of drainage water is the largest, while industrial and municipal wastes in aggregate do not exceed 0.35 km^3/year. A part of the Caspian Sea Basin is also located within the borders of Turkmenistan.

Currently, the man-made Golden Age Lake is under intensive construction. The lake is to accumulate discharges from the largest drainage systems. The country has 187 deposits of fresh, brackish and saline groundwaters, of which 130 are explored. Useful groundwater resources are estimated at 6 million m^3/day, with probable reserves of around 9 million m^3/day. In the national water balance, the share of groundwater use does not exceed 2.5 per cent. The potential of groundwater resources in Turkmenistan can reach up to 70-80 km^3.

At present, Turkmenistan uses 15 reservoirs with a total storage capacity of more than 3 km^3. In addition, the Dostluk water storage reservoir on the Tedjen River, with a capacity of 1.25 km^3, was built and is operated in cooperation with the Islamic Republic of Iran.

On average, 91 per cent of the total annual water use in Turkmenistan goes to irrigated farming; about 6.3 per cent to industrial needs; about 2.0 per cent to the water supply and municipal needs of the population; up to 0.1 per cent to fishery needs; and 0.6 per cent to pasture irrigation, rural water supply and other needs. The total area of irrigated land is 1.7 million ha.

UZBEKISTAN. Surface water resources are formed by waters flowing into the rivers from the mountain areas of neighbouring states as well as resources formed on its own territory. In addition, a part of river runoff comes through canals. Waters from lakes and groundwater also contribute to Uzbekistan's domestic water resources (64 million m^3/day). According to inter-State principles of water distribution in the region, the share of water resources for Uzbekistan is estimated to be 67.0 km^3 (including reuse of return waters in the volume of 4.1 km^3), including surface water resources (55.1 km^3) and groundwater resources (7.8 km^3).

There are more than 500 lakes in Uzbekistan, basically all constituting small water bodies with an area of less than 1 km^2. Only 32 lakes have an area of more than 10 km^2. Most lakes are situated in the mountain zones at the altitude of 2000-3000 meters. Mountain lakes are usually of a slide-rock or moraine-glacial origin, with water reserves of about 50 km^3. Natural floodplains and delta lakes are located in the valleys of local rivers.

At present, the country exploits 55 reservoirs, mostly for irrigation purposes. The total design storage capacity of these reservoirs is 19.8 km^3, and useful capacity is 14.8 km^3. The largest are the Tyuyamuyun, Charvak, Tudal and Kattakurgan reservoirs, which are used in an integrated manner, and intended mostly for irrigation, power supply and industrial purposes.

Natural water bodies in Uzbekistan are generally classified as clean or moderately polluted. Water bodies in mountainous and foothill zones of runoff formation are classified as clean, while a number of rivers and reservoirs in the lower reach of the transboundary rivers are assessed as moderately polluted. The main sources of pollution are agriculture, municipal sewerage systems and industrial wastewater.

The differences in water resources and water use status among the five Central Asian countries are significant. In Kyrgyzstan and Tajikistan, for instance, the scarcity of water resources, except in specific localities, is not yet acute, however in Kazakhstan, Turkmenistan and Uzbekistan scarce freshwater resources have already become a serious constraint for sustainable socio-economic development. Meanwhile, given the projected increases in population, industrial and agricultural production, as well as the expected consequences of global climate change, there is a high risk of a gradual increase in water deficits for all the countries of the region. These risks may further escalate in case formerly unused land resources are converted for agricultural use.

Reviews of long-term water quality monitoring data reveal a number of specific trends:

- There has been a steady increase in the amount of pollutants discharged into natural water bodies from the 1970s to the early 1990s in all the Central Asian countries, whereas in the following 15-18 years those volumes stabilized and in some countries even dropped. Recent years, however, show deterioration in water quality owing to the restoration of previous production capacity and unsustainable water use.

- For the past 20 years, there has been a significant shift in the structure of water pollution sources. While the agricultural sector remains the main source of pollution – mainly due to the uncontrolled use of mineral fertilizers and various herbicides, discharges of saline drainage waters and wastewaters from cattle-breeding and processing facilities – the adverse impact of the industrial sector on water quality has decreased and that of the municipal sector has increased, owing to degradation of municipal treatment and sewerage systems, poor administrative control in water protection zones and strips of surface water bodies and the unsatisfactory state of sanitary protection zones of groundwater deposits. In the runoff zones of some Central Asian transboundary rivers, risks of water pollution from radioactive substances and salts of heavy metals were increased due to the degradation of tailings dumps and other dumps of the mining industry.
- There is a gradual increase in the concentration of polluting substances in most transboundary rivers from source to mouth. The increase in pollution in the runoff zones is due to natural factors and in water-flow dispersion zones mainly to anthropogenic causes.

CHAPTER 2: REGULATORY AND LEGAL FRAMEWORK

2.1. Review of national legislation

Currently, the countries of Central Asia have similar systems of regulation of water resources, including regulatory requirements regarding the quality of water resources. The systems include, inter alia:

- Water legislation: Water Codes of Kazakhstan (2003), Kyrgyzstan (2005) and Tajikistan (2000); Code of Turkmenistan "On Water" (2004); the Law on Water and Water Use of Uzbekistan (1993);
- Environmental legislation: laws on environmental protection of Tajikistan (1993), Turkmenistan (1991) and Uzbekistan (1992); the Law on Protected Natural Territories of Uzbekistan (2004); the Law on Environmental Protection (1999) and the Law "General Technical Regulation on Ensuring Environmental Safety" (2009) of Kyrgyzstan; and the Environmental Code of Kazakhstan (2007);
- Sanitary and health legislation, including regulation of water quality norms: Public Health and Health-care System Codes of Kazakhstan (2009) and Tajikistan (2003); the Sanitary Code of Turkmenistan (1992); the Law on State Sanitary Inspection of Uzbekistan (1992); Laws on Public Health (2009) and on Sanitary Welfare and Health of the Population (2001) of Kyrgyzstan;
- Legislation regulating procedures of State environmental impact assessment of activities, including those that influence the quality of water resources: laws on environmental impact assessment of Kyrgyzstan (1999), Tajikistan (2003) and Uzbekistan (2000); the Law on State Environmental Impact Assessment of Turkmenistan (1995); the Environmental Code of Kazakhstan (2007);
- Legislation regulating procedures of standardization of activities related to water quality management and certification of entities functioning in this area: laws on technical regulation of Kazakhstan (2004), Kyrgyzstan (2004), Tajikistan (2009) and Uzbekistan (2009);
- National legislation on drinking water;
- National legislation on the structure of state authorities, on land, on subsoil, on energy, on emergency situations, and others, with norms directly or indirectly related to water use and protection.

So far, the Central Asian countries have completed development of their legal framework for the regulation of water resources management, including water quality management. Particularly, all the national legal systems have:

- Defined the key goals, principles and mechanisms for implementation of national water and environmental policy;
- Defined competencies of governmental and non-governmental agencies in water resources management and protection;
- Defined functions, rights and responsibilities of state agencies that regulate, monitor and supervise water quality;
- Defined the order of priority for various water uses;
- Defined responsibilities of legal and physical entities for violation of water and environmental legislation, norms and rules of water use, including water quality;
- Set mechanisms and procedures for managing wastewater discharges, polluting substances; and wastes into natural water bodies, water systems and water fund lands;
- Standardized the regimes of sanitary protection zones, water protection zones and strips;
- Set mechanisms and procedures for water quality monitoring;
- Established principles and mechanisms of inter-State water resources management.

Thus, national legislation in the region as a whole ensures water quality management. There are, however, notable differences in the rates of development and implementation of legislative standards and norms among the countries, mainly due to limited investment and institutional capacity or complications stemming from national political situations. Kyrgyzstan, for example, adopted its Water Code back in 2005, but has not implemented its norms until recently. Thus, additional urgent measures are being undertaken to amend and implement the norms of the Code and a number of other key laws. In other Central Asian countries certain laws, particularly those that were developed in the first years of independence, contain regulations that require updating, amending or reviewing. As a result of these shortcomings and the limited availability of resources in most of the countries, the current framework of environmental legislation in the region is not being fully implemented.

A comparative analysis of the legislation reveals discrepancies among the five countries in their approaches on a number of issues: the implementation of the principles of integrated water resources management; economic mechanisms of environmental management; the regulation of property rights related to water infrastructure facilities; the participation of non-governmental organizations (NGOs) and water users in the management processes; and the use of hydrographic principles of water management, among others. While each State has sovereign rights to develop its policies, the persistence of these discrepancies may hinder the harmonization of national legislation, and cooperation at the regional level may depend on the development of bilateral or multilateral agreements.

2.2. Review of national systems of water quality standardization

Official regulatory and legal enactments include Government resolutions, technical standards and regulations, guidelines, instructions and other official documents that have a legal force and specific mechanisms and procedures for implementation of legislation. In the planning and implementation of water conservation activities, water quality

Table 2

Standards and norms of water quality regulation in Central Asia

Water quality standards and norms	Countries of Central Asia				
	Kazakh-stan	Kyrgyz-stan	Tajikistan	Turkme-nistan	Uzbekistan
1	2	3	4	5	6
GOST 27065-86 (ST CMEA 5184–85.) Water quality. Terms and definitions	+	+	+	+	+
GOST 17.1.1.02–77. Environmental protection. Water Sector. Classification of water bodies	+	+	+	+	+
GOST 17.1.3.07–82. Environmental protection. Water Sector. Rules of water quality control in water bodies and watercourses	+	+	+	+	_
GOST 17.1.3.04–82. (ST CMEA 3077– 81) Environmental protection. Water Sector. General requirements for protection of surface water and groundwater from pesticides pollution	+	+	–	_	+
GOST 17.1.3.05-82. (ST CMEA 3077–81) Environmental protection. Water Sector. General requirementsfor protection of surface water and groundwater from oil and mineral oil pollution	–	–	+	+	+
GOST 17.1.5.04-81. Environmental protection. Water Sector. Instruments and devices for selection, primary treatment and storage of natural water samples. General technical specifications	+	+	+	+	+
GOST 17.1.5.05-85. Environmental protection. Water Sector. General regulations for selection of samples of surface waters and seawaters, ice and atmospheric precipitation	+	+	+	+	+
GOST 17.1.5.01-80. Environmental protection. Water Sector. General requirements for sampling of bottom sediments of water bodies for pollution analysis	+	–	+	_	+
GOST 17.1.1.01–77. Environmental protection. Water Sector. Utilization of water and water protection. Basic terms and definitions	+	+	+	_	+
GOST 17.1.2.03–90. Environmental protection. Water Sector. Criteria and quality characteristics of water for irrigation	+	+	+	+	+
GOST17.1.3.08–82. Environmental protection. Water Sector. Procedures for quality control of marine waters	+	–	–	+	+
GOST 2874–82. Drinking water	–	–	+	+	–
GOST 2874–82. Drinking water. Hygienic requirements and quality control	–	–	–	+	–
GD 52.24.309–92. Organization and performance of regular observations of the surface water pollution within the RoskomhydrometNetwork	–	+	+	–	–
GD 52.24.66–86. Measurement accuracy control system for the monitored environment pollution indices	–	+	+	_	+

1	2	3	4	5	6
GD 52.24.508–96. Guidelines. Organization and performance of transboundary surface waters status monitoring subsystems	–	+	+	–	+
GD 52.24.603–2002. Guidelines. Method for an integrated assessment of surface waters impurity index by hydrochemical indicators	–	+	+	–	+
HBH 33–5.3.01.85. Analysis sampling instructions	–	–	+	–	+
Guidelines on principles for organization of water quality monitoring and control system for water bodies and watercourses within the GoskomhydrometNetwork under the framework of State service for observation and pollution control of environmental objects	+	+	+	+	+
Temporary guidelines for hydrometeorological stations and posts in sampling and preparing water and soil samples for chemical and hydrobiological analysis and providing a baseline analysis	–	+	+	–	+
Goskomhydromet Guidelines for formalized integrated surface water and seawater quality assessment	+	+	+	–	+
Guidelines for chemical analysis of surface waters	–	+	+	–	+
Generic list of MAC and safe reference levels of impact (SRLI) of harmful substances for fishery water bodies	+	+	+	–	+
Guidelines for chemical analysis of surface waters	+	+	+	–	+
Guidelines for analysis of causes of extremely high levels of environment pollution. Hydrometeoizdat	+	+	+	–	+
Guidelines for sampling of water and bottom sediments at the regional network stations of water quality monitoring in the Aral Sea Basin. Central Asia hydrometeorological research institute (SANIGMI)	–	+	–	–	+
SanPiN 4630–88. Sanitary rules and norms of surface water protection against pollution	–	+	+	–	+
SanPiN 2.1.4.559–96. Sanitary rules and norms	–		+	+	–
SanPiN3.02.002.04. Sanitary and epidemiologic requirements for water quality of centralized water supply system	–	+	+	+	–
SanPiN3.02.003.04. Sanitary and epidemiologic requirements for protection of surface waters against contamination	–	+	+	–	–
SanPiN3.02.003.04. Sanitary and epidemiologic requirements for protection of surface waters against contamination	–	+	–	+	–
Standard RUzO,zDSt 950–2011. Drinking water. Sanitary requirements and quality control	–	–	–	–	+
Standard RUzO,zDSt 951–2011.Sources of centralized household and drinking water supply.Sanitary and technical requirements and selection criteria	–	–	–	–	+

1	2	3	4	5	6
Standard RUz RH 84.3.7.–2004. Procedures for development and preparation of draft standards of maximum acceptable discharges of polluting substances into water bodies and onto land	–	–	–	–	+
KazStandard P 51592–2003. Water. General requirements for implementation and methods of quality control	+	–	–	–	–
List of MACs and SRLIof harmful substances for water in fishery water bodies, 1990	+	–	–	–	+
KyrgyzStandard MJ 64–04. Maximum acceptable concentrations (MAC) of chemical substances in water of water bodies for household, drinking and community water use, 2004	–	+	–	–	–
KyrgyzStandard. Acceptable reference levels (ARL) of chemical substances in water of water bodies for household, drinking and community water use	–	+	–	–	–
KyrgyzStandard. Maximum acceptable concentrations (MAC) of chemical substances in water of water bodies for household, drinking and community water use in protection activity zones of chemical weapons storage depots and destruction facilities	–	+	–	–	–
KazStandard. Sanitary rules. Sanitary and epidemiologic requirements for water sources, household and drinking water, sites of community water use and safety of water bodies	+	–	–	–	–
SRD 01.01.03–94 Rules for protection of surface water in the Republic of Kazakhstan	+	–	–	–	–

Note: *For abbreviations in this table, please refer to the list of acronyms at the beginning of the publication. (+) Element included. (-) Element not included*

Table 3

Comparative data on water quality indicators in the Central Asian countries

Monitored indicators of water quality status	Unit	Common methods of determining indicators	Monitoring of indicators in Central Asian countries				
			Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
1	2	3	4	5	6	7	8
Hydrological indicators							
Water discharge, Q	m^3/s	«Speed-area»	+	+	+	+	+
Water depth, H	M	Geometric	+	+	+	+	+
Water flow, V	m/s	Tachometer	+	+	+	+	+
Hydromorphological indicators							
Integrated pollution index	number	Rated	+	+	–	not known	+
Physical indicators							
Water temperature	t°C	Liquid thermometer	+	+	+	+	+
Odours at 20°C	number	Organoleptic	+	–	+	+	+
Colour of water	Height of liquid column, cm	Cf. Reference standard	+	–	+	+	+
Floating material	pre-sence	Gravimetric	–	–	–	–	+
Suspended matter	Mg/l	Gravimetric	+	+	+	–	+
Dissolved oxygen, O_2	mgO_2/l	Winkler method	+	+	–	+	+
Chemical oxygen demand, COD	mgO_2/l	Titrimetric	+	+	–	+	+
Biochemical oxygen demand BOD_5/BOD_{total}	mgO_2/l	Titrimetric	+	+	–	+	+
Reaction pH	number	Indicator	+	+	+	+	+
Transparency	cm	Cf. standard type	+	–	+	–	+
Hardness	Mg/l	Complexometric	+	+	–	not known	+
Alkalinity	Mg/l	Titrimetric	+	+	–	not known	+
Bacteriological indicators							
Lactobacillus	unit/l	Membrane, Direct seeding technique	+	+	–	not known	+
Coliphage	unit/l	Titration	+	+	–	not known	+
Total content of coli bacteria	unit/100ml	Titration, Hollow-fibre filtering	+	+	–	not known	+
Faecal coliform bacteria	unit/100ml	Titration, Hollow-fibre filtering	+	+	–	not known	+
Faecal streptococci	unit/100ml	Titration, Hollow-fibre filtering	+	+	–	not known	+
Intestinal enterococci	KE/100ml	Titration Hollow-fibre filtering	+	+	–	not known	+
Colibacillus	KE/100ml	Titration Hollow-fibre filtering	+	+	–	not known	+

1	2	3	4	5	6	7	8
Helminth eggs	EPG	Titration Hollow-fibre filtering	+	+	–	not known	+
Total microbial count (TMC)	KOE/ml	Titration Hollow-fibre filtering	+	+	–	+	+
Coli – index	unit/1	Titration Hollow-fibre filtering	+	+	–	+	+
Nutrients							
Total Nitrogen, N_{total}	mg N/l	Titrimetric	+	+	–	not known	+
Nitrates, NO_3	mg N/l mg NO_3/l	Spectrophotometric	+	+	+	+	+
Nitrites, NO_2	mg N/l mg NO_2/l	Spectrophotometric	+	+	+	+	+
Ammonium, NH_4	mg N/l	Photometric	+	+	+	+	+
Total phosphorus, P_{total}	mg P/l	Spectrophotometric	+	–	–	not known	+
Phosphates / orthophosphates, PO_4	mg P/l mg PO_4/l	Spectrophotometric	–	+	+	not known	+
Elementary phosphorus, P_{el}	mg P/l	Photometric	–	+	–	not known	–
Salinity							
Total salinity, $Mineral_{total}$	mg /l	Gravimetric	+	+	+	+	+
Sulphates, SO_4	mg /l	Titrimetric	+	+	+	+	–
Chlorides, Cl	mg /l	Argentometric	+	+	+	+	+
Calcium, Ca	mg /l	Titrimetric	+	+	+	+	+
Magnesium, Mg	mg /l	Titrimetric	+	+	+	+	+
Ammonium salt, NH_4	mg /l	Spectrophotometric	–	+	–	–	+
Metals							
Boron, B	mg /l	Spectrophotometric	+	+	–	not known	+
Total iron, Fe_{total}	mg /l	Photometric with orthophenanthroline	+	+	+	+	+
Iron, Fe^{2+}	mg /l	Photometric	+	+	–	not known	+
Iron, Fe^{3+}	mg /l	Photometric	+	+	–	not known	+
Cadmium, Cd	mg /l	Atomic absorption	+	+	+	+	+
Total Nickel, Ni	mg /l	Photometric	+	+	–	+	+
Dissolved Nickel, Ni_{diss} (Ni^{2+})	mg /l	Gravimetric	+	–	–	not known	–
Mercury, Hg	mg /l	Atomic absorption	+	+	–	+	+
Lead, Pb	mg /l	Photometric	+	+	–	+	+
Total Chrome, Cr	mg /l	Photometric	+	+	–	+	+
Chrome, Cr^{3+}	mg /l	Rated Atomic absorption	+	+	–	not known	+
Chrome, Cr^{6+}	mg /l	Photometric	+	+	+	not known	+
Zinc, Zn	mg /l	Photometric, Atomic absorption	+	+	–	+	+
Manganese, Mn	mg /l	Photometric, Atomic absorption	+	+	+	not known	+
Total copper, Cu	mg /l	Photometric, Atomic absorption	+	+	+	+	+
Arsenic	mg /l	Photometric	+	+		+	+
Barium	mg /l	Photometric	–	–	–	not known	+
Selenium	mg /l	Photometric	–	–	–	not known	+

1	2	3	4	5	6	7	8
Silver	mg /l	Photometric	–	–	–	not known	+
Strontium	mg /l	Photometric	–	–	–	not known	+
Aluminium	mg /l	Photometric	–	–	–	not known	+
Other chemical indicators							
Petroleum products	mg /l	Thin-layer chromatography	+	+	–	+	+
Phenols	mg /l	Photometric	+	+	–	+	+
Fluorides, F	mg /l	Photometric with lanthanum / alizarin complexone	+	+	+	+	+
Synthetic surfactants	mg /l	Photometric	–	–	–	+	+
Thiocyanates	mg /l	Photometric	–	–	–	+	+
Cianides, CN	mg /l	Spectrophotometric	–	–	–	+	+
Total DDT	mg /l	Thin-layer chromatographic	–	+	–	not known	+
Benson	mg /l	Gas chromatographic	–	+	–	not known	+
Other organic micropollutants							
Xylene	mg /l	Photometric	–	–	–	–	+
Toluene	mg /l	Photometric	–	–	–	–	+
Methanol	mg /l	Photometric	–	–	–	–	+

Note: (+) Monitoring of an indicatoris conducted. (-) Monitoring of an indicatoris is not conducted.

regulation is carried out in all the Central Asian countries through the setting of maximum acceptable indicators of water content and its properties. Within these activities, safe living conditions of the population, favourable conditions for water use and the status of water ecosystems are ensured.

Modern national systems of water quality standardization in Central Asia normally include:

- Terms and definitions of water quality indicators;
- A list of water quality indicators;
- A list of polluting substances subject to monitoring;
- Sanitary/hygienic requirements for drinking water quality on organoleptic, physiochemical, microbiological, parasitological and radiological indicators;
- Requirements regarding water quality in water bodies used for irrigation, household use including for drinking water, fisheries and other types of water use;
- The maximum acceptable concentration (MAC) of polluting substances according to a standardized set of indicators;
- The maximum acceptable amount of polluting substances, according to a standardized set of indicators, for discharges into water bodies that are used for various purposes;
- General requirements for water quality monitoring;
- Requirements regarding methods, procedures and technical devices for water sampling;
- Requirements for the methods, procedures and technical facilities for water quality indicators analysis;
- Requirements for measuring the accuracy of water quality indicators.

