No.

Central Asia Region

Study on Intra-Regional Cooperation on Water and Power for Efficient Resources Management in Central Asia

Main Report

February 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

supported by the Ministry of Foreign Affairs of Japan

JAPAN WATER FORUM
JAPAN WATER AGENCY
TOKYO ELECTRIC POWER SERVICES CO., LTD.

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Preface

In order to promote intra-regional cooperation in Central Asian countries, the “Central Asia plus Japan” dialogue initiative was launched by the Japanese government in 2004. The action plan in each field was drawn up at the foreign ministers’ meeting in 2006. In 2007, at the 2nd “Central Asia plus Japan” intellectual dialogue in Tokyo, a specific theme called “Prospects for Regional Cooperation in Central Asia on Water Resources and Electric Power” was discussed.

The Japan Bank for International Cooperation (new JICA, Japan International Cooperation Agency, from October 2008) and the Ministry of Foreign Affairs of Japan conducted a basic study to set up a new direction for their support, and to concretize the roles of Japan by entrusting Japan Water Forum, Japan Water Agency and Tokyo Electric Power Services Co., Ltd. whit a further study.

The study team visited the four countries of Central Asia (Uzbekistan, Kazakhstan, Kyrgyzstan and Tajikistan) twice. The comprehension of the current situation and issues regarding water resources and the electric field was enabled by interviewing governmental organizations, international organizations, donors etc. (the first research). Furthermore, a presentation of the interim report to the organizations and a hearing of the opinions (the second research) were undertaken. The present report was compiled and finalized, as a result of the researches.

I would like to express my sincere appreciation to the officials concerned for their significant cooperation.

I hope that this report will contribute to the enhancement of collaborative relationships between the Central-Asia countries and Japan.

February 2009

Study Team on Intra-Regional Cooperation on Water Resources and Electric Power in Central Asia
Takeyoshi Sadahiro
Team Leader

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Abbreviations

ADB	Asian Development Bank
ASBP	Aral Sea Basin Program
BVO (BWO)	Basin Water Organization
CACO	Central Asian Cooperation Organization
CARs	Central Asian Republics
CAPS	Central Asian Power System
CAREC	Central Asia Regional Economic Cooperation, ADB
CDC	Nongovernment Noncommercial Organization Coordinating Dispatcher Center <Energy>
CDM	Clean Development Mechanism
CEPC CA	Coordinating Electric Power Council Central Asia
CHP	Combined Heat and Power
CIS	Commonwealth of Independent States
DOE	Department of Energy, USA
DSM	Demand Side Management
DSS	Decision Support System
EBRD	European Bank for Reconstruction and Development
EC-IFAS	Executive Committee IFAS
ECO	Economic Cooperation Organization
EEC	Eurasian Economic Community
EPIQ	Environmental Policy and Institutional strengthening indefinite Quantity contract
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
GWP	Global Water Partnership (NGO)
HPP	Hydro Power Plant
ICAS	Interstate Council on. the Aral Sea Basin Problems
ICKKTU	Interstate Council for the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan
ICSD	Interstate Commission for Sustainable Development
ICWC	Interstate Coordination Water Commission of Central Asia
IFAS	The International Fund for Saving the Aral Sea
IFI	International Financial Institution
IWRM	Integrated Water Resources Management
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JSC	Joint Stock Company
KOREM	Kazakhstan Operator of the Electric Energy and Power Market
KEGOC	Kazakhstan Electricity Grid Operating Co
LOLE	Loss Of Load Expectation
NASPI	Naryn Syrdarya cascade Planning Instrument
NEDO	New Energy and Industrial Technology Development Organization of Japan
NDC	National Dispatch Center
NRMP	Natural Resources Management Project
ODA	Official Development Assistance
O&M	Operation and Maintenance
OSCE	the Organization for Security and Cooperation in Europe
PPA	Power Purchase Agreement
PDPAT	Power Development Planning Assist Tool
RETICS	Reliability Evaluation Tool for Inter-Connected Systems
SANIIRI	the Central Asian Irrigation Research Institute
SCADA	Supervisory Control and Data Acquisition
SCO	Shanhai Cooperation Organization
SDC	Swiss Development Cooperation
SIC-ICWC	Scientific Information Center of ICWC
SJSC	State Joint Stock Company
S/S	Substation

T/A	Technical Assistance
TPP	Thermal Power Plant
TWEP	Transboundary Water and Energy Project
UDC	Unified Dispatch Center
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
WMS	Water Management System

＜Unit＞

BCM	Billion Cubic Meter
MTOE	Million ton oil equivalent
MWh	Megawatt Hour
GWh	Gigawatt Hour
TWh	Terawatt hour
mln	Million
bln	Billion

Chapter 1. Outline of the study

1-1 Background of the study

In order to promote intra-regional cooperation in Central Asian countries, the "Central Asia plus Japan" dialogue initiative was launched after the former Minister of Foreign Affairs, Yoriko Kawaguchi visited the foregoing nations in August 2004. In 2005, under the concept of this dialogue, a survey on water resources and electric power, as one of the main pillars of the initiative, was conducted by the Japan Bank for International Cooperation (JBIC) to focus on Japan's possible assistance in promoting intra-regional dialogue among the countries in the Central Asian region.

At the 2nd foreign ministers' meeting in 2006, chaired by former Minister of Foreign Affairs of Japan, Mr. Aso, and with other respective delegates: the foreign ministers from Kyrgyzstan, Tajikistan and Uzbekistan, and a special envoy from Kazakhstan, adopted and signed the "action plan" that specifies the concrete directions where it leads for the five pillars: policy dialogue, intra-regional cooperation, business promotion, intellectual dialogue and cultural & human exchange, and constructed a framework of promoting intra-regional cooperation. In this "action plan", "water & energy issues" is clarified as one of the targeted subjects that will contribute to the assistance for intra-regional cooperation.

In order to realize effective intra-regional cooperation in "action plan", it is inevitable that countries of Central Asia should take an active approach, and build a reliable relationship among the countries. The countries of Central Asia expressed their determination to overcome various difficulties, move forward and promote further cooperation for social & economic development in each country and also in the region as a whole. Japan welcomed the efforts proactively taken by Central Asia, and expressed its intention to consider the possibility of supporting these countries giving technical advice etc. once the direction they take became obvious and clear.

In January, 2007, at the 2nd "Central Asia plus Japan" intellectual dialogue in Tokyo, a specific theme called "Prospects for Regional Cooperation in Central Asia on Water Resources and Electric Power" was discussed. In the discussion, it was apparent that Kazakhstan, Uzbekistan, and Turkmenistan have fossil fuel such as oil and natural gas, while Kyrgyzstan and Tajikistan in the upstream of the Syrdarya River and Amu Darya River have water resources, and that regional cooperation is needed for an optimal distribution of water resources and electric power. The following were pointed out regarding possible roles played by Japan:

Japan leads in areas such as water saving, water resources management and energy saving, and can therefore provide Central Asian countries with its excellent technology.

Technical assistance should be expanded to reform systems including improving the management of power-related facilities such as power generation, transmission, and distribution.

It is appropriate to start with projects which will be conducted within a country but nevertheless will have regional impacts rather than immediately venture gigantic projects which will go beyond borders.

One idea is that Japan could offer opportunities to have in-depth discussions at the political level as well as the technical level among Central Asian countries.

The purpose of this study is to set up a new direction for the support and concretize the roles of Japan as listed above.

1-2 Purpose of the study

Regarding water resources and electricity in Central Asia, it is of great importance for the countries in the region to have a proactive approach and to establish reliable mutual relationships. In order to develop regional coalition based on “Central Asia plus Japan” dialogue mechanism and the “action plan”, Japan’s role needs to take shape: for example, Japan provides platform for creating better intergovernmental dialogue.

A study on Intra-Regional Cooperation on Water and Power for Efficient Resources Management in Central Asia, conducted in 2005, proved that there was economic benefit in each country by optimization of interconnection of electric power system even when water resources in the region was used for vegetation purpose in accordance with the previous rules.

In Kyrgyzstan, which is the upstream country of Syrdarya River, there has been a difficult situation in coordinating water use of the Toktogul reservoir between Kyrgyzstan, where electric power generation is necessary during the winter season and Uzbekistan & Kazakhstan, where there is a great water demand for vegetation during the summer time. In addition, there has been a conflict with regard to the construction of a hydropower plant between Tajikistan (that relies on water power resources) and Uzbekistan.

In this study, based on the statements above, the direction was considered towards integration and efficiency of the use of water resources. Concretely, measures for alleviating damage in the downstream area caused by floods that have been brought about by discharge for electric power during winter and impact on optimization of the interconnection of electrical power system are taken into consideration. Furthermore, the problems are grasped in terms of what means will be necessary in order to manage water resources in an integrated and an efficient manner. Moreover, the relevance of supply and demand in the region is also being considered.

Predicting that Japan shares the outcome with the countries in Central Asia to deepen dialogue of political / technical level in regional countries, the outcome of the study will be organized. It is intended to make concrete suggestions for Japan’s role and the direction of support that may contribute to efficient use of water resources and power resources.

1-3 Term of reference (TOR)

The Terms of Reference (TOR) of this study are the following:

(1) Review of "Study on Intra-Regional Cooperation on Water and Power for Efficient Resources Management in Central Asia".

・ In order to implement this survey efficiently and effectively, the report mentioned above will be under close scrutiny prior to the survey.

(2) Extraction of the status quo and the issues regarding regional cooperation on electric power and water resources in the Syrdarya river basin.

・ The extraction of cause, obstacles, and problems that prevent systems of water resources and electric power interconnection from being established.

・ Indication of Japan's role and possible description of the systems of water resources and electric power interconnection, and its actual systems.

(3) Extraction of the status quo and the issues regarding water resources development and management in the Syrdarya river basin.

・ Organization of the transition and the status quo of policies, laws and regulations regarding water resources development and management in and among countries of Central Asia including the relevant development and management of electric power.

・ Organization of the transition and the status quo of development and management of both soft and hard infrastructure regarding water resources in the Syrdarya river basin.

(4) Consideration of mitigating flood damage in the Syrdarya River.

・ Extraction of the current condition and cause of flood in the Syrdarya River.

・ Proposal for countermeasures against floods, consideration of possibility of mitigating damage.

(5) Understanding of the status quo and the problems regarding power generation in the Syrdarya River that is conditioned by the "Study on Intra-Regional Cooperation on Water and Power for Efficient Resources Management in Central Asia (July, 2005).

・ Extraction of the status quo and the problems etc. regarding both possible and scarce volume of electric power generation, the volume of electricity generated by hydropower.

・ Prediction of influence in the case mitigation of flood damage is attempted as one of the issues of the above stated, "the status quo and the problems regarding power generation".

(6) Suggestions for the direction of and measures for the New JICA's intellectual cooperation, technical assistance, and yen loan.

・ Based on the statements above from (1) to (5), the proposal for concrete support by New JICA.

Extraction of points, problems, issues that New JICA ought to tackle aiming towards the realization of the above suggested programs.

1-4 Area and scope of the study

The four countries that this study covers are the following; Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan.

In order to understand the actual condition and the intentions of the countries and organizations with regards to water resources and electric power, the on-site survey conducted interviews with regional representative organizations, leaders of governments, donors, and relevant organizations. The review and analysis based on the outcome and the material used for the study were summed up as an interim report, and were announced at the 2nd study with the purpose of receiving comments and opinions.

The report summarized the 2nd on-site survey and analysis and the results evaluated and summarized the information obtained by bibliographic survey.

The 1st on-site survey was carried out in Kyrgyzstan, the upstream country of the Syrdarya River, Uzbekistan and Kazakhstan, mid & downstream countries of Syrdarya. What was done there was to collect materials, as well as to hear and gained measures and intentions of each organization, and to investigate the impact on electricity and the basic plan for alleviating flood damage etc. based on the outcomes.

At the 2nd on-site survey, the information that was insufficient was augmented, and as an interim report the results of the study as to electricity and water resources management on measures for mitigating flood damage was explained to the four countries; Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan., and the exchange of opinions was implemented.

As mentioned above, the survey was intended to gain an understanding of basic information and realistic issues when the direction and the measures for Japan to take and support are presented.

Figure 1-1 shows the locations of the area and scope of the basin, and the reservoirs.

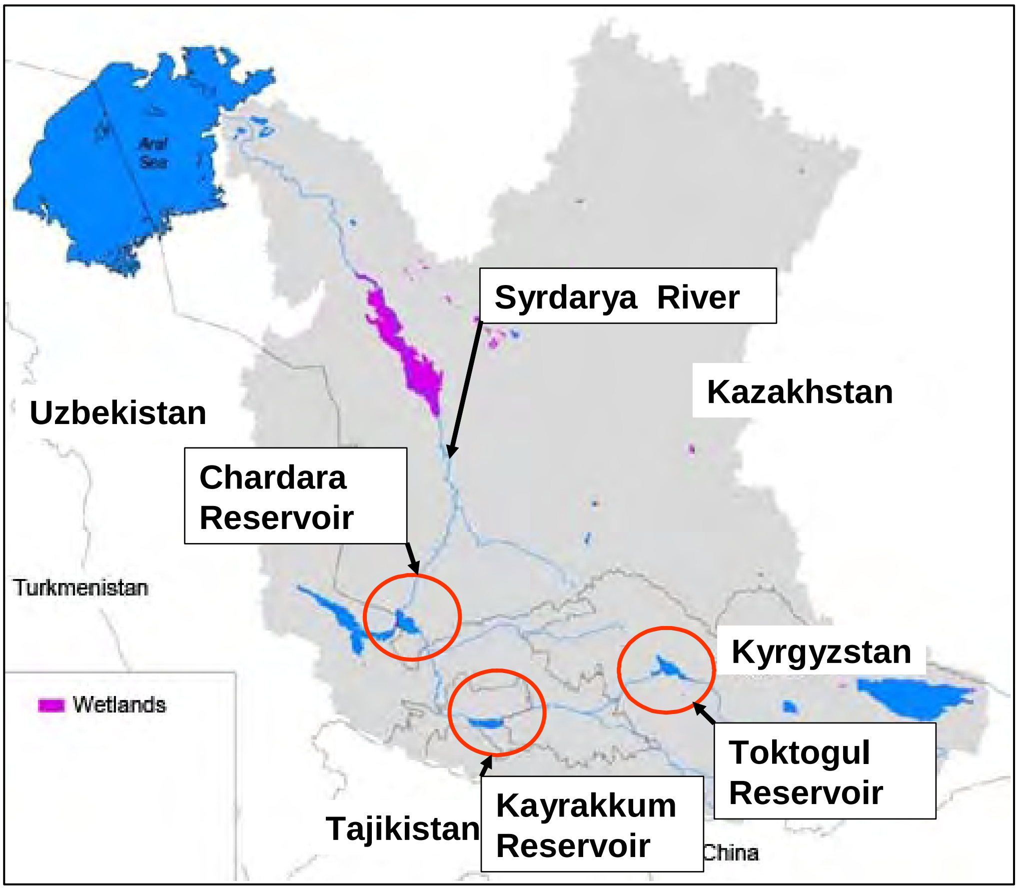


Figure 1-1 Locality map of Syrdarya River basin

1-5 Members of the study team and itinerary of the research trip

The study was carried out by the study team described in the following table.

Table 1-1 Study team members

Name	Task
Takeyoshi Sadahiro (Japan Water Agency)	Team Leader, Water resources management
Masahiro Sugiura (Japan Water Agency)	Water resources management
Kunio Kawamoto (Japan Water Forum)	Water resources policy
Hitoshi Furukoshi (Tokyo Electric Power Service Co., Ltd.)	Electricity
Yasuhiro Yokosawa (Tokyo Electric Power Service Co., Ltd.)	Electricity

Research trips were carried out twice for the study.

The itinerary of the 1st research trip is indicated in Table 1-2.

Table 1-2 Itinerary of the 1st research trip (September 2008)

Date			Sadahiro, Furukoshi, Kawamoto	Sugiura
1	2-Sep	Tue	Tokyo→Seoul (OZ101)→Tashkent (OZ573) 13:30→21:00	Same as on the left
2	3-Sep	Wed	Tashkent	Same as on the left
3	4-Sep	Thu	Tashkent	Same as on the left
4	5-Sep	Fri	Tashkent	Same as on the left
5	6-Sep	Sat	Tashkent	Same as on the left
6	7-Sep	Sun	Tashkent	Same as on the left
7	8-Sep	Mon	Tashkent	Same as on the left
8	9-Sep	Tue	Tashkent→Chardara→Koksarai→Shymkent (car)	Same as on the left
9	10-Sep	Wed	Shymkent→Almaty (KC972)→Astana (KC853) 09:45→14:40	Shymkent→Tashkent (car)
10	11-Sep	Thu	Astana	Tashkent→Seoul (OZ574) 22:20→08:50
11	12-Sep	Fri	Astana	Seoul→Tokyo (OZ106) 17:10→19:30
12	13-Sep	Sat	Astana	
13	14-Sep	Sun	Astana→Almaty (KC952) 09:00→10:40	
14	15-Sep	Mon	Almaty	
15	16-Sep	Tue	Almaty	
16	17-Sep	Wed	Almaty→Tashkent (HY766) 12:50→13:40	
17	18-Sep	Thu	Tashkent	
18	19-Sep	Fri	Tashkent→Bishkek (HY781) 09:10→11:35	
19	20-Sep	Sat	Bishkek	
20	21-Sep	Sun	Bishkek	
21	22-Sep	Mon	Bishkek	
22	23-Sep	Tue	Bishkek	
23	24-Sep	Wed	Bishkek	
24	25-Sep	Thu	Bishkek→Tashkent (HY780) 09:55→10:25	
25	26-Sep	Fri	Tashkent→Seoul (OZ574) 22:20→08:50	
26	27-Sep	Sat	Seoul→Tokyo (OZ102) 10:00→12:10	

The itinerary of the 2nd research trip is indicated in Table 1-3.

Table 1-3 Itinerary of the 2nd research trip (November-December 2008)

Date			Sadahiro, Furukoshi, Kawamoto
1	25-Nov	Tue	Tokyo→Seoul (OZ101)→Tashkent (OZ573) 13:30→21:10
2	26-Nov	Wed	Tashkent→Termez (HY1151) 09:25→11:25、Termez→Dushanbe (car)
3	27-Nov	Thu	Dushanbe
4	28-Nov	Fri	Dushanbe
5	29-Nov	Sat	Dushanbe→Termez (car)、Termez→Tashkent (HY1154) 15:55→17:40
6	30-Nov	Sun	Tashkent
7	1-Dec	Mon	Tashkent→Astana (HY721) 14:45→18:00
8	2-Dec	Tue	Astana
9	3-Dec	Wed	Astana
10	4-Dec	Thu	Astana
11	5-Dec	Fri	Astana→Almaty (KC952) 09:00→10:40
12	6-Dec	Sat	Almaty→Bishkek (car)
13	7-Dec	Sun	Bishkek
14	8-Dec	Mon	Bishkek
15	9-Dec	Tue	Bishkek
16	10-Dec	Wed	Bishkek→Tashkent (HY778) 08:50→09:20
17	11-Dec	Thu	Tashkent
18	12-Dec	Fri	Tashkent→Seoul (OZ574) 22:30→09:00
19	13-Dec	Sat	Seoul→Tokyo (OZ102) 10:00→12:10

Chapter 2. Present situation, problems and measures concerning development and management of water resources

2-1 Overview

The situation of the Syrdarya River basin in Central Asia is remarkably different from that of a natural river. It has a large reservoir in upstream, whose effective capacity is 14 billion m^3 while the average annual inflow to Toktogul Reservoir is about 12 billion m^3 (average from 1991 to 2007). Therefore, the river has a characteristic that operations of storage and discharge of water greatly influence downstream flow regime, and that the operation plan of the reservoir influences the reservoir capacity over the years.

During the former Soviet era when the Toktogul Reservoir was constructed, among the republics of the Soviet Union, the roles were allocated to either generating hydroelectric power (upstream countries) or engaging in vegetation farming (downstream countries) under the strict control of the central government. The upstream countries operated reservoirs for the purpose of supplying irrigation water to promote agricultural production of downstream countries. In compensation for this, the downstream countries supplied fuel and electricity in winter to the upstream countries, thereby maintaining regional balance. After the republics gained independence, this scheme became difficult to be maintained. Each republic was forced to give priority over their own interests to protect themselves. Therefore, damages became remarkable such as floods in downstream countries caused by water discharge from Toktogul Reservoir for power generation in winter, and in return, shortage of water during summer.

Presently, the coordination of this operation of water resources has become a political issue among the riparian countries concerned. Despite the efforts paid by the countries, international organizations, and donors, a framework and a long-term agreement for settlement have not been established yet.

Focusing on these problems of the water resources development and management in the Syrdarya River basin, this chapter summarizes the efforts paid to promote the effective use of water resources as well as the current status and problems concerning water resources management, and considers measures to be taken for the future.

2-2 Operational status of major reservoirs in the Syrdarya River basin

The operational status of the major reservoirs in the Syrdarya River basin is described below.

(1) Inflow to and storage capacity of Toktogul Reservoir

Figure 2-1 shows monthly average inflow to Toktogul Reservoir from 1991 to 2008. Figure 2-2 shows the secular change of pondage of Toktogul Reservoir from 1991 to 2008. Since precipitation in the river basin is low, inflow is mainly composed of snowmelt flow. It is understandable that base flow remains slightly less than 200 m^3/s level.

Among fluctuations of pondage, there are both yearly fluctuations and those occurring every few years. This indicates that it is presumed there is a periodic cycle found in the fluctuations of inflow, that is, the apparent cycle of increase and decrease occurs every 4 to 6 years. Another reason for the fluctuations of pondage every few years may be that Toktogul Reservoir is a dam, whose storage capacity is bigger than the inflow mentioned, thus requires years of planned operation.

Inflow to Toktogul Reservoir has continued to decrease for the past 5 years. Since the reason for this is unknown, the cause that brought about the decrease is not going to be specified in this study, although it is said it happened because the glaciers have melted, which resulted in the decrease of inflow.

One of the phenomena of successive decrease of inflow was the storage capacity, of which the lowest figure was recorded in recent 18 years with 6.4 billion m^3 in late April, 2008. If 5.5 billion m^3 was subtracted, which was the capacity of dead water*, it means that the pondage decreased to the level of about 0.9 billion m^3, while total active capacity is 14 billion m^3.

> Dead water*: storage water which provided to measure against future sedimentations and not for water use

Base flow of that year was lower than before, less than 100 m^3/s. In order to find the cause and to estimate the future, analysis of glacier area changes, snow accumulation data, etc. is needed. For the present, it is necessary to pay attention to the fluctuations of future inflow.

Figure 2-3 shows the fluctuations of long-term inflow for 97 years from 1911 to 2007 and their sorted data in order with the biggest inflow at the top. Provided that the accuracy of inflow measurement during the observing period had been kept the same at a certain level, a characteristic is found that yearly fluctuation of inflow is larger than the average long-term inflow. A periodic cycle of a few years to 10 years seems to exist, although it is not always clearly evident. The inflow in 2007 was at the average level from the viewpoint of the long-term inflow level. Water shortage due to this level of storage decrease could also occur in the future (2007 was not an unusual year).

On the other hand, considering the fact that inflow fluctuates greatly, and that the years of less inflow existed in the past, the data also suggests that the year of the same inflow level as 2008, or much less than that, would be more likely to come, causing much severer water shortage.

Figure 2-4 shows the monthly inflow for the last 18 years. The inflow from October 2007 to September 2008 remains at the lowest level over the last 18 years. Annual inflow will be about 9.8 billion m^3, based on the estimate of actual inflow until the first 10 days in December, 2008. 2008 is thus a year of water shortage, with an inflow of less than either the one of 2007 or a long-term average inflow.

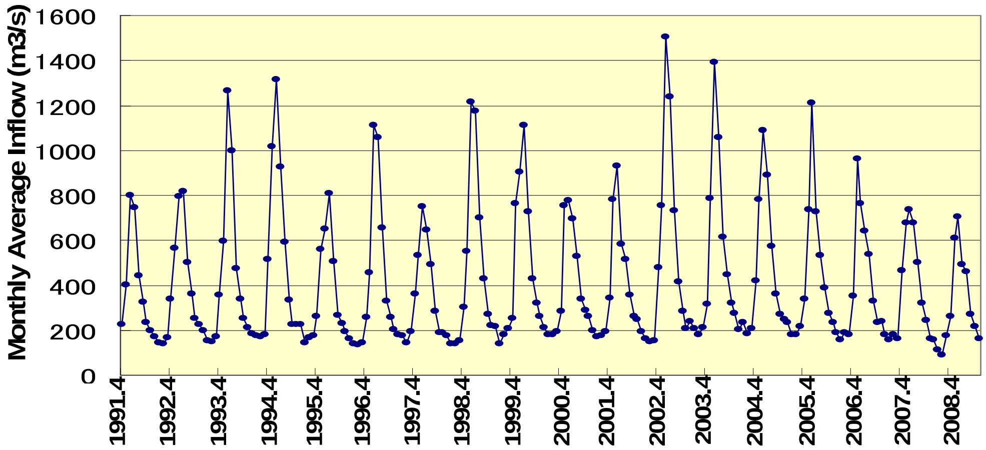


Figure 2-1 Annual average Inflow of the Toktogul Reservoir (1991-2008)

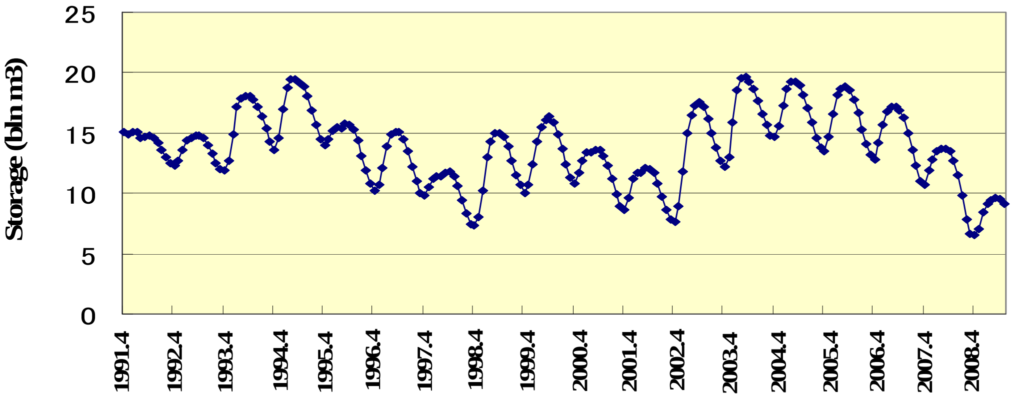


Figure 2-2 Change of storage in the Toktogul Reservoir (1991-2008)

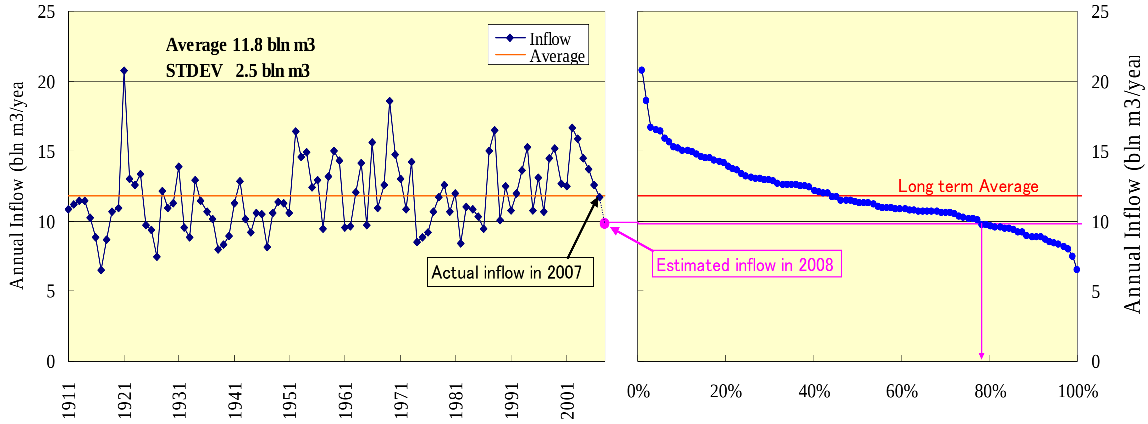


Figure 2-3 Long Range fluctuation of inflow of the Toktogul Reservoir (1911-2007)

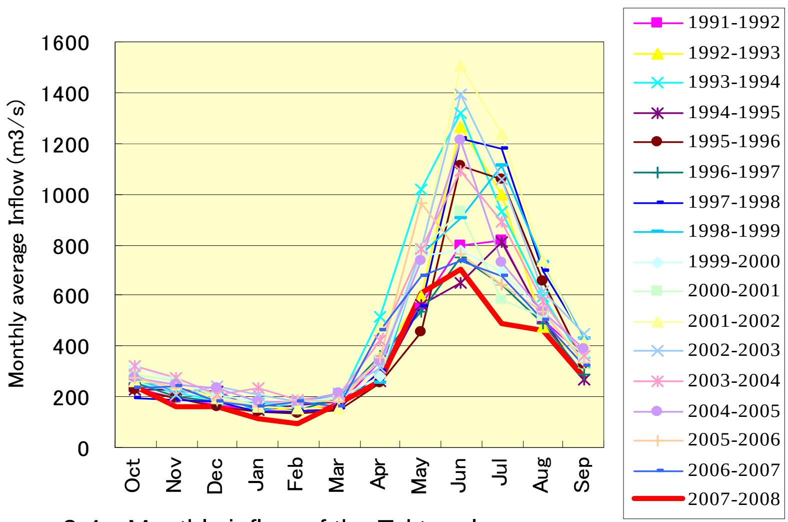


Figure 2-4 Monthly inflow of the Toktogul Reservoir (1991-2008)

(2) Operational status of Toktogul Reservoir

(a) Operational status

Figure 2-5 shows the changes of inflow and outflow of Toktogul Reservoir over the past 18 years from 1991 to 2008. This shows that there are two peaks of outflow, one is for power generation in winter, and the other for vegetation in summer, and we can see that the outflow for power generation is higher than the other.

The inflow peak of snowmelt flow is almost around June every year. However, the time when the peaks of inflow and outflow matched each other was in 1991 and 1992, just after the republics gained independence, and it's the period of time that irrigation mode operation had still been valued. From 1993, the peak of outflow in winter had become higher than that of irrigation outflow. From 1995 to 1997, the peaks of outflow in winter and in vegetation season had reached the same level, however, after 1997 the winter outflow became remarkably larger. This tendency was very strong especially during the last 5 years. At the same time, during the last 5 years, the peak of outflow has been increasing, while inflow has been continuously decreasing. This suggests that controls had been conducted that caused storage decrease of Toktogul Reservoir. This also corresponds to the situations that the protocols among riparian countries have not been complied with since 2003.

Figure 2-6 is a comparison between the outflow of vegetation season and that of non-vegetation season from Toktogul Reservoir in the last 18 years. This shows that the outflow in non-vegetation season has been increasing gradually, reflecting the shift from the irrigation mode* operation in the former Soviet systems to the power generation mode** in winter after gaining independence.

On the other hand, outflow in vegetation season has been obviously decreasing compared to the level of 1991, while yearly fluctuation is also large.

> Irrigation mode*: reservoir operation that prioritizes the use of storage and discharge for irrigation.
> Power generation mode**: reservoir operation that prioritizes the use of storage and discharge for power generation.

(b) Discussion

Table 2-1 shows the relationship between outflow and inflow. Figure 2-7 shows the relationship between annual inflow and annual storage. They show that the reservoir stored water in the years with relatively high inflow (2002 to 2005), and that pondage decreased in the years with low inflow (1991 to 1993, and 2007 to 2008) with outflow being higher than storage.

Figure 2-7 shows the relationship between annual inflow and annual storage (inflow minus outflow). Data of 18 years show that annual inflow balances annual outflow when annual inflow is about 14 billion m^3. In this case, annual inflow is higher than long-term average inflow of about 12 billion m^3, and it suggests that controls were done which gave higher priority to demand side on operation balance. This correlation chart shows that storage would decrease by about 4 billion m^3, provided that annual inflow was 10 billion m^3.

As Figure 2-6 shows, some controls have been done so that outflow in both non-vegetation season and in vegetation season increase gradually, although annual inflow to Toktogul Reservoir has been decreasing in the latest 5 years. If this tendency continues due to electricity demand and vegetation demand, water shortage would become much severer in the future. Details are not known because control rules are not disclosed. However, it is necessary to immediately consider the measures to improve the reservoir operational balance as shown in Figure 2-7, and to prevent shortage of storage water as much as possible. Incidentally, in the vegetation season in 2008 (April to September), a control was conducted to decrease outflow to preserve storage, having an impact of water shortage.

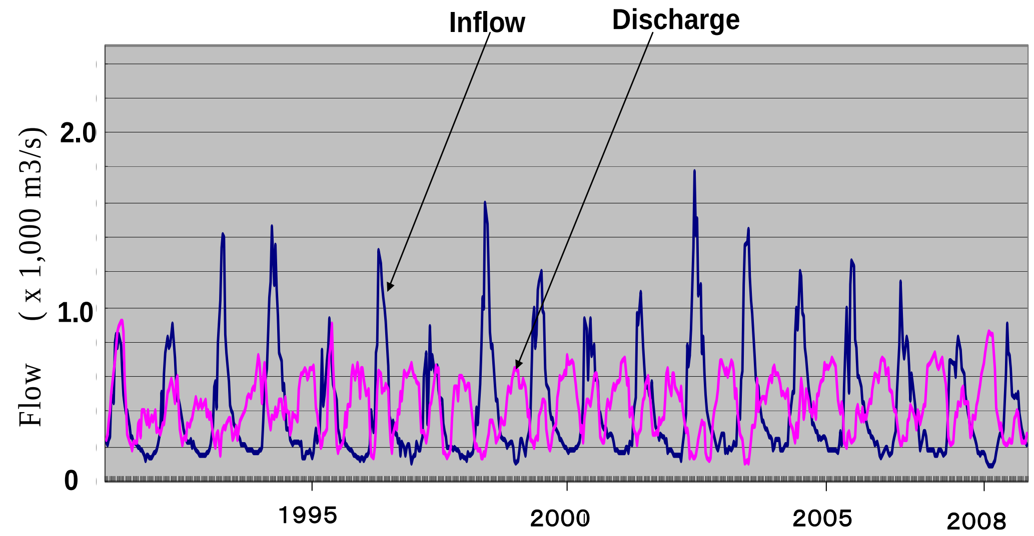


Figure 2-5 Inflow and discharge of the Toktogul Reservoir (1991-2008)

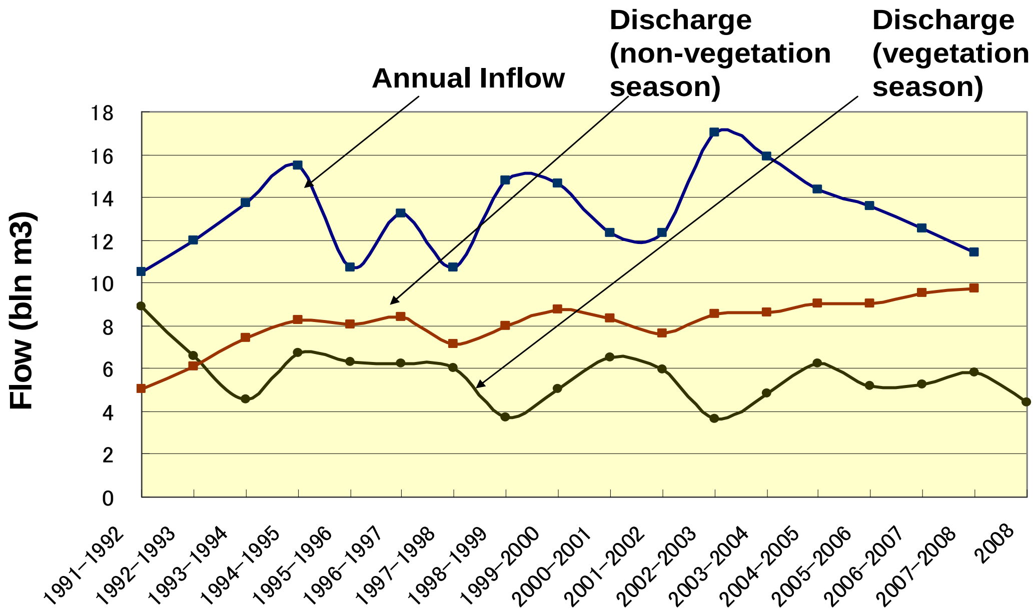


Figure 2-6 Annual Inflow and discharge for (non vegetation season and vegetation season) of in the Toktogul Reservoir (1991-2008)

Table 2-1 Annual Inflow and annual storage in the Tokutogul Reservoir (1991-2008)

Number	Period	Annual Inflow (bln m3)	Annual Inflow – Annual Discharge (bln m3)
1991	1991.4–1992.3	10.54	–3.38
1992	1992.4–1993.3	11.95	–0.71
1993	1993.4–1994.3	13.71	1.69
1994	1994.4–1995.3	15.49	0.52
1995	1995.4–1996.3	10.73	–3.64
1996	1996.4–1997.3	13.25	–1.35
1997	1997.4–1998.3	10.70	–2.52
1998	1998.4–1999.3	14.79	3.12
1999	1999.4–2000.3	14.62	0.80
2000	2000.4–2001.3	12.34	–2.51
2001	2001.4–2002.3	12.35	–1.22
2002	2002.4–2003.3	17.02	4.87
2003	2003.4–2004.3	15.93	2.41
2004	2004.4–2005.3	14.36	–0.92
2005	2005.4–2006.3	13.60	–0.61
2006	2006.4–2007.3	12.54	–2.29
2007	2007.4–2008.3	11.42	–4.15

Annual storage*:

Annual inflow - Annual discharge

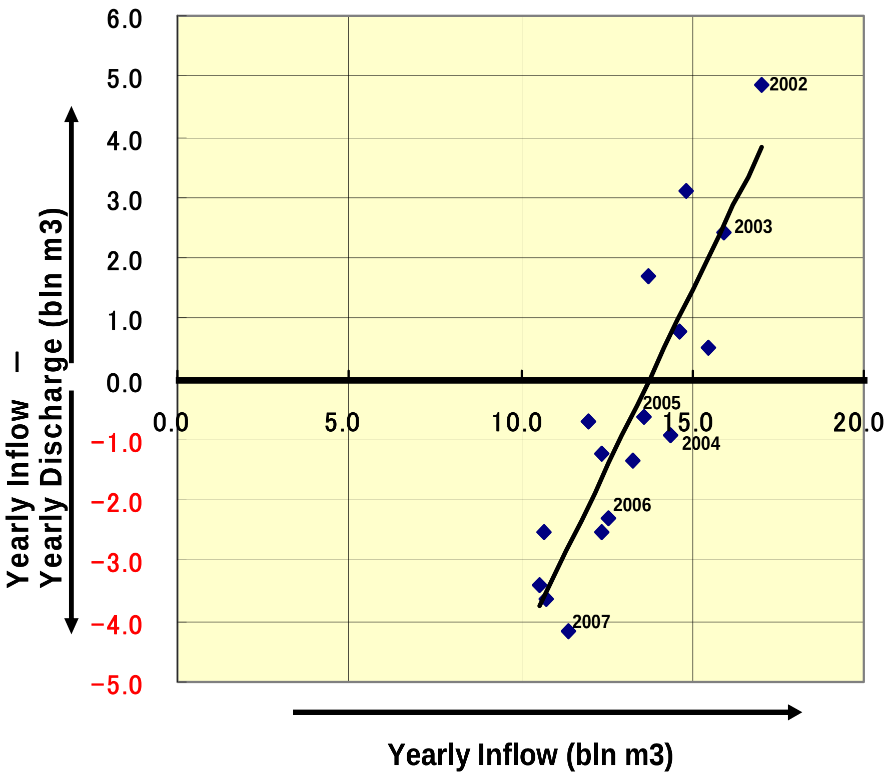


Figure 2-7 Annual Inflow and annual storage in the Tokutogul Reservoir discharge (1991-2008)

(3) Balance of inflow to Toktogul Reservoir and water demand (for power generation and vegetation)

(a) Balance of annual inflow and annual water demand

Operation of Toktogul Reservoir is closely linked with domestic electricity demand in Kyrgyzstan (including export of electricity) and water demand for vegetation in downstream countries. Figure 2-8 shows the relationship of annual inflow (average and fluctuation range) and water demand, using electricity demand in Kyrgyzstan as a parameter to show general characteristics. Annual inflow distributes around average figures (about 12 billion m^3). The sum of electricity demand in non-vegetation season and water demand in vegetation season is assumed to be annual water demand because water demand for power generation in summer is lower than outflow for vegetation.

Figure 2-8 shows that average inflow and the curve of annual water demand cross at around 50 GWh/day of electricity demand. This means that long-term operation of the reservoir enables balancing inflow and supply if electricity demand is 50 GWh/day. Although balance was sometimes lost due to the fluctuations of inflow, the balance had been kept as a whole. Water stored in the year with high inflow could be used in the year of water shortage.

However, electricity demand in Kyrgyzstan in recent years increased, and the peak demand in last winter was estimated to be more than 60 GWh/day. Alternative power supply has not been fully prepared. Therefore, unless inflow increases by about 2 billion m^3 than the one in an average year, storage water would be discharged from the viewpoint of input and output balance, and thus storage volume of the reservoir would be likely to decrease.

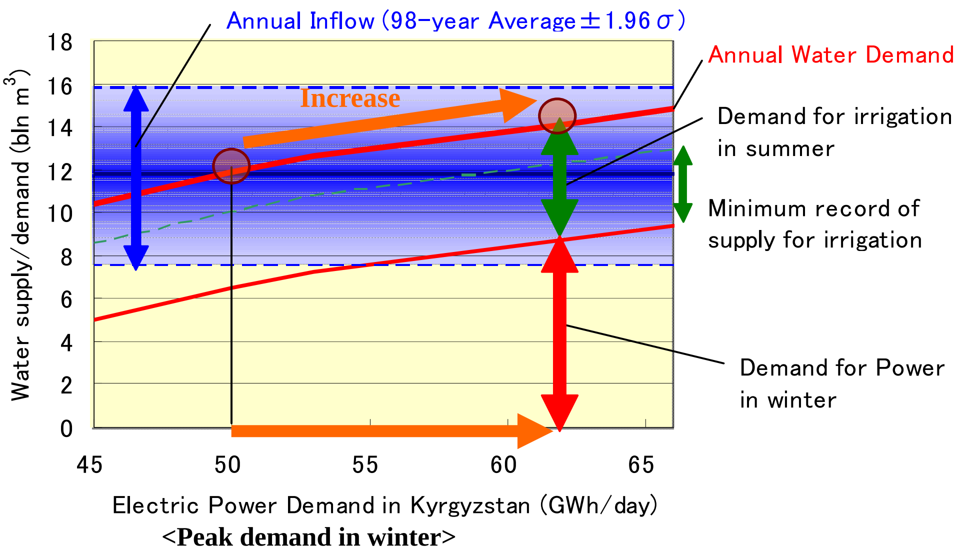


Figure 2-8 Balance between annual inflow and water demand of Toktogul Reservoir

The electric power demand (peak demand in winter) in Kyrgyzstan is shown on the horizontal axis, the inflow and water demand (for electric power and irrigation water) of Toktogul Reservoir on the vertical axis. The graph indicates the inflow to Toktogul Reservoir in response to electric power demand in Kyrgyzstan.

(b) Balance of inflow and water demand in vegetation season and non-vegetation season

Figures 2-9 and 2-10 also show water balance of non-vegetation season and vegetation season. In non-vegetation season, the amount of water needed to meet electricity demand is larger than that of inflow. Therefore, it is necessary to release storage water of Toktogul Reservoir to meet the demand. In vegetation season, it is necessary to store water to meet the electricity demand in non-vegetation season. As shown in Figure 2-10, when storage water for power generation and release for vegetation are totaled, inflow would be insufficient if power demand increases, as in the case of annual balance.

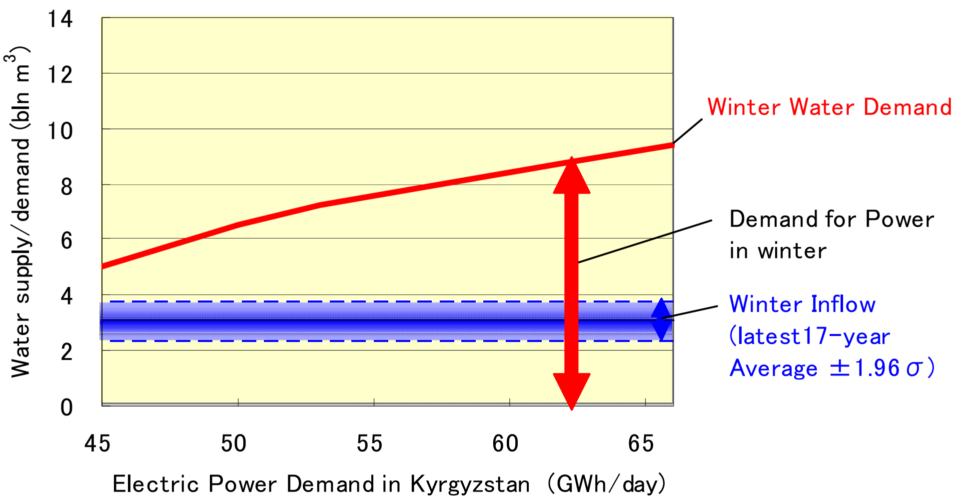
(c) Discussion

The simulation tried in this paragraph shows macroscopic characteristic. However, when water demand exceeds average inflow, storage water would be much more likely to be insufficient in terms of long-term operation, making sound operation difficult from the viewpoint of demand and supply balance.

Concrete measures for improvement may include:

・Conserve water by controlling water resources and power demand
・Use water resources effectively by improving the efficiency of water management
・Reduce electricity usage by using alternative power supply (new development of a power plant, interconnection of electric power systems, etc.)

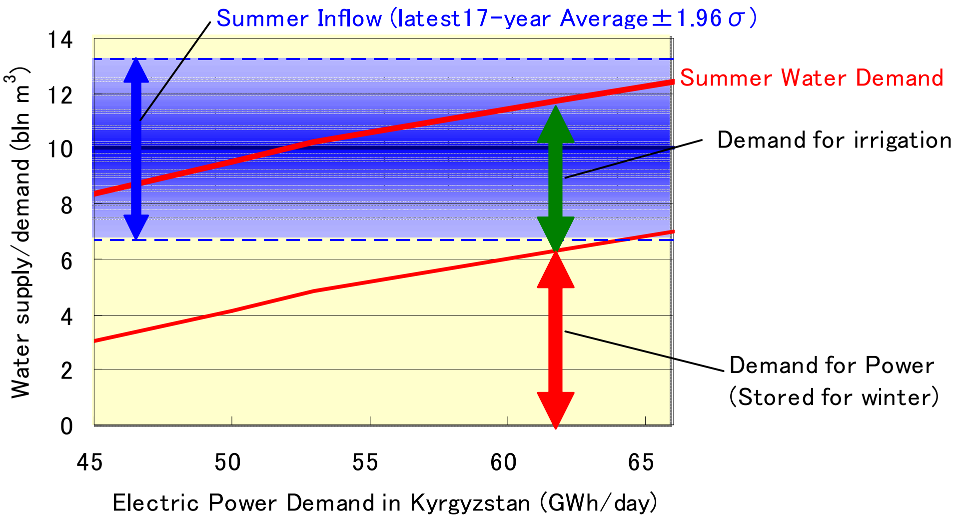
Since many of them require consensus among concerned countries, a specific discussion is expected to be held soon.



<Peak demand in winter>

Figure 2-9 Balance between water demand and inflow of Toktogul Reservoir (non-vegetation season)

The electric power demand (peak demand in winter) on Kyrgyzstan is shown on the horizontal axis, the storage volume (for electric power demand) of Toktogul reservoir on the vertical axis. The graph indicates the balance between water demand and inflow of Toktogul Reservoir in winter (non-vegetation season).



<Peak demand in winter>

Figure 2-10 Balance between water demand and inflow of Toktogul Reservoir (vegetation season)

The electric power demand (peak demand in winter) in Kyrgyzstan is shown on the horizontal axis, the inflow and water demand of Toktogul Reservoir on the vertical axis. The graph shows water demand (for electric power of winter season and irrigation water) of Toktogul Reservoir in summer (vegetation season).

(4) Operation status of Kayrakkum Reservoir and Chardara Reservoir

Figures 2-11 and 2-12 show the fluctuations of inflow and outflow of the two reservoirs of Kayrakkum and Chardara over the past 18 years from 1991 to 2008.

(a) Kayrakkum Reservoir

Located in Tajikistan, the total storage capacity of Kayrakkum Reservoir is 3.4 billion m^3, and effective capacity is 2.5 billion m^3. The fluctuations of inflow and outflow generally match, suggesting that almost the same amount of water as inflow is normally released. From 2003, the levels of inflow and outflow have been increasing. This seems reasonable to assume that it's because the amount of discharge from Toktogul, as mentioned earlier, has been increasing.

(b) Chardara Reservoir

Chardara Reservoir is situated in Kazakhstan with a total storage capacity of 5.2 billion m^3, and an effective capacity of 4.7 billion m^3. The levels of inflow and outflow were the same until about 1994. From 1995, however, outflow has seemingly been controlled between the amounts of 600 m^3/s to 800 m^3/s by storing inflow. It seems that the excess water is being released into Arnasay Reservoir, yet, the state of control is not clearly revealed. From 2003, outflow has been increasing. This seems also the same as what is happening at Kayrakkum Reservoir, namely the impact caused by increasing discharge from Toktogul Reservoir.

