Preparatory Survey on Integrated Water Resources Management in the Syrdarya River Upper Basin
Final Report
Summary

April 2010

Japan International Cooperation Agency (JICA)

Japan Water Forum
Japan Water Agency
NEWJEC Inc.

Cost Estimation in this report is based on price levels as of October 2009. The applied currency exchange rate is as follows.

Currency Exchange Rate

1 com = 2.03 yen
1 Somoni = 20.5 yen
Exchange rate as of October 1, 2009

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Abbreviations

ADB	Asian Development Bank
ASBP	Aral Sea Basin Program
BVO	Basin Valley Organization
CACO	Central Asian Cooperation Organization
CAIAG	Central Asian Institute for Applied Geosciences
CARs	Central Asian Republics
CAPS	Central Asian Power System
CAREC	Central Asia Regional Economic Cooperation
CDC	Nongovernment Noncommercial Organization Coordinating Dispatcher Center <Energy>
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
CIS	Commonwealth of Independent States
DOE	Department of Energy, USA
DSM	Demand Side Management
EBRD	European Bank for Reconstruction and Development
EC-IFAS	Executive Committee IFAS
ECO	Economic Cooperation Organization
EEC	Eurasian Economic Community
EU	European Union
EU/TACIS	The European Union's Technical Assistance to the Commonwealth of Independent States
F/S	Feasibility Study
GEF	Global Environmental Facility
GIS	Geographic Information System
GPS	Global Positioning System
GWP	Global Water Partnership (NGO)
HPP	Hydro Electric Power Plant
ICAS	Interstate Council on. the Aral Sea Basin Problems
ICWC	Interstate Coordination Water Commision of Central Asia
IFAS	The International Fund for Saving the Aral Sea
IWRM	Integrated Water Resources Management
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
NEDO	New Energy and Industrial Technology Development Organization of Japan
NOAA	National Oceanic and Atmospheric Administration
ODA	Official Development Assistance
SCADA	Supervisory Control and Data Acquisition
SCO	Shanhai Cooperation Organization
SDC	Swiss Development Cooperation
SIC-ICWC	Scientiffic Information Center of ICWC
SRM	Snowmelt Runoff Model
T/A	Technical Assictance
TPP	Thermal Power Plant
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organization
USAID	United States Agency for International Development
WASP	Wien Automatic System Planning Package
WB	World Bank
WEC	Water Energy Consortium
WHO	World Health Organization

<Unit>

BCM	Bilion Cubic Meter
MTOE	Milion ton oil equivalent
MWh	Megawatt-hours(1 thousand kilowatt-hours)
GWh	Gigawatt-hours(1 million kilowatt-hours)
TWh	Terawatt-hours(1 billion kilowatt-hours)
mln	Million
bln	Billion

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Chapter 1 General Description of the Survey

1-1 Background of the Survey

(1) Startup of “Central Asia + Japan” Dialogue and the first survey

The government of Japan launched the “Central Asia + Japan” Dialogue in August 2004 while then Japan’s Minister for Foreign Affairs, Kawaguchi, was visiting Central Asian countries to promote cooperation. As one form of support determined in these dialogues, a supporting program to be applied in 2005 to cooperate with Central Asian countries was studied. For this purpose, JBIC researched the management and control of water resources and hydro power, mainly focusing on hydro power.

The first survey showed that even if the irrigation within the region is used according to conventional regulations, each country could benefit economically through the optimization of international hydro power interchange.

In the second foreign ministers’ meeting held in 2006, an “action plan” showing concrete policies in the following five fields (1. Political dialogue, 2. Cooperation within the region, 3. Business promotion, 4. Intellectual dialogue, and 5. Cultural exchange and human exchange) was signed to formulate a system which promotes cooperation within the region. The “action plan” clearly defines that “water and energy problems” are one of the targets for regional cooperation and support.

According to the “action plan”, Central Asian countries are required to voluntarily participate in the plan and foster relations of mutual trust with each other. Japan announced plans to supplement these voluntarily efforts and study the feasibility of cooperation (including technical advices) if the orientation of practical cooperation is clearly defined.

(2) “Central Asia + Japan” Intellectual Tokyo Dialogue

The second “Central Asia + Japan” Intellectual Dialogue was held in Tokyo on January 30, 2007. The theme was “Prospects for Regional Cooperation in Central Asia on Water Resources and Electric Power”[Note)]. In the discussion it was pointed out that regional cooperation is necessary for appropriate distribution of water resources and hydro power. It was also pointed out that Japan should:

- Offer its excellent technologies concerning water saving, water resources management, energy saving, etc. to Central Asiatic countries.
- Provide technical cooperation in terms of software for system reformation concerning

management etc. of hydro power-related facilities such as generation, transmission and distribution.

- Start with projects which will be conduced within a country but nevertheless will have a regional impact rather immediately venture gigantic projects which will go beyond borders
- Offer opportunities for in-depth discussion at the political level as well as technical level among Central Asian countries.

Note: "Central Asia + Japan" The Second Tokyo Dialogue - Chairperson's Summary -, January, 2007

(3) Second survey in 2008 (hereafter 2008 Survey)

Reflecting the recommendations made in the first Tokyo Dialogue, JBIC and Japan's Ministry of Foreign Affairs conducted a "Survey on regional cooperation for electric power and water resources" based on results of the survey conducted in 2005.

In the Central Asia, there is an unsettled dispute between the Kyrgyz Republic[Note)] and Uzbekistan and Kazakhstan regarding the operation of water available from the Toktogul Reservoir located in the Kyrgyz Republic (Upstream of the Syrdarya River). This is because the Kyrgyz Republic uses the water for generation in winter, while Uzbekistan and Kazakhstan significantly increase water demand in summer for irrigation. There also has been conflict between Tajikistan which depends on hydro power generation and Uzbekistan over the erection of hydro power generation.

The survey focused on the water resource, studying how to reduce the damage caused by water discharged for generation through the Syrdarya River and how to improve water resources management.

Based on results of the survey, recommendations on improvement of water resources were presented. These improvements include: support to emphasize a monitoring system for hydrology and water use especially in the Kyrgyz Republic located in the upper basin of the Syrdarya River, support for a national water resources management project, and enhancement of power plants to cope with insufficient hydro power supply.

Note: In this report, Central Asiatic countries having "stan" meaning "nation" are designated as they are while Kyrgyz Republic having no "stan" is called Kyrgyz Republic.

1-2 Objectives of the Survey

Based on the background described in 1.1 and results of the survey in 2008, the objectives of this survey were set up as follows:

[1] To understand the basic information sharing system on water resources and water resources information-related facilities and equipment for optimizing water resources management in

countries upstream in the Syrdarya River.

[2] To identify basic information for developing a plan of sharable water resource information-related facilities among the basin countries. For this purpose, the Kyrgyz Republic was regarded as the model country.

[3] To identify basic information for developing guidelines for the monitoring and data integration and analysis system. For this purpose, the Kyrgyz Republic was regarded as the model country.

[4] To suggest effective assistant methods and processes to achieve the above objectives in the proposal for enhancing integrated water resources management in the Kyrgyz Republic and Tajikistan.

1-3 Description of the Survey Service (TOR)

The TOR of this research was as follows:

Sharing of information on the water resources necessary for countries along the upstream basin of the Syrdarya River to appropriately manage the water resources; checking of fundamental information on the maintenance of all water resources information-related facilities and equipment; and studying of possibilities of cooperating services which JICA planed to offer to these countries.

This research was conducted to collect basic information described above and to determine the orientation of Japanese support. As basic material to study an information database system necessary for the improvement of the water resources management of a country (in this case, the Kyrgyz Republic was selected as the model), an observation system, data integration and analysis system guidelines (plan) were prepared. This survey service also proposed cooperation items to improve the integrated water resources management in the Kyrgyz Republic and Tajikistan.

(1) Collecting and checking of fundamental information

Water distribution and water resources management conditions determined by representatives of countries on the Syrdarya River (with support of the ICWC) and the state of implementation of these conditions by Syrdarya River watershed organizations.

- To understand the water resources management status of the Kyrgyz Republic and Tajikistan, we collected and analyzed the following basic information.

1) Policies, laws and regulations related to the water resources management.

2) Organization, system, personnel and budget of ministries and agencies related to the water

resources management

3) Existing GIS database system, monitoring system and the integrated analysis method related to the water resources management.
4) Accessibility of source data of the database used for integrated water resources management.
5) Investigation of the water system (hydrology, water use and nature of the soil)
6) Facilities for the acquirement of fundamental information on hydrology and water use to implement water resources management
7) Socioeconomic framework (industrial structure, etc.), population movement, water demand and water balance, countermeasure scenario

(2) Checking of supporting states and contents of individual donors

We roughly grasped activities carried out by other donors and conducted investigations and coordination to enable Japan to efficiently support promotion of water resources improvement without causing duplication or a lack of support.

1) Water resource management plan of the countries supported by UNDP and other donors.
2) Transboundary water resources program implemented by GTZ,
3) The transboundary river management improvement program implemented by ADB and other water resources related management capacity building programs to be implemented.
4) The river basin organization capacity building programs being implemented by donors including WB and other collaborative international organizations.

(3) Drawing up a plan to emphasize the function of integrated water resources management

We checked contents shown in (1) above against the integrated water resources management plan of the countries supported by the donors and developed a support plan for fields requiring support.

1) Study an arrangement method for the water resources management database which is to be used by associated countries as common information. This study took the Kyrgyz Republic as the model country.
2) Review meteorologic, hydrologic and water quality observation (system design, data management, maintenance management) guidelines
3) Review Kyrgyz Republic standard specifications of monitoring facilities and the basic plan of monitoring facility networks

4) Review the regional data sharing system basic improvement plan

5) Develop an observation system and integrated data analysis method; and a training plan to nurture human resources and a technology transfer plan relating to maintenance and operation.

1-4 Survey Target Area

This survey covered facilities used for river condition observation, hydrological measurement and water use analysis, located in the upper basin of the Syrdarya River including the Kyrgyz Republic and Tajikistan. Figure 1-4-1 shows the survey target area.

Fig. 1-4-1 Survey Target Area

1-5 Members of the Survey Team and Trips tothe Site

The survey service was performed by the following personnel who were responsible for individual tasks shown in the table below.

Table 1-5-1 Members of the JICA Survey Team

Name	From	Area
Mr. Tetsuro Miyazato	Japan Water Forum	Leader, Water Resources Management
Dr. Takeyoshi Sadahiro	Japan Water Agency	Co-Leader, Water Resources Management, Organization and System
Mr. Taketoshi Matsunaga	NEWJEC Inc.	Hydrological, Meteorological, Water Use Analysis A
Mr. Sadayuki Hironaka	Japan Water Forum	Hydrological, Meteorological, Water Use Analysis B
Dr. Rokuro Kobayashi	Deer Consultants Inc.	Observation and Monitoring System A
Mr. Masahiro Sugiura	Japan Water Agency	Observation and Monitoring System B
Mr. Shigeru Kawamatsu	Ebara Densan Ltd.	Information System

The following shows a list of local organizations we visited during the first site survey.

Table 1-5-2 Surveyed Organizations during the First Site Survey (Uzbekistan)

Date		Visited Organization
1	Sept. 28, 2009	JICA Uzbekistan Office
2	Sept. 29	UNDP
3	Sept. 29	USAID
		ADB
4	Sept. 29	Japanese Embassy in Uzbekistan
5	Sept. 29	WB

Table 1-5-3 Surveyed Organizations during the First Site Survey (Kyrgyz Republic - No. 1)

Date		Visited Organization
1	Sept. 30	JICA Kyrgyz Republic Office
2	Oct. 1	Water Economy Department, Ministry of Agriculture, Water Resources and Processing Industry
3	Oct. 1	Hydromet
4	Oct. 1	Japanese Embassy in the Kyrgyz Republic
5	Oct. 1	Ministry of Foreign Affairs
6	Oct. 2	Hydromet

Date		Visited Organization
7	Oct. 2	ADB
8	Oct. 2	GTZ
9	Oct. 5	Ministry of Foreign Affairs
10	Oct. 5	Electric Power Plants
11	Oct. 6	JICA Kyrgyz Republic Office
12	Oct. 6	Water Issue and Thermal Power Generation Research Institute
13	Oct. 7	Water Economy Department, Ministry of Agriculture, Water Resources and Processing Industry
14	Oct. 7	Hydromet
15	Oct. 7	WB
16	Oct. 7	Central Asian Institute for Applied Geosciences (CAIAG)
17	Oct. 7	Hydrogeological Modeling Research Institute
18	Oct. 8	Program Management Unit in MoAWRPI funded by the World Bank
19	Oct. 8	European Commission
20	Oct. 8	Ministry of Industry, Energy and Fuel Resources

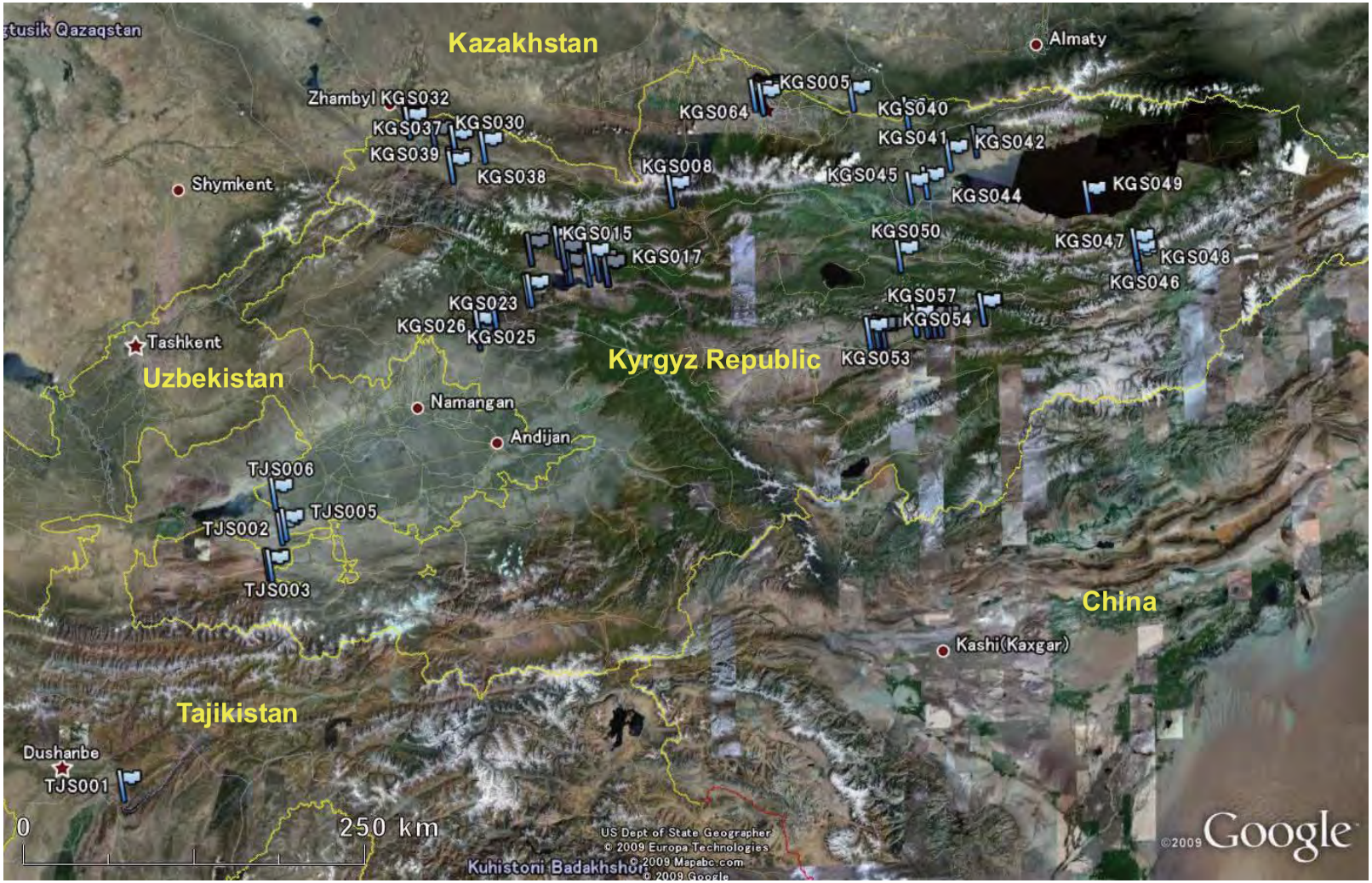
Table 1-5-4 Surveyed Organizations during the First Site Survey (Kyrgyz Republic - No. 2)

Date		Visited organization
1	Oct. 20, 2009	Bishkek Water and Sewage Department of Bishkek City Administration
2	Oct. 20	German Embassy in Kyrgyz Republic
3	Oct. 20	Ministry of Agriculture, Water Resources and Processing Industry, State Water Inspection
4	Oct. 21	Hydromet
5	Oct. 21	Hydromet Equipment Service Center
6	Oct. 21	CAIAG
7	Oct. 22	UNDP
8	Oct. 22	USAID
9	Oct. 23	JICA Kyrgyz Republic Office
10	Oct. 23	EC-IFAS

Table 1-5-5 Surveyed Organizations during the First Site Survey (Tajikistan)

Date		Visited organization
1	Oct. 26, 2009	JICA Tajikistan Office
2	Oct. 26	Japanese Embassy in Tajikistan
3	Oct. 26	ADB Tajikistan Office
4	Oct. 27	Emergency Civil Defense Committee
5	Oct. 27	Tajikistan Hydromet
6	Oct. 27	Ministry of Land Improvement and Water Resources
7	Oct. 28	Foreign Ministry
8	Oct. 28	Tajikistan Hydromet
9	Oct. 28	Swiss Co (in Tajik Hydromet) Swiss support project for “Hydromet of Countries in the Aral Sea Basin”

Date		Visited organization
10	Oct. 29	Tajik Hydraulic Technology Land Improvement Research Institute
11	Nov. 1	Soghd Water Economy Bureau
12	Nov. 2	Soghd Hydromet



Legend: Flag: Surveyed spots (the number corresponds to the number shown in Table 1-5-4 or 1-5-7.)

Fig. 1-5-1 Surveyed Spots in the Kyrgyz Republic and Tajikistan

The following shows a list of local organizations we visited during the second site survey.

Table 1-5-6 Surveyed Organizations during the Second Site Survey (Kyrgyz Republic)

Date		Visited organization
1	Feb. 3, 2010	JICA Kyrgyz Republic Office
2	Feb. 3	Japanese Embassy in Kyrgyz Republic
3	Feb. 4	Water Resources Agency, Ministry of Natural Resources
4	Feb. 4	UNDP
5	Feb. 4	Ministry of Foreign Affairs
6	Feb. 4	UNDP
7	Feb. 5	German Embassy in Kyrgyz Republic
8	Feb. 5	Hydromet
9	Feb. 5	GTZ
10	Feb. 5	CAIAG
11	Feb. 8	Naryn State Water Economy Department
12	Feb. 8	Hydromet
13	Feb. 8	Water Resources Agency, Ministry of Natural Resources
14	Feb. 8	Ministry of Industry, Energy and Fuel Resources
15	Feb. 9	JICA Kyrgyz Republic Office
16	Feb. 9	Hydromet
17	Feb. 9	JICA Kyrgyz Republic Office
18	Feb. 9	Water Resources Agency, Ministry of Natural Resources
19	Feb. 10	Water Resources Agency, Ministry of Natural Resources (explanatory meeting)
20	Feb. 11	Water Resources Agency, Ministry of Natural Resources
21	Feb. 11	SDC
22	Feb. 11	WB
23	Feb. 12	Chuy State Water Economy Department
24	Feb. 12	CAIAG
25	Feb. 19	Hydromet

Table 1-5-7 Surveyed Organizations during the Second Site Survey (Tajikistan)

Date		Visited organization
1	Feb. 15, 2010	Japanese Embassy in Tajikistan
2	Feb. 15	JICA Tajikistan Office branch office
3	Feb. 15	Emergency Civil Defense Committee
4	Feb. 15	SDC
5	Feb. 15	German Embassy in Tajikistan
6	Feb. 16	Tajikistan Hydromet
7	Feb. 16	Ministry of Land Improvement and Water Resources
8	Feb. 16	UNDP

Date		Visited organization
9	Feb. 16	Ministry of Industry, Energy and Fuel Resources
10	Feb. 16	ADB
11	Feb. 17	Ministry of Water Resources (explanatory meeting)

Chapter 2 Present Issues in Water Resources Management

2-1 Outline of water resources management in the Syrdarya River basin

An average of approx. 12 billion m^3 of water flows from the Syrdarya River into the Toktogul Reservoir located in the upper basin (1991-2007). The effective storage capacity of the reservoir is 14 billion m^3 of water.This significantly large difference between storage and discharge has a decisive influence on downstream regimes depending on the discharge operation. The difference also affects interannual storage capacity.

During the Soviet era when the Toktogul Reservoir was constructed, the central government assigned different responsibilities or roles to Upstream and Downstream (countries) in the Soviet bloc: Upstream (responsible for hydro power) operated the reservoir to supply sufficient amounts of water for irrigation to Downstream (responsible for irrigated agriculture) to support agricultural production. As compensatory measures, Downstream supplied fuel and electric power to Upstream in winter.

After these republics attained independence, they encountered difficulties in maintaining this framework for various reasons: price of fuel used as compensatory item became high because of introduction of the market price method; Upstream changed its water discharge mode from irrigation to power generation because they wanted to generate power in winter. Therefore, individual countries had to secure their own water resources and hydro power. The framework of compensatory measures no longer worked effectively. In winter, Upstream had to discharge water from the Toktogul Reservoir to secure hydro power which caused overflow in the downstream rivers. In contrast, water shortages occured in the summer.

Currently, these water resources operation problems are coordinated by efforts between individual countries. Because the water is used as water resources and hydro power resources, and the quantity of water is insufficient to meet demand for these resources, the water dispute has now become a political issue. Despite the efforts of concerned countries and international organizations and donors, a problem-solving framework or interannual agreement has not yet been announced.

Protocol has been implemented based on allocation specified during the Soviet era: amount of water from Syrdarya River - 50.5% to Uzbekistan, 42% to Kazakhstan, 7% to Tajikistan and 0.5% to the Kyrgyz Republic.

The operation of water in the Syrdarya River was originally specified in the “Syrdarya Framework Agreement” concluded in 1998 and the contents of the agreement largely depended on aid from USAID. However, it did not come into force despite coordination by individual countries due to changes in water use in the beginning of the century as described above

Subsequently, countries involved signed the protocol to start operation but after 2003, it became difficult for these countries to comply with the protocol.
Recently, ADB and GTZ started a regional effort to try to extend the results to other regions. That is, to start a supporting program aimed at [small basins and to apply the results to other basin countries and finally improve regional water management policy]. This realistic remedy has been applied to transboundary rivers in small basins.

Because Upstream are water-source countries and generate electricity mainly by water energy, hydro power and water resources are both regional issues. Hydropower demand in the Kyrgyz Republic has been increasing in proportion to its economic growth. Generation of more electrical energy is required also from the viewpoint of regional hydro power interchange.
During the last survey, we heard that Uzbekistan will withdraw from the regional power network. If it withdraws, new transmission lines will be required to assure power delivery.

After the collapse of the Soviet Union, water allocation was coordinated by ICWC. ICWC was established in 1992 according to the Almaty Agreement concluded by 5 Central Asian countries, and holds the river basin management organization (BVO- Syrdarya). In the Kyrgyz Republic and Tajikistan, water resources of the Syrdarya River will be managed based on the ICWC's water operation agreement.
According to an ICWC report (http:www.cawater-info.net/Syrdarya/water_e.htm (Mar.1, 2010), the quantity of Syrdarya River water resources is typically 37.2 km^3/year, 27.6 km^3/year of which flows across borders. The ICWC coordinates approx. 21.1 km^3/year of border crossing water.
Major facilities on the Syrdarya River will be managed and controlled by BVO-Syrdarya. It also monitors the water quality of the Syrdarya River in cooperation with responsible committees for the environment, hydrologic measurement, and hygiene survey of the countries concerned. Furthermore, BVO-Syrdarya supports operating aspects (flood control, water use and generation) of facilities on the Syrdarya River.
ICWC is currently working with such major issues as the "population issue due to population growth", "environmentally-friendly water use", "water and energy exchange within the region", " construction of water resources infrastructure in each countery without preadjustment", "effects of climate warming", "resolution method and procedure of water issues within the region", "exchange of hydrologic and meteorological data within the region", policy and program on economic integration within the region" and "improvement of water use prediction at the regional level".

2-2 Overview of Water Resources Management

2-2-1 Policy, Law and Institutions

[1] Water code

The water-related fundamental law in the Kyrgyz Republic is the “Water Code” which came into force in 2005. The purpose of the Water Code is the coordination of, water use, water protection, water resources development, appropriate and safe water supply, environmental protection and preparation of the water-related fund. To meet the requirements specified in the Code, various measures, regulations, plans, etc., have been/will be prepared: the fundamental principles of water resources management, national water policy specification, foundation of authorized national water organization, national water strategy and water resources utilization plan, utilization and fee payment of surface water and groundwater, conservation of water resources, safeguard of water resources and dams, coordination between the water economic sector and agricultural sector, and establishment of a water use fund.

[2] Road map

In response to the Water Code, a road map for the realization of IWRM principles by major water-related government agencies was established with the help of UCC-Water, UNEP, CWP, etc., in 2006 (Document 1).

According to the road map, preparation is being made to build an organization/system and to implement water management. The State Water Administration (SWA) is positioned as central organization of water resource related matters. The equivalent of this organization in terms of role is the “Water Resources Agency” established in Dec. 2009 as a subordinate organization of the “Water Resources Agency”. Policies related to water resources will be planned, established and enforced by the agency.

In this way, the Kyrgyz Republic will efficiently manage water resources as one of its national policies. For this purpose, it will develop and arrange necessary laws and legal systems, and organization; and place priority of national policy on monitoring facilities and database maintenance to see the conditions and usage of water resources which are the base of the water resources management system.

[3] Current understanding

With regard to above-mentioned “coordination between the water economic sector and agricultural sector”: organizational change was made last October while the survey team was visiting the Kyrgyz Republic, and as a result, the Water Economy Department of the Ministry of Agriculture, Water Resources and Processing Industry (hereafter the Water Economy

Department) was divided into the Ministry of Agriculture and Ministry of Natural Resources. Water will be managed in units of basins and a Basin plan will be designed for individual basins starting with the Talas River basin. To develop the Basin plan, reliable hydrological and meteorological information and water use data are required.

For effective use of water and for improvement of water management, integrated water resources management is necessary. As a bottom-up approach, water use associations will be set up. These associations will be managed by a newly established federation to gain ownership of the water management.

Document 1: Road Map Planned Steps Towards Realization of the IWRM Principles and rationale of the essential activities in the Kyrgyz Republic 2006, UCC Water, etc.

2-2-2 Organizational Framework, Personnel and Budget

An organizational change was made in the Kyrgyz Republic in October 2009 while the survey team was there. As a result, the Water Economy Department is divided into [1] Water Resources Agency responsible for the water resources policy and [2] National Irrigation Public Corporation which controls the water management in rural communities.

At the same time, the Water Resources Agency was placed under control of the Ministry of National Resources. The Water Resources Agency controls national policy and water resources management, while the Irrigation Public Corporation maintains and manages facilities for which the Water Economy Department is responsible. The “Water Resources Agency” functions as a liaison for international cooperation related to water resources management.

Below are the organization, personnel and budget of the Water Resources Agency and Hydromet and the organizational framework of the Ministry of Industry, Energy and Fuel resources (hereafter Ministry of Energy) and Joint-Stock Company Electric Stations. According to Ministry of National Resources, Hydromet will be reformed and will be placed under the jurisdiction of the Ministry.