The majority of water quality standards currently used in Central Asia is based on the System of Surface Water Quality Specifications developed in the Soviet Union in the 1960s-1970s. A number of standards that have been recently introduced in Kyrgyzstan, Kazakhstan, Turkmenistan and Uzbekistan are also based on regulations formerly underlying the Surface Water Quality Specifications, or on updated standards of the Russian Federation. Table 2 presents the norms and standards of water quality regulations currently in force in the countries of Central Asia.

The following conclusions can be drawn from the data provided:

- On the whole, national systems of water quality standardization in Central Asia contain all the required components to facilitate monitoring, planning and implementation of activities to ensure proper water quality in natural water bodies and in water systems of various purposes;
- These national systems of water quality standardization, however, contain a certain number of outdated regulations that ignore both the particularities of current water resources and water use status in the Central Asian region, new monitoring technologies and technical facilities and water quality management practices developed by European countries;
- Current standards are mainly focused on water quality indicators for a limited number of water uses, and overlook the need for setting requirements regarding acceptable environmental impact levels with a view to ensuring sustainability of water ecosystems;

- Current standards impose excessively strict requirements and stipulate the monitoring of a vast list of polluting substances that are often not typical for most water bodies of Central Asia (cf. the European Union Water Framework Directive (WFD)[2], which sets a shorter priority list of the most dangerous polluting substances);
- A substantial part of the standards are not being implemented due to deficits in State budgets and limited human and technical capacities.

2.3. Review of national water body classifications and water quality categories

The classification of water bodies facilitates efficient management of water quality by standardizing maximum acceptable concentrations of polluting substances and other water properties in accordance with the type of water use.

Currently, the countries of Central Asia apply several types of natural water body classification, developed on the basis of different criteria. For example, all five Central Asian countries traditionally classify water bodies and their parts on the basis of three categories of water use, each having special requirements for acceptable water quality indicators:

- **Household and drinking water:** Use of water bodies or their parts as sources of household and drinking water supply, and water supply for food-processing industries;
- **Municipal supply:** Use of water bodies or their parts located in the vicinity of populated areas for bathing, sports and recreational activities, irrespective of other types of use;
- **Fisheries:** Use of water bodies for habitat, reproduction and migration of fish and other water organisms.

By comparison, the current classification of water bodies in the Russian Federation based on types of water use provides the following three categories: specially protected natural water bodies; water bodies used for drinking purposes; and water bodies used for fisheries. Of no less importance is the classification of water bodies standardized in the EU Water Framework Directive 2000/60/EC, which includes five classes (*high, good, not high, low and poor*). Reference to a particular class depends on the types of water use and environmental status, on the chemical, physical, biological and hydromorphological indicators and on the presence of specific polluting substances. The Directive determines standard conditions for water body status assessment and standardizes the classification of specially protected zones in water bodies. The classification includes five classes: for drinking purposes; for protection of valuable biological species that have economic value; for recreation and bathing; territories sensitive to the impact of nutrients; and territories intended for protection of natural habitats.

2 Directive 2000/60/EU of the European Parliament and of the Council establishing a framework for Community action in the field of water policy.

In recent years, some Central Asian countries have been undertaking measures to review water body classifications. For example, in 2009 a special Government resolution of Kyrgyzstan abolished the enactment according to which water bodies were divided in the three above-mentioned categories; a new classification, however, has not yet been adopted. Kazakhstan is working on revision of the current classification system in view of the EU norms. Uzbekistan is also currently standardizing the list of those fishery water bodies or their parts that are important for the protection and reproduction of valuable fish species and for other fisheries objectives stipulated by the legislation.

Classification of water bodies in accordance with the integrated water quality indicator — the water pollution index (WPI) — which is also used by Central Asian countries, divides water bodies into seven classes:

I: very clean (WPI 0.3 and less);
II: clean (WPI 0.31–1.0);
III: moderately polluted (WPI 1.1–2.5);
IV: polluted (WPI 2.51–4.0);
V: dirty (WPI 4.1–6.0);
VI: very dirty (WPI 6.1–10.0);
VII: extremely dirty (WPI >10.0).

In this classification system, the WPI is calculated as the arithmetic mean value of six key hydrochemical indicators of a given water body, namely, the four polluting substances with the highest concentrations against standard values, as well as the content of dissolved oxygen and biological oxygen demand (BOD).

In 1999, Turkmenistan introduced National Standard TDS-2761-84 “Sources of centralized household and drinking water supply”, which establishes the following seven categories for water, subject to the total salinity indicator defined by the dry residue reading:

Ultra-fresh: up to 0.2 g/l;
Fresh: 0.2-0.5 g/l;
Waters of relatively high salinity: 0.5-1.0 g/l;
Brackish: 1.0-3.0 g/l;
Saline: 3.0-10.0 g/l;
High saline: 10.0-35.0 g/l;
Brine: more than 35 g/l.

Turkmenistan also applies an irrigation water classification in accordance with GOST 17.1.2.03-90 “Environmental protection. Hydrosphere. Criteria and indicators of irrigation water quality”, which divides water resources used for irrigation purposes into five classes of water quality depending on its impact on soil fertility and crop yields.

Kazakhstan is considering a proposal to introduce new hydrobiological indicators to classify water bodies, subject to the integrated saprobity index, which reflects a complex of physiological and biochemical properties that determine the habitat capacity for at least 12 reference species. This system has six classes of water quality — very clean, clean, moderately polluted, heavily polluted, very heavily polluted and very dirty.

Water quality assessment in Uzbekistan is carried out with the use of three integrated hydrobiological indices: a

Table 4

Recommended structure of a unified water quality classification

Type of water use	Range of types of water use	Water Quality Classes				
		I Very clean	II Clean	III Mode-rately polluted	IV Dirty	V Very Dirty
Ensuring sustainability of water ecosystem		+	+	–	–	–
Drinking water supply	Physical water treatment	+	+	–	–	–
	Physico-chemical water treatment	+	+	+	–	–
	Physico-chemical and biological water treatment	+	+	+	+	–
Fishery, reproduction and protection of water flora and fauna	Salmonidae fishery	+	+	–	–	–
	Cyprinidae fishery	+	+	+	–	–
	Valuable biological species habitat protection	+	+	–	–	–
Irrigated agriculture		+	+	+	+	–
Industrial water supply	Use of water in technological processes	+	+	+	+	–
	Water cooling	+	+	+	+	–
Recreational water use	Bathing and recreation	+	+	+	–	–
	Water sports and tourism	+	+	+	+	
Hydropower production		+	+	+	+	+
Mining		+	+	+	+	+
Water transport		+	+	+	+	+

Notes: (+) permitted types of water use for the water quality class.(-) forbidden types of water use for the water quality class.

saprobic pollution index, which is similar to the one used in Kazakhstan, a periphyton index of biotic integrity and a modified biotic index, which reflect complexes of abiotic conditions and chemical composition of water in catchment basins.

The simultaneous use of several classifications based on different principles and indicators within a region or even within a country complicates water quality management and development of inter-State cooperation in implementation of water protection activities on transboundary water bodies.

2.4. Recommendations on the development of a regulatory and legal framework for water quality regulation

An objective assessment of the current status of the regulatory and legal framework governing the whole complex of water resources in Central Asia provides a basis for formulation of the main directions for their further development. These directions are based on a pragmatic approach that considers both the peculiarities and traditions of water legislation in each Central Asian country, and the necessity for a step-wise harmonization of legislation under the framework of the regional integration processes.

The following subsections set out some priority activities for further development of national systems of water regulation, including water quality.

Priority activities on further development of the national systems of water relations regulation, including water quality include, inter alia:

A. Consistent improvement of water and environmental legislation

In the frame of national law-making programs, some norms of water and environmental legislation should be defined or amended. For instance, for several countries of the region the following issues are urgent and relevant:

- Adapting national legislation to the norms of international water law using an integrated water resources management approach;

- Designating responsibilities (functions and powers) between central and regional executive agencies in water resources management, water infrastructure systems and environmental management;
- Developing access mechanisms for NGOs, water users' representatives and the public to participate in discussions, decision-making and the implementation of decisions in water resources and water infrastructure management, as well as water conservation activities;
- Upgrading economic, administrative, fiscal and other mechanisms that prevent or substantially limit violations of water and environmental legislation and stimulate efficient use of water resources and protection of water ecosystems;
- Upgrading mechanisms of complex planning and implementation of water use and conservation activities on the basis of comprehensive schemes for water use and protection and/or basin-level water plans;
- Standardizing regimes of water runoff formation, zones of sanitary protection, water protection zones and strips and other specially protected natural resources;
- Standardizing sanitary and environmental requirements related to permissible river flow;
- Developing market mechanisms for water use, including the system of payment for water resources use;
- Specifying a number of legislative norms regulating the issues of drinking water supply, sanitation, sewage, fisheries, use of water bodies for recreational purposes, and others.

B. Development and adoption of unified classifications requirements for water quality for various categories of water use

To achieve this goal the countries should:

- Specify a standard list of types of water use relevant for Central Asian countries;
- Define and approve a standard number of water quality classes, criteria and water quality indicators for each class;
- Elaborate and adopt national standards of water quality classification on the basis of unified indicators.

A unified classifier can be elaborated on the basis of the principles of the EU Water Framework Directive 2000/60/EC, as set out in Table 4.

C. Optimization of the list of monitored polluting substances

To achieve this goal the countries should:

- Elaborate priority lists of polluting substances and adopt them as national standards;
- Consider the possibility of using an abridged list of indicators for mandatory control on agreed transboundary river sites.

D. Requirements for updating procedures, methods and facilities for water quality indicators

To achieve this goal the countries should:

- Assess the relevance of administrative and technological procedures of water quality indicators management with a view to reliability, the time necessary to obtain and disseminate data, the technical state of the monitoring network infrastructure, human resources capacity and other factors;
- Study the feasibility of introducing technical, economic, meteorological and other modernizing assessment methods, and the use of new reagents, technologies and technical appliances to be used in measurement processes;
- Estimate terms and costs of activities to implement new or modernized measurement methods and facilities, including logistics, personnel training and infrastructure development;
- Based on the above-mentioned, ensure the adoption of concrete decisions on modernization of methods and facilities for water quality indicators measurement;
- Considering these decisions, ensure the revision and adoption of new editions of national standards and by-laws that standardize requirements for monitoring procedures, methods and facilities for water quality indicators measurement.

CHAPTER 3: NATIONAL WATER QUALITY MANAGEMENT SYSTEMS

3.1. Distribution of water resources management functions and powers

In the early 1990s, the newly independent Central Asian countries all retained similar institutional systems for water resources management developed under the Soviet Union. In particular, most functions and powers in water resources management were assigned to the ministries of water resources and land reclamation. Later, however, the Central Asian countries started implementing measures aimed at reforming their national systems of executive power, and these reforms significantly affected the water sectors. As a result, the countries of the region now have largely modernized the structure of the State monitoring and regulatory agencies and have specified their competencies.

Despite certain differences in national approaches to the structure of the State agencies, there are similarities.

In all Central Asian countries the functions of water resources management and water facilities management are separated from environmental management and assigned to different executive agencies. In Kazakhstan, for example, water resources management and the management of water infrastructure facilities are carried out by the Committee for Water Resources of the Ministry of Agriculture; in Kyrgyzstan, by the State Committee for Water Resources and Land Reclamation; in Tajikistan, by the Ministry of Land Reclamation and Water Resources; in Turkmenistan, by the Cabinet of Ministers and the Ministry of Water Resources; and in Uzbekistan, by the Ministry of Agriculture and Water Resources. The environmental functions, including those related to water quality management, are assigned in Kazakhstan to the Ministry of Environmental Protection; in Kyrgyzstan, to the State Agency on Environmental Protection and Forestry; in Tajikistan, to the Committee for Environmental Protection under the Government; in Turkmenistan, to the Ministry of Environmental Protection; and in Uzbekistan, to the State Committee for Environmental Protection.

Contrary to the ecosystem approach of integrated water resources management, which requires surface water and groundwater resources to be treated together in a holistic manner, in Central Asian countries groundwater resources are managed by executive agencies that regulate mineral resources. In Kazakhstan, for example, this is the responsibility of the Committee for geology and resource exploitation under the Ministry of Industry and New Technologies; in Kyrgyzstan, Ministry of Natural Resources; in Tajikistan, the Main Department of the State Control of Safe Conducting Works in Industry and Mining Supervision under the Government of the Republic of Tajikistan, and the National Corporation “Tajikgeology”; in Turkmenistan, National corporation “Turkmengeology”; and in Uzbekistan, the State Committee for Geology and Mineral Resources.

Drinking water quality monitoring and regulation are assigned to specialized subdivisions (committees, departments, sanitary-epidemiologic control centres) under national ministries of health.

Emergency prevention and emergency response, including those related to the adverse impact of waters, are assigned in Kazakhstan, Kyrgyzstan and Tajikistan to the Ministries of Emergency Situations, and in Turkmenistan and Uzbekistan to the Cabinet of Ministers and local authorities.

Agencies of local state administration and local government are mandated to participate in water resources management (each country has a different list of functions).

Contrary to the IWRM principle of hydrographic approach, which requires creation of management structures within boundaries of water basins, the competence zones for territorial waters and water facilities management agencies in most Central Asian countries (except Kazakhstan) are drawn on an administrative and territorial basis. However, currently Kyrgyzstan, Tajikistan and Turkmenistan are taking measures to organize water resources management within water basins.

Regional and bilateral water cooperation is regulated by the State water management and environmental agencies of each country within their competences, as well as by the ministries of foreign affairs. In accordance with multilateral agreements, relevant data are continuously exchanged between the national hydrometeorological services that are subordinate to the relevant State agencies. An essential role in water use regulation in the basins of the largest Central Asia transboundary rivers is played by the regional organizations: the International Fund for Saving the Aral Sea (IFAS); the Inter-State Commission for Water Coordination (ICWC); the Inter-State Commission for Sustainable Development (ICSD); and the basin water organizations for the Amu Darya and Syr Darya Rivers. Along with these regional structures, bilateral committees that coordinate water management and/or water protection measures in some transboundary basins have recently become more active, including the joint Russian Federation-Kazakhstan Commission, the Kazakhstan-Chinese Commission and the Kyrgyz-Kazakhstan Commission on the Chu and Talas Rivers. A similar bilateral commission between Kyrgyzstan and Tajikistan is currently under development.

Despite the similarities in national water agencies, national structures for water resources and water facilities management also have significant differences.

In Kazakhstan and Uzbekistan, for example, the central water and agriculture governing bodies are united under one ministry, while in Kyrgyzstan, Tajikistan and Turkmenistan the governing bodies for water resources management agencies have an independent status.

Hydrometeorological services are subordinated to different ministries. For example, in Kazakhstan the Hydrometeorological Service reports to the Ministry of Environment Protection; in Kyrgyzstan, to a division of the Ministry of Emergency Situations; in Tajikistan, to a division of the Committee for Environmental Protection under the Government; and in Uzbekistan and Turkmenistan, to the Cabinet of Ministers.

Similarly, agencies that ensure observance of water and environmental legislation, norms and rules of water use have different statuses and subordination. Thus, in Kazakhstan supervisory functions are assigned to the Ministry of Environmental Protection, the Committee for Water Resources of the Ministry of Agriculture, the Committee for Geology and Resource Exploitation of the Ministry of Industry and New Technologies and the Committee for Sanitary and Epidemiologic Surveillance of the Ministry of Health. In Tajikistan these functions are assigned to the Committee for Environment Protection and the State Sanitary and Epidemiologic Service of the Ministry of Health. In Uzbekistan, the responsible agents include the local authorities; the State Committee for Nature Protection; the State Inspection on oversight of safe conduct of work in industry, mining and domestic sectors under the Cabinet of Ministers; the Ministry of Health; and the Ministry of Agriculture and Water Management. The use of groundwater resources is supervised by departments of the State Committee of the Republic of Uzbekistan for Geology and Mineral Resources. In Turkmenistan, these functions are assigned to the Ministry of Water Resources Management and the Ministry of Environmental Management. In Kyrgyzstan, similar functions are distributed between a number of departmental inspection bodies under the State Committee for Water Management and Land Reclamation, the Ministry of Natural Resources, the State Agency on Environment Protection and Forestry, and the Ministry of Health.

The Central Asian countries apply different approaches to the participation of NGOs and public coordinating institutes in water resources management. For instance, Kyrgyzstan has established the legal basis to form a national water council and basin councils, but the role of such bodies in decision-making processes is insignificant. In Kazakhstan, basin water councils are already in place, but no decision has been made as yet to create a national water council. The water legislation of other Central Asian countries does not yet envisage creation of such structures.

In Kazakhstan and Tajikistan, environmental NGOs make an important contribution to encouraging efficient use of natural resources and raising public awareness on urgent environmental issues, whereas in other Central Asian countries the NGO activities are not that significant.

There is certain diversity in approaches to the role of water user associations (WUA) in managing water infrastructure facilities among the Central Asian countries. In Kyrgyzstan and Uzbekistan, WUA and WUA federations (FWUA) are being actively developed with support of the State and foreign donors. Over the past five years, Tajikistan has been undertaking active measures for creation of WUAs with support of local water management bodies and local administrative agencies. In Kazakhstan, preference is given to rural water users' production cooperatives.

It must be noted that national structures of executive agencies, including those that participate in the regulation of water cooperation, are not yet sustainable in some countries. A prime example is Kyrgyzstan, where the principles upon which the State system is built — and even the constitutional norms — have been repeatedly changed.

Specific administrative problems in national water management are, inter alia::

- Limited capacity to implement administrative decisions owing to a lack of financial means and poor infrastructure;
- Insufficient coordination of activities of executive agencies and water users due to inefficient use of cooperation mechanisms;
- Duplication of functions and powers of agencies participating in water resources management in some Central Asian countries, for example, in the supervision, inspection and monitoring;
- Insufficient qualifications of governing body personnel at all levels, owing to the non-prestigious status of the profession, inadequate salaries and lack of training;
- Outdated technologies and management procedures as a result of lack of motivation for modernization;
- Outdated national information systems that hinder efficient and adequate administrative decision-making on the basis of objective and comprehensive data;
- Use of "reactive" management methods directed at addressing and eliminating water problems instead of focusing on prevention and the sustainable management of natural water ecosystems and water infrastructure;
- The absence or insufficient application of a comprehensive approach to planning and implementation of administrative decisions on the basis of the national water strategy, basin action plans, updated schemes of complex use and protection of water resources or other strategic documents defining the national water policy and key parameters of the status and use of water resources for a designated time period.

The above-mentioned administrative shortcomings indicate the need for further upgrading of national institutional structures and building their cooperation potential.

3.2. Mechanisms of water quality management

The constitutions of all five Central Asian countries declare State ownership of the country's water resources. Yet, each State sets various priorities to ensure these rights. Global best practice demonstrates that efficient water quality management can be achieved by harmonization of administrative, economic and fiscal mechanisms, while simultaneously conducting awareness-raising campaigns to actively involve the public in efficient water use and water conservation activities. In the Central Asian countries, the most widespread administrative measures, especially in the protected territories, are the licensing of industrial and business activities that affect the status of water resources; the introduction of a system for water use rights and issuance of permits to discharge polluting substances; and the restriction of particular types of economic and other activities. Other similar measures include the strengthening of the inspection capacity and responsibility of legal and physical entities in ensuring strict control of water and environmental legislation, norms:

- A system of payments for water supply services for all categories of water users;
- A system of payments for profit-oriented use of State-owned natural water bodies and water resources.

Among efficient fiscal measures that follow the polluter-pays principle are the introduction of payments for the discharge of wastewater, as well as penalty provisions such as additional higher tariff payments for exceeding allowed discharge volumes of polluting substances and payments for damages caused.

Moral incentives aim to strengthen the motivation of the population to save water and to teach the practical skills needed to participate in water conservation activities. Such activities include numerous large-scale awareness-raising programmes, training seminars, and various benefits and bonuses for enterprises that have achieved significant progress in implementing efficient and environmentally safe technologies for water use.

Table 5 presents mechanisms of water quality management in Central Asian countries.

Table 5

Main water quality management mechanisms in Central Asia

Water quality standards and norms	Countries of Central Asia				
	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
System of special water use rights issuance	+	–	+	+	+
System of permits/prohibitions for the discharge of untreated wastewater and polluting substances to water bodies	+	+	+	+	+
System of permits/prohibitions on disposal of wastes in water bodies and lands of water fund	+	+	+	+	+
Licensing of water management and water conservation activities	+	–	–	+	–
Certification of water management and water conservation enterprises	+	–	–	+	+
Restriction or prohibition of economic and other activities:					
• In water conservation zones and strips;	+	+	+	+	+
• In sanitary protection zones;	+	+	+	+	+
• In natural parks, reserves and wildlife preserves;	+	+	+	+	+
• In runoff formation zones.	–	–	–	+	+
Control of water legislation observance, norms and rules of water use by water inspectorates	+	+	+	+	+
Control of environmental legislation observance, norms and rules of water conservation	+	+	+	+	+
System of adequate penalty provisions for water pollution	+	+	+	+	+
System of water supply payments for water users of:					
• municipal-domestic sector	+	+	+	+	+
• industrial sector	+	+	+	+	+
• agricultural sector (irrigation)	+	+	+	+	+
System of payments for exploitation for profit of natural water bodies and water resources	+	–	–	–	–
System of payments for discharge of untreated wastewater and polluting substances in natural water bodies	– Prohibited	+	+	–	+
System of payments for disposal of industrial wastes in water bodies and lands of the water fund	– Prohibited	+	+	–	+
System of extra payments for exceeding permitted volumes of discharges of polluting substances in natural water bodies	+	+	+	–	+
System of benefits and bonuses to ensure efficient water use	+	–	–	+	+
Regular information, awareness-raising and training activities	+	+	+	+	+
System of extra payments for exceeding permitted volumes of discharges of polluting substances in natural water bodies	+	+	+	–	+
System of benefits and bonuses to ensure efficient water use	+	–	–	+	+
Regular information, awareness-raising and training activities	+	+	+	+	+

As seen from Table 5, the current systems of water quality regulations in Central Asian countries require further upgrading. The following arguments support this statement:

Although in some Central Asian countries the key administrative water quality regulators are defined in national legislation, the implementation of their norms is often delayed or inconsistent and lacks sufficient regulatory, institutional and financial support.

