UNITED NATIONS ECONOMIC COMMISION FOR EUROPE

in cooperation with
THE REGIONAL ENVIRONMENTAL CENTRE
FOR CENTRAL ASIA (CAREC)

SURFACE WATERS QUALITY MONITORING SYSTEMS IN CENTRAL ASIA: NEEDS ASSESSMENT

ALMATY, 2018

THE LIST OF ACCEPTED ABBREVIATIONS

APL	Approximate Permissible Levels
BAT	The Best Available Technologies
CA	Central Asia
CAREC	The Regional Environmental Centre for Central Asia
CIS	The Commonwealth of Independent States
CWPI	Comprehensive Water Pollution Index
EECCA	Eastern Europe, Caucasus and Central Asia
ECS	Environmental Control Services of the State Committee on Environmental Protection and Land Resources of Turkmenistan
GEF	Global Environmental Facility
GIS	Geo information systems
ICWC	The Interstate Coordination Water Commission
IFAS	The International Fund for Saving the Aral Sea
ISDC	The International Sustainable Development Commission
IWRM	Integrated Water Recourses Management
Kazhydromet	Republican State Enterprise “Kazhydromet” under the Ministry of Energy of the Republic of Kazakhstan
Kyrgyzhydromet	Hydrometeorology Agency under the Ministry of Emergency of Kyrgyz Republic
MAD	Maximum Admissible Discharge
MPC	Maximum Permissible Concentrations
MPHI	Maximum Permissible Harmful Index
RBDMP	River Basin District Management Plan
RWG	Regional Working Group
SAEPF	State Agency on the Environmental Protection and Forestry
SSAS	Synthetic Surface Active Substance
Tajikhydromet	Gidrometeorology Agency of the Environmental Protection Committee under the Government of the Republic of Tajikistan
UNECE	United Nations Economic Commission for Europe
UNDP	United Nations Development Program
Uzhydromet	The Hydrometeorological Service Centre under the Ministry of Emergency of the Republic of Uzbekistan
WMP	Watershed Management Plan
WPI	Water Pollution Index

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INTRODUCTION

This survey was prepared within the frames of the project “Strengthening cooperation on water quality management in Central Asia”, being realized by the United Nations Economic Commission for Europe (UNECE) in cooperation with the Regional Environmental Center for Central Asia (CAREC). The assessment was made possible thanks to the financial support of the FinWaterWEI program. The purpose of this project is promotion in development of the basin-wide regional cooperation on the water quality.

This regional survey provides assessment of needs of national systems on provision of water resources quality with elements of transboundary cooperation in five states of Central Asia - Republic of Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Turkmenistan and Republic of Uzbekistan (hereinafter – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan).

The following objectives were determined as essential: (1) actualization (updating) of the Diagnostic Report and of the Cooperation Plan on the Water Quality, developed within the frames of the previous project UNECE/CAREC in 2009-2012 and (2) carrying out the expert assessment of needs of national systems of water quality monitoring and of the transboundary cooperation on the water quality management.

The survey was carried out by national experts in the close coordination with CAREC, under the guidance of the regional expert Mr. Ruslan Melian. The study focused on hydrometeorogical services of 4 Central Asian countries (and the environmental control service in Turkmenistan) as these agencies are centrally involved in the evaluation of the quality of surface waters in the respective countries and have a mandate to conduct operational transboundary monitoring (of both quantity and quality of water).

This study based on analysis and synthesis of data presented by national experts and contains regional summaries and recommendations. The following experts participated in development of national and regional studies:

from the Republic of Kazakhstan – Ms. Danara Alimbaeva, the Republican State Enterprise “Kazhydromet” under the Ministry of Energy of the Republic of Kazakhstan, Director of the Environmental Monitoring Department;

from the Kyrgyz Republic – Ms. Vera Bondareva, the Hydrometeorological Agency of the Ministry of Emergency of the Kyrgyz Republic, the Administration of Monitoring of Natural Environment Pollution, Head of the Department of Monitoring of the Quality of Land Surface Waters.

from the Republic of Tajikistan – Mr. Bahrom Mamadaliev, the Academy of Sciences of the Republic of Tajikistan;

from Turkmenistan – Mr. Stanislav Aganov, the independent expert;

from the Republic of Uzbekistan – Prof. Sergey Myagkov, the Hydrometeorological Service Center under the Ministry of Emergencies of the Republic of Uzbekistan, Deputy Director of Hydrometeorological Research Institute.

CAREC Regional expert – Dr. Ruslan Melian, the Centre of Strategic Ecological Researches (ECOS), Director for Sciences, the Republic of Moldova.

The survey combined in two sections, six chapters, and annexes.

Whereby the first section focuses on actualization (updating) of the Diagnostic Report (2012). The section comprises two chapters, targeting the water resources quality system and excerpt from the Diagnostic Report, indicating changes occurred in CA countries after its publication.

The second section begins with a comprehensive information on national needs for improving surface water quality monitoring systems. The section consists of four chapters. The chapter 2.1 covers issues of needs in the information on the surface waters quality, determined by national legislation and mandates of different organizations engaged in the quality monitoring. The chapter 2.2 focuses on the review of available monitoring networks on the quality of surface waters on the main transboundary rivers in the region. The chapter 2.3 presents the expert assessments of needs of systems of monitoring of surface water resources quality on the example of agencies, engaged in the monitoring of water resources quality (“Kazhydromet”, “Kyrgyzhydromet”, “Tajikhydromet”, “Uzhydromet”, accordingly in Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan and of the Environmental Control Service in Turkmenistan). The study covers different aspects of planning, organization and monitoring programs in each of CA countries. Chapter 2.4 presents the current regulations about transboundary/regional cooperation of Hydrometeorological services of CA countries on issues of the waters quality monitoring.

The insights emerging from the above-mentioned analysis are complemented by a Conclusion section, whereby key findings from national reports, concerning actual needs of water quality monitoring systems revealed. It also provides expert arguments and recommendations on how to improve water quality monitoring systems at national level and transboundary /regional contexts.

This study was prepared by the national experts in close consultation with sector stakeholders, who were brought together within the context of a Regional Working Group to act as the CAREC counterpart throughout the assessment. The study considers the results of the consultative meeting with the Regional Working Group, which was held in Almaty, Kazakhstan on December 5, 2017 to discuss the key findings and recommendations emerging from the assessment.

SECTION 1. THE WATER RESOURCES QUALITY ASSURANCE SYSTEM IN CENTRAL ASIA AND REGIONAL PRIORITIES.

In 2012 the Diagnostic Report provided evaluation of the UN Development Account project on "Water Quality in Central Asia" completed during Feb - June 2012 and implemented in cooperation between UNECE and CAREC.

The goal of the project was to enhance the development of an efficient and coordinated policy on improvement of water quality in the framework of integrated water resources management (IWRM) and the focus was placed on the management of water quality in rivers. The Diagnostic Report reviewed relevance, effectiveness and efficiency of the project and included recommendations for possible further work on water quality cooperation in Central Asia.

The evaluation focused on the key strategic issues to provide assistance on improvement and perspectives of development of the regional cooperation on issues of the water resources quality. During the last five years, certain changes have taken place in CA countries. The synthesis of these changes is given in this section.

CHAPTER 1.1. THE WATER RESOUCES QIALITY ASSURANCE SYSTEM

This chapter basically is the theoretical development concerning the system of water resources quality assurance. It demonstrates how this system is functioning. The system of water resources quality assurance is a complex of interrelated legislative regulations, management solutions, instruments, procedures and mechanisms, which in the case of being realized holistically, orderly and consequently, provide this or that quality of water resources.

The concept “water resources quality assurance” is quite new in the CA region, though it includes well-known approaches to water-resources management widely applied in countries of the region. Traditionally, main objectives of natural surface waters management in the context of their quality consist in tracing of the situation. If the quality of waters deviates from normative requirements (the quality of water does not correspond with requirements of water resources managements or water ecosystems maintenance, for example, because of pollution from anthropogenic sources), then these or other measures preventing or reducing the negative influence of such pollution sources (point or diffused) on water resources are taken. This is a kind of “passive” management of the quality of natural water resources.

At the same time, a concept of “water resources quality assurance” has elements of the “active” management of water resources quality. First of all, it is “planning” of that quality of water body that is needed for the sustainable support of water consumption (the current or the planned) and at the same time to provide preservation and safety of the water environment for water eco-systems. In other words, the concept of “water resources quality assurance” is much like the concept “water resources quality management” and to some extent – like the concept “Targeted planning of water resources quality”.

Insertion 1: Best Practices «Targeted Planning»
Today the targeted planning of water resources quality is the basis for natural water resources management in the European Union, which is determined on the legislative level for all EU countries in so-called Water

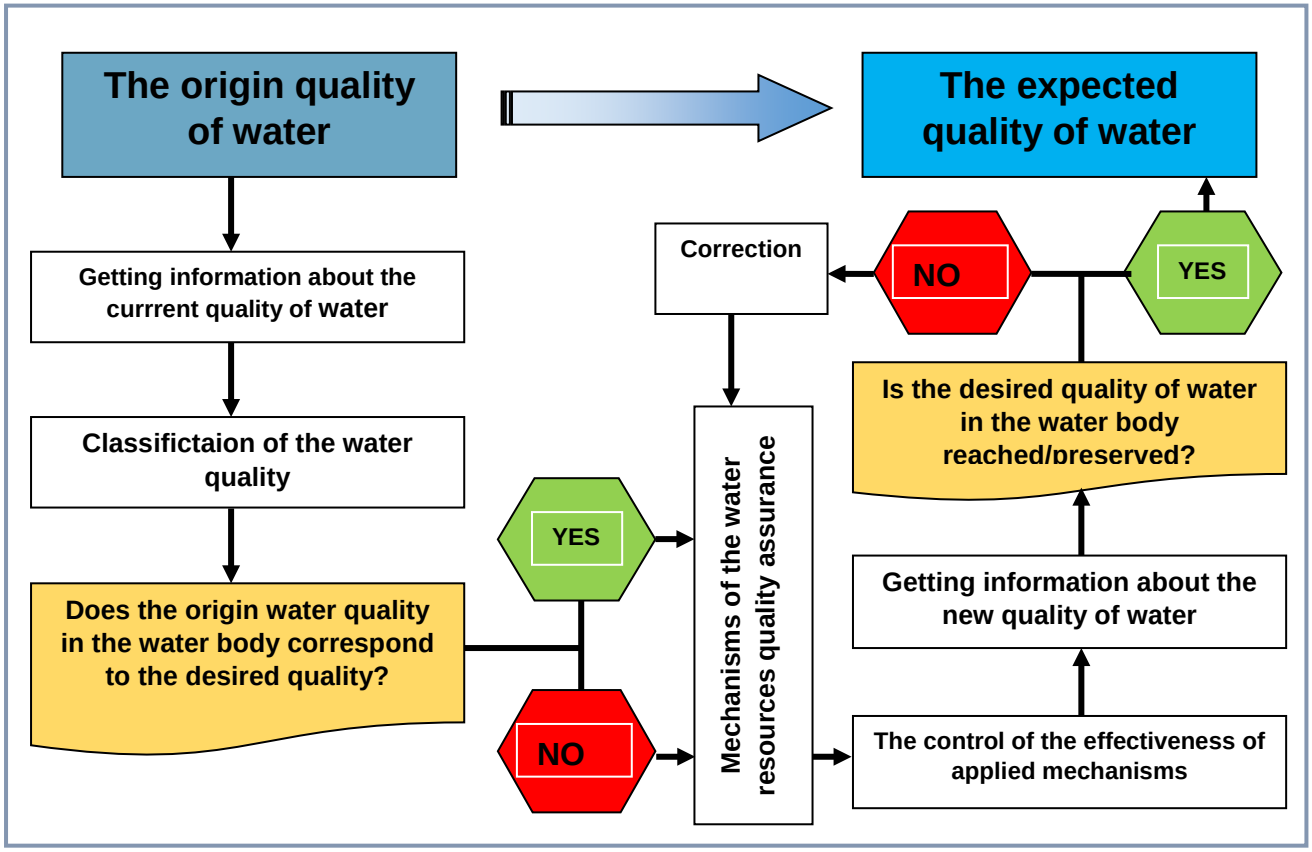
Framework Directive. As an example, it can be demonstrated how common objectives of water resources management in EU are formulated: ***«To seek that all surface waters in EU countries upon the expiry of 15 years would correspond to the good status and artificial and heavily modified water bodies would correspond to the good environmental capacity and good chemical status»***.

Setting up such an objective, the EU countries actively apply all necessary mechanisms and measures to implement this directive requirement. The concept "Good Status of Surface Waters" includes the combination of three so-called "water quality elements", and namely "good chemical status", "good biological status" and "good hydromorphological status".

For those water bodies , the state of waters in which already corresponds to "the good status" criteria, measures in supporting the current state and prevention of its worsening are planned. And for those water bodies , the water status of which is worse than a "good status", the measures on its improvement are planned. Measures are determined based on the analysis of reasons of the insufficiently good quality of waters and they are introduced into the plans of water bodies management. The plans determine time limits, finances and parties, responsible for realization of measures. For tracing of that to what extend the planned measures promote improvement of the water body quality (in other words, whether the good status is reached) the monitoring network is designed and observation parameters (on physical and chemical elements, on biological elements and on hydromorphological elements), and their periodicity are determined. The monitoring results are used for correction of the plan and confirmation of the reached status of waters.

Thus, in EU countries, the management of water resources is realized on the planned and target basis and it provides all mechanisms, needed for achievement of the set object on water resources management (to bring all water bodies to the "good status").

Figure 1. The system of natural water bodies quality assurance



To understand how the natural waters quality assurance system works, it is necessary to understand its conceptual aspects, as seen in Figure 1.

The first step in water resources quality assurance is assessing the quality of water in the water body. It can be done through monitoring of the water quality. The monitoring results are compared with classifiers (for example with MPC dimensions, quality classes or with other systems of classification of natural waters quality).

Following the monitoring results, a conclusion should be done - if water is acceptable for drinking, sanitation, health, commercial and industrial use, and agriculture and irrigation. Different activities require different levels of water quality (e.g., water quality for drinking and irrigation have different standards). There are cases where the original (current) quality of water in the water body corresponds to established standards and allows to use water without restrictions (water supply, irrigation, etc.), that is already carried out or is planned to be carried out on the certain water body.

However, in certain cases where the current quality does not correspond with water consumption requirements by the quality of water resources also known. Nevertheless, on the next stage it is necessary to use certain mechanisms for provision of the water quality. In the first case, these mechanisms should be at least sufficient for maintaining the acceptable quality of water and prevention of its quality worsening. In the second case – the applied mechanisms should result in improvement of the water quality on the water body to such extent, that in the course of time there would be no limitations for water consumption and water ecosystems would be able to exist steadily.

Mechanisms for provision of the water quality are available in all CA countries, though often their specific realization and effectiveness depend on national circumstances. Nevertheless, the complex of mechanisms on provision of natural waters quality is well known in the CA region and usually includes the following:

- Regulatory mechanisms (permission and/or prohibiting the discharge of untreated waste waters; permission or prohibiting disposal of wastes in water areas (aquatoriums) or on the Water fund lands; licensing/certification of the economic activities on the water collecting territory; prohibiting/limiting disposal of toxic compounds (poisons) as a part of wastes waters; prohibiting application of especially dangerous agricultural chemicals (pesticides) etc.).
- Fiscal mechanisms (payment for the discharge of waste waters; payment for the excess of discharge rates; payment for the discharge of waste waters etc.)
- Stimulating mechanisms (benefits, bonuses, tax exemptions, other economic instruments, stimulating the rational natural resources management and reduction of wastes and discharges)
- Preventive mechanisms (implementation of hew infrastructure projects, according to the procedures of the Environmental Impact Assessment; ecological expertise of the project documentation; ecological audit of enterprises etc).

If application of mentioned mechanisms is not enough to preserve or improve the quality of the water body then other, so-called “structural measures” shall be taken. Structural measures and arrangements, of course, are more expensive, for example construction of new or repairing of available waste treatment facilities; changing/improvement of the

process of the discharge treatment; liquidation and carrying over landfill sites; construction of water-blocking buffer strips; cleaning of water reservoirs from sediments and deposits etc.

It is very important to understand that application of planned mechanisms, measures and events should be periodically monitored in the process of their realization and it's necessary to assess their effectiveness. In other words, it is necessary to know whether the improvement of the water quality in the water body is observed, whether its quality is not becoming worse, to see how effective are the applied mechanisms and what is the effect from structural measures and arrangements being realized.

And again such understanding can be reached through the regular monitoring of the water quality in the water body and comparing of received data with the expected quality of waters. Finally, in a certain period of time it is necessary to make a following conclusion – is the expected quality of water body reached or not. Here again two scenarios are possible. If applied measures and mechanisms turned out to be effective and the quality of water in the water body corresponds to the expected quality, it is necessary to continue supporting it. And if the required quality of water is not reached, then it is necessary to look for reasons for this, to assess how effective were the mechanisms and/or to plan new arrangements and measures on improvement of the water quality.

It is obvious that the system of provision the natural waters quality can be effective only in that case when all its elements (the targeted quality, monitoring, decision-making, applied mechanisms and measures, analysis of the effectiveness etc.) are interconnected and "work" in one direction – for preservation and improvement of the quality of a concrete water body. For this purpose the clear and exact plan on quality assurance of this or that water body is needed. It is necessary to determine the targeted quality of the water reservoirs, the time frame for achieving this target, to determine responsible executors, material and financial resources, planning arrangements and structural measures. In accordance with principles of the Integrated Water Resources Management (IWRM) it can be reached through realization of Watershed Management Plan (WMP). In some countries of the CA region, though it has been declared in the legislation, such kind plans practically are not developed or are developed in the limited volume,.

Insertion 2. Good practice «Watershed Management Plan»

The most illustrative example of planning the water resources management, including their quality management, is development of River Basin District Management Plan in accordance with the EU Water Framework Directive. River basin district management plan (RBDMP) is developed on the basis of the preliminary comprehensive analysis of the catchment area.

All water bodies - surface ones (rivers, natural lakes, sea and transitional waters) and underground ones are subdivided to so-called water bodies, that are elementary management units. For such division a number of criteria is used, for example for surface waters these are the following: ecoregions boundaries, the type of the river or the lake, hydrographic networks, loads from hydraulic structures and loads from contamination sources. Based on the assessment of hydromorphological loads the decision is made – does this or that water body refer to category of Artificial, Heavily Modified or Natural/Quazi-Natural water body?

For every water body, depending on its category the targeted water quality objectives shall be set, for example: ***"to reach good economical status of the water body up to 2020 or to reach transferring of the water body from the bad ecological status to the moderate status up to 2017 or to provide a high ecological capacity for heavily modified water body (water reservoir) up to 2017".***

Taking into consideration perspectives for reaching the targeted status of the water body and starting from its

current status, a complex of measures and arrangements (of the structural and legislative-regulator character) shall be developed. These measures in case of being effective will allow to reach the expected targeted status for the given water body.

For taking control of effectiveness of planned measures special monitoring programs shall be set (physical and chemical quality of the water and bedload sediments, hydrobiology, composition of waste waters, effectiveness of the discharged treatment, protected territories etc.). Through such monitoring programs the state of the water body shall be monitored and decisions are made – are there additional measures or special arrangements needed on the water catchment area or not?
RBDMP is developed for the period of 6 years and corrected after 3 years of its realization. At the same time development of RBDMP for the next planning cycle shall be started.

CHAPTER 1.2. ACTUALIZATION OF THE DIAGNOSTIC REPORT

This chapter presents a kind of brief resume of the Diagnostic Report[1], reflecting its main aspects and conclusions. The changes which had taken place in CA countries from the moment of its publication mentioned in the boxes below.

1.2.1. LEGISLATIVE FRAMES

The existing legal framework in all countries covers (i) general objectives, principles and mechanisms of water and environmental protection policy (water and environmental legislation), (ii) sanitary and epidemiological provision of the population health related to the drinking water (sanitary and epidemiological legislation), (iii) mechanisms of water relations regulation, including those that provide the quality of water resources (legislation in the sphere of ecological expertise, permission, prohibitions for the water consumptions and economic activities of water catchment territories and close to water bodies, systems of payment for the use and contamination of water resources, (iv) mechanisms of monitoring and control over compliance with the water and environmental legislation.

CA countries continue developing of the legal framework for water resources management.

Thus, in Uzbekistan in 2013 the Law “On water and water consumption” was updated.

In Tajikistan On December 30th, 2015 the Government of Tajikistan adopted the Water Sector Reform Programme 2016-2025. The water sector reform is about transferring water management from administrative to hydrological boundaries, separating water policy and regulatory functions from operations, while applying IWRM principle; and on improving provision of clean drinking water supply to the population for the period of 2008-2020. To systematize all water-related goals and objectives of sustainable development, the country is currently drafting its 2030 National Water Strategy. A new draft of the Water Code of the Republic of Tajikistan that accounts for current trends and requirements has been introduced and is currently under consideration. The human right to safe drinking water and sanitation is given priority in these documents. The Law “On water uses associations” which was adopted in 2006 was revisited in 2011.

In Kyrgyzstan, it is planned (recommended) to introduce the expanded concept of the Integrated Water Resources Management (IWRM) principle into the Water Code as well as the basin approach with regard to the complex use and protection of surface, underground and return waters, taking into consideration climatic specifics of the region; development of the unified system of water quality classification in water bodies; elaboration of standards for Maximum Permissible Harmful Impacts (MPHI) on water bodies; more clear division of official functions in the sphere of setting water quality standards. In 2015 with the purpose to regulate issues in the sphere of water resources consumption and protection, “Regulations on protection of underground waters” was approved. These regulations determine the order of use and protection of underground waters

[1] For development of regional cooperation on water quality assuranceb in CA. Diagnostic report and Plan on the cooperation development, 2012.

In Kazakhstan some changes were introduced into the “Environmental Code”. The introduced amendments will allow to exclude additional administrative barriers and to prevent contamination of the environment.

At that the Diagnostic Report states that in countries of the Central Asia region:

- rates of elaboration of legislative water and environmental norms are different;
- legislative norms often have regulations that need to be clarified, complemented or reviewed;
- legislative norms often are not realized in full because of limited resources.

1.2.2. INSTITUTIONAL STRUCTURES

On the issue of *differentiation of authorities in the sphere of water resources management*, the Diagnostic Report postulates that in principle in CA countries functions and authorities on water resources management, including provision of their quality, have been distributed to different ministries and agencies. Functions on surface water resources management (mainly by qualitative aspects and water infrastructure) are usually concentrated in Ministries or Committees of water management and agriculture; environmental functions are entrusted to Ministries, Committees and Agencies on the environmental protection. Functions of underground waters management are implemented by executive bodies, regulating natural resources management. Issues concerning sanitary and epidemiological situation and the quality of drinking water are addressed by the Ministries of health. In addition, functions on prevention and liquidation of emergencies after-effects including those connected with technogenic accidents and extreme contamination of water resources are trusted to corresponding Ministries of emergencies or they are the prerogative of the Cabinet of Ministries and of local authorities.