[1] Water Resources Agency and Water Economy Departments (Naryn State, Chuy State)

[Water Resources Agency]

- Organizational framework and personnel (after organizational change) -

Each Water Resources Agency consists of approx. 30 personnel. As of Feb. 2010, its system and organization were not defined but it seemed to be responsible for the monitoring of water resources (hydrological and water), integrating and organizing use and protection of water resources, technology policy and investment, legal affairs and international cooperation and water supply in rural areas. It is also responsible for the management of three reservoirs (Kirov, Papan and Orto-Tokoy). It will organize 5 Departments of River Basin Management which will

actually manage the basin. Their budgets will be derived from that of the Water Economy Department. In 2010, the Water Resources Agency will allocate budgets to these bureaus. This report will use the name “Water Resources Agency” when describing their future activities and old organization names when describing organizations and budgets.

- Organizational framework and personnel (before organizational change) -

Because most of the surface water is used for agriculture, its source has been managed by the Ministry of Agriculture, Water Resources and Processing Industry, and the Water Economy Department is mainly responsible for this task. The department plans and designs the water economic system; designs and builds structure, building and technical facilities; and plans and implements water use according to policy. The Water Economy Department is also responsible for water resources management of the basin and region, and for this purpose, supervises its subordinate agency, the State Water Economy Department. It also supervises projects and science laboratories related to water resources management.

It has administrative functions such as, construction projects for key structures, project planning and the issuance of permission of water allocation. In contrast, the State Water Economy Department is responsible for practical water resources management.

The water consumption, domestic water allocation and water resources section of the Department is responsible for:

1) Recording of water volume and water consumption,
2) Supporting management and measurements for water resources from the aspect of meteorologic observation,
3) Preparation of proposals of international cooperation concerning water topics such as water allocation at transboundary canals
4) Monitoring of water management facilities and disaster prevention facilities,
5) Granting of water rights for rational consumption and economic rationality, and complex arrangements of water consumption according to the rational water allocation.

The Kyrgyz Republic consists of 7 states (Chuy, Talas, Issyk-Kul, Naryn, Barken, Jalal-Abad and Osh) and each State Department of Water Resources is responsible for practical water resources management in the state.

- Observation of water use -

Water use is observed by Rayon which performs water operation. Below describes results of investigation at Naryn State Water Economy Department and Rayon.

- In Naryn State, 41 observation stations are installed. They are posted on the canal and managed by Rayon (subordinate organization of Naryn State). Half of these stations must be repaired.
- To install an observation station, approval by the government (has budget allocation

rights) is required: additional installation is not easy.

- The annual overall budget of Naryn Rayon was 32,500,000 com and approx. 4,000,000 com of which was used for operation and facility maintenance (including water usage observation). The 32,500,000 com Naryn Rayon budget included 488,000 com of collected water use fees.

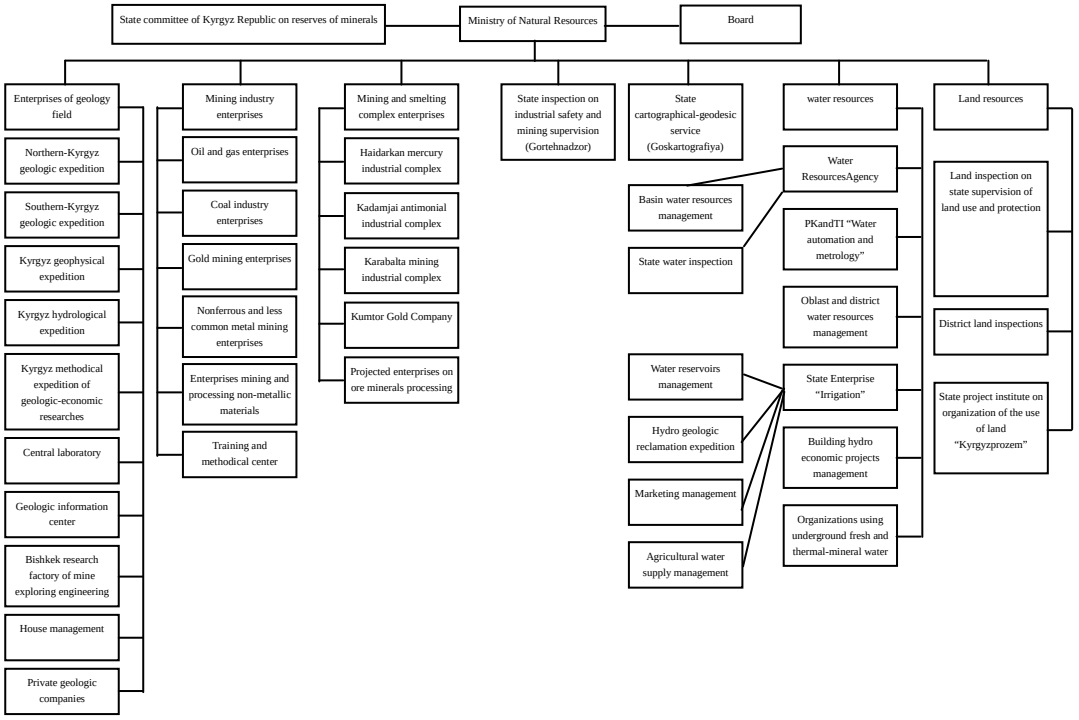


Fig. 2-2-1 Organization of the Ministry of Natural Resources in the Kyrgyz Republic after Reorganization

- Budget (before organizational change) -

By glancing over the budgets of the Water Economy Department 2006 through 2008, it can be found that the overall budget increased 1.5 times for 3 years. Salaries also increased 2.6 times indicating that workers are well paid. The 2008 budget of the Water Economy Department indicates that main expenditures of the budget are "Personnel cost and electricity usage fees" (57%) and projects (28%). This project cost (28%) is small when compared with the project scale. This is because practical water management is carried out by the State Water Economy Department. The difference in the budget allocation ratio between the Water Economy Department and the State Water Economy Department shows that they have different roles (the Water Economy Department is responsible for planning and supervising water resources management, and the State Water Economy Department is responsible for practical aspects of management). To effectively enhance the water resources management system with these

budgets, functions of both Water Economy Departments should be closely linked for cooperation. That is to say, both Departments as C/P increase organizational capability for water resources management by increasing the capability of water resources management policies and programs. After restructuring, the Water Resources Agency and Department of River Basin Management will responsible for these tasks.

Table 2-2-1 Budget for the Water Economy Department (Kyrgyz Republic)

Cost	2008 budget (Thousand com)	2008 Single/total cost ratio	2008 to 2007 comparison	2007 budget (Thousand com)	2007 Single/total cost ratio	2007 to 2006 comparison	2006 budget (Thousand com)	2006 Single/total cost ratio
Personal costs	148,785.4	0.30	1.9	76,989.4	0.17	1.4	56,686.6	0.2
Social fund/bond	28,191.3	0.06	1.8	15,503.4	0.04	1.3	11,875.0	0.0
Travel expenses	994.1	0.00	0.9	1,073.2	0.00	1.0	1,035.0	0.0
Project costs	141,876.8	0.28	1.0	146,731.6	0.33	1.1	128,079.2	0.4
Rental fees	0.0	0.00	0.0	45.0	0.00	1.0	45.0	0.0
Transportation costs	9,606.0	0.02	0.6	15,759.0	0.04	1.4	11,404.0	0.0
Other service costs	13,628.4	0.03	0.6	21,127.5	0.05	0.7	28,708.1	0.1
Building and maintenance costs	120,106.8	0.24	0.8	159,610.0	0.36	1.5	103,148.4	0.3
Machinery costs	35,925.8	0.07	6.8	5,285.9	0.01	29.4	180.0	0.0
Sum total	499,115.3	1.00	1.1	442,125.0	1.00	1.3	340,801.3	1.0

* 1 com = 2.03 yen (as of Oct. 1, 2009)

Below is the region level water resources management made by the Chuy and Naryn State Water Economy Department.

[Chuy State Water Economy Department]

- Organizational framework and personnel -

The irrigated area in Chuy State is approx. 320,000 ha (approx. 4,600 ha unused) which is equal to approx.1/3 of the nationwide irrigated area. The quantity of water intake is approx. 1,235 million m^3 (including approx. 206 million m^3 of groundwater).

Chuy River is connected to the Great Chuy Canal, West Great Chuy Canal, and South Great Chuy Canal (total length of trunk canals is 364 km) which are connected to the Chuy River. These canals also carry water from 12 tributaries.

The number of government employees working for Chuy State is 1,056 as of 2010/01/20, of which 406 officers are working for the Chuy State Water Economy Department (except for Rayon) managing water resources. Water resources in Chuy State are managed by the Chuy Water Economy Department and 8 Rayons (Kemin Chuy, Issyk-Ata, Alamedin, Sokluk, Moskva,

Zhayl, Panfilov) and main canal sections and reservoir sections. Many Chuy Water Economy Department employees are working also for these main canals and reservoir sections.

104 irrigation associations are established and 78 of them are active. The number of associations increased until 2005. They are trying to improve their own operation or activity. The chief of the Water Economy Department of each Rayon is responsible for operational coordination between associations. They prepare the state water use plan based these coordination activities. Water allocation for individual canals is determined by agreements made between the chief of the Water Economy Department and Rayons (once per year). These agreements may be modified as necessary. Water allocations are reviewed based on monthly reports on the river discharge (Hydropost data taken at 5 rivers such as Chon Kemin) from Hydromet and also data of measurements taken by the Water Economy Department at 3 locations.

- Budget -

The Chuy State Water Economy Department provides approx. 90 million com as labor costs and facility maintenance costs for the water resources management. The budget is broken down into two: approx. 67 million com from the national budget and approx. 23 million from a special fund. Approx. 52% (47 million com) is employment costs and 48% (43 million com) is facility operation costs.

[Naryn State Water Economy Department]

- Organizational framework and personnel -

The Water Economy Department controls overall state water resources, instructing Rayons and Ayl Okmotu. In the headquarters of the Naryn Water Economy Department, 15 personnel are deployed, and 4 persons among them are responsible for water management practice. Details of organization and personnel composition or the Naryn Water Economy Department were not available. We heard that the organization and system of all state Water Economy Departments are similar.

Water users are organizing water use associations as unit water management organizations. More than 700 water use associations are controlled under a federation which controls management of water and will become an accounting entity. Application for water use is submitted to, before the irrigation season, to the state Water Economy Department through the irrigation association or directly. Application is determined after coordination has been made.

The users should pay irrigation fees. The users in Naryn Rayon should pay a water fee of 0.01 com/m^3. This rate is lower than that of the national standard rate of 0.03 com/m^3, reflecting the low agricultural productivity of the region. The water use fee is determined in a conference.

The members of the conference are selected by the irrigation association. The membership includes farmers andofficers of Ayl Okmotu, etc.

From the survey conducted in Feb. 2010, it was found that the services of the Naryn Water Economy Department would be modified according to a restructuring of central government offices.

- Budget -

Naryn StateWater Economy Department uses 47-48 million com: approx. 46–47 million com from the central government budget and 1 million com from a special fund (water use fee). Approx. 6 million com are for labor costs and facility maintenance costs for the water resources management.

The budget for Naryn Rayon under control of the Naryn Water Economy Department is 32.5 million com: 4 million for electricity for water pumping and 17 million for facility operation and maintenance costs. Approx. 65% of the overall budget is used for maintenance and management costs.

The budget of Naryn Rayon is 32.5 million com/year of which 488,000 com is collected water use fees. Expenses: 17 million com for electricity for pumping irrigation water to 9,000 ha land; 4 million com for facility operation/maintenance; and pump maintenance costs. The expenses necessary to pump water is 0.4 com/m^3, while water use fees from users in Naryn Rayon is 0.01 com/m^3 (1/40 electricity expense).

The budget is lower than during the former Soviet era and the emigration of engineers has occurred.

Pay standards were raised last year but employees are still not well treated.

[2] Ministry of Emergency Situation Hydromet Agency

- Organizational framework and personnel -

In the Kyrgyz Republic, the State Agency of Hydromet under control of the Ministry of Emergency Situation is responsible for Hydrologic and meteorologic measurements.

The purpose of Hydromet: 1) to monitor the natural environment to protect people from natural disaster, 2) to provide information on natural environmental pollution, 3) collection and systematic analysis of information on meteorological, agrometeorological and hydrological states and natural environmental pollution, and preparation of countermeasures against avalanches and create lists.

Hydromet deploys observation data centers in certain districts as its local agency. Individual local observation data centers collect data from observation stations and arrange the data and transfer it to Hydromet. Fig. 2-2-2 is an organizational diagram of Hydromet. Hydromet observation data is transferred in the order of Hydropost (observation station), Local Management Center, communication center, and Hydropost where the data is summarized.

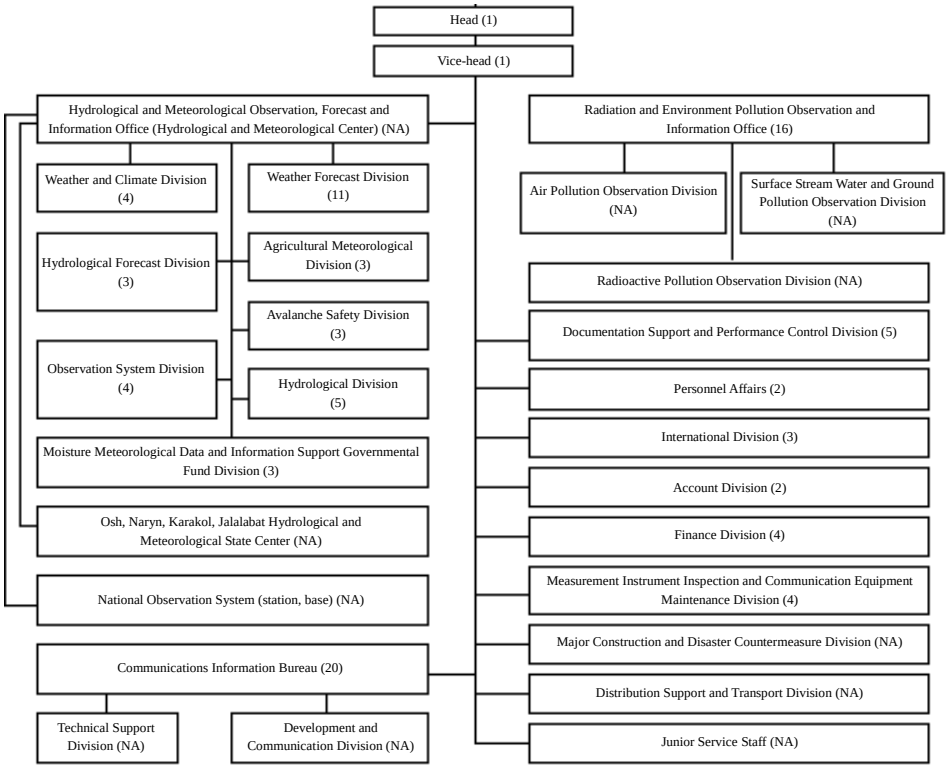
- Budget -

Annual budgets of Hydromet for 2006 to 2008 show that the overall budget increased 1.9 times over these three years. Salary and miscellaneous expenses increased by 2.3 times indicating that the treatment of personnel has improved. Since 76% (2006) and 92% (2008) of the budget were used for “Personal costs and various allowances”, and only 3% was used for maintenance of observation facilities, the budget should be increased.

The head of Hydromet said that he strongly requested the government increase the budget, that he told the president why treating the personnel well is necessary, and that the additional budget was allocated for reinforcement of observation network as described above. Furthermore, the head described organization vitality efforts by requesting a budget and human resources based on potential and results. This organizational reform was made while we were conducting our survey. Observation equipment maintenance costs increased by 1.5 times,and although overall budget is insufficient, this is a top-down approach toward improvement.

92% of the 2008 budget was for salaries and overhead costs. This is a result of regarding the improvement of low personnel wages as an emergency priority measure to maintain the observation system.

To effectively strengthen the observation system under this poor financial situation, facility maintenance costs should be decreased. For example, degraded/aged equipment should be replaced with one that requires less maintenance service and cost, and should be repaired or certified in-house. Equipment such as observation instruments should be periodically inspected and repaired if faulty. To reduce maintenance cost, staff should perform periodic inspection, and try to repair as necessary by purchasing spare parts. Only troubleshooting that requires high technical knowledge and experience should carried out by the manufacturer. For example, once degraded/old observation equipment is replaced, the remaining equipment should be repaired and certified by the responsible personnel. Effective countermeasures include, supply of observation equipment with no-charge, deployment of repair/calibration facilities, and support of engineer training programs.



Number of staff in parentheses

Fig. 2-2-2 Organization of Kyrgyz Hydromet (October 2009)

Table 2-2-2 Budget for Kyrgyz Republic Hydromet

Costs	2008 budget (Thousand com)	2008 Single/total cost ratio	2008 to 2007 comparison	2007 budget (Thousand com)	2007 Single/total cost ratio	2007 to 2006 comparison	2006 budget (Thousand com)	2006 Single/total cost ratio
Salary	27,050.7	0.79	1.4	18,845.3	0.85	1.46	12,870.0	0.72
Benefits package	4,600.0	0.13	6.6	700.0	0.03	1.08	650.0	0.04
Overhead cost	632.6	0.02	0.8	802.0	0.04	0.91	879.6	0.05
Communication cost	311.8	0.01	0.7	468.8	0.02	0.31	1,507.2	0.08
Observation facilities maintenance and operation cost	1,079.5	0.03	2.9	371.3	0.02	0.60	620.0	0.03
Fuel cost	300.0	0.01	2.1	140.4	0.01	0.67	210.0	0.01
Facilities renewal cost	183.8	0.01	0.2	875.0	0.04	0.75	1,170.0	0.07
Total	34,158.4	1.00	1.5	22,202.8	1.00	1.24	17,906.8	1.00

* 1 com = 2.03 yen (as of Oct. 1, 2009), (Source: Kyrgyz Republic Hydromet)

[3] Ministry of Industry, Energy and Fuel Resources

- Organizational framework -

The role of the Ministry of Energy is the supply of stable energy, regulation of energy consumption, control of energy supply organization, and promotion of environmental

improvement related to industry, energy and fuel. Since thermal power generation is a major energy source, its generating capacity must be exactly estimated by improving accuracy of related data such as Hydrologic measurements and estimation of infrow rates at water reservoirs.

[4] JSC Power (Joint Stock Company Electric Stations)

- Organizational Framework -

The JSC Power has 8 power plants, generating 3.64 MW. In the Kyrgyz Republic, 90% of available electric power comes from hydro power generation. For JSC Power, Hydrologic measurement data and water infrow rates to reservoirs are very important to estimate hydro outputs. JSC Power is responsible for operation of the Toktogul hydraulic power plant and obtaining such important data through Hydromet.

2-2-3 General Description of Hydrological and Geological Conditions

[1] General description of the hydrogeological condition

The climate of Central Asia is roughly characterized by interaction between the Siberian anticyclone growth in winter and cyclone disturbance caused by westerlies, and the difference in local precipitation due to the geometry of the mountainous topography. The climate over the basin in the Kyrgyz Republic is dry and hot during June through September while average temperatures during December through February are below 0°C. In addition, annual average temperature in mountain territories exceeding 3,000 m is below 0°C.

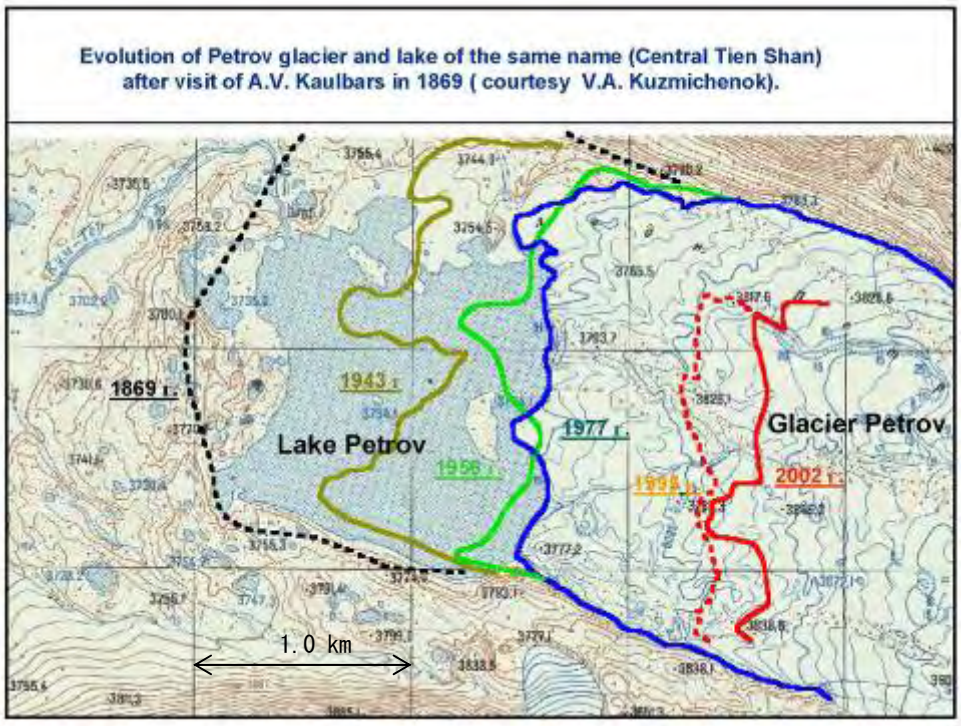
Precipitation is high from December to February and the mountains are covered with snow.

The upstream water sources which deliver a larger amount of water than other sources to the river are snow (melting) from April to May and glacier (melting) in July.

Over the Tien Shan range area in Central Asia, 15,953 glaciers have been identified according to records from a glacier inventory survey edited by the Soviet Union in 1973 and records from a similar survey conducted by China in 1987. Among all glaciers located in the former Soviet bloc, 45% are said to be in the Kyrgyz Republic. As the Kyrgyz Republic has not performed a glacier inventory survey since the Soviet breakup, it uses data prepared during the Soviet era. According to this data, the total number of glaciers located in the country is 8,208, total glacier area is 8,076.9 km^2, total glacier volume is 494.7 km^3 and the altitude of the equilibrium line is 4,203 m. Many glaciers in the Kyrgyz Republic are located between altitudes of 3,000 and 6,500 m where the annual average temperature is below 0°C.When the distribution of glaciers is expressed in terms of area, larger sections of glaciers are located at altitudes between 3,700 and 4,500 m.

The Kyrgyz Republic does not "conduct" nationwide glacier monitoring but conducts monitoring on specific glaciers for research purposes.

The Petrov glacier (7th largest glacier in the country) first had its ends surveyed in 1869 by means of a topographical survey. Its ends were then subsequently monitored by means of aerial photos (1943–) and GPS (2002–). Figure 2-2-3 shows changes on the ends of the glacier from 1869 to 2002. From the figure, we can see that the Petrov glacier is receding.



Source: Central Asian Institute for Applied Geosciences (CAIAG)

Fig. 2-2-3 Transition of Glacier Petrov Fringe (1869 to 2002)

Firstly glaciers in the Kyrgyz Republic are considered in the mass, its volume has been significantly reduced since the mid. 1970's. due to the effect of global warming. Secondly close reservation of individual glaciers indicates that small and mid-size glaciers at medium to higher altitudes (3,000–4,000 m) are melting at a higher rate, increasing the river discharge. However, the river discharge will sharply drop starting around 2020 because large numbers of small glaciers at medium altitudes will start to disappear one by one from 2020, while larger glaciers at higher altitudes will not melt easily. Note that the discharge transition described above refers to upstream only. For example, only approx. 4% of the water in the Naryn River running through Toktogul comes from melting glaciers. Note)

Note: According to an estimate by the Institute of Water Problems and Hydro Power, National Science Academy of the Kyrgyz Republic. With the Soviet calculation method, melting of snowfall on glaciers is included in "glacier melt". If the water running through Toktogul is analyzed using this Soviet method, half or more of the water will come from "glacier melt" (glacier melt + snow melt (on glaciers)).

[2] General description of geological condition

The geography of Central Asian region including the Kyrgyz Republic can be divided into three zones of desert, piedmont and mountain. The desert zone spreads over the northern part of Central Asia. This area is a typical alluvial plain formed by meandering rivers such as the Syrdarya River, Amdarya River and Ili River. The capital Bishkek is located on the Chuy River basin formed by the Chuy River, and is classified as piedmont. The piedmont is very small in area when compared with the other 2 zones, but its functional range is large because it has a large portion of population in Central Asia.

The mountain zone spreads over the southern part of Central Asia. In the southern part, rocks of Paleozoic and Precambrian eras dominate, while in the western part, rocks of the Jurassic period and Cretaceous period dominate. A large part of the Kyrgyz Republic is situated in a mountain zone at an altitude of 3,000 m or higher where edge lines run 6,000 to 7,000 m high.

2-2-4 Water Use

[1] Naryn River Hydrologic characteristics of inflow (Naryn River, etc.) to the Toktogul Reservoir

Long-term variation in inflow

From annual inflows to the Toktogul Reservoir during 1911–2008, a relationship between the cumulative inflow and years (called Mass Curve) can be drawn as shown in Fig. 2-2-4. The inflow has increased slightly over a long period. It is not clear that this is caused by effects of climate change.

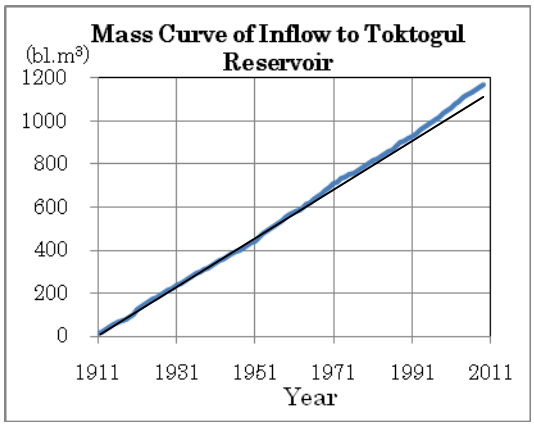


Fig. 2-2-4 Mass Curve of Inflow to Toktogul Reservoir

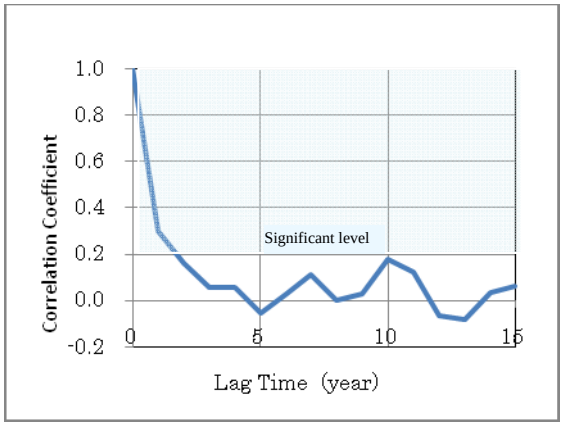


Fig. 2-2-5 Change of Autocorrelation Coefficient of Inflow Time Series to Toktogul Reservoir

Variability characteristics of inflow

For annual inflow time series to the Toktogul Reservoir, the variation of auto-correlation

coefficients of the inflow time series is as shown in Fig. 2-2-5. Because the significant level for 98 sets of data from 1911-2008 is approx. 0.2, the time series of inflow to the Toktogul Reservoir does not statistically and clearly show periodical characteristics of 1 year or more cycl.