The weak human and financial resources in national inspectorates and their limited competence in some Central Asian countries limit enforcement efforts such as the proper control of water, compliance with environmental norms and the imposition of relevant sanctions on violators. Moreover, the lack of a strong monitoring mechanism and the failure to impose sanctions on violators lead to a culture of impunity with regard to environmental offences.

Legislation in Turkmenistan provides free access to water for irrigated agriculture, but the system makes no use of economic stimuli for efficient water use. Other Central Asian countries apply economic measures in one way or another, but in general their impact on water conservation and water quality is minimal. While Central Asian countries do tend to gradually increase tariffs for household and industrial water supply, such measures do not affect significant savings of drinking water. The tariffs for irrigation services remain inadequately low. This is partially due to the weak capacity of farms and individual farmers to pay, and the desire of local authorities to stimulate the development of agricultural production in conditions of an incomplete reform of the agrarian sector. Irrigated agriculture is the main consumer and one of the key polluters of water resources in the region and insufficient use of economic incentives for the efficient use of water in this sector is one of the key causes of water quality deterioration in the region.

The low efficiency of fiscal measures for water quality regulation in the region is explained by several factors. The tax base is limited as payments for the discharge of polluting substances and the disposal of waste in a number of Central Asian countries is imposed mainly on municipal enterprises of the centralized water supply, sewerage and large industrial enterprises. As a result, small and medium-sized businesses and the population, especially in rural areas, are not included in this payment system, and hence, the solution of this problem is a difficult task. In addition, the tariffs for the discharge of polluting substances are too low in comparison with the extent of damage caused to natural bodies and the costs of measures to mitigate the impact of such pollution. Finally, insufficiently transparent procedures and targeted use of collected fiscal resources result in insufficient payments to finance water conservation activities adequately.

Although, industrial production temporarily dropped in Central Asian countries following independence, there have recently been drastic changes in the sources of water pollution. Now, the main sources of pollution, along with the production and primary processing of agricultural products, are the activities of small and medium-sized businesses and household waste (as the result of insufficient management, transport and disposal). Current mechanisms of State management and control fail to account fully for these factors, which result in the prevalence of non-point sources of water pollution over point sources. Therefore, measures to modernize these mechanisms should not only provide for the adequate identification and monitoring of new sources of pollution, but should also impose greater responsibility on those conducting activities that lead to the deterioration of water quality. The measures aimed at the public for the creation of sustainable incentives to prevent the deterioration of the environment and to provide the public with relevant practical skills are insufficient.

The low efficiency of regulatory measures is mainly caused by lack of professionalism and sometimes the improper execution of duties by officials of State management and control agencies. Therefore, imposing greater responsibility on the officials of executive agencies for proper execution of their entrusted powers and functions is no less important than strengthening the responsibility for water use.

3.3. Water resources monitoring systems

Despite certain differences in structures of water resources and water infrastructure management, reflected in section 3.1 of this report, Central Asian countries apply very similar approaches to defining the roles and powers in water resources monitoring.

In particular, the functions of monitoring the quantity and quality indicators of the status of surface water bodies and groundwater are usually differentiated and assigned to different organizations, including hydrometeorological services and hydrogeology agencies. Responsibility for control of environmental indicators, including water quality indicators, is assigned to environmental agencies. Agencies of sanitary-epidemiologic control, which report to the Ministries of Health, as well as local or municipal administration agencies, usually have their own infrastructure, technical and information base for in-situ water quality monitoring of drinking water supply sources.

Monitoring of irrigation water use is normally assigned to central water management agencies that can either have an independent status or be under the ministry of agriculture. The government regulations assign these agencies wide powers in monitoring, but limit their activity to monitoring the volume of water intake, distribution and use in State irrigation systems. All the Central Asian countries lack systematic monitoring of irrigation water quality indicators. Moreover, water quality is monitored by a limited number of indicators and only occasionally-if there are large discharges of polluting substances or any other force majeure situations occur. Irrigation systems that do not have their own laboratory facilities to analyse water samples are compelled to use the laboratories of environmental agencies or other organizations.

Regular monitoring of the quantity and quality of drinking water is mainly carried out by municipal water supply utilities and large industrial companies that set special requirements for water quality characteristics and wastewater. Though water legislation of most Central Asian countries imposes on all categories of water users the duty to keep the primary record of water use, these requirements are in fact ignored everywhere, particularly in small cities and rural settlements. Over the past few years, however, Kyrgyzstan, Kazakhstan and Uzbekistan have taken measures to improve control over the use of water. Such measures include installing water meters in residential areas, industrial enterprises and service companies in large cities, as well as equipping irrigation systems that serve WUAs and FWUAs with hydrometric posts. Similar measures were also planned in Tajikistan, but the projects were not implemented, largely due to limited financial resources and insufficient involvement of water users.

Responsibility for water quality control in zones subject to radioactive, toxic and bacteriological contamination risks is assigned to State environmental or emergency agencies. However, Central Asian countries do not have sufficient capacity to organize regular monitoring to ensure safe status of tailings dumps, waste rock dumps and industrial wastes containing heavy metals and other highly toxic components, or to ensure safe maintenance of burial grounds for animals, landfills and other sources of environmental contamination.

In summary, Central Asian countries currently monitor only a limited number of water quality indicators through inadequate and limited programmes. Moreover, standard terms of water sampling and analysis are seldom observed, and monitoring data are inefficiently used. This conclusion is further supported by the following data that reflect the degradation of technical facilities and technological infrastructure of national monitoring systems over the past two decades:

- The number of monitoring stations and posts on surface water bodies in Kazakhstan was reduced from 400 to 151. From 1990 to 2000, the number of water sampling sites had been reduced from 400 to 216. Nonetheless, during the period from 2000 to 2011 the number of stations has begun to grow.
- In Kyrgyzstan, during the period 1990-2010 the number of monitoring stations and posts on surface water bodies dropped from 127 to 77, the number of water sampling sites decreased from 80 to 10 and the number of monitored water quality indicators was reduced from 38 to 33. If earlier water sampling and analysis was normally made once a month and, in some stations, at least once a quarter, nowadays these operations are made only once or twice a year. Moreover, the number of special laboratories of environmental management and hydrometeorological service agencies to analyse water quality indicators was reduced from 8 to 5.
- For the same period in Tajikistan the number of monitoring stations and posts on surface water bodies was reduced from 122 to 37, whereas the number of water sampling sites decreased from 92 to 25, and the number of monitored water quality indicators decreased from 41 to 30. If water sampling and analysis was previously undertaken 6–12 times a year, today these operations are carried out only at some sites and only twice a year. The number of special laboratories carrying out analysis of water quality indicators under the environmental management and hydrometeorological service agencies has been reduced to 2.
- In Turkmenistan the number of hydrological monitoring stations on surface water bodies has been reduced by 45 per cent in recent years and now comprises just 32 stations and posts.
- In Uzbekistan the number of monitoring stations and posts on surface water bodies was reduced from 134 to 120, whereas the number of water sampling sites was reduced from 134 to 84, and the number of monitored water quality indicators has decreased from 60 to 52. Periodicity of control is established in accordance with the category of stations: in Category III stations, monitoring is carried out monthly; in Category IV stations, in the main phases of water regime (7-8 times per year). Over the same period, the number of special water quality analytical laboratories under the environmental agencies has increased from 15 to 18, and the number of analytical laboratories in hydrometeorological service agencies has remained at the same level.

Similar trends are observed in the national systems of groundwater monitoring and, to a lesser extent, in the systems of drinking water quality monitoring, which are the responsibility of sanitary-epidemiologic control and drinking water supply agencies. Therefore, the current status of water quality monitoring systems in Central Asian countries can as a whole be assessed as unsatisfactory.

These negative trends are caused by the following factors, characteristic of all Central Asian countries:

- Insufficient financing allocated to maintenance of monitoring networks and engineering personnel of monitoring agencies;
- Use of worn out and obsolete measuring devices, water quality monitoring data processing and distribution owing to a lack of sufficient financial resources allocated to modernization and development of monitoring systems;
- A shortage of stationary and mobile analytical laboratories equipped with modern equipment and provisions;
- Insufficiently qualified personnel due to inadequate salaries;
- In some cases, a change in the water management setting and the absence of mandatory monitoring of particular bodies.

However, not all shortcomings of the national monitoring systems are a direct consequence of scarce financial resources. The absence of established data exchange procedures between the central and territorial executive agencies and the absence of uniform national databases, until recently, on the status and use of water funds testify to the continuing trends of sectoral fragmentation and weak coordination among the various agencies. Moreover, negligent natural resources users who are subject to management regulations are not interested in efficient State control systems that could hinder them from achieving their personal interests. These factors indicate that there is a need for an integrated approach to upgrading the systems of natural resources regulation as a whole and to the development of water quality regulation mechanisms in particular.

3.4. Recommendations on development of mechanisms for water quality regulation

Differences in some of the principles of the State systems and national legislation and the varying economic potential of the Central Asian countries complicate the development of common requirements to improve water quality regulation mechanisms acceptable to all the countries in the region. Nevertheless, such circumstances cannot interfere with the capacity of the countries to coordinate the general directions for the development of such mechanisms on the principles of IWRM and global best practice.

The following sections list priority actions recommended as a basis for planning further steps.

A. Optimization of national water management systems through

- Strengthening coordination among all State agencies participating in water resources management and water management systems at country, provincial and local levels, using IWRM administrative mechanisms and approaches such as national and basin water councils and other coordinating institutes;
- Introducing the principles of IWRM, taking into account particularities of national legislation;
- Ensuring transparency and public participation in decision-making and the implementation of taken decisions;
- Strengthening human capacities of water sector management agencies through a series of trainings, regular certification and recertification of the personnel and the use of economic and moral incentives;
- Strengthening the material base of controlling agencies(taking into account the real economic capacity of each country);
- Ensuring the step-wise introduction of information technologies in management.

B. Improvement of oversight and responsibility for efficient natural resources use through

- Enhancing and streamlining the activity of State inspectorates while ensuring human and technical capacity development (taking into account the real economic capacities of each country);
- Increasing responsibility of State agencies to ensure execution of their assigned functions and competences, and introducing management mechanisms that seek to avoid rigidity and prevent corruption;
- If necessary, tightening administrative sanctions for non-observance of water legislation norms and rules of water use by water users, including for non-observance of water quality standards;
- Developing mechanisms and procedures of public control over efficient water use management.

C. Development of economic and fiscal mechanisms of water use regulation through

Recommendations to achieve this goal are as follows:

- In Central Asian countries, where systems of payment for water use are already applied, ensuring regular revisions of water supply tariff rates in view of real costs of water management services and capacities to pay water users in various water-consuming sectors of the economy. Providing flexible, differentiated systems of tariffs, including the provision of economic incentives for efficient water use;
- In Central Asian countries, where a system of payments for discharge of wastewater into natural water bodies is already applied, ensuring regular revisions of relevant tariff rates, and modernization of mechanisms and procedures for collection, consolidation, transparent and targeted use of payments;
- Tightening punitive economic sanctions for exceeding the maximum acceptable discharges of polluting substances into natural water bodies;
- Enhancing or introducing economic incentives directed at promoting efficient water use, introduction of best available practices that facilitate the step-wise reduction in poorly treated wastewater discharges into water bodies and lands of the water fund;
- Elaborating and introducing efficient mechanisms of environmental insurance against adverse impacts of human activity on the environment;
- In view of the specificities of national legislation, ensuring efficient application and development of a system of payments for use of natural water bodies and water resources.

D. Rehabilitation and further development of national systems of water fund monitoring through

- Compiling an inventory of the technical status of monitoring systems, and developing comprehensive programmes for their rehabilitation and development;
- Restoring hydrological and hydrochemical stations, posts, wells, measuring stations and other monitoring network facilities on surface water bodies and groundwater and on water management systems to at least pre-independence levels;
- Rehabilitating and modernizing the monitoring infrastructure equipment;
- Restoring to an adequate level the number of laboratories providing complex analyses of water samples and providing them with the required equipment and consumables. Similar projects should aim at equipping all basin agencies of water and environmental management bodies and/or hydrometeorological services, as well as sanitary and epidemiologic stations of large cities, with chemical and biological laboratories.

- Ensuring joint construction, equipment and maintenance of monitoring stations and posts in agreed-on sites on transboundary water bodies;
- Undertaking a series of measures to specify the impact of wastewater and return flows on the reserves and quality of water resources;
- Modernizing technologies for processing, compiling and disseminating monitoring data, as well as enhancing forecasting methodologies for providing prompt expert opinion for decision-making;
- Recruiting personnel for departments of State agencies participating in monitoring activities, and ensuring their adequate qualification levels by organizing regular training courses;
- Building sustainable systems for securing personnel by providing attractive salaries, adequate logistics, favourable working conditions and moral incentives.

E. Development of information systems through

- Improving or introducing legislation to establish national information systems and databases that contain a series of indicators on status and use of water funds;
- Introducing, if required, advanced procedures for State statistical reporting to provide detailed data on the status and use of water resources;
- Ensuring backup and transfer to a computerized version of the data characterizing dynamics of controlled indicators of water resources monitoring by period;
- Modernizing methodologies and procedures of national water cadastres and ensuring their regular updating;
- Ensuring introduction of programmes and procedures for sustainability of information systems and prompt dissemination of current data among stakeholders;
- Developing geospatial information system technologies in national information systems;
- Ensuring efficient coordination among all stakeholders for regular stocking and updating of the databases;
- Ensuring free access of all stakeholders to information system databases.

F. Provision of training and awareness-raising through

- Elaborating and organizing training and special qualification improvement courses on advanced technologies of water quality regulation for staff of State water management and environmental agencies;
- Elaborating, updating and distributing manuals and information materials required for training courses;
- Updating curricula in institutes and colleges to include IWRM policy, advanced technologies and processes of water quality regulation and monitoring;
- Facilitating the organization of working seminars, roundtables and similar activities directed at the dissemination of knowledge among independent water users and the public in the efficient use of natural resources, including prevention of pollution;
- Facilitating the dissemination of data and forecasts on the status and use of national water resources, problems of domestic and international water cooperation and other urgent issues through the mass media;
- Expanding participation of scientific organizations, higher educational institutions, local administrations, local governments and NGOs in training and awareness-raising campaigns on various environmental topics, including the protection of water resources.

CHAPTER 4. REGIONAL COOPERATION IN WATER QUALITY MANAGEMENT

4.1. Review of water and environmental cooperation practices

For centuries, the inhabitants of the region have been compelled to maintain close cooperation on water, as their life conditions were in many respects determined by access to the water resources of the transboundary rivers. After the collapse of the Soviet Union new legal and institutional mechanisms for regional water cooperation had to be urgently created for the five new sovereign States. The first important step in this direction was the agreement at the level of the Heads of State and Government of Central Asian countries on the principle of maintaining the former quotas of national water consumption from the transboundary sources. This decision has been crucial in order to prevent conflicts on the grounds of water distribution even during critical low-water seasons.

Cooperation has developed further as a result of the creation of inter-State coordination agencies - the Executive Committee of the Fund for Saving the Aral Sea (EC IFAS), ICWC and ICSD. The positive outcomes of their activities have also served to foster the conclusion of a number of interstate agreements on water, hydropower and ecological issues, as well as the development of bilateral water cooperation (for example, the creation of the Chu-Talas Commission). A number of similar bilateral commissions have already been created and the process is ongoing in the other transboundary basins of the region.

At present, regional water and environmental cooperation is carried out simultaneously in a number of directions:

- Within the framework of the ratification process of global and international conventions and agreements by Central Asian countries;
- Within the framework of implementation of regional and bilateral agreements;
- Through participation in inter-State coordination agencies (IFAS, ICWC, ICSD);
- Within the framework of implementation of international projects with financial support of foreign donors (the United Nations Development Programme, the World Bank, the Asian Development Bank, the EU, the Organisation for Security and Co-operation in Europe, the United States Agency for International Development and the agencies for international development of the United Kingdom of Great Britain and Northern Ireland, Japan, Switzerland, Germany, and others);
- Through direct bilateral and multilateral contacts of state and NGOs with foreign partners, for example, on data exchange and the coordination of joint activities.

Setting their national interests as a priority, the Central Asian countries have their own visions on questions of joining a particular agreement or convention. Information on the participation of each country in the processes of international and regional cooperation is presented in Table 6.

In order to objectively evaluate the degree of regional cooperation, the following should be taken into account:

During the past two decades, the priority areas of interaction were focused on water resources distribution between the countries and the coordination of modes of water inflow and intake in the water storage basins, taking into account the energy and irrigation demands of the different countries, the need to prevent further degradation of the Aral Sea and adjacent areas and the need to ensure the safety of water infrastructure. In this context, the problems of water quality deterioration were mentioned from time to time in Declarations of the Heads and Governments of Central Asian countries and in regional framework agreements, but no large-scale measures were undertaken to tackle these problems.

Despite a common desire to develop water cooperation, each Central Asian country has its own priorities, which are mainly linked to its national interests. Tajikistan and Kyrgyzstan, whose territories are located in the upper courses of the largest waterways, are less worried than other Central Asian States about the problems of water deficiency and water quality deterioration. These countries are mainly interested in maintaining sustainability of run-off formation zones and landfills of dangerous industrial wastes, prevention of mudflows and flooding, breaks of high-mountainous lakes, development of hydropower engineering and irrigated agriculture. In contrast, Kazakhstan, Turkmenistan and Uzbekistan acutely feel water shortages, degradation of water ecosystems and the salinization and desertification of land caused by intensive irrigation development and population growth. Certainly, the most urgent problems for these countries are prevention of an environmental catastrophe in the Aral Sea basin and provision of access to water for drinking and irrigation. These differences in national priorities are key obstacles for the development of cooperation on water quality management.

According to the 2005 assessment data of the United Nations *Central Asia Human Development Report*[3] the Central Asian countries annually lose about US$2 billion due to inefficient cooperation in water and energy supply. This situation also negatively affects the development of joint water conservation activities. Draft regional agreements, for example, have now been elaborated on a number of water issues, including: “On strengthening the institutional structure of management, protection, and development of transboundary water resources in the Aral Sea Basin”, “On creation and functioning of national, basin and regional databases for integrated use and protection of water resources in the Aral Sea Basin” and “On protection of transboundary waters, rules of quality control, and ensuring environmental sustainability in the region”. Adoption of these agreements could facilitate improvement of a legal basis for cooperative development. These documents need further review and

3 Bringing down barriers: Regional cooperation for human development and human security. UNDP Regional Bureau for Europe and the Commonwealth of Independent States (Bratislava, 2005).

Table 6

Participation of Central Asian countries in international conventions and regional agreements

Conventions, Agreements and Protocols	Participation of CACs in international conventions and agreements				
	Kazakh-stan	Kyrgyz-stan	Tajiki-stan	Turk-me-nistan	Uzbeki-stan
United Nations Framework Convention on Climate Change (1992)	+	+	+	+	+
United Nations Convention to Combat Desertification and Land Degradation (1994)	+	+	+	+	+
ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) (1992)	+	–	–	–	+
United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses (1997)	–	–	–	–	+
ECE Convention on Environmental Impact Assessment in a Transboundary Context (1991)	+	+	+	–	–
ECE Convention on the Transboundary Effects of Industrial Accidents (1992)	+	–	–	–	–
ECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (1998)	+	+	+	+	–
United Nations Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971)	+	+	+	+	+
Protocol on Water and Health to the Water Convention (1999)	–	–	–	–	–
Regional multilateral and bilateral agreements					
Agreement of the Heads of State of the Central Asian countries on joint activities in addressing the Aral Sea and the zone around the Sea crisis, improving the environment, and ensuring the social and economic development of the Aral Sea region (1993)	+	+	+	+	+
Agreement of the Heads of State of the Central Asian countries on cooperation in the sphere of joint water resources management and conservation of inter-State sources (1992)	+	+	+	+	+
Agreement on cooperation in the area of environment and efficient use of natural resources (1992)	+	+	+	+	+
Agreement on the use of water and energy resources of the Syr Darya River basin. (1998) Agreement on Cooperation in the sphere of environmental protection and efficient use of natural resources (1998)	+	+	+	–	+
Agreement on General Principles of interaction in the rational use and protection of transboundary water bodies of the Commonwealth of Independent States (CIS) member States (1998)	+	+		–	+
Agreement on cooperation in the sphere of hydrometeorology (1999)	+	+	+	–	+
Agreement of the CIS member States on cooperation in the sphere of environmental monitoring (1999)	+	+	+	–	+
Agreement of the CIS member States on cooperation in the sphere of hydrometeorology (2003)	+	+		–	
Agreement among Governments of Republic Kazakhstan, Kyrgyz Republic, Republic of Tajikistan and Republic of Uzbekistan on cooperation in the sphere of hydrometeorology (1999)	+	+	+	–	+
Agreement on the Status of the International Fund for Saving the Aral Sea and its organizations (1997)	+	+	+	+	+
Agreement between Turkmenistan and Uzbekistan on cooperation in the sphere of water management (1996)	–	–	–	+	+
Agreement on the use of water management facilities of intergovernmental status on the rivers Chu and Talas (2000)	+	+	–	–	–
Agreement between the Governments of Kyrgyzstan and Kazakhstan on cooperation in the sphere of environmental protection (1997)	+	+	–	–	–
Agreement between the Governments of Kazakhstan and Uzbekistan on cooperation in the sphere of environmental protection and efficient use of natural resources	+	–	–	–	+

endorsement, and so far the Central Asian countries have not undertaken any actions in this direction.

The Commonwealth of Independent States (CIS) Agreements “On cooperation in the sphere of environmental monitoring” and “On cooperation in the sphere of hydrometeorology”, signed in 1999, served as a legal basis for close cooperation among Central Asian countries in organizing joint water quality monitoring. These agreements called for harmonization of the national systems of normative, technological and programme support, regular data exchange, consolidation of resources to execute joint projects and other components of cooperation. Most of these obligations, however, have not yet been implemented, or are being executed at a limited and reduced scale.

There are risks that the Central Asian countries located upstream of transboundary rivers might damage the downstream countries as a consequence of natural and anthropogenic accidents to watercourses, as well as the pollution of water resources. Such circumstances show that further development of cooperation must be based on balancing of national interests of all the countries in the region.

All these factors demonstrate that the current status of regional cooperation in water resources, including water quality, is insufficient. At the same time, Central Asian countries aim at further development of these relations on the basis of parity.