During the last five years, quite significant institutional reforms were realized in countries of the CA region.

Thus in Uzbekistan “Uzhydromet” was moved under the Ministry of Emergencies.

In Tajikistan, the water sector reform resulted establishment of the Ministry of Energy and Water Resources and the Agency of Melioration and Irrigation, instead of the Ministry of Melioration and Water Resources. It’s brought significant change in the institutional structure whereby separated policy and operation functions of water resources management in Tajikistan.

In Kyrgyzstan in 2012 the State Inspection on the ecological and technical safety was formed. It is a specially authorized state executive organ taking control over issues of environmental and technical safety. Previously control functions were assigned to the State agency on the environmental protection and forestry (SAEPF).

In Kazakhstan in 2014 the Ministry of Environment and Water Resources was liquidated, and corresponding functions and authorities were delegated to the Ministry of Energy.

The Diagnostic Report in particular refers the following problems related with institutional issues of water resources management and provision of their quality as underlying problems:

- limited resources (financial, personnel, material and technical) for implementation of managerial decisions;
- overlapping functions and authorities in the sphere of control and inspectorial activities, monitoring;
- application of imperfect procedures in water resources management, in particular (i) insufficient application of a complex approach to planning of water resources consumption and protection, (ii) lack or gaps in national strategies, plans and schemes on the management of water resources quality, (iii) fragmentary use of principles of Integrated Water Resources Management and of the basin approach, (iv) the preferential application of managerial methods aimed at removal and liquidation of negative situations, and not at their prevention;
- imperfection of information systems for making decisions on the basis of objectives and reliable information about water resources.

The following can be added here:

- inadequate awareness on issues of state division of authorities in the sphere of water resources management both among the population and economic entities;
- insufficient use of scientific capacity and engagement of scientific institutions to issues of consulting state authorities in application of managerial decisions;
- lack of coordination and exchange of information including parameters of water resources quality, and access to electronic databases.

1.2.3. LEGAL FRAMEWORK AND MECHANISMS

The Diagnostic Report has a section on reviewing *mechanisms on water resources quality assurance*. Here it is mentioned that in all CA countries the system of permissions/prohibitions for the discharge of untreated wastewaters and polluters of natural water reservoirs as well as discharge of wastes into water bodies and water fund lands is applied. In all countries also the control-inspectorial activities are realized over compliance with water and environmental legislation and the system of penalties for offences and payments for the water delivery is in force. Other mechanisms, for example, licensing and certification of water uses, benefits and economic stimulus are applied only in some countries of the CA region.

During the last several years normative and legal mechanisms on water resources quality assurance in CA countries have not changed significantly. In some countries new by-laws were developed. Thus in Turkmenistan since 2008 “The methodology on assessment of the harm to the environment because of the contamination of water bodies” is applied. The “Methodology of the tariff calculation for water delivery service is in the process of being endorsed. In this methodology in addition to the tariff for the actual delivered water (currently the per hectare tariff is in force), also the quality of delivered water for irrigation is taken into account. Also stimulation mechanism for the water saving has been developed.

New “Rules on surface waters protection” adopted in Kyrgyzstan in 2016 have preserved previous requirements to the composition and the qualities of water in watercourses and water reservoirs for different types of water consumption by 3 categories (economic-drinking, cultural-domestic and fisheries water consumption). Also national Maximum

Permissible Concentrations (MPC) and Approximate Permissible Levels (APL) in the water of water bodies of economic-drinking and cultural-domestic consumption were accepted.

However, it is stated in the Diagnostic Report that in CA countries:

- application of regulation norms and mechanisms is often delayed or implemented inconsistently.
- inspection authorities have limited capacities and technical equipment for the adequate inspection of enterprises, determining sources and cause of ground and surface water pollution. Whereby sanctions are often not sufficiently tangible for those who run afoul of the laws.
- tariffs for the water consumption, especially in irrigation is low, that is often stipulated by the low paying capacity of farmers. Although the incentive mechanism to encourage rational water-consumption in the agriculture is not sufficiently developed.
- tariffs for the discharge of waste water and contaminating bodies into water reservoirs fall critically less than a cost of environmental damage caused and expenses for consequences liquidation.
- the structure of sources of water resources contamination has changed a little, with the increased role of diffusive contamination. Economic units of small and medium-sized businesses began dominating; disordered maintenance of auto transport and discharge of domestic wastes was observed.

1.2.4. STANDARDS

In the sphere of *standardization of water resources quality systems*, the Diagnostic Report states that in all CA countries permissible values of natural waters composition and qualities are set, within which safe conditions for the population's life sustenance and for the economy are provided, as well as favorable conditions for the water consumption and water ecosystems state. In the list of standards applied today on the national level in CA countries for standardization of water resources quality, as a rule, the following normative and legal requirements are used:

- key terminology and definitions.
- the list of water quality indicators and maximum level of contaminating constituents typically collected in water quality sampling standards in natural waters for different types of water consumption (economic-drinking, communal-domestic, irrigation and fisheries).
- the system of norms of natural waters quality based on maximum permissible concentrations (MPC) for separate substances and for separate water consumptions that assumes avoiding the excess of these norms;
- developing of the water quality monitoring network includes methods and procedures, the accuracy of sampling and technical requirements.

Major differences in application and the ways in development of water quality standards have been monitored in CA countries.

Thus, in Turkmenistan over the last 5 years the water quality standards have not been revised.

In Uzbekistan in some cases MPC norms have been revised for approximation the level of water sources quality to real indicators. So if it is impossible to deliver water to consumers with mineralization less than 1 g/l (MPC), then for any specific case the norm is set by the acceptable limits (in accordance with background conditions of the water quality).

In Tajikistan, the norms and rules were updated, including SanPin (Sanitary rules and norms) 2.1.4004-07 “Drinking water, hygienic requirements for the quality of water in centralized systems of drinking water supply. The quality control”, SanPin 2.1.4005-07 “Drinking water, hygienic requirements to the quality of water in non-centralized systems of drinking water supply. The quality control”, SanPin 2.15.006-07 “Zones of the sanitary protection of water supply sources and water pipes for domestic-drinking use”.

In Kyrgyzstan in 2016 hygienic standards “Maximum Permissible Concentration levels of chemical composition in the water of water bodies for domestic-drinking and cultural-domestic water consumption” and “Approximate Permissible Concentration levels of chemicals in the water of water bodies for domestic-drinking and cultural-domestic water consumption” were reapproved. Despite of formal adoption of new documents in both countries, these standards have basically repeated the old one.

Water quality standards were subject to more significant reforming in Kazakhstan. The system of natural waters quality norms was revised. This system was based on maximum limited concentrations (MPC) for some substances and for separate water uses that formally assume non-admission of the excess of these norms. Normative documents “The unified system of classification of the water quality in water bodies” and “The methodology for development of targeted indicators of the water quality in surface water bodies and arrangements for reaching these indicators” provide for introduction of ecosystem model of regulating water related activities and transferring the current system of assessment of the water quality and of the contamination level in water bodies to new systems of water quality standards. The new approach has been developed taking into consideration the European and international conception, practices, methodology and harmonization results reached in EECCA countries.

On the initial stage of the environmental legislation reforming, it included two assessment instruments: the first one – the hierarchal five-level classification of water bodies on the basis of requirements to the water quality of essential categories of water consumption such as fisheries, domestic-drinking, recreational (cultural-domestic), irrigation, industry; the second one – numeric values of water quality standards by the list of substances, approved for implementation of the state ecological monitoring.

In the long view, by results of implemented of ecosystems assessments by each river basin it will be necessary to determine “targeted indicators” that should be approved in relevant water related documents as “the base policy”. Currently a number of normative documents on application of “The unified system of classification of the water quality in the water bodies” in the system of state monitoring and assessment of the environment conditions are being developed. In addition, in Kazakhstan the work is continued on improvement of standards of impact on the water bodies such as Maximum Permissible Discharge (MAD) and Maximum Permissible Harmful Impacts (MPHI). The method of technological regulation of the contamination control on the basis of MAD standards will be based on the concept of using the Best Available Techniques (BAT). As one of ways to improve the MPHI standards it is recommended to use the water balance equation.

At the same time, the Diagnostic Report covers the national systems of water quality standardization:

- developed in the USSR in 1960-1970-s regulations are morally obsolete. They do not optimally take into consideration the modern specificity of water resources management and their quality aspects in the region;
- missing new technologies and technical means of monitoring;
- have contradictions in the context of interpretation of the monitoring data for different water uses that jointly use common water bodies and to a limited extend take into consideration requirements to assurance of the quality of natural waters for water ecosystems;
- impose excessively hard requirements to indicators of the water quality (any deviation from the standard of natural waters quality is considered to be an offence);
- the list of quality parameters provided for the monitoring often is not typical for some water bodies;
- insufficient realization of standard requirements, due to the lack in financing and technical equipment, staff capacities of organizations engaged in the monitoring.

1.2.5. Classifiers

The Diagnostic Report specifies some similarity on the issue of water resources classification, but also a number of quite significant differences in applied approaches and principles of natural waters classification by their quality. Traditionally, since the times of the Soviet Union, three categories of water resources consumption have been determined in CA countries – domestic-drinking, communal-domestic and for fisheries, and to each of these categories these or those requirements to the water quality are applied. However, concrete water bodies are not distinguished by these categories and often one and the same water body serves or is designed for satisfying considerably larger spectrum of water consumption (drinking and industrial water supply, irrigation, fishery and recreation, livestock watering and also for maintaining natural characteristics of inhabitation of different water and semi-aquatic organisms, and as a whole of water and water-wetland ecosystems). In view of this, it is not always clear which of standards should be applied in this or that concrete case.

In countries of the CA region also integral assessments of surface waters are applied (WPI index) which are based on MPC values for fishery water bodies. Usually the essential decision on the water quality in natural water bodies is made by the WPI index. Despite of this, only limited list of water quality parameters is used for the WPI calculation, that consists of six hydro-chemical parameters. This is incomparably less than extensive and officially approved MPC lists.

The water quality assessment by hydro-biological parameters and relevant systems of natural waters classification are applied only in some countries of the region (Kazakhstan and Uzbekistan).

Assessment of natural waters quality in the CA region is still traditionally based on using of the list of substances (water quality parameters) and on values of their Maximum Permissible Concentrations (MPC, APL, quality norms for irrigation waters etc.) in different water reservoirs (fisheries, domestic-drinking and cultural-domestic water consumption). In practice the water quality is usually assessed by the excess of concentrations of different

parameters revealed in the water of water reservoirs over standard values (ratio to MPC) and by the number of cases of the MPC excess for the certain period.

For today, from all countries of the region, only Kazakhstan is in the process of transferring to classifiers of natural waters quality based on classes of the water quality. Classification includes numeric values of water quality standards by biogenic elements, organic compounds, main mineralization ions and metals, physical and hydro morphological indexes. Classification consists of numeric values of water quality standards by categories (types) of water consumption and characteristics of water consumption classes. From those classifiers, which provide the integral assessment of the water quality in the region, the Water Pollution Index (WPI) is used toa limited extend (in separate countries or in separate agencies). This index is calculated on values of six hydro-chemical indicators.

Since 2015, in the system of state ecological monitoring in Kazakhstan, for assessment of the level of surface waters pollution the complex water pollution index (CWPI) is applied. After determining the CWPI for each group of provisional combinations for the period of year being determined, such, for example, as broken down by months, for the period of spring floods and high waters, for the period of summer-autumn-winter low water season and broken by years (depending on targets and objectives of the complex assessment), the average measured CWPI for the watercourse or the water reservoir as a whole is calculated and the contamination class is determined.

The general conclusion of the Diagnostic Report states that simultaneous application of several classifiers, based on different principles and indexes, makes procedures of water resources quality regulation difficult.

1.2.6. Monitoring of water resources quality

In CA countries functions of carrying out the *water quality monitoring* is formally differentiated among different. Registration of qualitative and quantitative indicators of surface and underground water resources is assigned to hydrometeorology and hydrogeology bodies. Environmental protection authorities are responsible for the control of quality indexes of the aquatic medium and of pollution sources. Drinking water supply sources are controlled by public health authorities, local authorities and water services companies. The quality of irrigation and drainage waters is checked by river authorities. The control of emergencies leading to contamination of water resources is assigned to emergency response authorities.

At that, there are observed serious difficulties in practical realization of numerous ecosystem monitoring programs in the CA region. One of main reasons is the deficiency of budget financing, lack of laboratories in the region and obsolete material and technical base of available laboratories, turnover of employees. In the region, reduction of the number of water quality parameters by which the control is taken, is observed, the periodicity of samples collection is reduced, as well was the number of hydrometric and hydro-chemical posts and the number of section lines being controlled.

Over the last year the situation with monitoring in CA countries has not changed significantly. Monitoring of the water quality is carried out by different agencies by their own programs that often are not coordinated by sampling sites, analyzed parameters, measuring frequency. While carrying out the control of natural waters quality on the same water reservoirs, each agency applies its own system of standards (fisheries, drinking water

supply, recreation, irrigation water consumption etc.) and assessments (MPC, technical standards). All this complicates the interpretation of monitoring data and calculations about targeted quality of water for the water reservoir. It is expected that in Kazakhstan after passing to ecosystem approaches and introduction of unified system of water quality classification in the water body, these contradictions will be removed.

However, in CA region, the administrative approach is still dominating. At that, this trend towards decreasing of laboratories' capacity is pointed out as very acute (equipment and laboratory basis, personnel, methodologies).

In the majority of CA countries, the monitoring network density is not sufficient for covering important water bodies. An assessment of the impact of pollution sources, providing information about background or etalon conditions of water resources. For implementation of different departmental monitoring programs on the level of countries, significant capital and operational expenses are required. At that, "the quality" of received data is declining because of the insufficient number of samples collection, reduction of the list of test items because of the obsolete material and technical base and of identification methods because of the personnel problems.

Only in Kazakhstan a number of observation points over the surface waters quality are gradually restored. In 2013-2015 hydrochemical monitoring was carried out on 240 section lines located on 105 water bodies, in 2016 - on 392 section lines on 128 water bodies ; in 2017 on 404 section lines on 133 water bodies . The number of parameters to be determined has been increased insignificantly because of insufficient fitting of test laboratories with technical equipment, insufficient human capacity. Since 2017 "Kazhydromet" is carrying out monitoring of organochlorine pesticides in surface waters of transboundary rivers.

The Diagnostic Report has revealed quite a critical situation in CA region regarding monitoring of natural waters quality. The situation as a whole is assessed as unsatisfactory. The main problems are in the following:

- reduction of the density of observation networks as by hydrological observations and also by hydrochemical indicators;
- limitation of monitoring programs as by the spectrum of control parameters and also by the frequency of samples collection;
- using of the physically and morally obsolete means of measuring, processing, storage and distribution of the information about the quality of water resources;
- lack of human capacity and lack of programs for advanced training, training of specialists;
- extremely insufficient volume of financing for carrying out monitoring of water resources quality and supporting of observation networks and laboratories.

1.2.7. Regional cooperation on water quality

Central Asian countries maintain water cooperation, as their living conditions are largely determined by access to transboundary water resources. Currently in the region, the interstate cooperation is focused mainly on distribution of water between the countries, maintain and exploitation of transboundary water infrastructure, general safety of hydrotechnical structures. However, the greatest challenge for CA countries remains to ensure that transboundary waters are used in a reasonable and equitable way, taking into particular account their transboundary character, and all water-dependent ecosystems.

The main problem is the conflict between water consumption for hydro energy and for irrigation needs. Thus, cooperation to a larger extent is focused on division of water resources and their re-distribution. At the same time there is practically no cooperation on the water quality and water related ecosystems[2].

International conventions are the important mechanism for cooperation. At that, each country has its own vision for participation in this or that convention. Therefore, the international law is applied in the CA region still insufficiently and non-uniformly[3]. Regional and bilateral agreements on water resources and environmental protection and participation of countries in interstate coordination bodies – the Executive Committee of International Fund on Saving the Aral See (IFAS), the Interstate Coordination Water Commission (ICWC), and the International Commission on the Sustainable Development (ISDC) are also very important elements of the regional cooperation. In addition, supporting of different water and nature protection projects by foreign donors is currently very important for the region as a whole and for countries in particular.

For development of the regional/interstate cooperation on issues of the transboundary water resources quality in the CA region still significant efforts and development of the purposeful policy is required as on the part of countries and also on the part of the international structure. The demonstrative example of specific development of such cooperation is the cooperation between Kazakhstan and Kyrgyzstan on the basin of rivers Chu (Shu)-Talas. Since 2016 there was established the expert working group on protection of the environment under the Secretariat of the Commission of the Republic of Kazakhstan and Kyrgyz Republic on the use of interstate water facilities on rivers Chu and Talas. The working group included representatives of the number of profile organizations, including those engaged in the monitoring of surface waters quality in both countries. Five working meetings were conducted on issues of the water quality of transboundary rivers, including those with the support of GEF/UNDP/UNECE project “Promotion to the transboundary cooperation and integrated water resources management in basins of Chu(Shu) and Talas rivers. Experts did the joint assessment of the quality of surface waters of the basin. Currently the list of measurable indicators for the further joint collection and analysis of water samples on transboundary watercouces has been agreed.

The priority tasks for joint efforts include harmonization of standards for assessment of surface waters quality; development and introduction of the unified monitoring program; joint collection and analysis of water samples and exchange of the monitoring information.

Despite of the quite developed international legislative framework for cooperation between the countries of the region on water issues, the Diagnostic Report has pointed out that:

- priority and key directions of cooperation between CA countries are issues of water resources distribution, the regime of water reservoirs exploitation and maintenance of the water management infrastructure.

[2]Assessment of the state of transboundary water resources in the UNECE region: assessment and monitoring of the state of transboundary rivers, lakes and underground waters in Central Asia. Materials of the working group on the monitoring and assessment and on the integrated water resources management, ece/MP.WAT/WG.2/2011/4 – ece/MP.WAT/WG1/2011/4

[3] For development of the regional cooperation on assurance of the quality of waters in CA. The diagnostic report and plan on the cooperation development, 2012

- though issues of joint water resources quality were periodically specified in declarations of Heads of states and governments and in agreements, but any scaled joint activities for addressing problems of water resources quality were not undertaken.
- most commitments undertaken by countries on issues of transboundary waters quality, the information exchange and harmonization of normative, technical and information background, for example on the line of ecological monitoring and hydrometeorology on the level of CIS countries by and large were not realized.

As a whole, the Diagnostic Report states that the modern level of regional cooperation in the context of water quality assurance is not efficient enough, though intentions of countries for the further development of these relations on the parity basis is obvious.

After identifying the actual situation on issues of the regional cooperation, assurance of the quality of waters, after determining shortages and difficulties the Diagnostic Report has outlined the main regional level priorities on cooperation of countries of the region in the context of joint water resources quality. These priorities on the first stage suggest the unification (harmonization) of the normative-legal basis for regulation of the water quality, and namely:

- coordinated classifiers of the quality of water resources for basins of transboundary rivers;
- the agreed list of water quality indicators for monitoring of transboundary watercourses and especially dangerous sources of pollution.
- agreed values of maximum admissible concentrations (quality standards) for the region or basins of transboundary rivers;
- unified methods and provision of the equipment (instrumentation) for measuring indicators of the quality transboundary natural waters;
- the agreed methodology on processing of the monitoring information;
- coordinated procedures for the regular exchange of data on the quality of water resources, including criteria and procedures of prompt notification in case of volley contamination of transboundary rivers.

In future it is recommended to focus the regional cooperation on development of regional standards and basin agreements and also on realization of joint projects on rehabilitation and modernization of monitoring networks, joint monitoring of the quality of water bodies , inventory of transboundary sources of pollution, training and retraining of the personnel, formation of regional information system, etc.

The Diagnostic Report is accompanied by the Plan of regional cooperation on assurance of the quality of surface waters in countries of the CA region. This plan is based on three strategic directions:

- regional harmonization of directions on reforming the system of assurance of water resources quality (“conservative” or “dynamic” scenario);
- coordination of activities on development of monitoring of the quality of transboundary watercourses and procedures of the regular data exchange; and
- development of the legal status of regional cooperation in the sphere of regulation of natural waters quality and establishment of the effective regional expert structure.

1.2.8. Relevance of the Diagnostic Report

The Diagnostic Report developed in 2012 is still an actual document deterring main strategic directions on improvement of the cooperation between countries of the CA region in the context of the quality of joint surface water resources. Over the last five years, in the number of countries of the region there were taken certain steps on the national level on improvement of the mechanisms on maintaining the natural waters quality. These changes mainly concerned the redefinition of functions of ministries/agencies responsible for these or those aspects of waters quality management and also for modification of national legislative acts and normative legal documents.

However it should be noted that changes in the institutional and legislative-normative sphere in the number of CA countries that have taken place over the last years not always fully reflect the necessity of implementing complete reforms on issues of water resources quality. Often, while developing new national acts there is used the available customary normative-legal basis without due analysis of its effectiveness in new social and economic conditions, without due consideration of structures of this or that country. Old but customary approaches are used (in particular application of the system of MPC of substances for different water reservoirs.

The following coordinated efforts are needed on the national level for provision of the effective improvement/modernization of the system of the quality of natural water resources management in countries of the region on the basis of IWRM principle. Currently it is recommended to concentrate these efforts on practical aspects of development and introduction of IWRM principles in each country of the region, in particular:

- giving due attention to water resources quality on the national level and linking water quality with quantitative indicators of water resources accessibility for different water consumers;
- reconsidering principles of rating, standardization and classification of the water quality taking into consideration new social and economic realities and their impact on the sustainable development of natural, social and economical environment;
- determining functions of the quality water monitoring as the instrument for target-oriented assessment of water resources conditions and as the basis for taking managerial decisions on reaching desired quality of water bodies ;

On the regional level, the main recommendations of the Diagnostic Report and realization of the regional cooperation plan on assurance of the quality of surface waters are remaining actual to the full extent as no significant changes have taken place in this issue over the last years.

In the next section (Section 2), the regional analysis of monitoring systems carried out currently in five CA countries on transboundary watercourses is presented. This analysis is dedicated to assessment of the need to improve monitoring of water resources quality on the national and regional levels. In this section, assessment of current conditions on different aspects of monitoring of the quality of water resources is given, main reasons of reducing monitoring programs are revealed as well as limitations with which countries are facing at realization of these programs. In this section, concrete and specific recommendations are given which being realized can help countries to restore monitoring networks and expand quality control programs taking into consideration new realities, challenges and current requirements to the monitoring of water resources quality.