Runoff from the Naryn River

Figure 2-2-6 shows the time history of inflow to and outflow from the Toktogul Reservoir. The inflow to Toktogul Reservoir in the irrigation season (April to September) almost determines annual inflow. This large amount of inflow to Toktogul Reservoir reflects the characteristics of inflow rivers. Inflow in the non-irrigation season (October to March) is at a stable rate every year. Most inflow to the Toktogul Reservoir comes from the upper basin of the Naryn River. Main carriers of these inflows are tributary streams which merge between the Naryn point (see Fig. 4-2-1, Hydropost-1) and Uchi Terek point (Fig. 4-2-1, Hydropost-2).

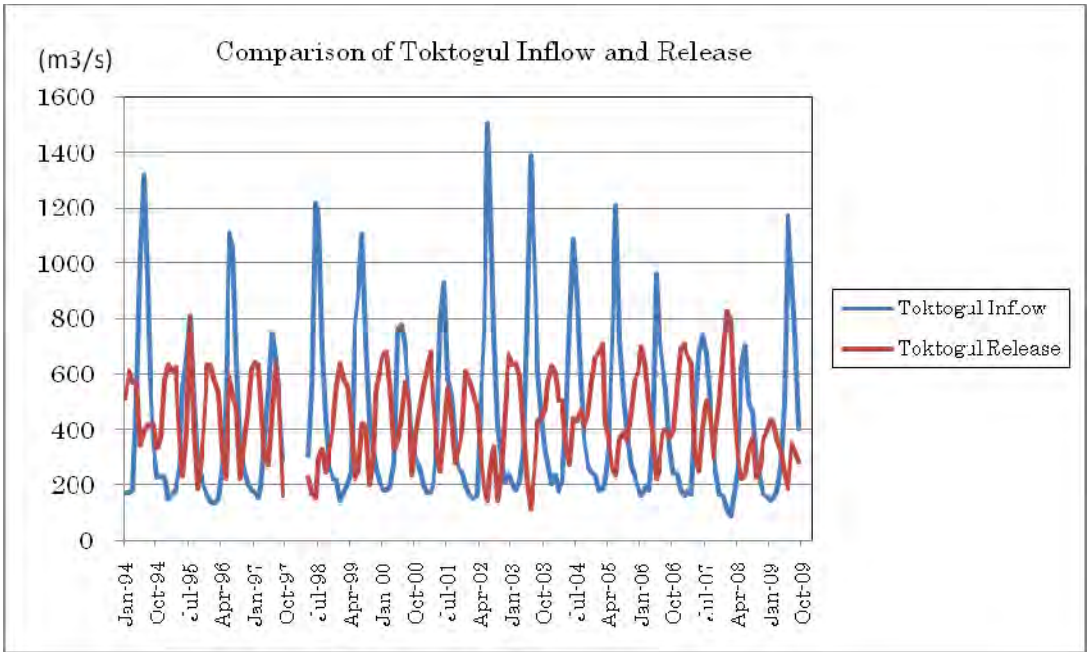


Fig. 2-2-6 Comparison of Toktogul Inflow and Release

Probability assessment of Naryn River outflow

Outflow characteristic of the Naryn River: annual inflow to the Toktogul Reservoir over long periods of time (1911-2009) is shown by the approximately-linear line on the logarithmic normal distribution graph as shown in Fig. 2-2-7.

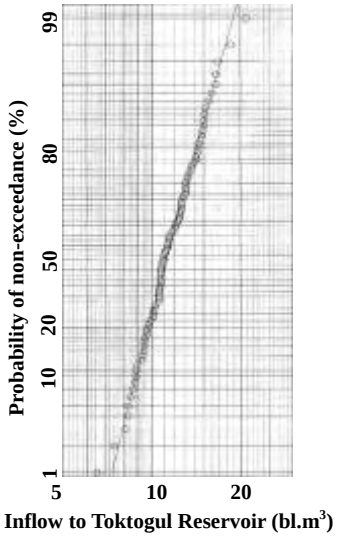


Fig. 2-2-7 Discharge Probability Diagram

From the figure above, 10-year probability of inflow of high-water , low-water, and average year as shown in the table below can be obtained.

Table 2-2-3 Estimation of Inflow to the Toktogul Reservoir - High-water, Low-water, and Average-water

Year	Inflow to Toktogul Reservoir ($bl.m^3$)	Year nearly corresponds to definition shown left in 1994–2008(probable years)
High-water	15.1	1994 (11), 2003 (16)
Average-water	11.5	2000, 2001, 2006
Low-water	8.9	2008 (5)

[2] Water use in the Kyrgyz Republic

Table 2-2-4 shows changes in water demand of the Kyrgyz Republic. As shown, peak demand occurred in 1988 and then demand decreased by approx. 30% without significantly fluctuating. Dominant demand for water is for irrigation (90%). According to the Ministry of Energy, 70% of available water resources in the Kyrgyz Republic is used for hydro power generation. This means that the water resources in the Kyrgyz Republic provide almost all the energy necessary

for economic activity in this country.

Table 2-2-4 Changes in Water Demand of the Kyrgyz Republic (Units in Million m^3)

Year	Surface water (upper column) Groundwater (lower column)	Total	City water	Industrial water	Irrigation water	Clean water in rural community	Other
1988	12,976 948	10,050	265	634	8,905	201	44
1998	8,321 526	6,420	309	138	5,858	105	10
2005	7,889 304	4,485	149	59.4	4,119	16	14
2006	8,007 306	5,289	128	229	4,196	19	116
2007	10,300 334	6,316	159	842	4,381	168	766
2008	8,469 302	5,396	94	189	4,434	21	658

Figure 2-2-8 shows water use records of individual states of the Kyrgyz Republic. Naryn State and Issyk-Kul State located along Naryn River, upstream basin of the Toktogul Reservoir, use most of the water for irrigation. The quantity of irrigation water has decreased when compared to that of 1988 and has remained at stable levels since 2005. The ratio of irrigation water to the flow of the Naryn River (annual flow at the Naryn point) is approx. 15%. Meanwhile, according to a hearing during the site survey of the Naryn River, water loss through irrigation canals has increased to 40% (approx. 6% of Naryn flow, approx. 1.6% of inflow from the Naryn River to the Toktogul Reservoir). This means that the water resources may be increased by repairing and modifying the irrigation canals.

In Chuy State, the peak water use, 3,100 million m^3, was recorded in 1988 and then decreased to 750 million m^3 in 2005, and again increased to 1,500–1,750 million m^3 starting in 2006. During 2007 and 2008, water use for other purposes increased significantly to approx. 600 million m^3. In response to our question, the Water Resources Agency suggested the existence of incorrect data.

According to Chuy State Water Resources Bureau, in 2009, 64% of available water 1,235 million m^3 was used for irrigation. Used groundwater was 0.2 million m^3. The breakdown is as 798.9 million m^3 for irrigation, 70.6 million m^3 for living, 70.6 million m^3 for industry, 14.4 million m^3 for parks, schools, etc., and 6.9 million m^3 for rural areas.

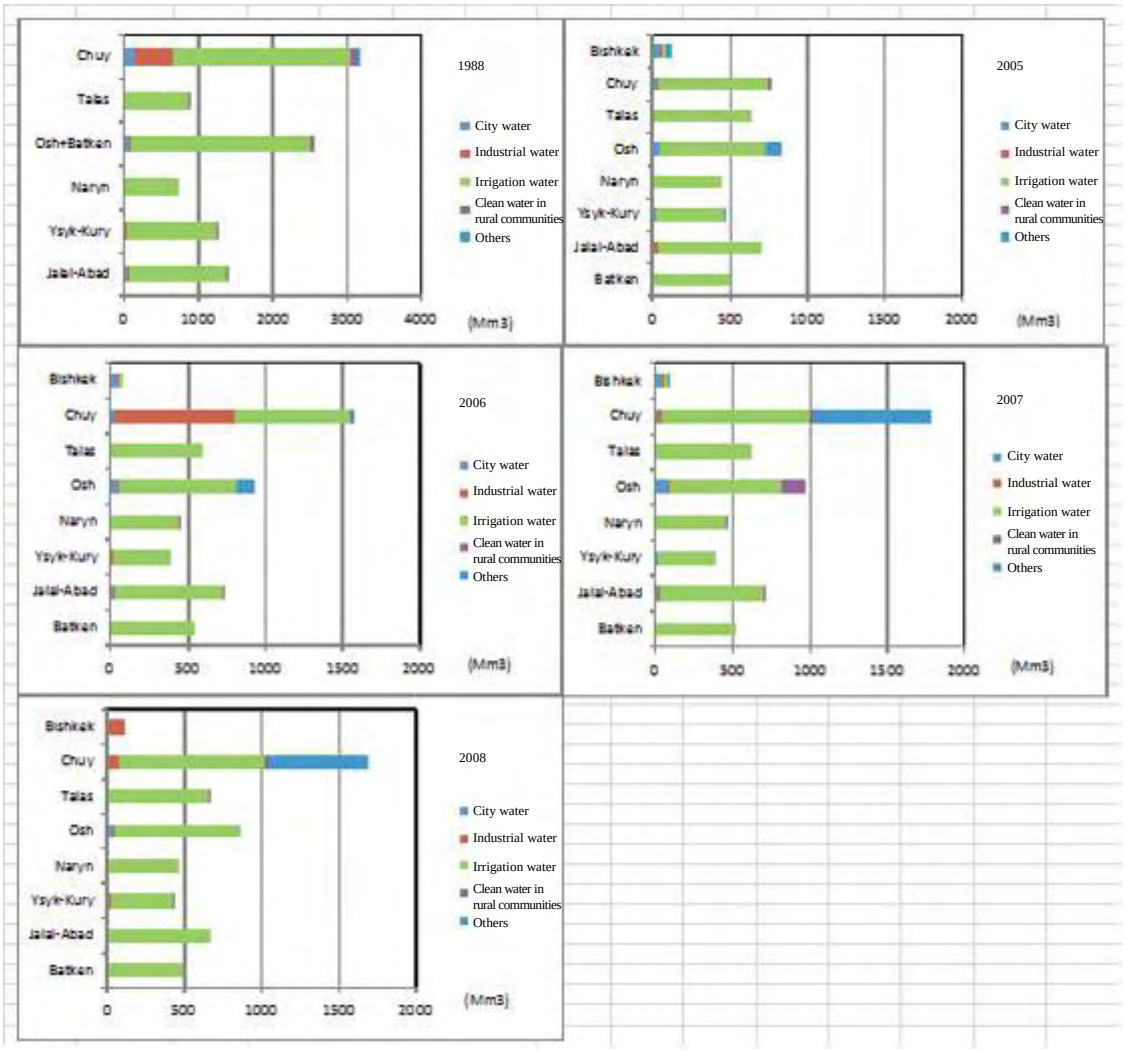


Fig. 2-2-8 Water use in the Kyrgyz Republic (1988 to 2008)

Actual Intake by Bishkek Water work and Sewer Work Department

Bishkek City has used groundwater for all its water supply. Table 2-2-5 shows the quantity of groundwater used for water supply.

Table 2-2-5 Water Intake from Groundwater Resources for Water Supply in Bishkek City (unit in 1000 m^3)

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Water used	139,988	125,886	115,291	113,297	112,464	113,785	113,746	113,779	112,520	117,859

As shown in the table above, the quantity of groundwater intake has decreased starting with

1999 to approx. 1.1 hundred million m^3/year by 2001 and has stayed at around this level.

[3] Operation characteristics of the Toktogul Reservoir

Figure 2-2-9 shows interannual changes of water balance related to inflow to and release from the Toktogul Reservoir during the irrigation period (April 1 to September 30) and the pondage of the Toktogul Reservoir at the end of the irrigation period (September). As shown, flow to the Toktogul Reservoir during the irrigation period and pondage in the Toktogul Reservoir at the end of the irrigation period have varied (increased/decreased) year by year. Meanwhile, release during the irrigation period has gradually decreased since 1991. Note the statistics in 2008: inflow during the irrigation period was low and pondage was at the lowest among others.

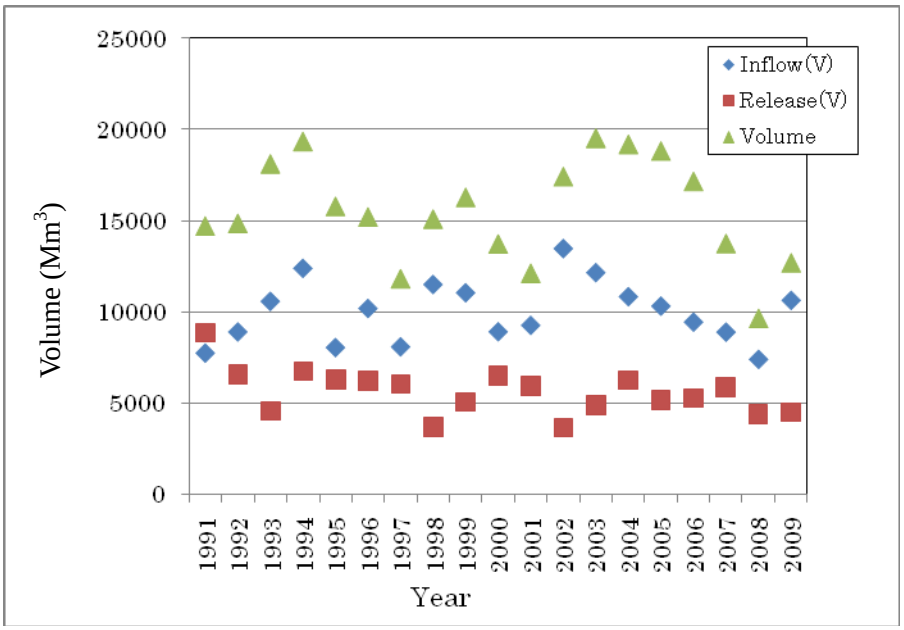


Fig. 2-2-9 Variations of Inflow and Release During the Irrigation Period and Water Balance at the End of the Irrigation Period in the Toktogul Reservoir

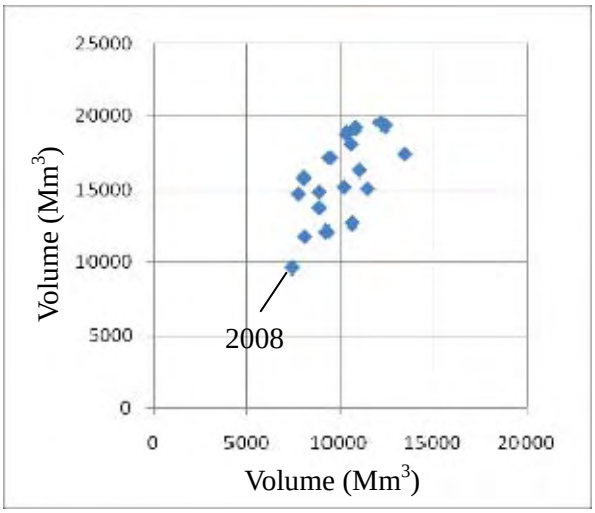


Fig. 2-2-10 Relationship between Inflow during the Irrigation Period and Storage at the End of the Irrigation Period in the Toktogul Reservoir (1991 to 2009)

Figure 2-2-10 shows relationship between inflow to the Toktogul Reservoir during the irrigation period and the pondage at the end of irrigation season using the same data as the preceding figure. The figure clearly shows that in 2008, both inflow during the irrigation period and the pondage at the end of irrigation season were low. It shows the unique hydrological characteristics of the Toktogul Reservoir during the non-irrigation season (across 2008–2009)

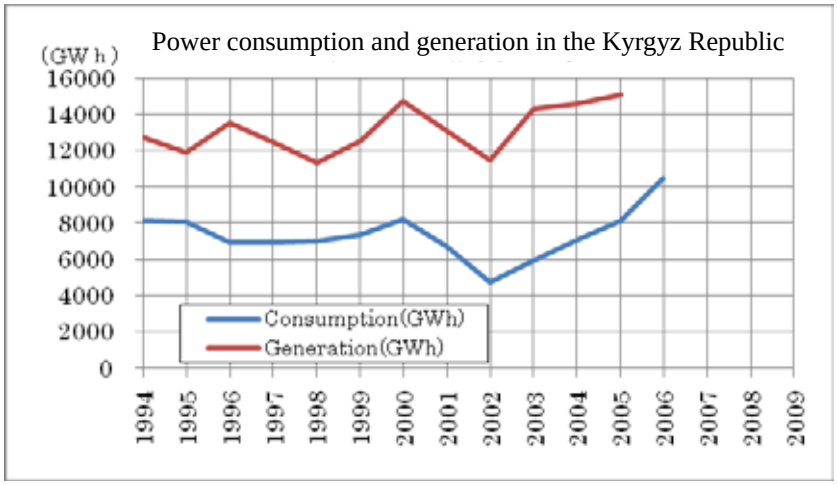
In respect to hydro power having significant effects on water demand, we drew the transition of power consumption and generated power (total of thermal and hydraulic power) in the Kyrgyz Republic as shown in Fig. 2-2-11 based on survey result described in the previous report (JICA, Feb. 2009) and data available from the website of the World Bank. The figures indicate that electric energy output has gradually increased every year from 1994 to 2005 by up to 2% on average. At the same time, power consumption did not fluctuate very much until 2000 and then sharply dropped in 2002 and then increased at a high rate. This indicates that changes in water operation correspond with the protocol regarding water use in the Syrdarya River area no longer being observed in 2003 and later.

In the Kyrgyz Republic, the generation mode of the Naryn Cascade Group has changed from the irrigation mode to non-irrigation mode of power generation, because 97% of hydro power is produced by the Naryn Cascade Power Plant Group composed of the Toktogul Reservoir and other plants, overflow stream of this plant group is small, and release pattern of Toktogul Reservoir changed in 2002 as shown in Fig. 2-2-11. The drought in 2008 where power demand increased showed the difficulty of operation of the Toktogul Reservoir approaching critical limits.

According to the Ministry of Energy, the basic operation rules of the Toktogul Reservoir is to

keep its pondage 9 billion m^3 or more. According to a government agreement between the Kyrgyz Republic and Republic of Kazakhstan, electric power of 0.54 billion kWh is to be sold during summer. Monthly generation plans and water discharge rate from the Toktogul Reservoir are set according to these rules and conditions. This agreement is reviewed every year.

Assuming that an approx. 10% margin can be produced by preventing leakage with modified irrigation canals and by improving water resources management (e.g. reservoir management) based on inflow prediction, the irrigated area in these basins can be increased and power generation during the non-irrigation period can be increased by using water stored in the Toktogul Reservoir.



Central Asia "Commissioned survey on regional cooperation within Central Asia regarding power and water resources" report, Feb. 2009 and additional data obtained from Web site of World Bank

Fig. 2-2-11 Transitional Change of Power Consumption and Generation in the Kyrgyz Republic (1994 to 2006)

[4] Necessity of introduction of a long term (several months) inflow forecast to reservoir operation

From a hearing at the Electric Power Plants (EPP), the following information was obtained: estimation of inflow to generating facilities is made by Hydromet, but its prediction accuracy has dropped to +/-30% error for reasons attributable to a reduction in the number of Hydroposts after the collapse of the former Soviet Union, certain monitoring items e.g. glacier observations were obsolete, shortage of equipment and workforce, etc. Because the inflow estimation is used in the storage reservoir operation schedule, increasing the error will cause operation problems. Conversely, an improvement in accuracy will create an advantage where operating according to the schedule becomes easy.

As the inflow estimation of the Naryn Cascade Hydro Power Plant Group is used for operation of the power plant group during the irrigation period, improvement of its accuracy is very important for promoting the efficient use of water through the irrigation and non-irrigation periods.

If the inflow to the Naryn Cascade during the irrigation period is estimated more accurately, the estimation can be applied to operation of the reservoir during the irrigation period, enabling an efficient countermeasure in response to the state of the reservoir at the end of the irrigation period and to the state of water use during the non-irrigation period extending to the following year.

For this reason support to continue flow observation performed by Hydromets and support to improve inflow estimation will be a great contribution to water use in the Kyrgyz Republic.

Concrete assistanceis as follows:

- Provision of equipment and personnel for monitoring the river discharge and irrigation water frow rate and improvement of capability/capacity
- Support for reinforcement of snow coverage/glacier monitoring equipment, organization and system, and training of personnel and improvement of capability
- Improvement of Naryn River runoff forecasting capability (capable of forecasting long term river flow volume in several days to 6 months)

[5] Water use in the Chuy basin

According to the head of the Chuy State Water Economy Department, an outline of water use on Chuy River for irrigation is as follows: Irrigation area in the Chuy State is 0.32 million ha (4,624 ha left unused), approx. 1/3 nation wide irrigated land. For this purpose, water from the Chuy River is divided into three canals, namely, the Great Chuy Canal, West Great Chuy Canal, and South Great Chuy Canal. A total of 12 branche rivers from mountain areas join these canals. Total length of the main canals is 364 km. The number of locations for measurement of water use is 1,166 and the number of large facilities (intake weir, culverts) is 1,976. A sand stilling basin is located on the Kyzyl Suu River and Alamedin River.

Fig.2-2-12 shows locations of irrigation canals and Hydroposts and meteorological observation stations whose rebuilding is requested by Hydromet, and priority of rebuilding.

In addition for irrigation, water is used in cement plants and the Bishkek thermal power plant (for cooling). “Other utilizations” include parking lots, parks, hospitals, etc. These water uses vary 20 to 25% within a year.

Allocation of water to the canals is determined once a year through an agreement between the State Water Economy Department and state Rayon (water allocation for the next years is planned during the agricultural off-season). The river discharge data sent from Hydromet once per month (measured at Hydropost of 5 rivers, e.g. Chon Kemin and data of measurements at 3 locations performed by the Water Economy Department) are reviewed and allocation is adjusted as necessary. The personnel responsible for management of water flow to the canals based on the schedule arranged by the head himself. Though measurement at major intake points has

been automated since the former Soviet era, observers are deployed. As a rule, the observer measures levels of water surface with a gauge rod and converts the reading to the equivalent discharge by referring to the rating curve. The Kazakhstan Committee bears some amount of repair cost for monitoring equipment through the Chuy-Taras committee of Kazakhstan-Kyrgyz Republic. Deposited sand in the sand stilling basin is excavated in winter.

Fees for irrigation water are 0.03 com/m^3. The fee collection rate is 65-70%, remaining 30% is paid in goods.

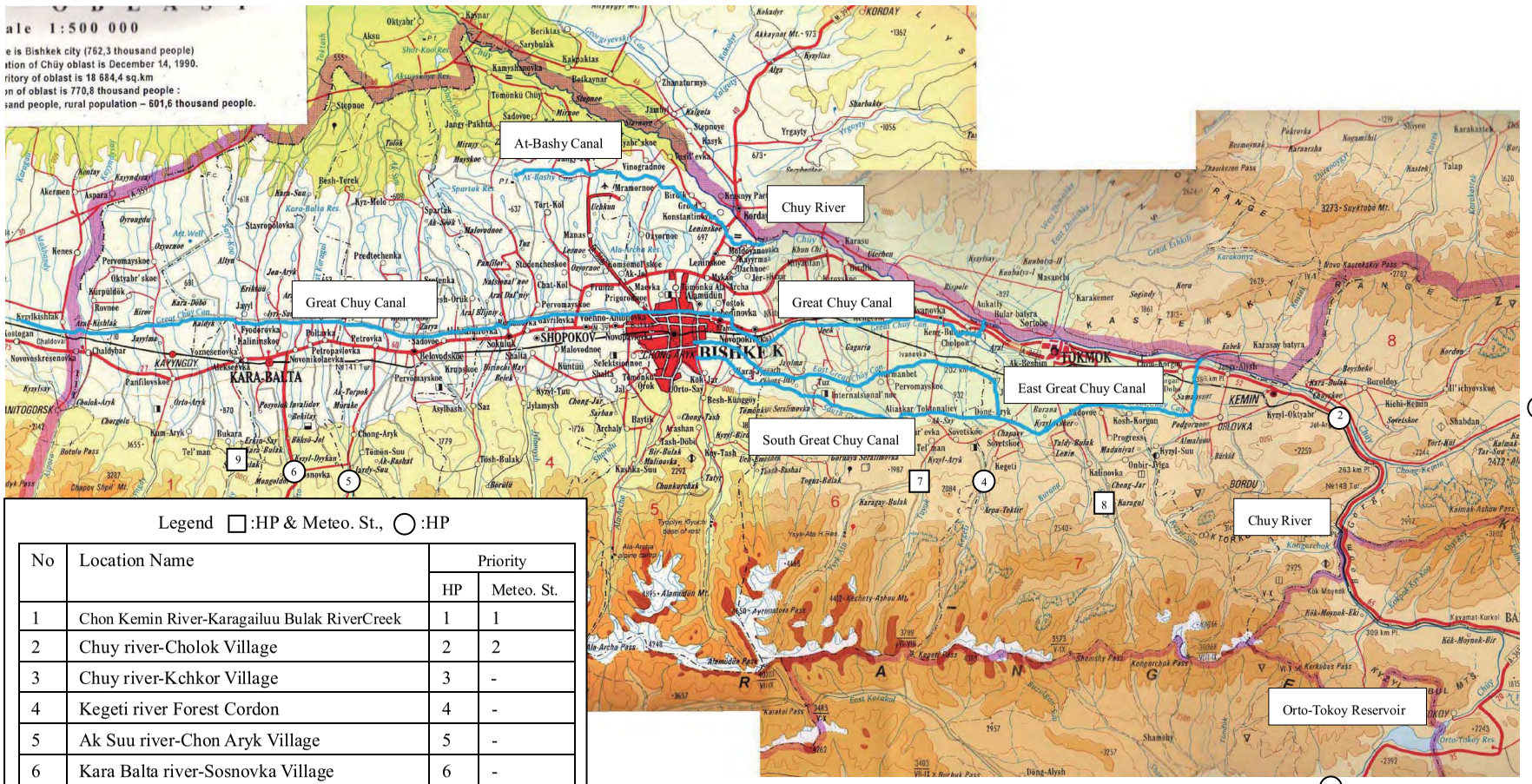
The State Water Economy Department has no relationship with Bishkek water and sewerage.

The South Great Chuy Canal constructed by the Water Economy Design Institute (now private organization) will be extended. This canal will increase the irrigation area by approx. 26,000 ha.

It is a potential pilot basin for improvement of water use along the river.

[6] Water use in the Naryn upper basin

Naryn State and Issyk-kul State on the upper stream site of the Naryn River use most of the available river water for irrigation. Water demand started to drop from1988 until 2005 to a certain level and has remained constant (whole Kyrgyz Republic has shown similar trend). Approx. 15% of the mass flow of the Naryn River is used for irrigation.



Legend □:HP & Meteo. St., ◯:HP

No	Location Name	Priority	
		HP	Meteo. St.
1	Chon Kemin River-Karagailuu Bulak RiverCreek	1	1
2	Chuy river-Cholok Village	2	2
3	Chuy river-Kchkor Village	3	-
4	Kegeti river Forest Cordon	4	-
5	Ak Suu river-Chon Aryk Village	5	-
6	Kara Balta river-Sosnovka Village	6	-
7	Issyk Ata river-Yur'evka Village	7	3
8	Shamsi RiverForest Cordon	8	4
9	Chon Kayindy river-Chon Kayindy canyon	9	5

Fig. 2-2-12 Approximate Location of Irigation Canals, Hydroposts and Meteorological Observation Stations requested to reconstruct in the Chuy Basin

2-2-5 Social Economic Framework, Demographics

Table 2-2-6 shows the growth rate of real GDP sector by sector according to the World Bank website. Among these sectors, the construction and transportation/communication sectors are significantly growing. On the other hand, the industry sector is greatly affected by various factors: global and regional business depression, resultant negative effects on the export of textiles and construction materials, and domestic energy issues, and decreasing sector growth rate. International trade has also limited its growth rate.

