2. STATUS OF THE SYRDARYA WATER AND ENERGY COMPLEX

2.1. Status of Basin Water and Energy Complexes and Their Interaction

2.1.1. Water Management Complex

2.1.1.1. River Hydraulic Facilities, Reservoirs, Diversion Works, Irrigation System and Collectors, and Their National Identity

The following large river stations, dams, reservoirs, and main water-collecting facilities are functioning in the Syrdarya basin:

- **Kazakhstan –** Kzyl Orda, and Kazalinsk hydro-stations on the Syrdarya River; Chardara reservoir on the Syrdarya River, and Bugun reservoir on the Arys and Bugun rivers;
- **Kyrgyz Republic –** Great Namangan Canal (GNC), Left-Shore Naryn Canal (LNC) on the the Naryn river; Toktogul reservoir on the Naryn river, and Tortgul reservoir on the Isfara river;
- **Tajikistan –** Farkhad hydro-station on the Syrdarya River, Upper-Dalverzyn canal; Kairakum and Farkhad reservoirs on the Syrdarya River; and
- **Uzbekistan –** Kampyravat, Teshiktash, Kunganyap, Assakin hydro-stations on the Karadarya river, Uchkurgan hydro-station on the the Naryn river, Northern Fergana Canal (NFC), Great Andijan Canal (GAC), Great Fergana Canal (BFK) on the Naryn river, KMC, South Golodnaya steppe canal (SGC), Akhunbabaev canal on the Syrdarya River, Sarykurgan hydro-station on the Soh river, Gazalkent hydro-station on the Chirchik river. Andijan reservoir on the Karadarya river, Tashkent reservoir on the Akhangaran river, and Charvak reservoir on the Chirchik river.

As a result of fulfillment of a set of water use activities aimed to develop agricultural irrigation, the Syrdarya basin has a significant amount of engineered hydro-technical constructions, which allow withdrawal water for irrigation systems of the region. Below, we briefly describe the most important of the constructions listed above.

Uchkurgan HPP, the last HPP of the Naryn cascade, is constructed 90 km downstream from Toktogul hydro-station on the Naryn river above its exit to Fergana valley on the territory of the Kyrgyz Republic. Its general constructions include: concrete dam with maximum capacity of 1175 m^3/s, blind ground dam, HPP, two irrigation canals, which allow diversion of 18 m^3/s of water on the left side (LNC), and 27 m^3/s on the right side (GNC), which increased to 65 m^3/s after the construction of the second part. There are 4 aggregates located in the HPP with a capacity of 45 MW each. The under-water part of the building is equipped with eight holes to remove sediments. The maximum flow through the bottom holes is 2700 m^3/s.

Uchkurgan hydro-station (or Uchkurgan irrigation barrage) is located on the Naryn river close to Uchkurgan village, 14 km down-stream from Uchkurgan HPP, and includes the following main constructions: concrete dam and two regulators – the right-side regulator provides water to the NFC (110 m^3/s), and the left-side regulator supplies the BFK (330 m^3/s). The dam consists of 12 gates up to 10 m each; the maximum capacity of the dam is 3000 m^3/s.

Farkhad hydro-station is located in the middle-stream of the Syrdarya River in the ravine created by the Farkhad rocks, 4 km above the city of Bekabad, and allows diversion of water to the irrigation system of Golodnaya steppe, and to the Dalverzin irrigation system. The main constructions of the hydro-station include concrete dam with a capacity of 5000 m^3/s, blind ground dam with a height of 28 m, and a length of 500 m, HPP, regulators of the derivation and Dalverzin canals. The main regulator of the derivation canal is a shield construction, which has 7 gates 10 m each, with a capacity of 520 m^3/s. The right-side regulator of the Dalverzin canal has a capacity of 70 m^3/s, while the derivation canal has a length of 14 km; the withdrawal construction of the South Golodnaya steppe canal with a capacity of 300 m^3 is located near the water head basin of the HPP.

Kzyl Orda hydro-station is located on the Syrdarya River close to the city of Kzyl Orda on the territory of the Republic of Kazakhstan, and serves the main diversion of water to the irrigation canals of the left and right banks. The main constructions include: shield water-elevating dam with a capacity of 1700 m^3/s, two regulators with flow of 210 m^3/s through the left-bank regulator, and 110 m^3/s through the right-bank regulator, two cesspools on each of the canals, water outflow canal for the supply of the village.

Kazalinsk hydro-station is located in the downstream region of the Syrdarya River in the territory of the Republic of Kazakhstan, 32 km above Kazalinsk city. The hydro-station consists of a shield water-elevating dam with a capacity of 1000 m^3/s, left-bank and right-bank water-receivers with water flow galleries, and one-part lock for fish, left-bank (100 m^3/s) and right-bank (85 m^3/s) main regulators.