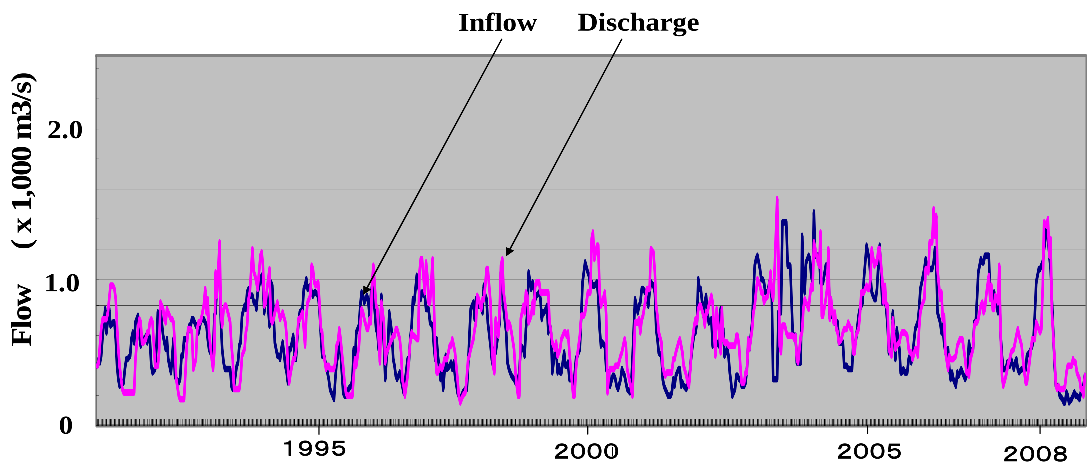


Figure 2-11 Inflow and discharge of the Kayrakum Reservoir (1991-2008)

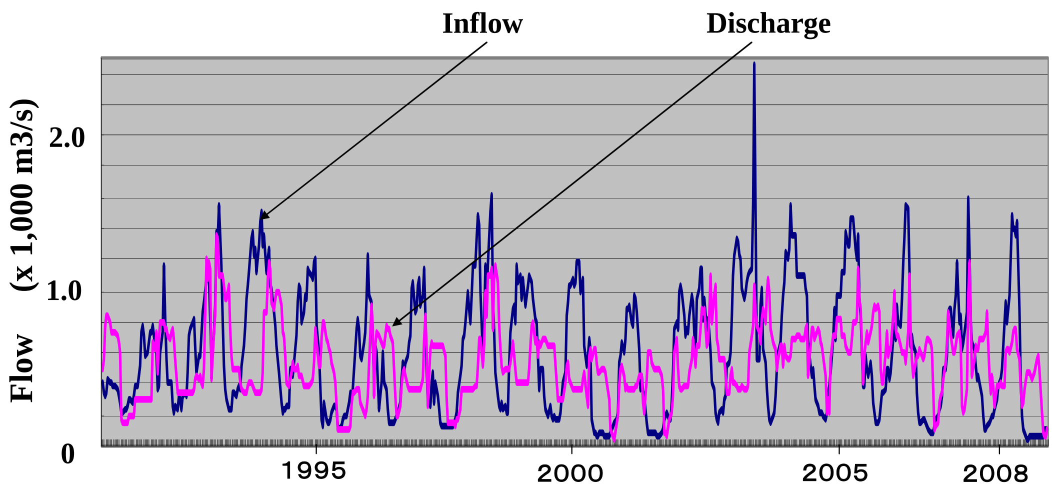


Figure 2-12 Inflow and discharge of the Chardara Reservoir (1991-2008)

2-3 Water use in the Syrdarya River basin

Before mentioning "2-4 Present Situations and Issues on Water Resources Development and Management in the Syrdarya River basin", we shall review the previous JBIC Study on the Syrdarya River basin, carried out in 2005, as briefed in Box 2-1. We will then represent the data for water resources and water use collected after the first JBIC study in 2005.

Box 2-1 Briefing of the Syrdarya River basin studied by JBIC in 2005

1. Hydrometeorological Observation Networks

a) Reduction of river gauging stations

After the collapse of the Soviet Union, the operation and maintenance of hydrometeorological networks were disintegrated and undertaken by each riparian country. The number of gauging stations activating in 2000 was roughly fifteen percent less than that in 1985.

b) Method of observation and data transmittal

The water level and discharge measurements are carried out by the outdated recorders. The observation interval is usually twice a day.

c) Present conditions of runoff forecast

The runoff forecast is normally carried out twice a year. The first forecast is made in October in the non-vegetation season to estimate the usable irrigation water next year. The second forecast is carried out in April, to practically modify the first estimate and determine the final water distribution for vegetation.

2. Water Use in the Aral Sea basin

Since 1960's, water use in the Aral Sea basin has increased due to population growth, industrial and agricultural developments in the region. Water use for vegetation covers more than 90 % of the whole water usage. Per capita water use had decreased from 4,000 m^3 in 1960 to 2,500 m^3 in 2000.

3. Water Use in the Syrdarya River basin

a) Historical change of water use and drainage into the Aral Sea

After the collapse of the Soviet Union, the energy situation in Kyrgyzstan became worse. Under this situation, The Toktogul HEP shifted its operation from originally designed irrigation mode to power mode, prioritizing power demand in winter. After the Syrdarya Framework Agreement, Kyrgyzstan tried to negotiate with downstream countries for barter trade of energy, but, the coordination among relevant countries has still been a daunting task.

The shift to power mode operation of the Toktogul in winter has caused artificial floods at downstream countries such as Uzbekistan and Kazakhstan and it has become a political issue. The power mode operation of the Toktogul has also induced an overflow from the Chardara Reservoir in Kazakhstan into the Arnasay Depression in Uzbekistan, and accelerated the reduction of inflow into the Aral Sea.

To overcome this situation, both Kazakhstan and Uzbekistan have strategically determined to construct additional regulating reservoirs, prioritizing the national security. Uzbekistan constructed the Arnasay reservoir and Kazakhstan also started to construct the Koksarai reservoir downstream of the Chardara reservoir.

b) Water allocation ratio

According to the information obtained from the SIC-ICWC, the water allocation ratio for each riparian state is as follows:

Uzbekistan:	51 %
Kazakhstan:	42 %
Tajikistan:	7 %
Kyrgyz Rep.:	0.5 %

c) Future water demand prediction

The SIC-ICWC estimated the water demand up to 2025. It was predicted that water demand in 2025 would be a few percent more than that in 2005. On the other hand, water demand for vegetation use in 2025 would be a few percent less than that in 2005.

d) Inefficiency of water use

The inefficiency of water use has become a serious issue in water management in the region. The water loss is estimated to be around 15 % to 35 %, mainly caused by the deterioration of facilities.

4. Deterioration of Water Quality

The prime sources of pollutant are chemicals which are contained in fertilizers draining into the vegetation and drainage canals.

5. Environmental Issues in Water Resources

a) Reduced storage volume of the Aral Sea: The lake volume has reduced by 75 % in the past 40 years, and the mineralization has increased about sixfold. The World Bank has supported the conservation projects in the coastal area and dam project to protect the coastal environment of the Aral Sea.

b) Irrigated area: Sixty percent of the whole irrigated area tends to be harmed by salt.

c) Catchment area: A due care is paid for the environmental issues in the mountainous catchment areas.

(1) Water resources in the Syrdarya River basin

1) Surface water resources

The long-term water balance pattern of the Syrdarya River basin is shown in Table 2-2.

2) Groundwater resources

It is estimated, but not assured that groundwater resources in the whole basin. In Uzbekistan 6.5 to 7.0 Billion m^3 of groundwater is withdrawn annually. The groundwater level is rising because of the excess vegetation in summer and the excess drainage in winter. Thirty one (31) percent of the whole vegetation area has a groundwater level within 2 meters.

Table 2-2 The long-term water balance pattern of the Syrdarya River basin

Catchment area (km^2)	402,800
Basin population	19.5
Mean annual rainfall (mm) (Billion m^3)	320 128.9
Mean surface runoff (Billion m^3)	38.8
Runoff ratio (Billion m^3)	30
Runoff draining into the Aral Sea (Billion m^3)	5.2
Runoff ratio to rainfall (%)	4.0
Runoff ratio to surface runoff (%)	14.0
Per capita annual rainfall (m^3)	6,610
Per capita annual surface runoff (m^3)	1,990

Source: Project ADAPT (2003)

(2) Water use in the Syrdarya River basin

The water use in the riparian countries is summarized in Table 2-3.

Table 2-3 The water use in the riparian countries

Country	Annual Domestic Water (%)	Annual Industrial Water (%)	Annual Agricultural Water (%)
Kyrgyzstan	3	7	90
Tajikistan	5	7	88
Uzbekistan	4	12	84
Kazakhstan	4	17	79

Source: Project ADAPT (2003)

The historical change of runoff draining into the Aral Sea is shown in Table 2-4.

Table 2-4 The historical change of runoff draining into the Aral Sea

Period	Ratio to total runoff (%)
Before 1961	50-60
1961-1973	25-30
1974-1987	5-10
After 1987	10-20

Source: Project ADAPT (2003)

(3) Socioeconomy

1) Territory and population

The Syrdarya River basin is divided into four nations that were parts of the U.S.S.R. before their independence in 1991. Each nation's territorial land area and population in the Syrdarya River basin are shown in Table 2-5.

Table 2-5 Each nation's territorial land area and population in the Syrdarya River basin

Country	Territorial land area (%)	Population in the basin (thousand persons)
Kyrgyzstan	28	2,672
Uzbekistan	13	13,174
Tajikistan	6	1,824
Kazakhstan	53	2,573
Syrdarya River basin	100	20,243

Source: Project ADAPT (2003)

2) Crop production

Major crops produced in the Syrdarya River basin are shown in Table 2-6.

Table 2-6 Major crops produced in the Syrdarya River basin (unit: 1,000 ton)

Country	Grain	Potato	Cotton	Vegetable
Kyrgyzstan	719	341	34	324
Tajikistan	110	85	252	150
Uzbekistan	1,983	1,388	1,667	425
Kazakhstan	479	150	287	360
Syrdarya River basin	3,291	1,964	2,240	1,259

Source: Project ADAPT (2003)

Land productivity of each crop in the Syrdarya River basin is shown in Table 2-7.

Table 2-7 Land productivity to each crop in the Syrdarya River basin

Crop	Land productivity (ton/ha)
Cotton	2.89
Wheat	2.82
Rice	3.99

Source: Project ADAPT (2003)

The average production cost per area including cotton, wheat and rice production is estimated as 714 USD/ha, and the water charge per ton is 0.11 USD/m^3.

2-4 Present situations and issues on water resources development and management in the Syrdarya River basin

Box 2-2 summarizes the several issues on institutional and legal frameworks for water resources management in Central Asia, historical change of regional cooperation for water management and major issues on regional cooperation which were revealed by JBIC's Study in 2005.

Box 2-2 Several issues on institutional and legal frameworks for water resources management in Central Asia

1. Institutional and Legal Frameworks for Water Resources Management in Central Asia

a) Water management system in each country

After the collapse of the Soviet Union, each country commenced to establish a new water management system in line with the transition toward a market economy. In Uzbekistan, the progress in the water sector was slow, but, the transition toward a market economy in the water sector in Kazakhstan was relatively realized within a short period. In Kyrgyzstan and Tajikistan, the water sector reform was carried out with all deliberate speed. In Tajikistan, a water law was enacted in 2000.

b) Regional water resources management before the independence

During the Soviet era, all the water resources management system was controlled by Moscow. The water allocation was carried out in an integrated manner, and no water conflict emerged.

c) Present condition of the regional water management system

The ICWC was established in 1992 to obtain a mandate on the mechanism of regional cooperation for water resources management, maintaining the basic concept for the water allocation established in the Soviet era. On the other hand, the IFAS was established in 1993 and which functions were 1) to execute the decision on the Aral Sea, 2) to carry out the programs and projects, and 3) to support the ICWC, etc. Two BVOs were established for the Syrdarya and Amu Darya River basins, obtaining a mandate to carry out the O&M for the interstate river facilities. However, the issues on the interstate water resources management became serious, and political matters that could not have been resolved with the efforts of ICWC and IFAS only, remain until now.

2. Historical Change of Regional Cooperation for Water Management in Central Asia

a) Regional water management after independence

The interstate coordinating organizations such as IFAS, ICWC and BVOs have not properly functioned. Therefore, each country has been forced to uphold the interests of each country and to use water preferentially for domestic needs. Presently, no agreement is made on the water allocation which shall be shared among the relevant countries.

b) Move toward improvement of regional water management

In 1998, the Syrdarya Framework Agreement was made among the five relevant countries. However, no progress has been made after this preliminary agreement. Even though they are situated outside of the Syrdarya River basin, for the Chu-Talas River and the Fergana Valley progress has been made toward the joint water resources management among two or three countries to expectedly be a model case for the regional cooperation.

c) Difficulties of regional water management

When several international coordinating organizations such as CAREC, CACO and WEC were established, they were expected to propel the water and energy nexus in the region. However, no progress can be seen until now. USAID, on the other hand, had supported on the regional water and energy nexus since 1993, but, no actual involvement on this matter has been made since 1995.

e) Points to remember for future technical supports judged by things past

With the past lessons learned in mind, a supporting strategy shall be adapted to be strenuous, long-termed and integrated taking into consideration the interests and conflicts among the relevant countries. A due care shall be given to the transboundary water and energy issues which have become political issues.

3. Major Issues on Regional Cooperation for Water Management in Central Asia

a) Delay of consensus on regional agreement

The upstream-downstream issue in the Syrdarya River basin became a particularly serious one. A power mode operation of the Toktogul reservoir causes floods downstream in winter. It is practically impossible to shift the power mode operation to the originally designed vegetation operation at the Toktogul reservoir in winter. Because the demand of power of Kyrgyzstan in winter is in severe condition and there are no alternative power source under the circumstances. Uzbekistan seems to have proceeded in the planning of several flood regulating reservoirs, which would minimize the impacts of the artificial floods by the Toktogul's power operation in winter. In Kazakhstan too, the Koksarai reservoir was planned to be constructed downstream of the Chardara reservoir to minimize the flood inundation caused by the artificial floods. Realistically, both countries consider this as a national security issue.

b) Undeveloped international water resources law

Since each country had no diplomatic issues during the Soviet era, each country has little experience with regards to international relations. It was observed that a legal framework would be established by the technical support of EU, based on the IWRM concept for each river basin.

c) Undeveloped water-related information management system

After the collapse of the Soviet Union, hydrometeorological observation system has been deteriorated and basin-wide water resources management system has not been functioning until now. There have been some programs and projects supported by international organizations, but they remains in a small scale.

d) Lack of socio-environmental considerations

Water-use oriented development plans have still been carried out in four republics until now. Programs and projects paying attention to the environment have gradually undertaken under the guidance of international organizations.

e) Weakened interstate organizations

The interstate coordinating organizations such as IFAS and ICWC have not been functioning to proceed regional cooperation. No interstate organizations exist to take a role of coordination for water and energy nexus in particular.

f) Lack of efficient and integrated water resources management

Several matters have become serious, such as inefficiency of water management system, delay of development of hardware and software facilities, delay of implementation of IWRM, deterioration of water-related facilities and high cost for rehabilitation projects, etc.

2-4-1 Present situation and problems concerning water resources development and management of riparian countries

Law and institution of water resources management do not have major change compared to those of the previous study. Box 2-2 shows the water resources management structure of each country summarized in the previous study.

The new trend concerning law and institution and infrastructures of water resources management of each country found in this study are described below.

(1) Kyrgyzstan

1) Kyrgyzstan, as a nation, is somewhat behind in "water resources management" compared to Kazakhstan and Uzbekistan in terms of National IWRM Plan. Regarding the operation plan of Toktogul Reservoir, they probably conduct reservoir operation not in response to a long-term regulation, but in response to "short-term demand response operation" by releasing enough water for power generation to meet necessary electricity (according to the hearings with the Ministry of Energy in September 2008). Review of the operation rules of Toktogul Reservoir is needed, which has a large storage capacity and years of operation has to be carried out.

The annual inflow in 2007 was the lowest in the latst 18 years, and that of 2008 has been continuously decreasing. In such current situation, Kyrgyzstan will be required to control reservoirs strictly so that they could meet domestic electricity demand in winter and release irrigation water to downstream countries in summer. Formulation of the operation plan of reservoirs to achieve this is an immediate issue.

2) Precise strategy concerning the water resources management of Kyrgyzstan, which should be the base of national water resources management, has not been clearly found as far as studied.

National strategy of Kyrgyzstan's water resource management is important for identifying the vision of Japan's future cooperation to Kyrgyzstan. Before starting support in the field of water resources management, it is expected to identify and prioritize issues to be enhanced concerning the aspect of institutions and regulations as well as that of operation and maintenance (including infrastructure), taking into consideration of the reviews of the actual conditions of their water resource management.

The UNDP has started to support "National IWRM Plan Development" for Kyrgyzstan, however, they are still starting assessment, with no details considered yet. Presently, it is appropriate for Japan to support in bottom-up approach and focus on practical technical issues, while observing the progress of the National IWRM Plan.

3) Basic understanding of water resources is, as specified in the Water Code, "Water is the goods" of the country where water resources are located. The country had made a large investment into constructing reservoirs. Upstream countries inhibit power generation (in non-vegetation season), and release water for the use of vegetation in summer for downstream countries. Downstream countries pay for it in return. Upstream countries use that money to buy oil and coal". This is the basic understanding of Kyrgyzstan that has water as its most important natural resource.

4) The government regards domestic water resources as "goods" from a national strategic point of view. "Law Concerning Water Resources in Kyrgyzstan and Multilateral Use of Water Related Facilities", which was enacted in 2001, legislates the property rights of the water resources and water related facilities within the borders of Kyrgyzstan, and stipulates the cost-share financing method for the programs of multilateral water use. Kazakhstan partly compensates for irrigation water, while Uzbekistan has been denying its legitimacy.

5) Gauging stations for monitoring data of water resources, which are important for the upstream country for water resources management including outflow forecasting, have been remarkably decreasing compared to those in Soviet era. When the first field study was conducted in September 2008, ministers were interviewed (Ministry of Agriculture, Ministry of Water Resources, and Ministry of Foreign Affaires) and appealed this condition to the study team, and urged Japan to support in this field. Japan's support for strengthening the monitoring system of glacier, reservoirs and rivers would contribute to the construction plans of dams and hydroelectric power plants. This could consequently lead to "stable domestic supply (electricity)" and "securing resources in regions (water resources, electricity)", and could also be applied to the forecast of inflow to existing reservoirs, which would therefore be effective to water resources management. In order to use observation data for operation of the reservoir and to share them domestically, it is necessary to secure accuracy and swiftness of data as well as digital processing. It is thus required to define data specifications and adapt them to data processing and data sharing. In addition, in order to achieve reinforcement and coordination of water resources management in the region, it is indispensable to introduce methods of data processing and communication which are

compatible between riparian countries.

6) Especially, domestic irrigation systems have suffered great water losses,, with 30 to 40 percent of the loss occuring before supplying to the farms (hearings from the Ministry of Agriculture and Water Resources). One reason lies on the aging of irrigation canals, water intakes, and reservoir facilities constructed in the Soviet era. Another reason is that loss is generated when water is distributed from the irrigation canals of Soviet era to each farm, which is required by the privatizing structural changes from large-scale national collective farms with 5,000 to 6,000 hectares in Soviet era to small-scale farms with 1 to 2 hectares.

It is possible to save water by using agricultural water effectively, through the improvement of irrigation systems. To improve irrigated agricultural land, it is necessary to improve and modernize water intake and canal networks which extend to 5,000 km. There are more than 200 pumping stations. Farm lands extend to more than 80,000 hectares. Infrastructures are aging, and the newest pumps are 25-year old. The government requested Japan the provision of construction machinery and excavating equipment. Among irrigation canals and farm land irrigation infrastructures which need rehabilitation, most are secondary and tertiary canals, total extension of them is 24,000 km.

Private farms, transformed from collective farms in Soviet era after independence, have been rehabilitated by the water user’s council (a private organization) with the support of the World Bank. In addition, the World Bank formulated a national plan to rehabilitate irrigation and drainage systems.

The World Bank and the Asian Development Bank have implemented rehabilitation works. However, only 10 to 20 percent of the planned works have been completed by now.

7) There was an intention that Japan’s financial support would promote the rehabilitation of reservoirs and power plants (by the Ministry of Agriculture, Water Resources, and Industry). There is also an issue of sedimentation in the reservoirs. They asked for the provision of heavy machinery from Japan to construct a pond to stock them and to maintain irrigation facilities.

8) One of the remarkable activities concerning water issues in Kyrgyzstan is the effort of operationalizing the International Water Energetic Academy in Bishkek (IWEA). IWEA calls for Central Asian countries to participate in its activities, supported by EU and Germany, in response to the insufficient function of the existing schemes of intra-regional coordination in Central Asia. Its concept paper regards the activities as international actions to follow up “Water and Sustainable Development Based on Dublin Declaration” and “Helsinki Conference Concerning Conservation and Use of Transboundary Water Resources and Lakes”.

Its purpose is to propose mutually acceptable projects, programs, and agreements based on science and international standards, supported by EU and Germany. IWEA’s practices include:

- Collection and analysis of systematic information regarding regional water-energy and regional environmental conditions.
- Satellite monitoring of water resources conditions of Tian Shan and Pamir, as well as reservoirs, glacier and snow.
- Modeling and optimization of the control regime of the reservoirs in transboundary rivers,

taking into account the hydraulic long-term changes and climate changes.

- Providing materials for a new agreement on the efficient use of water and energy.
- Proposing on the optimization of fuel and electricity energy balance, and developing the energy market.
- Conservation of water and energy, and improving water-energy efficiency, along with economic growth and commerce. Providing materials to prepare the development of irrigation systems.
- Enhancing related abilities of experts and top managements.

Central Asia Geography Research Center has been established and will be expanded to the academy. At the moment, “Mountains Summit” will be held in 2009.

(2) Tajikistan

1) Tajikistan, just like Kyrgystan has also started the action to formulate “National IWRM Plan”, as a basic national law concerning water resources management, supported by the UNDP. Details have not been developed yet, but the Ministry of Water Resources has organized a working group which will make a proposal to the government about water resources management and improvement of organizations by the end of 2008.

2) Tajikistan, as a nation is also behind in “water resources management”,(similar to Kyrgyzstan), compared to Kazakhstan and Uzbekistan in terms of National IWRM Plan. To improve this situation, they are planning to establish a river basin committee, which will be the first step toward a new scheme of river basin management under the direction of the President.

- Tajikistan is planning to set up the Department of River Basin Management to respond to the water resources management. They will also set up the river basin committee next year which is responsible for all water users, to change the scheme of river basin management.
- The river basin committee will be established firstly for the irrigation management of the Zarafshan basin, which is isolated from other regions by the mountains on both banks. There were three water management units in this river basin, with the water users council set up under them. The water management units functioned until 1990.
- There are 16 river basins in Tajikistan. The river basin committee will be set up successively for each area. It will take 2 or 3 years to establish the committees.

3) Basic understanding of water resources is “Water is the goods of the country where water sources are located, as is the case with other resources. The country had made a large investment into constructing reservoirs. Upstream countries do not generate electricity in non-vegetation season. Downstream countries pay for it as compensation. Upstream countries use that money to buy oil and coal.”

4) Irrigation

The government recognizes the necessity of water conservation in the field of irrigation. They have to supply irrigation equipment such as pumps to replace aging ones.

5) Monitoring

Most of the monitoring facilities are aging and are unable to operate. There are 150 hydro posts, but only 45 are functioning. There are too many rivers which makes it difficult to install them quickly. The monitoring unit table will report the mineralization of irrigation water, groundwater, and soil condition, every year.

To observe water quality, it is necessary to have a testing laboratory.

6) Government is trying to collect water charge, but it is difficult because of the delay for meter installation.

7) The projects to promote IWRM are implemented in the area near Kayrakkum Reservoir, with the support of the Asian Development Bank. The project costs 1.5 billion dollars.

8) The Basin Management Plan has not started as a project yet, but in the preliminary stage of planning. The governmental decree will be issued to promote it step by step.

9) The Water Code is concerned with both the administration partition between municipalities and the river basin partition in Tajikistan. The study team confirmed following two facts by on site fact-finding. (i) The Water Council is the annual conference held with attendance of all water users, where the cost of water service, water charge, and others will be determined in the future. (ii) 10 percent of the water fee is paid by the government, whereas 40 percent is paid by farmers, although it seems to be difficult to collect the water fee from them.

There were government branch offices to enforce the management 5 to 7 years ago. Since then, farmers have gradually become independent. The first step principle of river basin management includes water management policy, the norm, water conservation, and environmental awareness enhancement.

(3) Kazakhstan

1) Although required to be more efficient in "water resources management", Kazakhstan seems to be active in dealing with this issue as a nation with the advantage of its economic strength. Major milestones to promote IWRM are the six items listed below:

- In 2003, a new Water Code will be enacted, although it needs improvement, which will guide the implementation of the "National IWRM Plan".
- The Environment Conservation Law was enacted in 1997. The draft of the Environment Code concerning water environment will soon be legislated.
- In 2001, the national strategy plan effective until 2010 was formulated, including issues concerning the water resources development, water resources management, and the environment consciousness.
- Eight River Basin Management Organizations (RBO) have been established for each river basin. RBO had been stipulated in the Water Code enacted in 2003, coordinating stakeholders to participate in the decision making process of water resources management in the basin.
- Since Kazakhstan has achieved rapid economic development, it is expected to improve environmental awareness, involvement of citizens' groups, and accessibility to information.

2) Regarding the "National IWRM Plan" of Kazakhstan, which will be the base of water resources

management, planning and domestic coordination have almost finished. It will be approved by the President in spring next year, with procedures under way. The facts found out by the study regarding the plan scheme are described below.

[Kazakhstan's IWRM plan]

Kazakhstan has formulated the National IWRM Plan, supported by UNDP. At the same time, administrative reform has also been promoted. The budget is integrated into a 3 years budget, reflecting the financial method that places stress on economic stability based on a mid-term plan.

The IWRM Plan was first intended to be formulated and adopted by the government. However, it was changed to be conducted under the Presidential approval, aiming at more effective enforcement.

a) Scheme

It is a long-term plan effective until 2025, divided into the phases for every 3 year. The plan consists of blocks for each item.

Examples: "water level and monitoring", "disaster prevention", "water operation", "new irrigation technology", "science and methodology", "environmental system", "farm land restructuring", "transboundary", etc.

b) Specification

Presiding ministries should be those related to each block. The committee of water resources presides over water operation, and manages all issues comprehensively including irrigation water.

The National IWRM Plan consists of "strategic parts", "provisions", "management", and "implementation". Ministries are in charge of the strategic parts, and the committees are in charge of management and implementation. The lead office in charge of all water issues (coordinating relevant ministries) will be set up in the government. This will enable comprehensive water resources management. The study team confirmed that the government will start the preparation for the establishment of a new lead office by on site fact-finding. After winning approval of the President, each program will be formulated as "Plan".

In the "water operation block", there are plans such as long-term forecast of inflow, measurement of water use by monitoring, safe condition of hydraulic facilities, and remote control. A satellite is planned to be launched to monitor water surface (when a river overflows by a flood). It is also planned to monitor water intakes of irrigation and transmit data to organizations concerned.

In the "water level monitoring block", monitoring of water resources facilities (controlled by the Ministry of Environmental Conservation and the committee of water resources) by the government will be developed including:

- i) Calculation of water quantity consumed, and formulation of the proposal to introduce modern equipment for it
- ii) Introduction of a real time information system of water intake
- iii) Measures concerning introduction of a monitoring instrument and an automation device
- iv) The water resources management and conservation agency at Kyzyl-Orda (a city near the Aral Sea) will become a data collection center to handle the data of the Syrdarya River in Kazakhstan.

It is planned for public enterprises and private companies to be obliged in the future to measure the data for water utilization of water users required by a law. Data specifications (accuracy, etc.) will be determined by the government in "technological procedures".

A company to deal with weights and measures has been founded, however, the ability of existing engineers should be enhanced as a new measuring is going to be introduced. Water saving falls under the sub block of "water management block". The study team confirmed the following fact by on site fact-finding. In case of conversion of rice farming to others, it is necessary to take comprehensive measures such as supporting farmers familiar with rice farming, changing its devices, and securing food safety, and to produce competitive products. Regarding the infrastructure, canals and relevant facilities are aging. The movement of the transformation from collective farming to private farming, private farmers may become the owner of their canals in the future.

"Disaster prevention block" has issues such as flood, water shortage, salt damage, and high level of groundwater.

"Transboundary block" has an issue of integration of water resources management at the countryside, nation, and regional levels.

The National IWRM Plan is assumed to be approved in April after being discussed in a ministerial meeting.

In the implementation stage of the National IWRM Plan, the Kazakhstan government says that they need support, as the national budget is not sufficient.

3) Basic understanding of water resources is "Countries concerned basically have to implement water management according to international river laws, securing equity and transparency", which is contradictory to the claim of upstream countries, "Water is an economic good". However, it is worth noting that Kazakhstan has taken a realistic approach of buying 0.6 billion m^3 of irrigation water from Kyrgyzstan in July 2008. Kazakhstan paid for it by buying 0.5 billion kWh of electricity, however, the price was three times the one in 2007, as well as four times the domestic price in Kyrgyzstan. The study team confirmed the following fact by on site fact-finding. Kazakhstan claims that not all of the water reached to the farms, and that the farmers in southern Kazakhstan were in trouble. In addition, the basin of the Syrdarya River in southern Kazakhstan has been continuously damaged by the flood caused by the release from Toktogul Reservoir in winter. In response to this, Kazakhstan negotiates with Kyrgyzstan for the reduction of water release during winter. Additionaly, Kazakhstan also requests the securement of releasing irrigation water in summer, buying electricity and providing fuel as compensation to Kyrgyzstan.

4) The number of gauging stations installed for monitoring water resources data and used for forecast of outflow has been overwhelmingly decreasing compared to those in the Soviet era. In the hearings with Kazakhstan, they requested Japan to repair the hydro posts set along the Syrdarya River.

The contents of the hearing with the Hydromet in Kazakhstan are shown bellow.

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[Hydraulic and hydrological measurement situation in Kazakhstan]

In the mid-1980s, there were 340 weather observation stations and 560 flow observation stations in Kazakhstan. The number of these stations had decreased sharply during the 1990s, with that the number of flow observation stations reduced to 150 (to the same level as in the 1940s).

In the 2000s, the loan to improve weather observation stations continued to increase, and a series of observation and flow stations started to function again. On January 1, 2008, the number of hydraulic observation stations (water level, flow, and water temperature) became 276, and that of weather observation stations became 253.

Hydro post equipment is in very bad condition. 60 to 80 percent of all equipment should be immediately replaced. The velocity meters made in the 1950s are still being used.

Communication equipment also should be updated. In addition, no hydro posts have been automated yet.

Measurement is done twice a day, each in the morning and in the afternoon. Measurement data taken manually are reported to the head office by radio transmission. It takes a whole day to measure the flow of the Syrdarya River because of its broad width.

Automatic sampling of water quality is not conducted. These existing monitoring systems should be immediately improved.

Regarding water quality measurement, there is still no water 20 km from Astana, and water is transported by trucks. Groundwater cannot be used as drinking water, which is mostly taken from rivers. Recently, water quality is regarded as highly important.

Examples: Irtysh River, Ili River – Flowing from China. Development by China is remarkable. Water usage is increasing. There are 11 hydro posts along the Syrdarya River within the borders of Kazakhstan. 8 of them are placed in Kyzyl-Orda, and the other 3 are in South Kazakhstan. Kazakhstan requested JICA to repair them.

In 2002, a research center was established under the Hydromet, and has been researching water resources with primary experts and scientists in Kazakhstan.

Data communication: Manual measurement → Weather center → Meteorological Agency (presiding ministry) → shared by the state governments, Kyzyl-Orda state and South Kazakhstan state

The Ministry for Emergency Situations reports to the Ministry of Environment Conservation, water users, and the committee of water resources. Reservoir inflow forecast is also conducted.

In spring, flood forecast is conducted including forecast on when the river freezes and when ice is broken. To do this, the state of glacier (thickness of ice and condition of ice) are observed.

In 2003, Hydromet advised on the optimal use of Syrdarya reservoirs. Before water is released from Toktogul Reservoir, a part of stored water should be released from Chardara Reservoir, which will prevent flood damage in residential areas downstream of Chardara Reservoir while as much as water is released. If this advice is followed, little water would be discharged into Arnasay, but more water would be discharged into the Aral Sea.

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5) Management plan concerning water resource use

Regarding the management of water resource use, it is planned for water users to measure water usage according to a law in the future, and to be obliged to report to the water resource operation and protection agency so as to be stored in a database (from the hearings with the Committee of Water Resources). The study team confirmed that the government will define the specifications of the data in a "technological procedure" by on site fact-finding.

6) It is necessary to rehabilitate aging water facilities. Water utilization facilities have been enormously aging, needing rehabilitation and replacement (from the hearings with the Ministry of Emergency Situations). The facilities of Chardara Reservoir were modernized last year.

7) The situations of flood at the downstream of Chardara Reservoir are as follows (from the hearings with the Ministry of Emergency Situations and the provided materials):

The areas damaged by floods are 69 residential areas in Yujno-Kazakfstanskaya and Kyzylordinskaya, where approximately 400 thousand people live. In winter, the Syrdarya River freezes from the point about 60 km downstream from Chardara Reservoir. Discharge capacity becomes lower, and ice accumulates near a bridge (narrowed point), causing a major flood. Table 2-8 shows the examples of flood damage that occurred in the past. The great number of refugees (more than 30 thousand during the flood in 2005) indicates that flood damage is severe. To address this problem, the Kazakh government appealed to Kyrgyzstan to reduce the outflow for power generation in winter, compensating for it as well. However in fact, only this course of action could not solve the problem. The Ministry of Emergency Situations has made efforts every year to repair and dredge river channels, and to blast ice in winter, aiming at securing the river discharge capacity of 700 m^3/s.

8) Construction of a regulating reservoir to reduce water flow

The Kazakh government decided to take a measure in response to 6), to construct Koksarai regulating reservoir on the right bank upstream the area subject to flood damage, and to transmit flood waters from the river channel in winter, thereby preventing flooding downstream and using stored water for irrigation. Following the President’s decision, the construction started in 2008, with a four-year-construction term, beginning with building canals to the regulating reservoir.

Koksarai regulating reservoir is highly anticipated to reduce flood in winter, and to reduce water shortage in the vegetation season. Considering procurement of electricity from Kyrgyzstan (removing the conditions requiring Kyrgyzstan to release water in winter) as well, Kazakhstan is speeding up the construction.

9) It is necessary to rehabilitate aging water utilization facilities. Domestic irrigation systems in particular, have a problem of significant loss of water. To improve the irrigation systems, it is particularly necessary to rehabilitate or construct pump stations.

In Kazakhstan, the projects to repair or expand irrigation and drainage facilities have been conducted supported by the World Bank. Currently, preparations for the second phase are underway, and infrastructure that ought to be covered is considerable.

Table 2-8 Flood damage of Syrdarya River (2004-2008)

Occurrence time	2004	2005	2006	2007	2008
Damage (mln Tenge)	280	853	–	927.2	–
Damage (mln US Dollar)*	2.38	7.25	–	7.88	–
Flooded area (ha)	55,733	30,460	–	93	–
Flooded:					
residential areas (units)	2	6	–	2	–
country houses (units)	3	5	–	5	–
schools (units)	–	1	–	–	–
residence buildings (units)	805	74	–	269	–
private lands (units)	–	–	–	577	–
Evacuation (people)	2,085	31,824	–	1,500	150
Resettlement (people)	289	–	–	420	–
Breach of living conditions (people)	–	–	–	700	–
Allocated resources and equipment of Ministry of Emergency Situations (people/technical equipment)	134/20	222/32	92/19	108/26	289/94
Explosion works (explosion/expenditure, ton)	– /4	122/17.73	127/19	93/28	56/14.35

* 1 Kazakhstan Tenge = 0.008501 US Dollar
Source: Ministry of Emergency Situations, Kazakhstan

(4) Uzbekistan

1) Because Uzbekistan played the primary role in the Soviet era in "water resource management", there are many institutions (SIC-ICWC, etc) and experts dealing with regional water issues. As for the geographic conditions, it is located at midstream and downstream of the river, borders other countries, and occupies a pivotal area of Central Asia.

Regarding the discussion on water resources distribution in the region, Uzbekistan sees the Syrdarya Agreement in 1998 as "still in force and it works", while having been absent from the agreement coordination meetings with other countries since 2003.

Recently, in response to the lowest storage level of Toktogul Reservoir in the last 18 years and the electricity crisis in winter in Kyrgyzstan, countries concerned agreed on the protocol for the first time in six years from 2002, which decided on the supply of fuel to Kyrgyzstan and on the storage of irrigation water for downstream countries. However, they have not reached a conclusion on long-term agreement concerning water distribution.

2) Draft of "National IWRM Plan" was formulated supported by the UNDP, as a national strategy regarding water resources management in Uzbekistan, which will become the base of its water resource management. The procedure to enforce the plan will probably start soon. In this way, Uzbekistan seems to have chosen the way to begin with the integrated water resources management in small-scale river basins, to achieve successful results, and to expand them nationwide and regionally, before tackling the entire international river such as the Syrdarya.

Uzbekistan takes the standpoint that water resources operations between nations, such as water distribution of rivers "should be implemented with agreements among interested parties and disclosure of information, based on international river laws", which is directly opposed to the standpoint of upstream countries that state that "Water is an economic asset, and is owned by the countries that produces it. A price should be paid to obtain water."

3) Legal systems: Regarding the national policies, the organizations, and the legal systems of water resources management in Uzbekistan, important parts of the report prepared for the promotion of MDG supported by the UNDP are quoted and summarized below:

i) Policy scheme

The purpose of the water resources policy of the Uzbek government is to promote reasonable use of water resources and to preserve them. It also aims to improve the efficiency and reliability of water resources management, and to promote existing infrastructure's restructuring, operation, and maintenance. Activities with high priority are as follows:

- Conservation of all water consumption, and improvement of water quality
- Development of the system to supply drinking water of superior quality
- Soil improvement and prevention of salt damage
- Prevention of soil erosion, and maintenance of vegetation
- Mitigation of ecological and economic adverse effects on the coast of the Aral Sea

The two Cabinet Office regulations were promulgated in 2003, shifting from a centralized management to a more flexible river basin approach.

- Cabinet Office Regulation No. 290: Improvement of the Ministry of Agriculture and Water Resources.
- Cabinet Office Regulation No. 320: Improvement of the water sector management

ii) Organization scheme

The following organizations implement the water resources management at a national level in Uzbekistan:

- Cabinet of ministers
- Goscompriroda
- Uzhydromet
- MAWR
- Local governments (under the direction of Oliy Majlis Commission)

Major tasks of MWAR are as follows:

- Policy planning concerning agriculture and water resources sector
- Development and promotion of new technologies concerning the agriculture and water resources sectors
- Coordination with organizations concerned
- Conducting irrigation and drainage projects for improving water resources management
- Deciding policies of river basin management organizations
- Support for WUAs
- Promoting IWRM at a river basin level

- Support of research institutions and creation of training programs aiming at improving irrigation on farm

iii) Legal scheme

Water resources have been managed on the basis of the water laws and regulations enacted in the 1970s during the Soviet era. However, after the independence of 1991, the new constitution made in 1992 identified the rights, restrictions, and regulations of the use of natural resources, and conservation of the environment. Some laws have stipulated the relationship between water resources and conservation of the nature. Laws concerned are listed below:

- Nature Conservation Law (1992)
- Land Law (1993)
- Law of Water Resources and Water Use (1993)
- Special Protection Natural Area Law (1993)
- National Hygiene Inspection Law (1992)

4) Measure points for observation and management of water resources data, which are important for water resources management, have been decreasing compared to those in the Soviet era. In order to make water resources management efficient, it is necessary to enhance fundamental monitoring systems and to use data accurately with these systems. Supported by the Swiss government, Uzbekistan conducted an efficient operation project of water resources in Fergana region, modernized hydro posts, and modernized Uch-Kurgan Dam and others. At the same time, Uzbekistan consults with Tajikistan on the operation of Kayrakkum Reservoir, and regards securing transparency of hydro post measurement data by other countries in the region as an issue to be considered. It is also considering to form a consensus document on water operation of the Syrdarya River (e.g., the consensus framework proposed by the Asian Development Bank), provided that "information concerning water release and intake is transparent" and that "information is shared" (by the Ministry of Agriculture and Water Resources).

5) Deficiencies due to the ageing and the deteriorating function of water resources management infrastructure is a critical issue in Uzbekistan as well. Canals, pump stations, intake weirs, and irrigation dams need repairing or rehabilitating, and are receiving support from the World Bank, the Asian Development Bank, etc. Water conservation actions are also an important issue of the government. It is necessary to reduce the loss of water caused by aging facilities by rehabilitation.

6) Safety management of facilities

Following the law enacted in 1991, governmental organizations started to implement safety management, which led to the establishment of the State Inspection (SI). The SI is responsible for ensuring safety and reliability of facilities and equipment.

SI's standpoint towards water related facilities is "Water usage of downstream countries is directly affected if the water resources facilities (dams, weirs, pumps, etc) of an international river are broken. Ensuring safety and reliability of water resources facilities should therefore be regarded as a regional issue involving the whole of Central Asia, not only limited to Uzbekistan.

The SI also says "There is no system to monitor reservoirs, banks, and facilities, as part of countermeasures against aging and deterioration. Real time monitoring of water level, gate opening, and flow could ensure safe control". These points are to be noticed in ensuring safety of regional water.

The SI says "More than 15 percent of emergencies are due to lack of experience and knowledge." 90 percent of water related facilities are man-made irrigation facilities. The SI classifies them into Classes I, II, and III, in order of importance, and monitors them. There are 273 facilities in Classes I and II. Of the total, 54 are reservoirs, 29 are power plants, 60 are main water canals, 65 are water diversion devices, 35 are pump stations, and 25 are water canals. There are 7 rivers, with a total extension of 2,000 km.

7) Flood damage

In Uzbekistan, flood damage also occurred in Andijan and Namangan districts in the Fergana basin, where water overflowed from canals. Measures have been taken such as repairing water canals and relocating damaged houses. In addition, flood damage occurred because of swollen water (max. 6 m) in winter along the zone in the mid river basin, from the border downstream of Kayrakkum to Chardara.

Specific information such as the plan to construct a regulating reservoir to reduce flood has not been obtained from Uzbekistan. As in the case of Kazakhstan, it would be an effective measure for Uzbekistan to construct a regulating reservoir against the water release from Toktogul Reservoir for power generation in winter, and to use stored water for irrigation. However, it is a necessary precondition that discussion and agreement on discharge for irrigation are done with the downstream country, Kazakhstan. It is also necessary to study the geography and geology of the site planned to construct a regulating reservoir.

2-4-2 Changes in development and management of soft/hard infrastructures

This section describes the changes in development and management of soft/hard infrastructures for water resources in the Syrdarya River basin, considering whether the infrastructure such as dam reservoirs and its operation, which could be a means for intra-regional cooperation, has been effective (in flood control, water utilization, and power generation), and considering what kind of measures would be possible to improve them if the effect is insufficient or adverse. Soft infrastructure for water resources development and management in the Syrdarya River basin means the organizations and legal systems to manage river basins. (The changes in the organizations of river basin management are described here, since the legal systems will be described in "Changes in Water Policies, Legal Systems, and Administrative Organizations of Each Country Stated in 2-3-1"). Hard infrastructure means dam reservoirs, etc.

Figure 2-13 shows major dams, canals, power plants, pump stations, and hydraulic observation stations in the Syrdarya River basin.

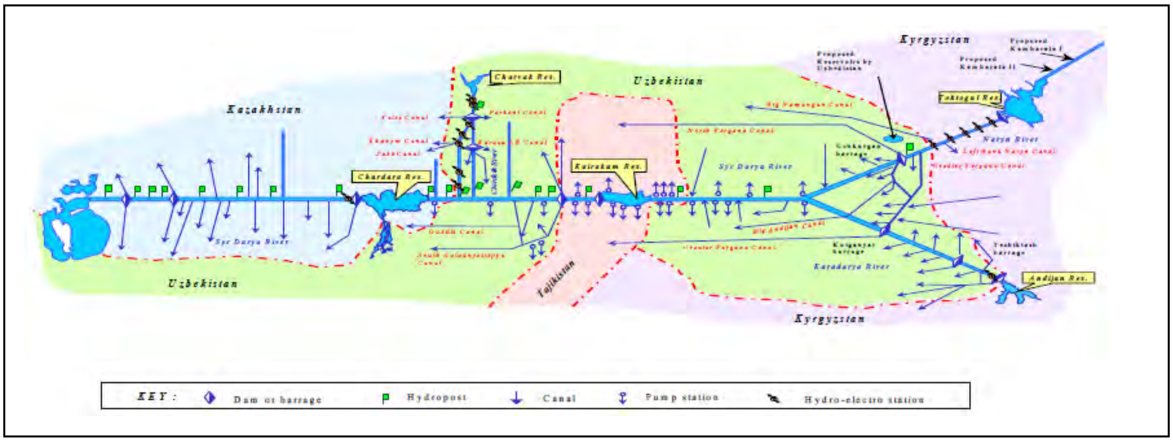


Figure2-13　Water resources facility in Syrdarya River basin

Reference：WB (2004)"WATER ENERGY NEXUS IN CENTRAL ASIA"

(1) Changes in development and management of hard infrastructure

With regards to hard infrastructure, for the important water resources in the Syrdarya River basin, a number of water utilization facilities such as dams were constructed in the basin of the river before the collapse of the Soviet Union (1991). This was done based on the water policies of the former Soviet, and had been effective in flood control, water utilization, and power generation. Many dams were constructed in Kyrgyzstan, located upstream of the Syrdarya River, because under the water policies of the former Soviet Union, it was considered that irrigation for the cultivation of cotton and rice in Kazakhstan and Uzbekistan both located downstream of the river remained the top priority.

Toktogul Reservoir, the most distinctive one among those dams, had been operated with the purpose of supplying irrigation water to two downstream countries, bringing disadvantage to Kyrgyzstan. (Water storage in winter for power generation was decreased, inhibiting power generation in winter, since Kyrgyzstan had to supply irrigation water in summer to two downstream countries.) The Soviet Union used to compensate Kyrgyzstan for it, by giving a budget concession and supplying oil, coal, and natural gas from two downstream countries.

After the collapse of the Soviet Union, the five independent Central Asian countries concluded the Almaty Agreement in 1992, including a provision to maintain the same rules of water distribution as in the Soviet era. This agreement ignored the economic development of the two upstream countries, Kyrgyzstan and Tajikistan, through utilizing water resources, but continued the water operation of Toktogul Reservoir in the Soviet era, where irrigation was given a higher priority. When controversial points of this agreement became apparent, the agreement was abandoned, and Kyrgyzstan chose to operate Toktogul Reservoir in the way that power generation had priority over irrigation, in order to protect their own interests. This led to irrigation water shortage in two downstream countries in summer, while water released for power generation in winter caused flood in downstream areas.

Kazakhstan tried to control floods by operating the Chardara Reservoir. However, flowing flood waters which could not be held there were released through the Arnasay lowland to the Aidar Lake. Uzbekistan then constructed a dam in the Arnasay lowland in order to domestically use the water that flowed from Chardara Reservoir. Uzbekistan also constructed Razaksay Reservoir and Kangkulsay Reservoir.

Kazakhstan also is constructing Koksarai Reservoir (Figure 2-14). It has asked Kyrgyzstan for inhibiting outflow for power generation in winter so that it can ensure water flow for irrigation in summer. However, the two countries could not coordinate mutual interests in intra-regional discussion, and have not succeeded in concluding a protocol since 2002. Kazakhstan suffered flood damages, shown in Figure 2-8, and also faced a big problem such as irrigation water shortage in summer. For this reason, Kazakhstan took an unprecedented step and bought 600 million m^3 irrigation water from Kyrgyzstan in 2008.

Under such circumstances, Kazakhstan started to construct a regulating reservoir in 2008, directly upstream of the place down Chardara Reservoir where people suffered from flood damage, with a storage capacity of approximately 3 billion m^3, and as a protection measure to reduce flood damage. Its capacity will hold flood waters in winter to mitigate flood damage downstream, and will also use stored water for irrigation. It is scheduled to take about four years to complete the construction, but an earlier completion is needed from a national policy point of view. Kazakhstan asked our study team whether Japan could cooperate in the promotion of the construction.

The regulating reservoir would be effective in reducing flood damage and using stored water for irrigation. The promotion of its construction is anticipated. It may be possible for Japan to cooperate either technologically or financially.

There was a statement in the interview that the construction of Koksarai Reservoir would enable Kazakhstan to procure electricity from Kyrgyzstan and distribute it to South Kazakhstan.

In the delta at the very end of the downstream of the Syrdarya River, Aklak Dam is being constructed for the purpose of the conservation of the environment and ecology as well as for water utilization.

Figure 2-14 Koksarai regulating reservoir project site (left) / Canal construction site (right), photos taken in Sep. 2008. – Koksarai regulating reservoir is planned to be connected to the Syrdarya River by two canals. It is intended to alleviate flood damage during the winter season (stored water in the regulating reservoir) and to ensure water use during the irrigation period (released from the regulating reservoir to the river that is to be sent for farming). Prior to the construction of the regulating reservoir, canal excavation work had started.

Next described is the present situation of hard infrastructure for development and management of water resources in Uzbekistan, as one of the examples of the four countries in the Syrdarya River basin. Uzbekistan manages more than 200 large-scale and important water utilization structures as hard infrastructure for the development and the management of water resources. Among them, those 30 years old or more have mostly not been updated, due to financial restrictions. Accidents are occurring caused by the deterioration of water resources facilities. Uzbekistan regards both potential large-scale accidents and urgent need of measures as major political issues. Under these circumstances, the State Inspection (SI) set up in the Cabinet Office in 1999 inspects the safety of aging infrastructure for development and management of water resources, and thus responsible for safety management of primary water utilization facilities in Uzbekistan through monitoring actions. Our study team interviewed the SI in September 2008, and found out that they classified the facilities concerning water resources development and management into Classes I, II, and III in order of importance. 273 facilities are categorized into Classes I and II. Of the total, 54 are reservoirs, 29 are power plants, 60 are main canals, 65 are diversion works, 35 are pump stations, and 25 are canals. The way the SI views is as follows: (i) Uzbekistan used to focus too much on energy and water resource issues and did not emphasize on the safe operation of water resources facilities; and (ii) since downstream countries are directly affected when the water resources facility of upstream countries in an international river are broken, ensuring safety and reliability of water resources facilities should be necessary to all basin countries of the Syrdarya River, as well as Uzbekistan, and regarded as an intra-regional issue. This recognition is reasonable, and important in ensuring safety of water resources in Kazakhstan, Kyrgyzstan, and Tajikistan in the basin of the Syrdarya, as well as Uzbekistan.