Significant reduction of GDP in the industrial sector in the first half-year 2009 was caused by the reduction of GDP in the energy sector, textile industry and construction material sector.

As power interruptions have stopped since June 2009, the water level on Toktogul Reservoir may be restored but it may not assure stable electric generation which will greatly affect the economy of the Kyrgyz Republic.

Table 2-2-6 Real GDP Growth Rate of Each Sector in the Recent Kyrgyz Republic

	2007	2008	1hf07(*)	1hf08	1h09
GDP	8.5	7.6	10.0	6.1	0.3
GDP excl. gold	9.0	5.4	12.2	5.5	1.3
Agriculture	1.6	0.7	2.2	2.4	2.1
Construction	32.3	-10.8	43.6	-27.6	28.5
Industry	6.3	16.5	3.8	6.7	-18.9
Industry excl. gold	9.2	-1.6	15.1	1.9	-17.7
Services	12.6	10.7	14.1	9.5	4.4
Trage	10.9	9.2	14.4	6.6	3.4
Transport/communication	44.4	29.7	40.8	29.4	10.8

(*)If07: First half of 2008

(original source: Kyrgyz National Statistical Committee, WB web site)

Similarly the socioeconomic indicators on the Kyrgyz Republic can be obtained from the World Bank website. Table 2-2-7 shows major indicators for years 2002 to 2008. GDP increased by 8% and GDP per capita reached approx. $1000 U.S. Population as of 2002 was approx. 5 million and has been increasing at a rate of 1% /year. Figures for 2015 are estimated using the trend method.

The Kyrgyz Republic, as an agricultural country, possessed 1.2 million ha of irrigated land in 1988 as shown in Table 2-2-8, which began to decrease in the mid 1990's down to approx. 1 million ha and remains at this level now. Through hearings for a future social framework with

the Water Economy Department it plans to develop an additional 1.2 million ha of irrigated land on a long term basis (no concrete road map because this was planned during the former Soviet era). In the short term, it plans to increase irrigated land area by 8,000 ha for 3 years according to a national law in Dec. 2008.

Table 2-2-7 Socioeconomic Indicators

Parameter	2002	2003	2004	2005	2006	2007	2008	(2015)
GDP (million US$) (Nominal)	1,606	1,919	2,212	2,460	2,833	3,745	4,120	6,919
GDP growth rate (%) (Real)	-0	7	7	-0	3	8	8	-
GDP per population (US$)			436	478	550	729	956	1,792
Population (thousand)	4,993	5,039	5,093	5,144	5,192	5,235	5,278	5,620
Population growth rate (%)	1	1	1	1	1	1	1	-
Power consumption (kWh per capita)	1,598	1,955	1,651	1,842	2,015	-	-	2,605
Average salary (US$/month)			52	63	76	106	148	301

(From World Bank Web site, Recent Economic and Policy Developments)

Table 2-2-8 Transitional Change of Irrigated Land Area in the Kyrgyz Republic

(Unit in Million ha)

Year	1988	1993	1998	2005	2006	2007	2008
Irrigated area	1.20	1.08	1.08	1.04	1.02	1.02	1.02

In Chuy State, an extension of irrigation canals is planned. The South Great Chuy Canal will be extended to increase the irrigation area by approx. 26,000 ha. This plan is being reviewed by the Water Economy Design Institute (now a private organization).

Water demand estimation

In response to the social framework determined in the previous section, we estimated water demand in 2015 on the assumption:

- Usage of industrial water increases in proportion to the growth of GDP,
- Usage of city water increases in proportion to the growth of the population in urban areas (approx. 30% of citizens of the country live in urban areas and this percentage has remained almost constant since 2005),

- Irrigation area will increase by 8,000 ha; ratio of irrigation water will be the mean value over the past 10 years,
- Other water use is in proportion to averaged ratios of water use for other applications to water use for non-other applications since 2005.

  Table 2-2-9 shows the estimated water demand by the social framework in 2015.

Table 2-2-9 Prediction of Water Demand in 2015 of the Kyrgyz Republic

(Unit in Million m^3)

Total	Municipal water	Industrial water	Irrigation	Water supply in rural area	Other
6,316	143	1,112	4,552	60	448

2-2-6 Hydrologic, Water Use and Meteorologic Observation in the Kyrgyz Republic

(1) Conditions and issues about basic hydrological and water use information facilities for water resources management

During the former Soviet era, facilities were updated and financial resources and personnel were secured. Current achievement of river observation activities is only 30-40% of that in the Soviet era. The Water Economy Department, Ministry of Agriculture and Water Resources is responsible for the monitoring of intake weirs and water canals but sometimes it fails to do so because some district offices do not have flow meters. The Kyrgyz Republic has many mountainous districts where rocks and earth avalanches occur. Un-repaired measurement facilities affect water allocation.

The State Agency on Geology is responsible for monitoring ground water, and Hydromet is responsible for surface water, snow melt and glaciers. “No glacier monitoring” is currently implemented except for certain glaciers.

In the rivers in the Kyrgyz Republic, the amount of water from fallen snow (snow melt) is far larger than water from rainfall and glaciers (melting). To accurately estimate discharge over the region deposited snow and snow melt should be monitored. During the Soviet era, many snow gages piled into snowfields were photographed from the air for observation of snowfall or the snowmelt rate. Forecasting of snowmelt and discharge made based on these photographs were more accurate than currently announced forecasts. This is because the independent republic has reduced the number of the snow monitoring stations (especially at upstream basins (higher altitude)).

(2) Existing database system and data access

With regard to Hydromet: data of measurements manually acquired from Hydroposts and meteorological observation stationsdeployed in major districts is normally transferred every morning (8:00 AM) to the Local Management Center which summarizes similar data sent from other Hydropost deployed at major districts within the scope of this center. The center then transmits the arranged data to the Ministry at Bishkek. Certain stations having critical information may transfer data directly to the Ministry.

Transmission method

a) Radio equipment (verbally)
b) Telegram
c) Cell-phone (verbally)
d) SMS (Short Mail Service) through cell-phone

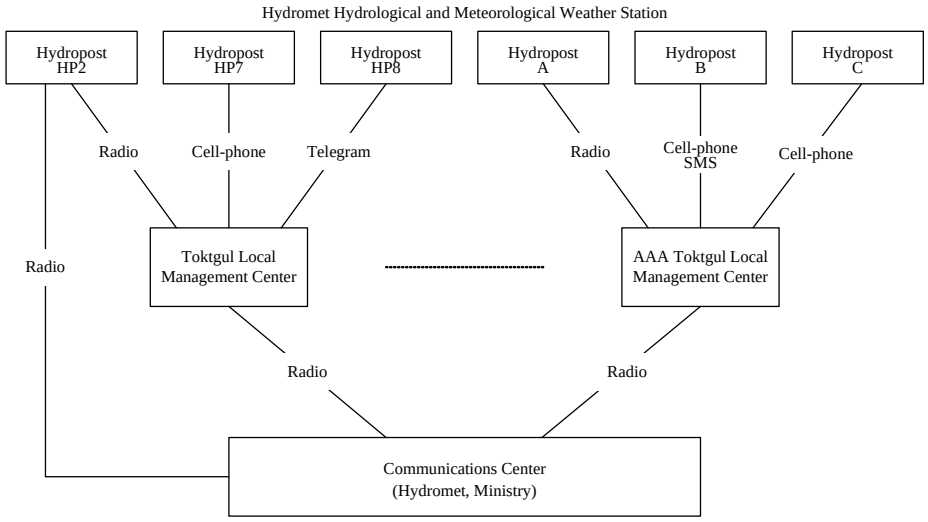


Fig. 2-2-13 Typical Hydromet Data Acquisition Network (Hydropost - Local Management Center)

Data transfer via telegram and SMS is based on World Meteorological Organization (WMO) format: coded data (5-digit number) string is sent in a text format.

Each meteorological observation station prepares handwritten monthly measurement reports for submission to the Local Management Center directly or by mail. Some key Hydroposts send the data directly to the Ministry without sending it to the Local Management Center.

At the Ministry, a communication information agency called the Communication Center was set up. Starting with 2002, Hydromet established a network linked with the Bishkek Hydropost (currently not working due to a PC software failure) and 4 Local Management Centers of Naryn,

Jalalabad, Karakol and Kuzulodel over the Kyrgyz Republic-Telecom public telephone lines. The center receives meteorological data and agricultural data every 3 hours by using the data collecting devices provided by USAID and automatically creates data in the form of original code. Data from other Local Management Centers and Hydroposts should be manually supplied to PC, but these data entries are not carried out smoothly due to a lack of instruction manuals and manpower.

In contrast, received coded data are delivered to sections within the Ministry as requested through LAN. The receiving sections decode the data prior to use.

The Communication Center also transfers data between Hydromets of other Central Asiatic countries (party of bilateral agreements) as necessary over the general Internet and through a Regional Center located in Tashkent.

The hardware in the Communications Center is composed of 1 server (1 backup server) for the database, 2 computers (Human Machine Interface: User interface) for HMI and 1 printer.

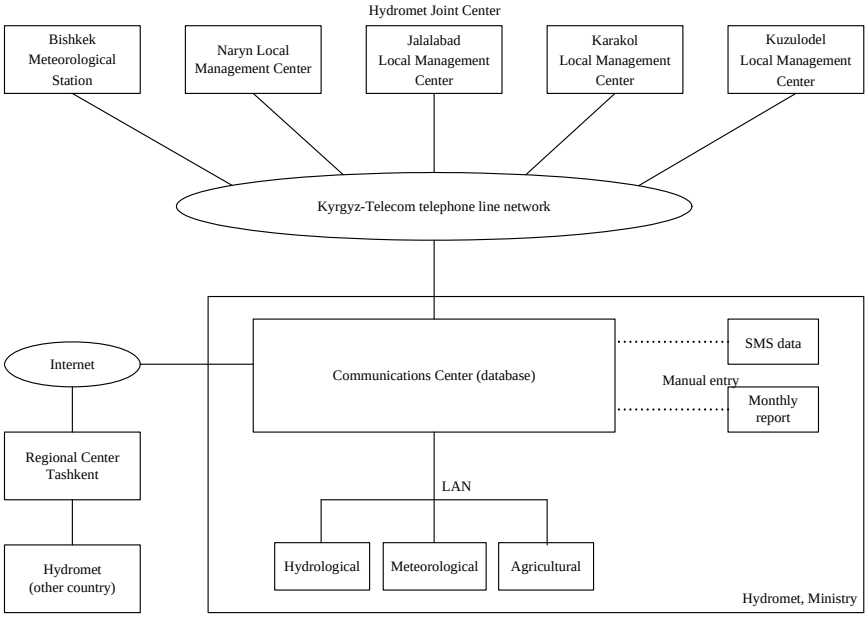


Fig. 2-2-14 Hydromet Data Acquisition Network (Local Management Center)

The Naryn Local Management Center operates the meteorological data automatic acquisition system for meteorological data provided by USAID in June 2009. The hydrological data (once/day) from 3 subordinate Hydroposts are entered manually but data automatically measured at meteorological observation stations installed at the site of the center are stored in a PC. The data are ambient temperature, humidity, ground temperature, wind direction, wind speed, pneumatic pressure, rainfall, etc. The data are sent to the Ministry every 3 hours via the

above-mentioned network.

The Ministry of Water Resources installed a SCADA (Supervisory Control and Data Acquisition) system to water diversion weir at the Kirov dam outlet (regulates water use at border of the Kyrgyz Republic and Kazakhstan on the Talas River basin), etc., with the help of donors to maintain facilities.

This cannot control (start/stop) the weir but can monitor its opening, operation and failure condition, etc., in real time. The center calculates discharge rate by using a water level indicator every 5 seconds and uses this data when negotiating with Kazakhstan on water use. Data collected at individual facilities are transferred to Ministry in Bishkek over the radio (once/day) and used to control water distribution.

(3) Observation system and data integration analysis system

[1] Information communication system

Certain data of the information systems operated by Hydromet and the Water Resources Agency have been controlled by computer since 2002 with the help of USAID. As not all of the data over the region are in the form of electronic information, monitoring and management are not performed by PC. GIS is not introduced. Only Hydromet Meteorological sector uses satellite images from NOAA (National Oceanic and Atmospheric Administration) to monitor the snow depth and to make short term forecasts of snow avalanches, etc. However, as described in “monitoring system (glacier and groundwater)”, the resolution of satellite imagery is low (1 km) and only a rough understanding of trends is possible.

On the other hand, CAIAG (Central Asian Institute for Applied Geosciences) independently has developed a unique Information Communication System which uses communication satellites. It installs natural disaster (e.g. landslide) monitoring points (called GNSS stations) and hydrological and meteorological data observation points (SMART stations) which use GPS (Global Positioning System) and operate from photovoltaic power generation to automatically perform observation and send data to CAIAG.

The hydrological data includes water level, water temperature and frow rate, and meteorological data including the amount of moisture vapor, amount of rainfall, amount of snowfall, humidity, ambient temperature, atmospheric pressure, amount of solar radiation, wind speed and wind direction. For data communication, GPRS (General Packet Radio Service) and VSAT (Very Small Aperture Terminal) are used to transfer data to the communication server of CAIAG. Figure 2-2-15 shows the VSAT network.

Collected data is used by the computer installed at the CAIAG main office to form a database which is delivered to partners via a VPN (Virtual Private Network) server, mail server and WEB server.

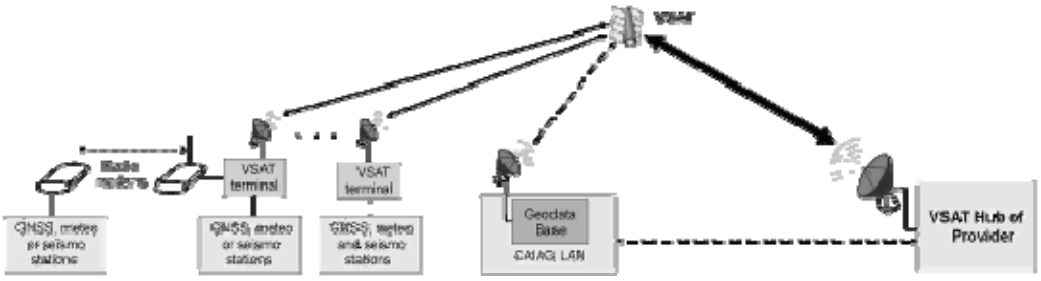


Fig. 2-2-15 VSAT Network

CAIAG is provided with data from 2 Hydroposts from each Hydromet of 5 Central Asian countries by using this system.

CAIAG will promote a model project to make hydrological and meteorological data sharable: currently, 4 GNSS stations and 3 SMART stations are operated. The Kyrgyz Republic, Kazakhstan, and Tajikistan have installed the system but Uzbekistan and Turkmenistan have not been provided with the system. Data to be commonly shared are 3 types of hydrological data and 9 types of meteorological data. The meteorological data are automatically collected and transmitted through GPRS and VSAT communications. By sharing the same data, individual organizations are not required to perform the same measurements within the same region. Individual organizations can build unique management systems by use of the same data.Use of the same data will save on maintenance and control costs.

Fig. 2-2-16 CAIAG Automatic Data Acquisition Points

CAIAG will increase the number of observation parameters and observation stations, and

acquire Hydromet data to monitor river basins, reservoirs, glaciers and the soil and to strengthen water resources management in Central Asian countries. As part of this plan, it has started a ZAWa (Zental Acien Wasser = Central Asian Water) project, setting 6 key items for solving water resources problems.

[1] Improve the network of hydrological and meteorological station network
[2] Unify data acquisition and analysis
[3] Build a system for uniform management of hydrological and meteorological data
[4] Builda data analyzing and modeling system
[5] Predict water associated risk
[6] Build a water resources management system based on reliable data

With respect to Hydromet data, CAIAG has started collection of the data approx. 1 year ago and promoting modeling. It requested countries in the basin to offer 2 hydroposts each as test sites (The Kyrgyz Republic, Kazakhstan and Tajikistan have installed the posts while Uzbekistan and Turkmenistan have not yet installed the posts). It also has started to build a prototype for network and data exchange.

Basic potential support are: rebuilding (or new) of observation facilities for hydrological and meteorological and water use based on existing Hydromet measuring methods. Meanwhile, use of GPS or VSAT is effective for observing glaciers because previous observation stations are no longer available and observation by personnel is difficult. Donors should prepare for regional cooperation with regard to water resources in Central Asia by studying the application of data sharing systems using VSAT.

Since the observation of glaciers through GPS and the system development of VSAT require time,a joint project with CAIAG which is a pioneer in this field should be taken into account.

[2] Monitoring system (except for glacier and groundwater)

Targets of monitoring are meteorological and hydrological observations. These are mainly managed by Hydromet. In addition, hydrological observation at irrigation canal facilities constructed by the Former Water Economy Department will be made.

<u>Bishkek meteorological observation station and regional management center</u>

Bishkek meteorological observation station and regional management center are located in the site of Hydropost. They manage 8 Hydroposts and transmit/receive observation data. Data is collected every 3 hours and sent to the Ministry over the radio. One radio device is equipped with a backup battery while the other operates only from AC power.

This meteo-station is the best in the Kyrgyz Republic in terms of maintenance and is regarded as a model station. Documents such as manuals are well maintained. The snow density meter is

installed only at this location.

Observation areas covered by automatic observation equipment is separated from areas covered by manual observation. The configuration of the meteorological data automatic acquisition/transmission equipment delivered by USAID is the same as that of equipment installed in the Naryn integrated station. However, it does not work and the software is also defective. It is not currently being used.

- State of Hydromet hydrological and meteorological monitoring -

Hydromet controls 76 Hydroposts (4 for lakes, 1 for reservoirs). Each post is assigned with regular personnel.

Figure 2-2-17 shows locations of meteorological and hydrological observation facilities controlled by Hydromet. Figure 2-2-18 shows the reduction status at the measuring location. At each location, noticeable reductions began in late 1980 and continued for 10 years. Remaining facilities have degraded.

In general, the life cycle of infrastructure changes along the deterioration curve shown in column 1. If not properly maintained or serviced, it will stop functioning. Hydromet equipment in the Kyrgyz Republic is at a critical point.

Measurement items by Hydromet are water level, discharge, water temperature, ambient temperature, precipitation, deposited snow and frozen state of the river. Measurements are hand written on record paper and mailed to the jurisdiction State Hydromet Branch Office every month. The branch office sends one-year records to the head office by mail (once/year). The branch office also makes calibrations of water level-discharge curves. This handwritten data is stored at the head office.

Fig. 2-2-17 (1) Distribution of Meteorological Observation Stations in the Kyrgyz Republic

Fig. 2-2-17 (2) Distribution of Hydropots in the Kyrgyz Republic

(a) Hydropots **(b) Meteorological Observation Stations**

Fig. 2-2-18 Decrease Trend of the Number of Meteorological Obsrvation Stations and Hydroposts in the Kyrgyz Republic

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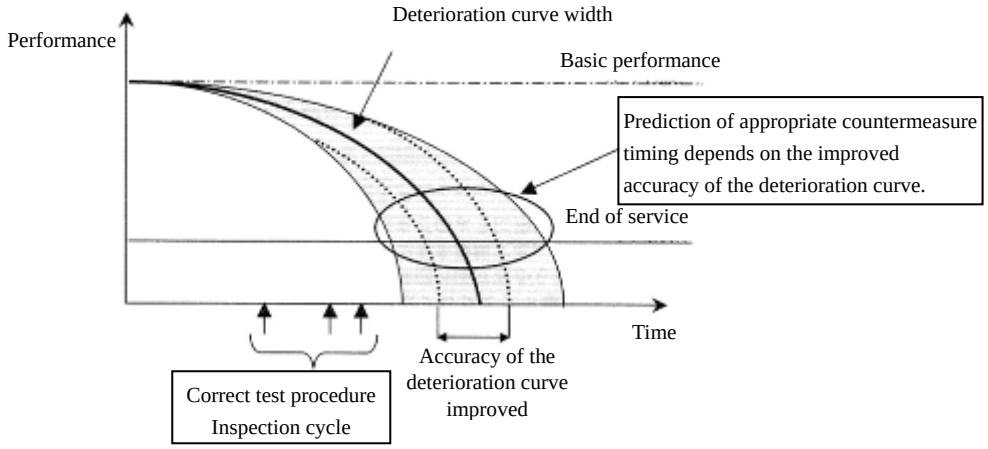
Column 1 **Infrastructure deterioration curve life cycle**

In general, civil engineering structures such as social infrastructure starts deteriorating as it starts service. To keep its function and performance for a long period, appropriate checking and maintenance service are required.



(Source: **http://www.pacific.co.jp/manage/pam/pampdf_files/pamreport10.pdf**)

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Monitoring equipment and communication equipment test and repair section

This organization consists of 5 personnel and is directly managed by the director of Hydromet. The section is located at a site where Vehicle and Procurement are also located. This section is responsible for repair, overhaul and certification of hydrological and meteorological observation equipment and communications equipment.

The current meter test unit is made in the Kyrgyz Republic, developed in a measurement technology institute belonging to Ministry of Agriculture and Water Resources. The current meter is placed in a circular water tank of approx. 2 m in diameter. The running water is rotated by a motor. The test unit is calibrated every 3 years. The section tests current meters once per year. Most of the current meters are those used in Hydroposts all over the Kyrgyz Republic. It releases a certificate under the name of Hydropost. The period of validity is 2 years. The section tests approx. 250 current meters every year.

The section repairs and adjusts all kinds of devices used in Hydroposts and meteorological stations and also agricultural meteorologic equipment. However, no personnel can repair anemometers.

Water quality monitoring

Until 1991, water quality monitoring was conducted on 102 samplings for 54 bodies of water

and tests were made at 2 test facilities (Bishkek and Osh). Currently, water is sampled only once per quarter at Chuy. The head office conducts only water quality tests at Bishkek. Sample specimens are tested at the water quality laboratory located in the Hydromet building. Main test items are pH, water temperature, water visibility, SS, BOD, DO, metal ion and hardness. The Hydropost located at the lowest stream of Naryn River conducts simple water quality tests. Results of the water quality tests were manually written on recording sheet. The JICA Technical Cooperation Project is computerizing these processes. Equipment, materials and reagents for the water quality tests are prepared and maintained with the assistance of foreign countries. The reagents are not enough.

Water quality problems caused by soil containing mercury were found in Osh State. Similar problems will arise because many water quality monitoring spots do not check the soil for heavy metals. Sediment loads are not monitored for the purpose of prediction of sand deposition in reservoir. Bishkek has no water quality problems because all tap water comes from groundwater.

Measurement items and system at Hydropost

Major items observed at each Hydropost (HP) are, water level, discharge, ambient temperatures (highest and lowest), amount of rainfall, amount of snowfall, etc. The measurement data are sent over radio to the Toktogul Joint Station every day at 8 AM. Normally, only one personnel (1 family) performs observation. At key Hydropost e.g. Naryn River, Uch-Terek point (Hydropost-2), 2 observers are stationed.

Hydropost-6 (Chychkan River - Bala Chychkan River Mouth)

Conditions such as measurement facilities, observatory cabin (also the home of observers) of the Hydropost-6 are poor. Cable for frow rate measuring remains but the gondola for carrying loads and humans during measurement is damaged. Currently, observation activities are not being carried out. Problem: the water level and discharge observation point is located downstream of the observer's house so that it is hard to maintain the facilities. To protect these facilities and equipment against damage and theft, they will be moved close to the house.

Hydropost-2 (Naryn River - Uch-Terek)

The automatic discharge observing system SEBA is installed. Positioning of the current meter and measurement can be performed from a bank by using remote control. This facility was installed by USAID in 2002. The height at the top of several steel piles placed on the bed are measured with reference to a reference point by using the leveling method. And then, every day at the specified time (8:00 and 20:00), water level is measured by determining the difference

between the water surfaces. Conventional current measuring system (GR-21) is also used. Observation data is sent every morning at 8 to the Toktogul regional management center and Bishkek by radio transmission.

Problem: In winter, the river freezes and it is difficult to measure the water level. The automatic water level observation unit as mentioned above was also installed through USAID. However, the pipe connecting the bank and the water level observation well is clogged with sand and stopped operation only 1 month after installation.

Ruins of the Torkent River Hydropost

Torkent River is the third largest tributary stream (approx. 60% of Chychkan River) flowing to Toktogul Reservoir, but its discharge is not measured. A lake formed by an earthquake upstream of Trukent river in 1992 broke in 1993 destructing the downstream Hydropost which should be restored. (See Fig. 4-2-1, [1])

Hydropost-8 (Kara Suu River)

Measurement items are only water level, frow rate and water temperature. An observation cabin (also home of the observer) has not been built. A measuring point (frow rate, etc.) was setup approx. 50m upstream but washed out June 1996 when the upstream lake broke. The measuring point has been moved to the current position (bridge). At this point, frow rate is measured by using the bridge. The measurement data is sent to Bishkek by telegraph. The data for 1 month is recorded on a registry which is sent to Toktogul regional management center every month. The problem associated with this Hydropost is the change of observers before transferring experience, knowledge, etc., to the successor. The main reason is that the observer is not provided with the house and land.

[3] Monitoring system (glacier and groundwater)

During the former Soviet era, snow melting on glaciers was included in “glacier melt” when calculating the river discharge. The main organization responsible for the monitoring of glaciers and snow is Hydromet. While the monitoring of snow at Meteopost (including joint station) at low altitude has continued, many of Meteopost at mountains at middle to high altitude are lost. Overall monitoring accuracy of glacier and snow are greatly decreased when compared with that of during the Soviet era. With Hydromet, monitoring of glacier is suspended.

Under these conditions, the amount of deposited snow and melted snow are monitored through NOAA satellite images (resolution 1 km). NOAA satellite image data has been stored since 2000 (during 2000-2008, the data was received and processed in Uzbekistan). In Oct. 2008, they received training on remote sensing held at a Swiss training component. Satellite data receiving

stations were given by Russian Hydromet July, 2009.Currently, they can directly receive and process NOAA satellite image data.

[4] Runoff Analysis

Discharge forecasts are divided into two in terms of period: short-period forecast is made 5 to 10 days in advance while long-period is released 1, 3 or 6 months in advance.

The traditional discharge forecast starting with the Soviet era is as follows: Taken Naryn River basin as example - “averaged rainfall level at 6 representative Naryn basin meteorological observation stations from previous Oct. to Mar.” is drawn on the horizontal axis and “discharge at Naryn River Hydropost (HP-2, Uch-Terek point) from Apr. to Sept.” is drawn on the vertical axis. Then this correlation diagram is used for forecasting.

Recently, discharge is also estimated by using a run-off model. This analysis software was developed by the Uzbekistan Central Asia Hydrological and Meteorological Research Institute and introduced to the Kyrgyz Republic 3 years ago by SDC (target is the Fergana Basin). This system has been used for forecasting the Naryn River basin discharge since 2008.

At Hydromet, we asked the chief of the section in charge of discharge forecasts “whether the accuracy of forecasting has improved since the introduction of the run-off mode”. The answer: “We do not have enough experience with this model method and weregard the model as a supplement. The final forecast is derived from several estimations including errors (traditional method and run-off model, etc.)

2-2-7 Water Consumption and Water Management

The foregoing discussion is organized from the view of water consumption and water management in the Kyrgyz Republic, and the issues and orientation of countermeasures in the discussion are summarized as follows.

(1) Water Consumption

[1] Hydropower Generation in the Days of the Former Soviet Union and Bartering Framework for Irrigation Water and Their Changes after the Soviet Breakup

In the Soviet era, hydropower generation was implemented in the upstream basin of the Syrdarya River and Naryn River while irrigated agriculture was practiced in the downstream basin of the rivers, having a relatively clear distinction between the role of upstream basin and downstream basin. Water from the Naryn River was mainly used to supplement irrigation water in the irrigation season. After the Soviet breakup, however, more water from the Naryn River was used for power generation in the non-irrigation

season in the Kyrgyz Republic because of increased power demand, escalating the fuel price and need of water release for generating power in the non-irrigation season (winter). Therefore, water from the Naryn River is used for balancing use to supplement irrigation water in the downstream basin in the irrigation season with use for power generation. Meanwhile, the Kyrgyz Republic is adjusting power supply with the riparian countries.