[Insert the text]

SECTION 2. SURFACE WATER QUALITY MONITORING SYSTEMS IN CENTRAL ASIA: NEEDS ASSESSMENT

This section presents the summary submitted by national experts on the issue of studying national requirements for improvement of systems of surface water resources quality monitoring. This section covers issues of importance of the information about the quality of surface waters determined by national legislation and mandates of different organizations engaged in the quality monitoring. Here also the review of available observation networks on the quality of surface waters on main transboundary rivers (more than 100 km in length) in the region is given, as well as the expert assessment of needs of systems of surface water resources quality monitoring on the examples of agencies ("Kazhydromet", "Kyrgyzhydromet", "Tajikhydromet", "Uzhydromet", accordingly in Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan and the Ecological Control Service in Turkmenistan) engaged in realization of the control over the quality of water resources. The study includes different aspects of planning, organization and realization of monitoring programs in each counties of the region as well specifics of laboratory management, management of the monitoring data, of information flows and using of the information about the quality of water bodies and international cooperation of hydrometeorogical services in CA.

CHAPTER 2.1: IMPORTANCE OF THE INFORMATION ABOUT SURFACE WATERS QUALITY

The quality and quantity of both surface and also of underground water resources is always interconnected. Exhaustion of water resources, lack and deficit of water are fundamental problems for the life sustenance of the population, for the social and economic well-being of states and for maintenance of due ecological balance of territories. Understanding of the importance of the water quality and of the excess to water resources is aprioristic and this paradigm (model) is widely spread in the Central Asia region.

But water as any other natural resource has also a qualitative aspect. Water of improper cannot be considered as a sustainable resource. In other words, the water of bad quality is equated with the limitedness or even with the lack of the resource. Even having water in sufficient quality, it cannot be used if it is contaminated or it can be used very limitedly with the risk for water users. Moreover, natural water of bad quality poses a threat for water ecosystems, breaks the ecological balance of water reservoirs, causes degradation of the natural component of water bodies that in turn inevitably leads to greater worsening of the quality of water in water reservoirs.

In view of this, the information about the quality of water resources is an important constituent part of the modern society, economics and natural protection in all CA countries. Understanding of the importance of such information is becoming more and more obvious in the region with aggravated water problems. The need for the data about the quality of water bodies, rivers and lakes, about the impact of sources of pollution on qualitative characteristics of water and about acceptability of the quality of water for different types of water consumption is determined on different levels.

Thus for example on the level of institutions and state management structures, the information about the quality of water resources is important for formulation of the state policy in the sphere of water resources, for provision of healthy and safe conditions for the population living, for elaboration of models and schemes of territorial and economical

development of territories, for maintenance of social and economic well-being of the country, for protection of the environment as a whole, for planning of water consumption schemes, for the interstate cooperation.

On the level of economic entities the importance of the information about the quality of water resources being used is determined by the safety and marketability of their products or rendered services, by understanding of the necessity to compensate the society losses/exhaustion of the resource caused by industrial activities and pollution.

On the level of the civil society and the population, the necessity of knowledge about the quality of water is connected with their right for clean and safe environment, qualitative drinking water and safe food products.

The reliable information about the quality of water resources is important for making managerial decisions and for the adequate management of water bodies. First of all it is connected with the need to duly regulate economic activities on water catchment areas and regulation of water consumption. It should be regulated in such a way that the economical development would not cause degradation and exhaustion of natural resources. Managerial decisions should lead to establishment of adequate compensation mechanisms for the use of the water resource and to application of regulation instruments (payment for water, payment for pollution, permission for water consumption, permissible discharge standards and for other negative impacts on water bodies).

The timely and operational information about the quality of water is extremely needed for informing and taking measures in cases of extraordinary, extreme, emergency contamination of water bodies with the purpose to provide safety of both economic activities and also of people's life and health.

Long-term data about the quality of natural waters is important for the scientific society and for state structures engaged in the long-term planning, for the analysis of trends in changing qualitative characteristics of water reservoirs, for development of strategies and plans, for responding to current challenges and threats (climate changes, for example).

The data about the quality of water bodies is needed for the purposes of nature protection, preservation and conservation of valuable biotopes, habitats, ecosystems, rare and endangered species.

Information about the quality of joint water resources is also important in the regional-transboundary context for the development of basin approaches to the management of joint water resources quality, development of coordinated water policy and measures on the international cooperation.

The need in the information about the qualitative characteristics of water bodies in the long view will only increase. The information can be obtained only through the monitoring – systems of the control, assessment and prognosis of the quality of natural environment including observations over the impact of people on this environment.

Currently the existing legislation in all CA countries provides the legal basis for the monitoring of water resources quality. Each country develops its legal framework in the context of providing monitoring based on national needs and specifics. In the majority of cases these are Water Codes, basic ecological and water management legislation, legislation about sub-surface resources, legislation on the sanitary and epidemiological well-being of the population. In the annex 1 the digest of basic laws and sub-law acts is

given that currently form the legal framework for carrying out monitoring of water resources quality on the national level in five countries of the region.

The monitoring of the quality of water in natural water bodies always was an important component of the general management of water resources in all CA countries. Development of systems of water resources quality monitoring in CA countries started in 70-es of the last century with organization of services of observations and control over the environment state on the basis of stations of hydrometeorological services. During this time, CA countries developed their national monitoring systems, gained experience and developed approaches, accumulated data and submitted information. Gradually other agencies (water, environmental protection, sanitary and epidemiological) were also involved into the process of natural waters monitoring. Over the last years, due a number of reasons reflected in Diagnostic Report[4] and in the Section 1 the capacity of national systems of water resources quality monitoring on providing the qualitative and timely information started to decrease.

Nevertheless, as a whole several types of monitoring of water resources quality carried out by different agencies in each of countries can be identified (annex 2)

- Monitoring of the water quality in surface natural water reservoirs (rivers and lakes)
- Monitoring of the impact of contamination sources on the quality of water resources
- Monitoring of the water quality on entrance ranges of water bodies, designed for the utility and drinking water supply.
- Monitoring of the water quality for irrigation
- Monitoring of underground waters quality

In spite of that different types of monitoring are being realized in CA countries, over the last years, as a whole, in the region there is observed decreasing of the effectiveness of the system of control over the qualitative state of water resources. It was revealed at the development and also at actualization (updating) of the Diagnostic Report. The Diagnostic Report especially underlines that the character of monitoring of waters quality currently is unsatisfactory, because in CA countries at present, actually the limited number of water quality indicators is controlled, by reduced monitoring programs, often without observing time limits for samples selection. The monitoring data is not used effectively enough.

Therefore, studying of the current state of monitoring systems in CA countries is crucial for making decisions on reanimation and restoration of national systems of water quality monitoring, as the need in qualitative and adequate monitoring information will only increase. The next chapters show the main needs of the system of monitoring of the quality of surface natural water reservoirs in CA region, revealed on the national and regional levels.

[4] For development of the regional cooperation on provision of the quality of waters in CA, Diagnostic Report and Plan on the cooperation development, 2012

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CHAPTER 2.2: OBSERVATION NETWORKS OVER THE QUALITY OF SURFACE WATERS ON THE MAIN TRANSBOUNDARY RIVERS IN THE REGION

This Chapter covers the analysis of monitoring networks over the water quality of surface transboundary watercourses in the CA region. This material gives a brief information about location of points for monitoring the quality of surface transboundary watercourses and about monitoring programs.

As the hydrographic network of the region is extended, this study was limited only by transboundary watercourses (the criteria – the common length of watercourse is more than 100 km). National monitoring systems have been considered in the context of three main river basins in the region:

- The basin of the river Amudarya, including the main course and transboundary tributaries:
  - Kyzylsu-Vakhsh
  - Kafirnigan
  - Karatag-Surkhandarya
  - Zeravshan
  - Amudarya (the main course)
- The basin of the river Syr-darya, including the main course and transboundary tributaries:
  - Naryn
  - Karadarya
  - Keles
  - Isfara
  - Syr-darya (the main course)
- River system Chu (Shu) – Talas – Asy (Assa)

2.2.1. OBSERVATION NETWORKS OVER THE QUALITY OF SURFACE WATERS IN THE BASIN OF AMUDARYA RIVER

Transboundary river system «Kyzylsu-Vakhsh»

The river system of the Vakhsh River is a large transboundary watercourse between Kyrgyzstan and Tajikistan. It is formed at junction of rivers Kyzylsu and Mukhsu and flows under the name Surkhob; after accepting the river Obihingou from the left side it receives the name Vakhsh. After joining with the river Pyanj on the territory of Tajikistan, the river Amudarya is formed. The total length of the river Vakhsh itself is 786 km, the area of the basin — 39,1 thousand km², the average flow rate — 156 m³/s. In Vakhsh river system the transboundary river is the river Kyzylsu, that originates on the territory of Kyrgyzstan then flows on the territory of Tajikistan until joining with the river Mukhsu forming a watercourse with the length of 235 km. The length of the river on the territory of Kyrgyzstan is 146 km, and on the territory of Tajikistan - 192 km.

The monitoring of the water quality in the river Kyzylsu was not carried out earlier by “Kyrgyzhydromet” on the territory of **Kyrgyzstan** and it is not carrying it out currently.

On the territory of **Tajikistan**, there are 2 point for observation over the water quality.

The first one is located on the river Kyzylsu within boundaries of kishlak Dombrachi, on the border with Kyrgyzstan and is joined with the stream flow measuring station. The point «Tajikhydromet» has been functioning for monitoring the water quality since 1962. Currently it is not functioning because of difficulties with transportation of samples and lack of the local laboratory. There is no data about the water quality for the last five years.

The second observation point of "Tajikhydromet" is located on the water course of the river Vakhsh, on the border with the natural reserve "Tigrovaya Balka" (Palvontugai) in the range of the stream gauge, approximately in 60 km from the place where Vaksh joins to Amudarya. This point was functioning since 1983. Currently it is not functioning to the full extend because of difficulties with transportation of samples and lack of the local laboratory. Whenever possible measurements are done only by temperature regime and by some physical qualities of the water. The periodicity of measurements varies from 1 up to 9 times in a year.

The river Kafirnigan

The river Kafirnigan is the transboundary watercourse between Tajikistan and Uzbekistan with the general length - 387 km. The river originates in Tajikistan and mainly flows on the territory of this country, partially forming a border with Uzbekistan in its mid-stream on the length of 32, 5 km. It joins to Amudarya. Kafirnigan starts on a slope of Hissar, where waters of rivers Sardai-Miyona and Sorbo flow together. The total length - 387 km, the area of the basin — 11, 6 thousand km², the average flow rate — 164 м³/s. The length of the river on the territory of Tajikistan is 387 km, on the territory of Uzbekistan – 32, 5 km. The border with Uzbekistan passes by the river watercourse. The left riverside belongs to Tajikistan and the right one - to Uzbekistan.

The monitoring of the water quality in Kafirnigan river in Tajikistan is carried out by «Tajikhydromet» on one observation point . The observation point is joined with the gauging station Tartki (kishlak Tartki, about 100 km from the place of joining to Amudarya). The check-point of observation over the water quality functioned since 1952 up to 1991. Currently it is not functioning because of difficulties with transportation of samples and lack of the local laboratory, There is no data for the last 5 years.

In Uzbekistan the monitoring over the water quality of Kafirnigan river is not carried out.

Transboundary river system «Karatag-Surkhandarya»

The river Surkhandarya is formed at junction of rivers of Tupalangdarya and Karatag, flowing from the south slope of the Hissar range. It flows into Amudarya. The length of the river Surkhandarya flowing on the territory of Tajikistan is 175 km (from the headstream of the river Karatag — 287 km), the area of the basin -13 500 km². The average flow rate in the mouth of the river is 65,8 м³/s. The transboundary watercourse between Tajikistan and Uzbekistan is the river Karatag, with the length of 112 km.

In Tajikistan, the monitoring of the water quality in the main watercourse of the river Surkhandarya is not carried out. But there are two points of «Tajikhydromet» for observation over the water quality on tributaries which form Surkhandarya river. One of them is located on the tributary Shirkent (the village Asbob, approximately in 30 km of joining to the main watercourse of the river Surkhandarya) and the second one on the tributary Karatag (near kishlak Karatag it is joined with the stream gauge), not far from the

place of joining to Surkhandarya). The point on the river Shirkent is functioning since 1956, and on the river Karatag - since 1964.

Currently because of the lack of the local laboratory the first-day analysis is not done on both points. Temperature and physical parameters of water are analyzed. Since 2003, doing analysis of biogenic elements and of some non-organic microelements has been renewed. Currently because of the lack of chemicals and of the instrumental basis the number of analysis has been reduced. During the last years the number of selected water samples varied from 3 up to 12in a year on each point .

In ***Uzbekistan*** there is one «Uzhydromet» point for observation over the water quality on the main watercourse of the river Surkhandarya, not far from the kishlak Shurchi. The observation point was established for getting information about the water quality upwards of Southsurkhanski water reservoir in the region of the point with organized disposal of wastewaters. Observations are conducted 1938. The section line is joined with the gauging station and the hydrological information has been provided since 1970. As a rule, samples are selected every month, temperature and physical qualities of water are analyzed, as well as oxygen conditions, mineralization and salt conditions, biogens and heavy metals, oil products, SSAS, phenols and organochlorine pesticides.

The river Zeravshan

The river Zeravshan originates in Tajikistan, it stems from Zeravshan glacier in the Koksu joint formed by junction of Turkestan and Zeravshan ranges. The initial section of the watercourse with the length about 200 km is named Matcha. From the left south side it accepts significant tributaries of Fandarya, Kshtut and Mogiendarya. After joining to Mogiendarya, it takes the name Zeravshan. After Penjikent, the river Zeravshan crosses the border with Uzbekistan. The present length of the river — 877 км, and the length up to Karakul oasis, where Zerafshan is divided into river arms is 803 km. The total area of the basin is 41 860 km². The average annual flow of the water measured down the mouth of the river Mogiendarya is 162 m³/s. The length of the river on the territory of Tajikistan is 301 km, on the territory of Uzbekistan - 576 km.

On the territory of **Tajikistan** there is one “Tajikhydromet” point for observation over the water quality, located on the distance of 584 km from the mouth of the river downstream Penjikent. The observation point has been designed for taking control over the water quality in the river on the transboundary section line with Uzbekistan. The observation point functioned since 1979. Currently because of the lack of local laboratory the samples selection is not carried out.

On the territory of **Uzbekistan** the monitoring of the quality of water in the river Zeravshan was not carried out.

The river Amudarya (the main watercourse)

The main watercourse of Amudarya river itself is formed by joining of rivers Pyanj and Vakhsh on the territory of Tajikistan. Amudarya enters the Aral Sea, forming delta of the river. The length of the river is 1415 km, the area of the basin is 309 thousand km² (up to city Atamurat), the average discharge of water near Atamurat is about 2000 m³/s. In the upper and lower stream 3 large right tributaries (Kafirnigan, Surkhandarya, Sherabad) and one left tributary (Kundus) join to Amudarya. Further, up to the Aral sea it doesn’t not

receive any other tributaries. The main runoff of Amudarya is formed on the territory of Tajikistan (80 %) and partially in the north Afghanistan. The river flows along the border of Afghanistan with Uzbekistan, crosses Turkmenistan, again returns to Uzbekistan and then enters the Aral sea. On the territory of Tajikistan the length of the river is about 80 km, on the territory of Uzbekistan – more than 300 km and on the territory of Turkmenistan - about 1000 km.

On the territory of Tajikistan there is one observation point on Amudarya river. The of Tajikhydromet point for observation over the water quality is joined with a stream gauge near kishlak Aivaj, approximately In 20 km upstream the state border with Uzbekistan. The observation point has been joined with the stream flow measuring station, but because of destruction of the hydrometric equipment the measurements of flow rates are not done. The point of observation over the water quality was established since 2013. Currently, because of the lack of local laboratory, selection of water samples and the first data analysis are not done regularly. One-two water samples are selected per year. The limited spectrum of water quality parameters is analyzed – physical qualities and temperature regime, biogens and some metals. The number of analysis during the last years is reduced because of the lack of chemicals and of the instrumental basis.

In ***Turkmenistan*** the control over the water quality in the main course of Amudarya river is carried out by the Ecological Control Service of the State Committee on the Environmental Protection and Land Resources. The National Hydrometeorology Committee "Turkmenhydromet" carries out only direct measurements of the flow rate on the river. The control over the water quality in the main course of the river is done on 3 monitoring points. The monitoring program has been unified: physical and chemical parameters of water, temperature conditions, oxygen conditions and the level of general organic contamination, mineralization and contents of salt and biogenic elements are analyzed. On some observation points oil products and SSAS are analyzed. Heavy metals and non-organic micro pollutant (pesticides) are not analyzed because of the lack of necessary materials and of the instrumental basis.

The first control section line is located in Kerki. The observation point was organized in 1952 for studying the global river flow and contamination from agricultural fields. It is joined with the stream gauge. From 4 up to 7 water samples are selected per year. Up to 2013, the pesticides were also included into the analysis, but now they are not analyzed. The second observation point is located near the town Darganata and it is located on the distance of 640 km upstream the mouth of the river. The observation point was established in 1975. It is joined with the stream gauge. The type of monitoring station - identification of multiyear tendencies. Over the last years from 3 to 5 water samples are selected. Analysis of pesticides in the water is done. The third point of monitoring the water quality is located near the town Lebal (519 km upstream of the river mouth). It is functioning since 1986 as a transboundary observation point. It is joined with the stream gauge. During the last years 3-7 water samples per year are selected. The presence of pesticides in the water is analyzed.

In **Uzbekistan** there are 3 point of observation over the quality of water in the river Amudarya. The quality control is done by "Uzhydromet". The first observation point is located downstream the dam of Tuyamuyun water storage basin and downstream the town Druzhba and is joined with the stream gauge. Observations are done since 1953. During the last years the number of selected samples on this observation point varied

from 3 to 6 samples. The second observation point is located near the town Kipchak and in 175 km downstream the dam of Tuyamuyun water storage basin for receiving the hydrochemical information about the quality of water in the zone of irrigated arable farming. It is functioning since 1977 and it is joined with the stream gauge. During the last years from 6 to 10 samples are selected per year. The third observation point was organized in 1974 as a transboundary point within boundaries of the town Termez and 2,5 km downstream the mouth of the river Surkhandarya, It is joined with the stream gauge. Every year from 10 up to 12 water samples are selected. On all 3 observation point the unified program of observation is carried out, including taking control over the temperature and physical qualities of water, oxygen conditions, mineralization and salt composition, biogens and heavy metals, oil products, SSAS, phenols and organochlorine pesticides.

2.2.2. OBSERVATION NETWORKS OVER THE QUALITY OF SURFACE WATERS IN THE BASIN OF SYR-DARYA RIVER

Naryn river

The river Naryn is an important transboundary watercourse. The river originates on the territory of Kyrgyzstan and is formed by joining of rivers Large Naryn and Small Naryn, stemming from glaciers of the Central Tyan-Shan. It flows on the territory of Kyrgyzstan and then on the territory of Uzbekistan. After joining with the river Karadarya it forms the river Syrdarya. The length of the river Naryn is 877km, the area of river basin is 59.9 thousand km. The average flow rate upstream the town Uchkurgan - 480 м³/s. The length of the river on the territory of Kyrgyzstan is 535 km, on the territory of Uzbekistan – 272 km.

In Kyrgyzstan up to 1992 the monitoring of the water quality in river Naryn was carried out by “Kyrgyzhydromet”. Currently because of the insufficient budget financing, observations over the water quality on this watercourse are not carried out.

In Uzbekistan there is one observation point of “Uzhydromet” in the mainstream station (outfall of the river) near kishlak Shamsikul. It is functioning since 1984. 5-8 water samples are selected in a year. Analysis are done by the standard scheme of “Uzhydromet” – temperature and physical properties of water, oxygen conditions, mineralization and salt composition, heavy metals, oil products, SSAS , phenols. Analysis of pesticides presence in the water is not done.

Karadarya river

The Karadarya river with the overall length of 180 km (together with the left component of Tar - 318 km) is a transboundary watercourse between Kyrgyzstan and Uzbekistan. Karadarya river is formed by joining of rivers Tar and Kara-Kulja, which stem from the south-eastern slope of Fergana mountain range and from the north slope of Alai mountain range in Kyrgyzstan. The area of the basin is 30 100 km². The average annual flow rate near the community Uchtepa - 136 m³/s. The river Karadarya in its upstream flows on the territory of Kyrgyzstan, comes out to Fergana valley and passes to the territory of Uzbekistan. It joins with Naryn river, forming Syr-darya river.

In **Kyrgyzstan** up to 1992 the monitoring of the water quality in the river Karadarya was done mby “Kyrgyzhydromet”. Currently observations over the water quality in Kyrgyzstan by this watercourse are not done.
In Uzbekistan since 1974 an observation point of Uzhydromet is functioning. It is located downstream the kishlak Saray on the distance of 59 km to the mouth of the river Karadarya. The observation point was organized for receiving information about the water quality in the area of the discharge of waste waters of industrial enterprises in the town Andijan, Selection of water samples is done every month. Here are analyzed temperature and physical qualities of water, oxygen conditions, mineralization and salt composition, biogens and heavy metals, oil products, SSAS and phenols.

The river Keles

The river Keles is a transboundary river between Kazakhstan and Uzbekistan. The length of the river is 241 km, the area of water basin is 3310 km². The flow rate in the mouth of the river is - 6,5 m³/s. The river originates on the mountain range Karjantau. Near kishlak Kaplanbek the river Keles comes out to the state border between Kazakhstan and Uzbekistan. Further the border partially passes by its watercourse. Then the river Keles again passes to the territory of Kazakhstan lands an joins to the Syrdarya river. The length of the river on the territory Kazakhstan is 102 km, on the territory of Uzbekistana - 139 km.

There is one observation point over the water quality on the territory of ***Kazakhstan.*** The observation point was organized on the gauging station Keles on the distance of 1,2 km from the place of joining of the river Keles to the main watercourse of Syrdarya river, The monitoring is carried out by “Kazhydromet” (its branch office on the south of Kazakhstan province). Hydrological observations are carried out since 1970. It is functioning up to present. Up to 12 samples are selected per year for analyzing the large spectrum of water quality, except for organic micro pollutants (pesticides).

In ***Uzbekistan*** the monitoring of the water quality in Keles river is not done.

Isfara river

Isfara river a transboundary watercourse with the length of 107 km. Three countries are located in the basin of this river – Kyrgyzstan, Tajikistan and Uzbekistan. The area of the basin is 3240 km². The river named Ak-Suu originates in Kyrgyzstan (near the border with Tajikistan) from the glacier Ak-Suu on the north slope of Turkestan mountain range. On the state border it joins with the river Kshemish (Kshemish-Say) and further it is named Isfara.

Monitoring of the water quality in ***Kyrgyzstan*** and ***Uzbekistan*** was not carried out.