The irrigation systems of the Syrdarya basin include the following:

- **Kazakhstan –** Kzyl Orda planning zone: Toguskent, Chiiliy, Kzyl Orda, Kazalin, Delta;
- **Uzbekistan –** Andijan planning zone: BFK, GAC, LNC, Upper Ulugnor, Siza, Pahtaabad; Dzhizak planning zone: SGC, KMC; Namangan-Naryn planning zone: BFK, LNC, GAC, NFC, GNC, Akhunbabaeva; Namangan-Syrdarya planning zone: GAC, Akhunbabaeva; Syrdarya planning zone: KMC, SGC; Fergana planning zone: BFK, SFC, GAC;
- **Tajikistan –** Khodzhent planning zone: NFC, BFK, Nauskaya, Khodzhaakirgan, Zafarabad, Ashtskaya.

The rest of the irrigation systems of Kazakhstan, the Kyrgyz Republic, and Tajikistan are fully included and are the same as the planning zones.

The Syrdarya basin is characterized by complicated water use systems, which redistribute the flow of many sources of water, allowing almost full use of the basin water resources. The main places of water withdrawal are: Uchkurgan hydro-station, no-dam withdrawal of water to the Great Fergana Canal, Uchkurgan irrigation barrage, no-dam withdrawal of water to the canal of Akhunvavaeva, Farkhad hydro-station, Chardara hydro-station, and in the downstream of the Syrdarya River – Kzyl Orda and Kazalinsk hydro-stations. In addition to that, pumping stations are located along the whole river, which take the water out to small canals.

Large canals and hydro-stations form the scheme of irrigation of the lands of the Syrdarya basin. For example, in the upstream region of the Naryn, which is a high mountain area, the irrigated lands are represented by separate small sites, and the development of irrigation is based on elevation of water from the Naryn and its tributaries with the use of pumping stations with a typical flow of 1 to 10 m^3/s. The central and western parts of the Fergana valley receive water from the Naryn and Karadarya Rivers, the areas located near mountains are irrigated from small mountain rivers, the eastern part – from the Karadarya and its tributaries. Small areas are supplied by the Syrdarya River itself, because the river bed is located at the lowest levels, which makes it difficult to take the water out without a dam.

The largest canals are: Great Fergana Canal (BFK), constructed in 1939, which withdraws water from two sources – the Naryn and Karadarya rivers, and the main withdrawal includes two tracts: upper, the Naryn, with a maximum flow of 270 m^3/s, and lower, Karadarya, with withdrawal of water near Kuiganyar village in the amount of 190 m^3/s; the upper tract transfers water from the Naryn to the Karadarya, and has two places where water is withdrawn– below Uchkurgan HPP in the amount of 150 m^3/s, and at Uchkurgan irrigation barrage – 120 m^3/s. BFK, crossing the whole Fergana valley from north-east to south-west, connects different mountain sources of the left bank into one water system, what increases the water provision in the irrigation zone. The length of the canal is 344 km, including 270 km in the territory of the Republic of Uzbekistan, and 74 km in the Republic of Tajikistan. In addition to that, the Great Andijan Canal (GAC) which supplies irrigation of the lands of the Central Fergana valley is a part of the BFK system; the canal begins at the supporting bed of the BFK 6.6 km downstream from Uchkurgan irrigation barrage in the Naryn river, crosses the Karadarya river with the help of a drucker, and enters the lands of the Central Fergana valley; the main flow of this canal is 200 m^3/s, and the length is 110 km. The Akhunbabaeva canal with a flow of 60 m^3/s is connected to the system of the GAC.

The biggest irrigation system in the right-bank part of the Fergana valley is the system of the Northern Fergana Canal (NFC), which was constructed in 1940, and withdrawal of water is carried out at the Uchkurgan irrigation barrage. The capacity of the main part of the canal is 110 m^3/s, and the total length is 165 km. The NFC goes along the Syrdarya River, supplying irrigation of lands in Uzbekistan and Tajikistan. Putting into operation the 2nd part of the Great Namangan Canal (GNC) allowed supply to the lands of the Republic of Uzbekistan, and Kyrgyz Republic above the NFC zone; the length of the GNC is 162 km, the capacity is 61 m^3/s, withdrawal of water is carried out from the head water of Uchkurgan hydro-station (with HPP).

The system of mountain rivers of the Fergana valley includes the Soh-Isfarin and Khodzhabakirgan irrigation systems, while the first one is located on the left bank of the Syrdarya above the BFK zone, and Soh and Isfara rivers are sources of water for irrigation. The Khodzhabakirgan irrigation system is located in the western part of the left-bank lands of the Syrdarya, and the sources of water for irrigation are the rivers of Khodzhabakirgan, Aksu, Isfara, and springs. The systems of mountain rivers of the right-bank area cover the lands located above the BFK, and are irrigated by water from the rivers of Padshaata, Kasansai, Gavasai, etc. The canals of this zone are not deep, and their specific feature is that they have many heads and are long.