The same trend can be seen in the operation record of the Toktogul Reservoir. Water release volumes in the irrigation season have decreased since 1991 while water released for generating power in the non-irrigation season has increased. On the other hand, water used for power generation in the non-irrigation season is used again at hydraulic power plants around Naryn cascade and then released downstream. A drought in 2008 caused a severe power shortage though power was generated using the poor storage of the Toktogul Reservoir in winter that year. Since 90% of the power supply relies on hydro power generation in the KyrgyzRepublic, water use for hydro power generation account for a large portion of stable energy supply which is one of important issues in Kyrgyz Republic.

[2] Water Use Status in the Entire Kyrgyz Republic

Water use (water consumption) in the Kyrgyz Republic recorded the biggest demand in 1988 between 1988 (in Soviet era) and 2008. Water demand decreased by approximately 30% during the following decade. Recently, the demand has been stable. Water demand by sector shows 90% or more taken by irrigation and the rest by industry, water supply in city areas, and clean water in rural areas. Accordingly the irrigation area in the Kyrgyz Republic decreased from 1.2 M ha in 1988 to approximately 1 M ha in 1993, and since then has remained at the same 1 M level. A hearing indicated that expansion of the irrigation area to 1.2 M is planned in the long term. The short term plan aims to increase approximately 8000 ha of irrigation area in three years from 2008.

The Department of Water Economy said that approximately 70% of available water resources in the Kyrgyz Republic are used for hydropower generation. In this sense, water resources in the Kyrgyz Republic are equivalent to energy as the base of the national economy.

[3] Water Use in Each State

Water from the Naryn River in Naryn State and Issik Kul State has been mainly used for irrigation. The volume had been decreased since 1988 and since 2005 has remained at the same level as the entire Kyrgyz Republic. Approximately 15% of discharge of the Naryn River is used for irrigation. On the other hand, hearings in the Naryn State indicate that water loss in irrigation canals reached approximately 40% due to canal deterioration and

canal sedimentation.

Water use in Chuy State recorded the biggest demand of 3100 M m^3 in 1988, and then had decreased to approximately 750 M m^3 in 2005. Since 2006, water use has stayed between 1,500 M m^3 and 1,750 M m^3. In 2009, irrigation water accounted for 64% of overall water use (1,235 M m^3; irrigation: 799 M m^3, domestic use: 71 M m^3, industry: 71 M m^3, parks, schools and others: 14 M m^3, water supply in rural areas: 7 M m^3), which indicates irrigation is outstanding.

Bishkek City uses groundwater for all of the clean water it consumes. The volume recorded in 1999 was approximately 130 M m^3/year and has decreased during the following few years, and has stayed around approximately 110 M m^3/year in recent years, consisting of domestic water (46%), heating (32%), public facilities such as hospitals and schools (11%), and cafes and restaurants (11%). The water quality in Bishkek City is significantly better than that in other cities such as Moskva, Kiev, Dushanbe, etc. as it is potable water.

(2) Issues on Water Management

[1] Issues on Overall Water Resources Management

Most of the water in the Kyrgyz Republic is used by irrigation and the rest by industry, water supply in city areas, clean water in rural areas, etc.

Monitoring of basic river discharge for water use and of precipitation, accumulated snow and glacier for runoff forecasts are conducted mainly by Hydromet. Meanwhile, the Kyrgyz State Agency for Geology controls groundwater, which means that what agency controls depends on where the water comes from (that is, surface water or groundwater). In order to promote water resources management, the state needs to establish an integrated management system.

Management issues at Hydromet are as follows.

- Although the state needs to develop a regional plan to promote water resources management, currently, the organization of hydrology material, etc is not adequate as a basis for a plan.
- The number of hydroposts and monitoring items is decreasing and keeping monitoring accuracy is becoming difficult due to a lack of maintenance and upgrading of monitoring equipment.
- In particular, hydroposts and meteorological observation nstations located at high altitudes are decreasing significantly. There is little monitoring of glaciers.
- Since monitoring data is saved in paper-based filing systems and not in computers, the data is not utilized adequately as a database.
- Because of low pay, competent workers are leaving. Some stations have experienced

difficulty in hiring new workers.

- Although budgets from 2006 to 2008 showed some improvement on working conditions, the maintenance budget for hydroposts and stations is still extremely low.

[2] Issues on irrigation water management

Naryn State

The followings are issues pointed out in hearings at the Water Economy Department of Naryn State.

- Half of the discharge gauging posts along irrigation canals needs renovation. Due to a lack of budget, it is impossible to install micropropellers (small current meters) in all posts/stations. Because of this, actual conditions of water use are not being researched adequately. This data accuracy problem prevents actual conditions from being accurately reflected in decision making of water allocation. Due to leafkage from canals underground and leakage from deteriorated portions of canals, the average water loss accounts for 30% and reached even 40% in some places, which causes irrigation water shortages in the irrigation season.
- It is difficult to increase stations because station increases are accompanied by worker increases and require a larger budget from the state.
- Water use fees are collected for funding stations/posts maintenance. However, given the actual maintenance costs, the fees are relatively low. This has caused a situation renovating station/posts is impossible with state funds only.
- Therefore, it is necessary to resolve these issues and make water management more efficient.

Chuy State

The followings are issues on water resources management pointed out in hearings at the Water Resources Department of Chuy State.

- Water loss (with underground flow) between Lake Orto-Tokoy and the first water intake point reaches 45%. It is necessary to mitigate water loss through discharge gauging.
- Leakage does not occur in concrete canals, but a 10 to 15% of water loss can be observed in other canals. Moreover, 10 to 15% of water theft also can be observed.
- There is little discharge gauging of tributaries from mountainous areas. Although monthly averaged data is sent from hydroments, accurate and periodical gauging is not conducted.
- Sediment discharges from mountainous areas becomes deposited in canals. There are

two sand stilling basins: one along the Kyzyl Suu River and another along the Alamedin River. Sediment is excavated in winter.

- Large scale state farms moved into small scale private farms but the efficiency of water use and agricultural management is poor in terms of water resources management, etc. Integrated plans back to larger scale farms are under review.
- Irrigated water cannot reach every ends of irrigation channel.
- Water discharge into canals is scheduled and managed by management supervisors at every section.
- Therefore, “it is necessary to make water management more efficient and improve management based on accurate discharge data.”

[3] Issues on city water management

Water Supply and Sewerage Agency in Bishkek has the following issue.

- Bishkek receives all of its water from groundwater and loses 12% because of 1) leakage, 2) cleaning, 3) excessive water use by commercial activities, 4) no water usage meters and 5) the fact that the nominal population in Bishkek is 468,000 but the actual population is 1,200,000, and that Bishkek supplies water to 1,200,000 people not to 468,000 people, etc.

[4] Issues on Water Demand of Hydro Power Generation

The government is addressing the stable supply of energy as a priority issue. Water for hydro power generation to supply energy heavily relies on storage in the Toktogul Reservoir in the non-irrigation season. In 2008, there was not enough water for hydropower generation to compensate for the shortfall of power demand in the winter season. This water shortage has become a serious issue. In the winter of 2008/2009, there was insufficient storage in the Toktogul Reservoir and the state experienced a difficult period. Power can be generated in winter through water release, but released water goes downstream without being used for irrigation.

Plans to built hydro power generation plants including small-middle sized plants are being developed. Kambarata II (360 MW) located upstream of the Toktogul Reservoir along the Naryn River is under construction. Moreover, a large scale hydropower generation plant, Kambarata I (1,900 MW) located immediately upstream of Kambarata II and 40 other small-medium sized plants are under review. Since December 2008 when the Renewable Energy Act was enacted, the possibility of hydro power generation has drawn more attention in many regions.

Regardless of the fact that there is more water in the Toktogul Reservoir this year than that

last year, many energy conservation programs are being implemented such as planned power outages, heating with coal and use of energy-saving lighting equipment in government offices, and the installation of electric usage meters. In order to ensure energy in winter and decrease water use for hydropower generation, thermal power generation is used. Since coal and natural gas for thermal power generation are imported and degraded thermal power generation plants must be renovated, costs for thermal power generation have increased, which has caused price increases for electricity and hot-water supply for heating. Thus the burden on the public is increasing. The collection rate for electric charges has significantly improved to approximately 95% compared with the rate before.

These issues are as follows.

- Power demand in winter depends on temperature, and runoff forecasts are reflected in operation plans of power plants. Both temperature forecasts and runoff forecasts are conducted by Hydromet. The forecast accuracy needs to be improved.
- 90% of electricity in the Kyrgyz Republic is generated in Jalal-Abad State and other states located in the south but states in the north consume 60 to 70% of the electricity. Since the current power transmission line from the south to the north is in sufficient, additional power transmission lines are required.
- The Kyrgyz Republic sets up an arrangement with Kazakhstan every year which stipulates the Kyrgyz Republic sells electricity in summer and buys coal for power generation in winter. This arrangement was successfully executed in 2008 and 2009. The Kyrgyz Republic also buys expensive natural gas from Uzbekistan to balance power demand with power supply.

(3) Orientation of Countermeasures

[1] For Overall Water Resources

- For the monitoring system of Hydromet and enhancement of the water use monitoring system by the Water Economy Department in the state, support to fund calibrating monitoring devices and training programs for engineers who work to enhance the system of maintenance and verification of monitoring devices.
- Renovate (or newly construct) monitoring facilities for hydrology, meteorology, and water use based on conventional monitoring techniques of Hydromet.
- In monitoring glacier and accumulated snow, aim to improve the forecast accuracy of inflow discharge by developing analytical methods by working with CAIAG.
- Work with and cooperate with donors involved with renovation or the construction of monitoring facilities for hydrology, meteorology, and water use as well as enhancement of water resources management, development of river basin

management plans, etc.

- Improve the data sharing system in the Kyrgyz Republic
- Enhance monitoring functions for hydrology, meteorology, water use, etc.
- Promote digitization of monitoring data and database development

[2] For using irrigation water

- Conduct leakage control and repair irrigation canals
- Continue to keep monitoring facilities and equipment in good condition to obtain accurate data of water intake and discharge.
- Promote efficient use of irrigation water and improve irrigation methods
- Naryn State holds seminars for water users several times a year (including content on efficient water use. The seminar is one to two days long).

[3] For water use for Hydropower Generation

- New power plants located upstream of the Toktogul Reservoir are planned. Kambarata II diverted river water flow in December 2009 and will launch operations in May 2010. Kambarata I is in the FS phase.
- Promote hydro power generation using water discharge in other tributaries
- Build hydro power generation plants in small-medium sized rivers, and recognize hydro power generation as an alternative energy replacing oil, etc. through putting in place a power supply network to regions.
- Enhance the river discharge gauging system by Hydromet and improve runoff forecasts, etc. so that appropriate hydropower generation planning and operation can be realized.

The above efforts will promote stable energy supply in the Kyrgyz Republic and contribute significant benefits to all of its citizens.

2-3 Overview of Water Resources Management in Tajikistan

2-3-1 Policy, Law and Institution

[1] Water Code

A Water Code was enforced in 2000 as a basic law regarding water administration in Tajikistan, in which the basic concept and direction of water resources management are organized. The objective of the Water Code is to prevent water pollution, water resources exhaustion and water damage, to conserve water resources, and to promote the development of laws for protecting water related rights of individuals and legal entities, meeting the needs of citizen, business sectors, and natural environment through rational utilization of national water resources.

[2] Road Map

Following the Water Code, a road map for realization of IWRM principles by main government agencies was established in 2006 under the support of UCC-Water, UNEP, GWP, etc. This road map advocates the importance of comprehensive implementation of water resources utilization by the nation and refers to rehabilitation activities of water resources monitoring etc. as technical issues. These facts indicate that the government acknowledges the importance of water resources management.

[3] Current efforts

According to this basic law, the government is establishing a new system toward appropriate water resources management based on the Water Code as transitioning from the former Soviet Union system. They are moving into water resources management on a basin basis. They are also focusing the IWRM process which involves users of water in water administration. As water resources management on a basin basis is being promoted, there is a move to build “water use associations” which administrate agricultural water. By delegating management of water canals in local areas which previously belonged to the former sovkhoz or kolkhoz to water use associations, the system of existing irrigation canal networks is shifting from government administration to water use association administration.

An organization to control the above associations is also being established (Soyuz). However, the transition from kolkhoz, etc. still has many issues to resolve such as the management of water canals in local areas which were previously managed by the central government, coping with water loss due to aging canals, new system establishment according to transition from public farming in large scale to individual farming on a small scale, etc. The establishment of

river basin organizations has becomes a key to manage basin management, and a legal system including the Water Code and water use association law has been developed. The Ministry of Water Resources newly created a “Water use association support section” and an “Information section” in order to address support establishment of water use associations and to create a database. These facts clearly indicate that the government has a strong willingness to promote water resources management.

2-3-2 Organizational Framework, Staff, Budget

The Ministry of Water Resources and Land Reclamation (hereafter Ministry of Water Resources) is mainly in charge of water resources management, and Hydromet is responsible for hydrological, meteorological and water use measurements.

[1] Ministry of Water Resources and State Ministry of Water Economy (Soghd State)

[Ministry of Water Resources]

- Organizational framework, personnel -

Water resources are mainly managed by the Ministry of Water Resources and its lower organizations are located in the state and region (Rayon). The Ministry of Water Resources has regulatory power over water resources and land improvement such as development of lands and irrigation, consumption of water and protection, building and management of facilities related to water resources and land improvement, water consumption in villages, irrigation in grass farms. Its tasks include, preparation of laws, planning and implementation of business and organization/system, and management and coordination of these items. The monitoring of water use is performed by the state Water Economy Bureau. In practice, water use is monitored by Rayon once/10 days.

- Budget -

The 2008 year budget for the Ministry of Water Resources was 25 million somoni, of which 13 million somoni (52%) was for land improvement and water resources management and maintenance. The facility maintenance cost used for construction of infrastructure was 11 million somoni (45% of total). The budget in 2007 for facility maintenance and management was lower when compared to 2006 and 2008. Budget allocation in 2006 and 2008 were similar.

Facility improvement and relocation seems sluggish because the budget for infrastructure construction is insufficient. The budget for these sections may be increased as these facilities age.

Future budgets will be aimed at for continued operation of infrastructure.

[Soghd State Ministry of Water Economy]

- Organizational framework, personnel -

The following describes state level organization taking the Soghd State Water Economy Bureau as an example. The number of staff working for the Water Economy Bureau is 28 (excluding laborers such as private police). Practical water management is done by 13 state Rayons which hold 3,880 persons responsible for water management tasks. Water is managed by three organizations: administration sector by the State Energy Bureau, maintenance practice by Rayons, and farmyards by farmers. There are 71 irrigation associations in theentire state and the system will be strengthened. 25 million somoni is allocated to overall state water management. Kanibadam Rayon collects water use fee 0.015 somoni/m^3 (free fall) and 0.0239 somoni/m^3 (pumping) from water users.

* 1 somoni = ¥20.5 (as of 10/1/2009)

[2] Hydromet

In Tajikistan, Hydromet (State Administration for Hydrometeorology) is in charge of hydrological and meteorological measurements. Hydromet is responsible for collection and supply of hydrological and meteorological information necessary to protect people from natural disasters caused by abnormal hydrological and meteorological conditions. It also responsible for the building and maintenance of a nationwide hydrological and meteorological measurement network, cooperation activities with international and national organizations related to hydrological and meteorological measurements, and environmental monitoring; and training of experts in the hydrological and meteorological fields. The Hydromet has branch offices called Local Management Centers which collect measurement data within the assigned areas and arrange and send the data to Hydromet headquarters. The total number of Hydromet staff is 700 (including 400 staff in local offices). The 300 members at the headquarters are divided into two groups: 150 staff work full time while the other 150 staff work part time for measurements during busy periods and pursuing their own business interests in the off-season. Five staff work for the integrated observation center (hydrologic, meteorologic and agrometeorologic) and one staff works for each observation station (hydrology and meteorology). We surveyed Hydromet observation stations on the Syrdarya River basin and found they have become older and were in bad condition (partly due to civil war) when compared with those in the Kyrgyz Republic. Tajikistan Hydromet as well as the Kyrgyz Republic Hydromet should improve personnel treatment (especially wages and salary) in order to maintain appropriate observation systems. Efforts are also required to secure observation sustainability with equipment improvement.

2-3-3 General Description of Hydrological and Geological Conditions

Tajikistan has a continental climate; it is dry during summer and precipitation increases between

fall and spring. On the plains, it is hot and dry between June and September with the highest temperatures over 35°C, while it is cold between December and February with snow and an average temperature of below 0°C. Mountain ranges in the northern part of Dushanbe and northwestern part of Sarez Lake have heavy precipitation of 800 to 1200 mm (400 to 800 in other areas). Average snow depth is more than 120 cm at the foot of the Mt. Zaravsan Mountain Range and Petra Pervogo Range.

In mountain ranges in Central Asia, various geologies show mosaic-like complicated patterns; Southwestern Pamir consists of a Precambrian basement block, Tian Shan is a product of mountain-building activity in the Palaeozoic era, Tajik sedimentation zone consists of sedimentfrom theMesozoic era and Cainozoic era, Central and Northern Pamir consists of compounds in an island arc zone and continental marginal zone.

These mountain areas divide Pamir into two sections (north and west) by Northern Pamir fault and Darvaz-Karakul fault. Gissar-Kokshal fault separates Tian Shan from Southern land block, forming complicated active fault sections.

Pamir Plateau located in Eastern Tajikistan is referred to as “The Roof of the World”, through which many glaciers run. Fedchenko Glacier, the largest glacier among them, extends for 77 kilometers with a 1,700 to 3,100 meter width and covering over 992 km^2. The thickness of the glacier is not less than 500 meters. This is the one of the largest glaciers found outside the polar regions. This glacier flows north from the northwestern ice field (6,200 meters) of Revolution Peak (6,974 meters), receiving ice from dozens of tributary glaciers. The glacier can move up to approximately 67 cm per day. It ends at an elevation of 2,900 meters near the border with the Kyrgyz Republic and melts and empties into the Balandkiik River, which meets the Amdarya River, a large river in Central Asia. Its waters eventually empty into the Aral Sea. In Pamir Plateau, there are two observation stations; Fedchenko glacier observation station in the western part and Markab meteorological observation station, in the eastern part. These two stations provide valuable information on climate change and environmental analysis in Central Asia. Since Fedchenko Glacier and many other glaciers in Pamir are shrinking now, the adverse impact on water resources has become a major concern.

2-3-4 Current Condition of Water use

Water use in Tajikistan can be summarized as follows based on document (*1).

Among available water, 84% is used for the agricultural industry, 8.5% for drinking and business, 4.5% for industry and 3% for remaining sectors. It should be noted that people equivalent of 25% of population use irrigation canal water as daily life water. During the Soviet era, usage priority of river water was given to countries located on the downstream basin of the Amdarya River and Syrdarya River for irrigation of land to grow cotton and rice. Approx. 55%

of water running to Aral Sea is produced in Tajikistan, and an economic slump and post-independence civil war caused deterioration of the irrigation and drainage system. Approx. 1/4 of population use water from mountain streams, irrigation canals, ponds, etc. In the economies of Tajikistan, the agricultural industry is important in terms of export and measures to fight poverty. Water lost in the canals amounts to 40% on average.

According to records showing the quantity of water intake (1986 to 2008) in Soghd through which the Syrdarya River runs, the quantity of water intake and supply recorded a peak in the late 1980s. Subsequently, the quantity decreased in 1990s, and the decreasing trend has continued after 2000. According to the Ministry of Water Resources, the low water supply during 1995 to 2008 was caused by poor water delivery to areas requiring irrigation. Every Rayon tried to increase the quantity of water supply but failed to do because control operation by Tajikistan was limited. Water balance of various rivers including small rivers and transboundary rivers such as the Kafirnigan River, Zeravshan River, Vakhsh River, Pyanji River, etc. in Tajikistan is not calculated. Tajikistan as a nation should consider this issue.

(*1) Water resources assessment, irrigation and Agricultural developments in Tajikistan by Kristina Toderich, Munimjon Abbusamatov and Tsuneo Tsukatani, Discussion Paper No.585, Kyoto University, Kyoto Japan, March 2004

2-3-5 Social Economic Framework, Demographic Movement

The social economic status of Tajikistan is represented on the 2009 country report of the World Bank. An abstract of major points related to water resource management is below.

(http://web.worldbank.org/WEBSITE/EXTERNAL/COUTRIES/TAJIKISTAN/)

Tajikistan generated powerful economic growth at a rate of 9%/year through 2000 to 2007, but the rate has slowed down due to defectiveness of its macroeconomic policy and insufficient energy supply in winter. Tajikistan's economy is greatly supported by cotton and aluminum exports and currency transfers from emigrants in Russia (43% of GDP in 2008). In 2009, the economy was affected by the world economic recession, and money from emigrants decreased by 30% while exports such as cotton also decreased – the economic growth rate will decrease by 3%. Tajikistan is the poorest country among Central Asian countries. Although economic indicators have improved for the last several years, insufficient public services, poor government function, continued energy shortages and low wages have not improved. Among European and Central Asian countries, only Tajikistan cannot reach its millennium development goal (MDGs).

The number of people below 29 years of age accounts for 67.5% of the population. The youth will powerfully contribute to develop and maintain a secure economy in Tajikistan.

Tajikistan has an abundance of natural resources, such as water, hydraulic power potential,

mineral (high-quality coal, gold, silver, jewelry of value, uranium, etc.).

According to the WB website and JICA Report (Tajikistan Country Gender Profile, JICA Tajikistan Office 2008, Dushanbe) showing major social economy index (2002 to 2008) of Tajikistan, the GDP growth rate has been stable at approximately 7%. Population increased by approximately 1% from 2002 to 2006, and has increased by approximately 2% since 2007. Meanwhile, power consumption growth has been small.

2-3-6 Hydrological and Water use Observation

(1) Current Condition and Issues of Basic Hydrology and Water use Information Related Equipment for Water Resources Management

[1] Current Condition and Issues of Equipment for Hydrology and Water use in Hydromet

There were 140 Hydroposts in the days of the former Soviet Union and currently 96 posts still exist. 15 of these posts are not available because of closure or damage. Many devices in the Hydroposts have aged, and 80% of the devices are past their estimated service life. There are two observation stations along the Syrdarya River in Soghd State, which can be barely used. Meteorological observation stations have decreased from 76 to 57. There are two water quality monitoring stations and 32 regional management centers (comprehensive observation stations) (14 stations mainly observe weather, 2 stations mainly observe agro meteorological weather, 1 station mainly observes mudslides). 93% of the national territory is in mountain regions and 75% of Hydroposts are at an elevation of 2, 000 meters or higher.

30 Hydroposts use cell phone SMS for data transmission. Meteorological observation data is also planned for transmission via cell phone SMS.

However the following issues should be considered.

(1) Since there are no factories for devices in Tajikistan, the devices have to be imported, which increases cost.
(2) Revenue shortfall of the government makes it impossible to update the devices.
(3) Staffing shortages
(4) Measurement accuracy is not good.

[2] CAIAG's Support Activity in Tajikistan

CAIAG is collecting hydrology and weather observation data in certain basins through the Regional Research Network ZAWa (= Central Asia Water). There is a plan for countries in the basin to provide two Hydroposts as test sites and exchange their data to create a network prototype. Observation items are as follows.

(1) Weather (9 items): Amount of water vapor, precipitation, amount of snowfall,

humidity, temperature, atmospheric pressure, amount of solar radiation, wind velocity, wind direction

(2) Hydrology (3 items): Water level, water temperature, flow velocity. Training regarding operations of Hydromets in each country will be offered to upgrade technical capabilities.

Main network hubs are planned to be set up at CAIAG, while branches are planned to be set up in each country.

(2) Existing Database System and Data Access

Hydromet in Tajikistan collects data from each Hydropost, encodes the data, and sends it to a Local Management Center or the communication center in head office in Dushanbe as Hydromet in the Kyrgyz Republic does. Data transmission devices (cell phone SMS), special receiving sets, and software provided by SDC which started the project in 2006 automatically transmit from 23 Hydroposts for construction of a database. Compiled data by SMS are transmitted to the Regional Center in Tashkent via Internet as necessary according to bilateral agreements.

Automatic meteorological observation devices supplied by USAID in 2004 are working in 6 stations, building a database other than SDC by receiving data via E-mail.

Hydrological and meteorological data are stored in the form of standardized sheets. The SDC project provides data processing devices with functions for data entry, database compilation, and almanac creation in order to computerize hardcopies of the paper data. By using these devices, Almanacs for 2000 to 2003 have been completed and currently the 2004 Almanac is being made. However, a lack of finances has significantly delayed data entry for the 2004 Almanac.

(3) Observation System, Data Integration, Analysis System

[1] Data Analysis System

The snowmelt rate management system uses GIS as its analysis system. Devices and software for analysis have been provided through the SDC project. There are two software: one for forecasting the snowmelt rate and the other for forecasting flow volume. Software for forecasting the snowmelt rate is used for inflow forecasting of the Vakhsh River. By taking in satellite images via the Internet, creating a snowfall amount map, and comparing/calculating the map size with data (altitude - area, amount of snowfall, etc.), they are able to forecast inflow several days later. Software for forecasting flow volume is used for flow volume forecasting of the Pyanj River. They are able to create forecasting models 1 to 6 month laters using hydrological and meteorological data from observation stations.

[2] Monitoring System (Other than Groundwater and Glaciers)

The Amdarya River comprises approximately 80% of water resources in Tajikistan. Meanwhile, the Syrdarya River comprises approximately 20% of water resources which are generated and flow through Tajikistan. Therefore, the extent to which support will cover the Amdarya River basin should be considered.

Current Condition of Hydromet

Since 93% of the national territory is in mountainous regions and 75% of Hydroposts(HPs) are at an elevation of 2,000 meters or higher, it is difficult to maintain Hydropost. Also, observation quality has been decreasing because of funding shortages, staffing shortages, and no device updates, etc. Since there are no factories for production and maintenance of devices in Tajikistan, the devices have to be imported, which increases observation costs. Since data accumulated for the past 130 years are stored in the form of paper documents, they would like to make this paper-based information electronically available.

Technical cooperation was provided to Central Asia Hydromet for 3 years by SDC, under which 13 meteorological observation stations were established, 9 Hydroposts were supplied with devices, and communication centers were built in Dushanbe and 3 states. Annual report creation and data entry of old documents were also supported. Although there is a workshop for repairing hydrological and meteorological observation devices in Hydromet, current meters have not been officially calibrated for approximately 15 years. With the assistance of SDC, current meter calibration equipments (Russian made) have been installed November 2009. These equipment can calibrate 6 meters/day. USAID also provided Hydromet with other support, under which automatic meteorological observation devices were installed in 6 hydroposts from 2004 to 2005. Cloud photography will apparently be supported by a China Meteorological Administration satellite. Several years ago, a Hydromet improvement plan was created. In that plan, Hydromet demonstrated its desire to reopen the Isfara Station (currently closed) in the Syrdarya River basin in Tajikistan.

Water quality testing laboratory

The test items are chromaticity, pH, NO_2, NO_3, NH_4, P, Si, Fe, Al, Cl_2, Mn, Cd, K+, N, SO_4, Mg++, O_2, Cl, Cu, Zn, and Pb, etc. The laboratory only has an inventory of test reagents for another year and a half, which was supplied by USAID.