On the territory of Tajikistan there is one observation point over the water quality. Observations are done on the stream gauge Tash-Kurgan (500 m downstream of kishlak Voruh), approximately on the distance of 6 km upstream the watercourse from the state border with Kyrgyzstan. The observation point of “Tajikhydromet” was established in 1926 for observation over the hydrological regime, observation over the water level, measuring the water temperature, measuring the flow rate, measuring solid discharges and taking samples for determining water silt content, taking samples for chemical analysis. The transboundary water distribution is carried out based on the data received on this station. The water sample is complex, two sub-samples are selected from the right and the left bank, from the surface. Then the general mixed sample is prepared which is then delivered

to the laboratory for doing analysis. Selection of samples (12 samples per year) for the chemical analysis was renewed in 2015. There are analyzed physical qualities of water, temperature, oxygenic regime, acidification regime and general organic contamination, salt composition, biogens and some non-organic microelements (metals).

Syr-darya river (the main course)

It is formed by junction of rivers Naryn and Karadarya in the eastern part of Fergana valley. The length of the river - 2212 km, the area of the Syr-darya basin - 219 000 km², the average flow rate — 703 m³/s. Previously Syr-darya fell into the Aral sea, but now, because of the catastrophic recession of its level and breakup of the sea into 2 parts (in 1989), the river falls into the northern part of the sea (so-called “Small sea”). It flows on the territory of Uzbekistan, Tajikistan and Kazakhstan.

The monitoring of the water quality on the main course of Syr-darya river on the territory of Tajikistan is done by «Tajikhydromet» on two observation points.

The first observation point is located approximately in 10 km upstream of the river flow from the state border with the Republic of Uzbekistan and is joined with the stream gauge Kzyilkishlak (the village Kzyilkishlak). The observation point was organized in 1953 for doing hydrometric measurements (hydrological regime, water level, measuring the water temperature, measuring the flow rate, measuring solid discharges and taking samples for identifying water silt content, taking samples for the chemical analysis). The water sample is complex, 2 subsamples are selected from the right and left bank from the surface. Then on the spot the general mixed sample is prepared and then delivered to the laboratory for analysis. Physical properties of the water, temperature, oxygenic regime and the general organic contamination, acidification conditions, salt content and biogens are analyzed. Up to 1990 analysis of non-organic microelements was done, but now these parameters are not studied because of lack of the instrumental basis. Selection of samples is done every month.

The second observation point over the water quality is located on the stream gauge Akjar near the village Kalam, approximately on the distance of 149 km upstream the water course from the state border with Uzbekistan. This observation point is transboundary because the state border between Tajikistan and Uzbekistan runs by the watercourse of the river. The right bank of the river belongs to Tajikistan and the left bank - to Uzbekistan. The observation point is functioning since 1953. The water sample is complex, 2 sub samples are taken from the right and the left bank from the surface, then on the spot the general mixed sample is prepared and then delivered to the laboratory for doing analysis. There are analyzed physical qualities of water, temperature, oxygenic regime and general organic contamination, salt composition, biogens and some non-organic microelements (metals). Selection of samples is done on the monthly basis.

On the territory of Kazakhstan there are points for observation over the water quality. Monitoring is done by “Kazhydromet” (branch office for the South-Kazakhstan region). The observation point over the water quality is joined with the stream gauge Kokbulak on the border with Uzbekistan. Observations are done since 1987. It is functioning till present. In water samples the wide spectrum of parameters is analyzed, including organoleptical and physical-chemical qualities, mineralization and main ions, biogens and metals, toxic and poisonous substances, organic pollutants. Since 2017 once a year in August water samples for pesticides analysis are sent to the laboratory of the branch office on the North-

Kazakhstan region. Radionuclides and microelements are analyzed in the institute of Nuclear Physics under the Ministry of Energy. 14 water samples are selected per year.

The second section line for observation of the water quality is located near the town Shardara, 2 km downstream the dam of the water storage basin Shardara in the section line of the water gauging station. This water reservoir regulates the outflow of the river Syr-darya and is located near the state border with Uzbekistan.

In ***Uzbekistan*** two «Uzhydromet» points for the water quality control on the main course of the river are functioning. The first one is located upstream of the town Bekabad, and downstream of the mouth of the river Shirinsay. The observation point was organized in 1937 for receiving the hydrochemical information about the water quality in the region of Bekabad city with the organized discharge of wastewaters. It provides the hydrological information since 1948. The second observation point is located downstream of the mouth of the drainage collector ГПК-С for taking control over the impact of drainage irrigation waters on the quality of water in the receiving watercourse. It is joined with the gauging station of the Ministry of Agriculture and Water Resources. 12 water samples in a year are selected on each of points. Temperature and physical qualities of water, oxygenic conditions, mineralization and salt composition, biogens, heavy metals, oil products, SSAS , phenols and organochlorine pesticides are analyzed.

2.2.3. OBSERVATION NETWORKS OVER THE QUALITY OF SURFACE WATERS IN THE BASIN OF THE RIVER SYSTEM CHU(SHU) – TALAS – ASI(ASSA)

Chu (Shu) river

The river Chu (Shu) originates in glaciers of Teskey-Ala-Too and Kyrgyz mountain range. In the beginning the river flows on mountainous regions of Kyrgyzstan, further it flows on Chui valley and forms a border between Kyrgyzstan and Kazakhstan and finally is gets lost in sands of Moyinkum desert in the South Kazakhstan. The length of the river - 1186 km. The area of the basin watershed - 67 500 km². The average annual flow rate at the time of outflow from mountains – about 130 m³/s. The length of the river on the territory of Kyrgyzstan – 386 km, on the territory of Kazakhstan – 800 km.

On the territory of Kyrgyzstan there are 9 observation points located by the main watercourse of the river Chu. The control over the water quality is carried out by “Kyrgyzhydromet”. The monitoring program on all monitoring points is unified. Organoleptical and physical qualities of the water, temperature and oxygenic conditions, general organic contamination, mineralization and salt content, biogens, contamination substances of non-organic origin are analyzed.

Up to 2016 the monitoring program included salts of heavy metals, oil products, phenols and SSAS. Currently they are not controlled because of the lack of the instrumental basis and obsolete methodologies. Organic micro pollutants (pesticides, polyaromatics) are not analyzed because of the lack of instrumental basis. Selection of water samples is done in accordance with observation program 4 times a year, taking into consideration hydrological phases.

The first observation point is located near the Burulday bridge, approximately on the distance of 1079 km from the river mouth. The point was opened in 2008 for determining

the background state of the water quality of the river Chu on the territory not exposed to direct anthropogenic impact.

The second and third monitoring points are located upstream and downstream of the town Tokmak for monitoring the impact of the organized discharge of waste waters from the town. Both points are functioning since 1966.

The fourth and fifth points for monitoring the quality of water have been established near the village Mylianfan, upstream and downstream of the drainage collector entrance for monitoring the organized discharge of waste waters of the Kant industrial hub. Both points are functioning since 1966. Up to 1992 the section line was joined with the stream gauge, but there is no stream gauge now.

The sixth and seventh points for the water quality monitoring have been designed for keeping track of the impact of organized discharge of waste waters from treatment facilities in Bishkek city on the quality of water. Points for the monitoring of the water quality have been located upstream and downstream of the place of discharge of waste waters from canalization system of Bishkek city. They have been functioning since 1966.

The eighth and ninth points are interconnected with the place of waste waters discharge of Novotroitsk collector. The points have been located downstream and upstream of the place of waste waters discharge near the village Nizhne-Chuisk. They have been functioning since 1966. Up to 1992 the section line downstream the village was joined with the hydrological post, but now the hydrological post is not functioning.

On the territory of ***Kazakhstan*** the control over the quality of water in the river Shu is carried out by «Kazhydromet» branch office of Zhambyl province. The transboundary with Kyrgyzstan observation point for monitoring of the water quality in the river was organized near the village Blagoveshenskoye (Kainar) – on the distance of 846 km from the mouth of the river. The hydrological measurements are done. Observations have been done since 1981. It has been functioning up to present. During the last 5 years up to 6 samples are selected per year.

The river Talas

Talas is the river flowing on the territory of Kyrgyzstan and Kazakhstan. The length of the river — 661 km, the area of its drainage basin — 52 700 km². It originates from glaciers of the Talas mountain range on the territory of Kyrgyzstan. In the lower course the river is lost in Moyinkum sands. On the territory of Kyrgyzstan the length of the river is about 200 km, on the territory of Kazakhstan – more than 450 km.

Since 1992, the monitoring of the water quality in ***Kyrgyzstan*** is not carried out on the regular basis because of limited budget financial capacity.

In ***Kazakhstan*** the transboundary (with Kyrgyzstan) point for monitoring the water quality in the river was established near the village Zhasorken (458 km from the mouth of the river).Hydrological measurements are done. Observations are done since 2008. The point for monitoring of the water quality of «Kazhydromet» branch office in Zhambil province has been functioning till present. During the last 5 years up to 36 samples are selected in a year.

The river Asy (Assa)

The river Asy (Assa) belongs to the class of transboundary rivers of Central Asia. It is formed by the confluence of rivers Teris (Ters) и Kurkireusu (Kukureusu) on the border of Kyrgyzstan and Kazakhstan. It is considered to be the left tributary of the river Talas, though the mouth of the river is lost in sands westward of the river Talas. The water drainage area is about 9 thousand km². The average annual flow rate (near the aul Akkol) is 4,45 m³/s.

Monitoring of the water quality is not done in ***Kyrgyzstan.***

On the territory of ***Kazakhstan*** the transboundary with Kyrgyzstan point for monitoring of the quality of water in the river, has been organized near the railway station Maymak (on the distance of 254 km from mouth of the river). The observation point of «Kazhydromet» branch office on Zhambyil province is designed for getting information about the water in the area of irrigated farming. Hydrological measurements are done. Observations have been conducted since 2008. It is functioning until present. During the last five years up to 12 samples per year are selected.

2.2.4. ANALYSIS OF MONITORING NETWORKS ON TRANSBOUNDARY WATER COURSES

Here the brief analysis of monitoring networks on basic transboundary rivers in CA region is given. The table 1 provides the summary information about points for monitoring of the water quality.

Table 1. Observation points on transboundary water courses in the region of Central Asia

Transboundary water course	Countries	The number of points for the water quality monitoring	Points per the river kilometer, km	From them, the active ones (the number of samples per year, 2012-2016)
The basin of the river Amudariya				
Kyzylsu-Vahsh	Kyrgyzstan	0	117	-
	Tajikistan	2		1 (1-9)
Kafirnigan	Tajikistan	1	387	0
	Uzbekistan	0		-
Karatag-Surkhandarya	Tajikistan	1	144	1 (3-12)
	Uzbekistan	1		1 (11-12)
Zeravshan	Tajikistan	1	877	0
	Uzbekistan	0		-
Amudariya (the main course)	Tajikistan	1	202	1 (1-2)
	Uzbekistan	3		3 (3-12)
	Turkmenistan	3		2 (4)
The basin of the river Syrdariya				
Naryn	Kyrgyzstan	0	807	-
	Uzbekistan	1		1 (5-8)
Karadarya	Kyrgyzstan	0	180	-
	Uzbekistan	1		1 (12)
Keles	Kazakhstan	1	241	1 (12)
	Uzbekistan	0		-
Isfara	Kyrgyzstan	0	107	-
	Tajikistan	1		1 (12)
	Uzbekistan	0		-

Transboundary water course	Countries	The number of points for the water quality monitoring	Points per the river kilometer, km	From them, the active ones (the number of samples per year, 2012-2016)
Syrdariya (the main course)	Uzbekistan	2	442	2 (12)
	Tajikistan	2		2 (12)
	Kazakhstan	1		1 (14)
The basin of the river Chu-Talas-Asy				
Chu (Shu)	Kyrgyzstan	9	119	9 (4)
	Kazakhstan	1		1 (36)
Talas	Kyrgyzstan	0	661	-
	Kazakhstan	1		1 (36)
Asy (Assa)	Kyrgyzstan	0	253	-
	Kazakhstan	1		1 (12)

As it is seen from the table, all main transboundary watercourses in the CA region are studied for the water quality. But as a rule (on 9 from 13 transboundary watercourses) the control of the water quality in the watercourse is carried out only by one of bordering countries, while another country (countries) don't have the necessary information about the water quality, because the monitoring is not carried out on their territory. We can speak about the transboundary character of monitoring in the region of CA only on four rivers (Karatag-Surkhandarya, Amudariya, Syrdariya and Chu (Shu)), were monitoring is carried out in all countries of the river basin.

As a whole it is typical for the region that there is not much observation points for monitoring of the quality of transboundary rivers. On the majority of rivers one observation point falls per 200-800 km of river course.

Moreover, the periodicity of taking water samples depends on possibilities of this or that country to implement national monitoring programs and it varies very significantly. Not all observation points in the region can be determined as effective, because some of them provide information fragmentarily, with the low periodicity and by the limited spectrum of quality parameters.

Further a brief summarized analysis on CA countries in the context of monitoring of transboundary watercourses is given.

In ***Kazakhstan*** all basic transboundary water courses are covered by monitoring that is carried out by 2 province branch offices of «Kazhydromet» by Jambyl and South Kazakhstan province. There is at least 1 point for the water quality monitoring on each of rivers. All points are active, every year prom 12 up to 36 samples are selected on them. The wide spectrum of contaminants and quality parameters is analyzed, including organoleptic and physical and chemical qualities, mineralization and main ions, biogens and metals, toxic and poisonous substances, organic contaminants by the standardized scheme. On some points pesticides are studied (once a year), as well radionuclides and micro-macro elements in water (2 times a year).

Apart from «Kazhydromet», the monitoring of surface waters quality in the region is carried out by territorial Jambyl and South Kazakhstan province subdivisions of the Committee of Ecological Regulation and Control under the Ministry of Energy. This agency does selection and analysis of water samples as and when necessary (in accordance with the internal plan

of territorial subdivisions, in case of occurrence of high and extremely high contaminations in surface waters they carry out selection of water samples jointly with concerned state authorities in the sphere of environmental protection).

In addition, the Sanitary and Epidemiological Service of the Ministry of Health carries out monitoring on objects of centralized and non-centralized systems of drinking, utility and drinking water supply and in places if cultural and domestic water consumption. The epidemiological safety of drinking water is determined by compliance with microbiological and parasitological indicators of the drinking water quality. On the basis of the carried out analysis the sanitary and epidemiological characteristics of the concrete water supply source by microbiological indicators and by the chemical composition is prepared.

In ***Kyrgyzstan*** the monitoring of the water quality is carried out by «Kyrgyzhydromet» only in the basin of the river Chu. On this transboundary watercourse and its basin there is available a well-planned and developed network of observation points, that is functioning mainly since 1966. All posts are active, selection of samples is done on the quarterly basis. At the same time other transboundary rivers are not covered by the quality monitoring due to different reasons. One of reasons is the lack of the laboratory in Osh that previously supplemented the research program of the central laboratory in Bishkek. The analytical programs on all posts have been unified. There are analyzed organoleptic and physical qualities of water, temperature and oxygenic conditions, the general organic contamination, mineralization and salt content, biogens. Because of the lack of instrumental basis such important parameters as metals, oil products, phenols, SSAS and pesticides are not included into the monitoring program. The building of the laboratory in Bishkek city is not in good technical conditions and construction of a new building is needed.

Apart from «Kyrgyzhydromet», the monitoring on the river Chu is carried out by the State Agency of Protection of Environment and Forestry (SAEPF) on 6 section lines by 17 indicators including heavy metals. The SAEPF program is aimed on monitoring of the impact of contamination sources on the quality of water resources, but currently it is carried out only on the river Chu.

In addition, the Department of diseases prevention and of the State sanitary and epidemiological inspectorate of the Ministry of Health keeps control over the quality of water on drinking water intake structures.

In ***Tajikistan*** all basic transboundary watercourses are covered by the «Tajikhydromet» system of the water quality control. Its structure includes 3 laboratories in Dushanbe, Kairakkum and Kurgan-Tube (the latter is not working because of the lack of instruments and specialists). The laboratory of monitoring of surface waters and of the radiation level is located in Dushanbe (the central laboratory). Itse building was constructed in 30-s of the last century and it is in a dilapidated condition. The laboratory in Kairakkum serves the basin of Syrdariya river and determines the water quality by 23 parameters. There are difficulties with instruments and with the laboratory equipment. The instruments and equipment currently available have mainly depleted their resources. There are no spare parts for their restoration and repairs. Because of insufficient funds the new equipment is not delivered and purchased.

Because of the listed above limitations, over the last years, the intensity of observations on the majority of transboundary rivers has reduced and on some rivers observations are not

carried out. Thus, from 9 observation points only 6 were more or less active during the last years. At that, on some posts 1-3 samples are selected every that is obviously insufficient for receiving the reliable information about the watercourse quality. Among others complexities are caused by difficulties with transportation of samples and the lack of regional laboratories. The list of analyzed parameters also differs very much on different control posts. On remote posts the first day analysis is not done and as a whole the observation program is quite limited (temperature, some physical qualities of water). On some points physical qualities of water, temperature, oxygenic regime and general organic contamination, acidification conditions, the salt content (salinity), biogens are analyzed. Laboratories have difficulties because of the lack of modern laboratory basis, chemical reagents, qualified personnel.

Apart from «Tajikhydromet», the control of safety parameters of drinking water and monitoring of the water quality in centralized and non-centralized water supply systems is carried out by the State Sanitary and Epidemiological Inspectorate. Laboratories in Dushanbe, Khujand, Kurgan-Tube, Kulyab and GBAO periodically do analysis of drinking water samples and of the water for swimming in basins with determination of physical and chemical, virusological ad bacteriological indicators. Because of the financial and personnel problems, not more than 60% of control objects are covered.

In ***Turkmenistan***, on the main transboundary watercourse – Amudariya river, three monitoring posts provide information about the water quality. The monitoring is carried out by the Ecological Control Service of the State Committee on Protection of the Environment and Land Resources, because «Turkmenhydromet» does only hydrological measurements. The monitoring program is unified. Physical and chemical parameters of water, temperature conditions, oxygenic conditions and general organic contamination, mineralization and salt content, biogenic elements are analyzed. On some posts oil products and SSAS are analyzed. Because of the lack of necessary material and of the instrumental basis heavy metals and non-organic micro contaminants are not analyzed.

In ***Uzbekistan*** the monitoring of the quality of water in main transboundary rivers is carried out by the Centre of hydrometeorological service under the Ministry of Emergency - «Uzhydromet». Currently, not all large transboundary watercourses are covered by the monitoring network. From 8 observation points on transboundary rivers 3 posts have been established on the river Amudariya and 2 posts - on the Syr-darya. Water samples are selected as scheduled and their number depends on the category of this or that observation point. Water samples are analyzed by standardized list of quality parameters, including temperature and physical qualities of water, oxygenic conditions, mineralization and salt content, biogens and heavy metals, oil products, SSAS, phenols. On some points, also organochlorine pesticides are studied.

CHAPTER 2.3. ASSESMENT OF NEEDS OF SYSTEMS OF WATER RESOURCES QUALITY MONITORING

The purpose of this chapter is to clarify the current situation on different aspects of f surface waters quality monitoring, revealing difficulties, problems, limitations and determining needs in the improvement. This study covers basic aspects of surface waters quality monitoring in CA countries, including:

- planning of monitoring programs;
- monitored indicators of the water quality;
- procedures of selection, conservation and transportation of samples;
- assessment of the quality of waters and their classification;
- capacity of laboratories (instrumental, methodological, personnel);
- the system of storage and processing of data, analysis and distribution of the information;
- procedure of the control and quality assurance, accreditation of laboratories;
- using information about the quality of surface waters in making decisions on water resources management;
- hydrobiological monitoring and control over pollution of bedload sediments.

In this chapter the emphasis was placed on hydrometeorological services of Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, engaged in primary monitoring of water resources quality in their own countries and on transboundary rivers. As in Turkmenistan the hydrometeorological service carries out only hydrological monitoring and is not engaged in issues of surface waters quality, then studying the needs for this country concerned nvironmental Control Service (ECS) of the State Committee on the Protection of the Environment and Land Resources.

In addition to the analysis of problems, bottlenecks, complications and recommendations on different issues of monitoring of water resources quality set forth in national reports, this chapter provides the summarized analysis of bottlenecks typical for the region. Here also recommendations of a regional midterm character on overcoming these bottlenecks are given.

2.3.1. MONITORING PROGRAMS (PLANNING)

Current situation:
Development of monitoring program is the most important element of activities of organizations and agencies engaged in monitoring of water resources quality. Approved monitoring programs are the basis for carrying out studies on the quality of water resources. In the system of hydrometeorological services in CA countries, a certain and quite similar practice of planning observations over the quality of surface water resources has been established.

Monitoring programs are developed directly by departments responsible for carrying out such monitoring. After that, the program is submitted to higher instances for approval. Thus in Kazakhstan, the program is approved by the governing body of «Kazhydromet» after coordination with the supervising Department of Environmental Monitoring and Information of the Ministry of Energy; in Kyrgyzstan the monitoring program is approved by the Chief of the «Kyrgyzhydromet» Department of observations over contamination of the natural environment; in Tajikistan – by the Director of the Agency on Hydrometeorology, in

Turkmenistan – by the State Committee on Protection of the Environment and Land Resources.

The current practice shows that monitoring programs as a rule are developed and approved within one agency. It is typical not only for hydrometeorological services, but also for other agencies (ecological, sanitary-epidemiological, aquicultural) that carry out monitoring of the water quality by their own departmental programs. Currently such situation is defined by the national legislation of CA countries. This legislation does not stipulate the obvious need for the interdepartmental coordination. At the same time in Uzbekistan there has been established and is functioning the system of the State monitoring of the environment and the draft of the monitoring program is coordinated with all Ministries engaged in its implementation.

Monitoring programs of hydrometeorological services are developed as a rule for one year (Kazakhstan, Tajikistan, Turkmenistan). In Kyrgyzstan and Uzbekistan programs on monitoring of surface waters quality are oriented for the midterm period – for 5 years with possible corrections on the annual basis. It should be noted that the time interval for planning the water resources monitoring is a very important parameter. The international experience shows that planning of the state monitoring network should be realized on the midterm perspective correlated with water bodies management plans. Thus, for example, in countries of Euro Union the plan period is determined for 6 years - the period defined by the law for realization of the basin management plan.

Monitoring programs in all CA countries as a whole are built on identical principles, though at planning different normative documents are used:

- Thus, in Kazakhstan both soviet standards are used (GOST /State All-Union standard/) 17.1.3.07-82 «Nature protection. Hydrosphere. Rules of monitoring of the water quality in water reservoirs and water courses»; GOST 17.1.1.02-77 «Water bodies classification»), and also national documents («Methodical instructions on organization and functioning of the subsystem on monitoring transboundary surface waters state in Kazakhstan»; «Environmental monitoring rules», «Methodical recommendations on carrying out complex examinations and assessment of natural environment contamination in districts exposed to the intensive anthropogenic impact», ПР of the RK 52.5.06-03.).
- In Kyrgyzstan principles of monitoring programs planning are based on regulations РД 52.24.309-92 «Methodical instructions. Nature protection. Hydrosphere. Organization and carrying out regime observation over contamination of onnshore ground waters on the network» and on the GOST regulations 17.1.3.07-82 «Nature protection. Hydrosphere. Rules of monitoring of the water quality in water reservoirs and water courses».
- In Tajikistan – on the document «Instruction to hydrometeostations and posts, issue 6, part 1».