An example of successful cooperation between the countries of the region is the 1997 bilateral intergovernmental agreement on environmental monitoring between the environmental agencies of Kazakhstan and Kyrgyzstan. In 2001, within the framework of this agreement, a plan for joint laboratory water quality analyses in the Chu and Talas river basins was adopted. The plan set out a list of sampling sites and monitoring sites for wastewater discharge from municipal treatment facilities, a list of 24 pollution substances to be monitored by both parties and the methods for measuring them. In accordance with the plan, the joint water quality monitoring in the Chu River and its tributaries is carried out annually in the summer season, at the expense of the State budgets of both countries by the environmental agencies of Kazakhstan and Kyrgyzstan.

Specialists from Kazakhstan and Kyrgyzstan conduct water sampling cooperatively. The samples are analysed simultaneously and independently in the laboratories of both countries. The results of these analyses normally show that water quality in the Kyrgyz part of the Chu river basin remains satisfactory, but there are significant discrepancies in the results of analyses done by national laboratories. The fact that such discrepancies exist underlines the need for unified national standards, technologies, equipment and analytical methods for water quality monitoring on transboundary water bodies,

4.2. Recommendations on the development of regional cooperation in water quality regulation

The limited resource base of Central Asian countries currently hinders the implementation of joint, large-scale projects aimed at overall improvement of water quality, but does not prevent the development of urgent water conservation cooperation that in the short term does not require significant investment. Planning each step of the joint activities and giving preference to projects that are of interest to all the countries involved would be expedient.

The following recommendations relate to efforts towards unification of the regulatory and legal framework for water quality regulation. In particular, the countries should:

- Coordinate a unified classification of natural water bodies, depending on priority types of water use and water quality indicators;
- Specify and coordinate the list of priority indicators which are subject to mandatory control at stations and posts located on transboundary water bodies and close to extremely dangerous sources of pollution;
- Specify and coordinate the MAC values of polluting substances from the agreed-on priority list for water bodies of various classes;
- Coordinate unified methods, technologies and periods of water quality indicators assessment, as well as unified technical and meteorological characteristics of devices and equipment applied to monitor transboundary water bodies;
- Coordinate a unified methodology of development and indicators of national water cadastres to ensure compatibility of cadastral data;
- Validate and coordinate volumes of minimum environmental flow in transboundary water bodies;
- Coordinate procedures for regular data exchange between the countries and early warning of emergency situations resulting from major discharges of pollutants into transboundary water bodies and adopt them at the level of national standards and legislative acts.

Coordinated activity will reduce the risks of conflicts and disagreements among the countries in assessing the status of transboundary waters and will promote mutual trust.

The next stage of development of the regulatory and legal framework could be the elaboration of a portfolio of regional environmental standards and additional agreements that would, taking into account the views of all the Central Asian countries, include the best international practices.

Implementation of joint (multilateral or bilateral) business projects is another important direction of cooperation that could be developed in the coming years. Such projects can include, inter alia:

- Rehabilitation and modernization of the equipment of monitoring stations and posts on transboundary water bodies and, as a first step, in transboundary stations where observance of inter-State distribution and quality of water resources are controlled;

- Regular monitoring and stability of specific natural, industrial and water facilities where a failure can cause dangerous transboundary impacts;
- Joint inventories of current or potential sources of pollution of transboundary water bodies
- Joint training courses for personnel of State agencies and WUA on the basis of higher educational institutions and training centres created at the ICWC in Kazakhstan and Kyrgyzstan;
- Further capacity-building and strengthening of inter-State coordinating agencies - IFAS, ICWC, ICSD, BWAs, CAREC, bilateral basin committees and basin councils;
- Step-wise formation of a regional information system on the basis of national databases, ICWC databases, the Central Asian eco-portal CAWater-info[4] and other public resources;
- Coordination and joint implementation of large-scale regional projects and, as a priority, the third Aral Sea Basin Programme of IFAS.

The projects recommended above could be successful with adequate support from foreign donors.

4 http://www.cawater-info.net/index_e.htm.

PART II. ACTION PLAN FOR REGIONAL COOPERATION ON SURFACE WATER QUALITY IN CENTRAL ASIA

The action plan presented below relies on the recommendations of national and international experts who took into account both the status and trends of regional water cooperation, as well as best international practice for cooperation in water quality management. The plan foresees a step-wise implementation of the proposed actions in the short term (five years), and also provides an opportunity for further development of cooperation among Central Asia countries in this direction. The plan is addressed to the Governments of the five countries of the region, to policymaking and decision-making agencies involved in water quality management, as well as to the regional inter-State structures, the international donor organizations, other stakeholders and the general public. The plan provides for the development of regional cooperation in the following priority strategic areas:

1. **Strategic Direction I** – regional harmonization of reform of the systems of water quality management based on the proposed models;
2. **Strategic Direction II** – coordination of monitoring of the water quality of regional transboundary watercourses and the regular exchange of data among the countries;
3. **Strategic Direction III** – improvement of the legal basis for regional cooperation in water quality regulation, and the establishment of an efficient regional expert body.

Coordinated activities in the specified directions will significantly reduce the risks of disagreements between the countries in assessing the state of transboundary waters and will enhance mutual trust. The involvement of all countries of the region in implementation of the recommended activities is of the utmost importance; however, a lack of consensus should not hinder cooperation. At the same time, some countries can take on leadership roles in certain areas of reform and serve as models for the rest of the region.

CHAPTER 5. STRATEGIC DIRECTION I: APPLICABLE MODELS OF WATER QUALITY MANAGEMENT IN THE REGION

The system of surface water quality regulation should:

- Ensure an overall improvement of water quality;
- Be affordable, that is, compatible with available resources;
- Be flexible enough to adapt to changes in water use and water quality.

Based on the above requirements, two basic models (scenarios) for the development of water quality management systems in Central Asia were proposed: a “conservative” and a “dynamic” model. A detailed description of the models is presented in Annex I “International experience of water quality management and models applicable in Central Asia”.

The “conservative” scenario calls for modernization of the existing system of water quality regulation based on MACs and MADs by overcoming or attenuating its flaws and by introducing selected elements of the EU regulatory system. The priority modernization measures may include: reducing the number of regulated parameters; reducing the stringency of certain MACs; changing the statistical basis for setting the water quality standards; and introducing a technology-based approach to regulating point sources of pollution. This scenario would provide the advantage of continuity for the water quality regulatory system. In addition, its introduction would not require substantial institutional changes. A major shortcoming of this scenario is that it does not ensure integrated water quality management, that is, regulation of different water uses can still be done independently, using different types of requirements (for sanitation, fisheries, etc.). Local experience shows that some countries of the region are already using some elements of this approach, though noting its flaws.

The “dynamic” model is based on the system developed by the Organisation for Economic Co-operation and Development (OECD) for the Republic of Moldova and recently proposed for application to the countries of Eastern Europe, the Caucasus and Central Asia[5]. Its key element is a unified system of water quality classes, ensuring the nexus between water quality and water uses. Another important element is the flexibility of the regulatory scope. The list of regulated parameters is determined by a combination of factors, such as regulatory objectives, the types of water use, the volume and composition of discharges, monitoring capacity and laboratory potential. All of these factors are variable, and the system provides for a periodic revision of the scope of regulation by withdrawing or adding parameters and/or updating the limit values of the quality classes.

This system foresees step-wise water quality planning and management, which allows for a balance to be struck between the desired water quality and available resources (financial, technical and human).

Concerning the establishment of effluent standards, the OECD system proposes to abandon the existing method of setting maximum allowable discharge levels. The pollution point sources are to be regulated in accordance with the combined approach, that is, effluent limit values should be based on best available techniques (for large industries) or

5 OECD, Establishing a dynamic system of surface water quality regulation: Guidance for countries of Eastern Europe, Caucasus and Central Asia. (Paris: 2011). Available from http://www.oecd.org/dataoecd/54/36/48994623.pdf.

minimum standard requirements for the quality of treated effluents (for municipal wastewater treatment plants), as is the practice in the EU countries in accordance with the Urban Wastewater Treatment Directive. These requirements can be made stricter if the status of the receiving water reservoir requires better treatment.

In comparison with the previous model, this system ensures more integrated water quality management, as the system of surface water use classes unites all types of water use. Moreover, this system is expected to be an active instrument of water resources management and decision-making. On the other hand, it represents an abrupt change from the traditional system of MACs. Consequently, its implementation will require significant changes in legislation, institutional structure and managers' minds. In addition, substantial technical work needs be done (for example, in defining water bodies and desirable water uses for each, and in the selection of regulated water quality parameters and the establishment of numerical values for various water classes).

CHAPTER 6. STRATEGIC DIRECTION II: IMPROVING THE TRANSBOUNDARY MONITORING SYSTEM

Currently, water quality monitoring in Central Asia is mainly based on national systems, which differ significantly in terms of the density of monitoring points, equipment, analytical methods, sampling frequency and quality assurance procedures. These differences could further deepen given the lack of coordination among the different types of monitoring, and even more so as there is no regular transboundary monitoring or regular information exchange among the countries of the region.

Pilot transboundary monitoring projects can facilitate the improvement of monitoring systems both at regional and national levels. The "Guidelines for Developing a Transboundary Surface Water Quality Monitoring Programme for Central Asia", presented in annex II to this report, will contribute to the regular monitoring of the quality of transboundary waters and the establishment of information exchange between the countries. The Guidelines provide for the following actions:

- The step-wise development of monitoring and assessment programmes;
- The establishment of the background status of water quality, an important element in a transboundary monitoring system;
- The monitoring of a limited number of parameters (five indicators plus water flow) that reflect the most important transboundary problems of water pollution and the quantitative parameters of water discharge;
- The step-wise development of a regional information exchange database, and agreeing on procedures for data input, checking and dissemination.

At the first stage, joint efforts should be mostly directed at a regular information exchange between the countries on the quality of transboundary watercourses. Subsequently, elements of coordinated assessment and coordinated water quality standards/norms would be added.

In the longer term, the countries will aim at introducing the river basin approach in water resources management, particularly by expanding the monitoring networks and adapting the monitoring programmes. This should include the extension of the list of water quality indicators, the quality assurance of analytical data, the organization of specific research, the assessment of trends and pollution loads, the defining of the reference status of waters and the updating of water quality qualifiers.

The modernization of national monitoring systems is of equal importance to the future reforms. Though both transboundary and river basin monitoring contribute to the development of national water quality monitoring systems, they can be insufficient, especially enforcement of national standards, pollution source control and water use regulation.

CHAPTER 7. STRATEGIC DIRECTION III: THE LEGAL BASIS AND INSTITUTIONAL MECHANISMS FOR COOPERATION

The development of regional cooperation in water quality management is not possible without a clear political will shared by the countries of the region. A common international legal platform is required for the development of cooperation in this direction. Global practice shows that such a legal basis can be provided either by regional agreements or by bilateral or multilateral basin agreements, covering, whenever possible, the major transboundary waterways.

At present, there are inter-State structures such as ICWC and the ICSD created in the region under the aegis of IFAS. Having relevant mandates from the Governments of the Central Asian countries, these technical bodies can take a leading role in water quality management. One of the main missions of IFAS is "support of [the] inter-State environmental monitoring system, creation of a databank and other information systems on the state of [the] environment of the Aral Sea Basin". A concrete mechanism for international cooperation on the integration of environmental, river basin management and water quality management issues into a uniform system of regional water resources management is currently being developed and discussed. The IFAS Executive Committee can explore opportunities for creation of a permanent working group on water quality similar to the Regional Centre of Hydrology.

The Inter-State Commission for Sustainable Development, which is empowered to form advisory and expert working groups, could head the organization and support the inter-State activity on water quality management, for example, through its scientific information centre, or take another organizational form.

The countries of Central Asia can also choose to adopt some other legal basis for inter-State cooperation on water quality management.

Whichever political platform of regional cooperation is adopted, the countries should create an efficient mechanism to support it. A permanent regional working group on water quality can become such a mechanism. There is already some experience of such an activity in the region, supported by the UNECE "Water Quality in Central Asia" project. In the longer term, it is important that such a working group be duly mandated by the Governments of all the countries.

The benefits for all the countries of the region in supporting a regional working group are as follows:

1. Through their representatives, the countries can directly participate in water quality management in the regional context;
2. Experts from all the countries would acquire a platform for sharing experience, analysing the problems of, and developing joint proposals for, tackling emerging situations and coordinating actions and efforts in priority directions;
3. The regional working group would provide an opportunity to disseminate the best practices from neighbouring areas, international organizations and other water basins throughout the Central Asia region;
4. The mechanism would increase the potential for acquiring national and international financial support to tackle regional problems of water quality and updated approaches to regulate them;
5. The inter-State regional bodies of IFAS would be provided with qualified technical expertise on various issues of water quality management to enhance their decision-making capacity;
6. The region would increase its potential for ensuring coordinated and integrated water resources management that takes account of water quality by applying regulatory mechanisms.

It is important that the representatives nominated by countries to the regional working group have the authority to promote the regional recommendations at the national level, and the national agencies must then take due account of them. Otherwise, the required efficiency cannot be expected from the activities of such a working group.

The permanent regional working group on water quality can have the following short-term (five years) tasks/objectives:

- Experience-sharing on water quality monitoring, wastewater discharge regulation and the modernization of legislative and regulatory mechanisms for surface water quality management;
- Assessment and analysis of joint or coordinated activities on pollution control and transboundary watercourses monitoring;
- Preparation of capacity-building projects for the countries of the region and the implementation of coordinated water quality policy.

The working group should operate on the basis of a regulation defining its structure, scope of responsibility, procedures and reporting.

CHAPTER 8. BUILDING POTENTIAL FOR REGIONAL COOPERATION

The main areas of regional cooperation on water quality management in the short term are:

- Creating and supporting the regional working group and the common administrative resource to fulfil exchange, storage and processing of regional monitoring data;
- Implementing pilot projects on transboundary monitoring of selected watercourses;
- Developing joint projects on transboundary monitoring and joint assessment of transboundary water quality;
- Evaluating the needs for modernization of laboratory equipment and for training of the personnel of the national monitoring agencies to ensure the control of surface water quality in the region;
- Coordinating the work of the laboratories to ensure a proper level of stakeholder trust and to promote the harmonization of procedures of water sampling and joint analysis;
- Preparing joint publications and organizing scientific and practical conferences on water quality management;
- Planning and implementing joint projects on harmonization of approaches to water quality control/management, especially in a transboundary context;
- Developing a unified system of water body classification that would set the requirements for water quality;
- Updating the list of polluting substances that raise major concerns in the region; acquiring data on background natural pollution of waters;
- Updating the list of regulated water quality parameters (at the national, transboundary or basin levels) and effluent limit values for particular sources of pollution;
- Developing harmonized requirements for water quality analysis methods, for equipment monitoring procedures and programmes and for controlling point and non-point sources of pollution.

The listed measures can be promptly and efficiently executed if the work is built in close cooperation with experts of the countries in the region. If these actions produce the expected outputs, the results could provide an impetus for the development of longer-term plans at the regional level and the enhanced harmonization of reforms in water quality at the national level.

TOWARDS DEVELOPMENT OF REGIONAL COOPERATION
IN ENSURING WATER QUALITY IN CENTRAL ASIA

Annex 1

International Experience of Water Quality Management and Models Applicable in Central Asia

Diagnostic Report and Cooperation Development Plan

CONTENT

1. INTRODUCTION

For many centuries, water resources have always been a major development factor in the Central Asian region. Consequently, water availability and water distribution issues have largely shaped the relationships among the regional actors.

At the beginning of the twenty-first century, the countries of Central Asia are facing a rising number of problems. At present, more than 60 million people live in the five countries of the region and the population continues to grow rapidly, as does the need for water. Water shortages in the region are primarily related to the inefficiency of irrigation practices, shortcomings of the water management system and water pollution, rather than a deficit of water resources. On the whole, the current approach to water resources management in Central Asia cannot be regarded as sustainable.

Climate change can further exacerbate these problems and the vulnerability of the region to such changes is rather high. The worst-case climatic scenarios for the region foresee the water resources of the main rivers dropping to 15-40 percent by 2030-2050. During the forthcoming decades, one can expect climate change to aggravate the region’s social, economic and environmental problems.

The quality of surface waters shows a clear tendency to deterioration. The discharge of drainage waters leads to poor water quality in the rivers that are used for drinking water supply. Water pollution threatens public health, economic development, and the integrity of natural ecosystems.

Water quality regulation in Central Asia is based on the Soviet system of maximum allowable concentrations (MAC) and maximum allowable discharges (MAD). The system was made as scientifically rigorous and ensuring a high level of protection of water from pollution. Over time, more than 1,000 substances have been regulated and the system became too complicated: if followed strictly, it would have been exceptionally expensive to implement. As a result, it has never been implemented to its full extent.

The ultimate goal of any regulatory system is ensuring the implementation of certain requirements. The environmental regulation is based on environmental quality standards aiming at the protection of human health and the natural environment from adverse impact. However, setting environmental standards is of no use if such standards cannot be applied. Their application depends on a number of factors, including the availability of relevant legal and institutional frameworks, technical and administrative feasibility, and financial affordability.

An efficient regulatory system relies on the availability of realistic environmental standards based on objective scientific criteria, as well as, on economic and technical feasibility and is applicable to all producers.

This document was developed in order to initiate discussions within the Regional Working Group (RWG) on water quality regarding the possibility and ways of adapting (or modifying) the current system of surface water quality regulation in the Central Asian countries. The aim of the RWG is to develop a step-by-step plan of coordinated water quality policy development in Central Asia. The work of RWG should also facilitate the development of a realistic water quality regulatory system that would respond to current challenges and be flexible enough to adapt to environmental changes.

The document is structured as follows. Section 1 provides a concise description of modern principles of water quality management. Section 2 presents the international experience of water quality management during the last 20-30 years including the Soviet system, the European Union (EU) water quality regulatory system of the 1980-1990s, the current EU system (the Water Framework Directive) and the United States approach to water quality regulation. The advantages and shortcomings of each system are briefly mentioned. Section 3 discusses several water quality regulation models suitable for Central Asian countries. The options evaluated include the modification of the water quality regulatory system in use, the new approaches adopted by Russia and Kazakhstan, as well as the regulatory system proposed by the Organisation for Economic Co-operation and Development (OECD) for Moldova and the Eastern Europe, the Caucasus and Central Asian (EECCA) countries.

2. PRINCIPLES OF WATER QUALITY MANAGEMENT

The availability of freshwater resources has always influenced the development of human society. Today, however, we are approaching a line where the provision of the required amount of water of suitable quality has become a clear limiting factor for further human development. Population growth, economic development and expected effects of climate change will only increase the existing tension in water supply. There is a clear understanding that freshwater is a limited and vulnerable resource, and an essential element of both human livelihood and the natural environment.

In most countries, water management practices have always been biased towards the quantitative component of water resources, whereas water quality has long remained a matter of lesser importance. Water resources management focused on abstracting water where it was abundant and transporting it to where there was a water deficiency, with little attention paid to any potential damage that would occur to existing natural ecosystems.

Water quality is as important for meeting the primary needs of humans and the environment as is water quantity; these two components of water resources are inseparably linked. The deterioration of water quality reduces its applicability for certain categories of water use. Pollution, for example, can make water unsuitable for drinking, bathing, industrial, or irrigation purposes, effectively reducing the available quantity. The more polluted the water is, the more expensive is the treatment necessary to make it available for any use.

The deterioration of water quality entails economic costs, including increased expenses for healthcare, negative impacts on economic activity (industry, agriculture, tourism), degradation of aquatic ecosystems and their services and increased costs of water treatment. In some parts of the world such costs can be significant. For example, according to the World Bank estimates (2007) the losses inflicted by water pollution in the countries of the Middle East and North Africa comprise 0.5-2.5 per cent of GNP[1].

For a long time, the dominant sectoral approach to water management, where the responsibility for different water uses (drinking water supply, irrigation, environmental protection) was borne by different organizations, resulted in inefficiency of the state policy in this area, management problems, and in the long run, in degradation of water resources.

These factors led to a development and implementation of Integrated Water Resources Management (IWRM), a more comprehensive system accounting for all possible sources of water. The IWRM approach reconciles the interests of all sectors and all levels of water use, takes a river basin perspective that involves all water users, and encourages rational use of water resources, ensuring environmental safety and sustainability of the water supply for population and environment[2].

The backbone of IWRM is the acknowledgement of interdependence of all types of water use. The IWRM approach takes into account the links between surface water and groundwater and between water quantity and quality, as well as the relationships between water resources and the terrestrial environment and with social and economic development.

All the countries of Central Asia adopted the principles of the Dublin Statement on Water and Sustainable Development (1992) as the leading principles for development of national policy for water resources management. One of the main Dublin principles of integrated water resources management is a deep and complex nexus between water quality and quantity.

The implementation of IWRM principles involves the following: 1) adaptation of policy and legislation in water resources management, 2) the establishment of an adequate institutional framework for policy implementation and 3) the creation of special instruments required for organizations to fulfil their tasks.

The core of the water quality regulation and protection system consists of setting permissible levels (standards, norms) of water quality for concerned water bodies. Such levels should secure public health protection and favourable conditions for water use and the functioning of water ecosystems. The standards form the basis for an environmental policy, as they reflect the public understanding of an acceptable quality of the environment. They are also important regulatory instruments defining allowable levels of wastewater discharge into the water bodies.

Unrealistic or outdated regulatory instruments cannot be used to tackle water quality issues. For example, a recent review of surface water quality regulatory systems in the EECCA countries[3] showed that despite all countries having in place the legislation regulating water quality, most water bodies are still in the category of “moderately polluted”. Many of the existing water quality standards are outdated and unnecessarily stringent, especially in view of a lowered capacity of state agencies involved in monitoring and enforcement of standards.

As the issue of surface water quality is gaining priority in developing countries, the gap between needs and the possibilities to satisfy them has become apparent. Particularly in low-income countries, defining sufficient/reliable water quality has to be balanced against what is achievable.

Efficient regulation depends on realistic standards that cover the entire regulated community; is based on objective scientific criteria, risk assessment and cost-effectiveness analysis and is backed by enforcement. For these tasks to be implemented a balance of interests of all stakeholders should be attained and a relevant package of regulatory instruments defined aiming to achieve the common environmental protection goals. It is important for the water quality standards to be flexible and subject to periodic revision so that the water quality requirements can be raised in the long term.