About Reopening of the Isfara Meteorological Observation Station

The Isfara meteorological observation station conducted observation since 1966 in the Isfara airport site. As the airport has rarely been used since 1996, meteorological observation is no

longer conducted. There is still management staff in the airport building, where wind velocity, wind direction, atmospheric pressure, temperature, etc. are still observed. Total cost of a meteorological station is approximately 25,000 US dollars (including housing for observers).

Isfara - Tash-Kurgan Hydropost

This Hydropost is located along the Isfara River in Voruch, Isfara District, (exclave in the Kyrgyz Republic), where water level and flow velocity are observed. Water level is measured at 8:00, 14:00, 18:00 (3 times a day) and measured data is sent once a day to 5 destinations to Dushanbe, Khujand Department of Water Resources, Isfara Water Resources Management Branch Office, Kyrgyz Republic, and Uzbekistan using a cell phone. Flow velocity is measured 10 times a month (August), 4 to 6 times (usually). The GR21 current meter has been used for 8 years and has not been officially examined after they started using GR21. The water level recorder was working until 1992, but a natural pond located upstream of the Isfara River collapsed in July 1992, which broke the recorder. This water level recorder and recorder in the Kyzlkaji irrigation canal was asked to be reinstalled.

Hydromet Data Management Center in Soghd State

This center manages 1) Akjar HP, 2) Kyzl-Kishalak Hydropost, 3) Voruch Hydropost, 4) Kayrakkum Hydropost, and 5) Uguk Hydropost (report only). Data is transmitted to Hydromet in Dushanbe. Since the Auchi Hydropost is broken, data is not transmitted. There are other stations where meteorological and air pollution observations are conducted. SMS is used for data transmission. The problem here is that working conditions (salary) are not sufficient to secure a stable source of manpower.

Kyzl-Kishalak Hydropost

This Hydropost conducts water level observation every hour and flow velocity observation 8 times a month (summer) or 3 to 4 times a month (winter). The Hydropost also conducts meteorological observations on water temperature, air temperature, precipitation, and wind direction.

Kayrakkum Hydropost

This HP has conducted observation since 1996. Measured water level data is automatically sent to the power plant every hour. Water quality is measured once a month.

[3] Monitoring System (Glacier, Groundwater)

Tajikistan Hydromet conducts special observation of glaciers. Glaciers in certain basins are

monitored by using helicopters twice a year. Exploratory observation is made for 6 basins out of 9 basins. These observations are conducted by international support (Oxfam Aga Khan fund, Switzerland). Currently observation is shifting to exploratory observations of glaciers and glacial lakes that are possibly broken.

[4] Runoff Analysis

Flood forecasting: forecasting 6 months into the future (Soviet Union method), forecasting one day into the future (Swiss method) have already been conducted for 5 years. These forecast procedures will be applied to the Pyanj River basin in the future. Forecasting long term future (U.S. method) will be introduced in the future.

Chapter 3 Current Condition of Donor Support, etc. Regarding Water Resources Management

3-1 Current Condition of Donor Support

(1) Overview

Efforts on regional water management by ADB and GTZ show some progress. ADB has supported a project aiming to improve the water resources management of the Amdarya River and Syrdarya River through Regional Technical Assistance (RETA) in the Uzbekistan office.

A transboundary water resources management project for the Chuy River basin and Talas River basin started based on an "Agreement on use of water management facilities for Chuy/Talas transboundary rivers" between Kazakhstan and the Kyrgyz Republic in 2000. The two countries have organized a "Joint Commission" to discuss a water management framework, which has been supported by ADB as well as UNECE, and UNESCAP, etc. Currently the project is in its second phase, in which periodic working-level consultations and water use data exchange between Kazakhstan and the Kyrgyz Republic are arranged, building amicable bilateral relations.

ADB supports the activities of the executive office of the Joint Commission.

Meanwhile, GTZ has initiated the "Central Asia Transboundary Water Management Project" since 2009. The project comprises and implements each of the three components of regional dialogue and cooperation on water resources management, approach to transboundary river basins, and improved water management on domestic pilot rivers.

In addition, WB is promoting the project to improve water resources management in the Kyrgyz Republic, where they are supporting establishment of a State Water Administration as major water related institution and the rehabilitation of water use facilities such as water canals. Hydropost Support is also included in their activities.

SDC (Switzerland) is promoting a project to streamline water use (water management, water-saving, etc.) in the Kyrgyz Republic, Uzbekistan, and Tajikistan. The project is forming a water use committee involving water users and other stakeholders in order to build a water canal management system for model river basin.

As described above, each donor has shifted from conventional regional support to bilateral support, and uses a method that starts to take action from projects targeting small basins, aiming to promote good practice in water management.

(2) German Support

Germany is promoting support to Central Asia in water-related fields as part of the EU's Central Asia Strategy. More specifically, activities are implemented in two separate sectors of the "Transboundary Water Management Project" by GTZ, and the "Project on Water Resources Related Information System" by CAIAG. For possible cooperation with JICA, the GTZ project has a number of interrelated segments with the project being proposed by the JICA investigation team, and presumably offers a lot of potential and a great deal of cooperation between the two parties.

[1] The Central Asia Transboundary Water Resources Management Project by GTZ

i) Project Content

GTZ and UNECE have planned to subsidize approximately 5.3 million Euros during 2009 to 2011.

a. The first component is dialogue and cooperation on water resources management within the Central Asian region. The purpose is to provide, under the charge of UNECE, support to such parties as IFAS and ICWCwhich are responsible for coordinating the water resources management in the region for structural/functional improvement.. GTZ-EU is planning to set up a trust-fund for IFAS' capacity building.

b. The second component is capacity building of organizations managing the water of transboundary rivers. Target basins and contents are as follows.

* Isfara and Chadzhabarkan (Tajikistan and the Kyrgyz Republic)
* Murghab (Afghanistan and Turkmenistan)
* Zeravshan (Tajikistan and Uzbekistan)
* Aral–Syrdarya (Kazakhstan and Uzbekistan)

• Assessment and monitoring in target basins, basin management.
Support for organization building for basin management, support for format creation, etc. of a monitoring system for Hydromet and SIC ICWC, etc. (by UNECE).
• Dialogue of stakeholders about their ideal basin conditions
• Development of a basin management plan
• Concept of an investment plan for infrastructure in the basin
• Assessment of the transboundary environment and social impact
• Safety of water related facilities and dams

c. The third component is improvement on an integrated small river water management by way of pilot projects and inter-sector managerial capacity building, generallytargeting domestic rivers.

• Organization building that emphasizes water, climate change, and energy

- Adaptation to climate change and analysis of damage
- Standards for hydro power generation
- Water recycling and sanitation
- Efficient use of agricultural water

ii) Current condition of the projects

The first component is regional institutional improvement for water resources management conducted by UNECE. Opinions about "how EC IFAS should be" are being collecting from related countries.

The second component is water management improvement for small transboundary rivers, starting with a project targeting the Isfara River and the Chadzhabarkan River as transboundary rivers in Tajikistan and the Kyrgyz Republic, aiming for establishment of a basin committee. SDC is expected to support this component.

The third component manages water volume (water allocation) flowing into water canals and conducts measurement in the Isfara River and the Chadzhabarkan River which are small domestic rivers in the Kyrgyz Republic. The Tortogul reservoir (capacity: 9 million m^3) is for drinking and irrigation. Since the reservoir has suffered damage by an earthquake, safety will be confirmed and managed through this component.

In implementing the JICA project as proposed by the investigation team, coordination may be required for related issues, and furthermore, it would be worth considering a frame-work for collaboration in order to attain an effective assistance outcome.

In particular, the issues below offer potential for information exchange and collaboration.

* Basin assessment and monitoring, basin administration
* Development of a river basin management plan
* Regional guidelines for water monitoring and data exchange

[2] Support on water resources related information system of CAIAG

i) Overview of CAIAG

CAIAG (Central Asia Institute of Applied Geosciences) was founded by the Kyrgyz Republic (approximately 55% investment) and GTZ Potsdam (approximately 45% investment). 60% of its 85 staff members are scientists.

ii) Project content

One of the themes of the 2009 program is an "Information and Monitoring System". The range of monitoring is meteorology, hydrology, earthquake, and GPS, and monitoring data are collected in real time. Hydromet and other organizations are providing information to a geodatabase. The "Central Asia Water Project" is trying to formulate a monitoring system aiming at the networking of hydrological and

meteorological data under the project name of ZAWa.

This is a program where riparian countries provide 2 HPs as testing sites, and collect and exchange data to make a prototype for a network. Observation consists of 9 meteorological items (such as temperature and precipitation) and 3 hydrological items (water level, water temperature, and flow velocity).

Target areas will be the Syrdarya, Naryn, and Zeravshan basins, where data has already been supplied by Hydromet and water balance in the basins is understood.

The CAIAG project discussed here will lead to the step of determining the measures and specifics of regional hydrological/meteorological monitoring when an agreement on conditions for information exchange is in place in the future. The project is highly likely to become related when the JICA project determines the specifics of its hydrological/meteorological monitoring, necessitating information sharing and offering a collaboration opportunity.

The range of monitoring is earthquake, GPS, weather, and hydrology, and the monitoring data is collected in real time. A geodatabase has been provided information by Hydromet and other organizations.

For meteorological observation, automatic data transmitting equipment is installed in Chuy River basin, intended for data comparison with measured values, with reportedly more or less four additional locations planned in the Syrdarya River basin. As for glacier observation, observation activities have been discontinued at Hydromet. By analyzing satellite images, changes in surface dimensions of glaciers such as the Inylchek Glacier are being observed and analyzed. Furthermore, the lakes formed at the head of glaciers are being observed for changes because they could threaten washouts.

CAIAG also owns educational/training organizations which offer training services such as data-processing for this project as well. The investigation team believes that it would be appropriate for JICA to share information with CAIAG and work hand-in-hand in the model regions.

(3) WB's Support

[1] WB's projects in the Kyrgyz Republic

Previous water related projects by WB in the Kyrgyz Republic had two directions: rehabilitation activity of the irrigation system and organization restructuring of the Ministry of Water Resources.

i) WB has promoted rehabilitation activities since 1998 to downstream sites of water discharge for irrigation where farms accepted the agricultural practice shift. WB

conducted 24 irrigation schemes and 4 dam safety projects. Since 2000, they have addressed organizational strengthening of water use associations as rehabilitation activities and O&M for on farm irrigation systems.

ii) WB has supported Water Code implementation as a part of its water resource management support, promoting foundation of State Water Administration, a core organization regarding water resources (State Water Administration was inaugurated in October 2009.). Although the Kyrgyz Republic has 14 billion m^3 of irrigation water volume in era of the former Soviet Union, it has decreased to 6 billion m^3.

Enhancement of IWRM is planned by each basin. WB is promoting a plan for the Talas River basin. Enhancement of Hydromet is included in the plan as a component. WB has planned to supply 32 HPs and 31 meteorological observation stations with devices centering on the Talas River basin and is renovating 11 HPs.

Moreover, WB is supporting the foundation of water use associations. 700 associations have been founded so far.

WB support is not intended for overall water management reinforcement in the basin area, but more directed toward supporting event-wise business operations such as the efficient use of irrigation water for agriculture and water-saving technologies as well as assistance to strengthen organizations responsible for water resources management.

(4) SDC's Project

[1] Integrated Water Resources Management

The "Integrated Water Resources Management Project" covering Uzbekistan, the Kyrgyz Republic, and Tajikistan, began in 2001 and is currently in its fourth phase.

The project cost, including 3.7 million dollars for the fourth phase (9.0 million dollars total), is provided by SDC as the donor. The agency implementing the project is SIC-ICWC. The project covers the Fergana Valley designating certain transboundary rivers as a pilot for the purpose of attaining equitable water resources allocation among water users.

The target area in the Kyrgyz Republic is the water canal along the left bank of the Akubra River which originates from the Papan Reservoir in Osh State, and the project provides managerial assistance to the water committee administering the canal. The water committee consists of all users of both irrigation and drinkable water together with other related parties (farmers, water use associations, local governments, regional office of the Water Economy Department), and has established a successful case of integrated water management.

Management objectives are water-saving, water resources management, water and land productivity improvement, and establishment of a water economy, etc., providing assistance starting from the tail end of water users. Although 55% of the canal operation cost is currently

budgeted by the central government, they plan to continue trying to become financially independent.

SDC are promoting the same project for the Hojobakurugan canal in Tajikistan. They are planning to expand this effort from canals to rivers in the future.

[2] Support on hydrological/meteorological observation

Ever since 2001, SDC has provided support on hydrological/meteorological observation covering the Syrdarya River and Amdarya River basins that extend over Uzbekistan, Tajikistan, the Kyrgyz Republic, and Turkmenistan. The project is currently in its second phase which costs 2.85 million dollars (5.8 million dollars total cost) to be provided by SDC as the donor. The agency implementing the project is CANHMS (National Hydro-meteorological Services of Central Asia).

In Tajikistan, SDC were providing Hydromet with equipment and materials for 9 HPs and 13 meteorological observation stations. The meteorological stations, having been provided with equipment and materials, are now in operation. Further support is being made for providing calibrating devices for current meters, which are under installation. For data management, support is being made for providing personal computers and manpower costs for compiling part of the meteorological data, hand written and accumulated so far, into almanacs.

This project was completed in 2009. However, the current project has covered only a part of the equipment and material requirements for the overall HPs and meteorological observation stations. Needs for improved support and the degree of urgency, therefore, remain high.

(5) ADB's Projects

[1] Efforts through CAREC

As a secretariat division of CAREC, ADB has supported transportation, energy including water resources, and regional partnership in international trade. ADB decided that they will work on water resources as an issue of an energy group and WB was in charge of energy. Meanwhile, ADB has been in charge of support on transportation and ports, etc. The current step is that initiatives for creating a road map of regional partnership have just started.

[2] Ongoing Support Projects

i) Support in Chuy and Talas

It has been a year since the current program started, which is promoting financial support of the joint office and administrative support of the working groups. They have studied water models covering two river basins, and have prepared a river basin management plan for the Talas River basin.They have also just started a study on the

effects of climate change. Working with UNEC and OSC, ADB is supporting formulation of operation manuals for reservoirs and canals. For the water intake weir, a pivotal facility located in the Chuy River basin, support has been provided enabling both countries to equally monitor the flow volume by real time data.

ADB and SDC have jointly (ADB;1 unit, SDC; 9 units) supported measurement computerizing in the control section in Talas River basin such as the reservoir's gate, water level, etc.

An unofficial donor consultation group (ADB, UNECE, UNESCAP, SDC, OSC) is working with and accepting other donors such as JICA.

ii) Regional Partnership Project on Water Resources Management in the Amdarya River and Syrdarya River

As new framework establishment of local water use has been planned since 2008 under "Water Use Efficiency of National Level", aid to countries in the corresponding areas required to manage water resources has started. The main target of this project is the Amdarya River.

(6) UNDP

Focusing on Central Asia, UNDP has supported each country for preparation of a roadmap to determine the respective national IWRM plan. In Kazakhstan, the national IWRM plan has been enforced by presidential order but other countries are at a point where they have just started such efforts.

As a potential water resources management undertaking, support is being provided for upgrading the water resources management of the Zeravshan River, a transboundary river connecting Tajikistan and Uzbekistan as a pilot river. Tajikistan, for its part, supports the IWRM project targeting the same river as a potential IWRM project, and is intending to study possible cooperation between the two countries in implementing the two projects. In Tajikistan, a 1.2 million dollar budget over three years has been approved by the Cabinet for improving a water-related legal system, improving drinkable water, and for enhancing a IWRM program toward building a framework for implementing river-basin-wise water resources management.

The Kyrgyz Republic also supports IWRM plans, but it is still in the early stages.

(7) USAID

USAID has worked on strengthening the water user organizations (in Uzbekistan and the Kyrgyz Republic) and enhancing communities for upgrading water management of small canals.

For monitoring and data management of hydrology and water use, USAID promoted area

support on meteorological and hydrology data information system from 2002 to 2004. As a part of this support, USAID supported local water use centers (joint activity with SDC) in Tashkent in 2003, and Hydromets in the Kyrgyz Republic and Tajikistan for the automation of measurement and data transmissions (including rehabilitation activities). Since 2005, USAID has specialized in support at the on farm level as described above.

(8) For Enhancement of Water Resources Management at the National Level

Table 3-1-1 shows activities by each donor as described in (1) to (7) of this chapter.

Table 3-1-1 Donor Activities on Water Resources Management in the Kyrgyz Republic and Tajikistan

		ABD	CAIAG	GTZ	SDC	UNDP	USID	WB
Regional framework for water resources management	Cooperation in local activity regarding water resources management	Framework project of local water management (Amdarya, Syrdarya) CAREC office		Laws on interstate water management Dialogue and cooperation on regional water management	Equitable water resources allocation among user nations (Trilateral)		(Support for the Syrdarya Agreement concluded in 1998)	(Support for regional cooperation regarding water use in Syrdarya)
	Monitoring and data management on local water issues		Central Asian Water Project: ZAWa	Regional monitoring and data management guidelines (Study specifics adopted by Hydromet, SIC, ICWC)				
Reinforcing institutional/legal systems	Establishment and strengthening of water related sections, Enhancement of legal systems			Reinforced function of IFAS		Support of Tajikistan's river-basin-wise water management system		Foundation of water management organizations in the Kyrgyz Republic
	State planning on water resources			Support on formulating a river basin management plan		Roadmap for IWRM Tajikistan's IWRM plan		
Transboundary river management	Water management of transboundary rivers	Support for the "Chuy/Talas River Commission with UNEC/OSC	Central Asian Water Project: ZAWa	Reinforced organization for transboundary river water management: Isfara, Chadzhabarkan and others	Management of monitoring equipment and material, and data (Talas) Transboundary River water allocation	Zeravshan River water management		
Improved water management on domestic rivers	Improved water management		Glacier/snow-melt observation and water balance	Effective use of irrigation water	Appropriate allocation of water resources among water users			Support for formulating river basin plans (Talas River basin) Rehabilitation on irrigation facilities
	Reinforced organizational system			Reinforced organization intersecting water, climate change, energy	Organizational reinforcement of water use associations		Strengthening of water user organizations Water management in small canals (on farms)	Support for establishing water use associations Organizational reinforcement
	Reinforced monitoring on hydrology/meteorology/water use		Improved monitoring technologies and GIS utilization study, Glacier/snow-melt observation and analysis	Studying monitoring specifics	Support of Hydromet		Support system for meteorological and hydrological data	Support for equipment and material for Hydromet (Centered around the Talas River basin)

Chapter 4 Proposal for the Orientation of Cooperation Required for Enhancing the Integrated Water Resources Management Function

4-1 Consideration of a Database System for Water Resources Management in the Kyrgyz Republic

4-1-1 Basic Plan for Improving the Data Management System

Many of Hydromet's measuring instruments have been broken or damaged, disabling measurement of the prescribed data items as well as area-based data utilization at each basin . Enhancement of functions such as – database construction by making files and accumulating collected data, and data analysis and data sharing with other organizations – are required.

To promote domestic data management in Kyrgyz Republic, itwould be effective to support improvement through the following steps.

[1] Support of the improvement and enhancement of the Local Management Center's functions

1) Digitization of existing data
   Convert paper-based data into electronic form thus promoting preservation and effective use of the existing data.
2) Automated data collection and database construction at observation stations in the territory.
   Digitize data received from observation stations in oral or paper form (see 4-3-1), and give support to automated data collection and database construction.
3) Runoff volume forecast, and water use monitoring management

Use automatically-prepared graphics, historical and real-time trend graphs to help establish an inflow/outflow simulation method.

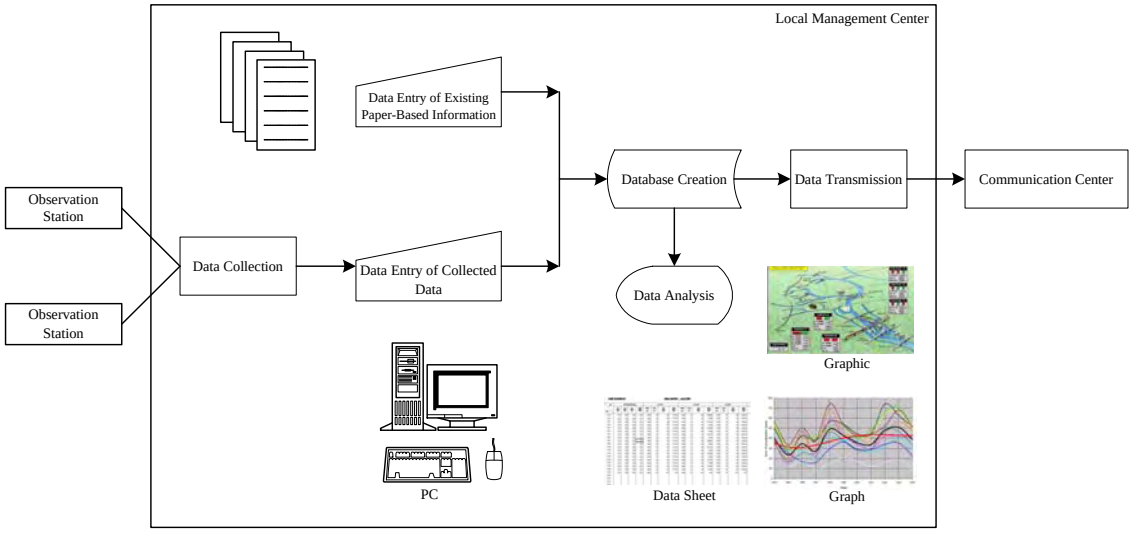


Fig. 4-1-1 Function Enhancement Flowchart of Local Management Centers

[2] Improvement of the Communication Center

The communication center collects data from each Local Management Center for management on a national basis. It is also required to promote data sharing with other ministries while approximating data we want them to disclose and those we can disclose.

The newly founded Water Resources Agency will take charge of overall control of hydrological data required to conduct Kyrgyz Republic water resources management, as well as flow volume forecast, water use plans and monitoring.

Regarding data exchange with other related organizations, as there is a possibility that different organizations use different data collection times, data formats, and communication protocols, it is necessary to determine data arrays, etc. through discussions.

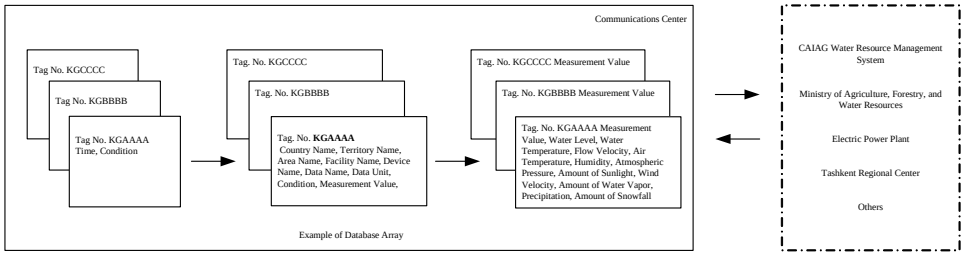


Fig. 4-1-2 Example of Data Format and Data Sharing

[3] Improvement of Observation Station functions

One way to promote data digitization at Local Management Centers is to digitize data sent from observation stations by way of mobile terminal SMS services or wireless devices. Another effective way is to promote the automation of data collection/transmission devices, combining

automatic measuring devices, data collection devices (PLC: Programmable Logic Controller, or RTU: Remote Terminal Unit, etc.), and data transmission devices (modem plus wireless devices or GPRS routers, etc.).

It is basically an effective way for hydrological and meteorological observation stations to be reconstructed with traditional methods based on sufficient monitoring experience in which it is possible to maintain or manage those stations independently. Meanwhile, it is important for data management to promote digitization and automation of data collection and data transmission.

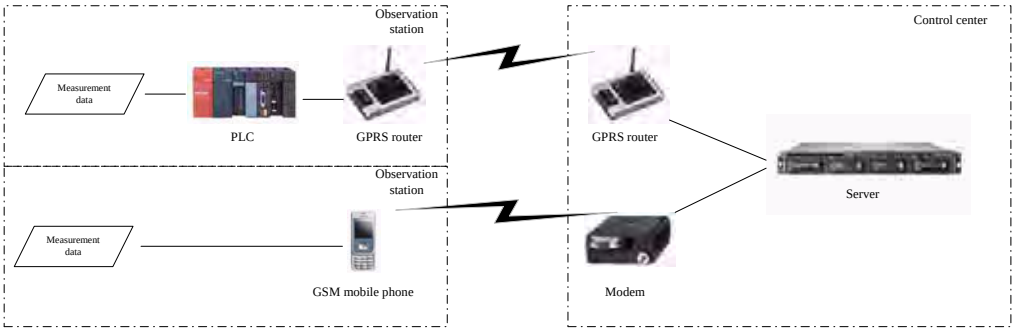


Fig. 4-1-3 Plan of Improvement for Observation Station Data Transfer

4-1-2 Consideration for a Data Sharing System and Application of GIS

1) Data Sharing System

Our stance for the support plan in this survey is to advance data sharing within target countries which will provide benefits for them.

The data sharing system configuration plan in the Kyrgyz Republic is described in Fig. 4-1-4. The basic policy is that each organization builds, operates, and maintains its own database, and based on this data, conducts river inflow forecasts and simulations for all river basins. Also, each organization will create a new database intended for sharing information so that data which is disclosed by each one organization can be shared by others. As sharing all data of each ministry is not a feasible idea in view of their characteristics and confidentiality, it's important to determine which data can be shared through inter-organizational discussions.

Regional data sharing must be promoted on the premise that trust between basin countries has been built regarding water use and each country's intentions needs to be confirmed from time to time.

2) Current status of GIS and consideration for application

Hydromets and the Water Resources Agency will firstly need to improve the data collection method and put existing data into a database. Introduction of a GIS-based system currently,

faces various problems, such as introduction cost, maintenance ability and human resources. Therefore, it is about time for them that a basic database is in sight.

Meanwhile, CAIAG is pushing forward with research on a GIS-based IT system targeted for 5 Central Asian countries. This approach is significant for improving water resources demand and supply management in the Central Asia region.

For future integrated water resources management of the Syrdarya River basin, sharing data of Hydromets and the Ministry of Water Resources by the GIS system is desired. Providing support by sharing information with CAIAG, which is going a step further in this field, will be effective.