Despite of that at planning of monitoring programs in CA countries different normative and legal acts are used, it should be specially noted that the normative base that currently serves as a basis for planning monitoring in CA countries, is mainly based on soviet standards established 25-35 ago. As a rule, a principle of “categorization” of observation postts (4 categories) and observation programs (full or shortened) is used.

Despite of that the experience of previous years is certainly taken into account at development of new plans of state monitoring systems, as a whole monitoring programs remain quite conservative, based on previous programs or are developed “by inertia”, and not “proactively”. As a rule, the program is developed on the basis of previous programs with the purpose to preserve a number of observations and more rarely - with consideration of emerging realities.

Monitoring programs in CA countries as a rule include the following standard information – purposes of monitoring, periodicity of observations, hydrochemical posts, list of parameters to be measured and analyzed, the time for selection of samples, the place of samples selection, analysis methods. At the same time, such needs of monitoring systems, like regular procedures of the quality control and provision of the data quality, as well as scheduled calibration, changeover and modernization of the equipment, conducting intercalibration and comparative tests, regular renewal of reagents, standards, expendable materials with expired period of validity, changing of the analytical determination method, carrying out scheduled training of the personnel and advanced training of employees, introduction of new software for processing and interpretation of data, accreditation of laboratories and methods, etc., are not included into the monitoring programs or are taken into account with few exceptions.

These articles of expenditure are usually included into the departmental yearly plans and are requested whenever necessary also by other budget lines, but as a rule remain underfinanced or are simply ignored because of the lack of financial resources, allocated to hydrometeorogical services. As a result, the quality of information by spectrum of parameters being analyzed and by periodicity of researches about the hydrochemical state of water resources, delivered by hydrometeorogical services, is falling off, the instrumentation pool is physically worn down and becomes morally obsolete. New methods of analytical control are not introduced, laboratories cannot purchase necessary components and new program products are not duly introduced.

As a whole, monitoring programs of hydrometeorological services in countries of the CA region are developed by the principle “as possible” and not by the principle “as necessary”. «Kazhydromet” can be an exclusion. It has 15 branch offices in each of provinces and also in Almaty and Astana cities. At present «Kazhydromet» has 307 hydrological posts, where water samples for the chemical analysis are selected, calculations of the water balance for river and lakes are done and in laboratory conditions hydrochemical analysis for more than 17 types of contaminating elements are done. Of course, it does not mean that the system of monitoring planning in this country does not require improvement, but as a whole, it looks like the most successful.

To some extent this situation is also good in Uzbekistan, where the monitoring program includes 53 parameters of the water quality and currently 84 posts for the water quality monitoring are functioning (from 134 points that were functioning before).

In remaining national hydrometeorological services of CA countries significant changes and adequate financing is required for programs of water resources quality monitoring.

Thus, for example, in Kyrgyzstan the “Kyrgyzhydromet” monitoring program covers only basin of the river Chu (23 section lines, 3 of them are located on the main river course, 27 indicators are analyzed). On other watercourses, including those of the international

importance, the quality control is not carried out because of the insufficient financing. Previously, up to 1992 in this country observations over the surface waters quality were carried out on 54 water bodies (80 posts), among others - on transboundary rivers Naryn, Karadarya, Chu, Talas. Thirty eight parameters were analyzed.

In Tajikistan, currently even approved monitoring programs of «Tajikhydromet» in fact are being implemented only by 40-50%. Previously in the country, 92 posts for samples selection were functioning and the research program covered 41 parameters of the water quality.

In Turkmenistan, the situation is much the same and the program of ECS activities is not realized to the full extend, because of the general underfinancing of services engaged in monitoring of water bodies quality.

As a whole, the national experts have assessed the situation in the context of development of programs on monitoring of water resources quality (planning of monitoring) in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
No significant changes are required	Improvement is required	Improvement is required	Significant improvement or full reconsideration is required	Improvement is required

Analysis and determination of basic need for improvement of the situation:

The sphere where improvements are required	Explication
Preominating of the departmental approach in planning systems of observation over the quality of natural resources; lack of the due coordination between agencies	In CA countries, to this or that extent in the water resources management the IWRM principles are applied, but in the context of planning the monitoring of surface waters quality they are not still duly applied in practice. Partially it is related to that targets and objectives of water resources quality monitoring carried out by hydrometeorological services, in the national legislation in regulations of such services are determined only in general terms. With the lack of specific plans and objectives of management of water bodies quality, water resources region and river basins, it is difficult to expect the adapted planning of monitoring systems oriented at concrete targets – for example, for confirmation/establishment of the target class of water reservoir quality or monitoring of the effectiveness of applied measures on reaching target objectives on the quality of this or that water reservoir. It is possible to overcome departmental barriers only with the major review of national water policies. More clear and concrete tasks should be assigned to agencies in the context of water resources quality monitoring.
Underfinancing of works on carrying out monitoring of water resources quality.	General funding shortages of monitoring programs in the number of CA countries (Kyrgyzstan, Tajikistan, Turkmenistan) is currently the main factor constraining the adequate planning of monitoring programs and receiving solid and reliable data about the quality of surface water bodies.
Related conditions for carrying out monitoring are considered as marginal tasks and are not a part of the process of providing effectiveness of efforts of services on observation of the quality of waters.	Currently in the majority of CA courtiers, the important operational needs of laboratories, such as a need of the equipment reolacement, procedures of the quality assurance, the need of laboratories intercalibration, professional development programs, etc., are not included into monitoring programs. These needs are often satisfied “whenever possible” also from other articles of the departmental budget, though just they are the prerequisite for the qualitative implementation of monitoring programs. In view of this, it is recommended to reconsider development of monitoring programs for the midterm period and include into programs also the issue of financing of all necessary elements (personnel training, quality control, equipment replacement, purchasing expendable materials,

	etc.). It will allow to realize monitoring programs reliably.

On the regional level, for synchronization of countries' efforts on this issue it is recommended:

- To carry out analysis of the national legislation, by-laws, regulations about services and of another normative-legal basis, concerning monitoring of surface waters quality with the purpose to set more clear and exact tasks for monitoring of surface waters, distribution of agencies' functions and improvement of coordination of their activities on monitoring of water bodies quality.
- To develop the regional guidance manual on planning monitoring programs in the context of IWRM.
- To carry out the pilot project on the design of monitoring networks and monitoring programs in the context of target oriented and basin principles.
- To organize training courses on issues of planning monitoring systems and programs.
- To revise existing national monitoring networks and programs on transboundary watercourses and to suggest ways of regional harmonization of systems of monitoring the quality of surface transboundary rivers.

2.3.2. INDICATORS (THE LIST OF ANALYZED PARAMETERS) OF THE QUALITY OF SURFACE WATERS

The current situation:

At present analytical laboratories of hydrometeorological services of CA countries are able to analyze a certain list of parameters of the water environment quality. Basically, the spectrum of studied parameters depends on technical and staff capacities of analytical laboratories and terms of their financing.

Thus, capacities of «Kazhydromet» allow to monitor bout 70 parameters of the water quality. Usually «Kazhydromet» branch offices by their own forces carry out assessment of the quality of surface waters on 47-49 physical and chemical indicators, including the temperature, suspended substances, coloration,transparency, pH, dissolved oxygen, biological oxygen demand in 5 days, mineralization, chemical oxygen demand, main elements of the salt composition, biogenic elements and main contaminants: oil products, phenols, heavy metals, pesticides and others.

The central laboratory of «Uzhydromet» in Tashkent can analyze a significant spectrum of ingredients (up to 53 parameters of the water quality), including heavy metals and organochlorine pesticides. However, the laboratory of Fergana carries out monitoring of the quality of water by the reduced list.

In other countries of the region, the spectrum of studied parameters is significantly low. So, currently, the monitoring program of «Kyrgyzhydromet» includes 27 indicators, though previously the monitoring program included 33 parameters. Because of the obsolete methodology and shortage of instruments and equipment in laboratories, the spectrum of observed parameters has reduced. The monitoring of surface waters carried out by «Tajikhydromet» and ECS in Turkmenistan today is limited by 20 and 26 parameters accordingly. Currently in these countries laboratories study the quality of water resources by those parameters which they able to do, but not by the real necessity. As a rule for all monitoring posts, the standard list of parameters is established.

In annex 3 the lists of main indicators of surface waters quality being currently analyzed on transboundary watercourses in each of countries are given. The spectrum of analyzed parameters of water quality is different for countries, but a number of parameters is analyzed in all countries. These are suspensions (suspended metals), transparency, hardness, temperature, pH of water. Also all countries do analysis of the salt composition of water and determine the general mineralization. All countries of the region determine the nitro-group (nitrates, nitrites, ammonium) and general content of nitrogen (except for «Tajikhydromet» and «Uzhydromet») by the content of biogens in the water,. Orthophosphates are monitored by all hydrometeorological services, except for ECS in Turkmenistan..

As to dissolved oxygen, the biological oxygen demand (BOD) and chemical oxygen demand (COD), in «Tajikhydromet» these important parameters are not determined. In «Kyrgyzhydromet» the COD is not determined. As to the group of non-organic micro contaminants and heavy metals, monitoring programs by these parameters in different countries vary very much. Only total iron content is analyzed in all laboratories. In «Kazhydromet» the large spectrum of metal salts is monitored and in «Uzhydromet» the list of analyzed metals is less. «Kyrgyzhydromet» has capacity to analyze only chrome[5] content and «Tajikhydromet» can analyze only the aluminum content in the water. In Turkmenistan analysis of this group of contaminants is not done. Oil products, phenols and SSAS are not analyzed by «Kyrgyzhydromet» and «Tajikhydromet» because of the lack of necessary instrumentation.

Currently the content of pesticides in the water can be determined only by «Uzhydromet» (of organochlorine line) and by «Kazhydromet». The rest of countries do not have instruments and methods for doing such definition.

For development of the monitoring program and selection of parameters by which it is necessary monitor the quality of natural surface waters in CA courtiers, different normative acts are used.

- So «Kazhydromet» is based on GOST 17.1.3.07-82. «Nature protection. Hydrosphere. Rules for monitoring of the water quality in water reservoirs and watercourses».
- In «Kyrgyzhydromet» the list of determined indicators has been established in ccordance with the observation program on the basis of РД 52.24.309-92 «Methodical instructions. Nature protection. Hydrosphere. Organization and carrying out regime observations over contamination of surface ground waters on the network» and on the basis of GOST 17.1.3.07-82 «Nature protection. Hydrosphere. Rules for monitoring of the water quality in water reservoirs and watercourses».
- In «Tajikhydromet» - the Semenov's manual on determination of chemical elements in the water composition is used.

Sometimes the indicators included into the monitoring programs have to be reviewed mainly for reducing the spectrum of controlled parameters of water resources quality because of the lack of necessary instrumentation pool, break-down of old instruments, lack

[5] In Kyrgyzstan, the SAEPF laboratory, equipped by modern equipment, is able to determine heavy metals and other contaminants.

of modern methodology, etc. And only in «Kazhydromet», during the last years, there is outlined a tendency on increasing the spectrum of analytical capacity of laboratories.

Thus, in Turkmenistan parameters of the water quality monitoring have not been reviewed for many years, though every year the State Committee of Turkmenistan on the Environment Protection and Land Resources approves the monitoring program of «Turkmenhydromet». In Tajikistan, the list of controlled parameters sometimes is changed, depending on the necessity and real capacity of laboratories and also because of the change of economic activities on the water catchment area or in case of emergencies. In Kyrgyzstan, the prerogative for formation of requirements to water quality parameters was defined only for the Republican state organ on protection of the environment (SAEPF), but no serious revision of quality standards was done. In Uzbekistan revision of the water quality parameters was not also done, they were approved in accordance with soviet methodologies. At the same time in Kazakhstan within the legislative-normative frames, the list of controlled indicators of the quality of surface waters was reviewed and the normative document "The unified system of water quality classification on water bodies" was developed and approved. The list of "priority substances" (on the basis of EU Water Framework Directive) recommended for Kazakhstan has to be discussed, coordinated and approved in the established order.

As a whole national experts have assessed the situation in the context of analyzed parameters of the quality of surface waters in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Improvement is required	Improvement is required	Improvement is required	Improvement is required	Improvement is required

Analysis and determination of basic needs for improvement of the situation:

The sphere where improvement is required	Explication
Dependence of the spectrum of analyzed parameters of the water quality on material and technical capacities of laboratories, but not on the real need to get information about the quality of water in water bodies for making managerial decisions.	Currently in CA countries, laboratories take control over the quality of water bodies mainly by standardized list of parameters determined in monitoring programs, which in term depends on the material-technical and financial support of laboratories. It means that on all monitoring points mainly the same parameters are analyzed. However, the practice of real situations on water reservoirs shows that it is not always justified. So, for example, if the state of the water body, mainly used for the drinking water supply, is assessed then the long-term study of hardly varying salt composition may be not so critical and monitoring of toxic contaminants, just on the contrary, may be very important. Differentiation of observation posts and of the spectrum of analyzed parameters on these posts will allow to optimize efforts and to make monitoring programs more practical and more justified for making decisions on the management of water bodies quality. In the long view, it is recommended to differentiate monitoring programs on surveillance, operational and investigative monitoring programs (on the analogy with IRD – surveillance, operational and investigative monitoring). It means monitoring of different quality parameters with different periodicity and different duration of observations. In view of this, it is important to consider the river basin from the point of view of its natural qualities and sources of potential substandard quality. National lists of contamination objects and characteristics of their impact on the quality of natural waters can become essential for planning monitoring programs and selection of control parameters for different observation points.

On the regional level for synchronization of countries' efforts on this issue it is recommended:

- To develop the regional, methodological manual on differentiation of observation posts over the quality of water resources
- To implement the pilot project on optimization of water quality parameters for the monitoring.

2.3.3. SELECTION OF SAMPLES, METHODS AND EQUIPMENT FOR SELECTION, CONSERVATION AND TRANSPORTATION OF SAMPLES

The current situation:

Procedures on samples selection, selection method and also method of conservation and transportation of samples have been standardized in hydrometeorological services of CA countries in accordance with the following normative documents :

- In Kazakhstan – by national standard ST RK GOST P 51592-2003 «General requirements to samples selection».
- In Kyrgyzstan – by GOST 31861-2012 "Water. General requirements to samples selection" and also in accordance with intra-departmental methodology of the department of observation over contamination of land surface waters.
- In Tajikistan - «The manual on chemical analysis of the land surface waters»
- In Turkmenistan - РД 52.24.309-92 «Methodological instructions. Nature protection. Hydrosphere. Organization and carrying monitoring observations over contamination of surface waters» and "Manual on the chemical analysis of land surface waters".

Despite of application of different normative documents, as a whole, the selection of samples in all countries is done in a similar way. Water samples for the chemical analysis, whenever possible, are selected on midstream of the water course and usually from the surface (0,1–0,3 m). Samples are selected either from the riverside, or by entering into the water or from hydrological bridges (if hydrological and hydrochemical posts coincide). There are no special sample cans (sample containers), samples are taken with enameled or plastic bucket. Containers for transportation of samples and their conservation, for oxygen fixation are filled on the site.

If the necessary equipment is available, some parameters are directly measured on the place of samples selection (usually it is temperature, pH, and if conductivity meter is available – the electrical conductivity). Expedition groups of «Kazhydromet» are the best equipped with express analysis instruments, though still it is needed to expand the list of express methods. The situation is worse in other countries. Thus «Kyrgyzhydromet» does not have a conductivity meter. And «Tajikhydromet» does not have express analysis instruments at all and it has serious difficulties with chemical reagents for conservation of samples and for oxygen fixation. In Turkmenistan, ECS laboratory is not equipped with instruments for measuring the water quality in field conditions. «Uzhydromet» does not have instruments for express analysis.

Usually for transportation of samples the common auto transport is used and only «Kazhydromet» has mobile specialized laboratories. Almost all expedition groups do not have cool chambers or they don't have enough of them.

Samples are selected directly by expeditionary groups (as a rule 2-3 persons) with necessary skills. Special training for samples selection groups on procedures of selection, conservation, transportation and analysis of samples in field conditions is usually conducted 1-2 times per year. In the majorly of cases it is a formal training rather than a training on standard procedures of samples selection.

Briefing on safety and health regulations for expedition groups is provided in accordance with national standards requirements for this category of work, both at hiring and also consequently - periodically (each quarter). In some organizations these training are integrated with trainings on providing the first medical aid. Nevertheless expedition groups not always are adequately provided with means of personal and collective safety. Only in rare cases selection of samples is done in life-jackets.

As a whole, national experts have assessed the situation in the context of samples selection procedures, field measurements, delivery of samples to laboratories in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
No significant changes are required	No significant changes are required	Improvement is required	No significant changes are required	Improvement is required

Analysis and determining main needs for improvement:

The sphere where improvement is required	Explication
Insufficient equipping of expedition groups with express analysis instruments in the field conditions or a total absence of such instruments.	Such equipment is needed for determining some rapidly changing parameters of the water quality on-site. Moreover, analysis of some parameters of the water quality directly on the sampling site can provide a preliminary information about the water quality and will allow to expeditionary group to address a number of issues, for example, whether additional volumes of samples are needed or not. If such instruments are available, the expeditionary group being directly in the sampling site can first signal about a sharp deviation of the water quality and start procedures of warning about potentially dangerous contamination. Availability of such instruments is especially needed also for tracing the process of emergencies, when it is needed to fix rapidly the quality of water, at that at several points and in different periods of time.
Lack of specialized auto transport and scarcely ever acceptable conditions for transportation of samples	Currently in a number of CA countries expedition groups have available only usual auto transport mean. It does not allow to carry out express analysis duly, and doesn't guarantee delivery of samples for long distances without changing their physical and chemical composition. Safety of samples at their transportation is an important aspect. As a minimum, it is necessary to provide the temperature regime for conservation of samples till the moment of their delivery to laboratories. Observation of these terms is very important in the hot climate of the region and also for providing the reliability of results. Cool chambers in the necessary volume should be provided to expedition groups.
Insufficient maintaining of the professional qualification of specialist on samples selection	Maintaining the necessary qualification of expedition group members is an important task. Conducting regular practical trainings (tests) should become a mandatory procedure. The role of trainings will increase if expeditionary groups are provided by express analysis instruments. Also it is very important to provide a special training on selection of samples on the pollution content which is determined in microquantities (pesticides, polyaromatics, other high-toxic compounds), and also for prevention of cross-contamination of samples and containers for transportation.
The need to provide safety conditions at	Improvement of the human life safety at samples selection is not only necessary, but also mandatory. Especially taking into consideration that many water quality

samples selection.	observation posts are not maintained or cannot be maintained from the engineering point of view. In conditions of high-velocity flows, complex bottoms of water reservoirs, changing the bank line contours in time of different hydrological events, the maintenance of expedition groups is an important element. Expedition groups should not only be provided with necessary equipment (portable folding stairs, ropes, carabines, life-jackets, watertight suits, warning devices (signaling means), etc.) but they should also regularly pass practical tests and trainings, including on the first aid treatment.

On the regional level for synchronization of efforts of countries on this issue, it is recommended:

- To realize a regional project on increasing capacity of monitoring services on issues of sample selection, including development of the plan of fitting out expedition groups with necessary equipment and conducting trainings for expedition groups.
- To purchase necessary equipment and conduct trainings.
- To develop regional methodological manual on samples selection and on doing field measurements.

2.3.4. METHODS OF THE QUALITY ASSESSMENT AND CLASSIFICATION OF SURFACE WATERS

Current situation:

In all countries of CA region assessment of the quality of surface waters is done on the basis of the MPC system, developed still in the USSR. Soviet normative documents are still used.

- Thus in Kazakhstan «The generalized list of maximum admissible concentrations (MPC) of harmful substances in fishery water bodies (1990)» is used.
- In Kyrgyzstan in 2016 new national standards were adopted, such as «Rules on the surface water protection», where the list of MPC for fishery water bodies and hygienic standards are given: «Maximum admissible concentrations of chemical substances in the water of water bodies of household and cultural and social water use» and «Provisional admissible levels of chemical substances in the water of water bodies of household and cultural and social water use». However, adoption of these documents has not changed much in the system of quality waters assessments, as they have mainly duplicated old regulations and standards of the water period.
- In Tajikistan assessment of the quality of surface water is done in accordance with the DD (Directive document) 52.08.23-84 «Organization and carrying out regime observation over contamination of surface waters" and DD 52.24.309.92 "Manual on doing chemical analysis of land surface waters».
- In Turkmenistan assessment of the quality of surface waters is done in accordance with DD 52.08.23-84 «Organization and carrying out regime observation over surface waters contamination», DD 52.24.309.92 "Manual on dong chemical analysis of land surface waters", «Sanitary rules and norms for protection of surface waters from contamination» and the national standard CHT 2.09.04-09.
- In Uzbekistan for assessment of the quality of natural waters, the generalized list of MPC and approximately safe impact level (ASIL) of harmful substances for the water of fishery water bodies is used.

Currently in CA countries for interpretation of results of waters quality monitoring the value of real concentrations excess over MPC values and the number of cases of such excess for the certain period of time, (for example for a year) is used. MPC values for fishery water reservoirs that are currently applied in CA countries, are given in the annex 4.

In addition to the direct comparison of substances concentrations, determined in the water of natural water reservoirs, with individual standards for each of these substances (MPC in fisheries), in the CA region also integrated indicators are used that allow to give more generalized assessment of the quality water conditions in water reservoirs. Thus in Kyrgyzstan, Turkmenistan and Uzbekistan the so-called Water Reservoir Pollution Index (WPI) is used. In Tajikistan WPI is not used in practice of water reservoirs quality assessment, though previously it was used.

WPI is a relative indicator of the water pollution characterizing by the cumulative availability of largest concentration of 6 measured parameters, including dissolved oxygen and BOD. For presentation of waters quality as a unified assessment, the remaining 4 indicators are selected regardless of limiting harmful index. At equality of concentrations, the preference is given to substances that have toxicological criterion of harmfulness. Such system of classification allows to differentiate waters by 7 quality classes:

Class	Characteristics of the class	The WPI value
I	Very clean waters	0,3 and less
II	Clean waters	0,31-1,0
III	Moderately contaminated waters	1,1-2,5
IV	Contaminated waters	2,51-4,0
V	Dirty waters	4,1-6,0
VI	Very dirty waters	6,1-10,0
VII	Extremely dirty waters	More than 10,0

In contrast to other countries of the region that use standards of the soviet period, in Kazakhstan during the last years the national system of complex assessment of the water quality (CWPI), finally fixed in 2012 in the document «Methodical recommendations on complex assessment of the quality of surface waters by hydrochemical indicators» was developed. It is also based on WPI principles, but it is suggested that it reflects the complexity of water conditions more adequately. For CWPI calculation, based on the homogeneity of ingredients being determined, substances are united into separate provisional groups: main ions, biogenic elements, heavy metals, poisonous substances, organic and chlor-organic compounds. CWPI is calculated separately by dissolved oxygen and biochemical oxygen consumption and also with consideration of the hazard class of this or that pollutant. Such system implies 4 classes by the level of contamination.