- Basically, the water quality regulatory instruments can be aimed at controlling the discharge of polluting substances at the source, or at controlling the water quality in the receiving water body. In the first case, common discharge standards are usually set for all regulated subjects by sector or region. In the second case, individual permits set specific discharge limits basing on existing surface water quality standards.
- A so-called combined approach foresees the establishment of uniform discharge limits that can, however, be made stricter if so required by the status of the receiving water body (e.g., in order to maintain a certain water use or a vulnerable ecosystem).
- The regulation of water quality by discharge control is inefficient in areas where non-point sources provide the bulk of water pollution. In such cases the focus is placed on management practices such as the introduction of best environmental practices for fertilizer and pesticide use in agriculture.
- The regulatory instruments of water quality management should be based on the objectives set at the stage of policy development and planning. In addition, the setting and application of water quality standards should be closely coordinated with the regulatory requirements for water quantity as these two aspects are interdependent.

1 http://siteresources.worldbank.org/INTMENA/Resources/00a-Front-Scarcity.pdf.
2 http://iwrm.icwc-aral.uz/iuvr_ru.htm
3 http://www.oecd.org/dataoecd/62/26/41832129.pdf

3. INTERNATIONAL EXPERIENCE OF WATER QUALITY MANAGEMENT

For the last decade the issue of reforming the water quality regulation system (and its key element – water quality standards) has become one of the most debated in various EECCA countries. In Ukraine and Moldova this can be explained by the political endeavour to integrate into the EU, and consequently harmonize national legislation with the EU acquis. Such an explanation is insufficient, however, for the rest of the post-Soviet territory. What is wrong with the old regulatory system, and why are the countries looking for alternatives? To answer these questions it would be useful to go back a few decades to trace the way water quality regulation developed in different parts of the world.

3.1. The Soviet MAC/MAD system

The USSR water quality standards, which are still applied with minor changes by the majority of the former USSR countries, were developed in the 1960s and 1970s. The legal basis was created by the Law of the USSR on the basic principles of water legislation in the USSR and the Union republics (1970) and on the Water Codes of the republics adopted in the early 1970s.

The water quality management system consisted of environmental quality standards (maximum allowable concentrations) and discharge standards (maximum allowable discharges):

- The maximum allowable concentration (MAC) is defined as the concentration of a substance in water, the exceedance of which turns water inappropriate for one or several uses (State Standard GOST 27065-86).
- The maximum allowable discharge (MAD) is the maximum mass of substance in wastewater allowed to be discharged at a certain point of the water body per unit of time in order to ensure the compliance with water quality standards at the established checkpoint (State Standard GOST 17.1.1.01-77).

The water quality standards in the Soviet Union were set to ensure that concentrations of toxic substances in water were not having either direct or indirect harmful impacts on people or animals. Therefore, the Soviet standards were set at such levels that (at least theoretically) could ensure a zero risk level for human health or water organisms. Even insignificant exceedance of a MAC was regarded as representing a potential risk to human health. Consequently, the standard-setting procedures were based exclusively on sanitary or toxicological criteria and ignored such factors as economic feasibility and monitoring capacity.

To set the fishery MAC for one chemical substance, for example, a whole series of toxicological experiments should have been carried out with the use of a number of various highly sensitive aquatic species. The tests required a few months, and the whole process took one and one half to two years. Tests on salmonid fish (most sensitive to pollution) or other commercially valuable species (sturgeon) were mandatory. The vast majority of such experiments were carried out in academic institutions based in the north of the USSR (Petrozavodsk, Saint-Petersburg), in cold and low mineralized waters. No review or validation of toxicological data was normally done.

The system of water quality standards was developed on the basis of water uses. Water bodies were classified in accordance with the three types of water use: fishery, economic and drinking, and community services. Two types of MACs were applied for these water use categories: sanitary/hygienic and fishery. Sanitary/hygienic MACs were applied to water bodies used for drinking water, recreation/bathing and/or utility/industrial purposes. Fishery MACs were applied to water bodies used for activities related to fish. The fishery MACs were often regarded as more generic environmental thresholds. By the time the USSR collapsed, more than 1 000 sanitary/hygienic MACs and about the same number of fishery MACs were set.

Sanitary/hygienic MACs are the maximum concentrations that have no (direct or indirect) impact on the health of current and future generations and have no adverse impact on sanitary conditions of water use. Fishery MACs are the maximum concentrations that have no influence on the fish industry at a certain water body and/or do not reduce the significance of this water body in maintaining sustainable commercial fishing.

The water bodies were classified in accordance with Regulation No.1045 of the Council of Ministers of the USSR dated 15 September 1958, which stipulated that, “*all water bodies and their tributaries that are being used or could be used for commercial fishing, or are of importance to commercial fish reproduction are considered water bodies for fishery purposes*”. Thus, practically all surface water bodies of the Soviet Union, a huge country of highly variable geophysical, climatic and social and economic conditions, were classified as water bodies for fishery purposes and were subjects to regulation aiming at ensuring sustainable commercial fishing and fish breeding. It was thought that an adverse impact on fish manifests itself at much lower concentrations than on human health; therefore, fishery waters needed a higher level of protection. At the same time, if a water body was used in a complex way by a number of water users, the strictest MAC was applied.

The second element of surface water quality regulation in the USSR was the maximum allowable discharge (MAD), which set limits for the mass of pollutants in wastewater. The MADs were set for each point source of pollution on the basis maximum allowable concentrations of pollutants in the receiving water bodies.

The MAD standards (norms) regulated the volume of harmful substances discharged by an enterprise (taking account of discharges from other sources, the background concentration 1 000 metres upstream of the discharge point, the plans of regional development and the dilution capacity), so that the concentration of harmful substances in the receiving water body would not exceed the MACs. The methodology of their calculation was set in a regulatory document. The MAD values were calculated using mathematical models proceeding from the necessity not to exceed MACs at the border of a so-called sanitary zone – 500 metres downstream from the point of wastewater discharge for fishery water bodies and 1 000 metres from the nearest water abstraction point for water bodies of other categories.

The maximum allowable discharges were developed by contractors, who were licensed by the Ministry of Environmental/Natural Resources Protection, to perform such work. Water users were first to coordinate the MADs with the local environmental agencies, including the fishery agencies, public health and hydrometeorological services; then, these standards were adopted by the relevant regional institution under the Ministry of Environmental/Natural Resources Protection. The MADs were used to issue permits for the discharge of pollutants. If discharges exceeded the set limit values, various sanctions were applied; the prevailing sanctions were fines. The compliance monitoring was carried out by the enterprises themselves, which then reported to the environmental agency. The capacity of supervising agencies to carry out analytical verification of compliance with the set limit values for discharges was rather limited.

Enterprises were also obliged to develop management plans providing a detailed description of the process to achieve compliance with established MADs. Usually, the enterprises exceeding the discharge limit values could negotiate provisional MAD levels with the environmental, health protection and fishery agencies.

Strengths of the Soviet system:

- Sets a (theoretically) high level of protection of water from pollution;
- Based on the idea of preserving suitable water quality in the receiving water body.

Weaknesses of the system:

- MACs were based solely on the results of scientific research, regardless technical feasibility, economic factors and cost of regulatory measures;
- MACs were based on the concept of zero risk for human health or aquatic organisms;
- Many MACs are excessively strict and, in certain cases, unachievable;
- No time framework or possible ways to achieve conformity with MACs;
- Fishery MACs were much stricter than sanitary/hygienic MACs and the Soviet practice of designating nearly all water bodies as fishery water bodies increased the load on the regulated community;
- The system of MACs was cumbersome and difficult to manage (more than 1 000 parameters);
- The regulatory system was not backed by a sufficient monitoring potential (the compliance control for all parameters was a priori impossible);
- The system rather inefficient in defining the general trends of water quality and, consequently, in planning capital investment in priority areas.

Such features as the absence of implementation terms and the tendency to designate all the water bodies as fishery waters are not proper characteristics of the MAC system, but rather principles and practices of planning and management.

3.2. Early European system

Basic system elements

Water is one of the most comprehensively regulated areas of EU environmental legislation. The early European water policy took shape in the 1970s with the First Environment Action Programme (1973), followed by a first wave of legislation starting with the 1975 Surface Water Directive and culminating in the 1980 Drinking Water Directive. This first wave of water legislation included water quality standard legislation on fish waters (1978), shellfish waters (1979), bathing waters (1976) and groundwater (1980). The Dangerous Substances Directive (1976) and its daughter Directives governed various individual substances by setting maximum allowable discharge values.

The first wave of directives regulated basic water uses by setting quality standards for surface waters meant for drinking and bathing purposes. In 1980 the Drinking Water Directive laid down strict quality standards for drinking water; it set methods and frequency of sampling, as well as methods of analysis.

In the late 1970s, quality standards were set for water as a habitat (for fish and shellfish).

The first Directive focusing on the sources of pollution and establishing limits for the discharge into the waters was the Dangerous Substances Directive (76/464/EEC). The Directive requires setting discharge limit values for dangerous substances as well as bans for the discharge of various individual substances.

In 1980, the Groundwater Directive, which followed the approach of the Dangerous Substances Directive, was adopted. However, the lists of dangerous substances in these two Directives are not identical.

A second wave of water legislation followed a review of existing legislation and identification of necessary improvements and gaps to be filled. This stage of water legislation development included two directives regulating different types of pollution sources, i.e. the Urban Waste Water Treatment Directive (1991) and the Nitrates Directive (1991). The Nitrates Directive requires the development of action plans for areas sensitive to nitrate pollution from agricultural sources. The Urban Waste Water Treatment Directive prescribes all population settlements to have wastewater treatment systems - mainly secondary treatment with stricter requirements for bigger settlements and sensitive areas. The implementation of this directive demanded large investments; hence, many EU countries faced problems in implementing its requirements.

Other elements identified were revisions of the Drinking Water and Bathing Water Directives to bring them up to date, the development of a Groundwater Action Programme and a 1994 proposal for an Ecological Quality of Water Directive. Besides, water pollution by large industrial enterprises falls under the Integrated Pollution Prevention and Control (IPPC) Directive of 1996.

Some Directives include explicit quality standards for surface waters (like the Drinking Water Directive), whereas other Directives do not contain explicit water quality standards (e.g. the Urban Wastewater Treatment Directive and the Nitrates Directive), although, in general, they aim at improvement of surface water and groundwater.

It should be noted that the number of directly regulated water quality parameters is comparatively small, e.g., the Surface Water Directive (1975) regulates the concentrations of 46 parameters, the Bathing Water Directive (1976) – 19 parameters, and the Directive on the quality of freshwaters needing protection or improvement in order to support fish life (1978) – 14 parameters. It can also be noted that the emphasis of these directives is on human health protection rather than preservation of water habitat (at least, judging by the number of parameters).

The piecemeal development of the EU water quality policy finally covered the following areas:

- Categories of activity contributing to certain types of pollution (e.g. nitrates from agricultural sources);
- Types of water use (abstraction for drinking purposes; drinking water quality);
- Water as a habitat for certain species (fish, shellfish);
- Pollution of water by dangerous substances.

By the late 1990s, the EU had not created a uniform framework for water resources management that took into account in an integrated way the following: a) the qualitative and quantitative aspects of water resources management; b) the interconnection between surface and groundwater; c) the issues of water use and environmental protection; and d) the water management issues in combination with other sector problems (agriculture, industry).

Strengths of the early EU regulatory system:

- Strict water quality regulation aimed at human health protection;
- Increased flexibility (quality standards for water bodies intended for the abstraction of drinking water in relation to the category of water treatment; guide values and mandatory values of parameters; standards for salmonid and cyprinid fish);
- Stipulated windows for the realization of requirements, where the regulation subjects were normally granted enough time to achieve them;
- Recognition of the possibility of and need for the regulations revision;
- Feasibility and affordability of the requirements for the regulated community;
- Significant progress in reducing point source pollution.

Weaknesses of the system:

- Failed to consider a number of aspects and interactions of water management elements in an integrated manner;
- Failed to take full account of the water quality criteria required for a proper functioning of natural ecosystems;
- Gave too much weight to the criterion of affordability;
- Was biased towards technological standards for wastewater discharges;
- Proved to be particularly inefficient in controlling non-point source pollution.

3.3. Current EU system

By the late 1990s it became obvious that efficient water protection required an integrated water policy to be adopted at the EU level. As a result, the Water Framework Directive (WFD) was adopted in 2000 aiming, inter alia, to improve the internal coherence, clarity, and efficiency of the EU water legislation. The WFD became the working instrument of the EU water policy. The Directive introduced new approaches to water management that have far-reaching consequences at institutional and technical levels.

Basic elements of the system

The WFD is oriented towards reaching two main goals:

- Managing the issues of water supply in the EU through creation of river basin districts, river basin committees and integrated management plans;
- Assuring the quality and status of waters through designation of protected zones, introduction of quality standards based on biological, chemical and hydromorphological characteristics, discharge limit values and mechanisms of damage compensation.

The objectives of the WFD include:

- Extending the scope of water resources protection to cover all water bodies, surface waters and groundwater;
- Managing water resources by the river basin principle;
- Introducing the “combined approach” to water quality regulation using both emission limit values and water quality standards;
- Achieving a good status of all water bodies by 2015;
- Simplifying the legislation.

Managing water resources on the basis of river basins, rather than according to administrative division became the basic principle of the EU water policy. For each river basin district, the WFD requires the development of a River Basin Management Plan and its revision every six years. Such a plan provides a detailed description of a process on achieving the target indicators set for a particular river basin (ecological status, quantity parameters, chemical status and indicators set for the protected areas) for a specific period of time.

Historically, two approaches were applied in Europe to control pollution. The first was focused on solving the problems at the source of pollution by means of technological solutions, while the second put an emphasis on the status of the recipient waters (environmental quality standards). In time, it became increasingly clear that neither of the approaches was sufficient to ensure the protection of environment. As a result, the EU adopted a “combined approach”, which was formalized in the Water Framework Directive. This approach includes both emission limit values (discharge standards) and water quality standards.

Concerning the sources of pollution, the WFD requires an introduction of all technological means of control. On the basis of a risk analysis, a list of priority substances is compiled and the most cost-effective package of measures is prescribed to reduce the load of those substances. Concerning the environmental impact of pollution, the Directive integrates all target indicators of environmental quality existent in the current legislation, and sets a new general objective of achieving a good quality status of all waters. The WFD requires undertaking additional efforts if the measures taken at the pollution sources appear to be insufficient to meet the target indicators.

The water quality regulation pursues several objectives, including general protection of aquatic ecosystems, special protection of unique and valuable habitats, protection of freshwater resources and protection of bathing waters. If all these purposes are applicable to a certain river basin they are to be integrated.

The Framework Directive introduces a general requirement to the protection of all surface waters – the achievement of "a good ecological status" and a general minimum chemical standard – "a good chemical status". The overall objective of the WFD is achieving "good status" of all waters (surface water and groundwater) by 2015.

One of the specific features of the WFD is its integrated approach. The WFD assessment of the status of surface water bodies includes biological, physico-chemical and hydromorphological quality elements, implying that a surface water monitoring network must be able to monitor various quality elements and use the collected data for an assessment in line with the criteria put forward by the Directive. Table AI.1 provides some details.

Table AI.1

Quality elements for assessment of ecological status in rivers and lakes (EU)

RIVERS	LAKES
BIOLOGICAL ELEMENTS	
• Composition, abundance of aquatic flora • Composition, abundance of benthic invertebrate fauna • Composition, abundance and age structure of fish fauna	• Composition, abundance of aquatic flora • Composition, abundance of benthic invertebrate fauna • Composition, abundance and age structure of fish fauna • Composition, abundance and biomass of phytoplankton
HYDRO-MORPHOLOGICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS	
• Quantity and dynamics of water flow • Connection to ground water bodies • River continuity • River depth and width variation • Structure and substrate of the river bed • Structure of the riparian zone	• Residence time • Connection to the ground water body • Lake depth variation • Quantity, structure and substrate of the lake bed • Structure of the lake shore
CHEMICAL AND PHYSICO-CHEMICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS	
• Thermal conditions • Oxygenation conditions • Salinity • Acidification status • Nutrient conditions • Specific pollutants: Pollution by priority substances identified as being discharged into the body of water. Pollution by other substances identified as being discharged in significant quantities into the body of water.	• Transparency • Thermal conditions • Oxygenation conditions • Salinity • Acidification status • Nutrient conditions • Specific pollutants: Pollution by priority substances identified as being discharged into the body of water. Pollution by other substances identified as being discharged in significant quantities into the body of water.

Good chemical status is defined as a compliance with all quality standards set for chemicals at the EU level. The Directive also provides a mechanism to review these standards and to introduce new ones.

For the first time at the EU level the Water Framework Directive provides a basis for integrated surface and ground water management.

The WFD makes the EU water legislation more streamlined, as it substitutes seven directives of the first wave, including the Surface Water Directive (1975), the Groundwater Directive (1980), the Freshwater Fish Directive (1978), the Shellfish Water Directive (1979), and the Dangerous Substances Directive (1976).

Nevertheless, certain components of legislation of the 1980s-1990s remain in force, including the Bathing Water Directive (1976), the Drinking Water Directive (1980), the Urban Wastewater Treatment Directive (1991), the Nitrates Directive (1991), and the Integrated Pollution Prevention and Control Directive (1996).

The replacement of the previous Directives with the Water Framework Directive provided a more consistent approach to pollution prevention and control throughout the EU. Various environmental quality standards from the daughter directives were included in the Dangerous Substances Directive. If those standards were previously applicable only to those EU members that were using the quality standards approach, the WFD has extended their applicability to all the EU countries. In addition, the WFD also provides a mechanism to set new quality standards, where appropriate.

As for discharge standards, the WFD does not set any parameters per se; it rather coordinates the use of parameters stipulated by other pieces of legislation, mainly by the Integrated Pollution Prevention and Control (IPPC) Directive. The IPPC Directive regulates major industries by binding them to issue integrated permits, which should set, inter alia, emission limit values that would not breach the local water quality standards. The Framework Directive prohibits deviating from the requirements of the IPPC Directive.

Strengths of the WFD regulatory system:

- Pursues several interrelated goals, including general protection of aquatic ecosystems, special protection measures for unique and valuable habitats, protection of freshwater resources and protection of bathing waters;
- Combines and integrates approaches and provisions of several first wave directives thus streamlining the water quality management;
- Introduces a combined approach to pollution control (technological measures + water quality criteria), thus providing the best achievable level of water protection;
- Introduces an integrated approach to assessing the ecological status of surface waters, taking into account the biological, physico-chemical and hydromorphological quality elements;
- Provides a basis for an integrated surface and groundwater management;
- Provides a mechanism to review water quality standards and introduce new ones (the mechanism of priority hazardous substances).

Weaknesses of the system:

- Has a complex proposed system of ecological status assessment of surface waters;
- Requires significant financial efforts that can be a burdensome even for the old EU member states.

3.4. Water quality regulation in the United States

Basic elements of the USA system

The system of water quality management in the United States developed in several stages. The first comprehensive legislation for water pollution control was the Water Pollution Control Act of 1948, which adopted the principles of state-federal cooperative programme development. This Act further developed into a Water Quality Act of 1965, under which the states were directed to develop water quality standards establishing water quality goals for interstate waters. By the early 1970s, all states adopted such water quality standards, which were further revised to reflect new scientific data, the impact of economic development on water quality, and the results of the water quality control measures.

At the time, the water quality standards had not proved effective as an enforcement instrument, and since 1970 the emphasis has shifted to technology-based standards for discharges of various industries. Nevertheless, the Clean Water Act (1972) retained the provisions for setting water quality standards for pollutants in surface waters and required discharge permits to be consistent with applicable state water quality standards. Thus, a combined technology-based and water quality-based standards approach to water pollution control is used in the United States.

Technology-based effluent limit values are applicable to all point-source dischargers and are implemented through enforceable permits. Effluent limits are uniform throughout the United States for similar point sources with similar characteristics, a provision that prevents geographic competition of industries from undermining water pollution control standards. The Clean Water Act forced the companies to gradually introduce more effective pollution control technologies. In the process of establishing technological requirements, a detailed economic analysis is carried out, which includes the cost of wastewater treatment technologies, energy use, and non-water quality impacts. Thus, the regulated community is directly involved in the standard-setting process. The provisions for comments and revision of standards, built into the process, ensure an objective analysis of information and the consideration of additional data.

Despite the emphasis of the 1972 Clean Water Act on a technology-based approach, the controls of water quality standards were not abandoned; rather they serve as a safety net to back up the technological control methods when they cannot attain the required water quality. The Act identifies specific water bodies with certain existing or expected water quality problems, and sets ***priorities for water use*** (the main designated water use categories are centralized water supply; protection and support of fish, shellfish or wildlife population; recreational use; water use in agriculture, industry and navigation[4]).

4 The US system of water uses classification is rather complicated. In addition to the main categories of water use there can be sub-categories such as protection of coral communities, coastal and marine waters, areas of groundwater recharge, protection of underground aquifers,

Furthermore, for those water bodies that are not expected to meet the water quality standards for particular parameters, ***total maximum daily loads*** (TMDL) are to be developed. The TMDLs normally specify the amount of pollution that must be reduced to ensure the desired water quality. These amounts of pollution reduction are divided among all point and non-point sources of pollution of a particular water body. To calculate TMDLs the so-called water quality criteria are applied.

In fact, these are ***maximum allowable concentrations*** (MACs) for chemical substances in water, which represent no threat to water life and human health. Thus, these criteria are similar to the Soviet MACs. Together with the use areas, the water quality criteria (the list of parameters and their maximum allowable concentration for a particular type of water use) make the water quality standards for a certain class of water bodies[5].

A distinctive feature of MACs for aquatic organisms in the United States, in contrast with the Soviet method, is that they are based on acute toxicity of chemicals. Short-term toxicological tests are strictly standardized for 2-3 species of aquatic organisms (fish, water fleas). The toxicity indicator determined under such conditions (semi-lethal concentration) is corrected by the so-called safety factor, that is, a reducing coefficient of 10, 100, and so on: the more toxic the substance is, the higher the coefficient. Moreover, water quality criteria are designed for various water ecosystems such as wetlands, coastal waters and freshwater.

Water quality standards are revised at least every three years. The TMDLs are set for a 15-year term.