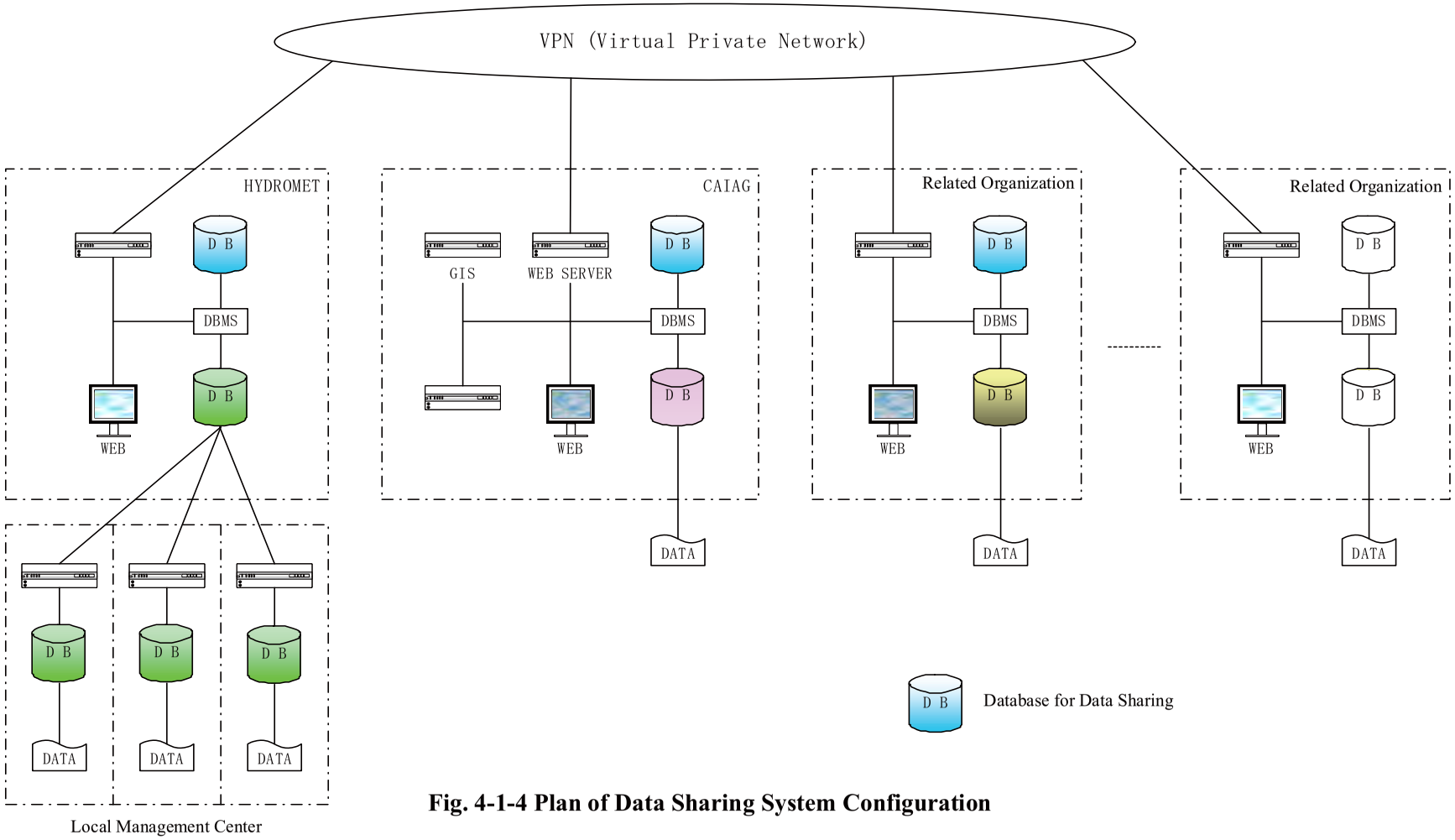


Fig. 4-1-4 Plan of Data Sharing System Configuration

4-1-3 Consideration of the Data Format for Building a Database

Data transmission from observation stations is performed using codes complying with meteorological reports from the World Meteorological Organization (WMO). Since these codes are shared internationally, it seems it would be appropriate to create a data format based on these codes

Example) Code/Data transmission

Position Name	Observation Date	Precipitation	Temperature	Pressure	Weather	• • •
AAXXX	01004	60012	10106	30200	71082	• • •

However, the following items need to be investigated. Also, if a gateway for data array conversion and binary conversion is necessary, it should be studied.

Different observation stations have different items which can be observed. This seems to be the reason that different data arrays and data lengths are sent to Local Management Centers.

1) Since measurement items vary depending on observation stations at present, different stations seem to send different data arrays and data lengths to Local Management Centers. The same data array and data length should be used.
2) As mentioned in 1), the format for measured data that was measured and recorded in past years should be consistent with the format for current data.
3) Data tag No., time stamp, facility name, device name, etc. used by donors need to be unified.
4) Since CAIAG uses automatic measuring devices for measuring water level and flow volume, etc., data seems to be collected continuously (depending on sampling time) by converting analog signals into binary data. On the other hand, observation in Hydromets is performed manually 1 to 3 times only a day. Therefore, how CAIAG data ensures consistency with Hydromet data should be studied.
5) To share data at the time when regional counties reach agreement in the future, differences described in 1) to 4) above need to be made consistent. JICA's support should be provided with this view in mind.

4-1-4 Consideration for a Guidelines Draft

(1) Meteorological, Hydrological and Water Quality Observation (System Design, Data Management, Maintenance)

For promoting hydrological and water use data collected and managed by various organizations

within the Kyrgyz Republic, system design, data management and maintenance of equipment are important. When giving consideration, in order to promote data sharing while securing continuous data management and maintenance under the current Kyrgyz current, pay heed to securing an observation system and safety as well as economic aspects, and utilize advanced technologies as the need arises. Furthermore, compliance with international standards, general-purpose properties, connectivity, expandability, and environmental friendliness will be necessary.

Basic review items are described below as a guideline for enhancing the Kyrgyz domestic hydrological/meteorological information management system.

[1] Design of the hydrological/meteorological information management system and data management

1) Basic system configuration

As a basic hydrological/meteorological information management system configuration, a trilaminar configuration – Communication Center (Hydromet), Local Management Center (regional data center) and Monitoring Department (observation station) will be considered.

2) System design

This system is designed for integrated real-time river status understanding. Pay attention to the followings in system construction. a) Hydrological, water quality and meteorological information collected by the Hydromet and the State Water Economy Department should be dealt with. b) Timing for information distribution and processing should be unified when necessary.

3) System configuration design

Input function: a) Hydrological and meteorological data should be collected by the Monitoring Department. b) In principle, a system which can operate at a prefixed interval for data collection should be considered.

Computing is processed at the Central Department (Local Management Center) in principle.

Accessibility: a) Information should be displayed, in principle, in forms of transition tables, graphs, maps and pattern diagrams by data type used and time intervals on the display of terminal devices. b) Output specifications of forms should be, in principle, in forms of daily reports, monthly reports and annual reports by data type used and time interval.

Communication interfaces are pursuant to the specifications of the Communication Center.

4) Network configuration design

For enhanced network, a) System transition plan, b) Improved reliability, c) Network expandability, d) Impact on the system at the time of construction and e) Operation, repair and maintenance need to be considered from the design stage.

5) Server device design

Basically, communication servers and service providing servers should be separated. Especially for communication servers, dual configuration should be reviewed in view of reliability.

6) Terminal device design

Existing personal computers meeting specifications at a certain level will be considered as terminal devices.

7) Network design

For network design, reliability, cost effectiveness and consistency with related systems should be well considered and be in line with the following: a) Condition ordering, b) Technical trend check, c) Basic design of the network, d) LAN/WAN design, e) IP address design, f) Routing function design, g) Security design and h) network management design.

[2] Maintenance of the hydrological/meteorological information management system

Lifecycle cost, as well as safety and reliability, should be as well considered for the configuration of the hydrological/meteorological information management system. Also, for ensured system functions, securing information security in addition to standby power and backup supplies needs consideration. In operation and management of electric communication equipment, reduction of operational and management costs should be discussed from the aspect of lifecycle cost.

Conducting daily inspections and other inspections to grasp working conditions of equipment makes difference. A maintenance plan should be prepared for the whole system taking into consideration various conditions such as the relationship to the priority of overall system development, rational work order with related equipment, budget equalization, lifecycle cost, and others. Components of the plan include the following: a) Inspection item/interval, b) Timing and details of equipment diagnosis, c) Timing and scope of interim maintenance, d) Renewal timing, and e) Approximate amount of maintenance costs. Results of the equipment diagnosis should also be reflected in the plan after each diagnosis.

(2) Data Integration, Data Analysis

[1] For Central Asia's water resources management by regional data integration

The first step is to reconstruct monitoring facilities and improve monitoring accuracy, which the Water Resources Agency and Hydromet is currently engaged in. In addition, related countries and organizations need to provide a global GIS system that can be shared among the countries with data from a database for water resources management supplied by donors. Extensive and accurate data integration and data visualization should be promoted. Although the GIS

developed by CAIAG is certainly an effective system, it must incorporate the opinions of related organizations and modify the system as the GIS system is implemented. JICA needs to provide support learning of previous issues and know-how since some other donors have already had practical experiences on the GIS system and worked with other organizations to provide support in various aspects.

[2] JICA's assistance aiming to improve water resources management of target countries

Currently, it's not easy to share hydrological, meteorological and water use data with neighboring countries, in particular downstream countries. JICA should, in its support activities, firstly focus on improving domestic water resources management in the target countries, and take an approach to produce benefits in those countries.

A draft of the flowchart for establishment of a water resources management system is described in Fig. 4-1-5.

When constructing the database, the following points should be clarified. At the same time, consistency with data management systems provided from other donors should be observed.

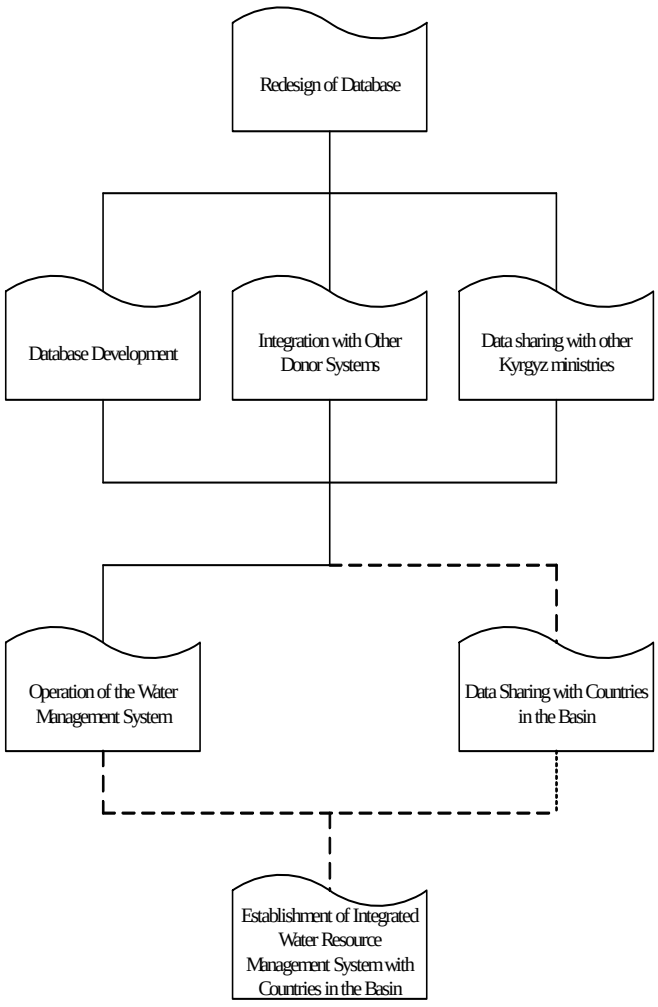


Fig. 4-1-5 Establishment (Flow) of Integrated Water Resources Management

1) Data collected in the past
2) Data being collected now
3) Data which can be shared with other ministries
4) Data indispensable for water resources management

Regarding 3), in particular, it's necessary to understand merits and demerits among ministries, and to discuss thoroughly data which can be disclosed and needs to be disclosed.

Once the data is put in place, integration with systems provided from other donors and data sharing with other ministries needs to be promoted in order to develop a water resources management system capable of forecast simulation and understanding of current status of Kyrgyz domestic water resources consumption, demand, and supply.

4-2 Specification and Deployment of Observation Facilities in the Kyrgyz Republic

4-2-1 Standard Specification of Observation Facilities

Most observation stations in the Kyrgyz Republic and Tajikistan use telegrams, wireless devices, or mobile terminals to send data. It takes 30 minutes or more for some observation stations using telegrams to go to telegraph offices. Because the power source is not stable, many wireless devices cannot be used at specific times or are often broken down. Taking such reality into consideration, using 2 types, mobile terminals and wireless devices, will be appropriate as a standard data transmission specification for observation stations.

4-2-2 Consideration of the Basic Plan for Observation Station Deployment

As for station development, hydroposts required for observing water volume flowing in the Toktogul Reservoir and required in the upstream part of the reservoir where there are no hydroposts at present were especially discussed. Among rivers flowing in the Toktogul Reservoir, the Torkent River is the fourth inflowing river following the Naryn River, Uzun Akmat River, and Chychkan River. A hydropost will be reconstructed (or newly constructed) in the lower course of the Torkent River to observe water volume flowing in the Toktogul Reservoir from the river (No. 1 in rectangle (□) in the figure below).

Moreover, one hydropost will be reconstructed (or newly constructed) at the Naryn Main River, upstream of the the Toktogul Reservoir (at the mouth of Kok-Irim River) and at the branch of Kekemeren River, respectively (No. 3 & No. 2 in rectangles (□) in the figure below).

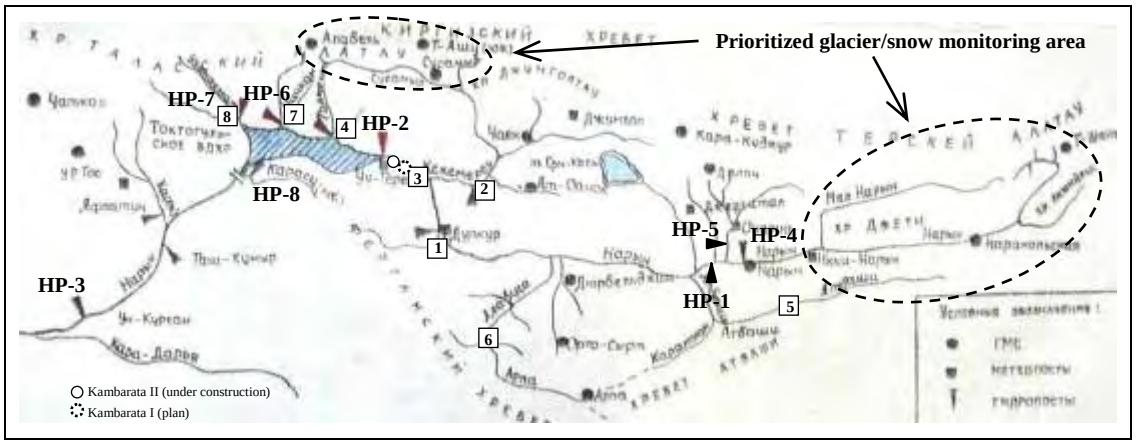
The working hydroposts (hydropost-1 to hydropost-8) need repair work. In particular, cables and gongola for flow current measurement are damaged at many hydroposts-4, -6 and -7.

Hydromet requests reconstruction/upgrading of 8 hydroposts shown as No. 1-8 in rectangles (□) in Fig. 4-2-1 in order of priority, reconstruction of 6 meteorological stations (No. 1-6 shown in the same way, and moreover,), communication equipment, repair machines, transportation equipment, avalanche monitoring stations (reconstruction of 2 stations) and others.

As for the hydroposts in Chuy State, as shown in Fig. 4-2-2, Hydromet requests reconstruction/upgrading of 9 hydroposts including the Chon Kemin River and Cholok River, reconstruction/upgrading of 5 meteorological stations, and communication equipment, transportation equipment, calibration equipment and others.

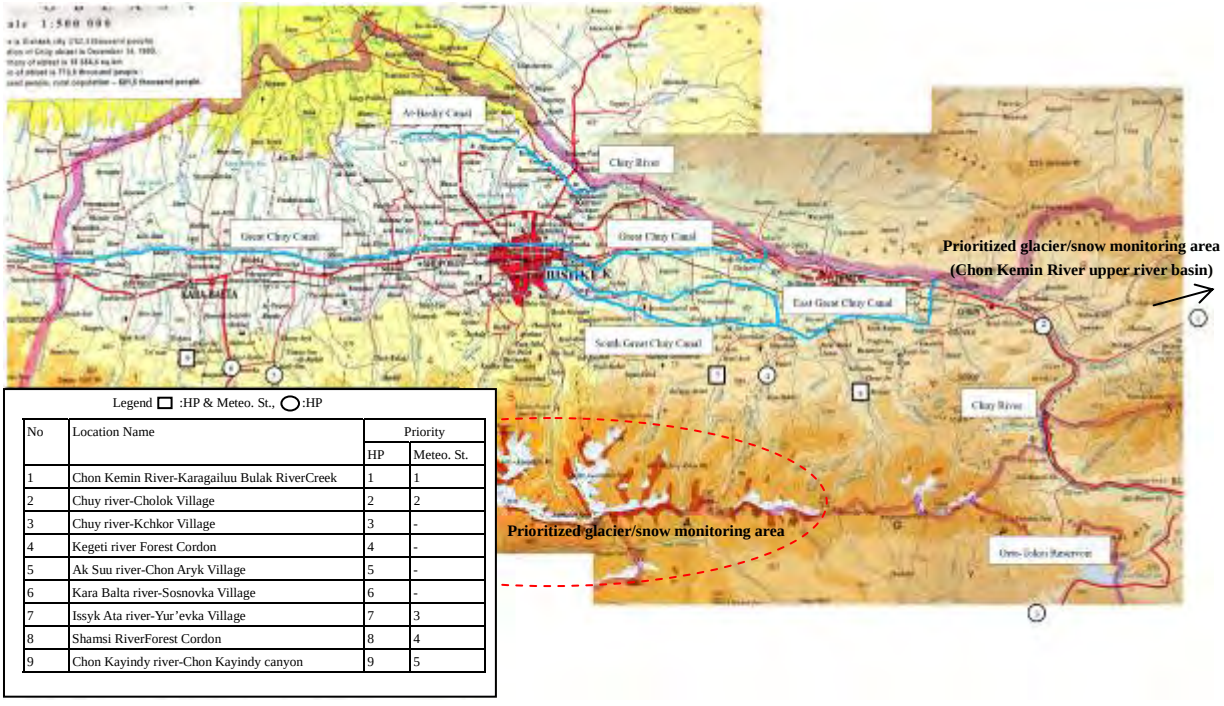
Meanwhile, regarding glacier-snow-monitoring, Fig. 4-2-1 is a plan of areas requiring high priority monitoring in the Naryn River Basin. In the Chuy River Basin, remote sensing-based high priority glacier-snow-monitoring will be needed in the upper basin of the 12 branch rivers

and the upper Chon Kemin River (See Fig. 4-2-2.).



(Results of hearings from Hydromets, etc. are added on the hydropost distribution map around the Toktogul Reservoir before the fall of the former Soviet Union.)

Fig. 4-2-1 Basic Deployment Plan of Hydroposts in the Naryn Upper River Basin



No	Location Name	Priority	
		HP	Meteo. St.
1	Chon Kemin River-Karagailuu Bulak RiverCreek	1	1
2	Chuy river-Cholok Village	2	2
3	Chuy river-Kchkor Village	3	-
4	Kegeti river Forest Cordon	4	-
5	Ak Suu river-Chon Aryk Village	5	-
6	Kara Balta river-Sosnovka Village	6	-
7	Issyk Ata river-Yur'evka Village	7	3
8	Shamsi RiverForest Cordon	8	4
9	Chon Kayindy river-Chon Kayindy canyon	9	5

Fig. 4-2-2 Reconstruction Requested Hydroposts and Layout of Meteorological Observation Stations and Its Priority in the Chuy Basin

4-3 Consideration of the Cooperation Program

4-3-1 Framework of the Cooperation Program and Improved Water Resources Management

(1) Concept of the cooperation program

i) Kyrgyz Republic

The goal of the Kyrgyz Republic in the water resources field is to enhance effective, transparent and fair water resources management, whereby contributing benefits to water users and basin residents in the country.

For enhanced water resources management, 4 components: [1] Formulation of basic laws, [2] Setup and reinforcement of implementation organizations (central and basin), [3] Drawing up of basin management plans and [4] Enhancement of organization and human resources involved in basin management.

In the Kyrgyz Republic, organization and institutional reform and planning are being promoted simultaneously.

[1] "Water Code" is now in force.

[2] The State Water Administration was in preparation for foundation supported by World Bank. However, in October 2009, the Water Economy Department was restructured and the "Water Resources Agency" was newly established under the umbrella of the Ministry of Natural Resources as a main water resources management organization.

[3] Preparation of the basin plan has started with priority given to important basins. The Talas River Basin plan was drafted with the support of the World Bank.

[4] A water users' union and a federation as its upper organization are being established, and donors are strengthening their support ability.

In the implementation of each item above, [1] and [2] are led by the central government. While eyeing the whole nation, [3] and [4] adopt an approach targeting relatively small basins as a model to gain and disseminate good experiences to the basins around the nation.

Needless to say, the basic conditions of [3] basin management plan and [4] enhancement of organization involved in the basin management are accurate measurements of hydrological/water-utilization information and proper management of these data. As confirmed in this survey, the hydrological/meteorological information monitoring and data management system requires immediate improvement. The survey team thinks an early start of providing assistance aimed for improved water resources management focusing on this field will be considerably significant.

ii) Tajikistan

a. Tajikistan's current status of hydrological/water-utilization monitoring and data management is almost same as that of the Kyrgyz Republic, with severer restrictions on human resources and government budgets due to civil war. In spite of that, basin-based water resources management has been set as a clear goal of national effort and an organization dedicated to this purpose has

been established. Hydromet' management has also demonstrated strong will for reinforced organization and improved measurement.

b. JICA is planning to work firstly on the upper stream of the Kyrgyz Republic and then Tajikistan in its assistance procedure. Regarding the capacity development necessary for water resources management, a framework that allows Tajikistan to participate in training, in line with the support to the Kyrgyz Republic, will be effective for future assistance condition development.

c. Tajikistan demonstrated its intention in the selection of its national pilot basins to target small basins including the sub basins of Amdarya River and not the transboundary Syrdarya River Basin flowing through part of the northern area. To finalize the assistance plan, target basins and assistance methods need to be discussed with recipient courtiers.

(2) Details of the support program

Draft support program for the Kyrgyz Republic is described below. Support program for Tajikistan will appropriately be made similar to that of the Kyrgyz Republic.

i) Purpose of the project

Purpose of the project is to the enhance water resources utilization by improving water resources management in Kyrgyz Republic. For this purpose, it is expected to give support to the improvement of hydrological/water use/meteorological monitoring and data management to enhance water resources management.

ii) Details of the project

Project is to improve and enhance Kyrgyz hydrological/water use/meteorological monitoring facilities and equipment as well as data management in Kyrgyz Republic. Furthermore, strengthen technological capability for enhanced water resources management and capacity development of human resources.

[1] Support reconstruction/enhancement of hydrological/water use/meteorological monitoring systems and data management systems of the Water Resources Agency and Hydromet.

[2] Support strengthening of capability related to hydrological/water use/meteorological monitoring, data management and water resources management.

[3] Support preparations for formulate of the Draft Chuy River Basin Plan.

iii) Flowchart of the draft support program draft and future approach for improve water resources management

Fig. 4-3-1 is a flowchart of the draft support program and future national approach for improved water resources management of Kyrgyz Republic based on the outcome of the program.

Improvement of monitoring and support to the basin plan will exert more desired effects and make it easier to see the outcome when linked to specific water resources management. For this reason, setting up model basins and promotion as a pilot project will be effective in this support program as well.

A concrete image is specifying target basins through discussions with the Kyrgyz government and, with the formulation of basin plan in mind, improving necessary monitoring and data management.

In setting and implementing pilot projects, matching the entire water resources management plan and strategies intended by the Kyrgyz government is required. It is also recommended to support improvement of the capability of basin management organization in relevant regions, and to work out guidelines through which pilot basin experiences and best practices can become widespread across the nation.

4-3-2 Assistance Needs for Each Item

Results of survey and analysis on the current status and assistance needs by each item according to the survey team are as follows.

(1) Enhancement of legal and institutional systems of water resources management

(i) Current status

The Water Resources Agency was establised in October 2009 as the main organization for Kyrgyz water management to attain the principle of the Water Code.

We assume that it holds jurisdiction over water resources-related monitoring and economic adjustment by water use, integrated use and protection of water resources, water resources-related technical policies and investments, legal and international cooperation, water supply management in rural areas and other matters. Toward the promotion of the integrated water resources management, the Kyrgyz Republic has been preparing for a basin plan for basin level management. It's also making efforts to have the water users' union to manage irrigation water. Water use fees collected from the water users' union are partly allocated to the management cost.

(ii) Needs for assistance and assessment

Regarding the enhancement of measures, laws and institutional of water resources management, there are signs of organizational restructuring in accordance with the Water Code in view of its significance. Since the World Bank is also providing assistance, it'll effective for JICA not to be directly involved but to conduct capacity development concerning "hydrological/water use/meteorological monitoring and data management system and basin plan formulation,"

which is the base of water resources management.

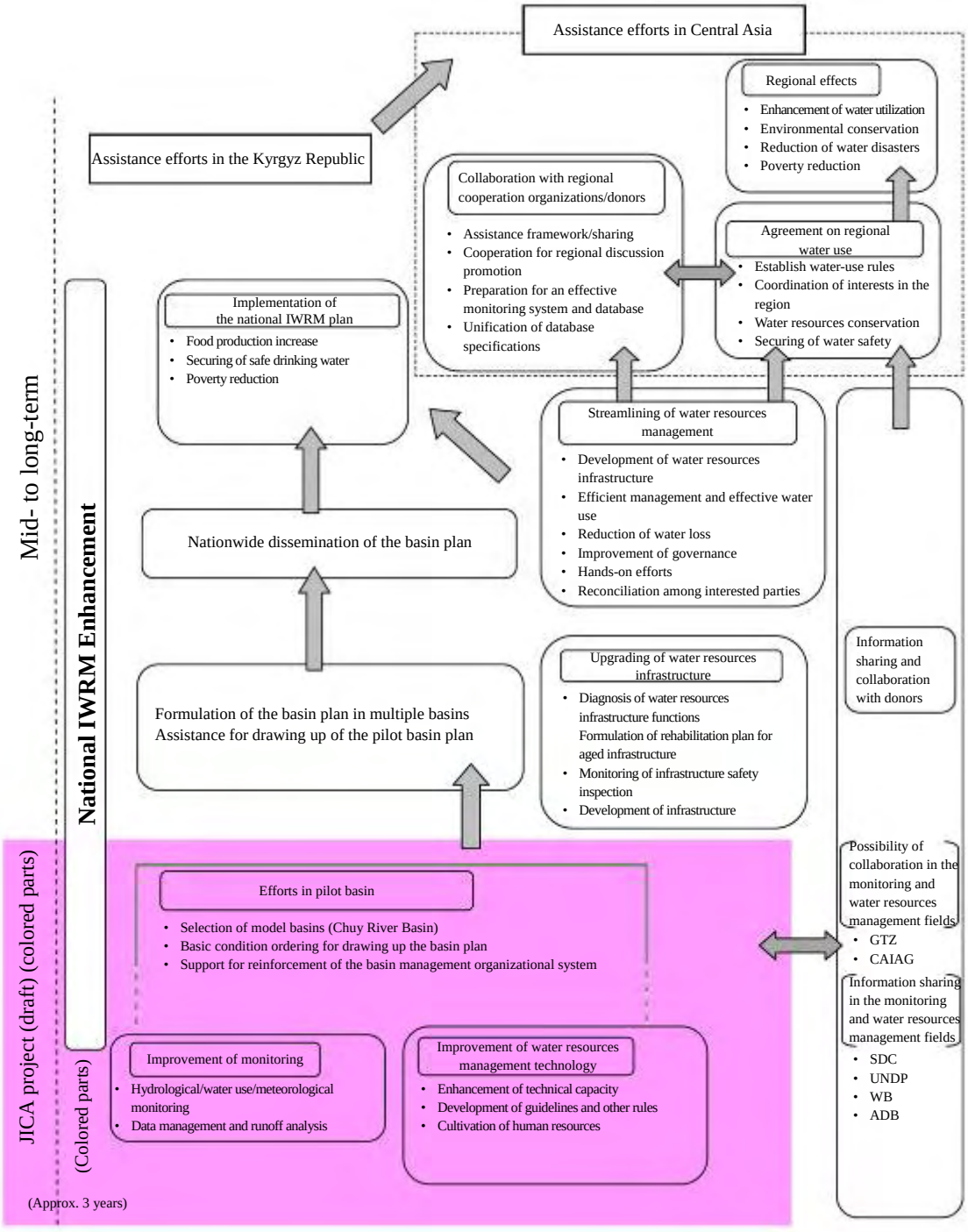


Fig. 4-3-1 Framework of JICA's Support for the Kyrgyz Republic and Implementation of Water Resources Management (Same Framework Applies to Tajikistan)

(2) Reinforcement of water resources management organizations

(i) Current status

In October 2009, the Water Resources Agency was set up as an organization which supervises Kyrgyz water management under the umbrella of the Ministry of Natural Resources. As a local organization under the Water Resources Agency, it's working to organize the "Basin Water Resources Management Department."