Here is the present condition of the water intake facilities of Dustlic Canal in Uzbekistan, where the study team visited in September 2008 for their on-site survey (Figure 2-15). Dustlic

Canal is managed and controlled by the BVO-SD. The management center of this water intake facilities conduct controlling water intake, receiving the directions on operation from the regional Dispatching Center. It also measures the water level data per hour near water intake points, and reports the record to the Dispatching Center once in two days in principle. To measure water levels, it uses water level measuring devices installed in the Soviet era. It seemed that a certain level of function of water intake facilities and canals had been maintained by the staff's efforts, despite the problems of aging measuring devices and water intake facilities as well as deposited sand in the canals. This is an example which requires improvement of information and communication systems and rehabilitation of facilities' function.

Figure 2-15 Intake Facility in the Dustlic Canal (Left) and Electric Control Panel for Intake Facility Operation (Right), photos taken in Sep. 2008.

(a) Concept of intra-regional cooperation in infrastructure development

In recent years, intra-regional water operation has been solved not only by the operation of dam reservoirs in the Syrdarya River basin, but also by infrastructure development to ensure safety of water by each country. This is a recent characteristic of infrastructure development.

Kazakhstan started to construct a regulating reservoir with its own funds, in order to mitigate flood damage in the downstream area of Chardara Reservoir as well as to ensure irrigation water. Some documents suggest that Uzbekistan has a plan to construct a regulating reservoir with a similar purpose; however, this did not become evident from the hearings with the government officials in charge of this issue.

Shortage of electricity in winter in Kyrgyzstan and Tajikistan can be regarded as a condition that requires infrastructure development in the course of recovery of each country that has arisen after gaining independence from the Soviet Union. Namely, they need the infrastructure first to improve the conditions such as flood damage, water shortage, and electricity shortage, just as Japan had suffered from similar situations in the postwar reconstruction. Once that infrastructure is completed, they will be able to start intra-regional cooperation.

The fact that Kazakhstan started constructing a regulating reservoir by itself could be regarded as “basic infrastructure development needed in its own country to reinforce intra-regional cooperation”, not as “an action to ensure its own interests apart from regional cooperation”. It could be compared to the infrastructure development in Japan, including installing flood control dams and dikes, and constructing water utilization dams.

Uzbekistan is also in the same condition as Kazakhstan. On the other hand, Kyrgyzstan and Tajikistan have to be quickly equipped with power systems. It’s not difficult to understand their point that “discussion on an equal footing as an independent country can be attained after the prospect of electricity supply comes in sight”.

In this case, it should be noted that Kyrgyzstan would not become isolated so as to solve energy problems by itself, and that downstream countries would keep cooperative one another. For this purpose, each country must recognize the necessity of the management of the whole river basin area as one for ensuring water safety (if the water management of any country in the river basin is deteriorated, significant troubles will be caused in ensuring water safety in all river basin countries) when formulating and implementing its national water resources management plan. At the same time, it is required for international organizations and donors to clarify the purpose of their aid as the promotion of regional water resources management and water safety ensuring.

(b) Promotion of efficiency in water use by rehabilitation of the function of aging infrastructure

Many water resources such as dams, weirs, and dike along the Syrdarya River were constructed in the Soviet era. They have been operated repeatedly, without being restored. Therefore, a collapse of the river caused by the operational error or safety deterioration of a river structure of one country could possibly lead to water disaster such as flood and water shortage in neighboring countries.

In order to cope with this situation, it is necessary for each river basin country to start implementing a series of systems including the functional diagnosis of the present situations, operation monitoring, required rehabilitation, formulation and enforcement of facility management standards to ensure safety of water infrastructure, as stated by the State Inspection of Uzbekistan.

It is also necessary to use infrastructures, such as reservoirs as the means to achieve intra-regional cooperation for the purpose of promoting water resources management in the river basin. The simulation of flood mitigation described in Chapter 4 shows the effect of reservoirs cooperation. In order to achieve this, it is obviously necessary for the concerned countries, to understand each other and have a consensus. In addition, it is of vital importance to reinforce or newly establish a series of systems including hydraulic data observation (measurement to forecast inflow, river flow, reservoir water level, inflow/outflow, amount of water intake, etc.), data processing, and data analysis with enough required accuracy to achieve the effect. Reliable data as objective materials can be critical in stakeholders’ meetings.

On those grounds, monitoring is regarded as an important item in the promotion plan of national water resources management.

(2) Changes in development and management of soft infrastructure

Soft infrastructure concerning water resources in the Syrdarya River basin includes the ICWC, established in 1992 according to the Almaty Agreement, concluded among the five Central Asian countries after the collapse of the Soviet Union, and the river basin management organization (BVO-SD), set up under the ICWC. Since then, the BVO-SD has been implementing water distribution and the management of major water resources facilities of the Syrdarya River.

The primary responsibility of the BVO-SD is to conduct water distribution and water management in the basin countries located from the Toktogul Reservoir to the borders of Kazakhstan. It is also responsible for monitoring the water quality of the Syrdarya River, with the cooperation of the committee of the environment, the hydrological observation, and the hygiene investigation of each country (http://www.icwc-aral.uz/bwosyr.htm, 5. Nov. 2008). The BVO-SD, the organization to implement cooperative management of the water resources of the Syrdarya River that turned into an international river after the collapse of the Soviet Union, has been supporting functions (flood control, water utilization, and power generation) of the infrastructure of reservoirs and others, especially by supporting the practical operation of the facilities. In addition, before the collapse of the Soviet Union, river basin management organizations (BVO) had been set up along the Syrdarya River and the Amu Darya River. Both BVOs had been operated by national budget through the Ministry of Land Reclamation and Water Resources.

With the economic development of Central Asian countries, the SIC-ICWC implements the operation of the training courses listed below and supports the development of the Syrdarya River basin in order to enhance capacity development of solving problems concerning the issues that need immediate measures. Here are three training courses concerning water resources management that are currently being carried out by the ICWC.

Figure 2-16 Training Room in the ICWC, photos taken in Sep. 2008.

- Strengthening of water resources management capacity by ICWC –

ICWC is in charge of operating training program for the enhancement of water resources management capacity, and supports Central Asian countries, including the Syrdarya River basin area for their development. ICWC has been cooperating with various donors including WB, and working on capacity development of RBOs.

1) Management of water-environment oriented investment project.

The given course constitutes desk studies based on lectures (62.5 hours) and practical training sessions (15.5 hours). Subject matter of the course is oriented to project management in the sphere of water management and ecology. All the themes are represented in the form of four modules:

1. Identification of nature protection projects and their financing
2. Preparation and development of investment projects
3. Financial analysis of investment projects
4. Procurement of goods and services

1,000.00 USD are required for the tuition.

2) Procurement of goods and services

The given course constitutes desk studies based on lectures and practical training sessions. Subject matter of the course I oriented to project management in the sphere of water management and ecology. The program was prepared together with World Bank instructors. The content of the course in brief is as follows:

1. Invitation to tender
2. Instructions for sealed bidding participants
3. Information cards of competitive bids
4. General terms and conditions of a contract
5. Specific provisions of a contract
6. Application for goods and services
7. Technical specifications
8. Samples of forms
9. Acceptability of goods, works and services provided within the framework of bank funded procurement

785 USD are required for the tuition.

3) Project management

The given course constitutes desk studies based on lectures and practical training sessions. Subject matter of the course is oriented to project management in the sphere of water management and ecology. This course was developed by Mount Royall College (Canada, Calgary) and was approved by the Project Management Institute (USA). The content of the course in brief is as follows:

1. The project management framework
2. Project phases and the project life cycle
3. Project integration management
4. Project scope management

5. Project time management
6. Project cost management
7. Project Quality management
8. Project human resource management
9. Project communications management
10. Project risk management
11. Project procurement management

785 USD are required for the tuition.

(Refer to: ICWC 2008 URL: http://www.icwc-aral.uz/bwosyr.htm, 28 Oct. 2008)

2-5 Background and issues on water resources and establishment on power exchange system

2-5-1 Efforts for regional water coordination by international organizations and donors

As stated in 2-1 and 3-1, there has been no particular progress regarding intra-regional cooperation on water resources and electric power since 2005 when the previous study was conducted by JBIC.

While water operation in the Syrdarya River has become a political issue in recent years, and the situation in the region has been even severer. As for donors' support activities towards intra-regional cooperation on water resources and electric power, USAID and WB had continued making coordination efforts until the early 2000. However, there has almost not been any significant progress since the study conducted in 2005. Both donors seem to have withdrawn temporarily from activities on intra-regional cooperation of water resources.

From the study carried out this time, the organizations that were engaged in making an effort to contribute to new intra-regional cooperation of water resources were only ADB and GTZ, and their efforts are going to be focused as described below.

(1) Regional international organizations

(a) IFAS (International Fund for Saving the Aral Sea)

IFAS was established by five countries in Central Asia, and marked its fifteenth anniversary this year. Tajikistan's chairmanship will continue until December 2007. Kazakhstan is scheduled to take over the chairmanship in 2008 and is now preparing for establishing an executive committee. In order to raise awareness about the importance of the Aral Sea problem, it is considered that there will be a possibility to incorporate IFAS into the UN's umbrella organization.

The major issues that are of current interest include promotion of cooperative relationship among Central Asian countries, water allocations in the Syrdarya River and the Amu Darya River, reasonable use of water resources, and utilization of human resources.

(b) ICWC (Interstate Coordination Water Commission of Central Asia)

The Information Center offers a database of information about regional rivers and reservoirs, which is classified into public data and nonpublic data that is available only to member states.

Concrete projects of implementation are highly focused on.

(2) International aid agencies

(a) UNDP (United Nations Development Program)

It provides support for the formulation of national IWRM (Integrated Water Resources Management) plans to four countries in Central Asia.

Kazakhstan is one step ahead and the National IWRM Plan is scheduled to be implemented in next spring after obtaining approval from the President (according to Kazakh Water Resources Committee hearings). It is likely that Uzbekistan's IWRM plan will also be initiated soon (according to UNDP hearings). Kyrgyzstan and Tajikistan are in the stage of starting to formulate a framework.

National IWRM Plans will serve as guidelines for future water resource management, and the establishment of organizational structures and infrastructure development will be promoted based on them. According to the UNDP (Uzbekistan) hearings, it was suggested that support activities should start with a pilot project, but because the first stage of support activities aims to assess the current state and encourage capacity development, if the project enable other donors to cooperate on it, Japan should participate in the project from the first phase of current state assessment.

The way each government of Central Asian countries promotes IWRM plans is to start improving domestic small-scale rivers first, to achieve successful examples, make the results known to governmental agencies and citizens to obtain their understanding, and then launching the IWRM plan at the national level.

(b) WB (World Bank)

WB has been implementing many support projects for the Syrdarya River, and is now striving to implement sustainable development projects for the Amu Darya River.

In Kazakhstan, irrigation and drainage projects (rehabilitation and extension of facilities) have been implemented, and the second phase projects are now being prepared. On the Pamir Highlands in Kyrgyzstan and Tajikistan, small hydroelectric projects are ongoing. The WB is implementing the reconstruction of the Kayrakkum Reservoir, and a water-saving project for the Fergana basin in Uzbekistan. It also offers loans for the Cool Energy Project in Kyrgyzstan. In addition, WB is implementing the projects of climate change, disaster mitigation, drought mitigation etc. The study team confirmed that WB has following opinions by on site fact-finding.

- Efforts made for the flood mitigation are important.
- There is no donor’s meeting held in the water and energy sectors. It is necessary to promote communication and cooperation among many projects implemented within the region. It seems that regional JICA offices would greatly facilitate collaboration between those projects.
- Data from Hydromets (observational station) in each country should be linked. It is essential to share data between common dispatch centers which were established during the Soviet era, but they cannot cooperate with each other due to political problems. Opinions differ on water management, but it can be said that it is an issue that the accurate data on water volume cannot be obtained.
- There are concerns about the Toktogul Reservoir because of unfit management. It is predicted that water shortage will occur next summer.

(c) ADB (Asian Development Bank)

From 2003 to December 2007 as the first phase of the project “Improve Water Resources Management”, ADB has worked to construct new regional frameworks for water resources management. Specific efforts have been made in the Chu and Talas Joint River, which is the border between Kazakhstan and Kyrgyzstan, including the establishment of a joint commission between two countries, the development of a water allocation model, and sharing of roles and cost for water resources management. It aims to show the framework established by the project to countries in the region and to establish a regional framework for water allocation.

In Central Asia, international organizations and donors have tried to establish a framework for regional collaboration in the water resources and energy sectors in the past, but have not succeeded yet. Therefore, the project approach has been changed by shifting the target area of the project from the whole river basin to small river basin. Successful results of small river basin have been accumulated and spread to the whole region.

This approach has the advantage that the integrated water resources management can be understood based on not only the concept but also on the implementation examples and that a shared awareness for approaches to issues and responses can be established.

To launch the second phase of the project "Water Use Efficiency at the National Level" in 2008, the ADB is preparing for negotiations with countries in the region. The study team confirmed that ADB has following opinions by on site fact-finding. The ADB shows a positive attitude toward collaborating with JICA, and can be a prospective collaborative partner to promote regional collaboration.

(d) USAID (United States Agency for International Development)

The past efforts will be described in 2-5-2 below. USAID had implemented continuous support for the Syrdarya Framework Agreement in 1998 and produced good results. In recent years it has suspended the establishment of a framework in the water resources sector, and instead has worked to enhance the organizational structures of water users (Uzbekistan and Kyrgyzstan) and community facilities (small canals).

(e) GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Development Cooperation))

GTZ intends to launch the "Program on Transboundary Water Management in Central Asia" as a new intra-regional cooperation program early in 2008. The program is planned to be launched in May 2008, and workshops on the current state of water resources management will be held in various countries. Based on those workshops, efforts will be promoted for the following items:

- Dialogue and cooperation on intra-regional water resources management
- Accumulation of successful results on transboundary rivers
- Implementation of domestic projects to improve water resources management

This program will be supported by the German Government as part of EU's assistance programs for Central Asia. The German Government decides to provide a grant of 20 million euros during the first phase of three years from 2009 to 2011. The study team suggests that it is an important project in terms of regional collaboration, and it is necessary to see how it progresses, including the possibilities of collaboration.

2-5-2 Obstacles for intra-regional accommodation's of water resources and electric power

In this study, issues where there are obstacles lying ahead in the way of building intra-regional cooperation on water resources and electric power were summarized and organized based on the outcomes of this study and previous review after 2005 (including supplementary). The previous review was intended mainly for the technical assistance (Study) comprehensively carried out by USAID and ADB's study in 2002 towards the framework for the Syrdarya Agreement in 1998.

Based on the previous review and the outcome of this study, issues of intra-regional cooperation on water resources were arranged.

(1) Review on the previous studies of water and power nexus

a) Briefing of technical assistance by USAID

For the purpose of strengthening the implementing framework for the Syrdarya Agreement in 1998, USAID Central Asia Mission had carried out several technical assistances between 1998 and 1999. These had comprehensively been undertaken under the USAID/CAR Technical Assistance Program, namely EPIQ (Environmental Policy and Institutional Strengthening Indefinite Quantity Contract).

The EPIC program had a broad range of studies including the following:

1) Funding by countries of water management system facilities
2) Allocation of operating and maintenance costs of interstate water control facilities
3) Integrated water resources management model
4) Assessment of the current situation in the Syrdarya River basin water resources use
5) Syrdarya basin water and hydropower O&M financing analysis
6) Problems of regulation, management and conservation of water resources of the transboundary Syrdarya River
7) Status of the electricity pool in Central Asia, and the problems of efficient joint use of water and energy resources of the Syrdarya River basin
8) Issues and alternatives of power market

b) Approaches to the procedure of funding by countries of water management system (WMS) facilities on transboundary rivers

This USAID study was completed and submitted in December 1998, headed by Dr. Victor A. Dukhovny who has been the President of SIC-ICWC. A water management system (WMS) was evaluated for the Syrdarya River basin to adopt the funding and cost and benefit allocation methods as summarized below:

1) The WMS main functions are formation and conservation of water resources.
2) Issues addressed to financing approaches to joint use of WMS projects by the participant countries (and sectors, correspondingly) will be considered with the Naryn-Syrdarya system taken as an example. The Basin Water Organization (BVO) Syrdarya internationally manages the Naryn- Syrdarya system. Republic agencies and organizations manage regulating hydro complexes (reservoirs), territorial irrigation and energy projects.
3) Basic production funds, and corresponding annual costs are allocated for the following main sectors:
    - Hydro systems serving hydropower, irrigation, and other water users' needs
    - Irrigation (irrigated farming)

- Hydropower
- Water supply and municipal economy
- Recreation
- Fish industry

4) WMS efficiency is governed by benefits from main sectors linked with use of basin water and land resources.
5) Different forms of project ownership in the zone of WMS activities are available.
6) According to WMS categories of ownership, principles of capital investments and annual operation costs have also been determined.
7) To regulate relationships for funding and allocating costs associated with joint use of transboundary water resources an international agreement of the Central Asian countries has been proposed and approved by three Governments (Kazakhstan, Tajikistan, and Uzbekistan) (17 June 1997). The agreement regulated the procedure of funding and allocation of costs for BVO being considered as an ICWC structural division.
8) For the advancement of the issue we have developed and proposed approaches to funding, allocation of costs and benefits in the process of a joint operation of WMS complexes by the countries:
   - Option 1: Determination and allocation of costs and benefits under the interstate and intersectoral use of the entire complex of facilities functioning on transboundary rivers; consistent to the principle of effects proportionate to costs, or costs proportionate to effects.
   - Option 2: Allocation of costs and benefits gained from joint operation by sectors of entire irrigation and energy hydro systems proportionate to the effects (is identical to hydro systems only).
   - Option 3: Method of allocation of O&M costs of the Toktogul hydropower system between energy and irrigation sectors based on regulated flow amounts and effects obtained in the sectors.

c) Allocations of O&M costs of interstate water control facilities employing the Use-of-Facilities Method

This ADB assistance was provided to the Executive Committee of the Interstate Council for the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan (ICKKTU) to develop regional principles on financing of operation and maintenance (O&M) of international (transboundary) water facilities of the region. The final report was submitted in December 1999.

The Syrdarya Agreement did not specify how O&M funding would be specified. Therefore, it was urgently needed to determine the coordination of a proper cost sharing for operation and maintenance of interstate water facilities.

A list of the types of transboundary facilities to be analyzed is as follows:

1) An irrigation canal facility

2) A water supply reservoir

3) A multiyear water supply and hydroelectric generating facility

4) A seasonal re-regulation water supply and hydroelectric generating facility

The following interstate facilities were finally selected for applying the use-of facilities method of cost allocation for example illustrative purposes:

1) West Big Chu Canal, in Kyrgyzstan, a component of the Chu River system serving Kyrgyzstan and Kazakhstan
2) Chon Kakpah Reservoir on the Talas River in Kyrgyzstan, serving Kyrgyzstan and Kazakhstan
3) Toktogul Reservoir and the associated Uch-Kurgan re-regulation reservoir in Kyrgyzstan, a multiyear water supply and hydroelectric generating facility serving Kyrgyzstan, Tajikistan, Uzbekistan, and Kazakhstan
4) Kayrakkum Reservoir in Tajikistan, a transboundary seasonal re-regulation water supply and hydroelectric generating facility serving Tajikistan, Uzbekistan, and Kazakhstan

Toktogul and Kayrakkum Reservoirs are considered to be operated jointly and to share the O&M cost.

d) Integrated water resources management model for the Syrdarya basin

This ADB study was completed and its final report was submitted in August 1999. This study constructed an integrated water resources management model for the Syrdarya River basin, headed by Prof. Dr. D.C.McKinney of University of Texas, USA. A new integrated hydrologic-agronomic-economic model has been developed and applied to the Syrdarya River basin. The main advantage of this model comes from system integration, which provides an analytical framework to consider both economic and environmental consequences of policy choices. Alternative solutions are compared based on hydrologic, agronomic, economic and institutional conditions within the integrated system.

The limitations of using a short-term model for river basin analysis are presented in this paper. The problems arise from the fact that long-term environmental impacts are not wholly connected to the utility of water uses. More specifically, groundwater quality degradation cannot be captured in this short-term model; soil salinity worsens, economic efficiency of drainage system improvements may be under-evaluated.

e) The USAID assessment of the current situation in the Syrdarya River basin water resources use

This report as to the assessment of the current situation in the Syrdarya River basin water and power resources was prepared in June 1999 in conformity with the Decision of the Meeting of the Coordination Group (Note: meeting organizer and participants are unknown) on Modeling the Operation Modes of the Naryn-Syrdarya Reservoirs Cascade held in Almaty on March, 1999, and where the need for assessing the state of the Syrdarya River basin resources use for the last few years: 1995-1998 was underlined.

Integrated Reservoir Operation in the Soviet Era

The paper sorted out several rules of basin-wide cascaded reservoir operations during the Soviet era.

1) First priority is given to the irrigation water demand downstream for the Toktogul Reservoir operation.
2) Three quarters of the annual volume of the reservoir releases are performed during the growing season (9.43 km^3). The growing season is a 6-month period from April to September.
3) During the inter-vegetation season (6-month period from October to March), the Toktogul Reservoir should release no more than 180 m^3/s (2.85 km^3 during the total period) which corresponds to the minimum power generation of the HPP.
4) These operation rules make it possible to maintain the sustainable surrounding environment and development in the basin.
5) The Kyrgyz electric power not generated in winter can be compensated through the delivery of the heat resources from other republics.

As indicated above, the operation of Toktogul Reservoir in the former Soviet era was mainly for irrigation mode, and the outflow in winter was controlled less than one third of the operation for power generation mode. However, it was not operated properly, considering the possibility of excessive volume of irrigation water which caused a problem to lower the water level in the Aral Sea and the environmental flow for keeping a certain water level in the Aral Sea.

Change of Cascade Reservoir Operation and its Effects Downstream

1) Toktogul Reservoir

In year 1988, appeared the first evidences of the change in the Toktogul Reservoir operation mode connected with the reduction of the coal delivery to Kyrgyzstan. During the non-growing season of 1989-1990 water year, the increase of the releases from the Toktogul reached up to 3.9 km^3. It went up to 4.9 km^3 in 1990-91 and 5.1 km^3 in 1991-92. The electric power production at the Toktogul reservoir doubled compared with the preceding period. In the late 1990's, the maximum output at the Toktogul HEP felt within the winter season (6-8.5 km^3). The cascade operation mode for the Toktogul, Charvak and Kayrakkum hydro schemes could not be rationalized.

2) Cascade of the Kayrakkum and Chardara Reservoirs

Since the Toktogul's releases during the non-growing season before 1992 did not exceed 5 km^3, the non-productive losses of the Syrdarya water were not observed. This point got past in the 1992-1993 water year when the Toktogul hydraulic system released about 6.1 km^3 during the non-growing season, and as a consequence, the releases to the Arnasay depression began to take place.

In 1988 the inflow to the Kayrakkum Reservoir, instead of 4-5 km^3 during the preceding period, increased up to 8-9 km^3 (releases raised from 3.5-6 km^3 to 6-8 km^3, respectively), and since 1992 the inflows reached the value 10-12 km^3 and releases10-12 km^3.

The character of the Chardara Reservoir operation was similar although as a consequence of certain restrictions downstream the Syrdarya River (the ice conditions and the regulating facilities for water diversion to the Aitek canal), the releases towards the lower reaches could not increase proportionally to the increase of the inflow, and the difference in the water amounts was discharged to the Arnasay depression. The inflows to the Chardara Reservoir increased from 3-6 km^3 to 7-9 km^3 (in 1987-1991) and up to 10-15 km^3 (from 1991 to 1999), while the releases raised from 1-3 km^3 (1974-1987) to 4-6 km^3 (1987-1992) and then up to 5-8 km^3 (1992-1999).

At the time when the winter releases from the Toktogul Reservoir increased by 2-3 times, the channel reservoirs have no need for the water accumulation since the beginning of the inter-vegetation season because at the inflow growth the Kayrakkum Reservoir was filled up even in December, whereupon the releases were over 1,000 m^3/s; even greater flow rate went to the Chardara, and the discharge to the Arnasay depression had become inevitable.

On the other hand, a different type of situation occurs at the Chardara Reservoir being drawn down by the end of the growing season up to the dead storage. In order to attain the optimum, it is necessary in good time to develop below Kzyl-Orda town the so-called "ice pipe" of the maximum large dimension, for which purpose there should be maintained a constant volume of the releases from the Chardara in December-February, the limiting value of which should not exceed 400 m^3/s.

Recommendations on Sustainable River Basin Water Resources Management

This USAID report arrived to the following conclusions as described below in summary:

1) The volume of the non-vegetative releases should not exceed 5-6 km^3 to avoid the water discharges to the Arnasay depression. In this case it is possible to attain the non-admittance of the inflow to the Chardara Reservoir in volume more than 11 km^3 that, at all other factors being equal, (the release from the reservoir is no more than 7-8 km^3 and during the growing season the reservoir is drawn down up to the dead storage) will provide a possibility to operate without the water losses.

   In summer the volume of the releases from the Toktogul Reservoir should be no less than 6.5 km^3 during a normal water year, at least 7.5 km^3 during the low - water years and 3-4 km^3 in low-water years.

2) It is required to continue the rearrangement of the Kayrakkum Reservoir operation that was started during the last inter-vegetation season of 1998-1999 water years. In the course of the first 1.5-2 months of the non-growing season (October-November) the releases should be the maximum ones in order to form the reserve storage in the reservoir bowl for the subsequent two thirds of the period when the Toktogul's releases will increase. This will enable to load the HPP's turbines during practically the whole non-growing season and to reduce the no-load releases during the second half of the non-growing season.

3) Accordingly, throughout October and during the first half of November the releases

from the Chardara Reservoir should be at least 600-700 m^3 to guarantee the maximum water supply to the Aral Sea and the Aral Sea coastal region and to succeed in the formation of the maximum dimension of the so called «ice pie». There should be provided a volume of the non-vegetative releases from the Chardara Reservoir of no less than 7-8 km^3.

4) The observance of the conditions listed in items 1-3 will make it possible to eliminate or drastically reduce the nonproductive water losses and to guarantee the water supply to the Aral Sea and Aral Sea coastal region.

5) At the beginning of the non-growing season, the channel reservoirs should be emptied, and as to the Kayrakkum Reservoir it is required to solve the problem concerning the influent channel clearing up for the water intake by the Makhram pumping station.

6) Taking into consideration that the states of the region are entering the world market system, the more widespread approach should be applied when tackling the problems and we shouldn't restrict ourselves only to the interrelations of the states, which interests are directly touched in the certain case.

7) Efficient intra-regional cooperation on water and power nexus shall be further proceeded.

8) The improvement of the river channel capacity downstream of the Chardara Reservoir shall be reinforced and the water conveyance to the Aral Sea shall then be enhanced.

Among the recommendations mentioned above, the improvement of river channel downstream of the Chardara Reservoir has only been carried out in Kazakhstan funded by WB, being driven by the necessity to urgently mitigate the flood inundation damages in winter. Other issues have not been agreed and implemented as yet.

The regional coordination among the republics to resolve the artificial droughts in summer caused by the consecutive decrease of inflows at the Toktogul during the past six years and power shortages in Kyrgyzstan has become a political issue. It can be said that the situations to cope with the floods and droughts caused by the power operation mode at the Toktogul Reservoir in winter are growing increasingly bitter.

f) The ADB study on water and energy nexus in Central Asia

This study provided an analytical basis for the Asian Development Bank (ADB) to formulate a regional strategy of timely assistance in the Aral Sea basin in Central Asia and was submitted in August 2002. It focused on the inter-linkage between water use management and energy trade. The study makes specific project recommendations and outlines an action plan for ADB to consider, which can be started in the immediate future and logically consistent with the analysis of present and emerging issues, donor and international financial institution assistance, major investment needs, strategic approach and implications, and short to medium-term project objectives presented in this study.

Present and Urgent Issues

This study has identified the following ten issues that must eventually be resolved if the water and energy nexus of Central Asia is to fully recover and properly develop:

1) The ownership of the river water resources of the region are not adequately defined or agreed upon, both at the regional level and the local level of individual farmers' water right.
2) There are major and developing international conflicts over reservoir operation for the generation of energy and water storage and release for irrigation.
3) Management of the agriculture sector has entered a period of reform, but there is still a long way to go. The reform process is affecting the efficiency of water resources management, and water-related issues should receive proper attention when developing new policies.
4) The institutional structure for regional water management is inadequate, as the responsibilities of the regional and national levels are unclear; decision-making forums are not working; and there is a lack of clarity in the information and database required for decision-making.
5) Water and energy national development planning is hindered by the failure to resolve regional issues, resulting in continued inefficiencies in resource use, and even in the possibility that governments will turn to inefficient solutions that can be implemented nationally.
6) Pollution of the natural water resources caused by agriculture, coupled with rapid deterioration of the rural water supply infrastructure is creating a rising health hazard in the downstream regions close to the Aral Sea. The irrigation system in these regions is used inefficiently to partly compensate for the lack of rural potable water supplies.
7) The energy sector is still far from operating according to market forces, at the national level and especially in the regional exchange of energy.
8) Energy transfers are inefficient because of the lack of proper management and operations infrastructure.
9) The basic infrastructures of both energy transmission and irrigation are in poor repair. Rehabilitation targeted at improved management, through the introduction of modern equipment and training is urgently required.
10) The cadre of resource management professionals is severely depleted, requiring human development interventions.

Investment Opportunity

This study recommended that the following specific projects are jointly undertaken by ADB and USAID in carefully chosen strategic locations and under jointly agreed goals and objectives.

1) Support cooperation in regional water resource management
   - ✓Install forecast, data collection, and communication stations to collect accurate snowmelt information and improve stream-flow operational forecasting
   - ✓Improve river water quality data collection and analysis by selectively upgrading key Central Asia laboratories
   - ✓Rehabilitate, automate and computerize basin-wide river management decision support systems to reduce operational water losses

2) Strengthen the irrigation and drainage infrastructure

- ✓Rehabilitate and provide automation and communication equipment on main canals in the Amu Darya basin to better allocate water to on-farm management schemes
- ✓Provide equipment to integrated on-farm water management schemes to improve the irrigation and drainage infrastructure
- ✓Construct and rehabilitate groundwater desalinization systems in rural villages and provide operations and maintenance equipment in Karakalpakstan

3) Create market reform in the energy sector

- ✓Provide technical assistance and training to the Government of Tajikistan Ministry of Energy to strengthen its legal, regulatory and institutional capabilities
- ✓Provide the Central Asia United Dispatch Center and the Syrdarya and Amu Darya River Basin Water Organizations with computers, offices, communication equipments and software to improve energy and water use dispatch and coordination
- ✓Extend the Central Asia United Power System into northern Afghanistan to create future energy trade markets with Central Asia

Action Plan (Draft)

It was recommended that the ADB consider taking the following actions in order to prepare for its program on the water and energy nexus of Central Asia:

1) Send ADB decision-makers to Central Asia to discuss details of this study analysis and recommendations with government counterparts, donors and IFIs, industry, consultants and advisors and other interested parties

2) Develop a portfolio of short to medium-term projects, based on this study and conduct follow-up meetings in Central Asia

3) Decide on the types of ADB funding instruments that best fit each project in the portfolio

4) Approach USAID (and other donors and IFIs) on partners to conduct certain projects, utilizing the strengths and resources of partners as a team

g) Transboundary water and energy project (Final Report FY 2002-FY 2005)

1) General

The United States Agency for International Development, Regional Mission for Central Asia (USAID/CA) decided to carry out the Transboundary Water and Energy Project (TWEP) in conjunction with the Central Asia Natural Resources Management Program (NRMP) in December 2001. This project delineated two phases. Phase I was implemented from December 2001 through April 2002 as tabulated below:

- ✓Reduction of energy losses in Kyrgyzstan: short-term
- ✓Improvement of the implementation of the 1998 agreement on water and energy use: short-term
- ✓Technical assistance to donors and international finance institutions (i.e., the

agreement on power trade relations): short- to medium-term

- ✓Development and strengthening of regional organizations (i.e., IFAS, ICWC, UDC and BVOs): short- to medium-term
- ✓Initial assessment of Kambarata 1 and 2 HEP: long-term; part of the structural solution

Phase II commenced in May 2002 and was completed in October 2005. The content of Phase II is described below:

2) Support on the power loss reduction programs in Kyrgyzstan

TWEP identified, prepared and implemented three electricity loss reduction demonstration models to complete this task.

- ✓Demonstration model on generation
- ✓Demonstration model on transmission
- ✓Demonstration model on distribution

<u>USAID possible follow-up activities (Draft)</u>

The following constitutes a simple action plan which is recommended for implementation if a loss reduction strategy is accepted at the highest political level.

- ✓Implementation of nodal internal metering which would enable distribution companies to perform internal power flow controls and loss tracking.
- ✓Development of metering, billing and collection software that would have the capacity to track internal power flows and generate management reports. All customers should be consolidated into one database to perform distribution loss control reports.
- ✓Internally, companies should make their authorized personnel responsible for losses in certain segments of the network. In the networks of 35/10/6 kV, the responsibility should be given to the technical department, and in the networks of 0.4 kV to the sales department.
- ✓Companies should perform baseline loss assessment for all segments of the networks and develop loss reduction targets with incentives and penalties for the authorized personnel.
- ✓Payment of electricity bills should be done only through the banking system. Meter readers should not accept any cash from the customers.
- ✓These measures should be performed under strict control of the SEA or Ministry. Once developed, they should approve and oversee the proposed detailed action plans.

3) Assessment on Kambarata 1 and 2 HEP

The initial report “An Assessment of the Kambarata 1 and 2 Hydropower Projects” evaluated these projects in Kyrgyzstan using studies and data from the files of USAID, the World Bank, and several government agencies in the region. The report provided discussion of these projects in the context of Kyrgyzstan’s energy system and also the interconnected Central Asia high voltage transmission grid.

TWEP/NRMP conducted two separate workshops to seek the comments of Kyrgyzstan and Kazakhstan power and water sector officials on the initial report. The report was distributed among Kazakh and Kyrgyz water and energy sector experts and decision-makers, fully reflecting the comments and recommendations.

The report presented the actions that need to be implemented in the short- to medium-term to improve the weaknesses in the regional water and energy sector, and particularly in Kyrgyzstan, before the development of Kambarata 1 and 2 Hydropower Projects as a long-term solution can be economically and financially justified.

4) Improvement for implementation of Syrdarya Framework Agreement

In July 2004, TWEP disclosed the latest report “Proposals for Improved Water and Energy Management in the Syrdarya River basin”, recommending the following four actions.

- ✓ The Syrdarya Basin countries continue to abide by the “1998 Framework Agreement on the Use of Water and Energy Resources between the Syrdarya Basin Countries”.
- ✓ The Syrdarya Basin counties agree to adopt and implement Toktogul Reservoir operation rules that would make the operation of the reservoir more responsive to water demands of Uzbekistan and Kazakhstan during the summer vegetation season.
- ✓ The Syrdarya Basin countries agree to a Multi-Year Electricity-Fuel Exchange Protocol as an urgent measure.
- ✓ The Syrdarya Basin countries agree to develop a Regulatory Framework for the 1998 Agreement as a permanent guideline to the implementation of the Agreement.

5) Development of river basin management methodology

TWEP worked with counterparts to develop the DSS for the Middle Syrdarya River basin and NASPI.

- ✓Decision Support System (DSS)
- ✓Link the decision support system to better data and information reporting among the riparian basin countries
- ✓Naryn-Syrdarya Cascade Planning Instrument (NASPI)

6) Recommendations

The TWEP team prepared recommendations for the next steps for major activities.

- ✓Development and replication of the Decision Support System
- ✓International agreement on information exchange
- ✓Development, application, support and replication of the Naryn-Syrdarya Cascade Planning Instrument
- ✓Develop databases for the main organizations that are involved in the management of water resources in the Syrdarya River basin

Country or Interstate Organizations	Name of Organization
Kyrgyzstan	1. JSC “Power Plants” 2. JSC “National Grids” 3. JSC “Electric Stations” 4. Water Resources Department of Ministry of Agriculture, Water Resources and Processing Industry of the Kyrgyz Republic
Kazakhstan	1. Dispatch Department of JSC “KEGOK” 2. KOREM 3. Water Committee of Kazakhstan 4. BVO Aral-Syrdarya 5. Chardara HEP Management Authority
Tajikistan	1. Ministry of Reclamation and Water Resources of the Republic of Tajikistan 2. Ministry of Energy of the Republic of Tajikistan 3. The Open Stock Holding Power Company “Barki Tojik” 4. Kayrakkum HEP Management Authority
Uzbekistan	1. SJSC “Uzbekenergo” 2. Water Resources Department of Ministry of Agriculture and Water Resources of the Republic of Uzbekistan
Interstate Organizations	1. IFAS 2. SIC-ICWC 3. BVO Syrdarya 4. UDC “Energiya” 5. IWEC 6. Hydromets of the four Republics

(2) Issues on intra-regional collaboration on water resources

The results of past studies and this study reveal the issues of intra-regional collaboration on water resources as follows:

1) Clarification of each country’s strategies for water resources management
   - i) National strategies for water resources management and existence of road maps (National IWRM Plan)
   - ii) Strategies for electric power supply and demand
   - iii) Implementation plan for national water resources management and arrangement of budget
   - iv) Capacity development of implementing organizations

2) Water-saving efforts
   - i) Review of water demand
   - ii) Water pricing policy
   - iii) Water-saving efforts in the agricultural sector
   - iv) Capacity development (water-saving action)
   - v) Reduction of water supply loss

3) Management method for water resources facilities in transboundary river
   - i) Determination of facility owners (national government or an agency)
   - ii) Basic rule for initial investment and classification of administrative and maintenance cost
   - iii) Funding associated with joint management and coordination of cost allocation

4) Simulation on water resources utilization

i) Collection of highly accurate data for long periods

ii) Reflection of actual water use for irrigation in the simulation

iii) Collecting of data for the calculation of the amount of damage (flood/drought)

iv) Rules for water use balance between irrigation and electric power

5) Cooperative operation of reservoirs

i) Improvement in accuracy of inflow forecasting, and monitoring (snowmelt runoff, glacier area, stream flow)

ii) Data sharing

iii) Planning of rules for cooperative operation

iv) Discussion on cooperative operation

v) Capacity development on cooperative operation

6) Improvement in monitoring system

i) Observation for inflow forecast by glacier, snow, snowmelt, and rainfall

ii) Observation of stream flow, water level, and water quality

iii) Observation of reservoir level and sedimentation

iv) Standardization of data communication protocol

v) Standardization of monitoring equipment

vi) Establishment of information centers (country level, regional level)

vii) Capacity development

7) Recovery of functions of infrastructures

i) Diagnosis of aging facility

ii) Prioritizing of facilities whose functions need to be recovered

iii) Operation and maintenance system

iv) Capacity development

8) Water Environment Conservation

i) Conservation of reservoir areas

ii) Water quality conservation

iii) Ensuring of environmental flow

Chapter 3. Current Issues and measures in the electric power field

3-1 Outline

The Central Asian Power System (CAPS) was planned and built in the Soviet era, and was then taken over by the five Central Asian countries. The System survived the collapse of the administration. Its plan was made based on regional characteristics; specifically, that primary energy is eccentrically-located and that the peak seasons for irrigation and power demand differ (the irrigation peak is in summer whereas the power demand peak in winter). This puts the highest priority on the irrigation use of water resources, so that electric power could be efficiently supplied in the entire region. Under this scheme, dams were built to generate power, in order to match the use of irrigation in water-rich areas in Kyrgyzstan and Tajikistan. Also, thermal power stations were built in fossil fuel-rich areas (such as natural gas), specifically in Uzbekistan, Kazakhstan (southern part) and Turkmenistan, located in the lower reaches of the river. The establishment of an interconnected high-voltage transmission system in the region allowed an efficient operating system, taking advantage of mutual characteristics of power station facilities.

Since their independence, the countries in question have owned and operated the power stations located in their respective territories. The conventional system used to be mutually supplemented, allowing stable power supply, and taking advantage of both hydroelectric and thermal power stations. However, it is no longer possible to secure a stable domestic power supply and difficulties have become obvious. Winter floods caused by power generation discharges of the Toktogul Reservoir to meet the power demands of Kyrgyzstan have occurred. This has led to a shortage of irrigation water supply in summer. With conflicts of interests among the countries, consensus decision making is not yet practiced.

The storage volume of the Toktogul Reservoir was recorded at its lowest in 2007 because of an increased electricity demand in Kyrgyzstan, due to a record cold winter season. Moreover, the inflow in 2008 has been lower compared to the actual record of these years. Water shortages for power generation during winter 2008 and for irrigation the following year were expected. Issues in the fields of water and power in Central Asia have therefore gotten more serious compared to the time of JBIC’s previous study in 2005.

Central Asian countries had meetings aiming at heading off the imminent problem in 2008, and agreed to re-introduce the conventional mutual cooperation system to mitigate the situation of this year.

In the previous JBIC study, the introduction of international power trade in Central Asia, which had advantages for stabilizing the power supply of each country, was recommended. In this section, the previous study has been reviewed and updated. As a result, the power supply became closer to the electricity demand because of an increased demand of electric power, but the development of power supply is delayed. Thus, power supply would not suffice for economical power trade even if it was introduced. To share the economical advantages of regional power trade among the Central Asian countries, the power supply in the area firstly needs to increase. Necessary measures to be taken are recommended in this report, based on our understanding of the current situation.

In addition, Turkmenistan was cut from the Central Asia power system at the time of the last JBIC study, and consequently started to export electricity to Tajikistan using the existing power network from 2007. From a regional cooperation viewpoint, it seems like a good movement, though Tajikistan has not officially reconnected.

3-2 Status and issues of the power field in Central Asian countries

3-2-1 Demand for electricity

After the independence in 1991, the aftermath chaos continued to influence and power demand in Central Asia declined. In the middle of the 1990's and thereafter, however, there has been signs of recovery. From the beginning of the year 2000, the power demand almost recovered to its level at the independence.

Figure 3-1 shows records of electric power generation and consumption from 1992 through 2005. The Central Asia Power System (referred to as CAPS) is a power network system in the following Central Asian countries; Uzbekistan, the southern part of Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan (Turkmenistan is currently cut off). Among these countries, Uzbekistan accounts for approximately 50% or more of the total electricity consumption.

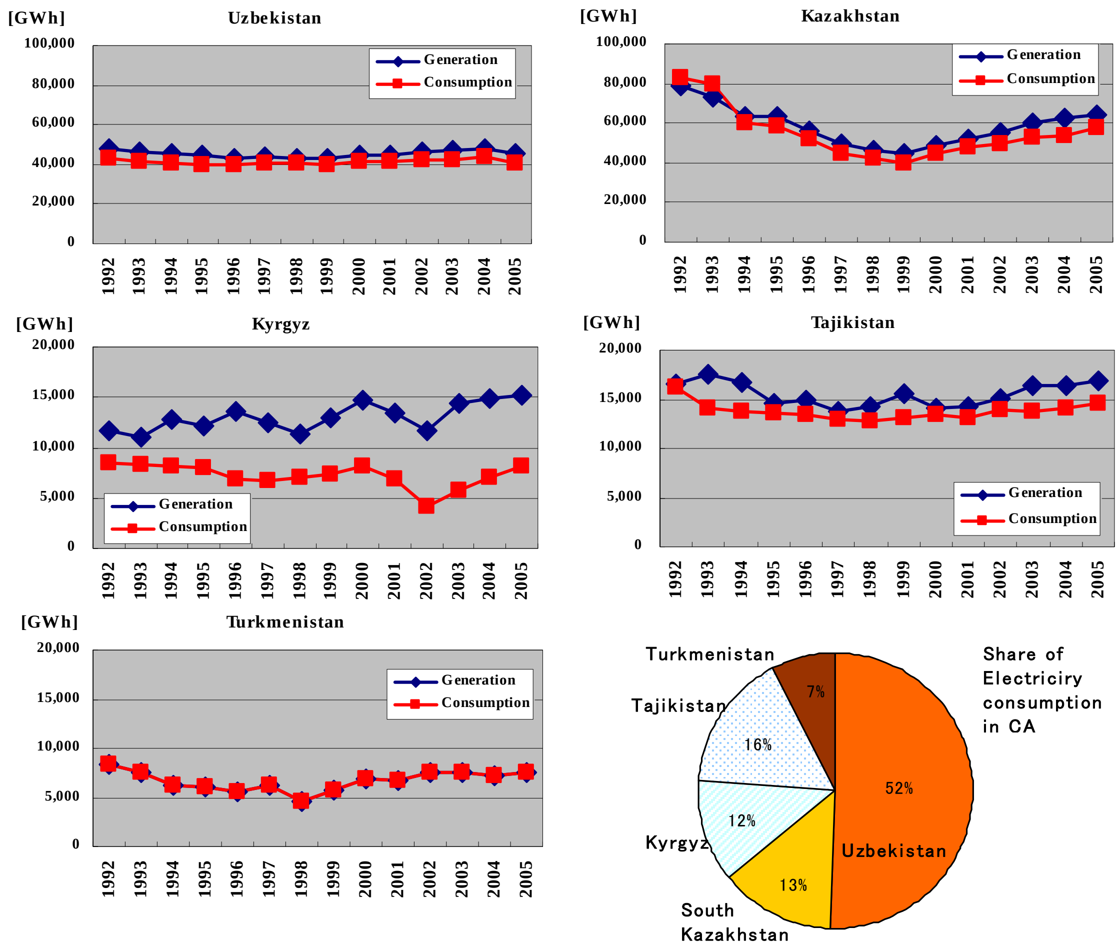


Figure 3-1 Power consumption and generation by the four countries in Central Asia

Source：DOE/IEA

In the year 2002, generation and consumption dropped in Kyrgyzstan. The reason of this phenomenon seems to be the lack of water storage capacity for generation because of the decrease of inflow observed that year.

According to Figure 3-1, the power demand of Uzbekistan seems to have declined in 2005. Meanwhile, it was related in an interview of this Study that the demand in 2006 and 2007 showed a 1 to 2 % growth per year. Electricity demands in the other countries of Central Asia are also following the same trend. No substantial change of trend is observed, but the record cold winters in 2007-08 provoked an increased electricity demand and caused deaths in Tajikistan. The situations surrounding the countries studied and mentioned in the previous JBIC study in 2005 are shown in Box3-1.

Box3-1 Situations surrounding the countries

(a) Uzbekistan

In Uzbekistan, due to the economic chaos after that followed the independence, power consumption growth was sluggish, in line with a slowdown in industrial use. However, during in 1995 and 1996, the consumption slightly increased, exceeding the 1992 figure in 2002. The peak demand in 2004 was 7,809MW, a low increase of about 0.2% as compared to that of the previous year. The annual generation was 49,483GWh, with a total demand of 49,200GWh. Kyrgyzstan and Tajikistan are the main trade partners in the power export/import for Uzbekistan. As there is a greater water demand in the summer irrigation season, the country imports hydroelectric power from Kyrgyzstan and Tajikistan, and exports it in winter.

Uzbekistan mainly depends on thermal electric power generation; the reservoir type hydropower stations supply electricity for the peak demand, such as the Charvak hydropower station (600MW) in the uppermost reaches of the Chirchic River. However, these hydropower stations cover not more than 10% of the total power supply capacity. How to secure a peak power supply is represents an actual and future current and future challenges.

(b) Kazakhstan

After the independence, there was a significant decrease in power demand for all of Kazakhstan. Due to sluggish domestic industries, power consumption, approximately 86,200 GWh in 1992, took a declining path to as low as 44,800 (GWh) in 1999. Since then, however, the economy took a favorable turn thanks to the economic reform and the expansion of imports, whereas power consumption also began to increase.

Since the independence, Kazakhstan has been an importer of power. However, in recent years, its imports and exports are well balanced, and in 2002, its exports exceeded its imports.

In the southern part of Kazakhstan, the peak demand was 2,440 MW in 2004. Its annual generation was 6,771 GWh, while the total demand was 12,967 GWh (estimated using a load curve of each month); which demonstrating a shortage of power in general. Also, the peak demand in the southern part of Kazakhstan, centering on Almaty, showed approximately 6% growth annually. Thus, the region receives the electric power from the northern system, which is the main system in Kazakhstan. The country has also made kW–base agreements with Kyrgyzstan and Tajikistan to deal with its peak demand.

(c) Kyrgyzstan

Power demand in Kyrgyzstan has been on a declining path since the middle of the 1990’s. On average, however, it shows an increasing trend. In 2004, the country’s peak demand was 2,657 MW with an annual generation of 14,944 GWh, and the total demand was 11,737 GWh. Kyrgyzstan adopted a policy to shift the domestic energy consumption structure from fossil fuel to electric power. This may reflect the spread of electric heaters which have come to be used more commonly. Also, the country’s power generation exceeds power demand, demonstrating that Kyrgyzstan is a power exporter with hydropower generation centrally.

Electric power in Kyrgyzstan is mainly generated by hydropower stations as typified by the Toktogul hydropower station. These hydropower stations are located in the upper reaches of the Syrdarya River (the Naryn River). Hydropower generation in Kyrgyzstan plays a role in supplying peaking power in the countries of Central Asia, contributing to controlling frequencies. On the other hand, the purpose of the water management of the Toktogul Reservoir was to supply irrigation water in summer to Uzbekistan and Kazakhstan, which are situated on the lower reaches, and in winter to Kyrgyzstan, when the country has a greater demand for power and its operation will be restricted from the viewpoint of flood control. However, as no alternative measures are available in Kyrgyzstan; the Toktogul hydropower station continues high output generation in order to supply its domestic peak demand, which has caused a flood problem in the lower reaches during winter in recent years.

(d) Tajikistan

Power demand in Tajikistan slightly increased in 1997; it has however not yet recovered to its 1992 level. In 2002, according to a survey carried out by the World Bank, the peak demand was 2,901 MW with an annual generation of 15,224 GWh, and the total demand was 16.016 GWh. Although until around 1999 the power generation exceeded the power demand, the supply capacity has not caught up to the demand since 1999. As for import and export of electric power, exports exceeded imports until 1999; but since then, the export quantity has significantly decreased. During these years, Tajikistan suffered from a shortage of electric power, in particular, in the winter when the demand is the highest.

Aluminum plants, the only and largest domestic industry in Tajikistan, accounts for approximately 30% of all domestic demand.

3-2-2 Power generation facilities in Central Asia

Table 3-1 shows the status of power generation in Central Asia. The electric power systems in Kazakhstan are divided into two distinct parts: the northern and the southern power systems. These systems are connected by a single circuit of 500 kV power transmission line, and an additional transmission line for increasing the capacity is now under construction. At this time, the survey covered only the system of the southern part of Kazakhstan included in CAPS, and the status of the southern system was noted elsewhere. As Turkmenistan has been cut off from the CAPS system, its power generation system is still shown together, for reference.