Strengths of the US regulation system:

- The polluting industries clearly know what measures to take in their production to reduce the volume of sewage or to improve wastewater treatment systems;
- The gradual introduction of technology-based standards requirements allows companies to plan their investments and stimulates the introduction of low-waste or waste-free manufacturing processes and productions;
- The system treats all industries the same;
- The industries are involved in the development of technology-based standards;
- TMDLs are not applied to all water bodies and polluters; only to those posing concern;
- A system of water quality standards revision is foreseen to include new scientific data on the properties of chemical compounds;
- The responsibility for water quality management is shared by both point sources and non-point sources of pollution.

Weaknesses of the system:

- Setting TMDLs for every particular water body requires significant effort;
- If water quality criteria by ecological parameters are to be set, the implementation of the system requires many years of field work, a good scientific basis, numerous approvals and the involvement of a large number of professionals and institutions;
- The approach of using short-term toxicological tests as a basis for taking action on long-term protection of water bodies entails uncertainty.

hydropower. At the same time, both seasonal water use and water use downstream must be considered, as well as such sub-categories as habitats in cold and warm waters, ecosystems with high and low biodiversity, ecosystems and habitats of individual species of specific hydroflora and hydrofauna. To compile a list of water uses categories for each water body, certain procedures are to be followed, such as public hearings to change the type of water use in the water body and expunge non-priority water uses, a system of disputes and appeals. The system is even more complicated for ecological use categories as it then requires preliminary scientific research and analysis, including physical, chemical and biological characteristics of the water body (more than 40 parameters), as well as execution of a biological inventory, definition of a biological status, assessment of ecological status, analysis of biological potential (moreover, individual methodologies have been developed for running waters, lakes, estuaries, etc.)

5 The system of setting water quality criteria in the US is complex and multistage. For example, it includes such aspects as the federal criteria and criteria for specific water bodies. These criteria can be either numeric or descriptive, either coupled with discharge permits and systems of individual control of enterprises, or irrespective of them. Two main aspects to be considered are public health (carcinogenesis of chemical compounds and systemic toxicity, uptake, risk assessment) and water as a habitat (criterion of maximum concentration for aquatic organisms, chronic concentration criterion, calculation criteria, or in other words, magnitude, duration and frequency of impact). To assess the uptake of a chemical compound by the human body the following factors should be taken into account: intake with drinking water, while bathing, with food, with fish products, the potential for bioaccumulation, etc.). Specific procedures of risk assessment and water quality criteria setting are stipulated for «priority» toxic substances, common toxic elements of the aquatic environment and chemical elements «sometimes showing toxic properties» (e.g., chlorides, ammonia). The system becomes even more complicated if we are to take into account the results of biological monitoring (existence of water organisms under continuous toxic pressure, methods of biological testing of water bodies, in-situ biological assessments, etc.), as well as quality criteria for sediments, water quality criteria for terrestrial and migratory species that come into contact with contaminated water, numerical criteria for wetland areas, specific criteria for the quality of unique, rare and strictly protected waters, etc. Methods of developing separate criteria for metals (dissolved or total fraction) are also being discussed.

4. WATER QUALITY MANAGEMENT MODELS APPLICABLE IN CENTRAL ASIA

A brief analysis of the international experience on water quality regulation highlights some objective reasons for changing the current surface water quality standards system. The recognition of shortcomings of the current system is the first step towards amending it to better respond to modern economic, social and environmental realities. The question is: what model of water quality regulation would be the most suitable for the countries of Central Asia? No matter what system is chosen, in order to be effective, it must adhere to a number of general principles.

The system should be as simple as possible and comprehensible. It should have attainable targets and take into account the burden (financial or other) created by the system of standards and imposed on both enforcement agencies and the regulated community. One of the important conditions for compliance with the regulations is their financial affordability. Even if companies understand the requirements and agree with a procedurally fair law, they will not comply with the requirements if they cannot afford to implement it.

A network of institutions with clearly defined authority and responsibilities should be put in place; the institutional fragmentation and lack of coordination must be overcome. Finally, real public participation in decision-making should be ensured; in other words, public pressure on the political process should be present.

In view of these principles, several models for development of surface water quality standards for the countries of Central Asia have been proposed. These tentative proposals should be regarded only as a discussion platform for the Regional Working Group on water quality. Either the adoption of one of the proposed models (either in original or modified form) or the development of a completely different approach can be the outcome of the discussions.

The scope of the proposals goes from a more or less significant upgrading of the existing system to its complete rejection and replacement by a new one. Specifically, the following models of the surface water quality standards have been discussed: (1) the modification of the current MAC system; (2) the system of standards in place in the Russian Federation; (3) the system adopted in Kazakhstan; and (4) the system proposed by the OECD for Moldova.

4.1. Modification of the current MAC system

This scenario envisages repair of the current MAC system by the elimination or mitigation of its shortcomings and the introduction of some elements of the EU system[6].

6 The proposals come close to the approach presented in the report Water Quality Standards System Concept, by Bill Parr & Jitzchak Alster. Draft Final Report. Water Governance in Central Asia Project. February 2010, and are partially based on them.

Reducing the number of regulated parameters

The first feature of the Soviet MAC system inherited by the CIS countries is its cumbersome character. Rules for surface waters protection contain water quality standards for more than 1 000 substances. The number of regulated parameters should be limited in view of laboratory facilities' capacities in the region. As of today and potentially the foreseeable future, there is still no analytical basis to determine the vast amount of regulated substances. The number of systematically measured parameters does not usually exceed 30. There is not much sense in setting a standard that cannot be checked for compliance. Logically, there are two options in this situation: either abolish most of the existing MACs or ignore them. The latter prevailed in the real life. In order to avoid such a legal nihilism, it would be useful to introduce, by a legal act, a limited list of regulated parameters. The main criteria for selection of parameters in such case could be the regional specificity in terms of pollution and the laboratory capacity to determine them.

This list of more than 1 000 regulated substances was developed for the USSR, a vast country, very diverse in terms of climate conditions, economic activities and pollutants. It is difficult to assume that each of the states that emerged from the collapse of the Soviet Union will have the whole range of those pollutants. Therefore, limiting the list of regulated substances to those that are systematically found in the environment and can be reliably measured by the designated laboratories is absolutely natural. In practice, this would mean that the list of regulated substances should be limited to those that are included in the current monitoring programmes.

Making several MACs less stringent

The maximum allowable concentrations developed in the USSR were based on the concept of zero risk to humans and aquatic life. For example, the fishery MACs were determined in long-term experiments on sensitive organisms[7], mainly in the north-western region of the country (cold waters and specific hydrochemistry). The limit values obtained in such experiments were then approved by relevant agencies without any discussion with the regulated community, and were applied throughout the entire country, often regardless of the specific conditions of the regions. Such a mechanism of MACs development and approval did not take into account the technical feasibility of the specified standards. Some of them were very stringent and under certain circumstances impossible to comply with. Further, the standards ignored the regional natural water quality characteristics, which could

7 Fishery MACs were determined in experiments on salmonid fish and were applied to all waters of the USSR, including those where such fish never lived (e.g., lowland rivers in southern latitudes). In the EU two types of fishery waters are defined («salmonid» and «cyprinid»), where different quality standards are applied. This provides more flexibility to the system of water quality regulation. On the other hand, another element of flexibility for the standards for waters intended for drinking water abstraction was introduced by the Directive 75/440/EEC as three different categories of treatment, depending on the actual quality of surface waters. This allows using water of different quality for drinking purposes, by varying methods of water treatment. The Central Asian countries could well study this practice.

significantly affect the behaviour and toxicological properties of regulated substances and, indirectly, the adverse impact threshold that determines the MAC. For example, turbidity and hydrochemistry greatly affect the bioavailability of heavy metals to aquatic organisms and, hence, their toxicity. Finally, the problem of background concentrations of regulated substances in natural waters was not adequately considered, which, de facto, led to tougher MACs.

In this respect, it seems appropriate to revise the current MAC values towards making several of the requirements less strict. The simplest option in this sense would be to use some of the water quality standards stipulated in the relevant EU Directives: surface water (75/440/EEC), freshwater fish (2006/44/EC), and bathing water (2006/7/EC).

A bolder approach would be to fully adopt the standard values from those three directives. It should be noted that a number of Directives along with mandatory values of regulated parameters contain so-called guide values. The latter are not binding. Their role is to set target levels which the EU member states shall apply in developing their strategies to improve water quality. Over the time the guide values may become binding, if the legislation is revised.

The statistical basis of the water quality standards

The use of maximum allowable concentrations, the slightest deviation from which is considered potentially dangerous, is not the ideal basis for regulation. Their use is theoretically justified for the substances showing acute toxicity, whereas for compounds having a potential lasting impact, the use of medians or percentiles seems to be more appropriate. With the application of percentiles, exceptional events do not affect compliance statistics, although the approach does require following a certain minimum frequency of sampling. Lately, the EU has been setting standards for some parameters with both maximum allowable levels and annual average values. Central Asian countries should study the EU experience.

Taking account of the background concentrations of regulated substances

One of the problems of the existing system is that it does not take into account the background (reference) concentrations of the regulated substances. There are cases where some countries reported having serious problems with water quality and pollutants concentrations significantly exceeding the MACs due to natural background. Consequently, background concentrations of regulated substances of natural origin should be determined in water bodies and these data should be taken into account when water quality is assessed. It is obvious that defining the background physical and chemical status of the surface waters is a big task that may require external support through targeted projects. Awareness of the natural background status of water bodies is also necessary for a correct calculation of the maximum allowable discharges. Currently, the calculation depends on measuring the level of pollution upstream and downstream of point sources. If there are other sources of pollution upstream, however, then the status at the respective measuring point can no longer serve as a reference. Moreover, it makes it impossible to monitor and assess the role of non-point sources of pollution.

Setting the background concentrations of regulated substances should take into account the EU practice in defining water bodies in accordance with the Water Framework Directive (2000).

Changing the principles of water quality planning and management

The shortcomings inherent in the MAC system are often exacerbated by the principles and practice of its application. The problem of categorizing virtually all water bodies as fishery waters is still practiced in the CIS countries. Since the fishery MACs are usually stricter than the standards set for water bodies used for drinking water or recreation, this imposes a serious additional regulatory burden. A more selective distribution of water bodies by type of water use would introduce more flexibility into the system.

In addition, the terms of water quality standards coming into force are usually not specified. In fact, the MACs are assumed to come into force immediately upon adoption, leaving no time to adapt to the requirements. In contrast, each EU Directive has a plan for introduction of new measures, a practice that is also worth adopting.

These proposed measures do not foresee the introduction of significant legislative and institutional changes.

Determining the effluent standards (MADs)

There are two main approaches to setting maximum allowable discharges (MADs): ensuring conformity with the surface water quality standards (MACs) in the receiving water body accounting for dilution capacity, and introducing sectoral standards for discharge of certain substances based on best available techniques in production and wastewater treatment. The former approach is being applied under the current regulatory system.

Under this approach the MAD values are often dictated by unrealistically strict MACs, which leads to "no-issue" situations when, for example, wastewater treatment plants may be required to remove almost all organic matter from the sewage in order not to exceed the MACs in the receiving waters. This is economically or even technically unfeasible. In addition, this method is not suitable for planning, particularly for investment planning, as wastewater treatment plants of similar size and capacity have to comply with different MADs due to different dilution capacity of the receiving waters. It is possible to overcome this situation only if using other simpler, clearer, and technically feasible principles for setting MADs. Here, it is worth paying attention to the provisions of the Urban Wastewater Treatment Directive (91/271/EEC). On the basis of this Directive, minimum standard requirements for the quality of biologically treated wastewater should be gradually introduced for municipal wastewater treatment plants.

Such a technological approach to the regulation of point sources of pollution is new for the post-Soviet countries. Its major strength is the establishment of clear and equal rules for all participants (at least, for municipal wastewater treatment plants). This will facilitate the monitoring and enforcement mechanisms and will assist in better identification of priorities and planning of investments for improving water quality. After all, the application of the Directive on Urban Wastewater

Treatment in combination with other Directives allowed making a real progress in improving the quality of surface waters in the 1980s-1990s in the EU. Thus, it is possible for the Central Asian countries to achieve good results using a similar approach.

System of water quality classification

All the CIS countries currently use the index of pollution for integrated water quality assessment. This index takes the average of six hydrochemical parameters, expressed as a fraction of their MACs. The corresponding system of seven water quality classes is mainly used for assessment (in 2003, for example, the river water quality corresponded to class III). While such assessments are to be applied in water management, the results are often used only for statistical and descriptive purposes. The existing system turned out to be inefficient in identifying trends in water quality, and therefore, was of little use in planning activities to improve water quality.

It is important to introduce a more flexible classification system (based not only on MACs) that would have a potential to become an active instrument for water resources management[8]. Systems that are based on a small number of routinely monitored parameters with established water quality targets, the achievement of which contributes to the overall improvement in water quality. Such a system of quality classes can well be used simultaneously with the MAC system and quickly introduced by government regulation. The main task in this case would be to determine specific quality standards of selected parameters as boundaries of different classes.

Since this type of water quality classification system is based on a limited number of hydrochemical parameters, it must be supplemented by a control system for dangerous substances (groups of chemicals that pose the greatest danger to the aquatic environment) and, possibly, a system for the biological assessment of water quality.

The EU has defined a list of 33 dangerous (priority) substances selected by the criteria of eco-toxicity, carcinogenicity and persistence, among others. These substances are subject to special control measures until their emissions are phased out. The Central Asian countries should also establish a list of dangerous substances subject to special regulation, which, in the first stage, would include a number of heavy metals and organochlorine pesticides. The possibility of creating such dangerous substances lists at the river basin level should be seriously considered. In any case, the current laboratory capacity is an important criterion for inclusion of certain substances on this list.

The biological assessment of water quality is one of the core ideas of the Water Framework Directive. At present the biological monitoring of water, based on macroinvertebrates, is carried out in Kazakhstan and experts from this country could assist in establishing a regional system of biological assessment of water quality based on the EU practice. One advantage to following such an approach to reforming the water quality management system is that it provides some continuity to the system that is well known in Central Asia. Another advantage is that following this approach will not require substantial institutional changes.

A relative drawback of this approach is that the water quality management is not integrated, in the sense that regulation is still done within the framework of different water uses (MACs for water bodies used for drinking water abstraction or recreation, and MACs for fisheries).

4.2. The Russian Federation regulatory system

The actual water quality management system in Russia is different from the system used in the USSR, although it retains some of its basic principles. After the collapse of the Soviet Union, the Russian Federation developed new laws on water protection and use, followed by the development of regulations that form a specific procedural and legal framework for water management and water protection.

In 2002, the new Law on Environmental Protection introduced principles of water quality standard-setting. In 2006, the new Water Code postulated the river basin approach in regulating water relations. Article 33 of the Water Code addresses the “schemes of integrated use and protection” of water bodies[9], and inter alia, sets water quality targets for water bodies. Article 35 directly determines the development and introduction of permissible impact norms on water bodies and water quality targets for water bodies.

New guidelines for the development of Permissible Impact Levels (PIL) were developed and adopted in 2006-2007[10]. These guidelines aimed at introducing safe levels of polluting substances, as well as other impact indicators on water bodies, while accounting for the climatic characteristics of water bodies in the region.

The PILs are determined on the basis of targeted use of water bodies. In the development of standards of permissible impact on water bodies, the unit territorial entity is a water-resources region.

The PILs are established (depending on the status of the water body and its ecosystem) on the basis of **water quality standards** (WQSs) in a water body. The WQSs are set in accordance with physical, chemical, biological, and other parameters. Observing the WQSs implies that statutory requirements for priority water uses are met, sustainable functioning of water ecosystems is ensured, and biological diversity is preserved. The maximum allowable discharge of substances and micro-organisms to water bodies is calculated on the basis of the PILs.

8 One of the examples to be followed was proposed in Water Quality Standards System Concept, by Bill Parr & Jitzchak Alster. Draft Final Report. Water Governance in Central Asia Project. February 2010.

9 Comparable with the requirement for development of River Basin Management Plans under the Water Framework Directive (2000).

10 “Guidelines on norms of permissible impact on water bodies” approved by the Ministry of Natural Resources dated 12.12.2007 N 328

In comparison with the Soviet system of surface water quality regulation, the approach adopted by the Russian Federation differs in a number of ways. The most significant difference is the introduction of PILs for a water body, which changes the whole regulation system. The previous system was based on experimentally determined MACs, which were used to calculate the MADs from point sources; the new approach is focused on the water body.

Since the PIL is a comprehensive indicator taking into account not only chemical pollution but also other anthropogenic pressure, this approach provides a more integrated and exhaustive protection of water resources.

Sanitary and fishery MACs that are selected according to the use of a particular water body are still used to calculate the PILs for chemicals. The methodology for setting these MACs has not changed.

Another significant difference is the idea of priority water use specified for a water body. The prevalence of fishery standards has been removed, and the protection of ecosystems and drinking water supply are clear priorities. The ecological MACs remain unclear, but most likely fishery standards will continue to be used until a proper methodology for defining ecological MACs is developed.

An essential provision has been introduced to take account of both point and non-point sources contributing to the general pollution of the water body. It is not yet clear, how this will affect compliance efforts or whether it will result in stricter wastewater quality requirements. In any case, a step in this direction has been made.

In all likelihood, the definition of PILs will be a difficult task even for well-funded institutions with adequate staff simply because this approach requires studying a large number of environmental factors and economic activities in the catchment area.

In addition, the current interpretation of the PILs in the Russian Federation context provides for assessing the degree of change of the water body as a result of previous human activity, an approach that draws it closer to the modern EU approach (highly modified water bodies), but the remaining components of the two systems differ significantly.

In general, the new requirements established in Russia demonstrate the tendency to consider and incorporate the modern principles of water protection. The influence of the European Water Framework Directive and the US regulatory system focused on the river basin approach is noticeable, but it is not clear to what extent the notion of water resources region (the water management unit in the Russian legislation) is interchangeable with the concept of water body in the European legislation.

Another important issue is the fact that Russia introduced procedures for the revision and amendment of standards, and is changing the concept of "control section", which in all likelihood will lead to a more objective compliance monitoring (full mixing zones).

The discussion on the applicability of the Russian approach to water quality regulation in the context of Central Asia countries is quite pertinent, considering that the region is still closely linked with the Russian Federation (politically, economically, historically). Kazakhstan's participation in an economic union with Russia will inevitably push ahead the process of convergence of the countries' legal frameworks, including in the field of water resources management. The two countries share significant transboundary water resources and have transboundary watersheds.

If Kazakhstan and/or other countries in the region decide to adopt water protection principles laid down in the current Russian legislation, they will need to make a thorough assessment of the consequences of introducing a new system. A simple transfer of regulatory principles, approaches, procedures and practices into the national legislation does not automatically yield the desired results.

The current Russian regulatory system represents a combination of the Soviet approach, the requirements of the European directives, and approaches adopted in the United States. In comparison with the former USSR, the current Russian system has been considerably upgraded. Thus, it has become not only comprehensive but also much more complicated and expensive, though not always reasonable and economically-sound.

In addition, little has been done for an effective implementation of this system, and the assessment of its efficiency and feasibility is therefore problematic.

4.3. The system developed for Moldova

During the last few years, Moldova has been working on harmonizing its laws with the EU environmental legislation, particularly reforming its water quality regulation system. Within this framework and with the support of the OECD, a new approach to the surface water quality regulation has been developed on the basis of the EU model. Subsequently, within the framework of a number of projects supported by the European Commission and the OECD, this approach was recommended for other EECCA countries.

The starting point for working out the technical issues of a new water management system in Moldova is the current surface water use. The aim of water management is to ensure that the current and future generations are provided with water for specific (necessary) water uses. The existing, often competing, variety of water uses forces the consideration of a certain balance among the desired types of water use (including ecosystem functioning). Such an approach inevitably leads to creating a certain hierarchy of uses according to water quality requirements, as shown in Table AI.2.

Table AI.2.

Hierarchy of uses

Categories	UNECE Guidelines*	Water Code of Moldova
Category 1: Uses without quality requirements	• Transport system (water, wastewater, navigation) • Extraction of minerals • Hydropower	• Wastewater discharge • Transportation • Hydropower generation
Category 2: Uses with certain quality requirements	• Process / cooling water in industry • Irrigation in agriculture • Fishery • Recreation and tourism • Domestic water supply	• Industrial purposes • Agricultural purposes • Fishery • Recreation • Drinking and other communal purposes
Category 3: Uses with «undisturbed» quality	• Ecosystem functioning	• Hunting and nature protection

** UNECE, 2000. Guidelines on water quality monitoring and assessment of transboundary rivers.*

The assessment of the actual surface waters use in Moldova showed a significant differentiation of water bodies by water use categories. For example, water from the large rivers (Prut and Dniester) is abstracted for drinking water production, while many water bodies and watercourses of the Prut-Dniester interfluve have very limited uses (such as local irrigation) and other water use types are absent or insignificant. Naturally, this situation must have an impact on the regulation of the water resources quality: for instance, it seems unreasonable to implement measures safeguarding fisheries when the concerned water bodies are not used for this purpose. In other words, there is no practical need to ensure similar water quality in all water bodies (nor is there sufficient financing).

The core element of the system proposed for Moldova is the relationship established between water quality and water uses that can be supported by that water quality. Such a scheme entails a uniform classification of water quality. Main elements of the system are an integrated system of surface water quality standards and a system of water quality planning and management.

The system of water quality standards contains five groups of limit values that define five target use classes. Each of the classes defines which water uses are supported given a certain surface water quality.

The system of target use classes for surface waters is presented in Table AI.3.

The various use classes can be characterized as follows:

- Use Class I corresponds to the status of a virtually undisturbed natural aquatic system. All intended uses are supported by waters of this use class.
- Water quality meeting the standards established for Use Class II will support all water uses, including functioning of aquatic ecosystems. Simple (physical) treatment methods are sufficient for the preparation of drinking water.

Table AI.3.