In the midstream region of the Syrdarya River, which includes the territories of Golodnaya, Dalverzin, Dzhizak, and Farish steppes, the Syrdarya is the main source of water for irrigation. Irrigation of Golodnaya steppe is based on the system of two main canals – Dustlik canal (the flow is 260 m^3/s), which brings water to the old irrigation zone, and Southern Golodnaya Steppe Canal (SGC, the flow is 300 m^3/s), which supplies the new irrigation zone. In addition to that, in the southern part of Golodnaya steppe, Tajik lands are irrigated by pump stations lifting water. Irrigation of Dzhizak steppe is carried out with the help of Dzhizak machine canal (DMC) with the total length of 310 km, and a design flow of 185 m^3/s, and the total height of elevation of the water of 176 m. Withdrawal of water to the DMC is located at the first part of the SGC, and in order to provide its normal functioning, it is necessary to widen the derivation canal to 900 m^3/s, and the main part of the SGC to 500 m^3/s.

The lands available for irrigation below Chardara reservoir are located in a narrow line along the Syrdarya River on the territory of the Republic of Kazakhstan. The largest irrigated areas, supplied with water from the Syrdarya River, are:

- Kylkum, located on the left bank of the Syrdarya; the water is supplied here through the Kzylkum main canal with withdrawal of water from the left-bank water outflow of Chardara reservoir (up to 200 m^3/s); the length of the canal is 50 km;
- Toguskent, located along the left bank of the Syrdarya, to the North of the Kzylkum area; water is supplied through the Kelintubin main canal (up to 50 m^3/s) with a length of 78 km; the water is withdrawn from the Syrdarya with no dam;
- Yanykurgan area, located on the both banks of the Syrdarya; the existing irrigated lands are located mainly on the left bank, and the water is supplied through Chiiliy main canal (up to 90 m^3/s), with a length of 20 km, and through Sunakatin canal (up to 20 m^3/s), with a length of 30 km. The water is withdrawn with no dam directly from the Syrdarya River;
- Kzyl Orda area in the downstream of the Syrdarya River is located in the region of Kzyl Orda city; the water is withdrawn from Kzyl Orda hydro-station. The left-bank lands are irrigated by Kzyl Orda main canal (up to 210 m^3/s), with a length of 81 km; the canal goes through the center of the area, and has two-side regulation. At the end, the canal is separated into the right arm with a capacity of 95 m^3/s, and the left arm with a capacity of 42 m^3/s. Irrigation of the right bank is carried out through two canals – the left-bank main canal with a flow of 44 m^3/s, and Aitek canal with a flow of 50 m^3/s; and
- Kazalinsk area, also located in the downstream region of the Syrdarya River, is supplied with water from Kazalinsk hydro-station. The systems of the left bank are supplied with water through the main canal with a flow of 35 m^3/s, and a length of 53 km, and the lands of the left-bank are supplied through the main canal with a flow of 18 m^3/s, and a length of 48 km, and through Baskara canal with a flow of 12 m^3/s.

The list of the main canals, which determine the technical scheme of irrigation of the lands of the basin of the Syrdarya River, is presented in Table 2.1.1.1.

Table 2.1.1.1
Main Irrigation Canals of the Syrdarya Basin.

Canal	Capacity (m3/s)	Length (km)
Great Namangan	61	162
Northern Fergana	110	165
Great Fergana	270	344
Great Andijan	200	110
Southern Fergana	130	103
Akhunbabaeva	60	50
Upper Dalverzin	40	30
Lower Dalverzin	78	25
South Golodnaya Steppe	300	127
Kirov	260	120
Kyzylkum	200	115

The main drainage water collectors in the Syrdarya basin are:

- **Fergana valley** – Achikul, Northern-Bagdat, Soh-Isfarin, Sarysui, Yazyavan, Sarydzhuga, with a total capacity of about 500 m^3/s (Uzbekistan), which collect about 4 km^3 of water per year;
- **Golodnaya steppe** – Central Golodnaya steppe (CGC), Shuruzyak, Main Water-Meadow (Uzbekistan), Arnasai, Kyzylkum, Tugainiy (Kazakhstan) with the total capacity of about 200 m^3/s, which collect about 3 km^3/year (about 1 km^3/year of which goes to the Syrdarya, and 2 km^3/year go to Arnasai);
- **CHAKIR** – Urtukly, Karasu, Sarysu, Sand (Uzbekistan), which collect about 1 km^3 of water per year; and
- **Downstream** (including ARTUR) – Eastern, Southern, Chiily-Telekul (Kazakhstan), which collect about 1 km^3 of water per year.

2.1.1.2. National and Regional Organizations Governing Regulation and Use of Water Resources

Two levels can be distinguished in the current water management structure in the Syrdarya basin: regional and national. The regional (international) level is represented by the Central Asian Economic Community (CAEC), and by the International Fund for Saving the Aral Sea (IFAS); the national level is represented by the Ministries (or Committees) of Water, Oblast Departments of Water, and Regional Departments of Water, their special organizations (or services), and basic departments (e.g., construction, industrial, planning, scientific).

The countries which are founders of IFAS participate in the Board of Directors of the Fund, which is headed by the President of the Fund, elected from the Heads of the founder countries. The permanent executive body of IFAS is its Executive Committee (EC IFAS). The EC IFAS has affiliates and departments in the countries of Central Asia. The International Coordinating Water Commission (ICWC) operates under IFAS, as well as its Scientific Information Center (SIC), and the Basin Water Management Organizations (BVOs) – BVO

Amudarya, and BVO Syrdarya. IFAS also includes the Sustainable Development Commission (SDC) and its Scientific Information Center (SIC SDC).