The installed capacity of the three countries in Central Asia (Uzbekistan, Kyrgyzstan and Tajikistan) and the southern system of Kazakhstan is approximately 23,000 MW. However, due to the aging power station facilities in the region, the available capacity at present has decreased to approximately 20,000MW with a reserve margin of 20%.

As for power generation facilities, hydropower generation accounts for some 40% and thermal power generation makes up the rest for the entire region, excluding Turkmenistan. Of all power capacity covered in the entire Central Asian area, the power generation facilities in Uzbekistan account for about 52%, Tajikistan for 19%, Kyrgyzstan for 16%, and the southern part of Kazakhstan for 13%.

The commercial operation commencement of new power plants, such as Tupolong hydropower (1st unit 30 MW) and Akhangaran hydropower (21 MW) in Uzbekistan, was scheduled at the time of JBIC’s last study, in 2005. Unfortunately these have not yet been completed. Therefore, no additional power supply has been developed since then.

Table 3-1 Outline of power generation in Central Asia

Item	Uzbekistan	Kazakhstan		Kyrgyz	Tajikistan	(Turkmenistan)	Total (Except Turkmenistan)	
		Whole	South				4countries	3Co.+South Kazakh
Installed capacity(MW)	11,993	18,240	2,924	3,709	4,377	(3,921)	38,319	23,003
- Hydro (MW)	1,394	2,000	525	2,950	4,059	(1)	10,403	8,928
- Thermal(MW)	10,599	16,240	2,399	759	318	(3,920)	27,916	14,075
Power Generation (GWh)	49,483	58,178	6,771	14,944	15,224	(11,191)	137,829	86,422
- Hydro (GWh)	5,512	8,861	2,248	13,942	15,086	(3)	43,401	36,788
- Thermal(GWh)	43,971	49,317	4,523	1,002	138	(11,188)	94,428	49,634
Available Capacity (MW)	10,223	13,840	2,538	3,493	3,438	-	30,994	19,692
Peak demand (MW)	8,247	11,086	2,868	2,726	2,512	-	24,571	16,353
Electricity consumption (GWh)	50,021	82,354	18,117	15,331	15,291	(8,908)	162,997	98,760

Source: Uzbekenergo, KEGOC, JSC Power Station of Kyrgyzstan, WB REEPS Report (2005)

Component ratio of thermal power and hydropower of each country are shown in Figure 3-2.

On the one hand, thermal power in downstream countries accounts for more than 80% of the installed capacity. On the other hand, hydropower is major in upstream countries. Therefore, a regional difference is apparent and reflects an uneven distribution of primary energy.

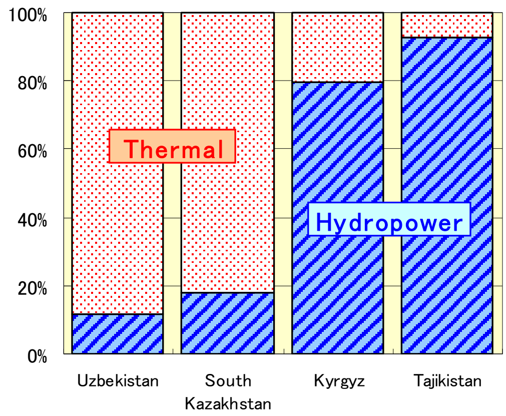


Figure 3-2 Component ratio of thermal/hydropower plants

Source: data from Table3-1

(1) Thermal power generation facilities

Outlines of thermal power generation facilities in the Central Asian region are shown in Table 3-2.

In Uzbekistan, thermal power is mainly generated by burning gas and heavy oil since the country ranks eighth, in the production of natural gas in the world. The first unit of the Talimarjan thermal power Station (800 MW) started commercial operations in 2004. But most of the other power stations launched their operations during the 1960's and the 1970's. The decreased heat efficiency caused by aged facilities requires their replacement.

In the southern part of Kazakhstan, thermal power is major as well as in Uzbekistan. Natural gas is supplied by pipelines via Uzbekistan. There are coal fired thermal power stations such as Almatynskaya that use coal produced in Karaganda and Ekibastus.

In Kyrgyzstan there are three thermal power plants with an installed capacity of 759 MW, mainly using gas, oil and coal. However, the produced power is not sufficient due to the lack of fuel and the aged power plants.

Tajikistan has two thermal power stations with an installed capacity of 318 MW. The fuels are oil for the Dushanbe Thermal Power Station and gas for the Yanvan Thermal Power Station.

Table 3-2 Outline of thermal power generation facilities in Central Asia

Name of TPP	Rated capacity (MW)	Max. available capacity (MW)	Nos of Units	Fuel type	Comissioning year	Remarks
(Uzbekistan)						
Syrdarya TPP	3,000	2,095	10	Gas/Heavy oil	1972-1981	#5: Stop
Novo-Angren TPP	2,100	1,750	7	#1-5: Coal/Heavy oil #6-7: Gas/Heavy oil	1985-1988 1991-1995	
Tashkent TPP	1,860	1,750	12	Gas/Heavy oil	1963-1971	
Navoi TPP	1,100	990	11	Gas/Heavy oil	1963-1981	
Angren TPP	484	484	8	Coal/Heavy oil	1957-1963	
Takhiatash TPP	730	630	5	Gas/Heavy oil	1967-1989	
Talimarjan TPP	800	700	1	Gas	2004	
Fergana CHP	395	305	6	Gas/Heavy oil	1956-1979	
Mubarek CHP	100	100	2	Gas	1985-1986	
Tashkent CHP	30	25	1	Gas	1954	
Total (Uzbekistan)	**10,599**	**8,829**	**63**			
(South Kazakhstan)						
Almatynskaya CHP-1	145	117	3	Coal/Heavy oil	1970,71,96	
Almatynskaya CHP-2	510	380	6	Coal/Heavy oil	1980-1989	
Almatynskaya CHP-3	173	156	4	Coal/Heavy oil	1962-1965	
Tekelyiskaya CHP-2	24	24	2	Coal/Heavy oil	1959-1960	
Djambulskaya TPP	1,230	1,104	6	Heavy oil/Gas	1967-1976	
Djambulskaya CHP-4	60	35	2	Heavy oil/Gas	1963	
Shimkent CHP-1	18	7	3	Heavy oil/Gas	1955-1964	
Shimkent CHP-2	12	6	2	Gas	1953-1954	
Shimkent CHP-3	160	119	2	Heavy oil/Gas	1981-1983	
Kzylordinskaya CHP-6	67	65	2	Heavy oil	1976,98	
Total (South Kazakhstan)	**2,399**	**2,013**	**32**			
(Kyrgyz)						
Bishkek CHP	674	514	10	Coal	1961-	
Osh CHP	50	32	2	Gas/Heavy oil	1966-	
Other			-	-		Block plant
Total (Kyrgyz)	**724**	**546**	**-**			
(Tajikistan)						
Dushanbe TPP	198	-	4	Heavy oil/Gas	1955-	
Yanvan TPP	120	-	2	Gas	1969-	
Total (Tajikistan)	**318**	**220**	**6**			

Source: Uzbekenergo, NDC, KEGOC, JSC Power Station of Kyrgyzstan, WB REEPS Report, etc.

(2) Hydropower generation facilities

Table 3-3 shows an outline of hydropower facilities in the Central Asian countries. There are large-scale hydropower stations in the upper reaches of the Syrdarya and Amu Darya Rivers, situated in Kyrgyzstan and Tajikistan. Of the four countries (Kyrgyzstan, Tajikistan, Uzbekistan and the southern part of Kazakhstan) 78% of the hydropower facilities are concentrated in the first two mentioned countries.

Table 3-3 Outline of hydropower facilities in Central Asia

River basin	Name of HPP/Cascade	Rated capacity (MW)	Nos of Units	Comissioning year	Remarks
(Kyrgyz)					
Narin river (Syrdarya)	Toktogul HPP	1,200	4	1985	
	Kurpsay HPP	800	4	1981	
	Tashkumir HPP	450	3	1985	
	Shamardisai HPP	240	3	-	
	Uchikurgan HPP	180	4	1981	
Other	Small HPPs (3)	80	-	-	
Total (Kyrgyz)		**2,950**			
(Tajikistan)					
Narin river (Syrdarya)	Kairakum HPP	126	6	1951-1957	
Vakhsh river (Amudarya)	Nurek HPP	3,000	-	1972	
	Baipaza HPP	600	-	1984	
	Golobnaya HPP	240	-	1962	
	Perepadnaya HPP	30	-	1958	
	Central HPP	15	-	1964	Stop since 1996
Other	Small HPPs	35	-	-	
Total (Tajikistan)		**4,046**			
(Uzbekistan)					
Chirchik river (Syrdarya)	Charvak HPP	600	4	1970-1972	
	Khodjikent HPP	165	3	1976	
	Gazalkent HPP	120	3	1980	
	Chirchik cascade (3 HPPs)	191	10	1941-1956	
	Kadyriya cascade (4 HPPs)	45	8	1933-1946	
	Tashkent cascade (4 HPPs)	29	10	1926-1954	
	N-Bozsu cascade (5 HPPs)	51	10	1944-1960	
Syrdarya river	Fakhad HPP	126	4	1948-1960	
Other	Shahrikhan cascade (4 HPPs)	28	6	1943-1965	
	Samarkand cascade (4 HPPs)	40	9	1945-1967	
Total (Uzbekistan)		**1,394**			
(South Kazakhstan)					
Syrdarya river	Shardara HPP	100	4	1958-1966	
Other (Ili river)	Kapchagai HPP	364	4	1970-1971	
Other	Almatynskaya cascade (10 HPPs)	47	16	1943-1963	
	Small HPPs (4)	14	9	1953-1963	
Total (Southern Kazakhstan)		**525**			

Source: Uzbekenergo, NDC, KEGOC, JSC Power Station of Kyrgyzstan, Barki Tojik, etc.

3-2-3 Interconnection of the power network system in the region

(1) Current situation

Figure 3-2 shows the Central Asian Power System (CAPS) formed in the Soviet Union era, under which, Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan were connected with bulk power transmission lines of 500 kV and 220 kV. The total length of the transmission line was 1,573 km for 500 kV, and 1,352 km for 220 kV. The outline of the transmission network is shown in Table 3-4. The Numbers in the table match those in Figure 3-2, which indicate a transmission line.

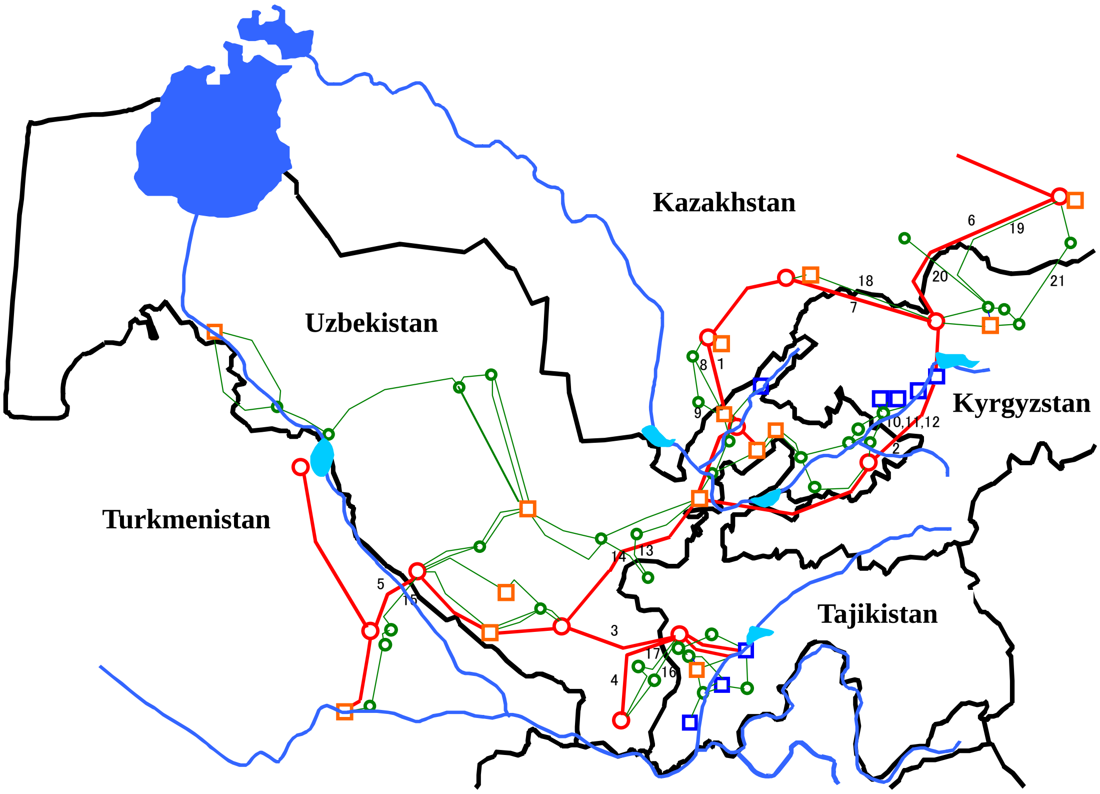


Figure 3-2 Outline of the Central Asian Power System (CAPS)

Table 3-4 Outline of the transmission network in Central Asia

No.	Line	Point 1	Point 2	Voltage (kV)	Length (km)	Capacity (MVA)
Uzbekistan - Kazakhstan						
1	L-501	Tashkent TPP	Chimkent SS	500	104.3	2000
8	L-2-4	Tashkent TPP	Chimkent SS	220	117.21	360
9	L-2-D	Tashkent TPP	Djilta SS	220	110.5	360
Uzbekistan - Kyrgyz						
2	L-504	Lochin SS	Toktogul HPP	500	178	2000
10	L-Kr-U	Yulduz SS	Kristall SS	220	62	314
11	L-Kr-S	Sardor SS	Kristall SS	220	69.3	314
12	L-Kr-K	Kyzyl-Ravat SS	Kristall SS	220	28.1	524
Uzbekistan - Tajikistan						
3	L-507	Guzar SS	Regar SS	500	250.3	2000
4	L-508	Surkhan SS	Regar SS	500	162.3	2000
13	L-Rudaki	Sary-Bazar SS	Rudaki SS	220	86	314
14	L-Samarkand	Samarkand SS	Rudaki SS	220	86.35	314
16	L-R-Sh	Sherabad SS	Regar SS	220	49.5	118
17	L-R-G	Gulcha SS	Regar SS	220	45	118
Kazakhstan - Kyrgyz						
6	L-514	Almaty SS	Bishkek SS	500	298.6	1897
7	L-515	Djambul SS	Bishkek SS	500	210.8	2143
18	L-D-F	Djambul TPP	Bishkek SS	220	178.4	263
19	L-A-G	Almaty SS	Glavnaia SS	220	198.7	263
20	L-G-Ch	Shu SS	Glavnaia SS	220	173.8	263
21	L-B-Z	Zapadnaiy SS	Bistrovka SS	220	80	263
Uzbekistan - Turkmenistan						
5	L-512 (off)	Karakul SS	Serdar SS	500	369	2000
15	L-K-4 (off)	Karakul SS	Chardjou SS	220	67.4	314

Source: Uzbekenergo, NDC KEGOC

The 500 kV transmission system forms a central loop linking each connecting point in the eastern part of Uzbekistan (Syrdarya TPP, Tashkent SS, Lochin SS, Tashkent TPP), the southern part of Kazakhstan (Djamble SS, Chimkent SS) and Kyrgyzstan (Bishkek SS, Toktogul HPP). The southern network system of Kazakhstan, which forms a portion of the central loop, connects with the northern network system of Kazakhstan via a 500kV transmission line from Almaty. This system also connects to the Russian network system.

The route of these transmission lines was designed without considering the borders of the countries, since these were planned and constructed during the Soviet era. Consequently, unreasonable issues such as the necessity of a consignment fee for transmitting through other countries even in the case of sending electricity to one's own territory rose up. Therefore, consensus building needs time.

There is news that Uzbekistan constructed a 500 kV transmission line within its borders for the electricity supply to the territory of the Fergana valley. Likewise, the construction of a transmission line between Kambarata in Kyrgyzstan and Dushanbe in Tajikistan, which route does not go through the territory of Uzbekistan, is ongoing, and is planned to be completed in September 2009. The construction between Kambarata and Khojend is now in preparation stage, whereas the part between Khojend and Dushanbe is under construction with the support from a Chinese loan.

A power purchase agreement for supplying electricity from Tajikistan to Afghanistan was agreed in August 2008, and the construction of a transmission line is in process; the construction in Afghanistan has already started, and the construction of the Tajikistan part will start from the spring of 2009. Moreover, further extension plans of transmission lines to Pakistan and Iran exist.

(2) Use of the interconnection network

Turkmenistan has been separated from CAPS since May 2003, and has a connection system with Iran since then. In 2007, a power purchase agreement was made for the purpose of measure for electricity shortage of Tajikistan in the coming five years, therefore transmission line partially connected to CAPS. At this moment, it has not yet been agreed among the relevant three (3) countries whether to reinclude Turkmenistan in the CAPS or not.

Under such power transmission networks in the region, the Unified Dispatch Center (UDC) in Tashkent monitors and controls the demand-supply balance, power voltage and frequency. In 2007, UDC was renamed to Nongovernment Noncommercial Organization Coordinating Dispatcher Center <Energy> (CDC) in preparation for the future introducing power market. As of now, CDC has taken over a function of UDC with operation facilities.

3-2-4 Approaches of each government for power supply

(1) Uzbekistan

Since unit No.1 of the Talimarjan Thermal Power Station (800 MW) started operations in 2004, the power supply in Uzbekistan has been rather stable during these years compared to the other countries in Central Asia. Recently, fossil fuel supply for power generation (Natural gas and mazut) became low since the electricity demand has been increasing. This explains the shortage in power supply. Increasing power supply capacity, including the replacement of the aging power plants remains a priority issue. The construction of a combined cycle plant, which installed capacity is 370 MW, is ongoing in Tashkent Thermal Power with the support of JICA. NEDO started assistance for the study on power facility improvement of Tashkent combined heat and power station.

A Presidential Decree on energy efficiency was issued in November 2008. An Action Plan including the review of power development plans is conducted. Study items such as efficiency improvement, utilization of domestically produced energy, introducing renewable energy, new development of power plants (930 MW) and repair of aging power plants (250 MW) are considered in the study. Envisaged candidates of power plant to be developed are the extension of the Navoi thermal power station, the construction of the Pskem hydropower station, the construction of a 2nd unit of the Talimarjan thermal power station, and finally the reformation of fuel conversion (from Natural gas to coal) of the Novo-Angren thermal power station.

The Ministry of Agriculture and Water Resources is in charge of the development of small to middle scaled hydropower plants. The construction of the Akhangaran hydropower station (21 MW) is conducted.

(2) Kazakhstan

In Kazakhstan, most of the power stations are located in the northern part of the country, and the southern part suffers from power shortages during winter. Furthermore, in the southern part of Kazakhstan, the peak demand has been increasing at a pace of some 6% annually.

In these years, electricity import utilizing CAPS becomes not possible because of a shortage of power supply in each of the connected countries; Uzbekistan, Kyzguzstan, and Tajikistan. Moreover, electricity supply from the northen power system in Kazakhstan is limited due to power transmission capacity. Therefore, southern Kazakhstan is forthed to use low efficiency thermal power plants to meet the peak demand.

Measures have been taken by the government of Kazakhstan and a stable power supply will be available. The enhancement of the 500 kV transmission network system between the south and the north is scheduled to be completed in 2009 (some parts have been in operation since September 2008). At the same time, a new natural gas pipeline to southern Kazakhstan, which was formerly planned to be connected to China for export, is planned.

In addition to the above, power development in the territory of Kazakhstan was planed and the construction of thermal and hydro power plants (8,100 MW; 5,400 MW of new power station, 2,700 MW of improvement and increasing capacity of existing plants) are being conducted.

There is a policy to reduce electricity consumption, and long term plan was issued for stable power supply and cost reduction. Modernization and efficiency improvement of power facilities by introducing new technology is planned. The modernization of domestic power network, due to the improvement of sub-stations and communication systems, is now in the final stage.

To reduce electricity consumption per capita, the expansion of electricity tariff, from 1 - 2 ¢ /kWh to 6 ¢ /kWh, is planned for evocation of energy efficiency. The introduction of natural/

renewable energy and nuclear power is also considered in the plan.

(3) Kyrgyzstan

The winter electricity demand is largest in Kyrgyzstan, since most of the heating depends on electricity. Especially in sever winters, it increases more. Thus, electricity demand increased in the winter 2007-08, and the water storage of the Toktogul Reservoir was then reduced. Moreover, inflow to the Toktogul Reservoir was smaller than that of the last several years, water level reduced almost to the dead water level of the reservoir in summer of 2008. It is forecasted that the winter 2008-09 will be severe, which makes the securement of electricity supply an urgent issue for this winter.

The generation release of the Toktogul Reservoir was increased in order to meet the electricity supply when increased. This operation method is not reasonable, as mentioned in section 3-3-3, therefore, the proper reservoir operation of Toktogul considering yearly change of inflow and the development of power supply are needed.

A rich hydropower potential has remained in Kyrgyzstan. Kambarata I（1,900 MW） and Kambarata II (240 MW) are the prioritized hydropower projects in Kyrgyzstan, and a feasibility study is currently on going and the projects are planned to be constructed with the support of Russia, Kazakhstan, and China.

Nevertheless, the rehabilitation of Toktogul hydropower station and Naryn cascade power stations is needed. Furthermore, the maintenance / replacement of the facilities and the aging control system and electromechanical equipments should be scheduled, as over 30 years have passed.

(4) Tajikistan

Tajikistan, blessed with a rich hydropower potential, puts the highest priority on developing new hydropower stations. This policy is not only aimed at addressing power shortage in the country, but also at exporting electric power. Although the country lacks of natural resources, hydropower is the only promising resources with much expectation. (The local aluminum industry imports mineral ores from Ukraine, and refines them using electric power).

Specifically, Sangtuda I hydropower station (670 MW) is under construction with the assistance of Russia and is scheduled to be completed in 2009. Sangtuda II is also planned to develop with the support of Iran and will be in operation in 2010. The construction of the Rogun hydropower station (3,600 MW) is now in final stage, and unit No.1 and 2 will start generation from year 2012. The development of these hydropower plants enables the resolution of the domestic electricity supply shortage. Moreover, the surplus electricity is planned to be exported.

There are many planned hydropower projects and Tajikistan intends to develop them in series. They are expected to contribute to an effective use of water resources in the Amu Darya River basin, as well as to an effective reduction of flood damages in the lower reaches of the basin. It should be noted here that Uzbekistan, downstream reach of Tajikistan, has consistently been opposed to the development of dams. Therefore, consensus building is needed.

3-3 Current situation and issues on generation in the Syrdarya River basin

3-3-1 Hydropower potential of Central Asian countries

Primary energy in Central Asian countries is unevenly distributed between upstream reach countries, where the hydropower potential is rich, and downstream reach countries, where the fossil fuel potential is rich, as shown in Table 3-5. For example, the hydropower potential of Uzbekistan and Kazakhstan, that are downstream reach countries, is respectively about 1/11 and 1/6 of Kyrgyzstan's potential, located in upstream reach.

The ratios of developed hydropower to potential of downstream reach countries are higher than upstream countries. Upstream countries are underdeveloped. It seems to be reflected that most of the hydropower plants were planned together with large scaled irrigation system, and the construction started from irrigation land and water supply facilities such as canals and major reservoirs. Then, the development of upstream dams started but stopped in the midway at the breakup of the Soviet Union.

Table 3-5 Hydropower potential (GWh/year)

	Uzbekistan	Kazakhstan	Turkmenistan	Kyrgyzstan	Tajikistan
Hydropower potential	15,000	27,000	2,000	163,000	317,000
Annual generation	5,512	8,861	3	13,942	15,086
Remained potential	9,488	18,139	1,997	149,058	301,914
Developed Percentage	37%	33%	0%	9%	5%

Source：REEP, WB, 2004, JBIC Study in 2005

The location of hydropower stations is studied and planned in suitable points, not only considering river discharge but also topographic/geological features. The development order of the planned hydropower stations in an area is generally decided to start from the most economical, the nearest candidate from the demand center, and the easiest to access candidate. There are economically unfeasible candidates included in the hydropower potential; viable candidate projects are therefore limited.

There is more flat land in the downstream reach countries, which generally makes the access to the planned hydropower sites easier compared to the sites in upstream reach countries. Hydropower projects in the downstream reach countries have been more developed, even though the hydropower potential is smaller. Accordingly, only a few hydropower candidates remained in the downstream reach countries. For example, Pskem hydropower station (404 MW) is the only large scaled project that remained in Uzbekistan.

However, there are undeveloped hydropower sites left in the upstream reach countries. Hydropower potential in Tajikistan is shown in Table 3-6. The annual generation of the viable potential hydropower is estimated at 117,700 GWh, which is almost equivalent to the current electricity demand of Central Asia.

In Kyrgyzstan, 38 hydropower stations located mainly in the Naryn River, and of which the installed capacity was 5,400 MW in total were planned in the Soviet era. Unfortunately, the feasibility study for most of these plans has not yet been conducted. Therefore, further studies, investigations and designs for the selection of large scaled hydropower, which will be developed next to the Kambarata hydropower, should be planned and conducted. There is the intention to develop small scaled hydropower in Kyrgyzstan, but most of these projects seem not able to generate in peak demand season in winter because of the freezing of the river. Therefore, it is recommended that each project plan be reviewed before any development is decided.

Table 3-6 Hydropower potential in Tajikistan

River	Hydropower Potential	Technically and economically viable potential	Ratio of viable potential
Pianj	122.9 ×1000 GWh	82.0 ×1000 GWh	67%
Kafirnigan	37.2 ×1000 GWh	8.7 ×1000 GWh	23%
Surhob/Obihingoy	26.3 ×1000 GWh	16.4 ×1000 GWh	62%
Zeravshan	33.9 ×1000 GWh	10.6 ×1000 GWh	31%
Total	220.3 ×1000 GWh	117.7 ×1000 GWh	53%

Source：Barki Tojik

3-3-2 Current situation of hydropower stations in the Syrdarya River basin

There are hydropower stations developed in the Syrdarya river basin as shown in Table 3-7. As shown in Figure 3-3, there are Naryn cascade hydropower stations upstream of Narin River, which is one of the main tributary of Syrdarya River. Downstream of these, are located the Kairakum and the Chardara hydropower stations developed with irrigation reservoirs, and the Falkhad hydropower station is located beside an irrigation canal. In the Chirchic River, a tributary of the Syrdarya River, there are Chirchic cascade power stations.

The installed capacity of the two cascade stations accounts for 92% of the total capacity of the existing hydropower stations. The Naryn cascade hydropower stations are located in Kyrgyzstan, with a total installed capacity of 2,870 MW, whereas the Chirchic cascade hydropower stations are located in Uzbekistan, with a total installed capacity of 1,200 MW.

Table 3-7 Hydropower stations in the Syrdarya River basin

Country	Name of HPP/Cascade	Rated capacity (MW)	Nos of Units	Generation in 2004 (GWh)	Plant Factor	Remarks
Kyrgyz	Toktogul HPP	1,200	4	4,400	42%	Naryn cascade
	Kurpsay HPP	800	4	2,630	38%	ditto
	Tashkumir HPP	450	3	1,555	39%	ditto
	Shamardisai HPP	240	3	902	43%	ditto
	Uchikurgan HPP	180	4	820	52%	ditto
Tajikistan	Kairakum HPP	126	6	650	59%	Generation year is uncertain
Uzbekistan	UltraChirchik cascade(3HPPs)	885	10	3,690	48%	
	Chirchik cascade (3 HPPs)	191	10	1,219	73%	
	Kadyriya cascade (4 HPPs)	45	8	337	86%	
	Tashkent cascade (4 HPPs)	29	10	145	57%	
	N-Bozsu cascade (5 HPPs)	51	10	234	53%	
	Fakhad HPP	126	4	562	51%	
Kazakhstan	Chardara HPP	100	4	582	66%	
Total		**4,422**		**17,726**		

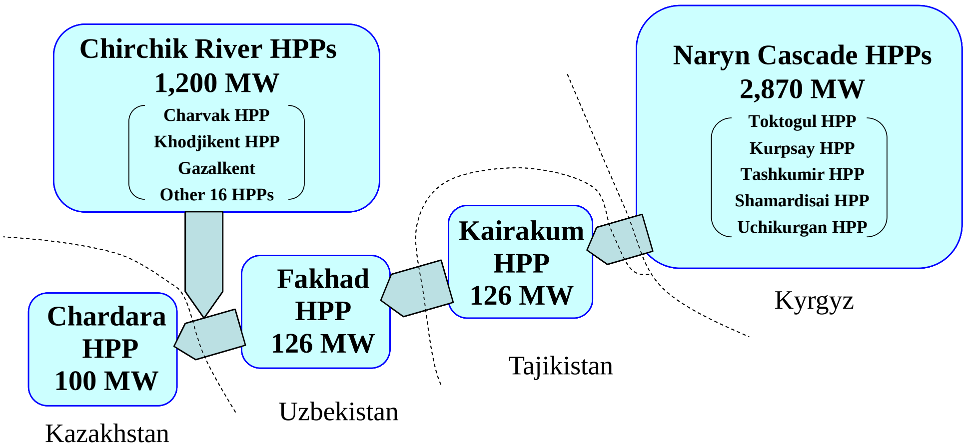


Figure 3-3 Hydropower stations in the Syrdarya River basin

Among these hydropower stations, the Naryn cascade hydropower are located downstream of the Toktogul Reservoir. The regulation capacity of each station (except for the Toktogul hydropower, which is located at Toktogul Reservoir), is small enough to be subject to the operation of the Toktogul Reservoir, which has a large storage capacity. The capacity factor is about 40% in average, which seems reasonable since spill discharge without generation is small and these stations were designed for peaking supply.

The capacity factor of the Ultra Chirchic cascade stations, located at the upstream of Chirchic cascade stations, is about 50%. These hydropower stations were also designed as peaking supply, just as the Naryn cascade hydropowers, and therefore seem to be in a reasonable range. The hydropower stations of Chirchic River, located between the Chirchic cascade and the confluence with the Syrdarya River are run off type. There generation is subject to discharge from upstream. The plant factor of these power stations ranges between 53% and 86%. Generations of some stations are lower. The aging of facilities seems to influence these numbers.

There are reservoir type hydropower stations, located at the dam/reservoir. These are the Kayrakkum hydropower station in Tajikistan and the Chardara hydropower station in Kazakhstan.

Both of these hydropower stations generate when irrigation discharge is needed or redundant water is there. Thus, generation decreases during the storing period for irrigation use of the next season. Considering these conditions, the plant factor of these hydropowers is in a fair range. In addition, the rehabilitation of the Chardara hydropower station is on going. In the Kayrakkum hydropower, a rehabilitation plan has been implemented, with the assistance of Czech.

Existing hydropower stations are planned and developed in the middle reach of Syrdarya River and its tributary Chilchic River, where the river flows from a steep valley to a plain, and has a larger head, such as beside a dam / waterway canal. Accordingly, there are only a few possibilities of developing additional viable hydropower, except for those utilizing less than 20 m of small head, in the area already developed. Meanwhile it seems that the potential for large scaled hydropower remains upstream of the developed area.

Based on the above, it seems that the development of Syrdarya River has been almost fair. The following issues should be considered with regard to development/rehabilitation of hydropower stations in Syrdarya River basin.

- Planned replacement including the enhancement of installed capacity is needed due to the aging of the power facilities.
- There seems to be possibilities for new large scaled hydropower in the upstream reach of the developed power stations., Studies are therefore needed for the nomination of viable projects, based on technical/economical evaluations. For example, project plans upstream of Kambarata hydropower station in Kyrgyzstan and Pskem hydropower plan located upstream of Chirchic River exist.
- Regarding the further development of the area, where many hydropowers are already developed, there seems that small-scaled and/or lower head hydropowers remain. From an energy utilization point of view, these are better to be developed, when economically viable.

3-3-3 Toktogul Reservoir / Naryn cascade hydropower stations

(1) Features of the Naryn cascade hydropower stations

Naryn cascade hydropower stations, located downstream of Toktogul Dam/ Reservoir, consist of the power stations mentioned in Table 3-8. The annual generation of this cascade accounts for 97% of the hydropower generation, and 77% of the total generation in Kyrgyzstan. Accordingly, the operation of the Naryn cascade, especially for the Toktogul hydropower (located uppermost stream of the cascade and has the largest scale in the cascade) plays quite an important role, which affects a stable power supply.

Table 3-8 Naryn cascade hydropower stations

Name	Installed Capacity	Number of unit / unit capacity	Maximum discharge	Year of completion
Toktogul HPP	1,200 MW	4 x 300 MW	924 m^3/s	1985
Kupsay HPP	800 MW	4 x 200 MW	972 m^3/s	1981
Tashkumyr HPP	450 MW	3 x 150 MW	950 m^3/s	1985
Shamaldysay HPP	240 MW	3 x 80 MW	1,035 m^3/s	N/A
Uchkurgan HPP	180 MW	4 x 45 MW	720 m^3/s	1961
Total	2,870 MW	-	-	-

(2) Operation of Toktogul Reservoir and power station

The Toktogul hydropower station was planned and developed mainly for irrigation purpose of the downstream reach countries. Central Asian countries attained independence after the collapse of the Soviet Union, and the Toktogul Reservoir was then owned and operated by Kyrgyzstan.

As already mentioned, the installed capacity of Naryn cascade is dominantly larger. Moreover, there are disadvantages regarding the thermal power in Kyrgyzstan such as greater risk caused by the necessity of fuel import and the higher generation cost. Therefore, electricity supply in Kyrgyzstan heavily depends on hydropower.

The monthly generations of the Naryn cascade hydropowers since 1991 are shown in Figure 3-4. In these records, the summer peaks, that depend on irrigation use, describe a decreasing trend, whereas the winter ones, for electricity need, are noticeably increasing since 2002. These trends fit together with recent changes of operation of the Toktogul Reservoir from irrigation mode to generation mode.

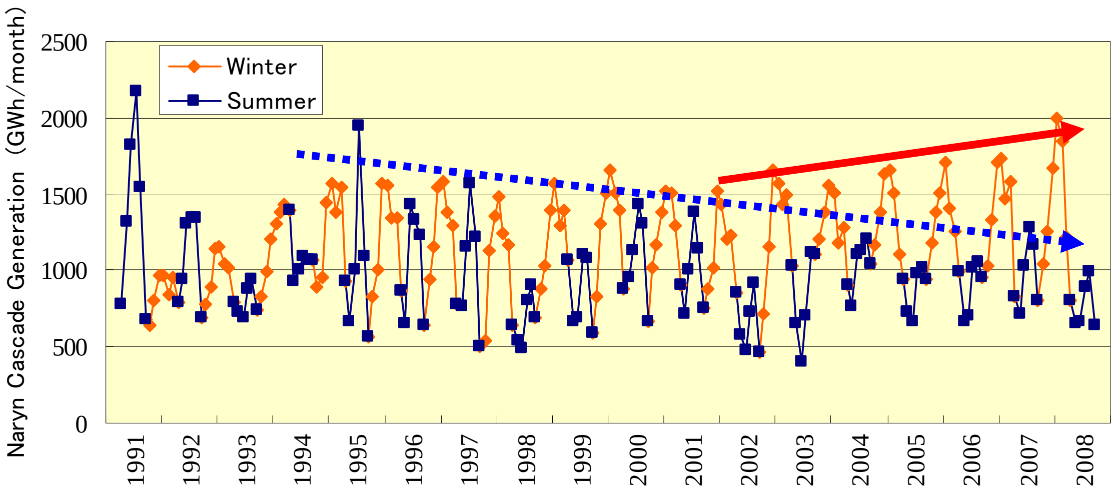


Figure 3-4 Monthly generation of Naryn cascade hydropowers since 1991
(Estimated from operation records of Toktogul Reservoir)

Operation of the Toktogul Reservoir and the relation between inflow and storage of the reservoir are described in detail including application of hydropower in section 2-2. As already mentioned, water demand has recently exceeded the long-term average of inflow into the reservoir as a result of increasing generation discharge to meet growth of electricity demand. From a viewpoint of sustainable reservoir operation, the stable operation of the reservoir considering demand /supply balance therefore seems to become difficult.

Consequently, the electric power sector also urgently required to take measures for decreasing the water demand for the Toktogul Reservoir, and to recover sustainable reservoir operation; such measures include the site management, and the construction of new power stations and/or increasing power import, able to take over the generation of Toktogul power station.

3-4 Effective utilization of electric power facilities with regional power trade

3-4-1 Objective of power balancing simulations between supply/demand

In the last JBIC study in 2005, series of simulation on balancing between supply/demand among CAPS interconnection countries, Uzbekistan, the southern Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan, were conducted. The simulation results were evaluated and indicated that the electric power exchange through interconnection among countries would provide benefits to the interconnected countries. (See Box 3-2) This study aims to examine mitigation of flood control with coordinating reservoir operation in the Sir Darya river basin. The hydropower generation is affected by the mitigations of reservoir operation. The effect of the changing reservoir operation is evaluated with simulation of balancing supply/demand utilized basic information and assumptions in this study. The results of evaluation with updated models are described in the chapter 4-3. The evaluation is conducted to grasp present situations of balancing electricity supply/demand as well as to evaluate the necessity of detail simulation of balancing supply/demand in the CAPS interconnected systems.

The conducted simulations for balancing electricity supply/demand were that the balance between supply and demand among interconnected systems was calculated with PDPAT Ⅱ based, on the models that were surveyed in 2005. PDPAT Ⅱ is a software that was developed by TEPCO and has been utilized in TEPCO's power development over 20 years. The simulations considered information such as the increase of electricity demand corrected during field survey in this study.

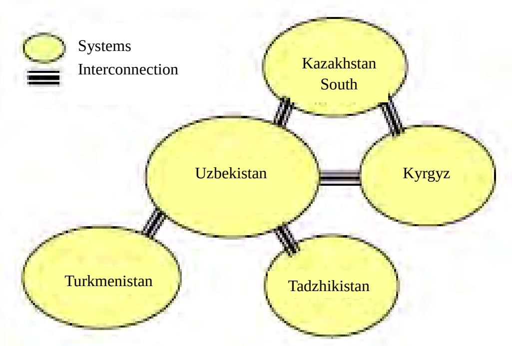


Figure 3-5 Models of simulation for balancing electricity supply/demand

3-4-2 Methodology of simulation balancing supply/demand

(1) Benefits from system interconnection

Benefits from interconnection have generally two aspects: improvement of the system reliability and fuel saving.

- ♦ Improvement of System reliability

Reserve capacity to secure system reliability criteria can reduce with a mutual utilization of reserve capacity, through interconnection due to peak demand diversities among interconnected systems.

- ♦ Fuel cost saving

Generation operation can be efficient to utilize discrepancy of system components among interconnected systems through interconnection such as an economical power exchange. The efficient operation provides fuel cost saving.

Box3-2 Results of simulation on balancing between supply/demand among CAPS interconnection (Source the JBIC study in 2005)

The results of series of simulation on balancing between supply/demand among CAPS interconnection based on information in 2004 are indicated as follows.

Situation of electricity energy balance in each country

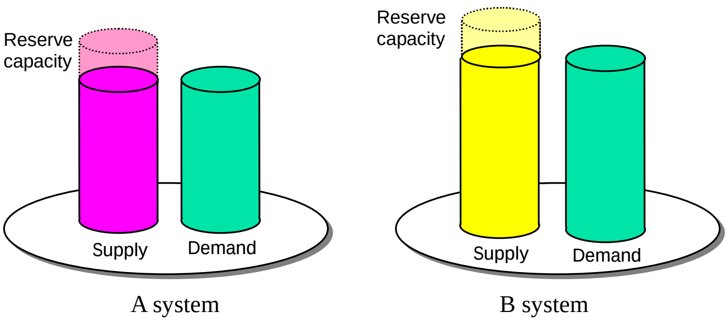
- System reliability of Uzbekistan was calculated to LOLE 2 hours. They could supply their electricity demands by themselves.
- System reliability of the southern Kazakhstan was calculated to LOLE 200 hours. The energy supply was insufficient even though they added a power exchange from northern Kazakhstan. It was important for the energy balance in Kazakhstan to reinforce the interconnection between the northern area and the southern area and to enhance development in the southern area.
- The energy balance in Kyrgyzstan was affected by the water flow in the Naryn River. The system reliability was that LOLE was calculated over 200 hours, even under satisfactory water flow of the Naryn in 2004 (14.5 billion cubic maters). Over water usage in winter of the reservoir in the Naryn from international agreement limited to 600 m^3/s is necessary, even in the case of a satisfactory rain fall year, so that electric energy supply in Kyrgyzstan caught up their peak demand. They could not secure their electricity demands in dry years, due to an insufficient water reserve.
- System reliability of Tajikistan was calculated over LOLE 1,500 hours. There is chronic electricity shortage in Tajikistan, except during the rainy season from April to August.

Benefits from power exchange through interconnections

- Interconnected systems except in Uzbekistan still remained in insufficient electricity supply capacities. Power exchange through the existing interconnection provided benefits for securing stable electricity supply among interconnected countries.
- System reliability among interconnected systems would increase with the interconnections of Kazakhstan – Kyrgyzstan and Tajikistan – Uzbekistan. The power exchange through interconnection of Uzbekistan – Kyrgyzstan was important to harmonize their operations for securing the power supply reliability.
- Power system operation could settle efficiently utilizing sufficient power from hydropower and high heat rate generators among interconnected systems, when reserve capacity is secured to meet their system reliability criteria. The effective system operation would provide a reduction in generation costs and fuel consumption. The interconnections could reduce approximately 2% of generation costs and 6% of fuel consumption in total for the four countries, according to the simulation results. Agreements among participating countries and facilities for regional load dispatching would be required for effective power exchange operations. The benefits from interconnection are expected to utilize existing interconnection.
- Water storage in the Toktogul Reservoir seriously affected system reliability among interconnected systems.
- System reliability of Kyrgyzstan could be worse then the case of isolated system based on 2004 water storage data, even if appropriate power exchange through interconnection when water for irrigation was secured in a case of insufficient water storage in the Toktogul Reservoir.

Transmission system operators can save on power reserve generation investment by sharing their peak supply by exploiting demand diversities amongst the interconnected systems. This is illustrated below (Fig.3-6).

Without interconnection: Each system independently develops sufficient supply capacity.



With interconnection: Interconnected systems exploit demand divergence to share reserve capacity through an interconnection.

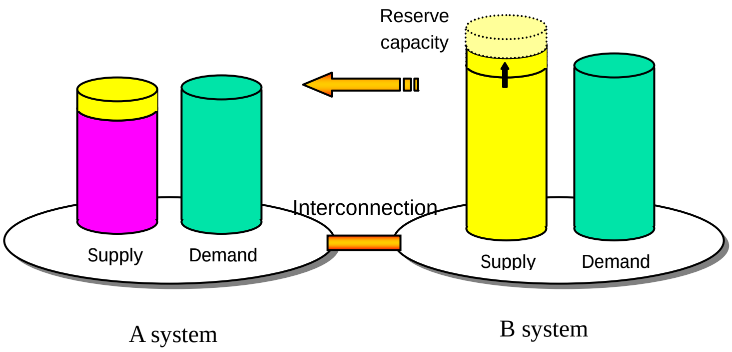


Figure 3-6 Concept of benefit from interconnection

(2) Methodology of system reliability analysis

The reserve margin of supply capacity in the interconnected systems is generally less than in isolated systems, to secure their system reliability criteria. The amount of reduction in reserve capacity in interconnected systems would saturate at some capacity of interconnection when the relation between the reduction amount of reserve capacity and the interconnection capacity is calculated. A limitation of availability surplus supply that can be mutually utilized among interconnected systems causes the saturation. The adequate capacity of interconnection can be obtained by comparing the annual costs of reduced investment for reserve capacity and the annual costs for developing interconnections. The system reliability analysis is conducted in adoption of the RETICS that was developed by TEPCO and adopted for system reliability analysis in Cambodia, Laos, Myanmar, Thailand, Vietnam, Malaysia, Indonesia, Sri Lanka and the Philippines.

(3) Methodology of fuel cost saving

The balance between supply/demand in 2005 is examined based on interconnection models in the region. The simulation is conducted with the PDPAT II, that can simulate up to 10 (ten) interconnected systems and was used in Cambodia, Laos, Myanmar, Thailand, Vietnam, Malaysia, Indonesia, Sri Lanka, the Philippines and Azerbaijan.

The results of the simulation contain the following items:

- Economical generation dispatching, considering the hourly basis constrains of generation operation (fuel costs)
- Electric power generation energy and Fuel consumption
- Annual costs for generation
- Power exchange through interconnections
- Potential power exchange by marginal costs

The optimal operation from an economic aspect can simulate on an hourly basis, 8,760 hours in a year. The simulation can be conducted considering a planned maintenance, a minimum output of generator, a daily start and stop (DSS), a weekly start and stop (WSS) and a reservoir operation for pumped storage hydropower. The surplus supply hourly basis marginal costs can be obtained through the simulation.

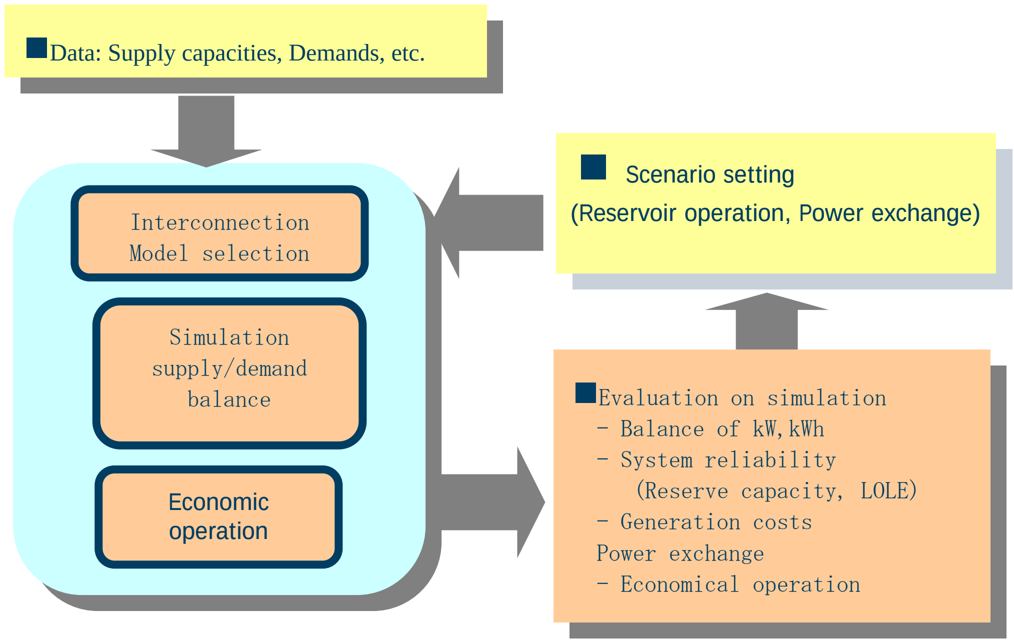


Figure 3-7 Procedure of simulation by PDPAT II

3-4-3 Model and condition of simulation on balancing supply/demand

The simulations of balancing supply/demand for Uzbekistan, the southern Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan are conducted depending on data submitted by counterpart personnel through interviews. For the interconnection to the Kazakhstan system, the interconnection case only to the southern Kazakhstan is selected. The simulations are conducted by the PDPAT II and the balance supply/demand of each system is examined. Conditions such as demands, supply capacity, fuel cost and model for simulation are described in the following section.

(1) Electric power demand

The demands of the four countries are described in table 3-9. The demands of Uzbekistan and Kyrgyzstan in 2007 were assumed by information submitted by counterpart personnel. 2007 Demands in 2007 in southern Kazakhstan, Kyrgyzstan, Tajikistan and elsewhere were estimated by the former JBIC study "Research on Regional Cooperation for Shared Electric Power/Water Resources in Central Asia" (2005) and the actual demand records were quoted from the website of US government's Department of Energy. Load profiles of the four countries were quoted from the JBIC study in 2005. Uzbekistan time was selected as base-time, due to one hour time difference between Kazakhstan and Kyrgyzstan on the one hand and Uzbekistan and Tajikistan on the other hand.

Table 3-9 Demands for simulation（2007）

System	Peak Demand (MW)*1	Electric Energy (GWh)*2	Load Factor (%)*1
Uzbekistan *3	8,247	50,021	69.2%
Kyrgyzstan *4	2,726	13,292	55.7%
Southern Kazakhstan	2,868	18,117	72.1%
Tadzhikistan	2,512	15,291	69.5%

*1: Data assumed from information of the JBIC study in 2005, *2: Assumed from data of the website of the Department of Energy US government, *3: Submitted data in 2007 from the Uzbekenergo, *4: Peak demand of Kyrgyzstan was estimated from incremental ratio from 2001 to 2005.

(2) Generation facilities

Generation capacities are shown in table 3-10. Data was assumed from submitted data and interviews from counterparts during the field survey in 2008 and from information of existing reports. A main point of different from JBIC's study in 2005 was that two units of Turkmenistan thermal power plants connected to the interconnected systems since December 2006. These thermal units were added for supply to the Tajikistan system.

Table 3-10 Supply capacities by systems (MW)

System	Hydro	Thermal	Total
Uzbekistan	1,394	8,829	10,223
Kyrgyzstan	2,950	759	3,709
Southern Kazakhstan	525	2,599	3,124
Tajikistan	4,059	444*1	4,503

*1: Including the supply power from Turkmenistan thermal power plants (Mary Thermal power plant, 126 MW)

(3) Fuel costs

Fuel costs were quoted from the “World Energy Outlook 2007” (IEA). Unit costs of fuel of the four countries were assumed as same price. Heat values of fuels were quoted from JBIC‘s study in 2005. The heat values of fuel for simulation are described in table 3-11.

Table 3-11 Fuel costs

	Gas	Oil	Coal
Unit price	7.31[US$/MBTU]	61.72[US$/bbl]	21[US$/ton]*
Heat value	8,400 [kcal/m^3]	10,000 [kcal/kg]	2,000 [kcal/kg]

*Assumed from coal data of IEA report.

(4) Models of interconnection configuration

The model of interconnected system among Uzbekistan, southern Kazakhstan, Kyrgyzstan and Tajikistan was adopted for a study from an electric power aspect and depended on the situations of interconnection in the region.