(ii) Needs for assistance

There are strong needs for observation and data management in the field of water resources for accurate understanding of the quantity of available water as part of the capacity development to realize water resources management effectively. Particularly, support to improve practical ability for water management, such as water use monitoring, data management, maintenance of water resources facilities and water use planning, is given high priority.

(iii) Assessment

It is recommended to accurately grasp available water quantity for water resources management planning and to give support to enhance the capability of the "Basin Water Resources Basin Management Department" which is to be organized as a local entity for water management.

(3) Support for preparation of the basin plan

(i) Current status

The Kyrgyz Republic is now going into transition from administrative–based water resources management to basin-based water resources management. As its first approach, it formulated a draft of the Talas Basin Plan.

(ii) Needs for assistance

Enhancement of hydrological/water use/meteorological monitoring data with sufficient accuracy is required for improving water resources management. Improvement of monitoring and data management and preparation for formulation of the basin plan are urgently needed.

(iii) Assessment

When providing support to hydrological/water use/meteorological monitoring and data management, applying these to specific basins and producing visible results will be effective. The basin plan lays the foundation for water resources management, and giving support to the planning it is meaningful. The Chuy Basin is an important basin in terms of Kyrgyz water use, and an approach in this basin will bring a high level of beneficial effect to the country.

(4) Development of a hydrological/water use/meteorological monitoring system

1) Development of a hydrological and meteorological monitoring system

(i) Current status

In the Kyrgyz Republic, maintaining the accuracy of observation has become difficult due to the reduced number of hydroposts and aging of monitoring equipments. There are also marked reductions in the number of hydroposts and meteorological stations at high altitude. Water resources management is important in electric energy as well, and formulation of the basin plan and a small-scale hydropower generation plan are needed. However, basic data for hydrological/meteorological monitoring are insufficient and need to be improved. Improved accuracy of runoff forecasts using these data is requested.

(ii) Needs for assistance

There are needs for support in the renewal of hydrological/meteorological monitoring equipments, reconstruction (new construction) of hydroposts, and monitoring equipment for repair and calibration.

(iii) Assessment

In order to maintain hydrological/meteorological monitoring functions, apply of equipments equivalent to those Hydromet has been traditionally using will facilitate maintenance of equipment and retainment of accuracy. Since the hydrological/meteorological monitoring functions are declining, start of support at an early date is recommended.

2) Development of a water use observation system

(i) Current status

For example, in Chuy State, a) Water loss reaches 45% by the first water intake point for the quantity of water discharge from Lake Orto-Tokoy. Moreover, there are problems in water use such as: b) For irrigation canals, water loss reaches 10-15% in areas which are not concrete, c) Currently, the inflow quantity from branch rivers in mountainous areas can hardly be measured, d) There is a problem with the deposition of sediment from mountainous area in canals, and e) In some areas, irrigation water does not reach the end of canals.

(ii) Needs for assistance

Many of the discharge observation posts set up in irrigation canals need remodeling. There are needs for canal repair, construction of sediment reduction facility, etc. as discharge measuring and water leakage prevention measures.

(iii) Assessment

The quantity of water use is not accurately recorded due to insufficient discharge monitoring at irrigation facilities. Support for the distribution of small current meters should be given at an

early date. Inspection and repair of canals and sediment deposition prevention measures are also required.

(5) Development of a water quality monitoring system

(i) Current status

Since there is a reduced number of monitoring points, water quality monitoring is now conducted quarterly in the Chuy Basin by sampling water only at Bishkek. From 2004 to 2008, JICA provided technical cooperation project for Central Asia's water quality monitoring, in which training and water quality monitoring equipment were offered.

(ii) Needs for assistance

Although JICA provided water quality monitoring coopertion, there are high demands for the introduction of portable water quality testing equipment nationwide. There's also a need for support procurement of reagents needed for water quality tests.

(iii) Assessment

Currently water qualitymonitoring is conducted at major points in the Chuy River. It's advisable to build a structure in which water quality tests can be conducted in other states and basins in the future.

(6) Preparation of a glacier/groundwater observation and monitoring system

(i) Current situation

a) Glaciers: Currently, only some glaciers are subject to monitoring for study purposes. Accuracy for river runoff forecasting cased by glacier melt is low. Also, in terms of fundamental inventory such as quantity, area and volume of glaciers in the country, data obtained in the former Soviet Union are used. It is necessary to grasp the current situation.

b) Snow: The number of observation stations for snow monitoring is also decreasing. Particularly, the number of observation stations in the upper stream of rivers (at high altitude) is remarkably reduced. Accordingly, the river runoff forecast accuracy for snow melt has decreased.

c) Groundwater: There are few groundwater observation points throughout the country. The number of groundwater observation points is decreasing year by year.

(ii) Support needs

a) Glaciers: For the purpose of runoff forecast accuracy improvement, high-precision observation data is required. For this purpose, there are needs for the reconstruction of Hydroposts in medium/high-altitude mountain regions where observation points have been

lost. Also, there are needs for application of glacier monitoring technologies using remote sensing technologies such as satellites.

b) Snow: For the purpose of runoff forecast accuracy improvement, there are needs for the reconstruction of Hydroposts in mountain regions at medium/high altitude, and needs for snowfall volume and snow melt volume monitoring support using remote sensing technologies.

c) Groundwater: There are needs for further preparation of groundwater observation systems throughout the country.

(iii) Evaluation

a) Glaciers: The current runoff forecast accuracy can be remarkably improved by making use of remote sensing technologies for monitoring. This action must be conducted in combination with support for preparation of a runoff forecast system.

b) Snow: Enhancing the accuracy of snowfall volume and snow melt volume monitoring by using remote sensing technologies enables runoff forecast accuracy improvement, as in the case for glacier monitoring.

c) Groundwater: Since the Chuy River basin is subject to water use of the highest level, preparation of equipment contributing to groundwater monitoring improvement is highly important.

(7) Preparation of communication and database systems

(i) Current situation

a) Observation station

Preriodically observed hydrological and meteorological data are transmitted to Local Management Center by using the SMS function of wireless communication equipment or cellular phones. Wireless communication equipment frequently has trouble under poor power supply conditions because of insufficient maintenance/management expenses. Observation stations cannot provide data observations at a uniform level because some items cannot be observed in case of such trouble.

b) Local Management Center (integrated station)

Mostly, the Local Management Center record data that has been collected from observation stattions into report form, and sends monthly reports to the Communication Center of the Ministry. Since the data is not digitalized, observation data cannot be fully utilized.

c) Communication Center

With the data management system using four computers, the Communication Center

prepares a database of digital data received from the Local Management Center. Input of data that has been collected in record form is delayed, which causes a hindrance in hydrological and meteorological management at the national level.

(ii) Support needs

a) Observation stations

For the purpose of promotion of database preparation in the Local Management Center, there are strong needs for support of digital transmission equipment to transmit observation data to the Local Management Center.

b) Local Management Center

It is very important to intensify the functions of the Local Management Center in order to improve water resources management in the basin. In addition to the function to collect data from each observation station in the current situation, it is necessary to introduce a system to contribute to water resources management and operations in the basins under control. There are needs for the digitization of existing data, automatic data collection, preparation of a database, and introduction of hardware and software to conduct runoff forecasts and water use monitoring and management by using these methods.

c) Communication Center

To conduct water resources management on a nationwide scale, intensification of data management is required. For this purpose, it is important to collect and analyze information on wide areas in real time by integrating data managed and maintained in the Local Management Center. There are needs for the introduction of hardware and software required for this purpose.

(iii) Evaluation

a) Observation station

To build a database for hydrological and meteorological monitoring, digitization of data collection is required.

b) Local Management Center

Accurate water resources management data over the basins under control is the basis for the intensification of data management and operations throughout the country. By introducing a data processing system (equipment and software) for water management, a leap of promotion of database preparation for hydrological, water use and meteorological data can be expected.

c) Communication Center

Through preparation of the information system in the Communication Center, functions required for nationwide water resources management can be provided. In the future, it will

serve as a system indispensable for construction of a data sharing system over riparian countries.

(8) Preparation of a runoff forecast system

(i) Current situation

Runoff forecasts have been conducted based on a traditional method (use of a precipitation - runoff correlation chart). In addition to this method, runoff forecasts using a runoff model has been conducted in recent years. However, there is a problem of accuracy of forecasting.

(ii) Support needs

Currently introduced runoff model input parameters are 1) temperature, 2) precipitation and 3) runoff. In the current situation, the runoff forecast accuracy is insufficient. To conduct runoff forecasts with higher accuracy, it is necessary to improve the runoff model so as to reflect hydrological and meteorological data, and to enhance the runoff model reproducibility.

(iii) Evaluation

Runoff forecast results of Hydromet have an influence on economical activities such as hydro power generation and utilization for irrigation. Therefore, each organization using water has great expectations for forecast accuracy improvement, and high priority is given to support.

Based on the description of 4-3-2, support needs and JICA activities plans are listed in Table 4-3-1.

Table 4-3-1 Support Needs and Donor Activity and Activity Plan of JICA (1/2)

Support needs within the scope of survey		Major activities of donors to meet support needs	JICA activity plan to meet support needs
Intensification of water resources management policy and system		ADB: Construction of a framework for regional water resources management (Amdarya, Syrdarya) GTZ: Discussion on regional water resources management and support for framework construction	JICA shall offer support to each country from upstream.
Intensification of water resources management organization		GTZ: Functional intensification of IFAS WB: Support for establishment of a Kyrgyz Republic governmental water resources management organization	Organizational support is being prepared by establishment of the "Water Resources Agency". Under this circumstance, JICA is planning support for the following fields, aiming for improvement of water resources management.
Basin management plan formulation support, and control of water use		WB: Support for formulation of a Talas River basin management plan GTZ: Organizational intensification for transboundary river water management, and support for formulation of a basin management plan as a part of organizational intensification	Support for formulation/preparation of a basin management plan targeting the Chuy River basin in the Kyrgyz Republic Application of Japanese basin management experience (River management, water use plan, hydrological and water use data management, infrastructure plan, facility management, environmental consideration, etc.)
Hydrological, water use and meteorological monitoring data management	Hydrological, water use and meteorological monitoring	CAIAG: Support for data management in the Central Asia region SDC: Support for Hydromet equipment and data management (mainly in Tajikistan) WB: Support for Hydromet equipment (mainly in the Talas River basin) GTZ: Monitoring and data exchange guidelines for discussion and Cooperation in regional water resources management	All donors' commitments are still partial support. Reconstruction of the monitoring system is highly required and highly important in the Kyrgyz Republic. JICA shall offer support for reconstruction of the hydrological, water use and meteorological observation at important points, and for making the basis of water resources management improvement throughout the country of the Kyrgyz Republic. Mainly, traditional equipment is subject to reconstruction. With the background of Japanese experience and expertise, close support is possible.
	Preparation of water quality monitoring	JICA: Offering water quality observation equipment and training	Preparation of equipment that enables water quality observation at important points (including moving measurement), and offering reagents
	Preparation of glacier/groundwater monitoring	CAIAG: Monitoring technology improvement, and study on GIS utilization	Technical support for reconstruction of observation stations in mountain regions at medium/high altitude where observation points have been lost, and snowfall and snow-melt forecasts using remote sensing and analyzing technologies via satellites.

Table 4-3-1 Support Needs and Donor Activity and Activity Plan of JICA (2/2)

Support needs (within the scope of investigation)		Major activities of donors to meet support needs	JICA activity plan to meet support needs
	Preparation of communication and database systems	CAIAG: Study on GIS utilization SDC: Support for formulation of a hydrological data yearbook	Digitization of data in hydrological, water use and meteorological observation stations (Meteo-stations) in Kyrgyz Republic, and application of Japanese advance equipment and software technologies to data transmission and management
	Preparation of a runoff forecast system	SDC: Runoff analysis targeting rivers in the Fergana Basin	Application of analyzing software that reflects accurate hydrological and meteorological data

4-3-3 Review of the Support Framework

Based on the description of 4-3-2, priority for evaluation of the survey team is listed below:

(1) Priority of support items

Table 4-3-2 Priority items for Improvement of Water Resources Management Ability (Kyrgyz Republic)

Code	Items for water resources management capacity improvement	Priority
(1)	Intensification of water resources management policy and system	Medium
(2)	Intensification of water resources management organization	High[Note 1]
(3)	Basin management plan formulation/preparation support	High
(4)	Preparation of a hydrological, water use and meteorological monitoring system	High
(5)	Preparation of a water quality monitoring system	Medium
(6)	Preparation of a glacier/groundwater monitoring system	High[Note 2]
(7)	Preparation of communication and data base systems	High
(8)	Preparation of a runoff forecast system	High

Note 1: Necessity of capacity development through organizational intensification such as training is high.

Note 2: Importance of glacier observation including snow melt observation is high.

(2) Basic plan of observation systems

Standard equipment to be installed is described below using examples as reference.

1) Reconstruction of hydroposts

As standard equipment for the Naryn River basin, the equipment required at Kek-Irim along the Naryn River is listed in Table 4-3-3.

Table 4-3-3 Material and Budget Necessary for Standard Hydropost Reconstruction

Name of equipment	Specifications	Quantity	Unit price (US$)	Total (US$)
Current meter	GR-21	2	1540	3080
Self-recording water level gauge	SUV	1	900	900
Winch	LG-1M1-2	1	1330	1330
Weight	100Kg		800	800
Weight	50Kg		500	500
Altitude measure		2	270	540
Water depth meter	1.1 m	1	100	100
Portable water depth gauge	1.0 m	1	60	60
Remote control runoff measuring instrument	GR-70	1	14550	14550
Water thermometer		2	230	460
Stopwatch		1	50	50
Life jacket		1	110	110
Surveying and design		LS	11370	11370
Observation building and lodgings		LS	40910	40910
Cable equipment for flood observation	River width: 150 m		8460	8460
Installation of GR-70		LS	2730	2730
Power supply equipment		LS	7960	7960
Fence wire net		LS	1820	1820
Total				96810

(Reference data of Hydromet)

For hydroposts that need repair, equipment costs for relevant items are required among those listed above.

2) Reconstruction of meteorological stations

As typical equipment required for reconstruction of meteorological observation stations, those required at Kek-Irim along the Naryn River are listed in Table 4-3-4.

Table 4-3-4 Material and Budget Necessary for Standard Meteorological Observation Stations Reconstruction

Name of equipment	Specifications	Quantity	Unit price (US$)	Total (US$)
Rain gauge	Tretyakov type	1	555	555
Graduated cylinder		2	35	70
Instrument screen		1	370	370
Thermometer	TM1	2	110	220
Thermometer	TM2	2	110	220
Snow altitude measure		3	35	105
Portable snow measure		1	34	34
Preparation of observation station ground		LS	870	870
Total				2444

(3) Preparation of communication and database systems

As communication and database systems, “digitization of Hydroposts”, “preparation and intensification of systems in the Local Management Center” and “functional intensification of the Communication Center” are required. Required equipment and reference costs are listed below. Specifications and prices of the equipment should be reviewed in the design stage.

a) Local Management Center

Name of equipment	Specifications	Quantity	Unit price (thousand yen)	Total (thousand yen)
Server	CPU: 2.4 GHz, Memory: 4 GB, HDD: 1 TB or more	1 unit	1,000	1,000
HMI	CPU: 2.4 GHz, Memory: 4 GB, HDD: 1 TB or more	1 unit	400	400
Monitor	22-inch TFT	1 unit	150	150
Printer	Color laser, A3/A4 size	1 unit	300	300
Uninterruptible power supply unit	1 kVA, 60 minutes or longer	1 unit	300	300
GPRS router	For Ethernet	1 unit	200	200
Hub, etc.	8 ports or more	1 set	100	100
Software, test run	Windows, SCADA, etc.	1 set	20,000	20,000
Total				22,450

b) Communication Center

Name of equipment	Specifications	Quantity	Unit price (thousand yen)	Total (thousand yen)
Database server	CPU: 2.4 GHz, Memory: 4 GB, HDD: 1 TB or more	2 units	1,000	2,000
Communication server	CPU: 2.4 GHz, Memory: 4 GB, HDD: 1 TB or more	1 unit	1,000	1,000
Gateway	CPU: 2.4 GHz, Memory: 4 GB, HDD: 1 TB or more	1 unit	1,000	1,000
Firewall	Throughput: 150 Mbps or more	1 unit	800	800
HMI	CPU: 2.4 GHz, Memory: 4 GB, HDD: 1 TB or more	2 units	400	800
Monitor	22-inch TFT	2 units	150	300
Printer	Color laser, A3/A4 size	1 unit	300	300
Uninterruptible power supply unit	2 kVA, 60 minutes or longer	1 unit	500	500
Layer switch	Layer 2	1 unit	200	200
Hub, etc.	8 ports or more	1 set	200	200
Software, test run	Windows, SCADA, etc.	1 set	60,000	60,000
Total				67,100

c) Observation Stations

Name of equipment	Specifications	Quantity	Unit price (thousand yen)	Total (thousand yen)
Wireless communication equipment	1.5–30 MHz, 100 W	1 unit	700	700
Cellular terminal	With SMS function	1 unit	100	100
Solar generation system	500 W	1 unit	1,000	1,000
Software, test run		1 set	500	500
Total				2,300

(4) Preparation of the basin plan formulation of the pilot river basin

[1] Activities for the pilot basin plan

The following are assumed as concrete steps for preparation and formulation of the basin plan.

- Support for the collection and analysis of hydrological, water use and meteorological data
- Support for the preparation of inventory about river water use facilities, users and water intake status
- Support for the analysis of water demand and forecasts of future demand
- Reconstruction support of hydrological, water use and meteorological facilities

- Introduction support of a data management system
- Basin infrastructure diagnosis and review of infrastructure arrangement

[2] Target river basin

The Water Resources Agency expressed their intention to select the Chuy river basin, which is an important basin in the Kyrgyz Republic, as the pilot basin. The Chuy River is 1,186 km long with a 62,500 km^2 basin area and twelve branches covering eight administrative districts (Rayon) including the capital of Bishkek.

The population in the basin is over half the population of the country. The irrigation area is 320,000 ha or one third of the entire landmass of the country, which is also important in the agricultural aspect. The main canals are the Great Chuy Canal, West Great Chuy Canal, and South Great Chuy Canal. The canal length is 364 km, and infrastructure construction is in progress.

On the other hand, there is a 40% water loss downstream relative to the discharge volume from the Orto-Tokoy reservoir. Since hydrological, water use and meteorological monitoring and data management are insufficient, there are strong needs for improvement of water resources management by selecting the Chuy River basin as the pilot basin.

(5) Possibility of information exchange and collaboration with other donor activities

i) Necessity of information exchange with other donors

In the field of water resources management, donor activities related to hydrological and meteorological monitoring and water resources management intensification for small basins are recognized in both the Kyrgyz Republic and Tajikistan.

Aiming for effective support, donors are in cooperation with each other, and each bears a role for the purpose of information sharing and collaboration. Information exchange and collaboration with donors are necessary for this project, which is desirable for support target countries, too.

ii) Possibility of collaboration

1) Possibility of collaboration with GTZ

Information exchange and collaboration are possible in terms of the following items, between the JICA project and the GTZ project.

Regarding information exchange and collaboration with JICA, GTZ expressed positive intention. It would be effective to hold discussions about their direction and role sharing by conducting information exchange in the stage where contents of the JICA program are fixed.

* Basin assessment and monitoring, basin administration

Uniform concept is required relative to transboundary river water data monitoring system.

* Development of river basin management plan

To support the pilot project for basin plan formulation/preparation, uniformity is required in the Kyrgyz Republic.

* Regional guidelines for water monitoring and data exchange

During review of monitoring specifications in the Kyrgyz Republic, information sharing is required so as to consider regional specifications in the future.

2) Possibility of information sharing and collaboration with CAIAG

The “monitoring system” is one of the subjects of the CAIAG 2009 program, which is applied to hydrological, water use, seismic and GPS monitoring.

Aiming for building a network of hydrological and meteorological data, the “Central Asia Water Project (ZAWs)” in which Hydromets of each country in Central Asia participate, is striving for automatic transmission of monitoring data, glacier-related observation and study, and preparation of basin models.

[1] Basin model

There is a plan to prepare basin models targeting Syrdarya, Naryn and Zaravshan, which is related to JICA’s support for basin plan formulation/preparation in the pilot basin that the investigation group has proposed. Therefore, information sharing is desired in the future, in view of uniformity of basin model construction in the country.

Snowfall and glacier monitoring data that determine river inflow volume and runoff forecast through analysis are important items for water resources management in both the Kyrgyz Republic and Tajikistan. It is preferable to conduct information sharing with CAIAG as well as collaboration when required.

[2] Glacier monitoring and study

Currently, Hydromet’s glacier monitoring is interrupted. Since the intensification of glacier monitoring is important for water management in terms of river inflow volume forecasts, it is preferable to collaborate with CAIAG which has advanced in this field.

3) Information exchange with WB

[1] Formulation of a basin plan for IWRM intensification

a. Support for formulation of the Talas River basin plan

The survey team has proposed support for preparation to set up the Chuy River basin plan. In order to ensure conformity with the concept of the Talas River basin plan, information exchange is required.

b. Intensification of Hydromet

WB is planning to offer equipment to thirty two hydroposts and thirty one meteorological observation stations. Since the experience in offering equipment to WB brings Japan important information, it is effective to conduct information exchange to proceed with support. The investigation group proposes support for preparations to set up the basin plan through data management as the basis of water resources management. In this meaning, information sharing is required.

4) Information exchange with ADB

[1] CAREC

As the CAREC secretariat, ADB is offering support for energies including transportation and water resources in Central Asia. If JICA proceeds with support for water resources in Central Asia in the future, collaboration with CAREC would be effective because it can spread the position of our support.

[2] Information sharing with the Chuy/Talas commission

For the purpose of transboundary river water resources management, ADB offers financial support to the Kyrgyz-Kazakhstan joint secretariat, and support for working groups. Information sharing is required for JICA's support.

5) Information exchange with SDC

[1] SDC has conducted an integrated water resources management project since 2001 to support water management for the Ak-Bula Canal of Osh State in the Kyrgyz Republic in the pilot basin and the Khodzhabakyrgan Canal in Tajikistan.

[2] Supports for hydroposts and meteorological observation station (ended in 2009) were offered for Hydromet. Also, support for data processing and forecast software are conducted. It would be effective to refer to the results of this support project and make use of them for JICA's project in the future.

6) Information exchange with UNDP

[1] Support for improving water resources management are offered for the Zeravshan River, as a transboundary river between Tajikistan and Uzbekistan.

[2] Governmental activities for basin level water resources management have become active in Tajikistan, and UNDP has participated in these activities. Since JICA's support involves preparations to formulate the basin plan, information exchange is required.

(6) Implementation of cooperation programs

As a result of this investigation, improvement of hydrological, water use and meteorological

monitoring and data management systems, and support for water resources management intensification proved to be necessary.

In the support plan, important basins for water resources management in target countries are defined as pilot basins, and support for monitoring the pilot basins and data management and preparations to setup basin plans by using these systems are proposed.

[1] Support for equipment and data management

Reconstruction of hydroposts, repair of existing hydroposts, and reconstruction/repair of water use monitoring stations in the Chuy River basin and other important points are offered to the Kyrgyz Republic Water Resources Agency and Hydromet. The support targets are measuring instruments and buildings at Hydroposts, and frow rate measuring cables, observation gondolas, communication equipment, personal computers, etc.

In principle, it is considered to be appropriate as JICA's support that conventional monitoring systems should be reconstructed, and then important structures should be automated.

Furthermore, it is effective that JICA should make a commitment leading to formulation of the relevant basin plan through activities in the pilot basins. Also, JICA aims for improvement of water resources management using a database of measurement data, through introduction of new communication equipment, and preparation of data processing equipment and software required for water resources management.

Certification and repair facilities to ensure the accuracy of hydrological and meteorological monitoring equipment are indispensable for continuous management.

In principle, introduction of hydrological measuring instruments with an equivalent level to conventionally used equipment in hydroposts is assumed. This is based on consideration of proven performance for long-term data management and for retention of observation conditions of existing monitoring equioment. However, to build a database of measurement data, personal computers, software, server computers for the state central station and Bishkek base station, data transmission equipment and backup equipment are newly required. In addition, equipment and software required to build data integration/analysis systems should be also allocated.

[2] Intensification of water resources management capacity

For capacity development related to water resources management in the Kyrgyz Republic, required fields, applied personnel, training methods/period, number of experts as input from our country (long-term, short-term), equipment to be provided and contents of training are described below.

For water resources management improvement, hydrological/meteorological and water use

monitoring and data management training, a framework involving the participation of Tajikistan is proposed.

a) Intensification of integrated water resources management capacity of project implementation organization

b) Formulation of guidelines

c) Formulation of regulations and standards for measurement and analysis

d) Formulation of a monitoring plan

e) Construction, operation, maintenance and management of a monitoring system, data integration/analysis system

f) Holding training in water resources management, hydrology, meteorology and water use

In addition to improvement of these monitoring systems, pilot basins shall be defined based on governmental intention, and intensified supports shall be offered in terms of basic data preparation, basin management organizations, and systems intended for formulation of basin plans for the pilot basins. Furthermore, for the purpose of water resources management technology improvement, support for capacity intensification (including preparation of guidelines) shall be offered.

A) Input from the Kyrgyz Republic

a. Appropriate allocation of CP personnel (number)

i) Project manager: 1 person, Title: Water Resources Agency Manager or equivalent (water resources management)

ii) Working-level responsible personnel of the Water Resources Agency: 1 person, Title: Section Manager or equivalent (water resources management)

iii) Working-level responsible personnel of Hydromet: 2 persons, Title: Section Manager or equivalent (Monitoring system, System/data management)

iv) Pilot project responsible personnel of the Department of Water Resources of Chuy State: 2 persons,
Title: Office Manager or equivalent (water resources management), Section Manager (water resources management)

Total: 6 persons (wherein, 4 persons (max.) of the Water Resources Agency, Hydromet and Chuy State Section Manager are full-time CP. The number of personnel shall be determined by discussion with partner organizations.)

b. Allocation of CP in charge of operations

A) Input from Japan

a. Long-term/short-term experts

i) Expert in water resources management (Long-term): 1 person
ii) Expert in measurement and analysis (Short-term): 1 person
iii) Expert in hydrology (Short-term): 1 person
iv) Expert in monitoring systems (data communication) (Short-term): 1 person
v) Expert in database and integration/analysis systems (Short-term): 1 person
vi) Expert in water use (Short-term): 1 person

b. Provision of equipment

i) Set of personal computers and peripheral equipment
ii) Set of computer software

c. CP training

Training shall be held for integrated water resources management, hydrological and meteorological monitoring, database, integration/analysis system, etc. in Japan (approx. twice).

[3] Project implementation organizations

Water Resources Agency, the Ministry of Natural Resources and Hydromet of the Kyrgyz Republic

[4] Project period

Because a large number of hydroposts need reconstruction or repairs, the support period shall be approx. 3 years (2 terms) in total. The project period shall be approx. 3 years.