ICWC, whose members are the heads of the water departments of the countries of the region, develops the general directions for regional water use policy in the basin, approves the limits for annual water withdrawal for each country, approves the operating regime for the large reservoirs, establishes annual amounts of inflow to the Aral region and the Aral Sea, and develops recommendations for the Governments of the basin countries about compensation for losses (expenses) related to mutual use of water resources. The BVOs develop for agreement by the ICWC the limits of withdrawal of water for all countries and consumers in the basin, calculate the operating regime for reservoirs, and, while being the executive bodies of ICWC, through its departments, supply and control water resources within the limits approved by the ICWC. SIC ICWC, according to the decisions of ICWC, carries out scientific research works and organizes the exchange of information among the countries.

The area covered by the BVO Syrdarya lays from Toktogul reservoir to the border of the Republic of Kazakhstan (at Chardara reservoir). Along with the republican committees of the State Committees of Environment, services of the Departments of Hydrometeorological Services (hydromets) and Sanitary Epidemiologic Departments, BVO Syrdarya also manages the quality of water in the Syrdarya River. BVO Syrdarya organizes water supply in the Syrdarya basin to the countries and consumers, develops constructions for withdrawal of water, carries out activities for the improvement of environmental conditions and control over the quality of water resources being used. The BVO controls the flow regime of the rivers Naryn, Karadarya, Chirchik, and Syrdarya itself above Chardara reservoir. For this purpose, BVO, first of all, manages the available water resources of the basin of the Syrdarya River, grounding the operation regimes of the Naryn-Syrdarya cascade of reservoirs, and developing plans of water supply to the water users under the limits of withdrawal approved by the ICWC, according to the requirements of the countries of the region, and according to the BVO's calculations. Also, the BVO carries out the following activities:

- middle-term planning, agreed upon with the water-use and power generation departments of the countries of the basin, prepares plans for mutual development and protection of water resources, participates in perspective planning;
- water supply to the water users, to the Aral Sea and Aral region, according to the decisions of the ICWC; carries out operational control over the water resources of the Syrdarya basin, and operational control over fulfillment of the limits for withdrawal of water;
- in case of change in the water use situation, or change in actual water provision in the basin, the BVO corrects the water withdrawal limits, and the operation regimes of the cascade of reservoirs;
- monitoring of the environmental condition of water systems of the Syrdarya basin, and monitoring of the quality of transboundary water resources;
- control over fulfillment of the operating regime of the cascade of reservoirs located at transboundary surface water flows, approved by ICWC;
- environmental protection activities within water protection zones of the transboundary rivers and reservoirs;
- development of measurements for non-accidental flow of floods, and protection of villages and agricultural lands from flooding and freshets; and

- other activities related to fulfillment of its functions and tasks, occurring during operation of the water use sector in the Syrdarya basin.

The BVO, which carries out regulation of the transboundary water resources and international distribution of water, manages the main hydro-technical constructions for withdrawal of water on the Syrdarya River and its main tributaries, as well as the canals which have international significance (first of all, "Dustlik" canal, and the Great Fergana Canal, BFK). The BVO manages 203 hydro-technical facilities, including 21 located directly on the main river bed of the Naryn, the Syrdarya, Karadarya, and Chirchik rivers. The flow through these constructions is equal to 20-2500 m^3/s, and the flow through the Dustlik canal and BFK reach 400 m^3/s.

As mentioned above, the main water user is irrigated agricultural; the area of the irrigated lands in the basin is 3.38 mln.ha, and 1.73 mln.ha are irrigated directly from the river. Registered withdrawal of water from the rivers and canals occurs at 445 points along the river, including 21 for main withdrawal of water, 36 stationary pumping stations, and 172 temporary pumping units. Registration of the surface river water flow is carried out mostly by the hydromets of the republics, while at withdrawal points registration is carried out by the BVO Syrdarya and by the departments of water use of the Central Asian countries. The headquarters of the BVO Syrdarya, located in Tashkent, carries out regulation through its territorial departments, according to the operating regime of the Naryn-Syrdarya cascade of reservoirs and the limits for withdrawal of water approved by ICWC for the non-vegetation and vegetation periods of each year, and the territorial departments – through the departments of hydro-stations. The water use complex managed by BVO Syrdarya operates:

1. Under conditions of normal guaranteed flow of water; and
2. Under extreme conditions:
   - extremely low water;
   - high water flow during very high-water years, with the necessity of non-accidental flood flows.

In order to support these regimes, it is necessary to take into account the flow of rivers, planned water flow, as well as the reserved water resources available in the basin reservoirs. Under conditions of multiyear flow regulation, reservoirs release storage over several years, depending on the availability of water resources, requirements for water, and possible changes in the regime of operation of the Naryn-Syrdarya cascade of reservoirs.