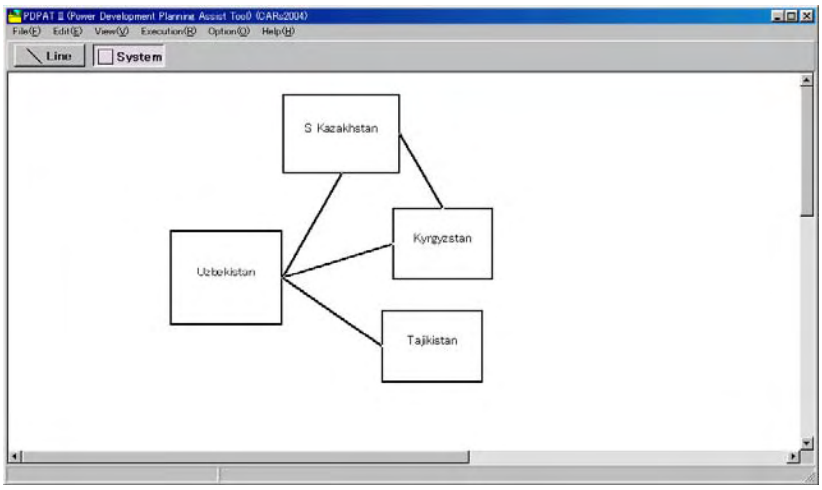


Figure 3-8 Interconnected system configuration

Capacities of interconnection were assumed and depended on available actual power exchange and interconnection operation records. The capacities of interconnection are described in table 3-12.

Table 3-12 Capacities of interconnection

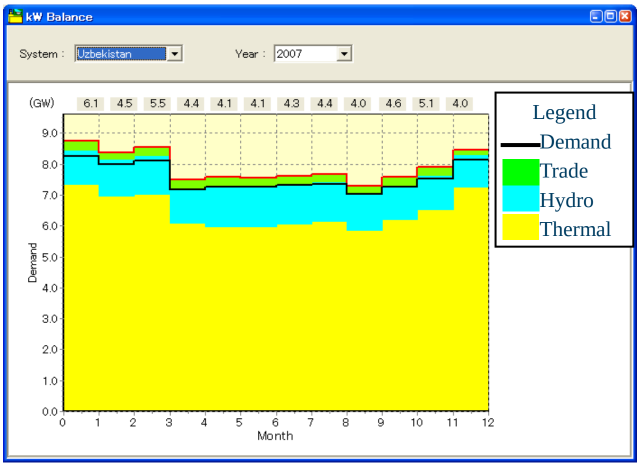
Interconnection	Capacity (MW)
Uzbekistan - Kyrgyzstan	3,152
Uzbekistan – Tajikistan	4,864
Uzbekistan - the southern Kazakhstan	2,720
Kyrgyzstan - the southern Kazakhstan	5,092

3-4-4 Results of simulation of balancing supply/demand and optimal operation

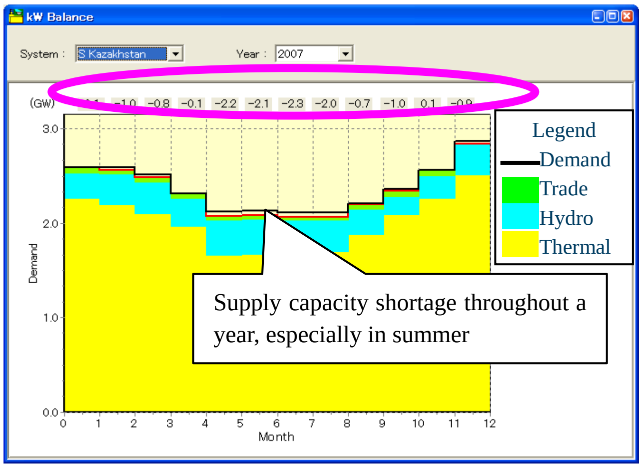
Series of simulations of balancing supply/demand and optimal operation in 2007 were conducted and depended on the aforementioned conditions. Results of simulation are illustrated in the following part.

(a) Balance between supply and demand

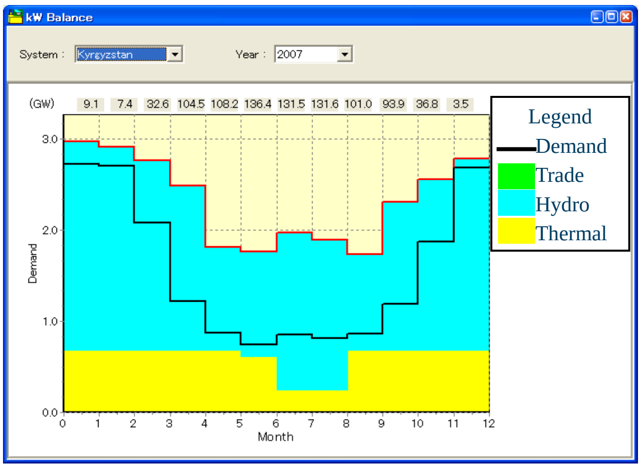
The balance between supply and demand is secured, except in the southern part of Kazakhstan during the summer season. Tajikistan can secure its balancing supply and demand depending on the reserve capacity provided by the thermal power units from Turkmenistan.



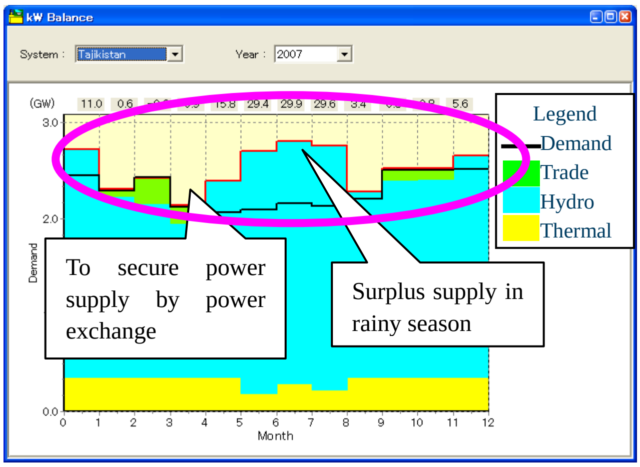
Uzbekistan



Southern Kazakhstan



Kyrgyzstan

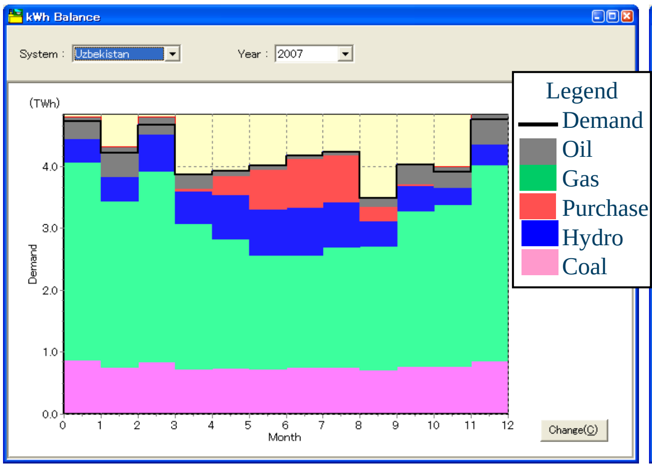


Tajikistan

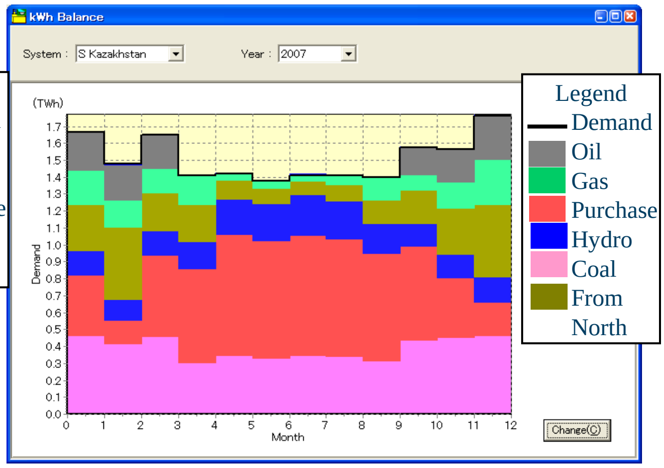
Figure 3-9 Balance of supply/demand by countries (the year of 2007)

(b) Electric energy balance

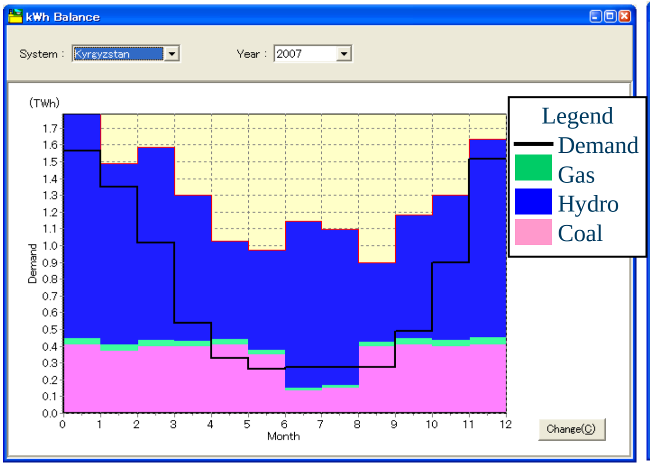
The electric energy balance can be secured in the region except in winter for Kazakhstan and Tajikistan. The electric energy balance is secured in the region, when surplus power from hydropower located in Kyrgyzstan and Tajikistan is utilized among interconnected systems.



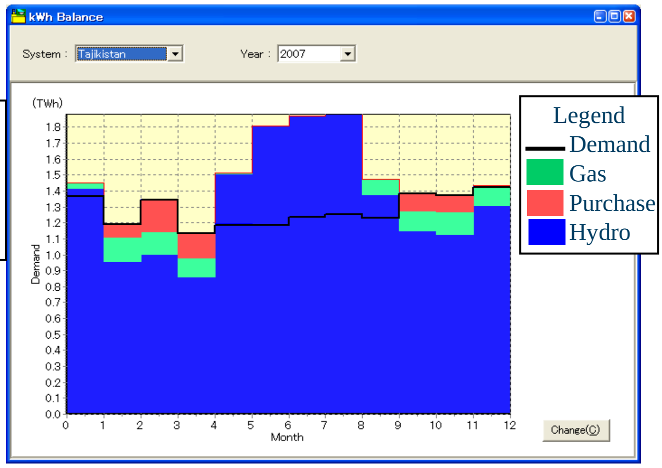
Uzbekistan



Southern Kazakhstan



Kyrgyzstan



Tajikistan

Figure 3-10 Electric energy balance by countries (the year of 2007)

(c) System reliability

The system reliability of the four countries, calculated based on the simulation is illustrated below. The system reliability in Uzbekistan and Kyrgyzstan might be secured at the same level as the developed country reliability level (LOLE:1-hour). The system reliability in southern Kazakhstan is lower than others. Electric power shortages can occur in southern Kazakhstan under normal conditions.

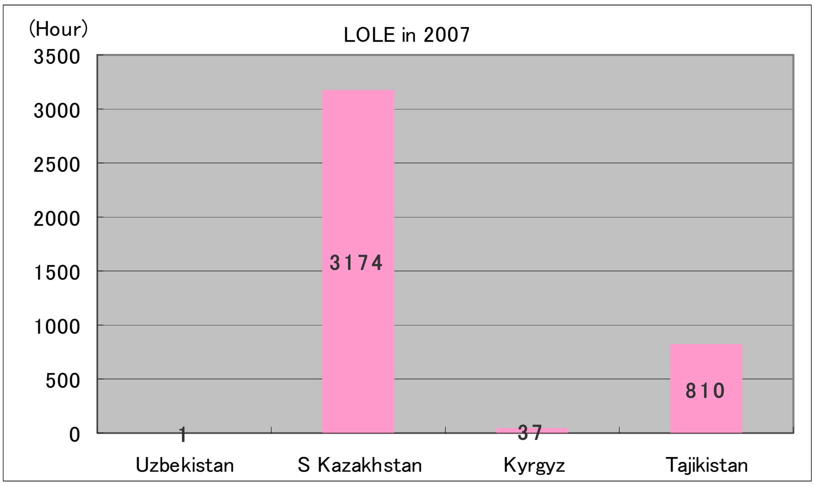


Figure 3-11　System reliability by country based on simulation results (2007)

3-4-5 Evaluation of results of simulation

The demands of the four countries increased in comparison to JBIC's study in 2005. Only two units of supply capacity were added in Turkmenistan. These cause an insufficient reserve capacity in the region. The lack of reserve capacity causes a reduction in power exchange among the region. It is required for the four countries to develop more supply capacities in order to obtain economic benefits from the interconnection.

3-5 Impacts of this winter's power shortages in Kyrgyzstan

Electricity shortage and securement of water storage for the irrigation use are problematic since the water storage capacity of the Toktogul Reservoir decreased. The decrease was caused by an increase of electricity demand during the severe 2007-2008 winter and the inflow in 2008 was less than in recent years. The Governments of Central Asian countries had meetings and specific measures such as electric power and fossil fuel supply from Kazakhstan to Kyrgyzstan were agreed.

Under these surroundings, the situation of this winter is estimated based on the reservoir storage in September 2008, when further assistance is not realized. In case 1 to 3, the impact is evaluated by calculating the difference between the inflow of electricity supply and the reservoir storage. High-, average- and low-inflow years during winter season are selected among the actual record of recent years and the actual record is applied as assumption of these cases. In case 4 and 5, effect of an introduction of planned outage of electricity supply is estimated. The assumed planned outages are 15% for case 4 and 33% for case 5, which were planned in September and put in practice in December 2008 respectively.

Table 3-13 Assumptions and estimated situations of electricity shortage of each case

Assumptions／Cases		1	2	3	4	5
Inflow In Winter	Same as 2007-08 (lowest in these17 years)	○			○	○
	Same as 2006-07 (average winter inflow)		○			
	Same as 2003-04 (highest inflow year)			○		
Electricity Demand	Same as 2007-08 (peak demand 68GWh/day)	○	○	○		
	15% of planned outage from October to end of March				○	
	33% of planned outage from October to end of March					○
Condition of Power supply	Generation at the available capacity is possible (Necessary fuel is supplied; considering support of Kazakhstan)	○	○	○	○	○
Power Import	Supply from Kazakhstan (250GWh) considered	○	○	○	○	○
Estimated situations	Timing of dry up of Toktogul Reservoir storage	Beginning of February	Middle of February	Beginning of March	—	—
	Storage of reservoir that can use for irrigation and/or generation of the next winter <Toktogul Storage at the end of March (bln m^3)>	0	0	0	0	2
	Deficit of electricity during winter except planned outage (GWh)	1300	800	200	0	0

Results of estimation are summarized as follows:

1) When the inflow during winter is low and the electricity demand is the same as in the year 2007-2008, the storage of the Toktogul Reservoir will be finished at the beginning of February, and generation will be short thereafter, since only inflow discharge is available for generation. (Case 1). Even in the case of a high inflow year, the storage will also be completed by the beginning of March, since the difference of winter

inflow by year is not large. (Case 3).

2) In the case of introducing 15% of planned outage from October in order to save generation discharge during winter, the storage of Toktogul Reservoir will be completed by the end of March. Therefore, electricity supply during winter seems available since peak demand period for electricity end by the end of March. (Case 4). In addition, executing 33% of the planned outage until the end of March, 2 billion m^3 of storage is estimated to remain at the end of March, which can be utilized for irrigation and/or winter generation of the next year. (Case 5).

When the storage of Toktogul Reservoir is nil, water release for irrigation and storage for generation of the next winter are forced to be covered only by inflow. As mentioned in section 3-3, the annual inflow of Toktogul Reservoir fluctuates widely by year, and the annual water demand is increased, due to the growth of electricity demand and overtakes the long-term average of inflow. Accordingly, water seems to be short since the release discharge cannot be increased by using storage of the reservoir even if an inflow discharge from next April is that of average year. Moreover, it seems to be necessary to take measures for restraint of electricity demand in Kyrgyzstan and support from Central Asian countries. In addition, lack of storage seems to bring a problem of irrigation water supply in spring in low-inflow year since water demand for irrigation starts earlier than increase of inflow discharge.

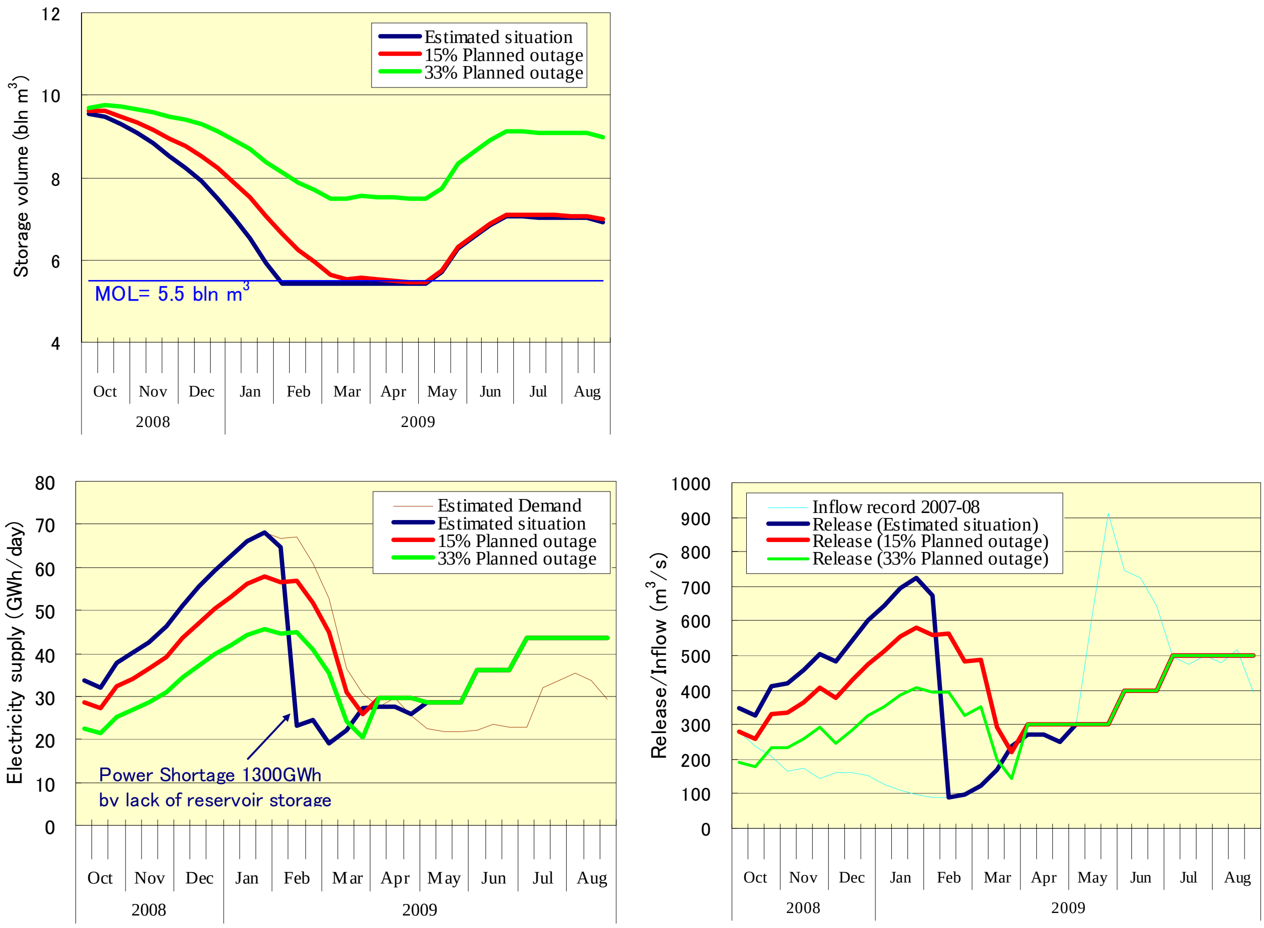


Figure 3-12 Result of estimation of power shortage of this year in Kyrgyzstan

Actually, 33% of planned outage has been executed. 2 billion m^3 of storage are expected at the end of March 2009, which will be obtained by this severe trial, is better for irrigation water supply, but effectiveness is limited because the volume is small. It seems that water supply for irrigation in 2009 is available if a heavy drought does not occur. Meanwhile, measures will be needed for the electricity shortage of the next year in Kyrgyzstan, when water inflow during summer is lower than average.

In order to achieve an improvement of the situation, fuel supply to the thermal power station of Kyrgyzstan is not enough. Further installations for power field, such as increasing power supply via interconnection is necessary. However, power supply is actually quite tight in each country interconnected by CAPS in Central Asia. Power import from the area outside the region is also impossible until the completion of the new South-North transmission line in Kazakhstan.

In Kyrgyzstan, electricity is used for heating in winter and currently there is no alternative. Large scaled planned outage has considerable impact on people's lives in Kyrgyzstan. Therefore, electricity import from Turkmenistan and other emergency assistance such as providing heating equipment with fuel should be taken.

3-6 Activities of each donor

3-6-1 The World Bank (WB)

The World Bank has played a leading role in the fields of optimization of electric power and water in Central Asia and in establishing power markets and so on. “Water Energy Nexus” and “Regional Electricity Export Potential Study (REEP)” were issued in 2004 and 2005 respectively.

After that, WB supported the construction of the South-North transmission line in Kazakhstan, in collaboration with EBRD, and also supported the development of small hydropower in the Pamirs. WB also provides assistance focusing on sustainable development projects in Amudarya River basin.

3-6-2 Asian Development Bank (ADB) ／CAREC

This organization plays a role as organizer for the CAREC Program (transportation, energy including water resources, and trade) which promotes economic cooperation in the region. In the CAREC structure, the World Bank plays a leading role in the fields of water resources and electricity, while ADB shares responsibility for transportation and ports, etc.

CAREC started a new approach in energy sector, and built consensus on basic strategy for regional cooperation among the CAREC member countries in November 2008. Long-term vision for the energy sector, approaches, policy/strategy on investment, capacity building are included in the agreement, which covers important issues such as electric power trading, stable power supply, energy efficiency improvement etc. in detail.

CAREC started to make up assistance plans in collaboration with donors instead of the previous manner; combining the plans of each donor that was separately planned and decided. WB takes the lead in this process in the energy sector.

Regarding the specific assistance of ADB in the power field, the Regional Power Transmission Modernization Project, consisting in the construction of a transmission line between Uzbekistan and Tajikistan, in collaboration with EBRD, was planned, but was suddenly canceled in 2005. After that, in 2008, assistance for construction of transmission line (220 kV) between Tajikistan and Afghanistan was decided.

3-6-3 United States Agency for International Development (USAID)

This organization provides assistance for the establishment of electric power market, which project name is Regional Electric Market Assistance Program (REMAP) and started from 2006. In this activity, organization of UDC, which took a role of regional dispatching of CAPS, has been changed and a Nongovernment Noncommercial Organization Coordinating Dispatcher Center <Energy> (CDC) was established.

After that, USAID planned to conduct assistance for international power trade including private trade. According to this plan, experts will be dispatched to 5 countries in Central Asia and will work in collaboration with each other. The establishment of a power market, and a power export to Afghanistan were highlighted in the plan.

3-6-4 European Bank for Reconstruction and Development (EBRD)

This organization does not deal with direct financing to the Government. Instead, two step loans to the local bank or direct financing to private companies are conducted.

Currently, The Bank has made a loan to KEGOC, a power system operation company in Kazakhstan, for part of the power transmission system (500 kV) expansion project between Southern and Northern Kazakhstan (Phase I, 89 million dollars). The plan consists of three phases. In Phase I, the southern part from Shu to YukGre was planned to be completed in 2008. Construction of Phases II and III, extend to Ekibastuz in the northern part are on going. Here, the Phase II work will be shared by the World Bank.

3-6-5 United Nations Development Program (UNDP)

In the field of electricity, UNDP provides assistance to the development of renewable energy (small-hydropower, solar power, wind power and biomass generation), and CDM projects from an environmental view point. This organization is interested in assistance to important issues, such as improvement of efficiency of water use, by collaboration and participation of donors.

3-7 Issues and measures in the electric power field

3-7-1 Change of issues since the last study in 2005 in the power field

There seems to be no fundamental difference according to the results of this study such as information collection and analysis, including simulation. Meanwhile, the negative impact of the issues, mentioned below, has intensified and difficulties have increased.

(a) Shortage of electric power supply

The electric power demand of each country is on the growth trend, but the improvement of power supply is delayed. In Kazakhstan, the demand supply balance was quite tight in 2008, but is expected to improve in 2009, since measures, such as the development of new power plants and the extension of the South-North transmission line that has been a neck of power import, have been taken.

In the other countries, the improvement of power supply has been delayed; therefore, demand supply balance will be tighter.

In the last study in 2005, it was pointed out that operation introducing regional power trade and utilizing existing interconnection systems, contributed not only to stabilizing the power supply but also had economical advantages. In reviewing this study, it was noticed that features of demand supply balance were the same, but that power trade in the region had decreased because available power supply for trade was smaller as well as only few reserve margin for demand.

For sharing advantages of interconnection in the region, the improvement of power supply is indispensable.

(b) Too much water demand for Toktogul Reservoir

The operation of the Toktogul Reservoir is important for both generation use in Kyrgyzstan and irrigation use in downstream reaches, of which relation is trade-off. Recent consensus among the relevant countries has not built in these years, in this way operation in “Power mode” has been conducted by Kyrgyzstan. Meanwhile, development of power supply is delayed in Kyrgyzstan. To meet the electricity demand in winter, which has increased due to heating needs caused by severe winter, increasing generation discharge of the Toktogul Reservoir is the only way for Kyrgyzstan as of now.

Inflow volume to Toktogul Reservoir is limited. The total water demand for generation and irrigation already exceed the annual average inflow. Therefore, it looks like both party scrambles to get the water, which is very limited.

Accordingly, the re-establishment of reservoir operation considering the fluctuation of inflow by year is of course necessary, but is not an appropriate solution from a middle to long-term point of view. Measures for reducing the total amount of water demand for the Toktogul Reservoir should be studied, evaluated and introduced immediately. This effort should be conducted in both the water management and the power field. Here, the improvement of power supply such as the development of a new power station in Kyrgyzstan and power import from newly developed power stations in Central Asian is one of specific alternatives in the power field.

(c) Large impact of drought years

In the last study in 2005, the power system operation in drought year was simulated to confirm the impact of drought year, that have an occurrence probability estimated at once per 10 years, to power supply, and pointed that 1) electricity is severely short in Kyrgyzstan and power import is needed to meet the demand, and 2) for this reason generation cost increased in the whole region.

Winter inflow in 2007-2008 was a long-term average discharge. The reason of decreasing water storage is expected that generation discharge increased to meet the electricity demand which increased by the severe winter.

According to the actual records of inflow, there are long-term cycles of fluctuations and there are series of several years in which the inflow decreases year by year. Accordingly, introducing proper reservoir management considering further decrease of inflow and preparation of measures for power shortage in drought year are needed.

3-7-2 Visions and strategies for support to the field of electricity

It is absolutely necessary to discuss among the countries for resolving the issues on water management and power in Central Asia, but actually discussions, are not getting further.

There has been a challenge to establish WEC, which is a subordinate organization of CACO, as a council for building consensus of the countries in a long-term vision. All of Central Asian countries including Uzbekistan assented to establish WEC, but there seems to be differences of understandings in each country. Changes in the situation, such as merger of CACO with Eurasian Economic Community and the withdrawal of Uzbekistan, led to the non-establishment of the WEC.

Meanwhile, CAREC discussed and build up a consensus on basic strategy for encouraging regional cooperation in the energy sector. Under this consensus, challenges, such as the establishment of WEC and other measures that prompt discussions for regional cooperation, seem to be effective. Therefore, the effort of CARE is meaningful.

Considering the abovementioned situations, it is recommended to establish vision and strategy of the assistance for the power field considering the followings:

1) Cooperation with other donors: Assistance that is planned and participated in collaboration with the relevant donors is effective for conducting continuous support to the complicated regional conditions.
2) Continuous assistance: Since there are many issues, scheduled and continuous assistance for step-up, not an isolated promotion, is needed.
3) Viable assistance: all countries understand the necessity of interconnection, but there are actually many issues that need a long time for consensus building. It is considerable to select projects that are viable at the time and that are not disadvantageous to the relevant countries.

Assistance vision for electric power field that has higher priority at the present are shown below, based on suggestions in the last JBIC study in 2005 and current situation

(1) Operational support to promote international power trade based on a long term vision <Institutional Support>

The World Bank suggested a future vision of power field in Central Asia; this includes traditional intra-regional power trade, enlargement of the area of power trade, interconnection to the surrounding countries, and power export by entry to wide area power market. This long-term vision is reasonable for long-term assistance concepts since these are in accord with that indicated by the simulation in the last JBIC study in 2005, even though there are many issues to resolve.

Assistance on such an agreement for setting long-term vision, establishment and management of council for discussion among the countries for realizing the vision, and support to specific institution and technical transfer on management are needed to conduct in collaboration with the relevant donors.

Regarding promising role for Japanese assistance that seems to be effective, one of the candidates is simulation work using an analysis tool, like the one which was used for the outline review in this study. Optimization of specific methods and process to attain long-term targets may clarify quantitatively what kinds of advantages and disadvantages the interested countries will have, allowing a specific adjustment among them. Furthermore, Central Asian countries must keep and improve supply reliability within the region with a view towards realizing their long-term visions. In this view, it is critical to conduct assistance on improvement of electric power business mentioned in item (2) in the first stage. At the time, therefore, common standard and specification for the facilities based on the future vision were introduced. Specifically, to this end, it may be necessary to provide the following assistance in both software and hardware aspects: 1) future demand forecast, 2) setting up of a desirable supply reliability level (LOLE), 3) optimum power development plan based on the set supply reliability, 4) establishment of a institutional system to manage power trade, 5) improvement in facilities of control centers, and 6) modernization of interconnection system and communication method among the countries, etc.

(2) Assistance for more efficient electricity business in the Central Asian countries <Institutional Assistance, Infrastructure Development>

Results of the supply/demand operation simulation conducted in the last JBIC study in 2005 pointed out that interconnection of the power network in Central Asia allowed the improvement of supply reliability and economic effect when enough reserve margin of supply capacity is there. The first step for realizing the long-term vision mentioned above is needed to improve supply reliability and to realize stable power supply in the region, and finally to share benefits among the Central Asian countries.

Currently available power supply has been short. It is advisable that supply capacity should be improved to the necessary level first, and then effective scheme for regional power trade will be established

Improvement of power supply needs to start from viable project plan, which is going ahead, since power shortage has been tight. For the medium term measures, it is expected that master plan of power field for regional and for each country is studied and economical power/transmission development plan is built, and developments are conducted in accordance with the consensus and cooperations in the region.

For the effective interconnection, the establishment of 1) unified power trade mechanism, which is able to reach settlement of the current conflict of interest from a view of international standard and 2) operation organization for adjustment from a stand point of an outsider are required, as well as the promotion of positive dialogue among the countries. First step has already marked since Nongovernment Noncommercial Organization Coordinating Dispatcher Center (CDC) was established with the support of USAID. Promotion of interconnection in the region, such as building mechanism and functioning, seems to be a base of introducing international power trade and discovering further possibility in the future.

3-7-3 Specific candidate of assistance in power field

Organization of power industry in each country is requested to improve power facilities and managerial efficiency from a view point of applying long-term regional decision of introducing international power trade, and also to build business system to be capable of meeting international competition.

Specific issues to be approached in short- medium term range are picked up as mentioned below. In addition, it is effective for promoting regional discussion for providing, as needed, results of technical study, such as simulation analysis, as a long-term support for international power trade based on long-term vision.

(1) Development of power supply facilities in the region < Infrastructural Assistance>

Electric power supply has been short in every country in the region. Especially, development of power supply for Kyrgyzstan is an immediate issue since the lack of power supply in Kyrgyzstan directly influences the operation of Toktogul Reservoir, which impacts irrigation water use in the downstream countries.

Power system of each country in the region has been connected by power network. Development of power plants located in the region where connection to the power grid is available is effective for mitigating power shortage in Kyrgyzstan. Meanwhile, detailed optimization study is needed but development hydropower in upstream countries and development of thermal power in downstream countries seems to be preferable from a viewpoint of optimization of regional power exchange. For a measure of early resolution, acceleration of construction

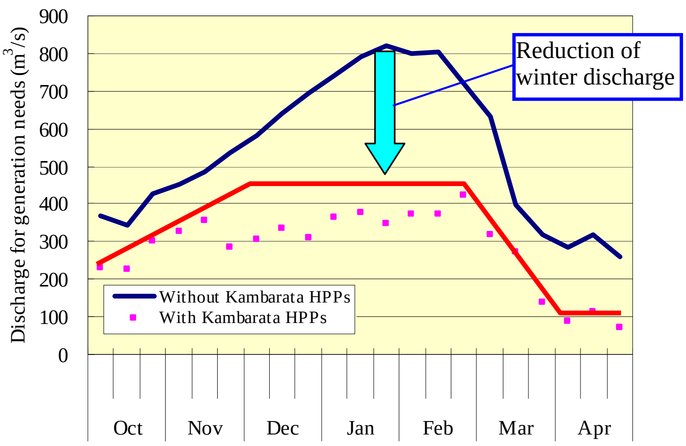


Figure 3-13 Reduction of winter discharge of Toktogul by installation of Kambarata hydropowers (approximate estimate)

of Kambarata I and II hydropower, of which plan already on going, seems to be a practical choice.

Purpose of development of Kambarata I and II hydropower is increasing power supply in winter in Kyrgyzstan. But it also the measure that contribute to reduce winter discharge of the Toktogul Reservoir, which is also a measure of reducing damage of winter floods, by introducing priority generation of Kambarata hydropower instead of Toktogul hydropower. Here, this effect will be reduced with an increase of power demand in Kyrgyzstan. Therefore, power plants to be constructed next to Kambarata hydropower should be planned and developed.

(2) Optimization of hydropower operation plan <Institutional and Infrastructural Assistance>

Inflow to the Toktogul Reservoir varies in long-term cycle. This feature should be reflected in the operation plan of the reservoir for sustainable use. Actually, water releases for generation when electricity is needed in winter, and the water storage for irrigation faced to shortage. Accordingly, technical assistance for reviewing the current operation rule and set immediate rule for generation use, and capacity building on this issue are desired. In addition to this, assistance for improvement of monitoring facilities for inflow etc., which is a common issue with water management field, is needed.

(3) Review of electricity demand forecast, and optimization of power development and rehabilitation works plan <Institutional Assistance>

Considering situations unique to the countries, it is necessary to review the electricity demand forecast and optimize plans on power facilities development and rehabilitation (both power plants and network). Especially, immediate promotion to the development of new power plants since power supply has been short.

In addition, a review considering optimum case introducing power trade in the region must be included in the above development rehabilitation studies. This review is expected to contribute to the discussion on confirming economical advantages of power trade and possibility of reduction of investment for development.

(a) Uzbekistan

Currently reserve margin is few because of increase of demand. Gas supply for thermal power is also not enough. As a measure for the future demand increase, extension of Tashkent thermal power, improvement of Tashkent combined heat power plant is now on going but not enough.

Establishment of an action plan for energy efficiency is just started reflects to the new presidential decree. In the development and rehabilitation plan of this, introducing high efficiency combined cycle thermal power, effective utilization of national resources (hydropower, coal), and retirement of aging plants will be included.

(b) Kazakhstan

The demand supply balance in south Kazakhstan is a predicament. This severe situation will however end, since power supply will increase, with the improvement of the south-north transmission line, of which a part has been completed, and construction of power plants.

For the future, plans such as replacement of low efficiency thermal power and introducing new/renewable energy and energy saving is needed to move into action.

(c) Kyrgyzstan

As Kyrgyzstan is poor in fossil fuels, it has no choice but to depend on hydropower. The Government decided to develop Kambarata hydropower, and a feasibility study is now conducted. Meanwhile, potential of hydropower is large but the project to be developed next to Kambarata hydropower is unclear. Since the development of hydropower stations is a long process, the early execution of a hydropower potential survey (master plan), the nomination of viable candidate projects, and the reviewing of development plan are required. Here, the replacement plan of aging plants is also included in the plan.

(d) Tajikistan

Development of hydropower plants is one of the policy pillars of Tajikistan. There is significant meaning in their continuous support to carry out F/S and so forth.

On the other hand, Uzbekistan constantly has been opposed to development of dam in Tajikistan. Therefore, it is necessary to make consideration for building consensus on the occasion of assistance.

(4) Assistance for the sound management of the electricity business <Institutional Assistance>

The countries are engaged in mechanism reform as part of the power sector reform. Assistance is to be provided so that they may continuously improve the business, and strengthen its basis. The following shows specific support items.

i) Countermeasures against Non-technical Loss, and Collection of Electricity Tariff

The countries have much loss of electricity, which is assumed to be stolen. They should take some institutional measures, including those to reduce non-technical losses of power and to promptly collect electricity tariff, for the implementation of sound management.

ii) Review of Electricity Tariff

Electricity tariff is set low for political purposes in some countries, as a “measure against poverty”. From a viewpoint of realizing an independent and sound electricity business, institutional reform for independent operation should be implemented where business costs can be recovered by the income from electricity tariff. As a measure for socially vulnerable groups, such as those in living in poverty, it is necessary to review the introduction of the government subsidy system or the increment tariff system in which the higher the consumption the higher the tariff.

(5) Technical assistance for introduction of the economic power exchange <Institutional Support>

The barter trade between water and power has continued since the collapse of the former Soviet Union. However, in the transition toward a market economy, the adjustment among the countries has stalled. Water use for irrigation and flood control of the rivers must be prioritized; under the water operation in such conditions, some technical assistance should be provided for an appropriate operation of electricity in the region.

For appropriate implementation of trans-boundary supply/demand operations, assistance may include: 1) technical transfer of supply/demand operation knowledge, 2) establishment of rules and introduction of the power exchange scheme such as economic power exchange, 3) creation of the power exchange plans, and 4) setting up of transparent power trade prices based on generation costs (such as peak, base).

In cooperation with USAID that support introducing power market in the region, assistance for the CDC (Coordinating Dispatch Center) including capacity building and improvement of facilities such as monitoring panel and communication tools are needed.

(6) Development of the facilities, including construction of power plants and repair work of the facilities based on plans <Infrastructural Assistance>

Planned assistance should be provided, in order to secure development at the time needed.

For example, from the viewpoint of optimizing a plan for the development of power facilities or rehabilitation work, a review may include 1) securing supply reliability for self-sufficiency of energy of the countries, 2) optimization of power sources balance, and 3) optimization of the power system in and out of the region. To this end, assistance may include: 1) development of reservoir type hydropower plants (including pumped storage power plants) to secure the necessary peak supply capacity, 2) rehabilitation and repair work for the conventional, aged power generation facilities, to secure supply capacity, 3) improvement of domestic energy security, 4) construction and enhancement of international transmission lines for the promotion of interconnection and international power trade both in and out of the region.

Furthermore, from the viewpoint of promoting economic power trade through an effective use of these power facilities, assistance may include improving functions of the dispatch center to allow more precise and hourly adjustment of the supply/demand operations: specifically, introduction of the SCADA system to UDC and the National Dispatch Center (NDC) of each country, as well as assist tools helping supply/demand operation.

(7) Assistance for saving energy <Institutional Assistance>

Electric power consumption in GDP per capita in Central Asian countries is larger than in other developing countries. Especially in Kyrgyzstan, electricity is used for heating, which is the legacy of a policy during former Soviet Union, and dissemination of fluorescent lump is not enough. Kazakhstan brings forward energy efficiency as stated in the long-term plan.

In consideration of the above, fact finding study is required. Based on the results of this, assistance for launching action program for saving energy, especially for reduction measures for electricity demand, is desired to conduct.

(8) Assistance for measures on new/renewable energy or those against global warming <Institutional Assistance, Infrastructural Assistance>

Continuous assistance should be provided to the development of new/renewable energies such as solar power, wind power, and small and medium hydropower plants because they may not only contribute to environmental conservation on the global scale but also match the intention of energy self-sufficiency of the countries. Furthermore, as the Kyoto Protocol has taken effect, investment and assistance for Japan to acquire CDM credit should be considered.

Chapter 4. Efficient utilization of water and electric resources of Syrdarya River, and mitigation of flood disaster

4-1 Flood and drought damages, and basic information on management of large reservoirs

4-1-1 Data for calculation

Available and disclosed data of the operation and the volume of the Toktogul, Kayrakkum and Chardara Reservoirs are indicated in Table 4-1.

Table 4-1 Availability of data of the operation and the volume of the reservoirs

Reservoir	Item	Period	Volume (bln m^3)	
			Full capacity	Effective capacity
Toktogul	Inflow	April 1998 – September 2008	19.5	14.0
	Release	ditto		
	Volume	ditto		
Kayrakkum	Inflow	April 1998 – September 2008	4.16	2.6
	Release	ditto		
	Volume	ditto		
Chardara	Inflow	April 1998 – September 2008	5.7	4.7
	Release	ditto		
	Volume	ditto		

Reference: CAWATERinfo (http://www.cawater-info.net/analysis/index_e.htm)

Flood damage at the down stream of the Chardara Reservoir in Kazakhstan is indicated in Table 4-2. We targeted floods in Kazakhstan which caused the largest damages in the Syrdarya basin. We could not obtain numerical evidences of floods in Uzbekistan although we got information of floods in Uzbekistan caused by winter release from the Toktogul Reservoir.

Table 4-2 Flood damage at the down stream of Chardara Reservoir (re-indicated)

Occurrence time	1st decade of Jan 2004	2005	Feb 2007	20 Feb 2008
Damage (mln Tenge)	280	853	927.2	–
Damage (mln US Dollar)*	2.38	7.25	7.88	–
Flooded area (ha)	55,733	30,460	93	–
Flooded:				
residential areas (units)	2	6	2	–
country houses (units)	3	5	5	–
schools (units)	–	1	–	–
residence buildings (units)	805	74	269	–
private lands (units)	–	–	577	–
Evacuation (people)	2,085	31,824	1,500	150
Resettlement (people)	289	–	420	–
Breach of living conditions (people)	–	–	700	–

* 1 Kazakhstan Tenge = 0.008501 US Dollar
Reference: Ministry of Emergency Situations, Kazakhstan
Integrated Regional Information Networks (http://www.irinnews.org/)
Reuters AlertNet (http://www.alertnet.org/thenews/newsdesk/L26371048.htm)

4-1-2 Analysis of flow-regime data

(1) Evaluation of data accuracy

The accuracy of operation data of the above-mentioned reservoirs was checked before the simulation. The operation data of Kayrakkum Reservoir is indicated in Table 4-3. The inflow was higher than the release from the second decade (10 days) of June 2003 to the third one of July 2003 while the volume decreased during the period. There is no consistency of the water balance (relationship among inflow, release and volume).

Thus, inflow data for the simulation was calculated with the volume and the release (‘calculated inflow’, Table 4-3). The inflow for the simulation of Toktogul and Chardara Reservoirs was also calculated with the volume and the release as a similar tendency was found.

The calculated inflow to the Chardara Reservoir is negative when a release to Arnasay Lake is higher than the inflow to Chardara Reservoir.

Table 4-3 Example of the operation data of Kayrakkum Reservoir

Date				Inflow m^3/s	Calculated inflow m^3/s	Volume mln m^3	Release m^3/s
1-Apr-03	–	11-Apr-03	I	313.0	924.5	3490.0	863.2
11-Apr-03	–	21-Apr-03	II	313.0	950.1	3543.0	1011.4
21-Apr-03	–	30-Apr-03	III	313.0	1459.8	3490.0	1537.3
1-May-03	–	11-May-03	I	756.0	1164.7	3423.0	1141.6
11-May-03	–	21-May-03	II	756.0	613.2	3443.0	538.0
21-May-03	–	31-May-03	III	756.0	453.5	3508.0	490.3
1-Jun-03	–	11-Jun-03	I	1383.2	606.6	3473.0	670.3
11-Jun-03	–	21-Jun-03	II	1383.2	650.6	3418.0	678.4
21-Jun-03	–	30-Jun-03	III	1383.2	275.7	3394.0	627.6
1-Jul-03	–	11-Jul-03	I	1081.0	179.9	3090.0	600.0
11-Jul-03	–	21-Jul-03	II	1081.0	71.1	2727.0	600.0
21-Jul-03	–	31-Jul-03	III	1081.0	341.6	2270.0	598.3
1-Aug-03	–	11-Aug-03	I	604.4	289.8	2026.0	600.0
11-Aug-03	–	21-Aug-03	II	604.4	473.6	1758.0	597.4
21-Aug-03	–	31-Aug-03	III	604.4	569.5	1651.0	600.0
1-Sep-03	–	11-Sep-03	I	428.0	475.7	1622.0	442.1
11-Sep-03	–	21-Sep-03	II	428.0	573.9	1651.0	435.0
21-Sep-03	–	30-Sep-03	III	428.0	833.4	1771.0	613.5
1-Oct-03	–	11-Oct-03	I	1280.0	871.2	1961.0	633.9
11-Oct-03	–	21-Oct-03	II	1040.3	744.7	2166.0	786.4
21-Oct-03	–	31-Oct-03	III	890.3	952.0	2130.0	859.4
1-Nov-03	–	11-Nov-03	I	1098.3	1133.0	2218.0	832.1
11-Nov-03	–	21-Nov-03	II	1148.8	1034.8	2478.0	797.5
21-Nov-03	–	30-Nov-03	III	1135.6	974.4	2683.0	884.1
1-Dec-03	–	11-Dec-03	I	1020.0	1250.2	2761.0	937.7
11-Dec-03	–	21-Dec-03	II	977.8	878.6	3031.0	919.1
21-Dec-03	–	31-Dec-03	III	1432.0	1237.9	2996.0	1231.6
1-Jan-04	–	11-Jan-04	I	1140.0	1220.5	3002.0	1190.4
11-Jan-04	–	21-Jan-04	II	1140.0	1171.9	3028.0	1107.1
21-Jan-04	–	31-Jan-04	III	1140.0	1150.2	3084.0	1086.0
1-Feb-04	–	11-Feb-04	I	976.5	1347.2	3145.0	1295.1
11-Feb-04	–	21-Feb-04	II	976.5	803.2	3190.0	748.8
21-Feb-04	–	29-Feb-04	III	976.5	838.5	3237.0	744.6
1-Mar-04	–	11-Mar-04	I	1081.8	943.5	3310.0	862.5
11-Mar-04	–	21-Mar-04	II	1081.8	1000.9	3380.0	933.8
21-Mar-04	–	31-Mar-04	III	1081.8	1244.6	3438.0	1202.5

(2) Estimation of minimum release causing winter flood

The artificial flood caused by the release from the Toktogul Reservoir happens in winter when a water way of the down stream of Chardara Reservoir is frozen and the capacity of the flow decreases. We assumed that the winter-flood period when the river could possibly be frozen was from November to March. During the period, the monthly average temperature at Saksaulskaya, located at the down stream of Syrdarya River in Kazakhstan, is below zero degrees C.

The release from the Chardara Reservoir in winter increased from 2004, and floods were caused (Table 4-4).

Table 4-4 Average release during each decade of the month from Chardara Reservoir in winter (m^3/s)

Period	November			December			January			February			March		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Nov 1998 - Mar 1999	660	575	500	406.7	400	400	400	400	400	400	400	493.8	637	780	790.9
Nov 1999 - Mar 2000	525.7	531.6	426.7	406	360	360	360	360	360	360	372	433.3	469.3	330	250
Nov 2000 - Mar 2001	500	510	444.7	362	396	370.9	360	360	360	360	381	381.6	460	460	460
Nov 2001 - Mar 2002	597	694	485	384	360	360	380	380	380	380	467.5	556.3	680	600	518.2
Nov 2002 - Mar 2003	350	445	490	400	400	389.1	360	360	360	387	360	360	360	380	595.5
Nov 2003 - Mar 2004	520	650	590	550	550	575.9	682.6	682.6	682.6	707.6	707.6	707.6	692.4	692.4	692.4
Nov 2004 - Mar 2005	823.3	823.3	823.3	721	721	721	650	600	600	610	700	787.5	800	825	1145.5
Nov 2005 - Mar 2006	619.5	830	989.5	745	710	705	655	605	605	600	530	728.8	1088.9	756	552.7
Nov 2006 - Mar 2007	541	675	870	770	720	605	605	655	718.6	729.8	656.5	255	205	245	357.7
Nov 2007 - Mar 2008	385.5	420	380	392	600	618.2	615	605	658.9	723	745	756.7	616	557	350.9

▢ : Release at flood in winter

It was estimated that the minimum release of Chardara Reservoir in the flood period was about 600 m^3/s (Table 4-2, Table 4-4). It was assumed from the flood events in the other years that floods in the period from November 2004 to March 2005 had happened in January or February

Thus, we carried out the simulation, as described below, by assuming that the minimum release causing winter flood was 600 m^3/s.

(3) Selection of a flow-regime period for the simulation

We selected a flood-regime period when the annual amount of water was high and the average-flow-regime period when the amount was average among the periods from April 1998 to September 2008 as described below. For the simulation, we defined, as the assumption in Table 4-4, the period from November to March as 'winter' and from April to October as 'vegetation period'. The winter and the vegetation period constitute one year cycle for the simulation.

(a) Selection of the flood-regime period

The winter floods at the down stream of Chardara Reservoir indicated in Table 4-2 were targeted. The period at which the accumulated inflow of Chardara Reservoir in winter was maximal was selected with the followed vegetation period as the flood-regime period holding a large amount of water.

The accumulated inflow in winter was maximal during the period from November 2004 to March 2005 (Table 4-5). Thus, the period from April 2004 to March 2005 was selected as the flood-regime period.

Table 4-5 Accumulated inflow of Chardara Reservoir in winter

	Nov 98 – Mar 99	Nov 99 – Mar 00	Nov 00 – Mar 01	Nov 01 – Mar 02	Nov 02 – Mar 03	Nov 03 – Mar 04	Nov 04 – Mar 05	Nov 05 – Mar 06	Nov 06 – Mar 07	Nov 07 – Mar 08
Accumulated inflow in winter (bln m^3)	10.13	9.36	9.36	10.31	9.42	11.8	13.93	13.85	11.71	11.56

(b) Selection of the average-flow-regime period

A flow regime of an average amount of water was selected to be compared with the flood regime. The period with the least amount of water was selected among the average flow regimes to clear up comparison with the flood regime.

Data of the inflow to Toktogul Reservoir for about 90 years from 1911 indicates that the actual inflows were average in 2000, 2001, 2006 and 2007 for the last decade.