Contamination level	Assessment indicators of water bodies contamination			
	by CWPI	by CWPI with consideration of the hazard class	by O_2, mg/dc3	by BOD5, mg/dm3
Normatively clean	≤ 1,0	≥ 2,0	≥ 4,0	≤ 3,0
The moderate level of contamination	1,1 – 3,0	2,1-6,0	3,1-3,9	3,1-7,0
High level of contamination	3,1 – 10,0	6,1-10,0	1,1-3,0	7,1-8,0
The extremely high level of contamination	≥10,1	≤ 10,1	≤ 1,0	≥ 8,1

Today in Kazakhstan, this system of complex assessment of water reservoirs' conditions is mandatory for «Kazhydromet» subdivisions. It should be mentioned that in Kazakhstan soon the reform on determining the unified system of water resources classification by their quality will start. Thus, Committee on Water Resources of the Ministry of agriculture has approved the new normative document - «The unified system of water quality classification

in water bodies». «The methodology on development of target indicators of the water quality in surface water bodies and measures on their achievement» was approved by joint order. The national classification of water bodie, as well as specification of water consumption classes and their class gradation will be stage by stage introduced into the system of state ecological monitoring of «Kazhydromet».

In Turkmenistan as an integral indicator of the water quality also quality classes are used, that are regularized by following indicators.

Indicators	Classes of the water quality					
	I	II	III	IV	V	VI
General physical indicators and indicators of non-organic substances						
Temperature, °C	<20	25	25	30	30	>30
pH values	6,5	6,5	6,5	6,0	6,0	6,0
Dissolved oxygen, mg/l	>8	6	5	4	2	<2
Oxygen intensity, %	>90	75	60	40	20	<20
Specific electrical conduction, мх	<400	700	1100	1300	1600	>1600
The general amount of dissolved substances, mg/l	<300	500	800	1000	1200	>1200
The general amount of dissolved substances, mg/l[1]	<20	30	50	100	200	>200
General hardness, n°	<15	20	30	40	50	>50
Chlorides, mg/l	<50	150	200	300	500	>500
Sulfates, mg/l	<50	150	200	300	400	>400
Ferrum (general amount), mg/l	<0,5	1	1	5	10	>10
Manganese (general amount), mg/l	<0,05	0,1	0,3	0,8	1,5	>1,5
Ammonium, mg/l	<0,1	0,2	0,5	2,0	5,0	>5,0
Nitrites, mg/l	<0,002	0,005	0,02	0,05	0,1	>0,1
Nitrates, mg/l	<1	3	5	10	20	>20
Phosphates FO4, mg/l	<0,025	0,2	0,5	1,0	2,0	>2,0
General phosporus FO_4 , mg/l	0,05	0,4	1,0	2,0	3,0	>3,0
General indicators of organic substances						
COD (permanganate), mg O_2/l	<5	10	20	30	40	>40
COD (bichromatic), mg O_2/l	<15	25	50	70	100	>100
BOD5, mg O_2/l	<2	4	8	15	25	>25
Organic carbonium, mg/l	<3	5	8	12	20	>20
Extractable substances, mg/l	<0,2	0,5	1,0	3,0	5,0	>5,0
Organic azote, mg/l	<0.5	1,0	2,0	5,0	10,0	>10,0
Indicators of non-organic industrial contaminants						
Mercury, mg/l	<0,1	0,2	0,5	1	5	>5
Cadmium, mg/l	<3	5	10	20	30	>30
Lead, mg/l	<10	20	50	100	200	>200
Arsenic, mg/l	<10	20	50	100	200	>200
Cuprum, mg/l	<20	50	100	200	500	>500
Chrome, mg/l (general amount)	<20	50	100	200	500	>500
Chrome, (3+), mg/l	<20	100	200	500	1000	>1000
Chrome, (5+), mg/l	<0	20	20	50	100	>100
Kobalt, mg/l	<10	20	50	100	500	>500

Nickel, mg/l	<20	50	100	200	500	>500
Zink, mg/l	<0,2	1,0	2,0	5,0	10,0	>10,0
Easily released cyanides, mg/l	0,0	0,0	<0,05	0,1	0,2	>0,2
The general amount of cyanides	0,0	0,0	<0,5	1,0	2,0	>2,0
Fluoride, mg/l	<0,2	0,5	1,0	1,5	3,0	>3,0
Chlorine, mg/l	0,0	0,0	0,0	<0,05	0,1	>0,1
Sulfates, mg/l	0,0	0.0	0,0	<0,01	0,02	>0,02
Indicators of organic industrial contaminants						
Active detergents, mg/l	0,0	<0,5	1,0	2,0	3,0	>3,0
Volatile phenol, mg/l	<0,002	0,01	0,05	0,1	1,0	>1,0
Petroleum derivatives, kg/l	0,00	<0,05	0,10	0,30	1,0	>1,0

In addition to enumerated above approaches to assessment of water bodies' (state) by hydrochemical indicators, for assessment of the level of natural water contamination also other criteria are used, such as – «high contamination» and «extremely high contamination». Thus in Kazakhstan it is determined by «Kazhydromet» normative documents, in Kyrgyzstan recommendations of Russian Federation[6] P52.24.756-2011 «Criteria for evaluation of the danger of toxic contamination of land surface waters at emergencies (in cases of contamination)» are used, in other countries – by similar normative documents of the Soviet period. In any case threshold values of high and extremal contamination are defined by the level of MPC values excess (10-100 times) taking into consideration the hazard class of this or that contaminant or changing of the water quality parameter (oxygen, BOD).

As a whole national expert have assessed the situation in the context of methods of water resources quality assessment and their classification in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Significant impovenet or full review is required	Significant impovenet or full review is required	Improvement is required	Improvement is required	Improvement is required

Analysis and determining main needs for improvement:

The sphere where improvement is required	Explication
Standards for the water environment quality have not been reviewed for new social and economic conditions	In CA countries standards (normatives) of the quality of natural surface waters have been used still since the soviet period times. They are based on the system of individual MPC or requirement to the water quality by some parameters. Assessment of water resources quality by hydrometeorological services in all countries of the region is done by comparison with MPC developed for fishery water reservoirs, unofficially accepted as MPC of ecological character in contrast to sanitary hygienic MPC, which are assigned for protection of human health. Calculated integral indexes WPI and CWPI are also based on values of the same fishery MPC. The MPC system being applied for several decades in countries of the former USSR was repeatedly analyzed and criticized. It was developed for social and economic conditions of a large country and does not reflect regional aspects of the toxicity of substances and sensibility/sustainability of local types of hydrobionts (aquatic organisms), that are exposed to toxic effect. First of all, it suggests quite

[6] In Kyrgyzstan using of the normative-legal base of Russian Federation is allowed by law

	hard (strict) normalization and any deviation from the norm is already considered as violation of standards. MPC values are very low, sometimes even beyond the margin of instrumental detection of substances in the water. It doesn't allow to judge about the quality of water bodies for other water consumptions which are usually carried out jointly. It is difficult to use the MPC system for regulation and planning of measured on gradual (step by step) achievement of the desired quality of water resources. In Kazakhstan these standards are currently reviewed for applying the system of water consumption classes (OECD) and introduction of the term of ecological status. On the level of specialists, the need to review the system of standards on natural waters quality is also understood in other countries of the region.

On the regional level for synchronization of efforts of countries on this issue it is recommended:

- To do analysis of the national legislation and normative legal base on issues of natural water quality standards and suggest ways on reforming the system of waters quality regulation mechanisms, taking into account current realities in the region.
- To realize a pilot project on testing different approaches and assessment of water resources quality (MPC, WPI , CWPI , water quality status, quality classes, water consumption classes, etc.) and their application in the regulation system.

2.3.5. LABORATORY CAPACITY

Current situation:

Currently the laboratory capacity for monitoring the surface water resources quality in CA countries differs very much. So in Kazakhstan, «Kazhydromet» has 16 accredited complex laboratories, 2 of which located in South Kazakhstan and Jambyl provinces are engaged in monitoring of transboundary water bodies in Kyrgyzstan and Uzbekistan. These complex laboratories have all necessary instruments and equipment for implementation of works on the monitoring of surface waters quality. Laboratories in Jambyl and South Kazakhstan provinces select water samples for determining organochlorine pesticides, but samples are delivered to the laboratory in the North Kazakhstan province, where the analysis is directly done. For the independent determination of mentioned pesticides and expansion of accreditation spheres of laboratories for determination of such indicators as dicophol, hexachlorobenzene, hexachlorocyclohexane, xanthoginates, DDD (dichlorodiphenyldichloroethane) it is necessary to purchase highly precise modern equipment. For installation of such equipment a separate premise is needed. Currently the area of laboratories does not allow to purchase such equipment.

In Kyrgyzstan, monitoring of surface waters quality is carried out mainly by 2 state bodies: the hydrometeorology agencies under the Ministry of Emergencies («Kyrgyzhydromet») and by the State Agency on the Environmental Protection And Forestry (SAEPF). At that, SAEPF functions imply monitoring of the environmental state of surface water bodies, i.e. determining contamination sources and the level of their impact to this or that object in result of discharging polluters into water bodies, including purified waste waters. «Kyrgyzhydromet» functions include monitoring of the natural environment. Both agencies have one central laboratory each. «Kyrgyzhydromet» currently doesn't have any regional laboratories. SAEPF has been fully equipped by the modern equipment. Since 2016 «Kyrgyzhydromet» has stopped observations over such important as heavy metals, oil products (petroleum products), phenols and SSAS, because of the obsolete and insufficient material and technical basis and obsolete methodologies. As a whole in «Kyrgyzhydromet» the instrumentation pool is obsolete, it is necessary to equip it with modern apparatus for

increasing the number of ingredients to be determined. For determining heavy metals, the atomic absorption spectrophotometer is needed.

In Tajikistan, currently 3 laboratories are functioning under «Tajikhydromet» - in Dushanbe, Kairakkum and Kurgan-Tube. The latter is not functioning because of the lack of apparatus and specialists. In all laboratories, an acute shortage of the equipment is observed. Available instruments and equipment have exhausted their resources. There are no spare parts for restoration and repairs of the equipment. The new equipment is not delivered and is not purchased because of the lack of funds. For the central laboratory in Dushanbe it is important to set going the process of analyzing the content of metals in water, but because of the lack of atomic absorption spectrophotometer, it is not yet possible.

In Turkmenistan, the monitoring of the quality of surface waters is done by the ECS laboratory of the State Committee on Protection of the Environment and Land Resources. In addition, monitoring of waters is also done by other Ministries and agencies in accordance with their regulations. The national committee on hydrometeorology «Turkmenhydromet» carries out the monitoring of hydrological indicators on all watercourses of the country, provides servicing and technical equipping of its gauging stations, but it does not carry out monitoring of the quality of water resources. Practically all instruments and laboratory equipment is obsolete and needs to be renewed.

There are two hydrochemical laboratories in the structure of «Uzhydromet», one of them is located in Tashkent, and the second one on Fergana, The equipment of laboratories is morally obsolete; the acute deficit of budget means for its modernization is observed. By this reason, it is difficult to do the analysis of samples for heavy metals, in particular for mercurium.

In particular, national experts have assessed the situation in the context of material and technical capacity of laboratories in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	significant improvement or comlete review is required	significant improvement or comlete review is required	improvement is required	improvement is required

In the context of provision of necessary chemical reagents, spare parts, expandable materials to laboratories, the greatest difficulties with provision of laboratories is observed in Tajikistan and Turkmenistan. As a whole national experts have assessed the situation by this issue in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	no significant changes are required	significant improvement or comlete review is required	improvement is required	improvement is required

The important aspect is the methodological basis for organization of monitoring and also specialized manuals for carrying out analysis.

As of today, among countries of CA region only in Kazakhstan the methodological support of laboratories is arranged and laboratories are provided with necessary literature, instructions, guidelines and methodologies.

At the same time, in Kyrgyzstan, the shortage of methodological literature is observed, because previously all material were sent from Rostov hydrochemical institute, and currently such links are lost. There are no scientific-research institutions in the sphere of hydrochemistry and hydrobiology in the country. Therefore, old training aids are used. The situation is similar in Tajikistan and Turkmenistan – there are no national centers on development of methodological technical guides and instructions for carrying out monitoring of surface waters quality, there is not enough specialized literature, old teaching guides and instructions are used. In Uzbekistan, there is also a problem in revision of soviet guideline documents, taking into consideration specifics of the country and introducing them into the national register.

As a whole national experts have assessed the situation in the context of methodological provision of laboratories in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	improvement is required	improvement is required	improvement is required	improvement is required

One of serious problems of the CA region countries is staffing of analytical laboratories with qualified personnel. Thus, the staff of «Kazhydromet» laboratories is in the whole completed with qualified specialists, in «Kyrgyzhydromet» the personnel is gradually renewed on the account of young specialists with quite high level of theoretical knowledge, but in other countries the situation is not so good. Thus, in «Tajikhydromet», because of the number of reasons (salary, work conditions) selection of the qualified personnel on the competitive basis is difficult and the turnover of employees is high. An acute shortage of qualified personnel in laboratories engaged in monitoring of water quality is observed also in Turkmenistan. In «Uzhydromet», there are not enough specialists with high chemical education.

In all countries of the region, the mechanism of re-attestation of employees of laboratories is applied. Specialists pass the procedure of reattestation for the job competence and for confirmation of qualification (as a rule once in 3 years). In addition, employees of laboratories as a rule attend specialized career development (qualification) courses. However, the content and effectiveness of these training significantly differs in countries of the region.

Thus, in Turkmenistan over the last 5 years training of employees was limited to courses on emergencies; in Tajikistan 6 specialists attended general training on the monitoring of surface waters, but two of these specialist have already resigned. “Uzhydromet” employees participate in trainings and qualification courses (advanced training courses). In 2017, two employees of the laboratory attended distant (remote) qualification courses in Roshydromet. Specialists of “Kyrgyzhydromet” and SAEPF (usually from 1 up to 3

employees) regularly participate in professional courses, mainly within the frames of international projects under the donors' support[7].

Most regularly (in the planned manner) training of specialists is carried out in Kazakhstan. Every year specialists of laboratories of South-Kazakhstan and Jambyl provinces attend specialized qualification courses. Over the last 5 years, both general and also specialized issues were included into the program of these trainings[8]. Specialists of "Kazhydromet" also participate in international trainings and in practical trainings (on-the-job training). In Kazakhstan, there is a number of training centers for the professional development, including for managers of the quality management systems in the sphere of ecology, for specialists-chemists in the sphere of assimilation of modern analytical equipment and new methodologies for doing measurements. In Kyrgyzstan, there are no such centers yet, but it is expected that in "Kyrgyzhydromet" structure the training center for the professional development in the sphere of hydrometeorology will be opened. In the long view, it is planned to suggest it as a regional center for the professional development. In Tajikistan previously employees of hydrometeorological laboratories attended advanced qualification courses in Central Asian Research Hydrometeorological Institute, but now they don't. The situation is similar in Turkmenistan and Uzbekistan, there are no specialized training centers in these countries for specialist In the sphere of hydro-chemistry and hydro-biology.

In all countries of the Central Asia region, the practice of cooperation of laboratories engaged in monitoring of water resources quality with educational institutions is set going. Students of these educational institutions have their practical training on the basis of these laboratories.

As a whole, national experts have assessed the situation in the context of human capacity in their countries as follows.

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	improvement is required	improvement is required	improvement is required	improvement is required

Analysis and determining main needs for improvement of the situation:

The sphere where improvement is required	Explication
The obsolete	It is urgently necessary to reequip laboratories of hydrometeorological services in

[7]The training course on the monitoring of the water quality, JICA, Japan; Training tour on monitoring of surface waters, Finland; Training in the Training center of the Institute of Environment and Meteorology in Finland by Finkmet project, Finland; Professional development courses on "Requirements on ИЛ by ГОСТР ИСО/МЭК 170255 on control of Shukhar maps"; Training on the work with software application MUkit – instrument for calculation of the uncertainty of measurements, FinWater WEL

[8] Advanced training on issues of occupational health and safety; ISO 14001-2015 «The system of environmental management», ISO 22004:2014 «The system of food products safety»; GOS ISO/МЭК 17025; Training and professional development in the sphere of technical regulation, metrology and management system; Uncertainty of measurement results; training of experts-auditors on confirmation of chemical products; Internal audit of the system of management of testing and calibration laboratories in accordance with requirements of СТ РК ИСО/МЭК 17025-2007 and СТ РК ИСО 19011; Adoption of the methodology on doing measurements of metals by atomic-absorption method on spectrophotometer MGA-915; Training course on issues of industrial safety; Briefing on exploitation of the liquid chromatograph «Lumachrom»; «Improvement of water resources management in CA»; Training course on the water quality; «Procedures on accreditation of testing laboratories».

instrumentation pool and equipment of laboratories, engaged in the monitoring of the quality of transboundary rivers	CA countries with the basic equipment and instruments. This concerns Kazakhstan to a less extent, because province (district) laboratories engaged in the monitoring of the quality of waters on transboundary rivers in the region are quite well equipped, though they also need to expand their instrumentation pool for doing analysis (atomic absorption spectrophotometer, mass spectrometers). The instrumental basis for determining the presence of metals in water and also of some priority pollutants is extremely needed for Kyrgyzstan, Tajikistan, Uzbekistan. In many laboratories, it is also important to address the issue with premises, either it is needed to extend their areas (Kazakhstan) or to do the major repairs (Kyrgyzstan, Tajikistan) and bring laboratory premises into compliance with required standards of premises.
Lack (inefficiency) of regional (district) laboratories	In Kazakhstan, the monitoring of surface waters quality is organized on the regional (district) level, that allows monitoring of the quality of transboundary rivers in the region. However, for other countries, the remoteness of central laboratories of hydrometeorological services from the watercourses and lack of regional (district) laboratories does not allow to carry out the adequate monitoring in remote districts of the country. In Tajikistan only one of 3 available laboratories carries out monitoring on the planned basis, one laboratory practically is not functioning, and the third one is not able to do monitoring to the full extent. The state of such laboratories and their supply with the equipment and employees is significantly worse than in central laboratories. At the same time, the delivery of samples to central laboratories of this or that country is quite difficult because of large distances, hard-to-reach areas and remoteness of monitoring points. In the long view, establishment of new regional laboratories or strengthening capacity of available regional laboratories certainly should become the objective of services engaged in the control of waters quality. As a temporary solution, it may be suggested to form regional expedition groups, that will engage in selection of samples, in doing initial analysis, conservation, marking and packing of samples. The delivery of samples to central laboratories may be organized on the basis of contract with transport companies, for example with air-travel companies.
Problems with reagents, expandable materials, inadequate methodological support.	In Tajikistan and Turkmenistan, one of restrictions for carrying out monitoring of transboundary water bodies is the lack of chemical reagents for conservation of samples and analytical definition. Also the methodological support of services, engaged in the monitoring is important. It may concern specialized methods for carrying out analytical works, but also general issues of monitoring, for example, methodical instruction on planning of the observation network, methods and principles of water resources quality assessment, selection of samples, management of the quality control, etc.
Need for the regular professional development program	The professional development of the personnel on the planned basis is an important aspect and this issue can be improved, especially in Kyrgyzstan, Tajikistan and Turkmenistan.

On the regional level for synchronization of efforts of countries on this issue, it is recommended:

- To implement a regional project on increasing the capacity of monitoring services on issues of analytical capacities of laboratories, including development of the plan on fitting out laboratories with necessary equipment and training of the personnel.
- To purchase the necessary equipment and carry out trainings. .
- To consider the issue about establishment of a regional training center on issues of monitoring of water resources quality.

2.3.6. DATA STORAGE, PROCESSING AND ANALYSIS SYSTEM

The current situation:

The data obtained about the quality of surface waters is stored in CA countries differently. As a rule, initially the information is introduced into primary laboratory log-books, and afterwards it is issued in the form of hydrochemical bulletins and yearbooks (catalogues).

In «Kazhydromet» the initial information is also introduced into the Excel format and into the SQL database (by transboundary rivers – since 2008-2009). The archive information for previous years is available still only in hard copies.

In «Kyrgyzhydromet» the information, including the archive one, is stored in the Excel format. All the information about the quality of waters, starting from the 1938 (except for the data on teIssyk-Kul lake) has been already transferred into the electronic table formats and currently the process of scanning of archive logbooks, bulletins and yearbooks has been started.

In «Tajikhydromet», the information since 2003 is also stored in the Excel format. The archive historic information has been already transferred into the electronic format and currently the process of documents scanning is going on.

In Turkmenistan, though it was attempted to transfer the data into the electronic format, currently because of the lack of sufficient financial means this work has been stopped.

In «Uzhydromet» the data of the surface waters quality monitoring is stored in the paper format (hard copy) in Hydrometfund (hydrometeorological fund), and also in the electronic version DOS. The data since 2003, has been also transferred into the Excel format. There are not yet any plans to transfer the entire archive information to the electronic carriers.

Transferring of the data to electronic carriers is usually done by the employee of the laboratory or of the information department. Often the entered information is checked for the accuracy of all records only visually. At that, only in «Kazhydromet» there is a normative document, that establishes requirements to checking the compliance of the information quality to set standards, checking the accuracy of records and transformation of the observation data, calculations, coding and entering of the information into technical carriers, checking the observation data for any deviations from established methods of doing measurements and data processing and also for rough casual mistakes (miscounts) at doing measurements, checking the availability and accuracy of records of the year, month, name of the post, its coordinate number, records in columns “date”, “time”, etc..

The access to electronic database in agencies is limited; there are duplicate recording carriers and copies. Archive materials in all countries are stored in special funds, where the access mode has been established and storage conditions are maintained.

As a whole, national experts have assessed the situation in the context of information safety and integrity in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	no significant changes are required	improvement is required	significant improvement or comlete review is required	improvement is required

As a rule, at processing and summarization of data received in result of the monitoring, simple methods are used, such as: figures on changing of the water quality by monitoring posts, diagrams on the excess of observed values over the MPC values, the frequency of such excess, and also calculation of integral indexes (WPI, CWPI) in those countries where

they are applied. In «Kyrgyzhydromet» with the support of the Finnish part, currently the information system DigiLab on management of the laboratory data and information is introduced. In «Tajikhydromet» with the support of the Finnish University within the frames of the investment project the information system on the laboratory data management is introduced.