Regulation of water resources is based on the February 18, 1992 Agreement establishing the ICWC, the March 17, 1998 Agreement on the Use of Syr Darya Water and Energy Resources, and other documents and acts approved by the Central Asian countries during the following years. Taking into account the prognosis of the level of water in rivers during the non-vegetation and vegetation periods, and of the availability of water in reservoirs of the Naryn-Syrdarya cascade, BVO Syrdarya develops and presents for approval to the members of the ICWC the regime of operation of the Naryn-Syrdarya cascade, and the limits for withdrawal of water by the republics from the Syrdarya river. The approved limits serve as the basis for realization of distribution of water among the countries through canals and pumping stations. In case of emergency, depending on the actual conditions, the withdrawal limits can be corrected, and if the correction exceeds 10% of the total amount, it must be re-approved by the ICWC. The approved withdrawal limits for the republics, canals, and pumping stations, with 10-day (decade) distribution for each month, are executed by the territorial departments of the BVO Syrdarya, sites, hydro-stations, and constructions for withdrawal of water.

Registration of water in the rivers Naryn-Syrdarya, Karadarya, Chirchik, and other small rivers is carried out with the help of hydro-metrical posts of the hydromets of the corresponding republics. On the main canals, where water is withdrawn from the rivers, the water is registered by the main hydro-posts served by BVO Syrdarya, including the main canals "Dustlik" and BFK. Operational regulation of water resources is carried out by the management of the BVO through the central dispatcher, with connection to territorial departments and hydro-posts. Based on the results of measures, analysis of the river bed and water use, balances of water resources are calculated for the decade, month, non-vegetation and vegetation periods, as well as the water year. When doing this, causes of differences and losses of water are determined, and measures for coverage of losses are taken.

The current structure of regulation of water resources has started to include elements of environmental protection, the principles of consensus of water users in the water use areas and energy resources (e.g., consultation, agreeing upon the regimes between water use and energy departments). The main resources of the countries and international organizations are directed toward finding and developing mutually beneficial regional decisions, which to the best extent satisfy the national interests. From the point of view of improved management of the system, proposals have been made about increasing the role and rights of ICWC, BVO, and other international organizations.

2.1.2. Energy Complex

2.1.2.1. Power Plants of the Basin Countries

The estimated capacity of the power systems of the countries in the basin of the Syrdarya River at the beginning of 2000 is shown in Tables 2.1.2.1 and 2.1.2.2.

Table 2.1.2.1.
Capacity of Energy Systems of Syrdarya Basin Countries (as of 01.01.2000).

Capacity	MW	TPP (%)	HPP (%)
Kazakhstan	3014.6		
including - APC and TATEK JSC	1276.6	66.7	33.3
URDTs "KEGOC" JSC	1738.0	94.3	5.7
"Kyrgyzenergo" JSC	3622.7	81.4	17.6
GAHK "Barki Tochik"	4354.5	96.2	7.3
Ministry of Power of Uzbekistan	11582.6	85.0	12.2
Isolated power regions of GAHK "Barki Tochik"	57.7		
Total	22632.1		

The structure of the estimated capacity of the heating power plants, and for the groups of equipment, as of 01.01.2000 are presented in Tables 2.1.2.3 and 2.1.2.4.

2.1.2.2. Power Grid of Central Asia

The joint energy system of Central Asia and Southern Kazakhstan or the electric power pool of Central Asia (EPP CA) provides power for the national economies and populations of four Central Asian countries: Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, as well as five *oblasts* of Southern Kazakhstan – South-Kazakhstan, Zhambyl, Kzyl Orda, Almaty, and Taldy Korgan.

The following power systems simultaneously operate as the part of the EPP CA under operational management: Uzbekistan, South and North Tajikistan, South and North Kyrgyzstan, Turkmenistan, and South Kazakhstan. Power is exported to Afganistan from sub-plants of Uzbekistan and Turkmenistan through power supply lines. The estimated capacity of the EPP CA as for 01.01.99 and 01.01.2000 is presented in Table 2.1.2.5. The main indexes of operation of the energy systems of EPP CA and South Kazakhstan are presented in Table 2.1.2.6. The quantity of power plants with their grouping according to the estimated capacity as for 01.01.2000 is presented in Table 2.1.2.7.

Power generation of the EPP CA is equal to 89.9 bln.kWh, and increased by 1.5% compared to 1998. Power generation by HPPs is equal to 36.4 bln.kWh, 40.5% of the total generation. Power generation by EPP CA's HPPs increased by 2.9 bln.kWh compared to 1998 because of the high-water year, and correspondingly decreased TPP generation. The structure of power generation of the EPP CA is presented below in Table 2.1.2.8.

Consumption of power in 1999 was 90.3 bln.kWh, and increased by 1.4% compared to 1998. A stable increase in power flow can be seen at all power systems of Central Asia, except for Kazakhstan, were a decrease in demand for electricity continues. Consumption of power by months for 1999, and by the power systems of CA is presented in table 2.1.2.9.

Operation of the EPP CA is carried out on the basis of the June 1999 Agreement "On Simultaneous Operation of Power Systems of Central Asian Countries," which provides technical and economic advantages and mutual benefits, reliability and economic effectiveness of power supply to consumers, and reflects the mutual aspiration of cooperation in the sphere of power generation on the basis of equal rights and mutual benefits.