The sum of total annual inflows to the Toktogul Reservoir plus the volume of the first decade of January was assumed as an annual maximum potential to supply water. The annual maximum potential to supply water was minimal in 2001 (Table 4-6).

Thus, the vegetation period in 2001 and the following winter, April 2001 – March 2002, was selected as the average-flow-regime period.

Table 4-6 Total annual inflow to Toktogul Reservoir and the volume at the first decade of January

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total annual inflow (bln m^3)	14.44	12.67	12.64	16.56	15.79	14.43	13.52	12.60	11.64
Volume at the first decade of January (bln m^3)	13.19	14.16	11.63	10.15	15.32	16.96	16.32	15.80	14.07
Annual maximum potential to supply water (bln m^3)	27.63	26.83	24.27	26.71	31.10	31.38	29.84	28.40	25.71

4-2 Measures for mitigation of floods and droughts

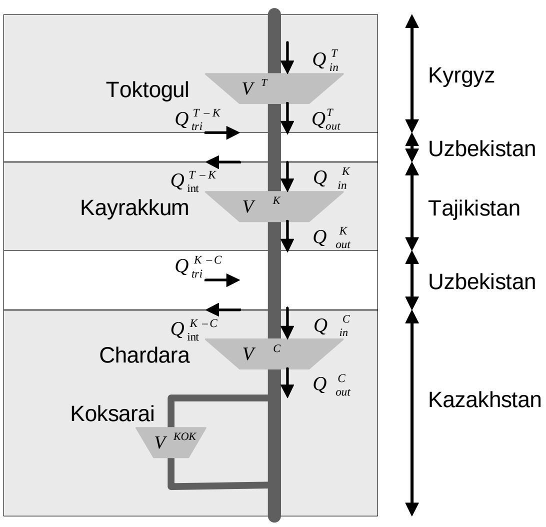
4-2-1 Setting of simulation cases

The simulation cases consist of the following four cases (Table 4-7): the release of the Chardara Reservoir is controlled to be not over the minimum release causing winter flood (600 m^3/s) by suppressing the winter release of the Toktogul Reservoir following the conventional agreement to control the release of Toktogul Reservoir (600 m^3/s, an example of January 2008) (Case 1), the release of the Toktogul Reservoir in the vegetation period is increased up to the agreed release for compensating shortage water in addition to Case 1 (Case 2), the volumes of the Kayrakkum and Chardara Reservoirs are decreased to the actual minimum before winter (Case 3), and the release from the Chardara Reservoir over the minimum release causing winter flood (600 m^3/s) is stored in the Koksarai Reservoir (Case 4).

Table 4-7 Simulation cases of each flow regime

Flow regime	Period	Cases
A. Flood	April 2004 – March 2005	Case A-1: Saving water discharge from the Toktogul Reservoir in winter (agreement basis)
		Case A-2: Ditto; subjecting every discharge to agreement
		Case A-3: Harmonizing operations of the Kayrakkum and Chardara Reservoirs
		Case A-4: Following actual operation (Koksarai Reservoir)
B. Average	April 2001 – March 2002	Case B-1: Saving water discharge from the Toktogul Reservoir in winter (agreement basis)
		Case B-2: Ditto; subjecting every discharge to agreement
		Case B-3: Harmonizing operations of the Kayrakkum and Chardara Reservoirs
		Case B-4: Following actual operation (Koksarai Reservoir)

Parameters regarding the reservoir operation for the simulation are indicated in Figure 4-1.



Toktogul	
Q_{in}^{T}	Inflow
Q_{out}^{T}	Release
V^{T}	Volume
Toktogul - Kayrakkum	
Q_{tri}^{K-C}	Inflow
Q_{int}^{K-C}	Intake
Kayrakkum	
Q_{in}^{K}	Inflow
Q_{out}^{K}	Release
V^{K}	Volume

Kayrakkum - Chardara	
Q_{tri}^{T-K}	Inflow
Q_{int}^{T-K}	Intake
Chardara	
Q_{in}^{C}	Inflow
Q_{out}^{C}	Release
V^{C}	Volume
Koksarai	
V^{KOK}	Volume

Figure 4-1 Parameter used for the simulation

(1) Saving water discharge from the Toktogul Reservoir in winter (Case 1)

Release from the Toktogul Reservoir over the minimum release causing winter flood is cut down to keep the winter release (November – March) of the Chardara Reservoir not over 600 m^3/s. The operation is a conventional one from the former Soviet Union era.

The cut-down release in winter is stored in the Toktogul Reservoir and released on average during the following vegetation period (April – October) in addition to the actual release. The annual water balance is in accordance with the actual amount (Figure 4-2).

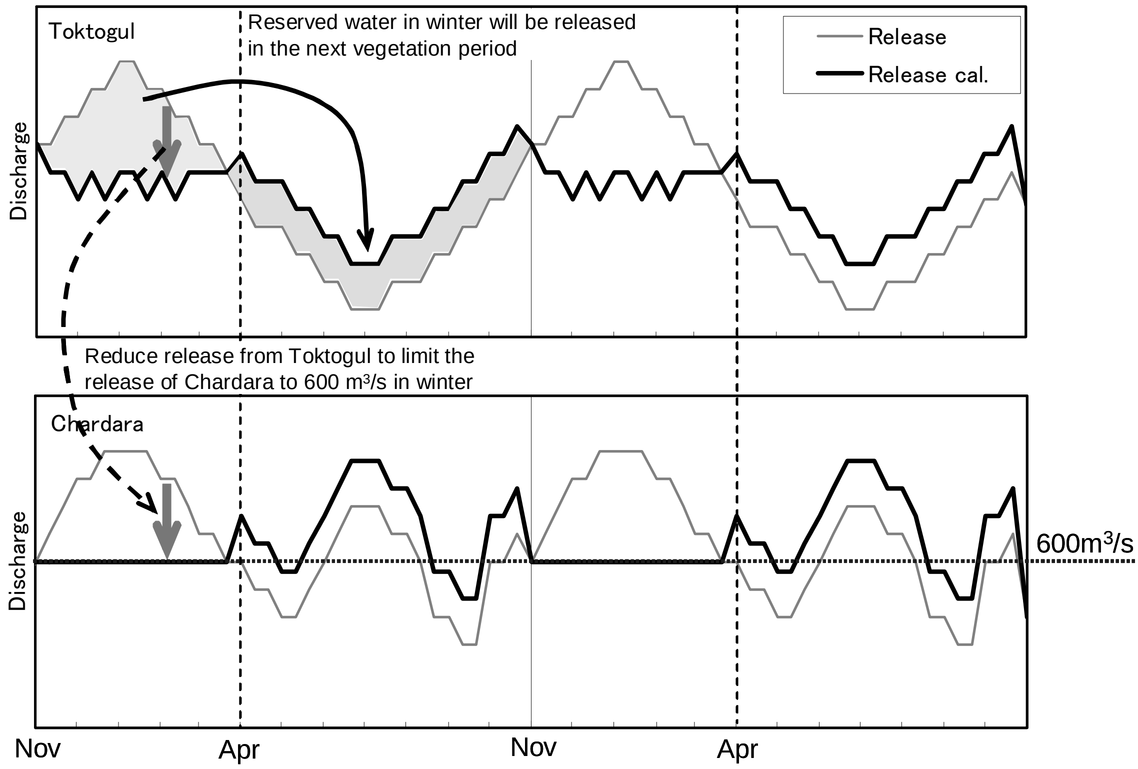


Figure 4-2 Operation procedure of control of winter release from Toktogul Reservoir

$$\Delta V^{C}_{win} = \sum_{i=Nov}^{Mar} (Q^{C}_{out_i} - Q^{C}_{\min}) \qquad (1)$$

$$\overline{\Delta V}^{C}_{win_y} = \Delta V^{C}_{win} \big/ \Delta t \qquad (2)$$

$$Q^{T}_{out'} = Q^{T}_{out} + \overline{\Delta V}^{C}_{win_y} \qquad (3)$$

Q^{C}_{out} : Actual release of Chardara

$Q^{C}_{\min}$: Minimum release of Chardara causing winter flood (600 m^3/s)

ΔV^{C}_{win} : Accumulated release over 600 m^3/s in winter

$\overline{\Delta V}^{C}_{win_y}$: Accumulated release over 600 m^3/s in winter divided by the vegetation period

Δt : Vegetation period (April – October)

$Q^{T}_{out'}$: Release of Toktogul

Q^{T}_{out} : Actual release of Toktogul

(2) Subjecting every discharge to agreement (Case 2)

The release from the Toktogul Reservoir is kept to a planned release agreed among the countries (agreed release). Operation by the control of winter release from the Toktogul Reservoir (Case 1) is checked, to know whether or not it satisfies the agreed release, and the release is increased up to the agreed release if the release is lower than the agreed release. Average agreed releases are used as the agreed release varies annually. The average agreed release of the Toktogul Reservoir for the simulation is an average of each decade of the months from April 1998 – March 2008.

The decreased reserved volume by the increased release in vegetation period is compensated by reducing the release in the following winter period (November – March). The annual water balance is in accordance with the actual amount (Figure 4-3).

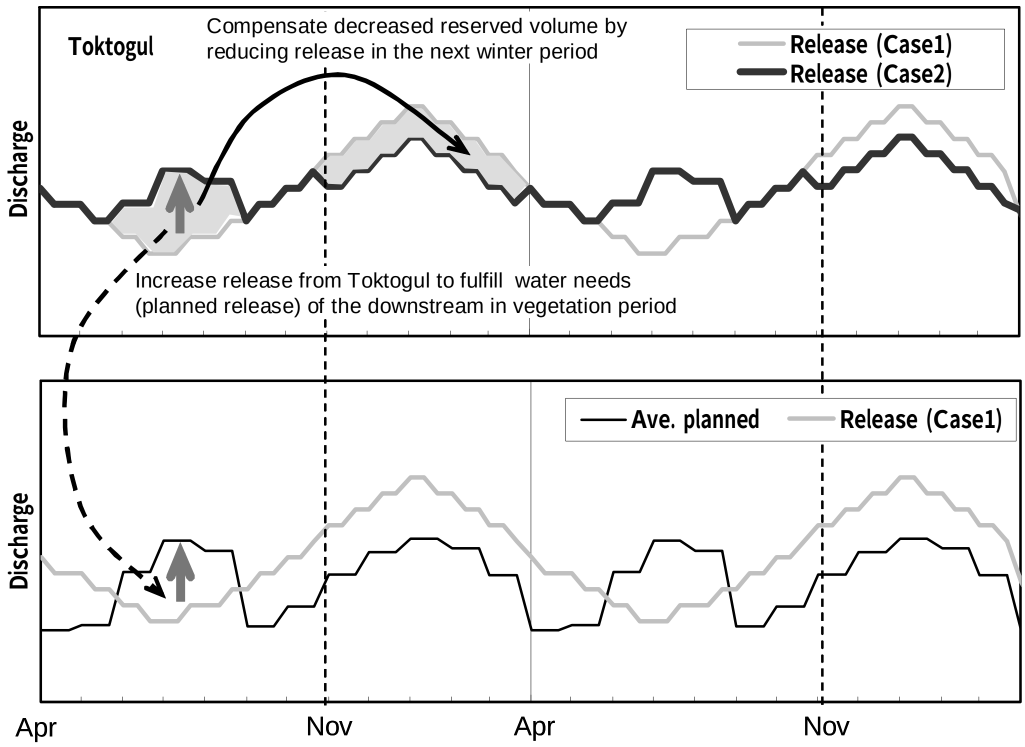


Figure 4-3 Operation procedure of keeping the agreed release from Toktogul Reservoir

$$\Delta V^{T}_{veg} = \sum_{i=Apr}^{Nov} (Q^{T}_{plan\,i} - Q^{T}_{out\,i}) \qquad (4)$$

$$\overline{\Delta V}^{T}_{veg} = \Delta V^{T}_{veg} \Big/ \Delta t \quad (5)$$

$$Q^{T}_{out''} = Q^{T}_{out} + \overline{\Delta V}^{T}_{veg} \quad (6)$$

Q^{T}_{plan} : Agreed release of Toktogul

Q^{T}_{out} : Actual release of Toktogul

ΔV^{T}_{veg} : Integrated amount of the agreed release over actual release in the vegetation period

$\overline{\Delta V}^{T}_{veg}$: Integrated amount of the agreed release over actual release in the vegetation period divided by the winter period

Δt : Winter period (November – March)

$Q^{T}_{out''}$: Release of Toktogul

(3) Harmonizing operations of the Kayrakkum and Chardara Reservoirs (Case 3)

The volume at the third decade of October is decreased to the actual minimal volume, and the release of the Kayrakkum Reservoir is controlled to make a release of the Chardara Reservoir not over the minimum release causing winter flood (600 m^3/s), by storing water in the Kayrakkum and Chardara Reservoirs (Figure 4-4). The operation procedures are as follows;

- Volumes of the Kayrakkum and Chardara Reservoirs are decreased to the actual minimal volume (Kayrakkum: 827 mln m^3, Chardara: 389 mln m^3) by the third decade of October.
- Release of the Chardara Reservoir is controlled to be 600 m^3/s from the first decade of November, and the release of the Kayrakkum Reservoir is controlled to keep the release of the Chardara Reservoir.
- After the volume of the Kayrakkum Reservoir reaches the actual maximal volume (3.67 bln m^3), the release of the Kayrakkum Reservoir is made equivalent to the inflow, and the release of the Chardara Reservoir is controlled not to be over 600 m^3/s.

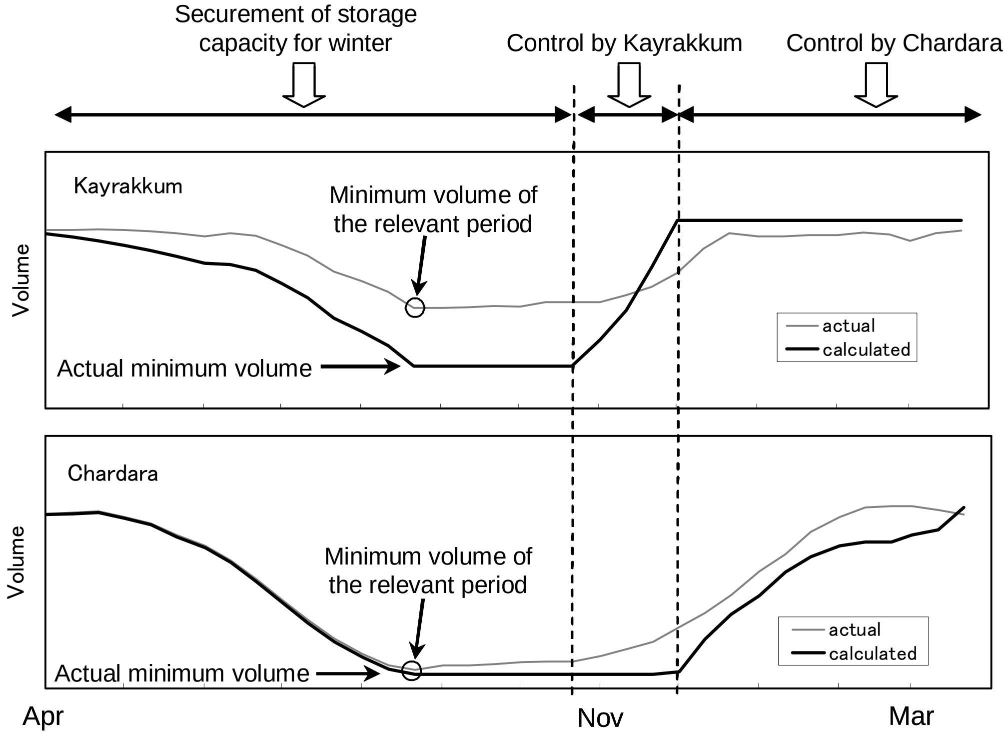


Figure 4-4 Operation procedure of the cooperation between Kayrakkum and Chardara Reservoirs

Details of the operation are described below.

(a) Securement of storage capacity in winter

- Difference between the minimum volume of the relevant period and the actual minimum volume is divided by the period from the first decade of April to a decade of the month with the minimum volume of the relevant period. The averaged volume is added to the release of each reservoir.
- Release of each reservoir is made equivalent to the inflow when the volume reaches the actual minimum volume. The operation is kept until the third decade of October.

i) Kayrakkum Reservoir

$$\Delta V^K_{\min y} = V^K_{\min y} - V^K_{\min} \quad (7)$$

$$\overline{\Delta V}^K_{\min y} = \Delta V^K_{\min y} \Big/ \Delta t^K \quad (8)$$

$$Q^K_{out'} = Q^K_{out} + \overline{\Delta V}^K_{\min y} \quad (9)$$

$\Delta V^K_{\min y}$: Difference between a minimum volume of the relevant period and the actual minimum volume of Kayrakkum

$V^K_{\min y}$: Minimum volume of the relevant period of Kayrakkum

$V^K_{\min}$: Actual minimum volume of Kayrakkum

$\overline{\Delta V}^K_{\min y}$: Difference between a minimum volume of the relevant period and the actual minimum volume divided by a period from the first decade of April to a decade of the month at the minimum volume of the relevant period of Kayrakkum

Δt^K : Period from the first decade of April to a decade of the month when the volume of Kayrakkum reaches minimum in the relevant period

$Q^K_{out'}$: Release of Kayrakkum

Q^K_{out} : Actual release of Kayrakkum

ii) Chardara Reservoir

$$\Delta V^C_{\min y} = V^C_{\min y} - V^C_{\min} \quad (10)$$

$$\overline{\Delta V}^C_{\min y} = \Delta V^C_{\min y} \big/ \Delta t^C \quad (11)$$

$$Q^C_{out'} = Q^C_{out} + \overline{\Delta V}^C_{\min y} + \overline{\Delta V}^K_{\min y} \quad (12)$$

$\Delta V^C_{\min y}$: Difference between a minimum volume of the relevant period and the actual minimum volume of Chardara

$V^C_{\min y}$: Minimum volume of the relevant period of Chardara

$V^C_{\min}$: Actual minimum volume of Chardara

$\overline{\Delta V}^C_{\min y}$: Difference between a minimum volume of the relevant period and the actual minimum volume divided by a period from the first decade of April to a decade of the month at the minimum volume of the relevant period of Chardara

Δt^C : Period from the first decade of April to a decade of the month when the volume of Chardara reaches minimum in the relevant period

$Q^C_{out'}$: Release of Chardara

Q^C_{out} : Actual release of Chardara

(b) Control by Kayrakkum Reservoir

- Release of the Chardara Reservoir is controlled to be the minimum release causing winter flood (600 m^3/s) from the first decade of November, and the release is kept until the third decade of March.
- Release of the Kayrakkum Reservoir is controlled to make the inflow of Chardara Reservoir 600 m^3/s, and the release is kept until the volume of the Kayrakkum Reservoir reaches the

actual maximum.

$$Q^K_{out"} = 600 - (Q^C_{in} - Q^K_{out}) \quad (13)$$

$Q^K_{out"}$: Release of Kayrakkum (until a volume of Kayrakkum reaches the actual maximum)
Q^C_{in} : Actual inflow of Chardara
Q^K_{out} : Actual release of Kayrakkum

(c) Control by Chardara Reservoir

- Volume of the Kayrakkum Reservoir is kept constant by making the release equivalent to the inflow after the volume of the Kayrakkum Reservoir reaches the actual maximum.
- Release of the Chardara Reservoir is kept below the minimum release causing winter flood (600 m^3/s)

(4) Following actual operation (Case 4)

The Koksarai Reservoir (storage capacity; 3 bln m^3) is under construction to mitigate floods at the down stream of the Chardara Reservoir. In this simulation case, the actual release of the Chardara Reservoir, over 600 m^3/s is stored in the Koksarai Reservoir.

It is assumed that the control-required release is the difference between the actual release of Chardara Reservoir in winter (November – March) and the minimum release causing winter flood. The necessary volume of the Koksarai Reservoir in the winter is estimated by integration of the control-required release.

The necessary volume is compared with the effective volume of the Koksarai Reservoir (3 bln m^3), and it is deemed that the floods can be mitigated by the Koksarai Reservoir alone if the necessary volume is not over the effective volume.

$$\sum_{i=Nov}^{Mar} (Q^C_{out\,i} - Q^C_{\min i}) \le V^{KOK} \qquad (14)$$

Q^C_{out} : Actual release of Chardara
$Q^C_{\min}$: Minimum release of Chardara causing winter flood (600 m^3/s)
V^{KOK} : Volume of Koksarai (3 bln m^3)

4-2-2 Results

Proposed operation of each case is indicated in Figure 4-8. The results are described below.

Table 4-8 Proposed operation of the each case

Reservoir	Case 1	Case 2	Case 3	Case 4
Toktogul	Release of Toktogul is reduced to make the release of Chardara in winter not over 600 m^3/s. Total volume of the release reduction of Toktogul is released in the vegetation period.	In addition to Case 1, release of Toktogul in vegetation period is increased up to the agreed release. Total volume of the release increase is compensated by reduction of release of Toktogul in winter.	–	–
Kayrakkum	Operation is changed according to the operation change of Toktogul.	Operation is changed according to the operation change of Toktogul.	Volume at the third decade of October is decreased to the actual minimum volume, and the release of Kayrakkum is controlled to make the inflow of Chardara below 600 m^3/s. After the volume reaches the actual maximum volume, the release is made equivalent to the inflow.	–
Chardara	Operation is changed according to the operation change of Toktogul.	Operation is changed according to the operation change of Toktogul.	Volume at the third decade of October is decreased to the actual minimum volume, and the release is controlled not to be over 600 m^3/s	–
Koksarai	–	–	–	Release from Chardara over 600 m^3/s in winter is stored in Koksarai.

(1) Saving water discharge from the Toktogul Reservoir in winter (Case 1)

(a) Flood-regime period

It is indicated that winter floods can be mitigated by controlling the release of the Toktogul Reservoir to keep the release of the Chardara Reservoir not over 600 m^3/s.

An alternative power supply, however, should be obtained to secure the electric supply for the tight demand in winter of Kyrgyzstan, as the release of the Toktogul Reservoir is decreased in winter.

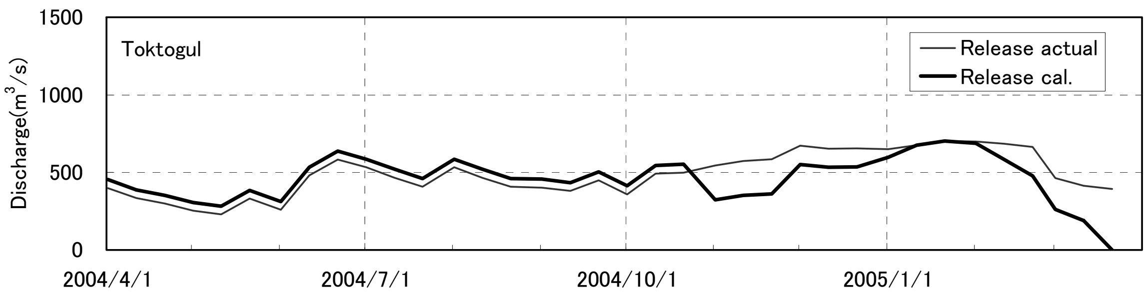


Figure 4-5 Secular change of release from Toktogul Reservoir

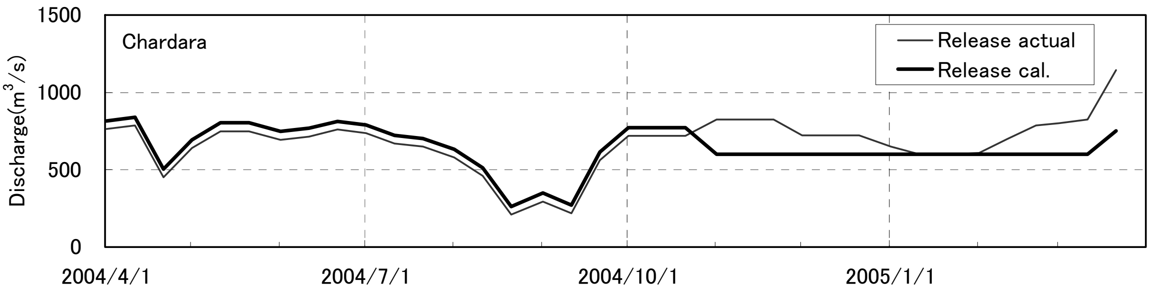


Figure 4-6 Secular change of release from Chardara Reservoir

(b) Average-flow-regime period

It is indicated that winter floods can be mitigated by controlling the release of the Toktogul Reservoir to keep the release of the Chardara Reservoir not over 600 m^3/s.

An alternative power supply, however, should be obtained to secure the electric supply for the tight demand in winter of Kyrgyzstan, as the release of Toktogul Reservoir is decreased in winter.

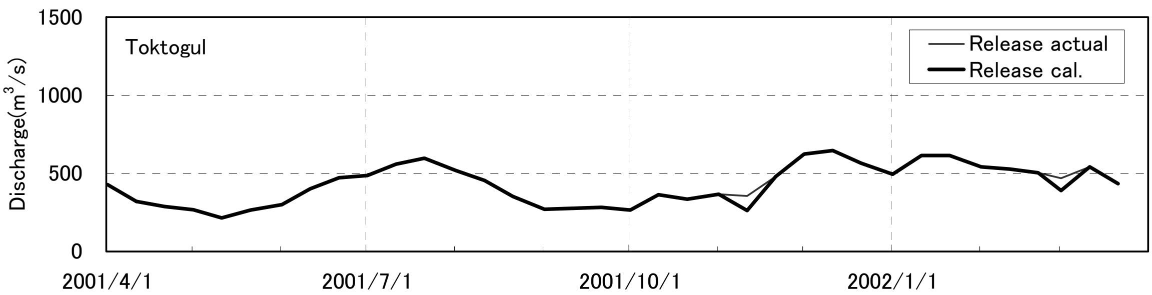


Figure 4-7 Secular change of release from Toktogul Reservoir

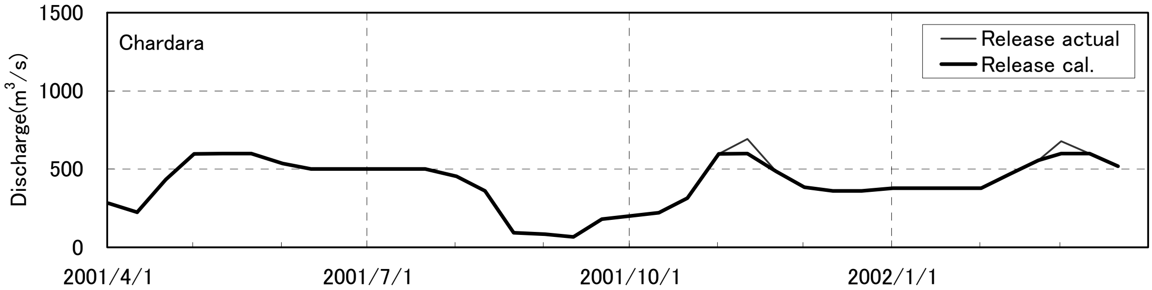


Figure 4-8 Secular change of release from Chardara Reservoir

(2) Subjecting every discharge to agreement (Case 2)

(a) Flood-regime period

It is indicated that the agreed release of the Toktogul Reservoir can be kept by increasing the release in the vegetation period.

An alternative power supply, however, should be obtained to secure an electric supply for the tight demand in winter of Kyrgyzstan, as the release of the Toktogul Reservoir is decreased in winter.

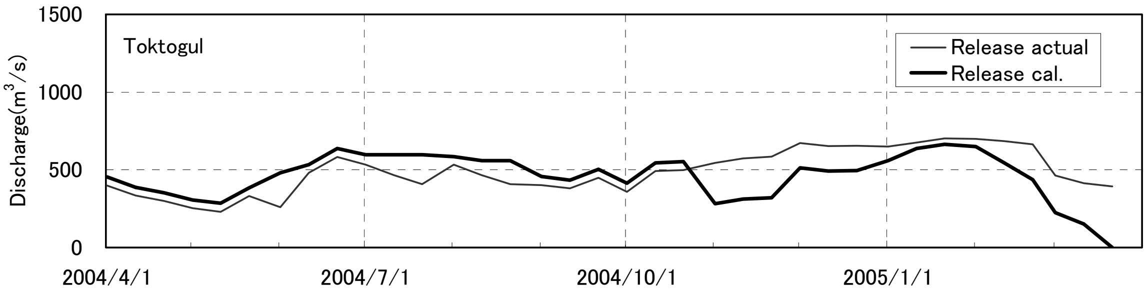


Figure 4-9 Secular change of release from Toktogul Reservoir

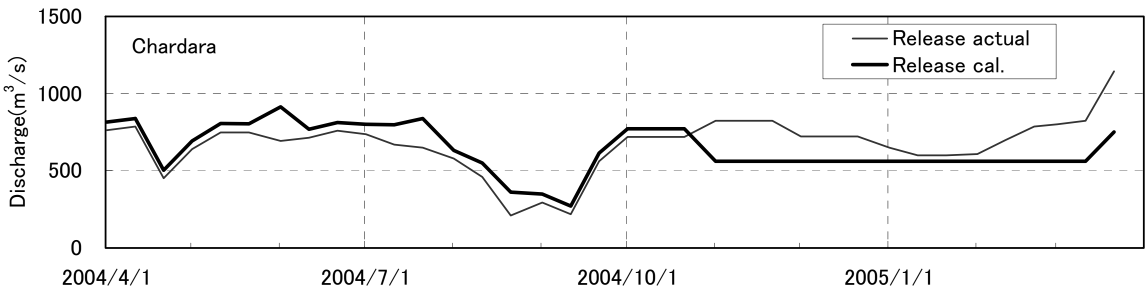


Figure 4-10 Secular change of release from Chardara Reservoir

(b) Average-flow-regime period

It is indicated that the agreed release of the Toktogul Reservoir can be kept by increasing the release in the vegetation period.

An alternative power supply, however, should be obtained to secure the electric supply for the tight demand in winter of Kyrgyzstan, as the release of the Toktogul Reservoir is decreased in winter.

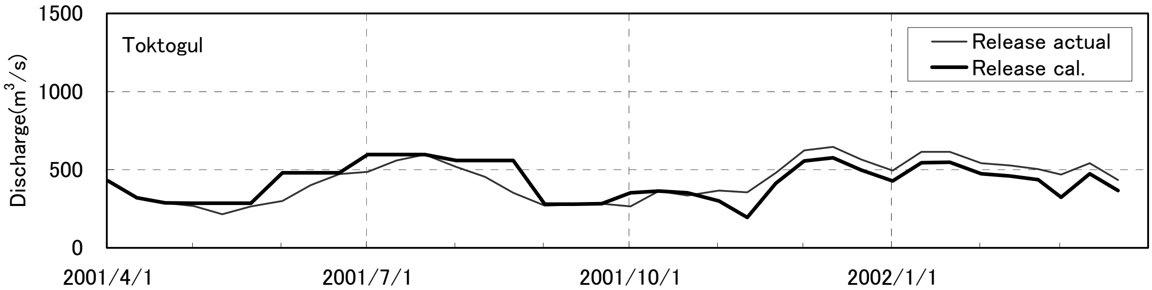


Figure 4-11 Secular change of release from Toktogul Reservoir

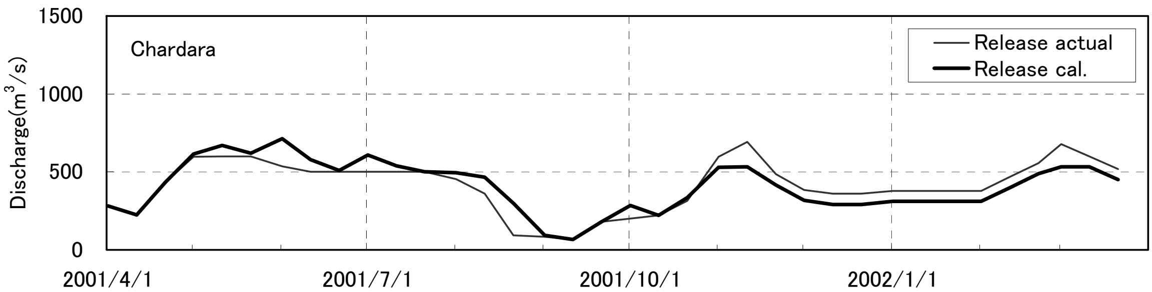


Figure 4-12 Secular change of release from Chardara Reservoir

(3) Harmonizing operations of the Kayrakkum and Chardara Reservoirs (Case 3)

(a) Flood-regime period

It is indicated that the release of the Chardara Reservoir can be kept below 600 m^3/s in winter, by reducing the volume of the Kayrakkum and Chardara Reservoirs to the actual minimum volume at the third decade of October, and that winter floods can be mitigated by preparatory operations for floods with the maximum utilization of the Kayrakkum and Chardara Reservoirs.

The actualization of this operation requires an agreement on the cooperative operation of the two reservoirs and the Toktogul Reservoir by the three countries, as well as accurate information for the operation of the reservoirs.

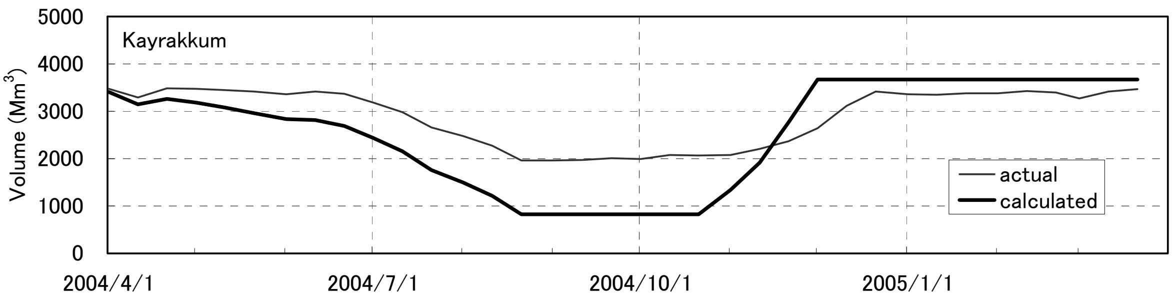


Figure 4-13 Secular change of volume of Kayrakkum Reservoir

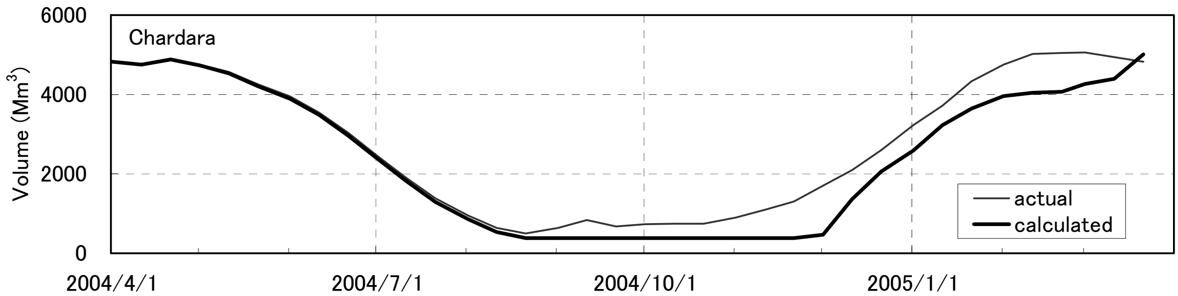


Figure 4-14 Secular change of volume of Chardara Reservoir

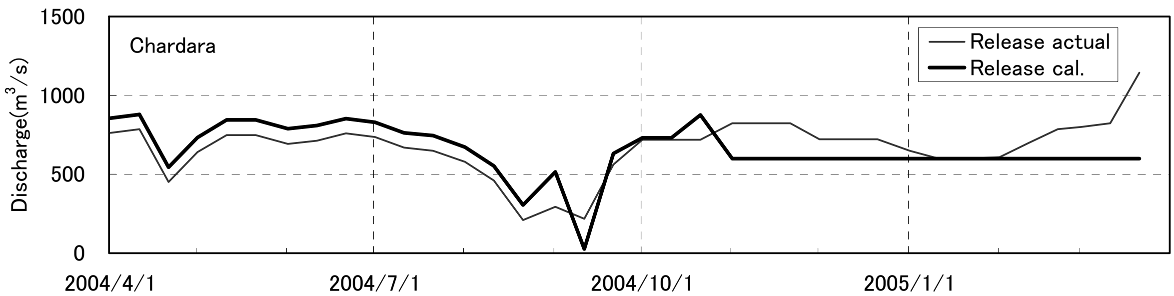


Figure 4-15 Secular change of release from Chardara Reservoir

(b) Average-flow-regime period

It is indicated that the release of the Chardara Reservoir can be kept below 600 m^3/s in winter, by reducing the volume of the Kayrakkum and Chardara Reservoirs to the actual minimum volume at the third decade of October, and that winter floods can be mitigated, by preparatory operation for floods with the maximum utilization of the Kayrakkum and Chardara Reservoirs.

The volume of the Chardara Reservoir is 2.2 bln m^3 at the third decade of March, and the next vegetation period is likely to be adversely affected. This operation is applicable if the volumes of the Kayrakkum and Chardara Reservoirs are controlled appropriately with an accuracy enhancement of the flow-regime forecasting and if the Toktogul Reservoir is operated reasonably.

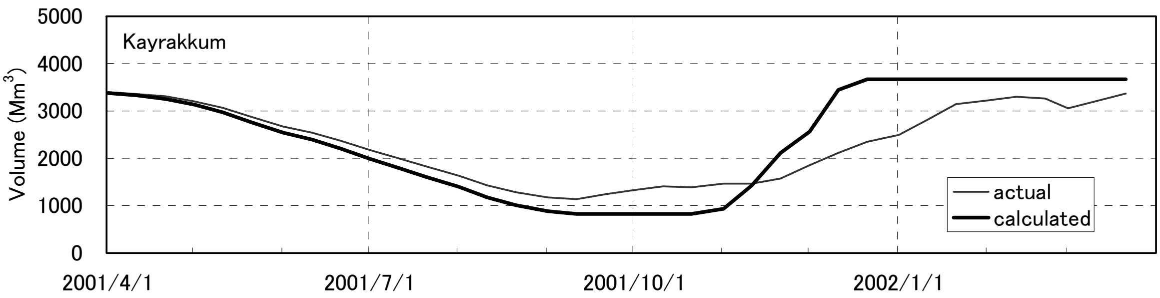


Figure 4-16 Secular change of volume of Kayrakkum Reservoir

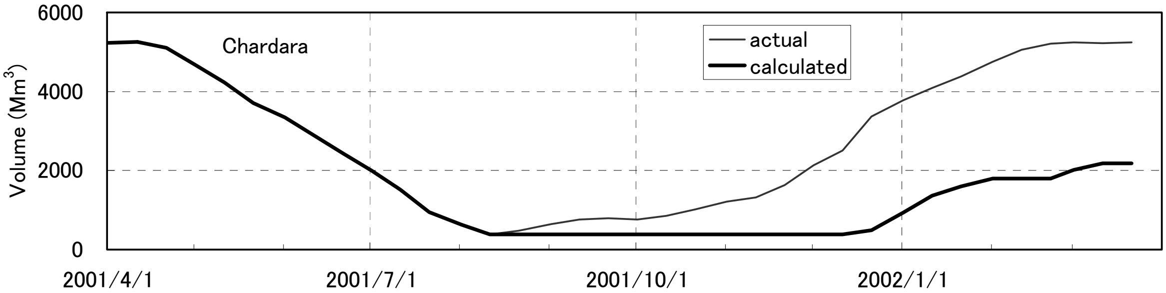


Figure 4-17 Secular change of volume of Chardara Reservoir

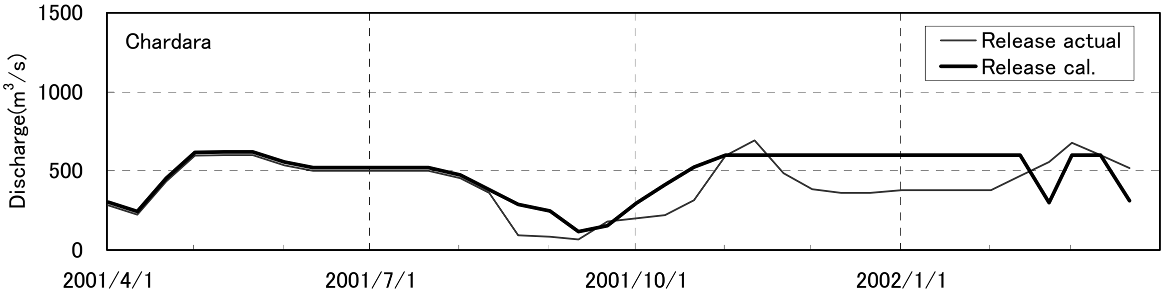


Figure 4-18 Secular change of release from Chardara Reservoir

(4) Following actual operation (Case 4)

The necessary volumes of each winters didn't exceed 3 bln m^3 of the storage capacity of the Koksarai Reservoir, even in winter of the flood regime (November 2004 – March 2005) (Figure 4-9). It is estimated that the building of the Koksarai Reservoir can mitigate the winter flood at the down stream of the Chardara Reservoir even if the Toktogul, Kayrakkum and Chardara Reservoirs keep the actual operation. Water stored in the Koksarai Reservoir can be used for summer irrigation, by returning the water to the main stream.

This operation is however, not a measure for floods in Uzbekistan.

Table 4-9 Necessary volume of Koksarai Reservoir in each winter

	1998.11 – 1999.3	1999.11 – 2000.3	2000.11 – 2001.3	2001.11 – 2002.3	2002.11 – 2003.3	2003.11 – 2004.3	2004.11 – 2005.3	2005.11 – 2006.3	2006.11 – 2007.3	2007.11 – 2008.3
Necessary volume (bln m^3)	0.42	0	0	0.15	0	0.78	2.06	1.58	0.88	0.44

4-2-3 Conclusion

It is indicated that the release decrease of the Toktogul Reservoir can mitigate floods and droughts. An alternative power supply, however, should be obtained as there is concern about electricity shortages in winter.

The cooperative operation between the Kayrakkum and Chardara Reservoirs can mitigate winter floods with the current facilities if each country agrees to and respects the operation and if it is conducted in an accurate way.

It is indicated that the building of the Koksarai Reservoir can mitigate the winter floods at the down stream, even if the other reservoirs keep the current operation. The stored water can be utilized for irrigation, by returning the water to the main stream in summer. A large investment is however, needed.

4-3 Evaluation of flood mitigation and prevention effects on electric generation

4-3-1 Relation between electric generation and spilled water by flood control mitigations

In section 4-2, mitigations for flood prevention were studied from an appropriate water resource operation aspect. In this section, the effects of mitigations on the electric power system will be studied.

(1) Cases of mitigations

The cases of flood control described in section 4-2 are listed in the table below. The effects on electric power system will be evaluated depending on the cases.

Table 4-10 Simulation cases of each flow regime

Flow regime	Period	Cases
A. Flood	April 2004 – March 2005	Case A-1: Saving water discharge from the Toktogul Reservoir in winter (agreement basis)
		Case A-2: Ditto; subjecting every discharge to agreement
		Case A-3: Harmonizing operations of the Kayrakkum and Chardara Reservoirs
		Case A-4: Following actual operation (Koksarai Reservoir)
B. Average	April 2001 – March 2002	Case B-1: Saving water discharge from the Toktogul Reservoir in winter (agreement basis)
		Case B-2: Ditto; subjecting every discharge to agreement
		Case B-3: Harmonizing operations of the Kayrakkum and Chardara Reservoirs
		Case B-4: Following actual operation (Koksarai Reservoir)

(2) Affected electric power facilities

The selected mitigations include modifications on the reservoir operation of the Toktogul Reservoir (Kyrgyzstan), the Kayrakkum Reservoir (Tajikistan) and the Chardara Reservoir (Uzbekistan). The electric power generation from associated hydropower plants should be changed when the operation of reservoirs is changed. The surplus water will discharge without generation, when water in flow exceeds the maximum volume, at which the hydropower generator operates. The electricity generation will be reduced, if there is water over flow in the reservoirs. The electricity generation and water over flow are adopted as indicators to evaluate the effects from the mitigation for flood prevention. Case A-4 and B-4 are base cases, because they do not change their reservoir operation.

(3) Methodology of evaluation of effects to electricity facilities

Outputs from generators should be coordinated to catch up system demands that vary at every moment. The other generators should be controlled, when hydropower has changed its operation by changing its reservoir operation. The effect on electric power facility is evaluated in comparison with optimal simulation results such as electric energy generation and water over flow by each case.

(4) Affected electric energy generation and Water over flow by flood prevention mitigations

i) Electric energy generation and water over flow in base cases

Shown in the Fig. 4-19 and Fig. 4-20, are the simulated average monthly electric energy generation and flood water in flow by power plants: Naryn Cascade hydropower station (Kyrgyzstan), Kayrakkum hydropower station (Tajikistan) and Chardara Reservoir (Uzbekistan). The output from the Naryn Cascade hydropower station was included in Toktogul hydropower station's, because the Naryn Cascade hydropower station is located in down stream of the Toktogul Reservoir. The results of the calculation of water over flow were too little to take into consideration.

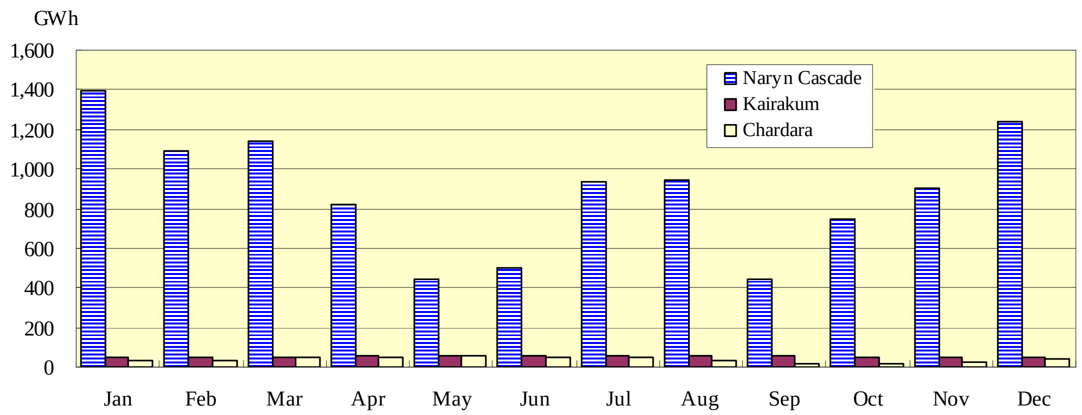


Figure 4-19 Monthly generation from the Naryn Cascade, Kayrakkum, Chardara hydropower stations (average water in flow)

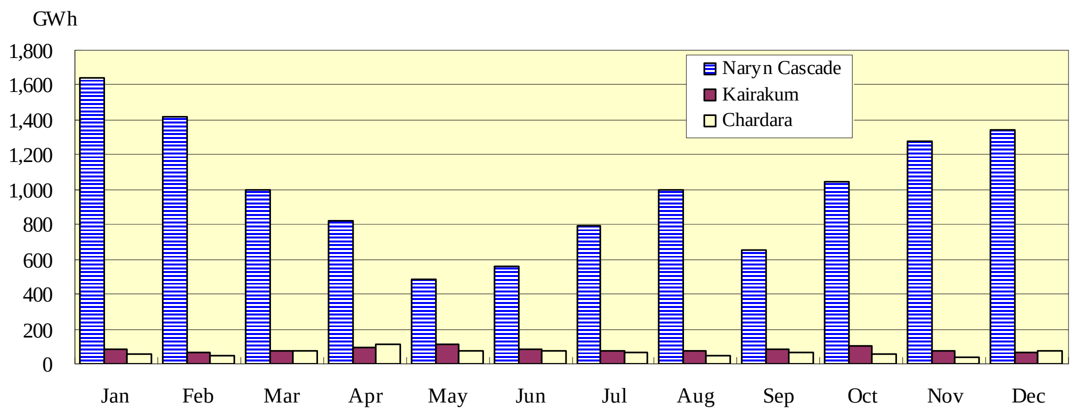


Figure 4-20 Monthly generation from the Naryn Cascade, Kayrakkum, Chardara hydropower stations (flood water in flow)

ii) Effects in flood water in flow

Illustrated in the Fig. 4-21, is the discrepancy of monthly electric energy generation under flood water in flow condition from case A-1, case A-2 and case A-3, in comparison with the base case. The monthly electric energy generations from April to October in case A-1, A-2 and A-3 exceed the base case generation. During April to October, the cases could supply to coordinate outputs from other generators. Additional supplies are required to supply their demands from November to March, because outputs from hydropower stations are insufficient to meet the peak demand, in case A-1 and A-2, especially reducing from the base case.

Shown in the Fig. 4-22, the reduction in outputs from hydropower station by the cases in December, when Kyrgyzstan has least reserve capacity. The reduction in monthly outputs from the Kayrakkum and Chardara hydropower stations is 20 GWh in average and maximum 40 GWh in every case. The energy generation reduction is equivalent to 50 – 70 MW of the supply capacity shortage. Such amount of supply capacity shortage can be absorbed by other generations due to little enough than the total system scale. Reduction in monthly outputs from the Naryn Cascade hydropower station in December could reach an average 300 GWh and maximum 700GWh from November to March. These are equivalent to 400 MW – 1,200 MW of supply capacity shortage. Such amounts of supply capacity shortage could be difficult to recover with the existing facilities, even if incremental outputs by surplus water in flow are taken into account. An additional supply capacity of at least 400 MW is required to supply their demand stably.