More complicated mathematical and statistical methods (for example, such as – analysis of multi-year variation series, regression and correlation analysis, prediction models, analysis of trends, calculation of samplings statistical values, sampling variation, determining statistical reliability of differences, etc.) currently are not applied for the data analysis, as it is not within direct responsibilities of services on monitoring of natural waters quality.

In addition, the Geo information systems (GIS) have not been yet introduced into the practice of services on monitoring of natural waters quality, as an instrument for spatial reflection of data and multifactor analysis, and also as an instrument of visualization of data about the quality of natural waters.

As a whole, national experts have assessed the situation in the context of procedures of data processing, information analysis and data interpretation in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	improvement is required	improvement is required	improvement is required	improvement is required

Analysis and determination of essential needs for improvement:

The sphere, where improvement is required	Explication
The need to keep the archive information preserved, transferring the data about the quality of water resources to electronic carriers	Currently in CA countries (Kazakhstan, Kyrgyzstan, Turkmenistan), the data received at monitoring of the quality of water resources, along with the paper form is entered into Excel tables, that of course is a correct step towards provision preservation of data and possibility for their improved analysis. In Kyrgyzstan and Turkmenistan, the historical archive information has been entered into the electronic format. It should be noted that the Excel format really allows to preserve and analyze pools of data, but it is not the database by itself. Such database is available only in Kazakhstan. It is organized on the SQL platform. In the long view, it is necessary to introduce modern information systems into the practice of data management. These systems include specialized databases integrated with the instruments of processing, analysis and visualization of information, including GIS.
The need to check the accuracy of archive data, transferred to electronic formats	Of course in CA countries at entering the new received data about the quality of water resources into the electronic format, it is checked for mechanical mistakes. However, the practice shows that the main reason of mechanical mistakes is a human factor, especially at entering of large data pools, archives into the electronic format. Therefore it is necessary to introduce the ways of verification of the accuracy of introduced information, using methods of detection of strongly deviating values, violation of correlation link between parameters, etc. It will allow not only to check the accuracy of data entering into registries, but also to take control over results of analysis for occurrence of “rough” mistakes at taking samples and carrying out analytical procedures.
Expanding of the informational content of monitoring programs and monitoring data	Currently, the services engaged in the monitoring of the quality of water objects gather significant volumes of information, but their informational content, as a rule, is limited only by several indicators (excess over MPC, pollution indexes). Taking into consideration that there are already available multi-year historical series of

	observations, the volume of available information is huge. With due application of modern information systems, this information pool can be transformed into the valuable information that is needed for assessment of water resources state in the retrospective and in the prospect (in the long view). This will increase the informational content of the received data, and the information will become more adapted for bodies making managerial decisions, it will become more understandable and clear, also for water users and for the civil society. The capacity of monitoring services in CA countries in this aspect can be strengthened through establishment of special information departments or groups in the structure of agencies, which will be engaged in processing, analysis, interpretation and visualization of the monitoring information. Of course, for this purpose there are needed modern databases, development of GIS layers, formation of the instrument for the request and analysis of the information.

On the regional level, for synchronization of efforts of countries on this issue it is recommended:

- To develop and introduce the regional program document (database and GIS analytical block) for information systems about the quality of transboundary water resources.
- To develop a regional methodological guidance on the analysis, processing and visualization of data about the quality of water resources and to carry out training for information groups.
- To introduce methods of verification multi-year datasets, being transferred to electronic carriers.

2.3.7. CONTROL AND QUALITY ASSURANCE, CERTIFICATION OF METHODS AND MATERIALS AND ACCREDITATION OF LABORATORIES

The current situation:

On the preparation stage for going out for samples and directly at samples selection, services engaged in the monitoring in the region of Central Asia, take control over marking of containers, utensils, flasks. At that, either the field logbook is filled or the protocol of samples selections or the talon-stab is filled out, to which on the sampling site the necessary information is introduced (the number, water object, post /section line, data and time of sample selection, the volume of the sample, etc.) and also results of measurements in field conditions are introduced. But as a rule, at delivery of samples to the laboratory the special verification act is not filled, though all necessary measures are taken to avoid mistakes. Also, with few exceptions, in the usual practice of monitoring of surface waters quality, there are not applied such methods of checking the sampling quality as “blank samples”, “duplicate samples” and “split samples”, though their share in analysis usually should reach 10-20%. In Turkmenistan such methods are applied, usually when the sample poses a challenge or a high turbidity of water is observed.

As a whole, national experts have assessed the situation in the context of the quality control on the stage of sample selection in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	improvement is required	improvement is required	no significant changes are required	no significant changes are required

Concerning provision of the quality of analytical works, the most favorable practice is observed in laboratories of «Kazhydromet» and «Kyrgyzhydromet».

«Kazhydromet» laboratories have been accredited for the compliance with GOST ISO/МЭК 17025-2009 «General requirements to the competency of testing and calibration laboratories». The within-laboratory control of results quality in «Kazhydromet» is carried out in accordance with requirements of GOST ISO 5725-6-2003, РМГ 76-2004, GOST 27384-2002, other guidance documents. A wide range of methods is applied, such as: the operational control of accuracy applying the sample dilution method; applying test samples; applying standard addition method; applying control methodology of analysis, control of the repletion rate and intra-laboratory reproducibility. State standard samples are used. All measuring tools of laboratories are exposed to the instrument standardization in accordance with the periodicity of calibration execution. «Kazhydromet» laboratories regularly participate in comparative tests in accordance with GOST ISO/МЭК 17025-2009 and in accordance with the plan of inter-laboratory comparative tests. The quality control in laboratories is carried out by the Principal engineer-chemist.

In «Kyrgyzhydromet» methods of internal control in accordance with the DD 52.24.66-86 «The system of control over accuracy of measurements results, indicators of the controlled environment contamination » are also used. The operating control of the reproducibility and correctness for volumetric research methods is used (sulfates, chlorides, etc.). Control measurements are done regularly during the entire controlled period. State standards samples are used. Results are entered into the logbook “The internal control of accuracy”, then at the end of the year the assessment of indicators is done. Control Stewhart charts are in the implementation stage. In addition, in the SAEPF laboratory the internal control is carried out in accordance with accreditation requirements by GOST ISO/МЭК17025, and among others, also Stewhart charts are used. Every year in «Kyrgyzhydromet» the state calibration of analytical instruments and equipment by specially authorized organ (Kyrgyzstandart) is carried out. Every year «Kyrgyzhydromet» and the SAEPF laboratory participate in comparative testing, organized by the Finnish Environment Institute SYKE, UNEP program GEMS/Water Canada, and also inside the country – by the ОСОО «ILIM». The quality control in «Kyrgyzhydromet» is carried out by the Chief of the laboratory, in SAEPF – by the Quality Engineer. The «Kyrgyzhydromet” on monitoring of the quality of land surface waters is not accredited as the major repairs or construction of a new building for the laboratory is required. The SAEPF laboratory is accredited in accordance with ISO/IEC 17025.

In Turkmenistan once in 3 years certification of laboratories is done. All formulars are filled out and submitted by the form, specified by Turkmengosstandard (Turkmen State Standard). These formulars include all the data on the personnel, specialists, instruments, reagents. The Turkmengosstandard national accreditation is available. The internal quality control is carried out using the resources of the laboratory itself.

Every year in «Tajikhydromet» the state verification of analytical instruments and equipment is carried out by the specially authorized organ “Tajikstandard” and by its results the certification about verification of tools and equipment is given.

In «Uzhydromet», in accordance with the established practice the external control with other departmental laboratories, as well as the internal control in laboratories is carried out. Verification of the equipment is carried out every year by the agency “Uzstandard”. Both

laboratories of “Uzhydromet” are not accredited but they are certified by the State Environmental Committee (Goscomecology).

As this study demonstrates, currently “Tajikhydromet” laboratories and laboratories in Turkmenistan do not participate in comparative testing and intercalibration between-laboratory tests.

As a whole, national experts have assessed the situation in the context of assuring the quality of analytical works in their countries as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	improvement is required	significant improvement or comlete review is required	no significant changes are required	no significant changes are required

Analysis and determination of essential needs for improvement:

The sphere, where improvement is required	Explication
Increasing reliability authenticity of the monitoring data, improvement of the quality control management	Improvement of the quality control management is the objective for all services of the region, engaged in the monitoring. Procedures on the quality assurance and the quality control should become a good practice for any laboratory, engaged in observations over the quality of water resources. It would be practicable to assign a separate job position (post) for these activities. It will allow to carry out the objective inter-laboratory control, to develop programs on the equipment verification, to conduct training of the personnel and to carry out tests of sampling procedures and of analytical works.
The need in laboratories accreditation	Of course all laboratories engaged in the monitoring of the quality of water resources and especially of transboundary waters should be accredited in the long view for the compliance with international standards, In Kazakhstan this issue has been addressed, but for other countries of the region it is becoming quite important, especially in the view of starting the data exchange and cooperation on the quality of shared water resources.
The need in regular comparative testing and intercalibration	Participation of laboratories in comparative testings, between-laboratory tests and in other programs on checking the qualification of laboratories should become a good practice. These programs were duly financed and they should be included into monitoring programs or at least into the plans of these services.

On the regional level, for synchronization of efforts of countries on this issue it is recommended:

- To develop regional methodical guidance on the quality management and conducting the regional training for the personnel of laboratories, responsible for the control procedures and quality assurance.
- To realize the project of providing technical assistance to services in accreditation of laboratories engaged in monitoring of the quality of transboundary water resources in accordance with national and international standards.
- To develop the regional program on comparative testing and to introduce it on the regular basis.

2.3.8. SUBMISSION AND USING OF THE INFORMATION ABOUT THE QUALITY OF SURFACE WATERS IN MAKING DECISIONS ON WATER RESOURCES MANAGEMENT

The current situation:

Information about the quality of surface waters is prepared as a rule on the monthly or the quarterly basis in the form of tables (Kazakhstan) or information sheets (Kyrgyzstan) or in ТГ-52 format (Turkmenistan).

In Kazakhstan, the yearly data is passed by «Kazhydromet» branch offices to the Department of environmental monitoring, which is coordinated by the Director of the Department. By results of the year, the «Kazhydromet» database is checked and passed to the archive. The analytical report is not prepared, but information is published as a section of the "Information bulletin on the environment state" on official sites of the Ministry of Energy and «Kazhydromet». In the structure of «Kazhydromet» there is an Administration of ecological monitoring under the Department of ecological monitoring. Specialists of the Administration carry out the statistical checking, processing of the data with different temporal resolutions and release information bulletins. In addition, the information on the quality of surface waters is regularly requested by Ecology Departments on Jambyl and South-Kazakhstan provinces, by the Department of Natural resources management under the Akimat of Jambyl province. In case of detecting the high-level pollution, the operative information for Ecology Departments and Emergency Committees is prepared.

In Kyrgyzstan, the information about the quality of surface waters is sent on the quarterly basis in the form of the information sheet to the Ministry of Emergencies, the Ministry of Health, SAEPF, National Statistical Committee and also by the consumers' request. In the end of the year by results of the monitoring the summary "Annual data about the quality of land surface waters of the Kyrgyz Republic" is prepared. In addition, the yearly account about the quality of waters is submitted to SAEPF for preparing the National report about the state of the environment. Yearly reports are checked by the Chief of the Department and approved by the Director. Information about contamination of surface waters is placed at free access on the site. «Kyrgyzhydromet» provides by request the information about the quality of surface waters to the Government, state institutions and ministries, non-governmental organizations, international projects, private companies. In case if results of observations show that the quality of water has deteriorated, the information is immediately passed to the operative Department of the Ministry of Emergencies. In the Department of Observations over Contamination of the Natural Environment, the Chief Specialist is engaged in the processing of data and preparing of the information.

In Tajikistan, the information received in result of the yearly monitoring is approved by the Director of Hydrometeorology agency and is stored in the Agency fund. Analytical report is not prepared. The information is provided upon request, for example from the Government, the Committee of Emergencies, scientific-research institutions and international projects. For the last 5 years, several dozens of requested information sheets have been prepared. The specialist of the Information Department processes the data and prepares the information by the established form for the Committee on the Environmental Protection.

In Turkmenistan the Agency engaged in monitoring, does not pass the data, it remains in archives of the organization. Analytical reports are not prepared. More often the information is requested by international projects.

In Uzbekistan every year 75 types of information about contamination of surface waters are released. The information is sent to the State Environmental Committee, to the Ministry of Health and by request - to other state organizations. In addition, "Uzhydromet" prepares the

annual review about the quality of surface waters. There is an Information Department that is engaged in the analysis and summarization of the data on monitoring of water resources quality. The information about the quality of surface waters is not published in public sources.

As a whole, national experts have assessed the situation in the context of procedures of providing information about the quality of water objects as follows:

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
no significant changes are required	improvement is required	improvement is required	improvement is required	improvement is required

Results of activities of services on monitoring of natural waters quality are used by Authorities, engaged in making managerial decisions in different ways.

Thus in Kazakhstan the Committee of Environmental Regulation and Control of the Ministry of Energy uses the information developed by “Kazhydromet” on the quality of surface waters, for taking measures on mitigation (or clearance) of contamination in environmental objects. Occasionally, as and when necessary, the information about the quality of surface waters is used by the Environmental Prosecutor’s Office, Akimats, the Committee on Emergencies, District Departments on Natural resources and Environment. The Committee of Environmental Regulation and Control every month provides to «Kazhydromet» the data about measures taken on contamination of water objects,.

In Kyrgyzstan, the information developed by «Kyrgyzhydromet» is used on the national level on the regular basis. For example the information about the contamination level of surface waters is submitted to the Ministry of Emergencies, Ministry of Health, National Statistical Committee, SAEPF (the mandatory quarterly circular). To other organizations and agencies the information is provided by request. On the basis of submitted information, the contamination objects are examined and measures for improvement of the situation are taken. The national report on the environment protection is issued, the statistics on the nature protection is gathered. The feedback information about measures taken on contamination sources usually does not come.

In Tajikistan and Turkmenistan the information developed by laboratories for making the managerial decisions is used occasionally, as and when necessary. The feedback about taken measures does not come.

There is no data about that how the information, developed by “Uzhydromet” is used. The feedback about taken measures, as a rule, does not come.

As a whole, national experts have assessed the situation in the context of using the information about the monitoring of the surface waters quality in their countries as follows.

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
significant improvement or comlete review is required	improvement is required	improvement is required	significant improvement or comlete review is required	improvement is required

Analysis and determination of essential needs for improvement:

The sphere, where improvement is required	Explication
Improvement of the submitted information about the quality of surface waters	The information flows (especially in Tajikistan and Turkmenistan) about the quality of water resources can be essentially improved. For this purpose, it is required to determine on the national level, to which agencies and in what kind should the information be submitted on the regular basis. In addition, for all countries of the region it is recommended to consider the issue about preparing the informational-analytical reports about activities of hydrometeorological services on issues of the water quality monitoring. In these reports the received data should be summarized, the problems of the quality of water resources should be revealed, the analysis and localization of "hot" spots should be done, conclusions should be made about that whether the monitoring program has reached its purposes, etc. This will provide transparency of activities of services engaged in the monitoring of water objects quality and will add them greater authority on the national level, as the main supplier of the monitoring information. In addition, it is recommended to improve the character of informing the civil society about the qualitative state of water resources through adaptation of the information provided in a free access (on websites). The submitted information should be easily understandable and accessible to non-specialists, expressed mainly in graphic forms and in the color spectrum. Using of GIS and interactive maps can improve the visualization of monitoring data as a whole.

On the regional level for synchronization of efforts of countries on this issue, it is recommended:

- To realize the pilot project on development of analytical-information report about results of monitoring of the quality of water resources and to conduct a training for information groups.
- To realize the demonstration projects on the subject "Adaptation of monitoring information for consumers" (water users, civil society).

2.3.9. HYDROBIOLOGICAL MONITORING, THE CONTROL OVER THE CONTAMINATION OF BEDLOAD SEDIMENTS

The current situation:

The hydrobiological monitoring in Kazakhstan has been established in West Kazakhstan and Karaganda provinces since the end of 1980-s. The hydrobiological monitoring is carried out on benthos, biotest, zoobenthos, zooplankton, periphyton, and phytoplankton. The program of hydrobiological monitoring has been developed on the basis of GOST 17.1.3.07-82 «Rules of monitoring of the quality of water in water reservoirs and watercourses». In addition, since 2003 the work was started on determining the concentration of mercury in fish tissues and studying of morphometric characteristics of fish. However, there is limited data available about hydrobiological monitoring of transboundary watercourses between Kyrgyzstan and Uzbekistan.

Hydrobiological monitoring in Kyrgyzstan is not carried out, but is one of actual trends that should be developed. Currently in Kyrgyzstan, there are no specialists in the sphere of hydrobiological monitoring and there is no experience in carrying out researches.

In Tajikistane and Turkmenistan, the hydrobiological monitoring is not carried out because of the lack of equipment, methodology and specialists.

In Uzbekistan, currently hydrobiological observations by the monitoring network of

«Uzhydromet» are carried out on the monthly basis, since March till November, only within the limits of Tashkent oasis, on 10 water objects, in 27 section lines, including 1 section line on the river Boshkizilsay on the territory of Chatkal biosphere reserve. The quality of water and the ecological state of watercourses is assessed by indicative biocenosis, being of high- priority for conditions of the region – by periphyton and zoobenthos in accordance with the methodical recommendations “Methods of hydrobiological monitoring of water objects in Central Asia” (RU 52.25.32-97, Tashkent, 1997). At development of these recommendations the experience gained in realization of hydrobiological monitoring on observation networks was used, as well as original developments of specialists of the hydrobiological laboratory “Uzhydromet” on adaptation of available methods of bioindication to hydrobiological specifics of the region. For assessment of the water quality class saprobity indexes are applied. By results of hydrobiological monitoring the information is issued in the form of yearly periodicals, information sheets and monthly bulletins about the quality and ecological state of the water quality, the level of trophicity and ecological conditions of watercourses.

Samples of bedload sediments in Kazakhstan collected with the purpose to determine the character, level and rooting depth (penetration depth) of specific, contaminating substances for monitoring duration of self-purification processes, calculation of the balance elements, determining sources of secondary contamination and consideration of the anthropogenic factor impact. Collection and the analysis of bedload sediments is done on 38 water objects twice a year (in spring and autumn). Monitoring is carried out on the basis of GOST 17.1.5.01-80 “General requirements to sampling of bedload sediments in water objects for the contamination analysis”; NPRD F (Nature protection regulatory documents) 16.1:2:2.2.63-09 “The methodology of measuring mass content of vanadium, cadmium, cobalt, manganese, cuprum, arsenic powder, nickel, hydrogenium (mercurium), chrome, zink, in the samples of soil, ground and bedload sediments by the method of atomic absorption spectrometry with the use of atomic absorption spectrophotometer with electrothermal atomization”, NPRD F 16.1:2.21-98 «The methodology of measuring mass content of oil products in soil and ground samples by fluorimethric method with the use of fluid analyzer”. Analysis of bedload sediments within the frames of the event “Carrying out monitoring of transboundary transfer of toxic components” is carried out by X-ray fluorescence and neuro-activation analysis.

Up to 90-s of the last century “Tajikhydromet” carried out regular expeditionary works on the Sarez lake and Nurek water reservoir, but only for determining the siltation cone, without determining the contamination level of bedload sediments. Thus no issues or sources of the public health hazard for local population observed.

Analysis and determination of essential needs for improvement:

The sphere, where improvement is required	**Explication**
Lack of hydrobiological monitoring on transboundary rivers	Arranging regular works on hydrobiological monitoring on transboundary rivers in the long term should become an important aspect of activities of services on monitoring of water resources quality. The classification of the water object status by biological indicators is important as it allows to orient monitoring programs on the ecological state of water reservoirs. This issue should be first of all duly developed in Kazakhstan as it is supposed that this country in due course will pass to the ecological classification of the water object status. The current experience of EU countries shows that reaching of so-called “good ecological status”, which is first of all determined by safety of water systems, is becoming a target of water

	resources management. For this purpose all rivers and lakes should be classified by ecological regions and types. One water object (for example, a river) may consist of sections of different types, depending on the water collection area, the height of the watercourse bedding, geological formations and other criteria. For every type, the typical set of biological and chemical quality and hydromorphology elements (ecological quality elements, chemical quality elements) is determined. The hydromorphological, hydrochemical and hydrobiological monitoring allows to assess the ecological status of the water body and also to follow up whether the target status will be reached in the result of taken measuresor not.
Lack of monitoring of the quality of bedload sediments on transboundary rivers	The control of the quality of bedload sediments currently is not the priority task for services engaged in monitoring of water resources quality. Nevertheless, taking into consideration the content of suspended materials (air-born dust) in the medium and lower watercourses of rivers in the region, as well as modern landscape processes, taking place in upper reaches of rivers (mudflows, landslides, avalanches, ice lakes, melting of glaciers (deglaciation), monitoring of the content of contaminating substances of the natural or anthropogenic origin can become the important aspect for assessment of the general state of water resources. Taking into consideration that suspended particulate matters are physical carriers of some metals, synthetic organic substances, radionuclides, and zones of regulating river courses by dams are accumulating “traps” – then this aspect may seem important also for determining transboundary transportation of contaminating substances.

On the regional level, for synchronization of efforts of countries on this issue it is recommended:

- To study the need and requirements in organization of hydrobiological monitoring on transboundary rivers and to develop the support program for countries.
- To study the need and requirements of organization of monitoring of the quality of bedload sediments on transboundary rivers and to develop the support program for countries.

CHAPTER 2.4.: TRANSBOUNDARY/REGIONAL COOPERATION BETWEEN HYDROMETEOROLOGICAL SERVICES ON WATERS QUALITY MONITORING

The Diagnostic Report[9] has specially emphasized the regional cooperation between CA countries on the quality of water resources, at that stating that the level of such cooperation is not effective enough. Section 1 of this document related to actualization of the Diagnostic Report, in the context of regional cooperation (Chapter 1.3) contains the thesis on that for development of the regional/inter-state cooperation on the quality of transboundary water resources in Central Asia still significant efforts and targeted policies both from the countries themselves and also from international structures are required. Therefore, within the frames of this study, the issue of cooperation between hydrometeorological services, as the most effective national structures on studying water resources quality, was elaborated in more details by national experts.

At present, the hydrometeorological services of Central Asian countries are important "providers" of the monitoring information at the national level, both in terms of the quantity of water resources and also by their quality, forecasting the hydrological situation on water objects, responding to critical state of water resources, including sudden changing of water resources quality, general assessment of the state of surface water resources. Thus, specification of the degree of hydrometeorological services participation in the regional cooperation is extremely important for planning measures on strengthening the cooperation of countries on issues of transboundary waters quality.

Annex 5 shows the extent of hydrometeorological services' involvement in international conventions in which countries of the region participate. Not all considered conventions are directly related to water resources, but in this way or another deal with them, to a fuller extent or indirectly.