Table 2.1.2.2
Structure of the Capacity of EPP CA as of 01.01.2000 (in MW and % of the total established capacity)

Name of the power system	Total capac. of PPs	Power Plants						PPs of other Ministries and departments					
		Total		TPP		HPP		Total		TPP		HPP	
		MW	%	MW	%	MW	%	MW	%	MW	%	MW	%
EPP CA	25226.6	24771.4	98.2	15941.0	63.2	8830.4	35.0	455.2	1.8	63.7	0.3	391.5	1.5
K a z a k h s t a n													
Almatyenergo	1276.6	1276.6	100.0	852.0	66.7	424.6	33.3	-	-	-	-	-	-
incl. APC	1239.0	1239.7	100	828.0	66.7	411.0	33.2	-	-	-	-	-	-
TATEK JSC	37.6	37.6	100	24	63.8	13.6	36.2	-	-	-	-	-	-
Uzhkazenergo (URDTs)	1738.0	1638.0	94.3	1638	94.3	-	-	100.0	5.7	-	-	100.0	5.7
Iicl. Uzh-Kaz PDC JSC	302	202	66.9	202	66.9	-	-	100.0	33.1	-	-	100.0	33.1
Zhambyl PDC JSC	1290.0	1290.0	100	1290.0	100	-	-	-	-	-	-	-	-
Kzyl-Ordinsk. PDC JSC	146	146	100	146	100	-	-	-	-	-	-	-	-
Kyrgyzenergo JSC	3622.7	3586.5	99.0	638	17.6	2948.5	81.4	36.2	1.0	34.7	0.96	1.5	0.04
GAHK Barki Tochik	4354.5	4354.5	100.0	318.0	7.3	4036.5	92.6	-	-	-	-	-	-
GETK Kuvvat	2652.2	2652.2	100.0	2651.0	99.9	1.2	0.1	-	-	-	-	-	-
Ministry of Power of the Rep. Uzbekistan	11582.6	11263.6	97.2	9844.0	85.0	1419.6	12.2	319.0	2.7	29.0	0.2	290.0	2.5
Isolated power regions	57.7	57.7	100.0	27.7	48.0	30.0	52.0	-	-	-	-	-	-
Total for CA	25284.3	24829.1	98.2	15968.7	63.2	8860.4	35.0	455.2	1.8	63.7	0.3	391.5	1.5

Table 2.1.2.3
Structure of the Estimated Capacity of the TPPs of the EPP CA as of 01.01.2000

Name	Capacity(MW)	Including							
		Power Blocks		Condensing equipment		Heating equipment		Other equipment	
		MW	%	MW	%	MW	%	MW	%
EPP CA and S. Kazakhstan	16004.7	11755.0	73.4	994.0	6.2	3084.7	19.3	171.0	1.1
K a z a k h s t a n									
Almatyenergo	852.0	-	-	50.0	5.9	802.0	94.1	-	-
Incl. APC	828	-	-	50.0	6.0	778	94.0	-	-
TATEK JSC	24	-	-	-	-	24	100	-	-
Uzhkazenergo (URDT)	1638.0	1230.0	75.1	-	-	408.0	24.9	-	-
incl. UzhKaz PDC JSC	202	-	-	-	-	202	100	-	-
Zhambyl PDC JSC	1290	1230.0	95.3	-		60	4.7	-	-
Kzyl-Ord.PDC JSC	146	-	-	-		146	100	-	-
"Kyrgyzenergo" JSC	672.7	-	-	-	-	672.7	100.0	-	-
GAHK "Barki Tochik"	318.0	-	-	-	-	318.0	100.0	-	-
GETK "Kuvvat"	2651.0	2105.0	79.4	150.0	5.7	225.0	8.5	171.0	6.4
Ministry of Energy Republic of Uzbekistan	9873.0	8420.0	85.2	794.0	8.0	659	6.6	-	-
Isolated rgions	27.7	-	-	-	-	-	-	27.7	100.0
Total for Central Asia	16032.4	11755.0	73.3	994.0	6.2	3084.7	19.3	198.7	1.2

Table 2.1.2.4
Structure of the Groups of Equipment (MW) of TPPs of EPP CA as of 01.01.2000.

Name	Blocks 150-300	Condensing		Heating				Other equip. GTU	Block-station
		Total	9 Mpa	Total	13 MPa	9 MPa	4,5 MPa		
EPP CA and S. Kazakhstan	11755	994	994	3021	1310	1615	96	171	63,7
Kazakhstan									
Almatyenergo	-	50	50	802	510	268	24	-	-
incl. APC	-	50	50	778	510	268	-	-	-
TATEK JSC	-	-	-	24	-	-	24	-	-
Uzhkazenergo (URDTs)	1230	-	-	408	160	206	42	-	-
incl. Uzh-Kaz PDC JSC	-	-	-	202	160	-	42	-	-
Zhambyl PDC JSC	1230	-	-	60	-	60	-	-	-
Kzyl Orda PDC JSC	-	-	-	146	-	146	-	-	-
“Kyrgyzenergo” JSC	-	-	-	638	-	638	-	-	34,7
GAHK “Barki Tochik”	-	-	-	318	120	198	-	-	-
GETK “Kuvvat”	2105	150	150	225	80	145	-	171	-
Ministry of Energy, Republic of Uzbekistan	8420	794	794	630	440	160	30	-	29

Table 2.1.2.5
Estimated capacity (MW) of the EPP CA as for 01.01.1999 and 01.01.2000.