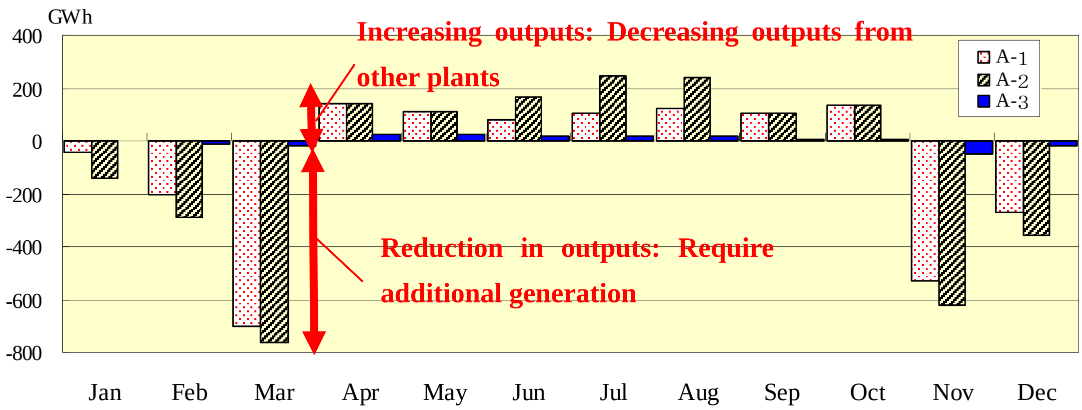


Figure 4-21 Difference of monthly electric energy generation from three hydropower stations in flood water-in-flow

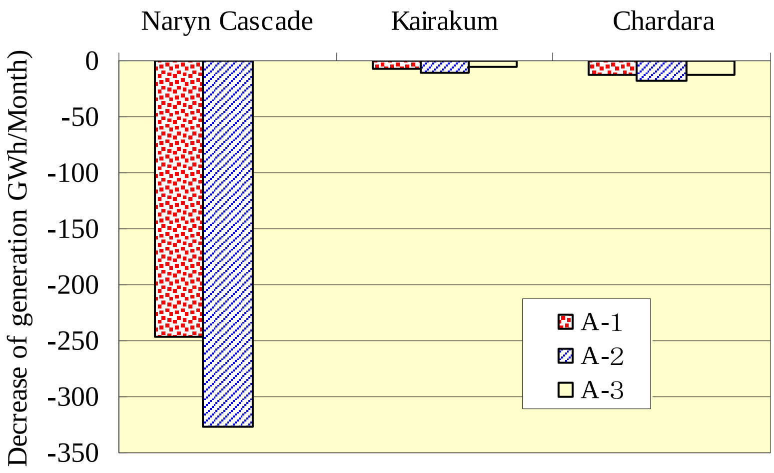


Figure 4-22 Reduction in outputs from hydropower station by the cases in December

iii) Effects in average water in flow

Described in the Fig. 4-23, is the monthly electric energy generation in case B-1, case B-2 and case B-3 depending on the average water in flow comparison with the base case (B-4).

The reduction in monthly outputs from the Kayrakkum hydropower station in November is around 25 GWh in the case B-3. The energy generation reduction is equivalent to 50 MW of supply capacity shortage. The reserve capacity can be secured with power exchange depending on the results of simulation in Kyrgyzstan and Uzbekistan systems in November.

The reduction in monthly outputs from the Naryn Cascade hydropower station in March and November in the case B-1 is equivalent to 140 MW of supply capacity shortage. In March and November, the reserve capacity can be secured by increasing the existing generators depending on results of simulation. They have surplus capacities, because peak demands in March and November are not during the winter peak.

The reduction in monthly outputs from the Naryn Cascade hydropower station from November to March is 220 GWh in average in the case B-2. The energy generation reduction is equivalent to 400 MW of supply capacity shortage. An additional supply capacity of at least 400 MW is required to supply their demand stably.

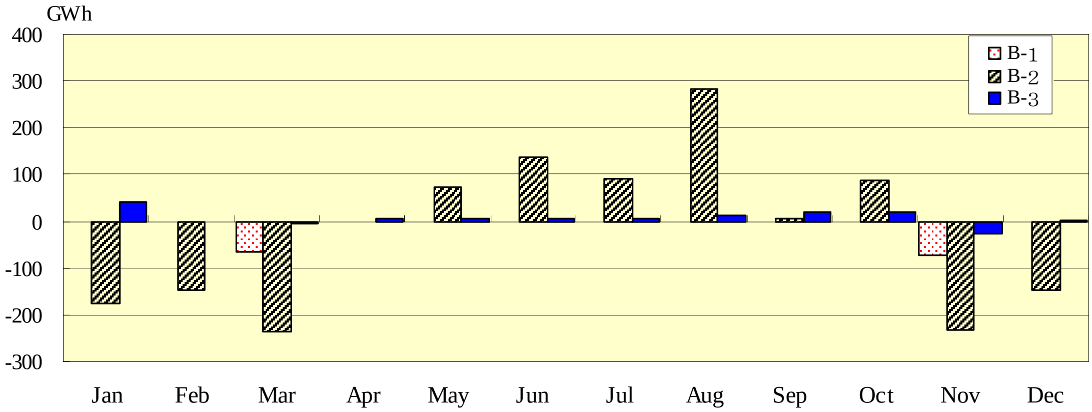


Figure 4-23 Difference of monthly electric energy generation from three hydropower stations in average water in flow

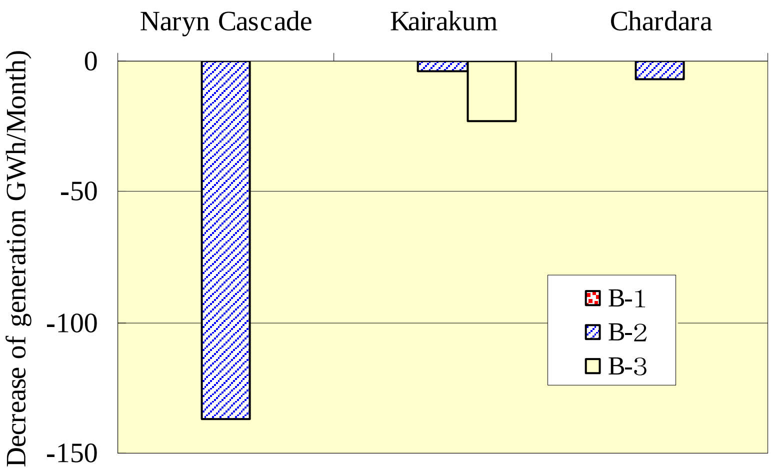


Figure 4-24 Reduction in outputs from hydropower station in average water in flow by the cases in December

4-3-2 Evaluation on mitigation for flood prevention from electric supply/demand balance

The effects of mitigations on flood control were evaluated in the sector 4-3-1. The results of the evaluation could be affected by the fluctuations of water in flow and demand. The results should be treated as reference, due to their uncertainty. The features can be summarized as follows.

Table 4-11 Summary of effects from mitigations on flood prevention

Flow regime	Cases	Effects to Electric power system
A. Flood	Case A-1: Saving water discharge from the Toktogul Reservoir in winter (Agreement basis)	It is necessary to secure additional power supply before adopting mitigations for flood prevention due to reduction in supply capacity critically in Kyrgyzstan system
	Case A-2: Ditto; subjected every discharge to agreement	Ditto
	Case A-3: Harmonize reservoir operation for the Kayrakkum and the Chardara Reservoirs	Available to manage effects by existing power plants in interconnected systems
	Case A-4: Following actual operation (Koksarai Reservoir)	(Base)
B. Average	Case B-1: Saving water discharge from the Toktogul Reservoir in winter (Agreement basis)	In spite of reduction in supply capacity critically in Kyrgyzstan system, available to manage effects by existing power plants in interconnected systems
	Case B-2: Ditto; subjected every discharge to agreement	It is necessary to secure additional power supply before adopting mitigations for flood prevention due to reduction in supply capacity critically in Kyrgyzstan system
	Case B-3: Harmonize reservoir operation for the Kayrakkum and Chardara Reservoirs	Available to manage effects by existing power plants in interconnected systems
	Case B-4：Following actual operation (Koksarai Reservoir)	(Base)

4-4 Recommended measures for mitigation of floods and draughts, and the conditions

From the above chapters 4-1, 4-2 and 4-3, the recommended measures for mitigation of floods and draughts are as following:

- The decrease of release of the Toktogul Reservoir can mitigate winter floods and supply irrigation water, while it requires new electric power facilities etc. (Case 1 and Case 2)

- The preparatory operation for floods needs forecasts on the release from the upstream reservoir. The supply of irrigation water will face problems if the volumes of the downstream reservoirs do not recover by the vegetation period. Thus, accurate forecasts of the flow regime, including the inflow of the Toktogul Reservoir, the agreement and observance of the cooperative operation among the three countries (Kyrgyzstan, Tajikistan and Kazakhstan), and the exchange of necessary information are needed. If they are implemented, winter floods will probably be mitigated with the current facilities, under the condition that the volumes of the Kayrakkum and Chardara Reservoirs are decreased before winter. (Case 3)

- The construction of the Koksarai Reservoir can mitigate the winter flood at the down stream, and the stored water can be used for irrigation in summer.
  We had no information about the commencement of the construction of the Koksarai Reservoir before starting our study. We found out during our research trip that Kazakhstan commenced the construction of the Koksarai Reservoir, as a national policy and aimed at completing it shortly. Thus, the Koksarai Reservoir is positioned as a trump card to mitigate floods and supply irrigation water in summer in Kazakhstan.
  From an environment point of view, a positive effect on the environment of the Aral Sea is expected, as water that is released to the outside-basin of Arnasay Lake when the Chardara Reservoir is full, will return to the main stream.
  Kazakhstan should deal with the costs of the construction and the continual operation and maintenance. (Case 4)

Results of the simulation are indicated in Figure 4-12.

The construction of the Koksarai Reservoir is promoted, and it is necessary to improve and stimulate the discussion occasions between the relevant countries, in particular with regard to information sharing, operation rules for the cooperative operation among each reservoir. In the long term, the planning and preparation of an alternative power supply would be important, to reduce the release of the Toktogul Reservoir, causing winter floods. These efforts should be carried out in an integrative way.

Table 4-12 Results and recommendations in the each case

Case	Flood mitigation	Drought mitigation	Issue	Measures
Case 1	Yes	–	Electricity shortage	Securement of alternative power supply
Case 2	Yes	Yes	Electricity shortage	Securement of alternative power supply
Case 3	Yes	–	Control of the volumes of the Kayrakkum and Chardara Reservoirs	- Accurate flow-regime forecasts - Reasonable operation rule for Toktogul - Cooperative operation between the three countries
Case 4	Yes	Yes	Large investment	Securement of financial resources

4-5 Measures to improve water use efficiency by promoting water resources management

4-5-1 Formulation of strategies for national water resources management

(1) Characteristics of water resources management in Central Asian countries

It seems that Central Asian countries, which have made a certain progress as a result of their efforts for restoration and economic stabilization through the transition to market economy after the economic shocks due to the Soviet Union's disintegration in the early 1990s, are on their way to recovery. Under such circumstances, in order to formulate national strategies based on Integrated Water Resources Management (IWRM) plans for sustainable development, countries which are still in the transitional stage to stable economic conditions will be headed for more difficult steering, compared to those which maintain stable economic conditions. In particular, there will be many difficulties in those countries that are in the process of developing legal systems and promoting political and economic reform and have not yet established the integrity among those efforts.

In the Soviet era that lasted for 70 years, republican countries in Central Asia developed politically and economically, and maintained a high level of educational standards. This background is distinctively different from other developing countries.

On the other hand, in the agricultural sector that made up most of water resources use, large-scale agriculture in state-run farms had been promoted under the centralized governance regime. The survey conducted in Tajikistan points out that the centralized governance regime influenced the conventional water management based on watershed areas. Under the integrated irrigation control system, one watershed area was categorized by district water management unit (Raivodhoz) and the leader of each local communist party served as the head of each district water management unit.

Such management method would be extremely inefficient under the market economy system. However, district water management units had been operated stably under the resource allocation system in the Soviet economy. On the other hand, no one really paid attention to maintenance management of the irrigation system and excessive consumption of water resources under such regime.

After the Soviet Union's disintegration, Tajikistan decided to supply irrigation water on a commercial basis in 1996 in accordance with the President decree and the Water Cord which was subsequently enacted (2000, 2006). However, because taxes related to water supply fall under the control of the Ministry of Economy and Trade, this semi-commercial mechanism has not yet led to the establishment of an economic basis for complex operation of water resources.

During the Soviet era, republican countries had been mutually complementing various requirements as a member of a federal state, including geographical requirements, water resources, and energy resource endowment conditions, and had been collaborating with each other based on the division of roles as a region through interchange of water resources (mainly irrigation water) and electric power resources (exchange of hydroelectric energy generated in upstream countries with oil, gas and coal produced in downstream countries).

After they became independent, this framework was destroyed and each country has been forced to give priority to the protection of its own interest in the process of restoring national land. Consequently, regional efforts have been put on the back burner.

As mentioned above, Central Asian countries are not considered as “developing countries”, and for those countries, development means “to restore, as an independent country, functions which they had once retained or shared as a member of a federal state”.

(2) Current state of National IWRM Plans in Central Asian countries

Since Central Asian countries became independent after the Soviet Union’s collapse in 1991, they have been in the process of restoring the socioeconomic system and establishing a new framework. Under such circumstances, in order to make a new start, the formulation of basic plans for water resources management could be said to be important for them in terms of timing.

Among Central Asian countries, Kazakhstan stays one step ahead with regard to efforts for the National IWRM Plan. Uzbekistan, which follows it, has already completed a draft National IWRM Plan and is in the process of building a consensus among ministries. It seems that Kyrgyzstan and Tajikistan have not started the formulation of plans yet. Interviews reveal the current state of Kazakhstan as shown below:

Kazakhstan’s National IWRM Plan

The project to formulate the National IWRM Plan and the water efficiency plan has been conducted with funds supported by the Norwegian Government, GWP (Global Water Partnership), UNDP (United Nations Development Programme), and DFID (UK Department for International Development). (2004-2007, 1.67 million dollars)

Water resources management in Kazakhstan has some problems, including adverse effect from the old hierarchical structure among water-related ministries, absence of concept for water resources management on the cost and revenue, and insufficient application of the Water Law. UNDP once described the present situation as “in the absence of a ministry to responsibly take control over water resources”.

For the purpose of addressing those problems, the National IWRM Plan and the water efficiency plan were formulated with the support of UNDP in December 2005.

The following describes the present situation based on hearings during on-site investigation:

i) Connection with other national plans

In Kazakhstan, administrative reforms have been promoted, and national budgets prepared for three-year periods to ensure a financial system focusing on economic stability based on medium-term plans.

Though the IWRM plan was initially scheduled to be decided and adopted by the government, it is determined that the plan should be decided in accordance with the presidential decree with the aim of implementing the plan more efficiently. National coordination will be promoted through ministerial meetings hereafter and approved by the President around in April 2009.

ii) Framework

The National IWRM Plan is a long-term plan to be completed by 2025, and is divided into three phases so that it can be incorporated into budgets. It is undisclosed and the details are not clear, but according to hearings at the Committee for Water Resources, it can be outlined as follows:

The plan consists of blocks by sector, including the “water level and monitoring block”, the “disaster prevention block”, the “water management block”, the “new irrigation technology block”, the “science and methodology block”, the “environment-related block”, the “farmland restructuring block” and the “transboundary block”.

iii) Detailed contents

A) Competent authorities

Each ministry has jurisdiction over its target block as a competent authority, and the Committee on Water Resources takes control over water operation. All problems, including irrigation water, are managed from multiple aspects.

For this reason, a new agency, which is responsible for all water-related problems and coordination between water-related ministries within the government, is planned to be established to realize multiple water operation. The preparation for its establishment will be initiated next year.

B) Detailed contents

Contents confirmed from hearings are as follows:

The “water operation block” deals with items, including long-term forecasting, water measurement by monitoring system, maintenance of safety level of water resources facilities, and remote control of water resources facility. It plans to launch a satellite for surface water monitoring (e.g. flooding). It also plans to monitor irrigation intakes and transmit the data to related organizations.

As part of efforts for water operation, the Aral Sea and Syrdarya River Basin Water Resource Management Inspection Bureau (ASBVI) was established in Kyzylorda City close to the Aral Sea. Institutional reforms in Kazakhstan led to the adoption of a system of “permission for exclusive use of water resources (RSVP (РСВП: разрешение на специальное водопользование))”. The RSVP system requires water users, whether public or private corporations, to use water resources in compliance with the requirements (the amount of water intake, intended purpose of water use, etc.). To that end, the headquarters of ASBVI should serve as a data assembly center to process the data on the Syrdarya River basin (2 provinces) in Kazakhstan. It is expected that the center’s activities will also be an important item for efficient use of water resources.

In addition, it is planned that public and private corporations will be required by law to keep measurement data on volume of water used on their own responsibility as water users.

Water-saving efforts are contained in the semi-block of the “water management block”, and include the introduction of watering technology and general reformation of agriculture. Efforts for conversion from rice cropping which needs a large amount of water have already been made in various areas. Besides, it is expected that comprehensive measures should be necessary to address such issues as support to farmers who had engaged in rice cropping, disposal of existing machinery for rice cropping, values of rice as a traditional food ingredient, and food safety. There is no doubt that it is necessary to create competitive agricultural products.

Issues related to infrastructure include old facilities, such as canals. It is anticipated that the tendency to shift from collective farming to individual farming will result in the ownership of canals by individual farmers.

The "disaster prevention block" covers flood and water shortages. It is also expected to take measures against salt damage, high groundwater level, etc.

The "transboundary block" deals with issues on the integration of water resources management at local, national, and community levels, which have significance from the standpoint of intra-regional cooperation.

iv) Cooperation from Japan

In accordance with a hearing conducted at the Committee on Water Resources, Ministry of Agriculture, Kazakhstan believes that the implementation of the IWRM plan needs not only its budget but also support from outside under the current conditions, and expects to receive support from JICA.

According to on-site investigation on the National IWRM Plan in Kazakhstan as shown above, the plan defines the fundamental direction for future national water resources management and provides for political measures and specific approaches in consideration of budgetary measures and coordination between ministries. It is confirmed that it can be a plan that forms the basis for future support offered by Japan in the water resources sector. Since the plan is just about to be launched upon approval by the President, it seems that it is effective to make efforts in conjunction with it in terms of timing.

As stated above, the Syrdarya River basin is stressed from water and suffers from serious water shortages under the influence of periodical fluctuations of climatic conditions. To address serious water shortages, downstream countries in the Syrdarya River have been making continuous efforts to reduce water consumption by carrying out water-saving programs and promoting the conversion of cultivation crops, however, it seems that the decrease in food production will be inevitable. Furthermore, there is concern that they will be put at greater risk of getting involved in competition over water resources. For the benefit of the riparian countries in Syrdarya River basin, issues on water, energy and food should be treated as a package.

In order to treat water, energy, and food as a package, it is necessary to see problems from a perspective of security on water in the region. IWRM road maps prepared by various countries in 2006 and interviews with central ministries that take control over water resources management show that for the purpose of reducing the loss of water use, conserving the water environment, and securing safe water, it is necessary to take "measures for sustainable management of infrastructure" by promoting "the improvement of efficiency in water use through information sharing on water resources", implementing deterioration diagnosis on facilities, and restoring their functions (including development of new facilities and equipment to respond to new water demand). The following describes the details about "improvement of efficiency in water use through information sharing on water resources" and "measures for sustainable management of infrastructure".

4-5-2 Improvement of efficiency in water use through information sharing on water resources

(1) Enhancement of monitoring as a means of sharing information

Prerequisites for promoting integrated water resources management should be to measure hydraulic and hydrological data at a certain frequency and accuracy, which will form the foundation of water resources management, and to use such data as basic information on management after they are transmitted and processed as needed. This is an item that has great significance in national strategies beyond simple reinforcement of measurement.

The survey reveals the monitoring state of water resources in each country as described in the section 2-4-1. The outline is shown as follows:

Kyrgyzstan: The number of gauging stations to carry out water resources data observations and management and to forecast runoff from source of a river, which are important facilities to countries that contain headwaters in their territorial spaces, has greatly reduced compared to the Soviet era. Requests for assistance from ministers concerned have been made.
To review the way of operation the Toktogul Reservoir, it is necessary to review observational data.

Kazakhstan: The National IWRM Plan (draft) clearly defines that monitoring should be conducted at the "water level and monitoring block" and the "water management block". On-site investigations confirmed the actual situation where measures to improve water quality should be promoted to curb worsening water pollution while they have made no progress due to lack of water quality observation data, and where old hydroposts installed in the Syrdarya River basin should be improved from a water management standpoint.

Tajikistan: Many monitoring-related facilities are deteriorated and become unusable. The survey results show that only 45 of 150 hydroposts are working. Ministries have a strong need to improve monitoring in source of a river which potential water power can be used to prepare the plans and promote water resources management.

Uzbekistan: Like other Central Asian countries, the decrease and deterioration of hydroposts are the issues to be solved. The survey results also shows that measures to promote safe water operation should be taken but proper operation and supervision of water resources facilities cannot be carried out, and as a result, water safety is threatened.

In addition to the above, Kazakhstan and Uzbekistan, which have recently suffered from serious water shortages, need to reduce damage from water shortages by carrying out the following: (i) investigation and clarification on the actual state of water cycle; (ii) prompt and smooth coordination when a water shortage occurs; (iii) review of appropriate agricultural water intake. To that end, it is crucially important to share information necessary to carry out the above (i) to (iii).

(i) Investigation and clarification on the actual state of water cycle (water balance)

When a water shortage occurs, the operation of reservoirs and return of agricultural water have a significant influence on the river flow regime. Because agricultural water is returned through tributaries and canals, it is necessary to investigate and clarify water balance as water use measures during a water shortage.

(ii) Prompt and smooth coordination when a water shortage occurs

In order to coordinate water use during a water shortage, it is necessary to collect data on river conditions at normal times (rainfall, river flow, water quality, and reservoir conditions) and water use conditions (amount of water intake) and to exchange such data among water users.

(iii) Review of appropriate intake for agricultural use

In order to ensure appropriate agricultural water intake and efficient water use, it is necessary to work with water users in conducting surveys on the actual state of land use and water intake and to promote the review of water intake. Moreover, it is necessary to rehabilitate aging intake facilities so that they could perform their functions and reduce water loss.

(2) Improvement of efficiency in water use through information sharing

The improvement measure is shown in the chart below. Steps to implement the improvement method are as follows:

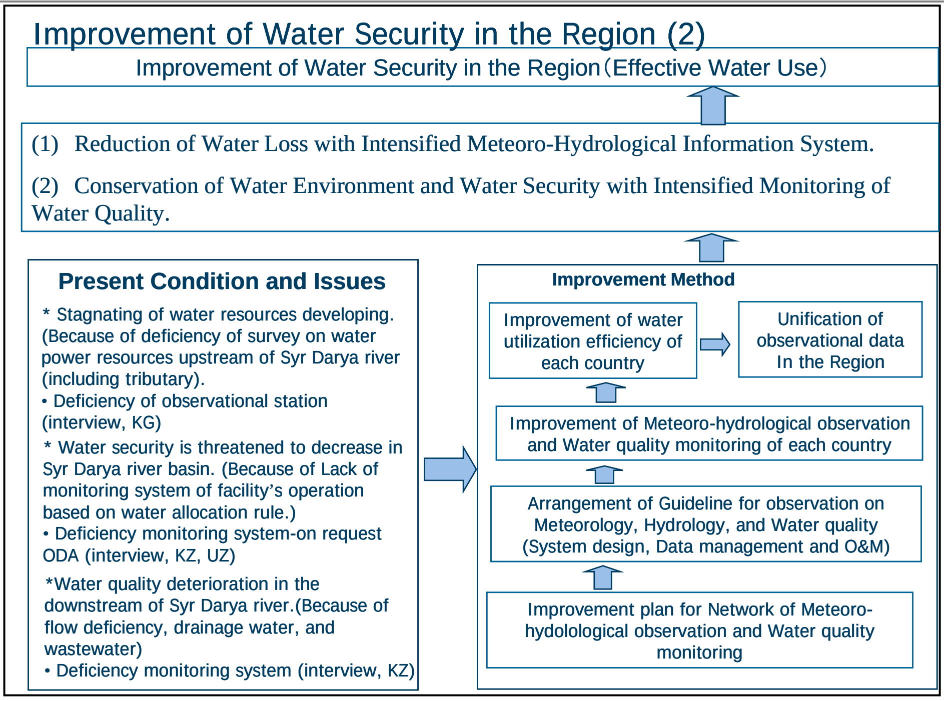
(i) Conduct assessment of the present monitoring condition.

(ii) Formulate a plan to improve the network for hydrological, meteorological and water quality observation in each country.

(iii) Formulate a guideline for strengthening observation. Categories for guidelines include system design, data control criteria, and facility maintenance and management. With the aim of realizing information-sharing in the region, specifications for data should be proposed and discussed at an early stage, and should be decided before deployment.

(iv) Reinforce the network for hydrological and water quality observation in each country based on guidelines.

The above steps will help to improve the efficiency in water resources utilization in each country. Improved efficiency in water resources utilization in each country will promote the reduction of water use loss, conservation of water environment, and securing safe water, as well as contribute to the preparation for the unification of hydrological, meteorological and water quality observation data in the region. They are effective as efforts at the national level in each country, and at the same time, it is expected that they will produce more profits for each country if they are carried out with a view to sharing observation data within the region.



4-5-3 Measures for sustainable management of infrastructure

(1) Awareness of issues on implementing water resources management by the central government in charge of water resources management in each country (sustainable management of infrastructure)

Since many water resources facilities in the Syrdarya River basin were built in the Soviet era and have not been renovated, they have become old. There is an urgent need to evaluate the state of being sound of structures and restore their functions, by establishing technology of Operation and Maintenance (O&M) and rehabilitating them.

In order to implement the above mentioned successfully, it is important to carry out the following: (i) surveys on current situations of water-related infrastructure; (ii) deterioration diagnosis and assessment; (iii) implementation of repair and reinforcement measures; (iv) standardization of measures to enhance durability of facilities and O&M technology; (v) capacity development of engineers.

(2) Measures for sustainable management of infrastructure

The improvement method is shown in the chart below. Steps to implement the improvement method are as follows:

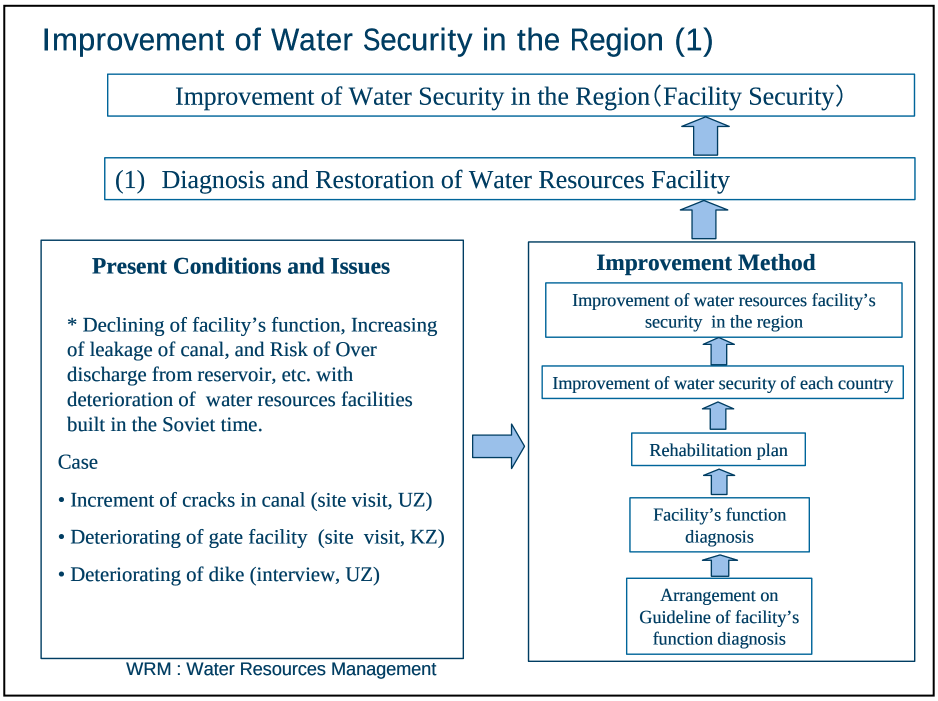
(i) Formulate a guideline for diagnosis on facility functions.

(ii) Conduct diagnosis on facility functions in accordance with the guideline.

(iii) Draw up a rehabilitation plan based on the results of facility function diagnosis.

(iv) Conduct a survey on needs for new facilities and prepare a new facility development plan, in parallel with (i).

The above steps will help to restore functions of water resources facilities in each country and to improve the efficiency in water resources management and the security of facilities. They can be beneficial to each country if they are promoted independently by each country, and simultaneously, it is expected that they will contribute to the improvement of efficiency and security in water resources management in the entire Syrdarya River basin.



Chapter 5. Proposal on the direction and measures for Japan's support

5-1 Direction of support to be offered for intra-regional cooperation toward problem solution

5-1-1 Basic principles on efforts for support to be offered by Japan

The region targeted for this study has suffered from pain and outrage in its history in the past that cannot be easily solved. In other words, each country in the region, which had to give priority to efforts for building nation on its own behalf after independence, had already had a system and operational procedures for facilities related to water resources and electric power, which had been planned and constructed with the aim of optimizing infrastructure in the whole region under the centralized governance structure during the Soviet era, but they were not necessarily appropriate. Therefore, it is not easy to reach an agreement among those countries on a new collaboration framework to improve such system and operational procedures because it may directly affect their vested rights and interests, and it makes it more difficult to promote coordination among them.

To solve problems, it seems to take efforts to continuously advance dialogue from a long-term perspective and gradually bring the relationship among countries closer to the ideal form of collaboration. The JBIC survey conducted in 2005 provided points for the selection of concrete efforts for the future. Taking changes thereafter into account, this survey proposes to promote the following items as basic principles.

(1) Strengthening of relations of mutual trust through continuous dialogue with countries within the region

It is possible to find solutions to problems by strengthening relations of mutual trust between each country in the region and Japan, as well as among the countries, through efforts for continuous "Central Asian countries plus Japan" dialogue. It is believed that it may be an effective way of using such strengthened relations to assume specific influences of plans to be implemented by introducing technical methods, such as assessment and simulation analysis on the actual state and to share objective information in the region. Indirect support for actual negotiations based on the facts can be effective in promoting negotiations on win-win measures.

In the course of promoting dialogue in the region, it is necessary to understand each country's circumstances and formulate mediation measures according to the situation in order not to isolate a particular country.

(2) Ongoing support from a long term perspective

Because issues are complicated and have developed into political ones, it is difficult to promptly take ideal measures to solve them. Therefore, it is necessary to make efforts for ongoing support from a long-term perspective for the purpose of achieving defined goals.

(3) Respect for the individuality of each country and support according to the state of

progress

Under the present circumstances, each country is in the process of reconstruction and should give priority to efforts for building nation on its own behalf. With full respect for their efforts and their particular circumstances, including economic power and resource reserves, it is necessary to consider concrete measures that can actually be accepted by those countries before starting dialogue with them.

(4) Not to cause a sense of unfairness among the countries

In order to promote support for intra-regional cooperation, it is necessary to build confidence by maintaining an attitude of equity. For this reason, support should be offered by ensuring the transparency of information and equitable manner that avoids causing a sense of unfairness. It is desirable to choose projects that bring benefits to all countries concerned (win-win measures). It is necessary to note that projects which may adversely affect a particular country should not be chosen, or otherwise, action should be taken to alleviate such adverse effects.

(5) Cooperation with other donors

Many donors, including the World Bank and the Asian Development Bank, have offered support in the water resources and electric power sectors over the past dozen years, and have also experienced failure. At present, donors are providing ongoing support in collaboration with each other, based on the past experiences. For Japan, the effective way to expand support to the Central Asian region for the future is to work with other experienced donors first. Then, we should participate in projects jointly with other countries or by doing our share, and should acquire information and knowhow on regional peculiarities with the goal of expanding the range and scale gradually.

(6) Support taking advantage of Japan's expertise

When participating in a project in cooperation with other donors, if technologies that are familiar to Japan can be introduced and used, the assistance will be more effective.

The areas are listed as follows:

1) Water resources

- i) support for monitoring technology on hydraulic and hydrological data that will be the basis for water resources management (technical assistance / infrastructural assistance)
- ii) support for functional diagnosis, rehabilitation, and new construction of water related infrastructure (technical assistance / infrastructural assistance)
- iii) support for enhancing O&M for efficient water resources management (technical assistance, law & institutional assistance, infrastructural assistance)
- iv) support for water quality conservation (technical assistance, infrastructural assistance)
- v) support for water saving program by promoting efficient water use (technical assistance)
- vi) support for strengthening organization and institution for water use and water distribution (law & institutional assistance)
- vii) support for National IWRM Plan (law & institutional assistance)

Each support item is positioned and shown in Figure 5-2 where support procedures are indicated. In order to enhance national or regional water resources management, the introduction of IWRM is effective. From i) to v) are the items for technologies that are bases for facilitating IWRM, and from vi) to vii) are for the software infrastructure such as organizations and systems. Japan's support for the aspects of law, technology, and infrastructure on basin management is critical in terms of contribution towards future collaboration and interchange between Central Asia and Japan in the 21st century, when issues on water resources are going to be highlighted.

2) Electric power

- i) increasing the amount of electric power supply in the region (infrastructural assistance)
- ii) optimizing the operational plan of power generation of hydroelectric power station (law & institutional assistance / infrastructural assistance)
- iii) reviewing the estimated amount of electric demand, and optimizing the development of electric power / rehabilitation plan (law & institutional assistance)
- iv) support for the sound operation of electric power project (law & institutional assistance)
- v) support for the introduction of economical power exchange scheme (technical assistance)
- vi) developing facilities including electric power development and restoration work (infrastructural assistance)
- vii) support for saving energy (technical assistance)
- viii) new / renewable energy

In Figure 5-3 where it says 'how to proceed', each support item is shown and put in particular positions. One of the biggest issues is to tackle power shortage against electric power demand in the region. From a close scrutiny of the current supply condition, it is important to give support for optimizing development and restoration of electric power and constructing the necessary infrastructures, whereas effective to make an attempt on sound electricity trades in the region, and to apply advanced technologies such as energy saving, new / renewable energy etc.

The region in question is an area where an increase of electricity is urgently and desperately needed. In this regard, the development of infrastructure for those purposes and Japan's support for promoting intra-regional power exchange in the region are highly expected as significant efforts to resolve problems and to strengthen the future relationships between Central Asia and Japan.

5-1-2 Vision of support for water resources and electric power sectors

In the Central Asian region, the water resources and electric power sectors are closely connected with each other. Therefore, both should be equally taken into account when considering optimum support in these sectors. For that purpose, efforts to facilitate consensus-building among countries based on a long-term vision have been made in the region, including the establishment of the Water Energy Consortium (WEC), which serves as a forum to comprehensively examine how to use water resources and electric power under control of the

Central Asian Cooperation Organization (CACO). Although CACO was absorbed by the Eurasian Economic Community (EEC) and then Uzbekistan left the EEC, Central Asian countries basically agree with the establishment of the WEC. What remains as an obstacle at the moment is said to be differences in concrete interpretation among those countries.

In November 2008, the Central Asia Regional Economic Cooperation (CAREC) built consensus on fundamental strategies for promotion of regional cooperation in the energy sector. It is expected that discussions in the CAREC will contribute to facilitating the establishment of the WEC or formulating a specific agreement on the establishment of an alternative forum in the future. At any rate, it is assumed that it will take long time until the forum can function as an organization to examine how to achieve the optimum utilization of regional water resources and electric power. In the meantime, it is necessary to continue discussions and provide support for them.

As mentioned above, with regard to support in water resources and electric power sectors for the future, it is necessary to comprehensively examine measures for those sectors as well as environmental issues closely linked with them from a long term perspective. However, the immediate priority is to strive to solve actual problems that both water resources and electric power sectors are facing, which should be addressed in the light of each long-term vision for water resources and electric power sectors proposed by the World Bank, and gradually the level of support should be raised.

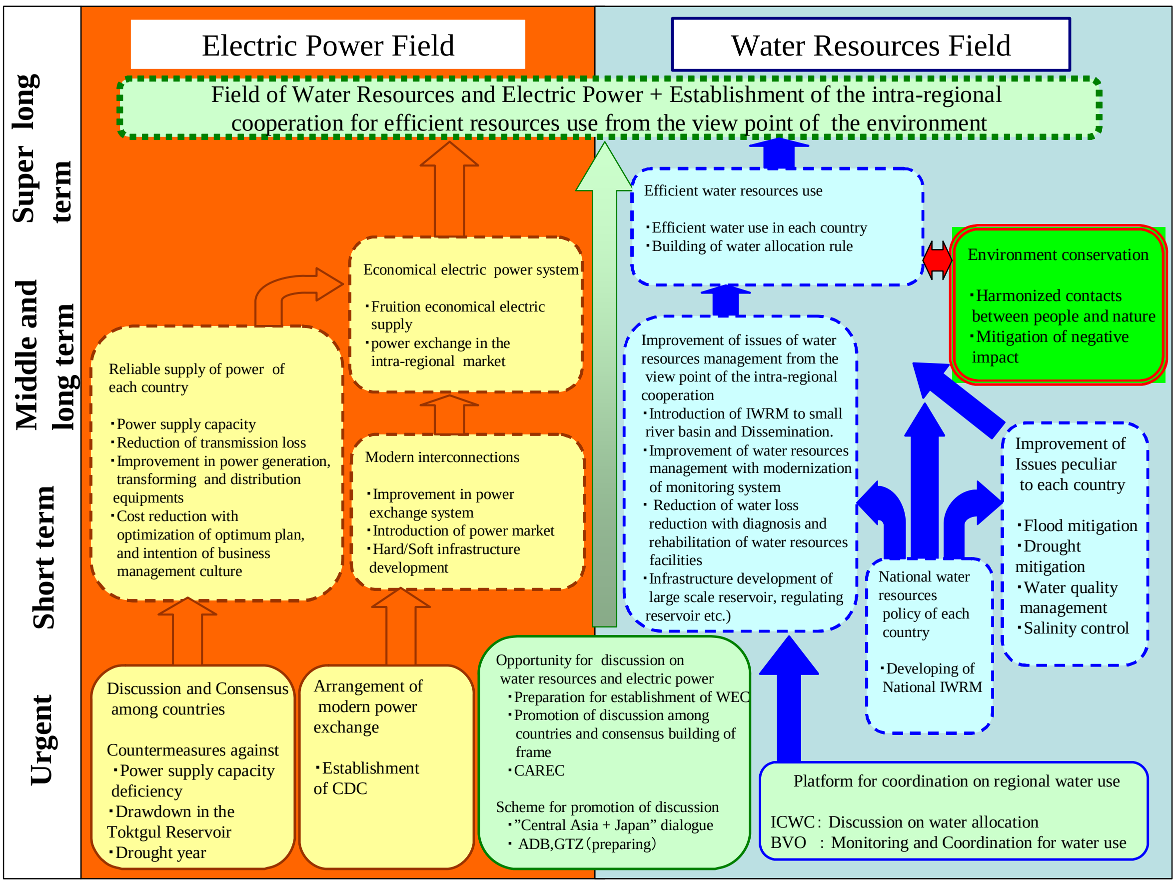


Figure 5-1 Long term vision on assistance of water resources field and electric power field

5-2 Feasible support measures for the water resources and electric power sectors

In Central Asian countries, it has recently become obvious that electric power shortages in upstream countries have affected water resources for irrigation use in downstream countries. As a result, countries that had never reached a specific agreement in the past discussed the measures to be taken in cooperation with each other and agreed to take action in 2008. Continuation and development of such movement toward cooperation with countries in the region, not as a program on a single-year base, will contribute to ensuring regional stability. It will also provide a favorable opportunity for supporting countries to offer efficient support. Therefore, it is hoped that concrete support measures will be enhanced at an early stage.

It is desirable that donors would share the vision of support and provide support for the water resources and electric power sectors in cooperation with each other, based on shared responsibility. From the standpoint of promoting cooperation within the region, detailed support should be discussed and determined by regional donor meetings after obtaining a common understanding among the countries concerned. For that reason, CAREC's schemes for discussions and dialogue will play a key role. In particular, support from Japan should be promoted by clearly indicating basic principles for regional support that "gives priority to projects producing effect not only for the countries where projects are carried out, but also for the entire region and all countries concerned". It is ideal that support activities will be initiated after countries in the region reach a mutual agreement on promotion of intra-regional cooperation through river basin management and electric power interchange based on such schemes, including dialogue between "Central Asian countries and Japan".

5-2-1 Procedures for promoting support for the water resources sector

(1) Procedures for promoting support

The long term goal in the field of water resources is to encourage each country in efficient, transparent and equitable IWRM and to contribute to the benefit of riparian residents as well as water users in the basin. This philosophy is also the same as in the regional perspective: to ensure effectiveness to the whole region caused by an agreement on water use signed by each country.

The current situation in the field of water resources is, from a country-level point of view, still in the beginning phase of formulating water resources management plan and its implementation has just started. Here are some examples of the existing problems: National IWRM Plan itself has not been fully prepared, organizations, laws & institutions that are fundamental to implement IWRM are insufficient, monitoring of basic data on water management is not properly functioning, inefficient water use and water loss occur due to the degradation of function in infrastructure, organizations that do not have the capacity to deal with water management, etc. to mention a few . Donors have been carrying out support individually, however, further long term efforts have to be made for the improvement of those poor conditions.

Meanwhile, at the regional level, IWRM for the whole basin is not working correctly because the coordination framework of water use has not been set up, which makes IWRM for a whole basin difficult to function, and brings about water disasters such as floods and droughts. Donors have started coordination against these problems since the late 1990s, but they haven't reached an agreement yet.

As to support the issues in the field of water resources, there are three stages: (i) addressing urgent matters such as water operation plans (draft) for reservoirs on a large scale that affects deeply the operation of water in the basin, (ii) short / mid term support to the countries considering IWRM plan of each country, and (iii) long term support towards the enhancement of IWRM in the region.

For the improvement of the regional water resources management, awareness and actions in each basin country are prerequisites. It is also necessary to go up step by step in the process to cope with the issues from a short / mid term to a long term period of time, after dealing with the urgent issues.

Another precondition is to have a local-based support hub for the region, and establish trust with the governmental organizations.

It is of importance to take part in the donors' community to exchange information, collaborate among donors, and share the responsibility for the support.

Hopefully, the support will be given in a way that Japan can offer its specialties: strengthening of organizational side, law & institutional part of water resources management (coordination of water users and fund raising), the method of efficient water use based on its delicate, well-organized and accurate management of water resources, improvement of water-related infrastructure and monitoring system, technical capacity development, and dispatching technical experts etc.

(2) Attention points for assistance

Water flows down natural rivers, improper management of data, such as water flow rate, by any country or district in the river basin greatly affects water use in the entire basin. As for irrigation, which is the major purpose of water use, there are some problems, including the difficulty of obtaining quantitative data on basic water volume or the inaccuracy of obtained data, which poses obstacles to objective consideration.

Basically, proper water resources management should be conducted based on objective and accurate data and it is extremely important to achieve integrated water resources management (IWRM) by improving and reinforcing the legal system and organizations required for proper management, developing infrastructure that meets demand, establishing decision-making process and management procedures participated by stakeholders, ensuring monitoring and transparency of data to keep accurate operations, and rehabilitating infrastructure to maintain efficient management.

In order to assist in facilitating IWRM, it is important to confirm the progress of formulating a national plan related to IWRM and establishing frameworks and to promote support activities in line with the progress.

On the other hand, it is an effective way of carrying out specific projects to take practical and bottom-up approaches that include matching with the overall plan and strategies, capacity building of watershed management implementing agencies as a sector to implement water resources management and, sharing of successful experiences within the country and the region. This could be obtained by starting with efforts for small-scale river basins, reinforcement of the water-related data monitoring system that forms the basis for management, and diagnosis on deteriorating infrastructure built in the Soviet era and restoration of its function.

To provide effective support, support plans should be selected under the assumption that they can take advantage of Japan's advanced technology, such as diagnosis on infrastructure functions and their rehabilitation, enhancement of hydrological and water quality monitoring, and meticulous water management and water-saving measures. Given the current situation, where water utilization in watershed areas has become a political issue, it is desirable to start with support for projects matched to each country's particular circumstances, which will help strengthen water resources management in each country, not directly initiating measures focusing on water operation in the whole region. Then, further support based on long-term strategies should be promoted so that the above project support can make a ripple effect in the whole watershed areas.

(3) Efforts to improve water resources management

With regard to regional collaboration in water resources, no arrangement or agreement has been made as yet on schemes for operations of the Toktogul Reservoir, in connection with water allocation and compensation for irrigation water storage. There is a conflict of interest among riparian countries, which has become a political issue, so it is necessary to facilitate ongoing discussions among basin countries and offer support to them so that they can reach an agreement. In recent years, the volume of river inflow has been decreasing. Under these circumstances, riparian countries shared a sense of crisis and decided to take urgent action to respond it in October 2008. It seems to offer a glimmer of hope to this stalemated situation.

It is necessary for Japan to offer support for intra-regional collaboration in the field of water resources and to make ongoing efforts, with the goal of contributing to the construction of a framework for discussions on water resources distribution and consensus-building for the whole region in the mid-and-long term. On the other hand, each basin country should make efforts to solve issues on water management in order of precedence. Such efforts will help each country to improve its water management level and raise awareness of collaboration, and will lead to the promotion of regional collaboration.

(4) Support for region-wide efforts to improve water resources management and solve problems

Support for the region, which is accompanied by reconciliation of conflicting interests among countries in the region, should be offered through long-term efforts. In order to reconcile conflicting interests among the countries, it is important to get a clear grasp of the situation in each country and continuously provide opportunities for dialogue. In this case, it is effective to make efforts in cooperation with donors which have achieved success in support. Candidate donors with whom we intend to collaborate include ADB, UNDP, and GTZ. ADB and GTZ have already initiated a new regional cooperation program on water resources, and UNDP has offered support for the formulation and implementation of national strategies for water resources management (National IWRM Plans) to countries in the region.

Participation in those programs at an early stage seems effective for preparing for basic matters, such as access to information, and taking part in strategies.

It is necessary to offer support that leads to a strengthened implementation of regional efforts in collaboration with international organizations in the region, including the Executive Committee of IFAS (EC-IFAS) and the Scientific Information Center of ICWC (SIC-ICWC).

In the water resources sector, support for each country in the region will contribute to the development of basic infrastructure for water resources and improvement in water resources management capacity in each country, and will lead to the improvement of the environment toward promotion of regional collaboration.

Each republican country is in the process of stabilizing the situation after independence to a greater or lesser extent of economic development, and is at the stage of giving primary importance not only to electric power, water resources development, measures against disasters, but also to the reconstruction and growth of its own country, in the same way as the postwar years of Japan. Based on this standpoint, it is necessary to attach importance to provide support required for each country as well as support to the region in conjunction with the above support.

(5) Support for country-level efforts to improve water resources management and solve problems

It is an effective way of offering support to each country in the region, to focus on efforts in order of priority, based on each "National IWRM Plan" which presents national strategies for water resources, consisting of improvement in organizational framework, advancement of water resources management technology, infrastructure building, improvement in hydraulic and hydrological monitoring, etc.

The National IWRM Plan is scheduled to be carried out in Kazakhstan and Uzbekistan at an early date, and it is assumed that we should take this opportunity to participate in support activities from the assessment stage in order to enhance the effectiveness of the support. Kyrgyzstan and Tajikistan have just started the formulation of the plans, and it is desirable that we should offer specific support which will help each country to formulate the national plan.

The IWRM road maps prepared by each country in 2006 and interviews with governing agencies on water resources management in each country in connection with this survey point out the need to address issues, including reduction of water loss, conservation of water environment, and securement of safe water through water quality conservation. In view of the above issues, it is necessary to reform organizational framework, build infrastructure, and strengthen such field as water resources management technology, with the aim of improving the efficiency of water resources management and realizing the national strategies. The final goal is to promote socioeconomic development and achieve poverty reduction through expand of food production, securement of safe drinking water, and mitigation of water-related disasters.

Specifically, priority measures to be taken include support to strengthen the items that form the basis for water resources management, such as enhancement of hydraulic, hydrological and water quality monitoring, and support for functional diagnosis on aging water facilities and necessary rehabilitation.

The possible support for large-scale reservoirs includes construction of a regulating reservoir downstream of the Toktogul Reservoir for both purposes of flood prevention and irrigation. In Kazakhstan, the construction of the Koksarai regulating reservoir is scheduled to be launched and to be completed within four years. This is an effective way of contributing to the maintenance of stable water environment in watershed areas through mitigation of water-related disasters, such as floods and water shortages, and is one of the candidate efforts for which we are planning to offer support. Uzbekistan seems to have prepared a plan to construct a regulating reservoir, while there are some issues to be solved, including adjustment of water use jointly with Kazakhstan and terrain and geological conditions.

Country-level support is targeted for specific countries, but it is important to select effective support that will lead to improvement in regional water resources management and that will result in the spread of benefits to all other countries in the region or at least never cause adverse effects on them. Support activities should be promoted efficiently by introducing best practices of support activities in a certain country to other countries.