Target use classes for surface waters

Use/Function	Differentiation by use	Use Class I	Use Class II	Use Class III	Use Class IV	Use Class V
Ecosystem functioning		+	+	–	–	–
Fishery	*Salmonid* *Cyprinid*	+ +	+ +	– +	– –	–
Drinking water supply	*Simple treatment*	+	+	–	–	–
	Normal treatment			+	–	–
	Intensive treatment				+	–
Bathing/Recreation		+	+	+	–	–
Irrigation		+	+	+	+	–
Industrial water use (technological processes, cooling)		+	+	+	+	–
Hydropower production		+	+	+	+	+
Mining		+	+	+	+	+
Transportation		+	+	+	+	+

+ use / function is supported
– use / function is not supported

- Use Class III is where some water uses become problematic. Simple treatment methods no longer suffice for drinking water preparation (physical and chemical methods are required). The conditions required by salmonid fish waters may no longer be supported. One can expect a deterioration of the aquatic ecosystem.
- Use Class IV will only allow low-quality demanding uses and will require intensive treatment of the raw surface water abstracted for production of drinking water. Even the conditions for cyprinid fish may no longer be supported.
- Use Class V will only suffice uses such as power generation with no quality requirements.

In addition to the general differentiation of water bodies according to their use, the regulated water quality parameters were to be selected and concentration limits were to be defined to mark the boundaries of the use classes. Instead of the long list of MACs poorly adapted to Moldovan conditions, a number of general parameters and specific substances were to be selected on the basis that they are present in the water bodies of the country, can in some way disturb the traditional water uses and can be monitored within the existing monitoring system. The implementation of these requirements led to the development of the following system of parameters related to specific conditions of the country and tailored to particular water uses. Table AI.4 provides the details.

Table AI.4.

System of parameters and water uses

Groups of parameters	Examples of specific parameters	Ecosystem functioning	Fishery	Drinking water supply	Bathing / recreation	Irrigation	Industrial water use
General conditions							
Thermal conditions	Water temperature	o	x			o	
Oxygenation conditions	O_2, BOD_5,	x	x				
	COD_{Mn}			x			
Nutrient conditions	P_{gen}, PO_4, NO_3, N_{total}	x	o	o			
	NH_4,	o	x				
	NO_2	o	o	o			
Salinity	Total salinity, chlorides, sulfates			o		x	
Acidification status	pH	o	o	o		o	
Other parameters	odour, colour, floating material	o	o	x	x		
	Mn, Fe, phenols, petroleum products		o	x			
Trace metals	Cd, Cu, Hg, Ni, Pb, Zn	x	x	x			
Bacteriological parameters	Parasites, ente-rococci, streptococci			x	x		
Micropollutants	Pesticides, PAHs	x	o	x/o			

x Parameters have a direct impact on the use/function.
o Parameters have an indirect impact on the use/function

The next step was to determine the maximum concentration for each parameter for each target use class. This rather a difficult task was tackled in Moldova as follows:

The water of Use Class I must correspond to a water environment virtually undisturbed by human activity. Consequently, the strictest quality standards were selected for this use class. Sometimes, the quality standards were the existing MAC values; sometimes, other international standards. The important thing is that the values were selected individually for each parameter. In order to adapt this use class to the specific conditions of Moldova, an alternative approach is stipulated in the long term. Once the background (reference) conditions are determined for Moldovan water bodies, those concentration levels can then be used to set the standards.

To develop the water quality requirements for Use Classes II, III and IV, the existing classification of surface water sources intended for centralized water supply system was applied. This classification distinguishes three classes of water quality depending on the water treatment technologies to be used. Since, waters of Use Class II and III are to support the existence of certain ecosystems and commercial fish populations, the concentration limits for certain parameters of the general list have been toughened (in some cases up to the level of MACs). Thus, at least a theoretical compromise has been to some extent achieved between the simultaneous use of the water bodies for fisheries and for the abstraction of water for drinking purposes.

Table AI.5 displays the final version of the surface water quality standards system.

Table AI.5

Surface water quality standards*

Parameter (group)	Acronym	Unit	Use Class I	Use Class II	Use Class III	Use Class IV	Use Class V
GENERAL CONDITIONS							
Dissolved oxygen	O_2	[mg O_2/l]	≥7 (or BC)	≥7	≥5	≥4	<4
BOD (5 days)	BOD_5	[mg O_2/l]	3 (or BC)	5	6	7	>7
COD, permanganate method	COD_{Mn}	[mg O_2/l]	<7 (or BC)	7	15	20	>20
Nutrients							
Total nitrogen	N_{total}	[mg N/l]	1,5 (or BC)	4	8	20	>20
Nitrate	NO_3	[mg N/l]	1 (or BC)	3	5,6	11,3	>11,3
Nitrite	NO_2	[mg N/l]	0,01 (or BC)	0,06	0,12	0,3	>0,3
Ammonium	NH_4	[mg N/l]	0,2 (or BC)	0,4	0,8	3,1	>3,1
Ortho-phosphates	PO_4	[mg P/l]	0,05 (or BC)	0,1	0,2	0,5	>0,5
Mineralization							
Chloride	Cl^-	[mg/l]	200 (or BC)	200	350	500	>500
Sulphates	SO_4	[mg/l]	<250 (or BC)	250	350	500	>500
Total mineralisation	Min_{total}	[mg/l]	<1000 (or BC)	1000	1300	1500	>1500
Trace metals							
Cadmium total (*Suspended solids= 30 mg/l*)	Cd_{total}	[µg/l]	<1 (or BC)	1	5	5	>5
dissolved	$Cd_{dissolv}$	[µg/l]	<0,2 (or BC)	0,2	1	1	>1
Copper total (*Suspended solids = 30 mg/l*)	Сиобщ	[µg/l]	<50 (or BC)	50	100	1000	>1000
dissolved	$Cu_{dissolv}$	[µg/l]	<20 (or BC)	20	40	400	>400
Zinc total (*Suspended solids = 30 mg/l*)	Zn_{total}	[µg/l]	<300 (or BC)	300	1000	5000	>5000
dissolved	$Zn_{dissolv}$	[µg/l]	<70 (or BC)	70	233	1163	>1163
Bacteriological parameters							
Lacto positive bacteria		[№/l]	1000	10000	50000	>50000	>50000
Colifage		[№/l]	absent	100	100	100	>100
Intestinal enterococci		[КЕ/100 ml]	<200	200	400	>400	>400
Escherichia coli		[КЕ/100 ml]	<500	500	1000	>1000	>1000
Organic micropollutants							
Alachlor		[µg/l]	0,3	0,5	0,6	0,7	>0,7
Atrazine		[µg/l]	0,6	1,3	1,7	2	>2
Benzene		[µg/l]	10	30	42	50	>50
Chlorpyrifos		[µg/l]	0,03	0,065	0,086	0,1	>0,1
1,2-dichloroethane		[µg/l]	10	20	26	30	>30
Dichloromethane		[µg/l]	20	40	52	60	>60
Diuron		[µg/l]	0,2	1	1,5	1,8	>1,8
Endosulfan		[µg/l]	0,005	0,0075	0,009	0,01	>0,01
Hexachlorobenzene		[µg/l]	0,01	0,03	0,04	0,05	>0,05
Hexachlorobutadiene		[µg/l]	0,1	0,35	0,5	0,6	>0,6
Hexachlorocyclohexane		[µg/l]	0,02	0,03	0,036	0,04	>0,04
Pentachlorobenzene		[µg/l]	0,007	0,014	0,018	0,021	0,021
Pentachlorophenol		[µg/l]	0,4	0,7	0,9	1	1
(Benzo(a)pyrene)		[µg/l]	0,05	0,075	0,09	0,1	>0,1
Simazine		[µg/l]	1	2,5	3,4	4	>4
Tributyltin compounds		[µg/l]	0,0002	0,00085	0,00124	0,0015	>0,0015

* *The table shows selected parameters; it does not reflect the full range of parameters.*

Parameter (group)	Acronym	Unit	Use Class I	Use Class II	Use Class III	Use Class IV	Use Class V
Trichloromethane (chloroform)		[µg/l]	2,5	5	6,5	7,5	>7,5
Trifturalin		[µg/l]	0,03	0,06	0,078	0,09	>0,09
DDT total		[µg/l]	0,025	0,05	0,065	0,075	>0,075
para-para'-DDT		[µg/l]	0,01	0,02	0,026	0,03	>0,03
Aldrin		[µg/l]	∑= 0,010	∑= 0,020	∑= 0,026	∑= 0,030	∑ >0,030
Dieldrin		[µg/l]	∑= 0,010	∑= 0,020	∑= 0,026	∑= 0,030	∑ >0,030
Endrin		[µg/l]	∑= 0,010	∑= 0,020	∑= 0,026	∑= 0,030	∑ >0,030
Isodrin		[µg/l]	∑= 0,010	∑= 0,020	∑= 0,026	∑= 0,030	∑ >0,030
Carbon tetrachloride		[µg/l]	12	24	31	36	>36
Trichloroethylene		[µg/l]	10	20	26	30	>30

BC: Natural background concentration

These water quality standards are integrated into a flexible system that allows a step-wise water quality planning and management in accordance with the changes occurring in the environment and strikes a balance between the desired water quality and available resources (financial, technical, and human). This involves the iteration of the following steps:

- Identifying water bodies based on the watershed and water use analysis;
- Identifying and agreeing on the desired/intended uses of the identified water bodies;
- Assessing whether the desired uses can be supported under the current water quality of the respective water body;
- Performing a feasibility assessment of measures to improve water quality to the required level if the current water quality cannot support the desired water uses;
- Revising the intended water uses, if necessary;
- Assigning a target use class to the water body and developing an action plan to achieve and maintain the target use.

These steps clearly show that the system is not intended to serve as a passive water quality assessment tool. In principle, the system is supposed to be used as an active water management and decision-making instrument, setting long-term goals for the use, and protection of water bodies.

The plan for effluent limits is to abandon the existing method of setting maximum allowable discharges. Urban wastewater discharge regulation approved by the Government of Moldova requires municipal wastewater discharges to be regulated on the basis of technological standards established by the EU Directive on Urban Wastewater (1991). This step is expected to remove an unduly strict regulatory burden on municipal services through adapting achievable standards that relate to actual social and economic conditions.

So far, however, these new requirements have not been linked to water quality classification system, and the approaches do not always fit together. Therefore, Moldova may choose to use a mixed approach where some discharged substances (five parameters for municipal wastewater) will be regulated by technology-based standards while other parameters (for example, dangerous substances) will be managed on the basis of surface water quality standards, depending on the targeted use of the water body.

This idea was further developed in the draft rules for surface water protection against pollution, which should introduce:

- The classification of water bodies by water quality in the context of their intended water use (five classes of water quality);
- The possibility and clear mechanisms for revision of general requirements for water classes;
- Mechanisms and procedures of assigning a water body to a particular class;
- Principles and mechanisms of assessment to determine whether the intended water use is supported by the actual water quality;
- The authority to take action if the water quality in a particular water body does not correspond to the intended water use class.

A separate section of the rules sets out a framework for regulation of pollution sources based on the mixed approach. The framework includes:

- Prohibitions and restrictions on discharges (including sensitive areas, which in the long term are to be introduced in Moldova following the requirements of the Nitrate Directive);
- The application of two approaches: technology-based (for municipal wastewater) and surface water quality-based approach (for other pollutants);
- The establishment of clear and transparent monitoring procedures for the quality and quantity of discharges, as well as reporting procedures for the treatment plant operators;
- The control of non-point sources of pollution on the basis of good practices.

The system proposed for Moldova provides a tool for more integrated water quality management, where the surface water use classes system unites all types of water use. This system is expected to be used as an active instrument of water resources management and decision-making.

On the other hand, the proposed system represents a quite abrupt separation from the traditional system of MACs.

Consequently, its implementation will require significant amendments of the existing legislation, and changes in institutional structure and people's mindset. In addition, it entails a substantial amount of additional technical work (for example, defining water bodies and assigning specific water uses for each).

4.4. Elements of the water quality management system used in Kazakhstan

The Republic of Kazakhstan is the first country in the region to have started reforming the system of surface water quality standards and has launched a revision to introduce the principles of integrated water resources management (IWRM). The resulting law includes a mechanism for the ecological regulation of water use with elements of ecosystems monitoring, reporting, planning, and stakeholder interaction. Kazakhstan develops IWRM programmes and schemes for a comprehensive use and protection of water resources at the river basin level. The main regulatory tools are maximum allowable levels of adverse impact, maximum allowable discharges for point sources, a water pollution index (WPI) and the MAC system for fishery and sanitary and hygienic water reservoirs.

In 2010, the guidelines on harmonization of surface water quality standards were prepared; they were endorsed by the relevant ministries and submitted for approval. This document is intended to replace the rigid MAC system and the impractical WPI system with a clearer and more realistic regulatory mechanism based on water quality classes.

The guidelines introduce five water quality classes and five water use classes into the practice of water management. The water use classes are linked with specific water quality requirements. Surface water quality can be assessed by a wide range of parameters (nutrients, metals, etc.) with numerical limits set for all five classes.

Plans call for further development of specific systems of water quality classes at the river basin level, a sensible approach for a country with diverse climatic zones and different water basins characteristics and background conditions. The fundamentally new aspects in the document are the following:

- A step-wise introduction of new requirements;
- The assigning of a class to a water body as an environmental status target;
- The clear distribution of responsibilities between the control and monitoring agencies;
- Programmes for pollution prevention and/or degraded habitats restoration aimed at achieving the environmental targets;
- Requirements for coordination of water resources monitoring, planning and management.

Bacteriological, biological and hydromorphological parameters are introduced in the unified water quality classification system (in accordance with the EU WFD). Where the country cannot ensure a full adaptation to the WFD, other parameters similar in effect are temporarily used[11].

The ongoing process of changing the approach to the surface water quality management in Kazakhstan is an attempt to introduce new elements into the regulatory system to make it more practical and environment-oriented (under the influence of the EU practice). Obviously, this process will require a significant period for adjustment and modification of the system and capacity-building. For example, it is not yet clear how the new guidelines will correlate with the system of maximum allowable adverse impact also at an early stage of implementation . In addition, there is still no clear connection between the target water quality classes and the MADs system regulating point sources of pollution. The control measures for non-point sources can only be discerned from the text of the document.

As more experience is gained from applying the IWRM principles and organizational, technical and human potential is built, the complex of regulations will be adapted to the realities of the regulatory process. In any case, the guidelines on harmonization of surface water quality standards serve as an excellent example of adapting a regulation to new circumstances, while maintaining the previous practice and experience, and remaining sufficiently flexible and applicable to a specific country.

A potential shortcoming of this regulation is that it remains an internal document of the Ministry of Environment Protection. If in the future it becomes a full-featured regulatory document with an account of amendments introduced in other regulations, it will ensure that achievement of the water quality targets will become the basis for planning and financing of water sector.

11 For example, the group of biological parameters was temporarily replaced by an integral biological index of toxicity, which is legalized in Kazakhstan, while the group of hydro-morphological parameters - by the total hydro-morphological index according to GOST 17.1.1.02-77.

5. CONCLUSION

The quality of surface waters in most countries of Central Asia has a clear tendency to deteriorate. As the population of the region grows, the economy develops, and the adverse impact of climate change deepens, the problem of water pollution will increase. Consequently, in order to lessen the water pollution increase, the water quality management systems need to be adapted to the realities of the twenty-first century. Sluggish approaches cannot break the trend of continuous water quality deterioration.

The system of water quality standards is at the core of water quality protection and regulation. It implies setting acceptable limit values (standards, norms) for regulated parameters that ensure human health, favourable conditions of water use, and the status of the aquatic ecosystem.

The Soviet system of water quality regulation no longer fits present-day realities. As it was created in the early 1950s, its provisions have become outdated and ignore both the status of water resources and conditions of water use in the region, as well as new approaches to the water quality regulation such as those developed by the EU countries. It is rather rigid and applies uniform and very stringent quality requirements to almost all water bodies and watercourses. Meanwhile, there is no practical need to ensure the highest water quality in all water bodies, especially given that the countries cannot afford it. The practical implementation of the MAC/MAD system often places the different industries discharging polluted wastewater into water bodies in unequal positions.

The current standards impose excessively stringent quality requirements and stipulate the regulation of a long list of contaminants that are often atypical of water bodies in Central Asia. In fact, the system has never been fully implemented due to poor logistics, lack of funds and human resources. It makes no sense and is even socially dangerous to have a system that cannot ensure attaining the main goals of regulation – good water quality for water uses necessary for current and future generations.

The choice of a regulatory model that is more consistent with the economic, social and environmental realities of the region should be based on the assumption that a modern system of water quality regulation should, at least:

- Ensure an overall improvement of surface water quality;
- Be realistic in terms of available resources;
- Be flexible enough to adapt to changes in water use and water quality.

Starting from these general principles two basic models (scenarios) of development for water quality management systems in Central Asia were proposed ("conservative" and "dynamic").

The "**conservative**" scenario calls for modernization of the existing system of water quality regulation based on MACs and MADs by overcoming or attenuating its flaws and by introducing selected elements of the EU regulatory system. This involves reducing the number of regulated parameters, lowering the stringency of certain MACs, changing the statistical basis for setting the water quality standards, taking into account the background concentrations of regulated substances, changing the principles of water quality management and planning, introducing a technology-based approach to regulating point sources of pollution and introducing a more flexible water classification system.

Following such an approach in reforming the water quality regulation system would provide the advantage of continuity to the system that is well known in Central Asia. Still another important advantage is that the introduction of this approach would not require substantial institutional changes. Its relative deficiency would be that the water quality management remains unintegrated, that is, the regulation within the framework of different water uses still can be done independently using different types of requirements (sanitary, fishery, etc.).

Some countries of the region made efforts to modernize their water quality regulatory systems by introducing different principles of planning and a more flexible water classification system, and by making several MACs less stringent. They are moving forward towards the improvement of regulatory systems.

The "**dynamic**" model is based on the system developed by the OECD for Moldova and recently proposed for the EECCA countries[12]. Its key element is a unified system of water quality classes ensuring the nexus between water quality and water uses that the quality can support.

Another important element is the flexibility of the regulatory scope. The list of regulated parameters is determined by a combination of factors, such as regulatory objectives, the types of water use, the volume and composition of discharges, monitoring capacity and laboratory potential. All of these factors are variable and the system provides for a periodic revision of the scope of regulation by withdrawing or adding parameters and/or updating the limit values of the quality classes.

These water quality standards are integrated into a flexible system that allows a step-by-step water quality planning and management in accordance with the changes occurring in the environment and strikes a balance between the desired water quality and available resources (financial, technical, and human).

This involves iterations of the following steps:

- Identification of separate water bodies on the basis of catchment analysis and existing types of water-use;
- Identification and negotiation of prioritised uses of water in identified water bodies;
- Assessment of whether the water quality of the respective water bodies allow for the priority uses of water;

12 Establishing a dynamic system of surface water quality regulation: Guidance for countries of Eastern Europe, OECD, OECD, 2011. Caucasus and Central Asia. March 2011 (draft).

- If the existing status of the water body cannot support priority uses of water, analyse whether measures to improve the status to the needed level are feasible; If not, review the list of priority uses;
- Establishment of a target quality indicator for the water body and develop a programme of measures to reach and maintain this indicator.

Concerning the establishment of effluent standards, the system proposes to abandon the existing method of setting maximum allowable discharge levels. The pollution point sources are to be regulated in accordance with the combined approach, that is, effluent limit values should be based on the best available techniques (for large industries) or minimum standard requirements for the quality of treated effluents (for municipal wastewater treatment plants). These requirements can be toughened up if the status of the receiving water reservoir requires better treatment.

It must be noted, that this system provides a tool for a more integrated water quality management, where a class system for surface water use unites all types of water use. In addition, the system is expected to be used as an active instrument for water resources management and decision-making. On the other hand, it is an abrupt change from the traditional system of MACs. Consequently, its implementation will require significant changes in legislation, institutional structure and people's mindsets. Substantial technical work needs to be done (for example, indentifying water bodies and desirable water uses for each).

Ultimately, the choice of a suitable development model for water quality regulatory system will be determined by such factors as national policy in water protection and related areas, international obligations, administrative resources, as well as, available financial, technical, and human potential of the countries.

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TOWARDS DEVELOPMENT OF REGIONAL COOPERATION
IN ENSURING WATER QUALITY IN CENTRAL ASIA

Annex 2

Guidelines for Developing a Transboundary Surface Water Quality Monitoring Programm for Central Asia

Diagnostic Report and Cooperation Development Plan

CONTENT

ANNEX II. GUIDELINES FOR DEVELOPING A TRANSBOUNDARY SURFACE WATER QUALITY MONITORING PROGRAMME FOR CENTRAL ASIA

This document has been developed within the project "Water Quality in Central Asia" funded by the United Nations Development Account and implemented by the United Nations Economic Commission for Europe (UNECE) in cooperation with the Regional Environmental Centre for Central Asia (CAREC). It builds on "Guidelines on monitoring and assessment of transboundary rivers" from March 2000 developed by the Task Force on Monitoring and Assessment under the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention).

1. INTRODUCTION AND PROBLEM DESCRIPTION

The countries in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) are dependent on each other with regard to the shared water resources of such transboundary rivers as the Syr Darya, Amu Darya, Chu, Talas, and Zeravshan. Water quality is an important aspect of integrated water resources management that has not been seriously addressed either at the national or regional level. Little is known about the quality of the transboundary waters and the dynamics of water quality. There is a need to improve national policies and regional cooperation with the ultimate aim to improve water quality as demonstrated in a recent assessment under the UNECE Water Convention.

Surface water monitoring is essential to gather background data and information for management of the water resources. This is a task requiring a sophisticated administrative framework and institutional infrastructure, as well as, political commitment.

The five countries of Central Asia have inherited a water quality monitoring network together with a political and administrative framework from the former Soviet Union. For different reasons it has not been possible to adapt this system to present and future needs, in particular with regard to transboundary aspects. The former homogenous legal and administrative framework has become fragmented, as the countries have established differing policies. The difficult process of economic transition did not leave room for investments in monitoring programs aiming to establish preconditions for environmental sustainability. Interests of upstream and downstream countries are also diverging in this area.

This has led to a situation where:

- A common operating administrative or institutional framework for regional water quality monitoring and assessment no longer exists;
- There are no agreed principles and no common goals for a regional water quality monitoring strategy;
- National monitoring strategies reflect particular interests (national or sectoral or those of the former Soviet Union) and are not applicable on the regional level.

There is a need for a common approach in water quality management. The problems are vast. Water quality of many important resources is deteriorating. This leads to losses in agricultural production, to a declining quality of life in many regions and to deteriorating ecosystems.