Power systems, power plants	01.01.99	01.01.2000
EPP CA	24668.6	24771.4
Including TPP	15826.0	15941.0
HPP	8832.6	8830.4
Block-plants	453.7	455.2
Including TPP	63.7	63.7
HPP	390.0	391.5
Total for the power plants of EPP CA	25122.3	25226.6
Including TPP	15899.7	16004.7
HPP	9222.6	9221.9
K a z a k h s t a n:		
Almatyenergo (APC and TATEK JSC)	1277.3	1276.6
Including TPP	852.0	852.0
HPP	425.3	424.6
A P C		
Almatynskaya TPP-3	173.0	173.0
Almatynskaya TPP-1	145.0	145.0
Almatynskaya TPP-2	510.0	510.0
Kapchagaiskaya HPP	364.0	364.0
Cascade of Almatynskaya HPPs	47.7	47.0
TATEK JSC		
Tekelyiskaya TPP-2	24.0	24.0
Karatalskaya HPP	10.1	10.1
Small HPPs	3.5	3.5
including:		
Uspenovskaya HPP	1.9	1.9
Antonovskaya HPP	1.6	1.6
Uzhkazenergo (URDTs "KEGOC" JSC)	1756.0	1738.0
Including TPP	1656.0	1638.0
HPP	100.0	100.0
Zhambylskaya PDC JSC		
Zhambylskaya HPP	1230.0	1230.0
TPP-4 of Zhambyl city	60.0	60.0
Uzhnokazakhstanskaya PDC JSC		
TPP-1 of Shymkent city	30.0	30.0
TPP-2 of Shymkent city	12.0	12.0
TPP-3 of Shymkent city	160.0	160.0
TPP-5 of Kentau city	18.0	-
Kzyl-Ordynskaya PDC JSC		
TPP-6 of Kzyl Orda city	146.0	146.0
Total for heating power plants of URDTs	1656.0	1638.0
Block-plants – total	100.0	100.0
including HPP (Chardara)	100.0	100.0

Power systems, power plants	01.01.99.	01.01.2000.
K y r g y z s t a n:		
“Kyrgyzenergo” JSC – total	3622.7	3622.7
Including TPP	672.7	672.7
HPP	2950.0	2950.0
South Kyrgyzstan – total	2920.0	2920.0
Including TPP	50.0	50.0
HPP	2870.0	2870.0
Oshskaya TPP	50.0	50.0
Toktogulskaya HPP	1200.0	1200.0
Kurpsaiskaya HPP	800.0	800.0
Uchkurganskaya HPP	180.0	180.0
Tashkumyrskaya HPP	450.0	450.0
Shamaldysaiskaya HPP (“NarynHPP” JSC)	240.0	240.0
North Kyrgyzstan – total	702.7	702.7
Including TPP	622.7	622.7
HPP	80.0	80.0
TPP of Bishkek city	588.0	588.0
Alamedinskaya HPP	31.3	29.8
Atbashinskaya HPP	40.0	40.0
Bystrovskaya HPP	8.7	8.7
Blocl-plants, including TPP - “K”	34.7	34.7
Kalininskaya HPP*)	-	1.5
T a j i k i s t a n:		
GAHK “Barki Tochik” – total	4354.5	4354.5
Including TPP	318.0	318.0
HPP	4036.5	4036.5
South Tajikistan – total	4228.5	4228.5
Including TPP	318.0	318.0
HPP	3910.5	3910.5
Nurekskaya HPP	3000.0	3000.0
Dushanbinskaya TPP	198.0	198.0
Yanvanskaya TPP	120.0	120.0
Main HPP	240.0	240.0
Perepadnaya HPP	30.0	30.0
Centralnaya HPP	15.0	15.0
Cascade of Varzobskaya HPPs	25.5	25.5
Baipazinskaya HPP	600.0	600.0
North Tajikistan	126.0	126.0
Kairakumskaya HPP	126.0	126.0

*) - for “Kyrgyzenergo” JSC: Kalininskaya HPP (N est. 1,5 MBт) put out of the list of power plants of Northern Kyrgyzstan and now is a block-plant