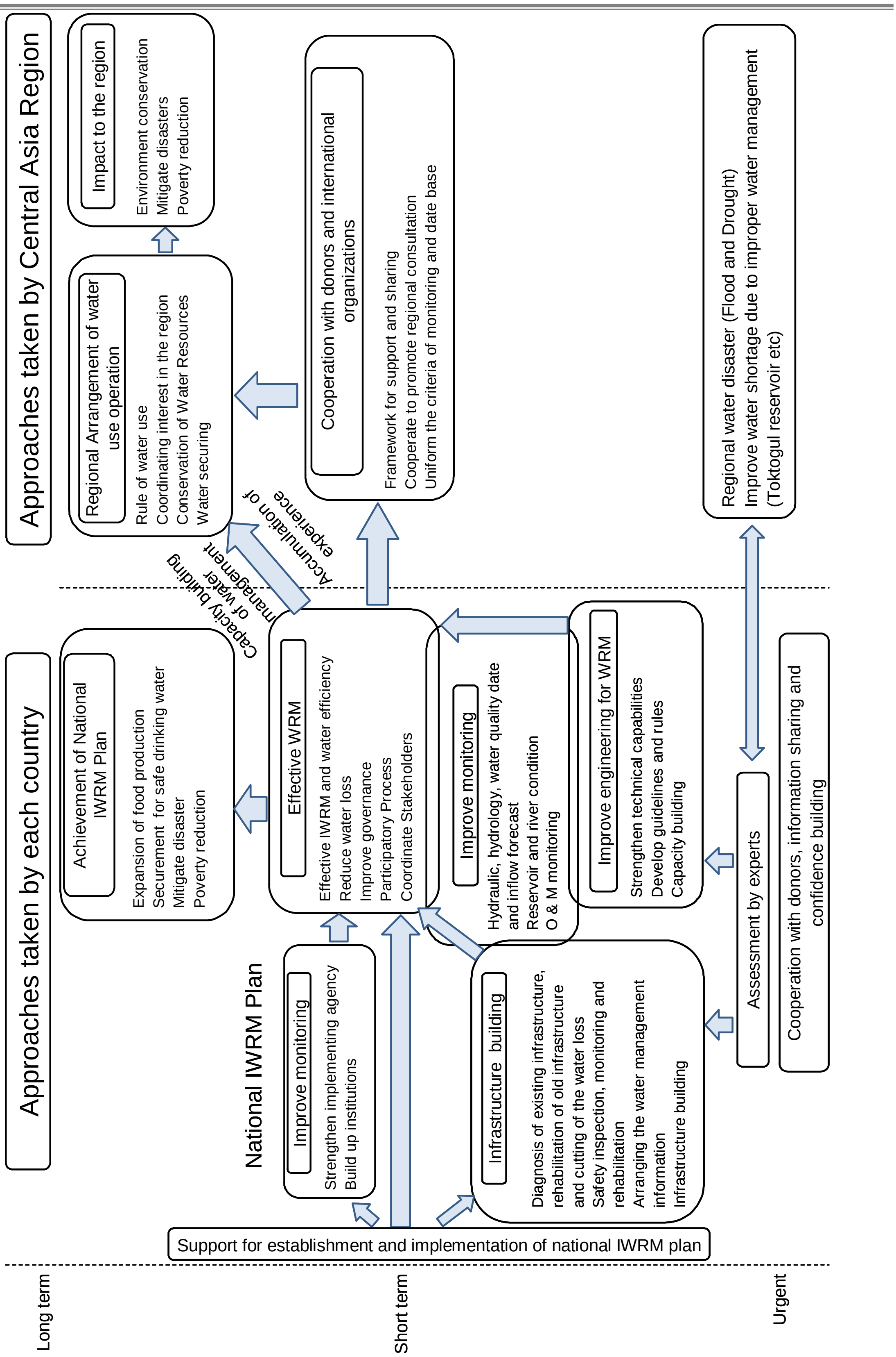


Figure 5-2 How to proceed with the support in the water resource field

5-2-2 Method to promote high-priority support for the water resources sector

[No.1] <Prompt support for urgent issues>

Project name	**Support for the improvement of the Toktogul Reservoir operation plan and strengthening of the hydraulic and hydrological monitoring systems**		
Field for support	Water resources and electric power	Target Country/Area	Kyrgyzstan, (Influences to the use in: Kazakhstan, Tajikistan and Uzbekistan)
Background and necessity	The Toktogul Reservoir has suffered from water shortages for the last twenty years, and it is difficult to cover the domestic demand for electric power in winter. The most urgent issue is to review reservoir operation in view of meeting the demand for power in winter and for irrigation use of downstream countries in summer. Because the present reservoir operation is conducted simply based on discharge according to demand for electric power, it is an urgent issue to be addressed by not only Kyrgyzstan but also riparian countries to improve the reservoir control by shifting to systematic fluctuation based on operation of inflow. Such activity will contribute to improve water resources utilization in each country. Kyrgyzstan is located upstream of the Syrdarya River, whose capabilities to forecast inflow by data of glacier and melted snow from the up-stream and to conduct monitoring on rivers for hydraulic and hydrological data, have been degraded compared to the Soviet era, and such insufficient forecasting and monitoring comprise an obstacle to efficient water resources management. Monitoring contributes to inflow forecasting, observation of river flow rate, improvement in accuracy of hydrological observation, and grasp of the actual state of water use, and transmission and sharing of the above data form the basis for managing international rivers and improving the efficiency of reservoir control. Specific measures include: a) preparation of a plan to introduce modern equipment for compute of water use amount; b) introduction of a real-time intake information system; c) introduction of automatic monitoring equipment. In order to promote smooth coordination of water use, it is necessary to collect data on river at normal conditions (rainfall, river flow rate, water quality, and reservoir condition) and water use condition (water intake) and to exchange them between relevant water users on a routine basis. Enhanced monitoring forms the basis of collecting such data. It is important to give support to prepare future specifications in common with countries in the region.		
Purpose of the project	To improve accuracy of monitoring for hydrological, meteological, and water quality data that forms the basis for water resources management, preparation of a plan to improve monitoring facilities and implement prioritized portion. The plan is composed of constructions of facilities improvement of communication measure, and common specification of monitoring facilities. Assess of past monitoring data and formulate the draft operation rule of Toktogul Reservoir based on inflow characteristic and on assessment of water demand, and then offer a suggestion to consultation place of riparian countries.		
Outline of the project	First phase ・Assessment of the current reservoir operation and monitoring data ・Formation of the basic rule for reservoir operation (provisional plan) based on inflow characterization and demand assessment ・Assessment of monitoring facilities ・Formulation of guidelines for meteorological, hydrological, and water quality observation (system design, data control, and maintenance) ・Preparation of a plan to improve monitoring facilities in Kyrgyzstan (examination of common specifications) Second phase ・Proposal for draft reservoir operation plan to the countries in the region ・Capacity building of organizations in charge of reservoir operation ・Improvement of observation facilities in Kyrgyzstan		

	・Preparation of an improvement plan for intra-regional data sharing system (definition of specifications)		
Expected benefits and beneficiaries	Beneficiary: Kyrgyzstan ・Rules for reservoir operation in consideration of water shortages should be reviewed to promote an efficient and balanced water use between electric power and water resources. ・Collection of accurate data on the glacier acreage, snowmelt rate, reservoir inflow (forecast and measurement), river flow rate, and water quality will enable to plan and implement proper operation and will contribute to mitigate damages from floods and water shortages, conservation of water environment, and improvement of efficient in water use. ・Promotion of sharing hydrological and meteorological data within the region will contribute to improvement of the water resources management capabilities in the entire Syrdarya River in the future. Affected areas: Uzbekistan, Kazakhstan and Tajikistan. Improvement of efficiency in water use. Measures against floods and water shortages, modeling of improved monitoring in each riparian country.		
Support method	Technical assistance and financial support	Framework of support	Dispatch of experts, technical cooperation projects, financial assistance (grant, yen loan)

[No.2] <Prompt support for priority issues in each country>

Project name	**Support for implementation of the National IWRM Plan and strengthened monitoring**		
Field for support	Water resources	Country/area to be supported	Kazakhstan (Influences to the IWRM in : Kyrgyzstan, Tajikistan, and Uzbekistan)
Background and necessity	Kazakhstan is scheduled to implement a "National IWRM Plan" early in 2009, upon approval of the President. The National IWRM Plan consists of some blocks, including (i) monitoring, (ⅱ) disaster prevention, (ⅲ) water operation, (ⅳ) new irrigation technology, (v) science and methodology, (ⅵ) environmental system, (ⅶ) farmland restructuring, (ⅷ) transboundary water management. The IWRM plan, which forms the base for national strategies related to water resources, is one of the important measures linked with budgetary steps for the implementation of strategies. In Central Asia, the formulation of IWRM plans has been promoted with the support of UNDP, and in Kazakhstan, the plan is expected to be approved by the president next spring. It seems that it is effective to offer support that contributes to the implementation of the plan in terms of timing. All items contained in the IWRM plan, such as monitoring, disaster prevention, water operation, new irrigation technology, and transboundary water management, are targeted items of this survey. It is desirable to start with support for the enforcement policy of the plan and move on to the next stage of support, such as assessment of detailed items, technical cooperation and financial support. The development of a hydrological and meteorological monitoring system based on the above plan is essential to mitigate damage from flood and water shortage and promote efficient water operation in Kazakhstan. It is expected that the sharing of hydrological and meteorological monitoring data will contribute to enhance capabilities for water resources management in the Syrdarya River basin. In recent years, damages from water shortages in the region have increased, and as mitigation measures, each country should use its own water-saving technology and carry out the following: (i) investigation and clarification of the actual state of water circulation; (ⅱ) prompt and smooth coordination during water shortages; (ⅲ) appropriate management for agricultural water intake. In order to carry out the above items, information sharing will have great significance. In particular, it is necessary to collect data on river conditions at normal times (rainfall, river flow rate, water		

	quality, and reservoir conditions) and water use conditions (water intake) and exchange such data among water users on a routine basis. In addition, technical assistance and financial support to facilitate construction of the Koksarai Reservoir, which is under construction, is considered an effective way of offering practical support.		
Purpose of the project	Assist efforts to enhance water resources management in Kazakhstan by supporting for enforce policies of the National IWRM Plan To mitigate damage from floods and water shortages, improvement of efficiency in water operation, promotion of water environment conservation, and increase of water security in Kazakhstan by strengthening monitoring on hydrological, meteorological, and water quality data that forms the basis for water resources management.		
Outline of the project	First phase ・ Support for the enforcement plan of the National IWRM Plan ・ Selection of priority projects ・ Formulation of guidelines for grasping the actual state of monitoring facilities and conducting meteorological, hydrological, and water quality observation (system design, data control, and maintenance management) and preparation of a plan to improve facilities Second phase ・ Financial support for the construction of the Koksarai regulating reservoir ・ Improvement of monitoring facilities in Kazakhstan ・ Preparation of a plan to improve intra-regional data sharing system ・ Capacity development		
Expected benefits and beneficiaries	Beneficiary: Kazakhstan The action plan to promote water resources management will be strengthened, and prioritized projects, as well as the technology and human resources necessary for them, will be enhanced. In concrete, water saving through efficient water use, mitigate damage of flood and water shortages, and conservation of water environment will be promoted by obtaining accurate data on river flow conditions, water use, and water quality. The intra-regional sharing of hydrological and meteorological data will contribute to improve water resources management in the entire Syrdarya River.		
Support method	Technical assistance and financial support	Framework of support	Dispatch of experts, technical cooperation projects, financial assistance (grant, yen loan)

[No.3] <Prompt support for priority issues in each country>

Project name	**Support for diagnostic function of water resources facilities and restoration of them**		
Field for support	Water resources	Country/Area to be supported	Uzbekistan (affected area: Kazakhstan)
Background and necessity	Many water facilities in Central Asian countries were constructed in the Soviet era. In Uzbekistan, there are over 200 large-scale important water facilities, which are managed as hard infrastructures for development and management of water resources. Most facilities that were constructed over 30 years ago have not been renovated, due to financial circumstances. There have been some accidents due to the decline in function of water facility structures, and urgent measures to tackle them are recognized as important issues. The State Inspection (SI) established in the Cabinet Office in 1999 takes control of security surveillance of important infrastructures for water resources development and management. It is responsible for operations of 273 water resources facilities (54 reservoirs, 29 power plants, 60 major water courses, 65 division works, 35 pump stations, and 25 channels). (i) Emphasis has not been put on safety of water resources facilities. (ii) Corruption		

	of important water resources facilities structures installed in an international river might cause direct damage to downstream countries. It is necessary for Uzbekistan, as well as all countries in the Syrdarya River basin, to ensure security and reliability of the above water resources facilities. Thus, management of important facilities should be considered as region-wide issues across borders. Although this project aims to offer support to Uzbekistan, it will produce effective results in the riparian countries.		
Purpose of the project	To reduce water-related disaster risk caused by damaged water resources facilities, enhance water safety, and protect lives and properties of inhabitants through diagnostic function of existing water resources facilities. To promote efficient use of water resources by restoring functions and contribute to water saving.		
Outline of the project	First phase ・Assessment of actual condition ・Formulation of guidelines for diagnostic function and their implementation ・Establishment of a monitoring system for safety diagnosis ・Preparation of rehabilitation plan and feasibility study Second phase ・Rehabilitation		
Expected benefits and beneficiaries	Beneficiary: Uzbekistan Securement of safety in water resources facilities, prevention of water-related disasters, reduction of water loss based on efficient water management by restoring facilities functions Affected area: Kazakhstan Improvement in the safety level of facilities in Uzbekistan as an upstream country Increase of available water volume by water saving efforts by Uzbekistan		
Support method	Technical assistance and financial support	Framework of support	Dispatch of experts, technical cooperation projects, financial assistance (grant, yen loan)

[No.4] <Short/Middle term support to promote efficiency of water resources management for intra-regional cooperation in water resources management >

Project name	**Improvement of water resources management by applying IWRM intended for small river basins**		
Areas for support	Water resources	Target countries/regions	Chosen from four countries in the Syrdarya River basin[1)]
Background and needs	Despite that the improvement of water resources management in the Syrdarya River is a critical issue for the Central Asian region, there has been no comprehensible agreement made on water use in the countries of basin area, which places them in a very difficult situation to solve the problems. The efforts have been made to introduce IWRM to small river basins: tributaries of the Syrdarya River as a pilot river basin create successful examples there to disseminate in each country and region as well as the direct support to those difficult situations. Application of IWRM to the small river basins is relatively easy, and it has an advantage of indicating and disseminating the outcome of improvement in water resources management as a successful experience. Moreover, it is highly anticipated that the countries concerned learn practical knowledge and experience for enhancing water resources management, and prepare for further intra-regional cooperation.		
Purpose of the project	By applying IWRM for small river basins, successful experiences in organizational, law & institutional areas and management & operational areas of water resources management in the basin are created. In the future, this movement will spread over the countries and the regions to promote each country's National IWRM Plan, and it will lead to intra-regional cooperation of water resources management.		
Outline of the project	Target basin: tributaries of the Syrdarya River Application of IWRM: back up to establish organization of coordinating water		

	resources management (organization, law & institution), to formulate O&M rules of water resources facilities (coordination of the burden of management fees), to strengthen observation and transaction of management data, and to construct infrastructures that are keyed to water resources management (initial operational support in infrastructure).		
Expected benefits and beneficiaries	Beneficiaries: river basin countries supposed to receive support Effect: Riparian countries in the Syrdarya River basin are subject to benefits by the successful examples disseminated in the region.		
Method of support	Technical assistance Financial assistance	Framework of support	Dispatch of JICA experts, JICA technical cooperation project, Financial aid (grant, yen loan etc.)

1) The support for small river basins has given satisfactory results in the Chu-Talas river basin and in Fergana region. SIC-ICWC advocates efforts and activities in downstream rivers. The selection of basins is to be made carefully based on the discussions between donors and international organizations and among related countries.

5-2-3 How to promote supporting activities in the electric power field

A future vision of power field in Central Asia was suggested, which is including such as enlargement of the area of power trade and interconnection to the surrounding countries, power export by entry to wide area power market. For the entry of power market, however, there are barriers needed to pass through such as realizing stable power supply in each country and establishing common operation rules and specification of facilities among the countries.

Currently, consensus building in the region has been tough because of interest opposition among the countries. Meanwhile, shortage of electric power supply becomes obvious, especially in Kyrgyzstan.

Considering these situations, viable approach for assistance in power field is to be classified 1) urgent assistance such as measures for current power shortage, 2) approaches for the whole of the Central Asian region, and 3) approaches for each country with the prospect of future vision of the region. Firstly, encouraging discussions for regional cooperation by promoting intra-regional dialogue are advisable as a general improvement of assistance. Then specific assistants are better to start from category 1) urgent assistance, in parallel with strategic movement for the promotion of category 2) and 3), which will be conducted gradually.

Assistance of donors in the region has been discussed from the planning phase by donors in charge, and the specific assistance conducted by sharing part of support in collaboration with relevant donors under common vision. There seems to be a lot of issues that need support, but budget is limited. When Japan plan to assist, specific support should be discussed at the donor meeting and sharing assistance with donors under common understanding among the countries is needed. Therefore, role of discussion at CAREC and other dialogue scheme are important.

Especially basic policy of Japanese assistance, like “Japan will provide assistance preferentially to effective projects, which have advantages not only for the object country but also for the whole region or relevant countries”, should be clearly specified. Then conducting the projects, based on a consensus of the countries on intra-regional cooperation by introducing interconnection of power grid, is needed by utilizing the scheme of “Central Asia + Japan” dialogue.

Regarding specific supports Japanese assistance, technical support and technical transfer will be provided by dispatching experts on specific themes such as planning, power business management, design etc., and financial support to the large scaled projects is envisaged. (Refer to Figure 5-3).

(1) Assistance to the measures for electricity shortage

Measures which can be implemented promptly are preferable for the measures against the current electricity shortage. The support project should be selected considering earlier realization and the assistance policy, which includes "advantageous effects not only for the object country but also for the whole area of the region or relevant countries"

(2) Assistance for the region

Assistance for the region is a sort of the preparation stage of promotion for achieving future vision. There is a future vision suggested by the World Bank, which is one of the objectives in the region and is to be achieved by discussions among the regional countries at WEC or another platform that is expected of establishment. In this suggestion, rationalization/modernization of intra-regional power exchange and then establishing wide-area power market for promoting export electricity to the surrounding countries are included.

To realize this vision, promotion from a long-term perspective, such as the introduction of common infra facilities/software and construction of power plants for the export generation in accordance with consensus built among relevant countries, is needed.

Actually, efforts for promoting discussion among the region, consensus on this future vision has not yet built since there are conflicts of interest and conditions of each country. It seems necessary for the consensus building that relevant countries should understand, select and agree with the viable scenario for stepping up to the future vision, which must consider current individual conditions of each country. Introducing simulation analysis for estimating advantages/disadvantages of each country at every event time from now to the future quantitatively is recommended as one of the measure for accelerating specific discussion among the countries.

(3) Assistance for each country

Because the vision for the future calls for the enhancement of international power trade and entering into the electric power market in competition with other countries, the reforming power industry of each country is indispensable. On the other hand, reforming is an important issue for each country whether entering into the power market or not. It is expected to produce ripple effects; the improvement of the electric power industry as a core industry leading to the growth of other industries, and improving conditions, which will advance foreign capital enterprises.

The power generation and distribution facilities of each country in the region have been decrepit by aging and lack of proper maintenance. Under these conditions there is large electric power loss, and electric power supply is not necessarily stable at present. Among the four countries, Kazakhstan has carried out organizational reform, including division and privatization of the organization, and leads other countries from a rationalization viewpoint. Other countries have not succeeded in sufficiently advancing improvements in spite of their efforts. Therefore, further assistance for improvement of power industry is necessary.

In general, approaches for improvement soundness and efficiency of both software and hardware of the power industry are desirable, though it is also necessary to select the content of assistance for each country according to its specific conditions. Moreover, it is preferable to consider secure self-sufficiency for electric power (energy security) at this stage, as this is a matter that every country feels concerned about.

As specific targets of assistance, overall tasks of power industry are covered such as 1) infrastructural issues; replacement/improvement efficiency of power facilities, 2) institutional reform of the business related to the power loss including stealing, 3) measures for fuel securing, and 4) introduction of new/renewable energy. It is important for improving efficiently to carry out an optimization study on the development plan of each country first, and advance gradually with a long-term view based on the development plan.

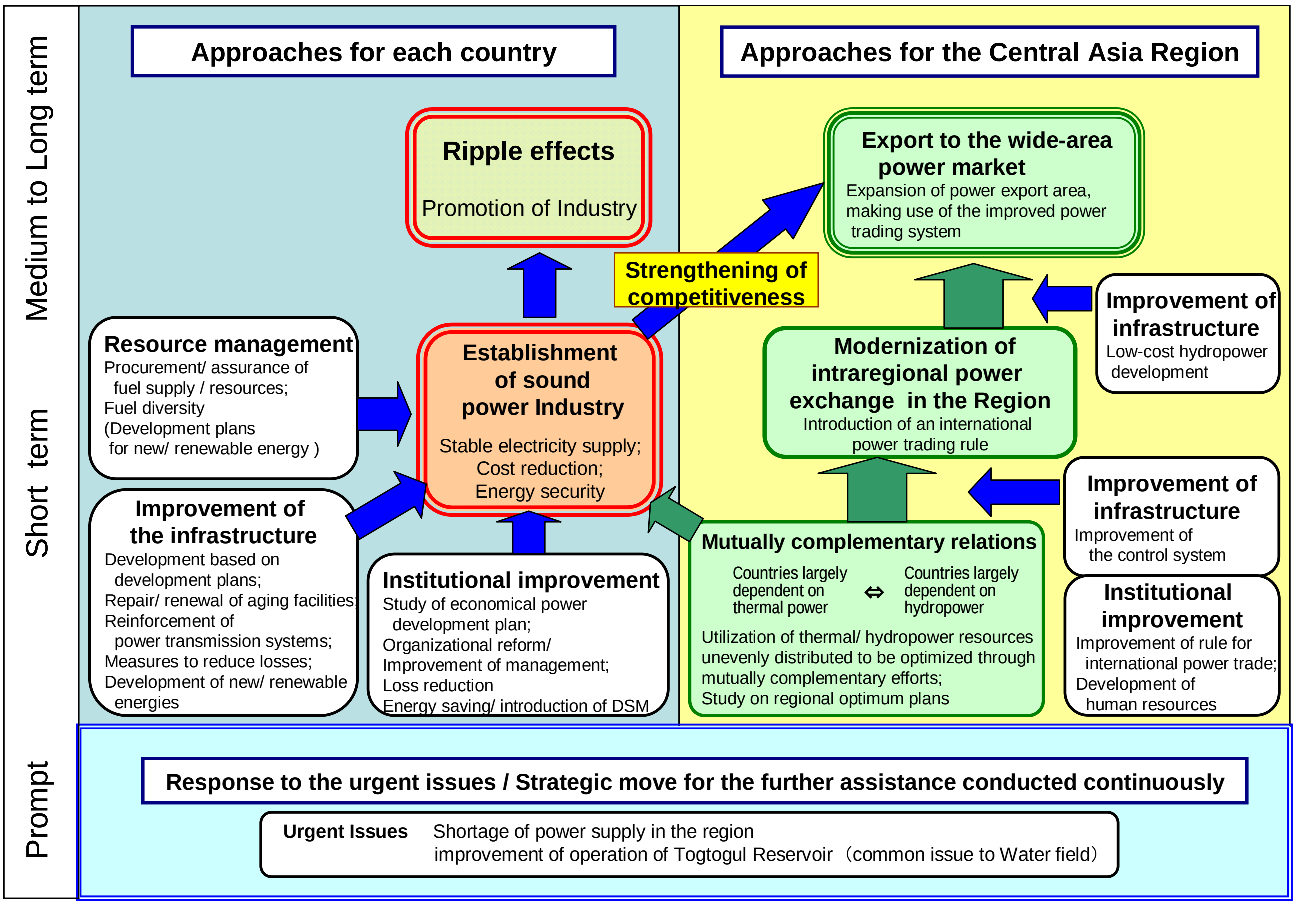


Figure 5-3　How to proceed with supporting activities in the electric power field

5-2-4 How to promote high priority assistance in electric power field

(1) Assistance in electric power field

There are necessities of assistance in the short to medium term as mentioned in Chapter 3. (Refer to section 3-7-3.) Among the items listed below, the early implementation of items i) and ii) is desirable, as measures for the current tight situation of demand/supply balance. Other items are for the assistance to improvement of power business of each country. Specific conditions of assistance will be decided considering the actual situations of each country.

i) Development of power supply facilities in the region
< Infrastructural Assistance>

ii) Optimization of hydropower operation plan
< Institutional and Infrastructural Assistance>

iii) Review of Electricity Demand Forecast, and Optimization of Power Development and Rehabilitation Works Plan
<Institutional Assistance>

iv) Assistance for the Sound Management of the Electricity Business
<Institutional Assistance>

v) Technical Assistance for Introduction of the Economic Power Exchange
<Institutional Support>

vi) Development of the Facilities, Including Construction of Power Plants and Repair Work of the Facilities Based on Plans
<Infrastructural Assistance>

vii) Assistance for saving energy <Institutional Assistance>

viii) Assistance for Measures on New/Renewable Energy or Those against Global Warming <Institutional Assistance, Infrastructural Assistance>

(2) How to start specific assistance

From a view point of effectiveness, Japanese assistance for electric power field is recommended to start from the followings:

- Immediate response to the urgent issues
- Strategic move for the future continuing support

Regarding promotion of medium to long term issues, it is recommended to provide continuing assistances considering collaboration and sharing with relevant donors. Alternatives will be nominated, during conducting preceding assistance, by evaluation of necessity, urgency, and effectiveness of the project, based on the actual experiences and knowledge.

(a) Assistance for the urgent issues

Mitigation for the electricity shortage of each country is an urgent issue. For this purpose, there are choices of measures such as new development/extension of power plants and power import from the neighboring countries. Here, there is a restriction to power import, which needs to convey through power grid from countries having enough margin. The extension of South-North transmission line is ongoing in Kazakhstan. After its completion, power import from North

Kazakhstan, or Russia interconnected to Kazakhstan will be available, but it should be noted that capacity is limited and building agreement among the countries is also needed. Meanwhile, the development of new power plants in the region is currently more realistic, because negotiations are limited to the region, since decisions regarding development will be made by the interested countries.

Alternative projects newly developed or extended in the region are supposed to nominate in accordance with the result of optimum study in the region. From a view point of early recovering, however, it is necessary to nominate among projects being planned. Accordingly, it is recommendable that the development of power plants focuses on 1) Kyrgyzstan, where electricity shortage by generation discharge in winter leads to winter flood in downstream reach, and 2) downstream countries, where electricity can supply Kyrgyzstan by power exchange in the region, especially in Uzbekistan since the development of power plants has been delayed. Specifically, technical and financial assistance for construction of power plants, such as Kambarata hydropower in Kyrgyzstan, Naboi thermal power and Pskem hydropower in Uzbekistan, seems to be preferable.

(b) Strategic move for the future assistance conducted continuously

Continuous assistance toward future vision is necessary for regional stabilization in Central Asia. For a first step, encouraging regional discussion for building optimum power development plan, considering regional power exchange and sharing common understanding are desired. Thus, to establish optimum power development plan of each country studied in consideration of regional power trade, to reconfirm advantages of introducing power trade, and to prepare baseline for the detailed discussion in the region.

Optimization study of the plan should be conducted based on understanding and considering conditions of each country. Accordingly, the assistance is desired to start from dispatching resident experts in the electric power field to the region for reviewing basic information, such as current development plans and candidate projects, and conditions of each country. And then, an optimization plan for each country and for the region will be able to develop in collaboration with the power engineers / experts for the planning of each country.

(3) Specific priority projects with urgency

Preliminary drafts of promising projects that urgently need implementation assistance among the assistance mentioned in the preceding clause, are shown below. Descriptions in these drafts are the items that have technical needs. Adjustment before implementation is necessary by consulting with the relevant organizations.

In addition, an urgent project for the improvement of the operation of Toktogul Reservoir that is listed in the prioritized project in the water resources management field is also important for the power field. Coordination for obtaining understanding of each country for this assistance, at least not to lead stiff objections, seems necessary since currently there are conflicts among the countries that have become political issues.

【 No. 1 】 <Assistance for the urgent issues>

Project name	**Assistance for construction of Kambarata hydropower in Kyrgyzstan**		
Field for support	Electric power and Water resource management	Country/ Area to be supported	Kyrgyzstan（Influences the water use in Uzbekistan and Kazakhstan）
Background and necessity	Power supply in Central Asia has been short. Especially in Kyrgyzstan, planned outage of above 30% was carried out in the winter of 2008, since electricity demand increased severely during winter in 2007 and storage water of Toktogul Reservoir decreased. This situation might be likely to repeat again, and early reinforcement of power supply is required. Kambarata hydropower is one of the projects that is able to develop in the shortest period. Accordingly, assistance in the construction for early increasing of power supply is meaningful. Meanwhile, additional advantages of mitigating/eliminating damage of winter floods is expected for the development of Kambarata hydropower, by means of proper operation of reservoirs and relevant power stations since the Kambarata hydropower is located upstream of Toktogul Reservoir. Accordingly, this project is not only for the object country but also has advantages for the countries located in the lower reach.		
Purpose of the project	The purpose of the projects is to assess the appropriateness of the feasibility study of Kambarata hydropower, as well as to confirm the advantages of development of Kambarata hydropower, which effects are to reduce the winter discharge of Toktogul Reservoir and also reduce the impact of winter flood damage. Assistance, such as financial support will be provided when this assistance is considered reasonable.		
Outline of the project	・Review and evaluation of feasibility study of Kambarata hydropower ・Set up a coordinated operation plan for Kambarata and Toktogul Reservoirs ・Confirmation of the effect of reducing winter discharge of Toktogul Reservoir ・Financial support to the project		
Expected benefits and beneficiaries	Beneficiaries：Kyrgyzstan (Solution for the current power shortage) :Uzbekistan, Kazakhstan (mitigate/eliminate damages of winter floods) Influences : discussion and optimization of water management measures since the regulation capacity of the Syrdarya River will be increased.		
Support method	Technical Assistance and Financial support	Framework for the support	JICA Technical Assistance, Dispatching Experts, Financial support (Grant, Yen loan)

【 No. 2 】 <Assistance for the urgent issues>

Project name	**Assistance for acceleration of power plants development in Uzbekistan**		
Field for support	Electric Power	Country/ Area to be supported	Uzbekistan (there are effects to whole countries in the region by utilization of interconnection)
Background and necessity	Regarding power shortage in Central Asian countries, power supply margin has been short not only in upstream reach countries but also in downstream countries, which results in no space for power exchange for each country. Therefore, early construction of higher efficient plants is desired. Currently in Uzbekistan, assistance for such constructions as that of the Tashkent thermal power by Yen loan and the construction of Tashkent combined heat and thermal plant is on going. Though, from a viewpoint of stability and efficient power supply, it is necessary to start preparation of the next projects and conduct construction earlier. Uzbekenergo has candidate projects such as Navoi thermal power, Pskem		

	hydropower, extension of unit 2 of Tarimarjan thermal power, but studies such as F/S or reviewing F/S, need a detailed design. Accordingly, necessary preparation studies should be started earlier and nominate the power plants developed next to the Tashkent thermal power.
Purpose of the project	The purpose of the project is to conduct Studies (F/S, D/D) on the candidate projects, which envisaged constructing next to the Tashkent thermal power, such as Navoi thermal power, Pskem hydropower, and extension of unit 2 of Tarimarjan thermal power.
Outline of the project	・Evaluation of power development plan, and advantageous effect of development to the interconnected power network. ・Reviewing and updating F/S for Navoi thermal power, D/D ・Investigation, F/S and D/D for Pskem hydropower ・Reviewing basic plan, conducting F/S and D/D for extension of Tarimarjan Thermal power ・Financial support to the project
Expected benefits and beneficiaries	Beneficiary：Uzbekistan (Solution for the power supply shortage, energy efficiency, reducing CO_2) ：Interconnected countries in the region (reliability of power supply, improvement of economic efficiency)
Support method	Technical Assistance and Financial support / Framework for the support: JICA Technical Assistance, SAF, Financial support (Grant, Yen loan)

【 No. 3 】 < strategic move for the continuous assistance in the future>

Project name	**Power development plan of each country, giving consideration to intra-regional power trade**		
Field for support	Electric Power	Country/ Area to be supported	Uzbekistan; Kazakhstan; Kyrgyzstan; Tajikistan; Turkmenistan
Background and necessity	The Central Asia power system was built in the Soviet era, and achieved a stable supply by exchanging electric power in the region. After independence, power trade decreased because the countries did not agree with each other, due to conflict of interest among them. However, intra-regional power exchange across borders is still not only necessary for a stable supply, but also produces economic advantages for each country, such as reducing fuel cost for generation and reserve margin. Currently, in every country of the region, the demand-supply balance is quite tight because of the shortage of power supply. Under this situation, power development that is able to start immediately has priority. Meanwhile, in the medium to long term, it is also desirable to optimize the investment for power development of each country, by reviewing the development plans so as to attain the most economical composition of facilities under the power trade system to be established in the region. In addition to the above, fact finding study and planning effective assistance measures for possibility of introducing new/renewable energy and energy saving is desirable.		
Purpose of the project	Review power development plan of each country in accordance with the assumption that power trade rule among Central Asian countries will be updated and set, so as to enable the most economical investment for power industry. At the same time, reconfirm the advantages of introducing international power trade for well understanding of each country. Planning assistance measures for energy saving and introducing new/renewable energy.		
Outline of the project	1） Review of the existing power development plan for each country 2） Review of power demand forecast for each country 3） Optimization of power development plan for each country under the condition of with or without power exchange in the region.		

<table>
<tr><td></td><td colspan="3">４） Confirmation of the effect of regional alliances by power exchange in the region under the optimal program for each country.
５） Report on the current situation of energy saving and new/renewable energy in each country, and assistance plan for them.
６） Plan for Technical transfer and capacity building.</td></tr>
<tr><td>Expected benefits and beneficiaries</td><td colspan="3">Beneficiary : each country in the region (optimization of investment in power development by introducing optimal development plan for each country)</td></tr>
<tr><td>Support method</td><td>Technical Assistance and Financial support</td><td>Framework for the support</td><td>JICA Technical Assistance, Dispatching Experts</td></tr>
</table>

Interviewees（1st research trip）

Tashkent / Uzbekistan

Date	Organization	Interviewee	Title and affiliation
2008/9/3	Embassy of Japan	Tsutomu Hiraoka	Ambassador of Japan
		Mitsuhiro Toyama	First Secretary
	JICA Uzbekistan Office	Noriaki Nishimiya	Resident Representative
		Yuka Sonoyama	Assistant Resident Representative
		Jun Yamazaki	Assistant Resident Representative
	GTZ	Ralf Peveling	Team Leader
	UZBEKENERGO	Shukhrat V. Khamidov	Head, Department for Foreign Investment Programs
2008/9/4	Ministry of Agriculture and Water Resources	Zakhid A. Salikhov	Deputy Director, Foreign Investment Department
		Ernazarov	Deputy Head, Main Department of Water Resources
	Ministry of Foreign Affairs	Afzal Artykov	Head, SCO (Shanghai Cooperation Organization) Department
		Aybek Isaev	Water Affairs Unit
	Ministry of Economy	Mirzaev	Head, Cooperation with IFI (International Finance Institutions) and (EAEU) Euro Asian Economic Union
		Mirhabibov	Deputy Head, Water and Agriculture Development Section
		Suyundikov	Main Specialist, Cooperation with IFI and EAEU
	Ministry of Foreign Economic Relations, Investments and Trade	Shavkat A. Tulyaganov	Deputy Minister
		Khasan V. Khasanov	Chief Officer, CIS countries Department
		Davron Dadakhonov	Senior Officer, Department for Registration and Monitoring of Projects
2008/9/5	ADB	Rustam Abdukayumov	Portfolio Management Officer
	USAID	Alexander G. Kakashnikov	Project Management Specialist
	WB	Dilshod T. Khidirov	Operations Officer
	UNDP	Ulugbek Islamov	Irrigation and Land Degradation Specialist
		Farhod Maksudov	Environment Specialist
2008/9/8	SIC-ICWC	Victor A. Dukhovny	Director
		Vadim I. Sokolov	Deputy Director
		Pulatkhon D. Umarov	Deputy Director
		Iskander Beglov	Project Manger, Central Asia Regional Water Information Base Project
		Denis A. Sorokin	Administrator of ICWC Information System, Central Asia Regional Water Information Base Project
	BVO Syrdarya	Loktionov Alexander	Deputy Director, BVO Syrdarya
	State Inspection	Shuhrat G. Talipov	Chief Specialist
		Utkirbek Sheraliev	Senior Specialist
		Bakhodir Uralov	Specialist
	CDC	KARIMOV Umar	Chief Dispatcher

Astana / Kazakhstan

Date	Organization	Interviewee	Title and affiliation
2008/9/10	Embassy of Japan	Hiroyuki Imahashi	Counsellor
		Hisanori Ogawa	First Secretary
		Takao Asamura	Attaché
2008/9/11	KEGOC	Sergey Katyshev	Managing Director-Development
		Nurshan K. Isenov	Chief of Development Department
		Marinina Oxana	Chief of Central Dispatching Center
	Ministry of Foreign Affairs	Kobrandin	Director, Central Asia Department
		Batorkhan Kurmanseit	Central Asia Department (in charge of Japan)
	Ministry for Emergency Situations	Yedil Abdraimov	Expert, Department of Prevention Emergency Situations & Perspective Development
		Laura Lukpanova	Main Expert, International Cooperation Department
		Dostan Ramazanov	Liaison Officer, International Cooperation Department
2008/9/12	Water Resources Committee , Ministry of Agriculture	Anatoly Ryabtsev	Chairman
		Bekniyazov M. Kabekenovich	Chief of Expert
	Ministry of Energetics & Mineral Resources	Turganov D.N.	Deputy Minister
		Klyakin V.I.	Deputy Director of Energetics & Cool Industry
		Azhikepov S.M.	Head of Management of Department
		Imandosov Z.M.	Director of International Cooperation Department
		Muhamediyar A.N.	Expert of International Cooperation Department

Almaty / Kazakhstan

Date	Organization	Interviewee	Title and affiliation
2008/9/15	WB	Christophe Bosch	Regional Sector Coordinator
		Mirlon Aldayarov	Senior Infrastructure Specialist
	UNDP	Aidyn Toilybayev	Project Manager
		Iger Petrakov	Legal Advisor, IWRM Project
		Inkar Kadyrzhanove	Head of Environment & Sustainable Development Unit (Astana)
		Natolio Panechenko	Programme Analyst (Astana)
		Zhanat Alyahasov	River Basin Council Specialist
		Olga Romanova	Finance & Procurement Specialist
		Gaukhar Zhorabekova	Head of Liaison Office
2008/9/16	Ministry of Environment Protection	Berik B. Omarovich	Director, Republican State-owned Enterprise "Kazhydromet", Scientific & Production Hydrometeorological Center
		Vsevolod Golubtsov	Leading Researcher, Republican State-owned Enterprise "Kazhydromet", Scientific & Production Hydrometeorological Center
	USAID	John Iron	Director, office of Economic growth
		Andrew Maybrook	Deputy Director, Program Support Office
	EC-IFAS	Almabek N. NURUSHEV	Executive Director

Tashkent / Uzbekistan

Date	Organization	Interviewee	Title and affiliation
2008/9/17	Swiss Cooperation Office	Hanspeter Maag	Country Director, Kyrgyz Republic & Uzbekistan Counsellor
		Omina Islamova	Regional Water Sector Program Manager
2008/9/18	Ministry of Agriculture and Water Resources	Zakhid A. Salikhov	Deputy Director, Foreign Investment Department
		Ernazarov	Deputy Head, Main Department of Water Resources

Bishkek / Kyrgyzstan

Date	Organization	Interviewee	Title and affiliation
2008/9/19	Embassy of Japan	Hirokatsu Inoue	Chargé d'Affaires, Second Secretary
		Tsutomu Shibara	Second Secretary
	JICA Kyrgyz Republic Office	Hideaki Maruyama	Resident Representative
		Kotaro Nishigara	Assistant Resident Representative
		Aidai Bayalieva	Program Officer
2008/9/22	Ministry of Finance	Tajikan Borbugulovna KALIMBETOVA	Minister
		A. Elibekov	Assistant Minister
		M. Baigonchokov	Head of the External Affairs Department
		K. Nawazov	Head of the Unit in the External Affairs Department
		R. Kunuanalieva	Head of the Budget Planning Unit
	Ministry of Agriculture, Water Resources and Processing Industry	Arstanbek Imankulovich NOGOEV	Minister
		K. Koshobaev	General Director of the Republican Water Department
		A. Soltobaev	Head of the Mechanics Unit of the Republican Water Department
2008/9/23	Ministry of Industry, Energy and Fuel Resources	Saparbek BALKIBEKOV	Minister
		K. Saztkaziev	General Director, Electric Power Plants
		A. Aytkulov	Deputy General Director, National Grid Company
		Anara Djumagulova	Head of International Relations and Investments Department
	GTZ	Andreas Clausing	Regional GTZ Representative in Central Asia
		Martin Schafer	Assistant to the Regional Representative
		Elena Zakirava	Assistant of the Regional Representative
	Ministry of Foreign Affairs	Ebnan Oskonovtsch KARABAEV	Minister
		Dinara KEMELOVA	Chief of Consular-Legal Division, Consular Service Department
2008/9/24	World Bank	Roger J. Robinson	Country Manager
	EBRD	Kenji Nakazawa	Head of Bishkek Office
	CAIAG	Bolot Moldobekov	Co-Director (Kyrgyzstan)
		Helmut Echtler	Co-Director (Germany)
		Dira Joldubalvo	Head of Department 5: Education, Training and Scientific Co-Operations

Tashkent / Uzbekistan

Date	Organization	Interviewee	Title and affiliation
2008/9/25	Ministry of Agriculture and Water Resources	Ernazarov	Deputy Head, Main Department of Water Resources
	SIC-ICWC	Victor A. Dukhovny	Director
		Pulatkhon D. Umarov	Deputy Director
		Denis A. Sorokin	Administrator of ICWC Information System, Central Asia Regional Water Information Base Project
2008/9/26	JICA Uzbekistan Office	Noriaki Nishimiya	Resident Representative
		Yuka Sonoyama	Assistant Resident Representative
		Jun Yamazaki	Assistant Resident Representative
		Óki Sugimoto	Assistant Resident Representative

Interviewees（2nd research trip）

Dushanbe / Tajikistan

Date	Organization	Interviewee	Title and affiliation
2008/11/26	Embassy of Japan	Yoshihiro Nakayama	Chargé d'Affaires
		Hiroshi Nagao	Attaché
	JICA Tajikistan Office	Seiji KAIHO	Resident Representative
		Tomonori ORITA	Project Formulation Advisor
2008/11/27	Committee of Emergency Situations and Civil Defense	Abdurasulov Nemat Sharifovich	Chief, Department of International Cooperation
		Manija Ibodova	Senior Officer, Department of International Cooperation
	Ministry of Economic Development and Trade	Valiev	Head, Department of State Investment Programs
		Khumatov	Deputy Head, Department of Innovation and Industry Development
		Asmutdinov	Head, Department of Cooperation with Foreign Countries
		Norov	Deputy Head, Department of Investments
	EC-IFAS	Rahimov Sulton	Chair, EC-IFAS Liquidation Commission
		Khairullo Ibodzoda	Member of EC-IFAS, Tajikistan Representative
2008/11/28	Ministry of Energy and Industry, OJSHC "Barki Tojik"	Rashid Gulov	Deputy Chief Engineer
		Salamsho Jugeliev	Head, Department of International Economic Relations
		Marat V, Vakhrushev	Deputy Head, Department of Construction of Hydro-Energy Facilities
	Ministry of Land Reclamation and Water Resources	Subhonkul Davlatov	Head, Department of Foreign Economic Relations
		Abdukhalim Sattorov	Leading Specialist, Department of Water Resources, Science and Technology
		Makhmasaid Isoev	Head, Department of Design and Operation of Drinking Water in Rural Areas and Grazing Areas
		Anvar Kamolidinov	Director, Tajik Branch, SIC-ICWC
	Ministry of Foreign Affairs	Sangmahmad Zaurov	Deputy Director, Department of Asia and Africa
	ADB	Makoto Ojiro	Country Director, Tajikistan Resident Mission

Tashkent / Uzbekistan

Date	Organization	Interviewee	Title and affiliation
2008/12/1	WB	Dilshod T. Khidirov	Operations Officer

Astana / Kazakhstan

Date	Organization	Interviewee	Title and affiliation
2008/12/2	Embassy of Japan	Shigeo Natsui	Ambassador of Japan
		Hisanori Ogawa	First Secretary
		Takao Asamura	Attaché
		Tatsuji Nishikawa	Project Formulation Advisor, JICA Kazakhstan Liaison Office
	Ministry of Energetics & Mineral Resources	Turganov D.N.	Deputy Minister
		Imandosov J.	Director, International Cooperation Department
		Bertysbaev N.	Director, Power Development and Coal Industry Department
2008/12/3	Ministry of Foreign Affairs	Erkin Tukumov	Director, Central Asia Department
		Aidor Abishev	Minister's Adviser
		Csulmira Sultanali	Management Head
		Aset Ualyev	Expert, Management Department Employee
	Ministry for Emergency Situations	Valeriy Petrov	Deputy Minister
		Abdrash Bektimirev	Deputy Director, Department of Emergency Situations Prevention & Perspective Development
		Yedil Abdraimov	Expert, Department of Emergency Situations Prevention & Perspective Development
		Laura Lukpanova	Chief Expert, International Cooperation Management
	KEGOC	Vladimir Osochenko	Vice President
		Nurshan K. Isenov	Director, Department of National Electric Grid Development
		Nurlan Duysenov	Chief Dispatcher, National Dispatching Center of System Operation
		Mayra Muhamedkaly	Head, Financial Management
		Oxana Marinina	Chief Expert & Manager, Hydropower Engineering Group
		Sabit Suyundikov	Chief Expert, Department of National Electric Grid Development
	ADB	Stephen Wermert	Country Director, Kazakhstan Resident Mission
2008/12/4	Committee on Water Resources, Ministry of Agriculture	Amirkhan K. Kenshimov	Deputy Chairman
		Zhakenov Mukhtar	Main Expert

Bishkek / Kyrgyzstan

Date	Organization	Interviewee	Title and affiliation
2008/12/9	Embassy of Japan	Yuichi Iizuka	Chargé d'Affaires
		Hirokatsu Inoue	Second Secretary
		Tsutomu Shibara	Second Secretary
		Hideaki Maruyama	JICA Kyrgyz Republic Office, Resident Representative
		Kotaro Nishigata	JICA Kyrgyz Republic Office, Assistant Resident Representative

	Ministry of Agriculture, Water Resources and Processing Industry	Koshmatov Baratali Turanovich	General Director of the Republican Water Department
		Mamatoliev Nurgazy	Director, Kyrgyz Branch, SIC-ICWC
	Electric Power Plants	Saparbek BALKIBEKOV	General Director
		Samat ALDEEV	Head, Foreign Affairs and Project Implementation Unit
	Ministry of Industry, Energy and Fuel Resources	Gulbarchin ASANOVA	Deputy Minister
		Marat MAMYTOV	Head, Department of Fuel and Power Complex
		Janna Imankulova	Leading Specialist, International Relations and Investments Department
	Ministry of Foreign Affairs	Dinara KEMELOVA	Deputy Director, International Economic Cooperation Department
		Bolot USENOV	Second Secretary, The Eastern Countries Department
	GTZ	Martin Schafer	Assistant to the Regional Representative

Tashkent / Uzbekistan

Date	Organization	Interviewee	Title and affiliation
2008/12/10	Embassy of Japan	Hiroshi Chayama	First Secretary
		Mitsuhiro Toyama	First Secretary
	JICA Uzbekistan Office	Yukihiko Ejiri	Chief Representative
		Yuka Sonoyama	Assistant Resident Representative
		Jun Yamazaki	Assistant Resident Representative
	ADB	Rustam Abdukayumov	Portfolio Management Officer
2008/12/11	Ministry of Agriculture and Water Resources	Ernazarov	Deputy Head, Main Department of Water Resources
		Rustam P. IBRAGIMOV	Director, Foreign Investment Department
	State Inspection	Shuhrat G. Talipov	Chief Specialist
		Utkirbek Sheraliev	Senior Specialist
		Bakhodir Uralov	Specialist
	UZBEKENERGO	Bahodir A. ABDURAHMANOV	First Deputy Chairman
		Shukhrat V. Khamidov	Head, Department for Foreign Investment Programs
		Marat Mulyukov	Chief, Hydro-Technical Facilities Department
2008/12/12	SIC-ICWC	Pulatkhon D. Umarov	Deputy Director
		Loktionov Alexander	Deputy Director, BVO Syrdarya
		Alisher Nazariy	Specialist on Water Use, Regional Water Use Section
	UNDP	Ulugbek Islamov	Irrigation and Land Degradation Specialist

References

<Water resources>

1 International Water Management Institute Progress Report 2003-2004, IWMI

2 The Power of Water in a Divided Central Asia, Max Spoor and Anatoly Krutov

3 Cooperation with the Countries of Eastern Europe and the CIS Current Projects 2004, 2004, Swiss Agency for Development and Cooperation

4 Regional Cooperation Strategy and Program for Central Asia Regional Economic Cooperation (CAREC) Member Countries 2005-2007, 2004, ADB

5 Water, Climate, Food and Environment in the Syrdarya Basin, 2003, Oxana S. Savoskul and others

6 USAID's Assistance Strategy for Central Asia 2001-2005, 2000, USAID Regional Mission for Central Asia

7 Aral Sea Basin Program Water and Environmental Management Project, 1998, The World Bank

8 Environmental Policy and Technology Project, 1997, US Agency for International Development

9 Water Productivity in the Syrdarya River Basin, 2003, IWMI

10 Cooperation in Shared Water Resources in Central Asia , 2002, ADB

11 Water Resources of Kazakhstan in the New Millennium, 2004, UNDP

12 Strategic Partnership on Water for Sustainable Development, 2004, EECCA, EU Water Initiative

13 Stakeholder's Participation and Public Awareness in Water Management Issues of the Border Rivers Chu and Talas, 2003, Gulnara Roll and Margit Sare

14 Cooperative Management of Transboundary Water Resources in Central Asia, 2003, Daene C. Mckinney

15 National Integrated Water Resources Management and Water Efficiency Plan for Kazakhstan, 2004, UNDP

16 Transition to Integrated Water Resources Management in Amu-Darya and Syrdarya Lowlands and Deldas, 2005, US State Department

17 The Aral Sea Basin, Evaluation of an Upstream-Downstream Conflict at the Syrdarya River, 2002, Swiss Federal Institute of Technology Zurich

18 Taping the Potential, Improving Water Management in Tajikistan, 2003, UNDP

19 Managing Transboundary Water Resources in the Aral Sea Basin in Search of a Solution, 2001, Sergei Vinogradov and others

20 Environmental Performance Reviews, Kyrgyzstan, 2000, UN Economic Commission for Europe

21 Integrated Water Resources Management - Fergana Valley (IWRM - Fergana), 2005, SIC-ICWC

22 Central Asia: Water and Conflict, 2002, ICG (International Crisis Group)

23 Joint River Management Programme, 2003, EU

<Electricity>

1 Energy Sector Status Report, Sixth Minister Conference CAREC, November 2007

2 Water Energy Nexus in Central Asia, 2004, World Bank

3 A Revised Approach to World Bank and Development Partner's Involvement in the area of Water-Energy Cooperation in Central Asia, 2004, World Bank

4 Central Asia Regional Energy Export Potential Study(REEPS), 2005, World Bank

5 Sector Study for Power Sector in Uzbekistan, 2004, JBIC

6 Study on General Development of Central Asia (Uzbekistan, Tajikistan), 2003, Engineering and Consulting Firms Association, Japan

7 Report and Recommendation of the President to the Board of Directors on Proposed Loans to the Republic of Tajikistan and to the Republic of Uzbekistan for the Regional Power Transmission Modernization Project (RRP: TAJ/UZB 35096), 2002, ADB

8 Optimization of the Use of Water and Energy Resources in the Syrdarya Basin Under Current Conditions, USAID, 2000

<Whole region etc.>

1 Contemporary Central Asia, 2004, Ichiro Iwasaki, Tomohiko Uyama and Hisao Komatsu, eds., Nippon Hyoronsha Co.,Ltd.

2 The Devil and the Disappearing Sea: A True Story About the Aral Sea Catastrophe, Rob Ferguson