All the Central Asian countries accept the need for improved cooperation in this area. The implementation of the Water Quality in Central Asia project and the establishment of a Regional Working Group on Water Quality (RWGWQ) are good bases for real progress.

The objective of this document, developed by RWGWQ under the Water Quality in Central Asia project, is to outline basic principles to be applied in the region for coordinated transboundary monitoring and assessment.

The objective of the development of a transboundary monitoring programme is to increase the common understanding of water quality and its management as a basis for future remediation. In international water law there is no basis for individual countries to be held economically liable for pollution. The polluter-pays principle applies only on the national level.

2. ESTABLISHING A TRANSBOUNDARY MONITORING PROGRAMME

2.1. Objectives of a transboundary monitoring programme

A water quality monitoring network depends on the development of information needed to enable reliable assessments and to support decision-making processes. In Central Asia, as in other regions, the development of transboundary monitoring programmes should take into account different types of water use – drinking and municipal; irrigation and industry; fisheries; recreation; and ecosystem.

Ideally, the monitoring programme should enable a user to gather all necessary information to make assessments on the conditions of surface water and support decisions related to a given water use. In practice, this goal is very ambitious and difficult to achieve, mostly because of limited financial resources and institutional capacities; nevertheless, it defines the overall direction of work.

2.2. Starting at a basic level and expanding step by step

The establishment of a monitoring and assessment programme requires sophisticated planning activities and broad experience. Institutional capacities have to be developed as well as laboratory capacities, transport capacities, capacities in data evaluation and interpretation. Workflows have to be elaborated and staff has to be trained. Many of these things can be done before the actual programme starts, but not everything. Training on the job for all participants is an essential part of the first phase of any newly established monitoring programme.

That is why it is recommended to start with a limited number of parameters, observations and locations and then to expand the programme according to identified needs step by step.

Such a step-by-step approach includes a progressive development from a first general appraisal of water quality to more precise assessments. It has the advantages that detailed planning is needed only for the first phase, and that mid-term and long-term goals can be outlined as a road map. During the implementation of the first phase, the fine-tuning of information needs and the general optimization of workflows is possible, and the results can be directly included in subsequent planning activities.

For the initial step of a monitoring programme it is necessary to:

- Prioritize monitoring efforts;
- Plan the first institutional set-up at the national and regional levels;
- Establish a first framework for data exchange and joint data administration;
- Formulate mid- and long-term objectives and draw up a road map.

Prioritization of monitoring efforts is important to avoid an overloading of the initial phase of a programme and to control costs.

The institutional set-up includes the design of the initial monitoring network, the necessary allocation of laboratory and transport capacities and the assignment and training of staff. Work plans have to be elaborated and additional financial and technical administrative entities may have to be established.

Establishing a framework for data exchange and joint data administration may start on a basic level with an informal data exchange and with joint discussions on results, and should then develop step by step to a more formal level with systematic working routines. In any case, this should lead to the establishment of a joint digital database.

2.3. The role of a pilot monitoring programme

One possibility for the step-by-step development of a water monitoring programme is to start with a pilot programme on selected transboundary watercourses. A pilot programme can:

- Equip decision-makers with additional knowledge and experience for the implementation of a monitoring programme;
- Show possible benefits of cooperation;
- Indicate the feasibility of a programme;
- Give a positive example and thus, initiate a long-term process;
- Help to develop mutual confidence.

A pilot can be considered as a test run for a subsequent monitoring programme. Ideally, the pilot programme should include the main features of a planned subsequent monitoring programme, although for a limited number of stations and observations. This way costs and efforts can be estimated effectively and trustworthy.

The mid- and long-term benefits of a water quality monitoring programme range from the indication of trends in the condition of ecosystems in upstream areas (regarding deforestation and/or soil erosion, for example) to improved operational management of any structures regulating surface water flow for downstream areas (to avoid critical temporal conditions in oxygen content or mineralization related to specific water uses or in general to aquatic life).

These possible benefits are not achievable immediately after the monitoring programme is implemented, but can be acquired step-by-step and with time. At the beginning, a prioritization of monitoring efforts and a diligent planning are essential.

Feasibility consists mainly of two parts. One part is the organizational and administrative side with the running and fixed costs that have to be estimated properly and the necessary institutional arrangements and changes for implementing the programme. On the other side, there is the technical feasibility. The desired information must be obtainable at the selected locations and in the laboratories with the equipment that is available.

If a monitoring programme proves to be feasible, it can serve as a positive example and help to develop cooperation and improve management on a national and regional level and it will lead to more mutual understanding and confidence.

2.4. Further requirements for successful implementation

The planning of a monitoring programme or a pilot programme should ensure that:

- The programme is compatible with the legislation and the national programmes of the participating countries;

- The programme is as simple as possible with a reasonable demand on institutional and technical capacities of participating countries;
- Only parameters of common, transnational interest are included;
- Methods follow national standards to the extent possible;
- Stations are regular stations;
- The priority is on data collection and exchange rather than on data evaluation and quality assessment;
- The involved administrative entities benefit from the programme.

Compatibility with national programs on a basic level means that there are no obvious contradictions or insoluble conflicts to national monitoring programmes of the participating countries. Ideally, the programme should be complementary to the national monitoring programmes of all the partners and strengthen them by supporting the institutional entities and technical facilities.

Implementing a new programme to improve and strengthen existing structures by training measures and a modernization of technical facilities is preferable to establishing new structures. Solutions should be found in transferring and allocating tasks and mandates to existing bodies.

Demonstrating feasibility is a main concern of the initial phase of the monitoring and assessment or pilot programme. Therefore, the programme should be kept as simple as possible. All the partners should define information needs jointly. Priority considerations may include:

- The most pressing water quality problems at the transnational level;
- The legal frameworks of the involved countries;
- Existing data and monitoring programs.

If the starting point is the most pressing water quality problems at a transnational level, then one strategy for the initial design can be to look for an overlapping of existing national monitoring strategies and programmes and to use them as a baseline following the principle of the lowest common denominator.

All the partners should share the benefits of the monitoring and assessment programme. Benefits in this context are not only those resulting from evaluation of collected data but also training measures and the strengthening of institutions.

3. WHAT PARAMETERS SHOULD BE MEASURED?

3.1. General considerations

The primary goal of a monitoring programme is to provide information needed to answer such questions as the following related to the classes of water use:

- Does a water body with a specific class of water use comply with the parameters under consideration?
- If not, what is the main problem in terms of water quality?
- What changes in water quality are necessary to meet the standards?
- What are the general trends or developments concerning water quality?

The development of a monitoring programme specifically for Central Asia can add more specific goals reflecting the particular situation in the region. This region consists of a huge geographic area with a considerable diversity of cultures and landscapes. The monitoring programme has to be of transboundary character.

More specifically, the programme should:

- Provide information regarding selected known surface water quality related problems of a transboundary character (general problems such as discharges of pollutants in municipal wastewater, non-point pollution from agriculture or mineralization);
- Provide information that is necessary to manage some of these problems;
- Indicate the range of the problem at different sections of the river and identify hot spots;
- Help assess the impact of possible measures.

The strategy when planning a monitoring and assessment programme is first to consider the main causes for water quality problems and then to select a limited number of suitable indicators. The indicators should serve to characterize a water body concerning defined causes of problems.

Potential causes of problems in this context can include:

- Discharge of municipal waste water (effluents, point sources of pollution);
- Waste waters from agriculture (non-point or diffuse sources of pollution);
- Industrial waste waters of specific industrial branches (oil products, tanneries, etc.).

The selection of indicator parameters requires background information on important water quality problems in the basin, and on their nature and basic cause-effect relationships.

Ideally, a complete inventory of the basin listing all known pressures on surface water quality and estimating their impact should be carried out before establishing a monitoring and assessment programme. Such an inventory can serve as background information.

For the selection of the parameters, additional aspects have to be considered, especially:

- Technical feasibility of sampling and lab analyses;
- Cost-effort relationships.

Not all preferable parameters are technically feasible or at least technically feasible at a reasonable price. Non-persistent parameters have to be measured in situ, a task that may require the presence of specialized technical equipment and trained staff at the sampling locations.

Sampling of stagnant water bodies may require special and sophisticated procedures because of stratification in the water body. Other pollutants may occur predominantly bound to particles either as suspended load in the water body or fixed in the sediments.

The goal is to find a limited number of suitable parameters or indicator parameters that are cost-effective and reliable and that enable the monitoring of water quality regarding the main mechanisms of pollution present in the basin.

3.2. Proposal for an initial monitoring programme

The selection of parameters for a monitoring programme has to consider the main pressures on water quality present in a basin. This section proposes a simple and cost-effective monitoring and assessment system that uses five indicator parameters (plus river discharge). The system focuses mainly on non-point pollution from agriculture, discharges of municipal wastewaters, mineralization and suspended loads. The latter parameter indicates soil erosion at the headwaters and susceptibility of silting of channels downstream.

In detail the proposed parameters are:

- Nitrate and ammonium;
- Oxygen (+ temperature);
- Chemical oxygen demand (COD);
- Mineralization;
- Total suspended solids (TSS);
- River discharge.

The nitrogen compounds relate to municipal wastewater discharges and point and non-point pollution from agriculture. Nitrate in agriculture is a main component of fertilizers and easily soluble and washed out of the soils into water bodies. Nitrate is not bound to particles and can serve as a general indicator for the impact of agricultural activity on water quality.

High concentrations of ammonium can occur together with livestock production and/or sewer systems and are highly toxic for fish.

The oxygen content (oxygen saturation + temperature, to be measured in situ) is important for the ability of a water body to sustain aquatic life.

The chemical oxygen demand (COD) can directly point to wastewater discharges. Any decomposition of organic pollutants in the natural environment consumes oxygen and at the same time oxygen saturation of a water body is the most important parameter for its ability to sustain aquatic life. This is important not only for fisheries and ecosystem stability but for any kind of water use because lack of oxygen leads to reducing conditions in a water body and often to a mobilization of toxic substances in secondary reactions.

Mineralization is the most important parameter with respect to the suitability of water for irrigation purposes. In addition, mineralization is important for drinking water because high salt content has negative health effects. Salt is also very difficult to eliminate in treatment processes.

If possible, chloride and sulfate can also be determined. They are the main components causing high values in mineralization and each has its own specific causes, cycles and effects. Effects are particularly important when the water body is used for drinking water or for irrigation.

For headwater areas, there is a direct correlation between total suspended load (TSL) and soil erosion. Therefore, the contents of TSL may directly give an indication of the state of the ecosystems in recharge areas. For technical facilities in downstream areas, the knowledge of TSL is important in the calculation of siltation processes.

Measurement of river discharge is important to transform concentrations into loads.

All proposed hydrochemical parameters are standard, and are included in the national monitoring programs in all Central Asian countries.

3.3. Trace substances, biological monitoring and monitoring of bacteria

Trace substances in water bodies (such as pesticides or heavy metals) often exist in great varieties and have behaviour in the natural environment that can substantially differ from that of the related water body. Many trace substances tend to be bound to particles and, therefore, can be found in the sediments in much higher concentrations than in the water body itself. Because of the much slower downstream movement of the sediments fluctuations in the occurrence of trace substances may also be lower than those of the main pollutants. Special sampling campaigns with a different design are necessary. This goes beyond the scope of the proposed monitoring programme for Central Asia and should be, if necessary, the topic of additional field surveys.

The situation is similar with biologic parameters by which reliable information on the overall state of the ecosystem can be obtained. Sampling, analyses and evaluation of results in biological campaign requires special expert knowledge and procedures that are different from those of standard chemical analyses. This requires specially designed campaigns and would also go beyond the proposed monitoring programme for Central Asia.

With the exception of Kazakhstan, biologic monitoring of surface water is not foreseen in the water quality management approaches of the Central Asian countries.

4. SAMPLING AND LAB ANALYSES

4.1. Sampling procedure, in situ measurements and storage of samples

Sampling has to be carried out at locations where regular sampling is possible under all conditions, including winter and flood periods. The samples should be taken from the free-running river where mixing of the water body occurs and in no case from stagnant zones or close to possible inflows. A landing stage or low bridge can be suitable sampling sites. Grab samples are usually sufficient. In cases where the water body is not well-mixed, depth-integrated grab samples are necessary.

A special problem is the sampling of reservoirs. Water in reservoirs tends to be layered, and different layers have different behaviours, especially regarding oxygen and nitrogen compounds. A single sample cannot be representative for the whole reservoir. Usually the outflow of reservoirs consists of weirs with overflow. Then, the upper layer of the reservoir water body near the outflow may be representative of the river water of the downstream section.

Plastic bottles are in most cases more suitable than glass bottles. They are less susceptible to damage and easier to transport. Also, the samples may have to be deep-frozen during transport to the lab.

The bottles should be washed out several times with sampling water before being filled. They have to be filled accurately without remaining air in the bottle. Closing the bottle beneath the water surface is the best technique.

In cases where the analyses are possible within one day, the samples have to be chilled and stored in dark for transport to the lab. If an analysis is not possible within one day after sampling, the samples for the nitrogen compounds and oxygen have to be deep-frozen.

A measurement for oxygen saturation should only be made in situ with electronic devices or photometric test sets. Compared with analytical methods in a lab, the in situ methods may be less accurate, but this is considered to be acceptable because the risk of adulteration after transport is high.

Electric conductivity, an indicator parameter for mineralization could also be easily measured in situ. Electric conductivity depends also on the temperature of the water. Hence the temperature has to be measured together with the electric conductivity. Modern electronic devices for the determination of electric conductivity often include automatic temperature compensation.

If required, chloride and sulfate can be determined at the lab using an ion chromatography system or photometric methods.

Biological and/or chemical oxygen demand or ammonium tests require the samples to be chilled or deep-frozen and stored in the dark after sampling. Deep freezing (-18° C) is necessary if it is not possible to start the analysis in the lab within one day after sampling. In this case chilling (+5° C at maximum) is not sufficient.

4.2. Lab facilities and equipment for sampling

The proposed monitoring programme depends on labs with standard equipment including devices for doing wet chemical preparations, and the availability of de-ionized water. Additionally, the following equipment should be available:

- Ion chromatography system or suitable equipment for photometric analyses for determination of the nitrogen compounds (and for chloride and sulfate if requested);
- Equipment for BOD5 analyses (incubation bottles and incubator) or equipment for COD analyses;
- Filtering equipment and department dryer for determination of TSS.

Additionally, the following are needed for sampling and in-situ measurements:

- Oximeter or a colorimetric test set for in situ measurements of oxygen content and saturation;
- Conductivity meter for determining electrical conductivity and temperature;
- Suitable bottles, isolated boxes with lid, ice packs.

Special sampling equipment is required if the water body is not well-mixed and depth-integrated samples have to be taken.

4.3. Sampling, lab analyses and quality management

The standard routines for quality assurance together with fieldwork and sampling include:

- Regular calibration of equipment;
- Field protocols following controlled procedures;
- Careful labeling of samples following controlled procedures;
- Well-defined and reproducible procedures for transport and storage.

Lab analyses follow similar rules:

- Defined and well-documented analytical methods;
- Well-structured workflow;
- Regular test routines with defined standards.

The pilot monitoring programme will be transboundary and will include several labs with different equipment and capacities. The comparability of the results of the labs depends on basic quality management:

- Information on methods and analytical standards should be exchanged;
- Quality management should include regular ring analyses.

5. SAMPLING FREQUENCY

The aim of the sampling campaign is to get a reliable time series of hydrochemical data for at least several months. Sampling frequencies should be oriented towards the national monitoring programs, but a sampling frequency less than once or twice per month for the proposed five parameters monitoring and assessment programme is not recommended. Seasonal variations and hydrochemical behaviour together with hydrological extremes such as drought or snowmelt events are important and should be covered.

Sampling on small rivers is proposed to be carried out at least 4 times a year and on large rivers monthly.

6. STATIONS AND NETWORK DESIGN

All stations must have the capacity to determine runoff continuously (analog recorder or data logger). Hydrochemical data that lack the corresponding determination of runoff cannot be fully included into evaluation procedures.

Therefore, only established stations with the possibility of measuring runoff are to be included. Lists of such stations are available for all Central Asian countries. Selected stations should meet the following conditions:

- The station should be in acceptable condition and part of the national network
- For determination of runoff, a recent calibration curve should be available
- Ideally, records of hydrochemical data already exist

The design of a monitoring network has many aspects – property borders, accessibility by roads and many others. The design of a monitoring network should consider the following:

- A sampling location should be representative for a section of a water body
- The selected section of the water body should be approximately homogeneous in relation to the monitored parameters
- The section should ideally differ from the previous and subsequent sections because of the impact of one single causing factor.

These goals may be often difficult or impossible to achieve in practice. The number of stations that can be established is always limited, and in many cases adequate information on the impact of single factors may not available. Also the situation at a water body may change without the possibility of adapting the network design. Compromises are necessary and individual local solutions have to be found.

7. DATA HANDLING, DATA EXCHANGE AND EVALUATION METHODS

All obtained data has to be stored and exchanged between the involved administrative bodies.

In general, there are two tasks:

- A project data base (of a temporary nature) should be established;
- Data should be collected and stored in a permanent regional database.

7.1. Storage of raw data

The project database should consist of two main components. The first component should store all raw data, and should contain:

- Field protocols;
- Lab protocols;
- Printouts of all collected raw data.

It is not necessary to centralize the raw database, nor is it necessary to fully exchange all information of the raw database between the partners in the monitoring and assessment programme. The results of the monitoring in a standardized form including data descriptions with all relevant information on their interpretation should be exchanged.

7.2. Data validation and storage of validated data

Collected raw data has to be validated and stored with the appropriate meta-data. Meta-data in this context refers to any descriptive information such as units, applied methods or accuracy.

The validation process consists mainly of plausibility checks for measured values. The time series has to be checked (either by graphical analyses or statistical tests) if a single measured value is an outlier or not. If a single measured value is an outlier, an individual assessment has to be made if the value can be considered as reliable or not.

Ideally, the result of this assessment process has to be stored as meta-data together with the measured value.

The validated data should be stored in a computer-aided database together with the meta-data and general background information on the programme, on the network and on the methods used for data evaluation.

In a first approach the electronic database can be informal, consisting of spreadsheets and descriptive documents.

As the amount of data increases, the establishment of a professional computer aided database may become necessary. The design of a professional computer aided database is a complex task. In addition to the simple storage of the validated data, routines for quality management, data evaluation can be included. The combination of the database with a geographic information system system and digital maps is desirable.

7.3. Data exchange

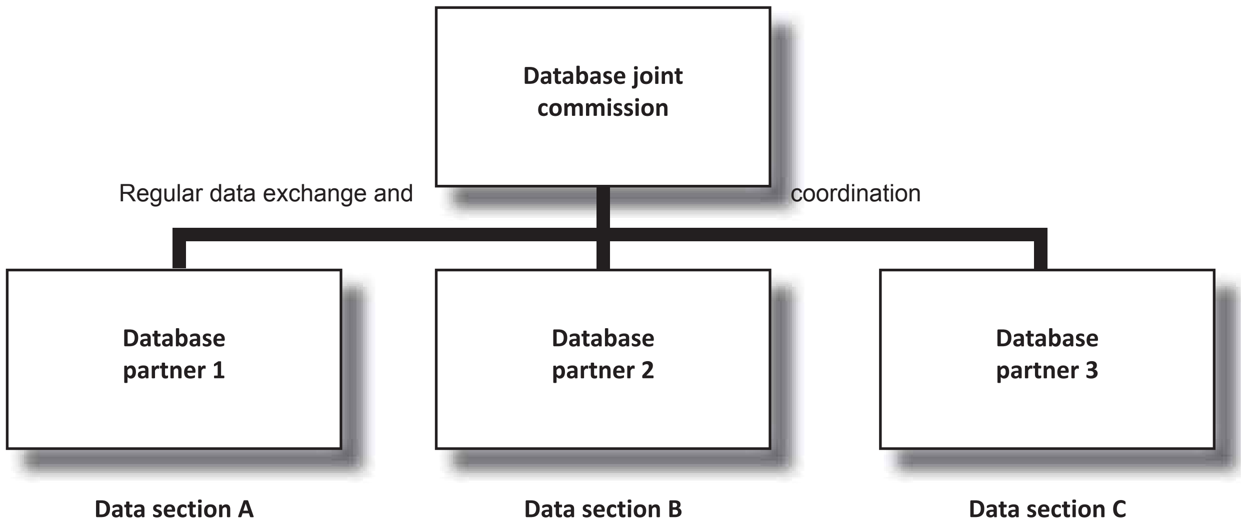
Routines for regular data exchange of validated data among all project partners are necessary. These routines require the technical set-up for a common database and a joint administrative unit with all the partners of the monitoring programme.

Ideally, a professional computer-aided database is designed and installed in identical versions at different locations for the different partners of the monitoring and assessment programme. These different partners can be the authorities of the different countries, or different authorities with different responsibilities within the same country.

The system must ensure that, though the databases are identical, the different partners can only insert or alter data within their own responsibility, but at the same time have access to all inserted data including the data of all other partners. This requires technical routines of regular data exchange and coordination among the different partners and locations. It has to be organized and overseen by a joint administrative unit that takes responsibility for data exchange and storage.

The system has the advantage that the data are stored at the same time at different locations. This minimizes the danger of data losses together with accidents or technical failures.

Figure 1. Structure of a joint database



The database should also contain information about:

- Network design, information on locations;
- Design of the sampling campaigns;
- Secondary information on the monitoring and assessment program (important documents, treaties).

7.4. Data evaluation

The basic routines in data evaluation should include:

- Testing for compliance with standards and classifications;
- Trend analyses;
- Calculation and estimation of loads.

It can be useful to prepare plots of concentration versus runoff. Effluents from point sources show in general a different behavior compared with pollutants from non-point sources that are washed into the water body from the surface or have passed through an aquifer.

It is usually more useful to use loads instead of concentrations to evaluate the dynamic of a single substance at a location. Loads refer to the absolute amounts of pollutants present in the water body and are independent from amounts of runoff. In trend analyses they can be useful to subtract out the influence of wet and dry seasons, periods or years.

Most standards and classification schemes in Central Asian countries are based on concentrations. Obtained concentration values can be automatically checked against a certain standard with a computer-aided database. Routines for giving out warnings can be implemented.

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