Thus, for example, hydrometeorological services of Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan are very closely involved in addressing issues of the United Nations Framework Convention on Climate Change (Rio de Janeiro, Brazil, 1992). They participate mainly in the context of the climate information. Within the framework of obligations under the "UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus, Denmark, 2000), the hydrometeorological services of Kazakhstan and Kyrgyzstan ensure transparency of the information on the environment quality, including on issues of water resources quality. In Tajikistan, the hydrometeorological service also participates in activities of the Aarhus Center under the Committee for Environmental Protection, providing the monitoring information upon request.

At the same time, the formal participation of hydrometeorological services in other international conventions is not observed. Their participation is limited by attraction of individual specialists to projects or workshops.

[9] For development of the regional cooperation on provision of the quality of waters in Central Asia and the plan on the cooperation development, 2012

The most important convention on the quality of transboundary water objects is the “UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, Finland, 1992) and the “Protocol on Water and Health”. Only three countries in the region (Kazakhstan, Turkmenistan and Uzbekistan) are parties to this convention. However, the role of hydrometeorological services in implementing provisions of this Convention is currently limited. In the long view, this Convention could become an important element in strengthening cooperation of countries of the region on many issues of transboundary watercourses management and protection.

In addition to international Conventions in the Central Asian region there are also regional Agreements that directly concern environmental and water resources issues (Annex 6). It should be noted that for today none of these Agreements explicitly includes issues of cooperation between countries on the quality of water transboundary resources into the agenda. Consequently, the hydrometeorological services are not involved in activities under these Agreements regarding the quality of water resources, though they are involved in other issues of Agreements implementation by providing the necessary monitoring information.

At the same time, there always existed a mechanism of cooperation and information exchange between hydrometeorological services, which was laid down still at establishment of these services (Annex 7). At the agency level, all hydrometeorological services of CA countries to the full extent cooperate on the hydrological and meteorological data exchange, as well as on the exchange of normative and methodological documents in the field of hydrometeorology and environmental protection. However, there is no information exchange on the quality of water resources, on methodological issues of assessment and analysis of the monitoring data on the water quality, on notification about the dangerous divergence of the water quality.

Bilateral agreements also can become an important mechanism for cooperation between countries on issues of water resources protection. Today, there are two such agreements in the region (Appendix 8). Thus, within the framework of the basin agreement between Kazakhstan and Kyrgyzstan on using of interstate water facilities on Chu (Shu) and Talas rivers there are examples of successful cooperation in joint environmental monitoring of transboundary watercourses and exchange of the monitoring information on the water resources quality. The key moment of such cooperation was establishment in 2016 of an expert working group on the environment under the Chu-alas Water Commission Secretariat.

Summing up, it can be stated that carried out analysis of cooperation mechanisms on issues of the quality of transboundary water resources in CA region (on the example of hydrometeorological services) demonstrates that with few exceptions there is no interaction between countries on this issue. The reasons for such situation have been analysed in national reports, which can be summarized as follows:

- Difficulties with the interstate division of shared water resources, in some cases – uncertainty of issues with operation and maintenance of the hydraulic infrastructure,

problems with regulation of the river discharge, taking into account water use priorities for hydroenergetics and irrigation. In such a situation, issues of regional cooperation on water resources quality often become less important or are ignored.

- Inconsistency of measures on reforming the water sector in the region in the context of IWRM principles, inadequate application of the basin approach to water resources management at the national and regional levels, and as a result, insufficiently active inclusion of issues of transboundary watercourses quality into the agenda of Governments and agencies making managerial decisions of regional significance.
- Not full coverage of countries of the region for participation in international conventions related to transboundary watercourses, in particular in the “UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, Finland, 1992)”.
- Lack of the legal basis of the regional or basin nature (except for Chu and Talas rivers) for cooperation of countries and departments on issues of shared watercourses quality. In this regard, there are no mechanisms for realization of such cooperation.

CONCLUSION

The study of needs of systems of monitoring of surface waters quality in the CA region showed the urgent need to reform and modernize this important water management sector, both at the country level and also in the regional context. National reports have recommendations and proposals specific to each country on improvement of water quality monitoring systems. This conclusion presents recommendations and proposals summarized in the regional context on responding to present-day regional challenges currently faced by hydrometeorological services engaged in monitoring of the quality of surface waters.

Recommendations of this study on identifying needs in the sphere of ensuring quality of surface waters in the region can be broken down into several interrelated areas. The conducted researches allow to formulate the basic strategic lines of such reform that consist in the following:

A. reforming of the water policy for monitoring the water quality in the IWRM context;
B. increasing the material and technical, methodological and human capacity of hydrometeorological services engaged in monitoring of the quality of water bodies;
C. promoting regional cooperation on issues of ensuring quality of transboundary water resources;
D. coordination and integration of efforts of countries on improvement of the system of monitoring and management of transboundary waters quality.

A. Reforms in the sphere of water policy

Though a detailed analysis of national legislative and institutional frameworks for the water quality monitoring was not the main objective of this study, but based on actualization of the Diagnostic Report and studying needs of water quality monitoring systems at the national level in the CA region countries, it can be stated that, despite of that the IWRM principles are reflected in the legislation of a number of CA countries, but their practical application for monitoring of the quality of surface water resources has not been yet duly developed.

It is reflected in the insufficient application of the basin principle in organization of monitoring networks, choosing quality parameters for determining the status of water bodies, applied standards and systems for classification of natural waters quality, sometimes in duplicating efforts of various agencies on monitoring water resources quality, lack of the information exchange between these agencies, and the most important - in the lack of clear understanding of the role of the data on water resources quality for making managerial decisions on ensuring the quality of water bodies.

Therefore, revision or adaptation of national water policies in general and in the context of on ensuring the quality of water resources, transferring natural waters

management to the planned principle, establishment of perspective target indicators on the quality of water objects for ensuring the reliable water use and protection of water/near-water ecosystems, overall coordination of agency-level monitoring systems of the water quality can become an important step at the national level.

As the first steps, it is recommended to carry out a relevant analysis of the legal and institutional framework in countries of the CA region concerning monitoring of the quality of surface water resources in order to add integral functions to monitoring of the quality of water bodies as an integral element of IWRM and defining an appropriate institutional platform for this. It is important to assign authorities and responsibilities to the national body/agency for formulation and implementation of national policies in this direction. Such a body/agency may be responsible for development of norms/standards on the quality of natural, waste and return waters, systems of water resources classification by their quality, division of water resources into water management or ecological sections in the context of existing and prospective water resources management and protection of relevant ecosystems, development of methodologies on assessment of the impact of pollution sources and defining national environmental priorities related to the quality of natural waters, setting target indicators on the quality of water bodies, depending on their economic or environmental purpose, development of plans on ensuring the quality of water bodies, coordination of departmental monitoring programs, preparing national reviews on the water quality, implementation of methodological and technical policy in the sphere of monitoring the quality of natural waters and standards for discharges etc.

In order to assist countries in this direction, it is recommended to develop a regional project that will study the existing national legislative and institutional specifics and will develop a set of recommendations for governments to add advanced functions and institutional frameworks to water quality monitoring systems in the IWRM context.

B. Increasing capacity of monitoring systems

For obtaining regular and reliable data on the quality of water bodies at the national and regional levels, certainly it is needed to increase the capacity of national services engaged in the monitoring of water resources quality. For today it can be considered a priority task in the CA region in the context of surface waters quality management. This study (section 2) has identified the main areas where it is needed to improve monitoring systems by countries and by the region as a whole:

The sphere, where improvement is required	**Kazakhstan**	**Kyrgyzstan**	**Tajikistan**	**Turkmenistan**	**Uzbekistan**
Planning of monitoring programs					
Spectrum of the water quality parameters for the monitoring					
Systems of assessment and classification of the quality of					

The sphere, where improvement is required	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
water resources					
Ensuring samples selection and transportation of samples					
Logistic and maintenance support of laboratories					
Provision of reagents to laboratories					
Methodological support of laboratories					
Staffing support of laboratories					
Information storage systems					
Data processing, interpretation and visualization of data					
Quality control at selection of samples					
Quality control at analytical works					
Information flows about the quality of water resources					
Using of the monitoring information					
Explication:					
Significant changes and reforms are needed, current approaches have to be revised					
Changing, modernization and specification of applied approaches is required					
No significant changes are needed, but efforts are needed for improvement of the situation					

Thus, the identified wide range of needs for carrying out the proper monitoring of water resources quality (on the example of hydrometeorological services) can be tentatively divided into three main groups, and namely:

- Material and technical capacity
- Methodological capacity
- Human capacity

Strengthening of the material and technical capacity. As of today, the adequate material and technical support of laboratories and expedition groups on samples selection is a critical factor in implementation of monitoring programs. Limitation of funds allocated for modernization and development of the technical capacity of laboratories engaged in the monitoring of surface waters led to the physical and moral exhaustion of the equipment fleet and, as a consequence, to reduction of a number of observation posts and of the number of studied indicators. Some laboratories do not have the basic equipment for doing analysis of heavy metals, oil products, SSAS, phenols and other industrial pollutants. Not all countries do analysis of priority industrial substances, Persistent Organic Pollutants, herbicides and pesticides.

One of important problems identified at the national level in all five countries is the inadequate equipping of expedition groups engaged in samples collection, doing primary analysis in-situ, conservation of samples and their delivery to analytical laboratories. There is a shortage or lack of instruments for doing the express analysis, there are no modern means for samples selection, cooling chambers,

specialized transport for the delivery of samples, sometimes –specialized dishes, containers and even reagents.

Of course, the situation with the material and technical capacity currently varies from the country to country, from the laboratory to laboratory. In any case, equipping of laboratories with modern analytical equipment for performing the required set of analysis at the expense of national budgets can be implemented only very limitedly. Therefore, for addressing this issue the donor support is needed. In this regard, this study strongly recommends to develop a regional project. Within the frames of this project it is necessary to carry out a detailed audit of the material and technical equipage of services engaged in the monitoring of water resources quality, to identify priorities for modernization of laboratories and equipage of expedition groups, to develop a regional investment plan for technical re-equipage and to prepare specification of the necessary equipment. Based on such a plan, at the next stage it is necessary to purchase and install the new equipment and to conduct a training on working with new equipment.

It is also important to mention the need to provide laboratories with necessary premises. In most cases, in the region, there are not enough laboratory areas, or buildings and premises do not meet essential standards, for some of them the major repairs or even construction of new premises is needed. Without addressing this issue, it is impossible to set going implementation of the quality monitoring, to accomplish accreditation of laboratories in accordance with national and international standards. The issue with premises should be mainly addressed through national funding.

In addition, it is necessary to address the issue with laboratories that supplement activities of central laboratories. Previously, in all countries, along with the central laboratories of hydrometeorological services, there was organized a network of regional (district) laboratories. Such a structure has been preserved and is functioning effectively in Kazakhstan, but in other countries the majority of regional (district) laboratories are either liquidated (Kyrgyzstan) or, because of the lack of equipment, reagents and qualified personnel, they are not able to carry out the set of required analysis (Tajikistan, Uzbekistan). In this regard, it is recommended to carry out a feasibility study on maintaining such laboratories and to decide whether their reanimation and further development is justified, or, it would be more effective to re-profile them for selection and transportation of samples to central laboratories, while expanding the area of sampling coverage and increasing the number of posts and frequency of water samples selection.

Strengthening of the methodological capacity. As this study has shown, the services engaged in the monitoring of water bodies quality have difficulties with the methodological support of their activities. This is using of outdated approaches to planning of monitoring networks, selection of water quality parameters for analysis, quality standards (MPC) and classifiers of water bodies. These approaches have not been revised already for several decades. Today, practically the entire regulatory and methodological basis for monitoring of surface waters quality in the region, with

rare exceptions (Kazakhstan), has remained unchanged in its essence still since the times of the Soviet Union.

Therefore, it is recommended to strengthen the methodological capacity of water quality monitoring in the region through a number of regional pilot/demonstration projects, by implementing which it is possible:

- to develop and test a series of regional methodological tools on planning and optimization of monitoring programs in the context of IWRM; on procedures of sampling and doing field measurements; on the analysis, processing, verification and visualization of data on the quality of water resources; on the quality management and procedures of the control and quality assurance etc.
- to develop and implement a pilot project on testing different approaches to water quality assessment (MPC, WPI, CWPI, the water body status, quality classes, water use classes, etc.) and their application in the regulating system.
- to develop and implement a demonstration project on development of an analytical and information report on results of monitoring of water resources quality and adaptation of the monitoring information for consumers and for making decisions.

Strengthening of human resources capacity. In the course of this study, it was revealed that certain efforts are needed in the region for maintaining and strengthening human resources capacity for water quality monitoring. Currently, the lack of qualified personnel has become one of key problems for some countries. Therefore, it is recommended to organize the process of professional development of the staff at the regional level. In the future, it can be accomplished through establishment of a regional training centre. On the basis of this centre regular thematic trainings for managers, engineering and laboratory personnel from all countries of the region can be carried out.

In the nearest future, for supporting countries in this direction, it is recommended to develop a regional project that will be aimed at preparing and carrying out basic trainings, for example for expedition groups, for the personnel of laboratories, for managers, for information groups and other specialists engaged in processing and analysis of the monitoring information, for specialists engaged in monitoring and ensuring the quality of data etc.

C. Supporting of the regional cooperation on the quality of water resources

As actualization of the Diagnostic Report (Chapter 1.2) showed, the cooperation of countries of the CA region on issues of the quality of shared water resources is still not effective enough. Fundamental principles of the Diagnostic Report still remain important.

Today, at the regional level, only this UNECE/CAREC project supports the cooperation of countries of the region on water quality issues. One of its crucial tasks is formation of a permanent Regional Working Group and ensuring its legal status, possibly under the aegis of one of international structures in the region (IFAS, ICSD,

ICWC). For this purpose, first of all, it is necessary to develop the mandate of RWG, to define its tasks, responsibilities, legal status and activities regulations.

At the level of certain river basins in the CA region, currently only the Chu-Talas Water Management Commission (Kazakhstan, Kyrgyzstan) has an expert group on environmental issues in its structure that deals with issues on water quality monitoring. Currently, by efforts of these two countries and with the support of the GEF project, the transboundary monitoring is being developed in this river basin. Therefore, support is needed for this working group, among others on issues of coordination of a unified system for assessment of the quality of water resources, organization of a transboundary monitoring network on the basin principle, setting target parameters on the quality of water resources in rivers etc. The experience of the Chu-Talas Water Management Commission on the water quality can become a model for other transboundary basins in the Central Asian region.

Thus, as it was mentioned in the Diagnostic Report, the main priorities on cooperation between countries in the context of the quality of shared water resources, at the first stage, suggest the unification (harmonization) of the regulatory and legal framework for the water quality regulation, and namely:

- agreed classifiers of water resources quality for transboundary river basins;
- agreed list of water quality indicators for monitoring of transboundary watercourses and especially hazardous priority sources of pollution;
- agreed values of maximum permissible concentrations (quality standards) for the region or basins of transboundary rivers;
- unified methods and instrumentation for measuring the quality indicators of natural transboundary waters;
- an agreed methodology for processing the monitoring information;
- coordinated procedures on the regular exchange of data on water resources quality, including criteria and procedures of prompt notification at sudden contamination of transboundary waters.

But for the sustainability of regional cooperation on the quality of transboundary water resources in the CA region, certainly a definite political platform is needed that can be implemented through the RWG mechanism or basin agreements on the quality of water resources.

D. Coordination and integration of efforts of countries on responding to new challenges

The following areas of the regional cooperation between CA countries can become important in the future. And though today such issues are not clearly and urgently included into the agenda of services engaged in the monitoring of the quality of surface natural waters, but they represent new challenges with which countries of the Central Asian region started already to come across. National water policies and Water Resources Management in the strategic plan should take these challenges

into account and offer their responses. In these issues, the regional coordination and integration of countries' efforts will be a critical factor.

Step-by-step restoration/extension of the network for monitoring the transboundary watercourses quality. As this study has shown (chapter 2.2), currently, the density of observation posts for monitoring of the quality of main transboundary watercourses in the region in the most cases is low. This does not allow to obtain the adequate information. As a rule (on 9 from 13 transboundary watercourses), only one country carries out monitoring of the watercourse quality, while other countries do not have the necessary information about the water quality, because the monitoring is not carried out on their territories. Therefore, while planning monitoring programs at the national level, it is highly advisable to coordinate location of observation posts taking into account the monitoring network of the neighbouring country. Over the long term it will allow to gather the information and judge about the quality of transboundary rivers. This is the first step towards establishing a regional network for monitoring the quality of transboundary watercourses in the CA region.

The basin approach to organization of the transboundary monitoring. As carried out studies show, currently, the IWRM principles are not applied in the monitoring of the water quality in transboundary watercourses in CA countries. Analysis of the location and functioning of observation posts for major transboundary watercourses in the region (Section 2) showed that there are not enough observation posts (for the majority of rivers, one observation station comes to 200-800 km of the river bed) for obtaining information on the quality of the river on its various environmental and water-resources sections, for different water ecosystems, in zones of basic water consumption and in areas affected by anthropogenic pollution sources.

Therefore, the basin approach in organization of a monitoring network for monitoring the quality of water resources, primarily of transboundary water resources is a challenge for all countries of the CA region. It is important from the point of view of IWRM principles application, as the quality of water in river systems is formed on the basis of particular qualities of this or that concrete basin (geology, water-collecting area, hydromorphology of riverbeds, substrates, biological cenosis, sources of point and diffuse pollution). Therefore, on a regional, transboundary scale, it is necessary to orient at organization of a monitoring network by the basin principle, covering the upper, middle and lower reaches of rivers, different climatic zones, topographic and landscape features (rivers typology), water management conditions and requirements for protection of water use and various ecosystems along the whole river. Such formulation of the task on designing monitoring networks is quite new for the region and it is associated with targeted planning of water bodies quality, identification of different conditions for water quality formation in the catchment area, assessment of the quality of the watercourse as a single hydrographic unit, and so on.

Therefore, it is recommended to start addressing the issue of basin organization of the monitoring network with development of a pilot and demonstration project for some rivers that will demonstrate the application of the basin approach to planning of water quality monitoring programs and show the ways and special aspects of building monitoring networks under the new principle in the light of IWRM.

Exchange of the information on the quality of water resources in the basin/regional context. As of today, there is no exchange of information between the countries on the quality of joint watercourses and transboundary water bodies, with few exceptions (in the Chu-Talas river basin the information exchange on the quality of transboundary watercourses is more or less arranged). This is due primarily to the lack of bilateral, regional or basin agreements on such information exchange. Today, none of international structures in the region sets addressing of water quality issues as its primary task, accordingly, there is no any interstate mechanism for sharing the information on the quality of water resources with the neighbouring country. It is possible to overcome this gap only by including the issues of awareness raising and exchange of the monitoring information into the agenda of one of international structures.

Therefore, for actualization of this issue it is recommended to develop a project on formation of a unified information system (database and analytical GIS unit) on the quality of transboundary waters in the CA region. In the long term it can become the basis for the exchange of agreed information on the quality of shared water resources.

Moreover, at the first stage, it would be advisable to study the possibility of exchanging information on the quality of transboundary rivers in the region through a departmental system of hydrometeorological services. Today, hydrometeorological services exchange the climate and hydrological data, but not the data on the quality of water resources. As mentioned in the Diagnostic Report, it is recommended to start the exchange of data by a limited list of indicators (temperature, oxygen, BOD/COD, nitrates/ammonium, mineralization). First of all, it will demonstrate the willingness of countries to cooperate on this very important issue.

Climate changes and the quality of natural waters. Currently, global climate changes and searching ways to adapt to them are becoming important issues in the agenda of many regions, including the CA region, where water resources are particularly vulnerable, both from the quantitative and also from the qualitative point of view. But, unfortunately, today in the region there is practically no information on the response of quality characteristics of water bodies to the climate change, as well as there are no long-term forecasts on the quality of natural waters in the light of climate changes. The current monitoring networks on the water quality in the CA region are not able to fix such changes and long-term trends, as they were designed for other purposes. Therefore, at the regional level it is recommended to design a specialized regional monitoring network that could fix climatic trends and changes, including changes of the quality of water resources. The location of observation posts for such a network and selection of limited water quality parameters should be

correlated with the meteorological and hydrological information. Presumably, such unified regional network could be built on the use of automated climatic, hydrological and hydrochemical complexes located in remote locations, that exclude the human impact and transmit information to central servers in the automatic mode. The related issue is the question of identifying such sections of watercourses and establishing monitoring of so-called reference conditions.

Improving the quality and reliability of monitoring data. As a whole, for the Central Asian region the issue of reliability of the received monitoring information on the quality of natural waters is important. It is connected both with the incompleteness of monitoring networks, insufficient frequency of samples selection, the use of morally and technically obsolete laboratory equipment, using of different methods and instruments, and also directly with samples selection and carrying out analytical procedures. Often the data of laboratories vary even when doing analysis of the same water sample, which causes distrust to the received information. And although in the most cases laboratories have established procedures for monitoring and ensuring the data quality, nevertheless, only laboratories in Kazakhstan have international accreditation. Therefore, it is recommended to implement a project of technical assistance to services in accreditation of laboratories engaged in the monitoring of the quality of transboundary water resources in accordance with national and international standards, and to develop a regional program of comparative tests and intercalibration of laboratories and to introduce it on the regular basis.

Adding ecological elements to the monitoring of the water quality. Currently, the monitoring of the quality of water resources in the CA region is mainly limited to monitoring of physical and hydrochemical parameters of the water quality. Only in Kazakhstan and Uzbekistan monitoring of the water quality by hydrobiological parameters is established and that is only for certain water reservoirs. Also, in the region, studies of the chemical quality of bedload sediments, the content of hazardous compounds in fish tissues and other hydrobionts, studying of the water quality on the basis of biological tests (biotesting) are carried out very rarely. Moreover, any specialized studies on the typology of watercourses and lakes for organization of water resources management by the basin principle, as well as assessment of hydromorphological changes caused by the human influence have not been carried out yet in the region.

However, in the future, these issues can become important for the region, especially in the light of prospects for the ecological rationing of the water quality, transition to the assessment of ecological status of reservoirs, consideration of the biological and hydromorphological components of the water quality. Such an integrated approach was determined by the European Water Framework Directive for countries of the European Union, when so-called "biological elements of water quality" began to be used as the main criterion for assessing the status of water bodies. This required a radical revision of principles for organization of the water quality monitoring systems, planning of monitoring programs and interpretation of the received data. All this led to that the system of surface waters quality monitoring in the European Union, from a

passive tool for data accumulation, became a part of active management of the quality of water resources for bringing them to a planned, targeted ecological status. In this case, monitoring of the quality of water resources (Chapter 1.1) becomes an instrument not only for assessment of the quality of water objects, but also provides an adequate information for bodies making decision on taking necessary measures for improvement of the quality of natural waters and serves as a tool for assessment of the effectiveness of taken measures.

ANNEXES