Power systems, power plants	01.01.99.	01.01.2000.
Turkmenistan:		
GETK "Kuvvat" of Turkmenistan – total	2529.2	2652.2
Including TPP	2528.0	2651.0
HPP	1.2	1.2
Maryiskaya HPP	1685.0	1685.0
Buzmeinskaya HPP	125.0	248.0
Turkmenbashi TPP	590.0	590.0
Seidynskaya TPP	80.0	80.0
Nebitdagskaya HPP	48.0	48.0
Gyndukush HPP	1.2	1.2
Uzbekistan:		
Ministry of Energy of Uzbekistan – total	11582,6	11582,6
Including TPP	9873,0	9873,0
HPP	1709,6	1709,6
Including power plants of RU – total	11263,6	11263,6
TPP	9844,0	9844,0
HPP	1419,6	1419,6
Syrdarynskaya HPP	3000,0	3000,0
Tashkentskaya HPP	1860,0	1860,0
Novo-Angrenskaya HPP	2100,0	2100,0
Angrenskaya HPP	484,0	484,0
Navoiyskaya HPP	1250,0	1250,0
Tahiatashkaya HPP	730,0	730,0
Ferganslaya TPP	330,0	330,0
Mubarekskaya TPP	60,0	60,0
Tashkentskaya TPP	30,0	30,0
Cascade of Sredne-Chirchikskie HPPs	905,5	905,5
Including: Charvakskaya HPP	620,5	620,5
Khodzhikentskaya HPP	165,0	165,0
Gazalkentskaya HPP	120,0	120,0
Cascade of Chirchikskie HPPs	190,7	190,7
Including: HPP of Loginova	84,0	84,0
HPP Tavakskaya	72,0	72,0
HPP Ak-Kavak-1	34,7	34,7
Cascade of Ordzhonikidzevskie HPPs	44,6	44,6
Including: Kadyryinskaya HPP	13,2	13,2
Kybraiskaya HPP	11,2	11,2
HPP Ak-Kavak-2	9,0	9,0
Salarskaya HPP	11,2	11,2
Cascade of Tashkentskie HPPs	29,0	29,0
Including: HPP Boz-su	4,0	4,0
HPP Burdzhar	6,4	6,4
HPP Sheikhantaur	3,6	3,6
HPP Ak-Tepe	15,0	15,0

Power systems, power plants	01.01.99.	01.01.2000.
Cascade of Bozsuiskie HPPs	50,9	50,9
Including: HPP N-Boz-Su-I	10,7	10,7
HPP N-Boz-Su-II	7,0	7,0
HPP N-Boz-Su-III	11,2	11,2
HPP N-Boz-Su-IV	17,6	17,6
HPP N-Boz-Su-VI	4,4	4,4
Total for cascade of Sredne-Chirchikskie Chirchik-Bozsuiskie HPPs	1220,7	1220,7
Farkhadskaya HPP	126,0	126,0
Ferganskie HPPs - total	32,8	32,8
Including: HPP Kudash	5,0	5,0
Andijanskie HPPs	27,8	27,8
Including Shaarikhanskaya HPP-6	11,4	11,4
Shaarikhanskaya HPP-7	7,6	7,6
HPP UFK-1	2,1	2,1
HPP UFK-3	6,7	6,7
Power systems, power plants	**01.01.99.**	**01.01.2000.**
Samarkandskie HPPs	40,1	40,1
Including: HPP Taligulyan-I	3,0	3,0
HPP Hishrau	21,9	21,9
HPP Irtyshar	6,4	6,4
HPP Taligulyan-III	8,8	8,8
Block-plants – total	319,0	319,0
TPP	29,0	29,0
HPP	290,0	290,0
Almalykskaya TPP	24,0	24,0
TPP AGZ	5,0	5,0
Andijanskaya HPP	140,0	140,0
Tuyamuyunskaya HPP	150,0	150,0
I s o l a t e d R e g i o n s:		
Isolated power regions – total	59,2	57,7
Including DPP+TPP	27,7	27,7
HPP	31,5	30,0
“Kyrgyzenergo” JSC – total	1,5	-
Including HPP	1,5	-
GAHK “Barki Tochik” of the Republic of Tajikistan	57,7	57,7
Includng DPP	27,7	27,7
HPP	30,0	30,0
Total for the power plants of EPP CA (RU)	24727,8	24829,1
Including DPP+TPP	15863,7	15968,7
HPP	8864,1	8860,4
Block-pkants total	453,7	455,2
Including TPP	63,7	63,7

HPP	390,0	391,5
Total for the EPP CA	25181,5	25284,3
Including DPP+TPP	15927,4	16032,4
HPP	9254,1	9251,9

Table 2.1.2.6
Main Indices of Operation of the EPP CA as of 01.01.2000

INDEXES	EPP CA	Kazakhstan		JSC Kyrgyz energo GAHK	Barki Tochik Tadzhi kistan	GETK Kuvvat Turkmenistan	Ministry of Energy of the Republic of Uzbekistan
		Almatyenergo (APC, JSC TATEK)	URDTs JSC «KEGOC» (Turkistanenergo, Kzyl Orda)				
Estimated capacity - 01.01.2000 (MW)	25226.6	1276.6	1738.0	3622.7	4354.5	2652.2	11582.6
Combined max. load in 1999 (MW)	15384	919	920	2509	2395	1351	7290
Power generation in 1999 (mln.kWh)	89955.4	4343.5	2645.5	13119.3	15796.0	8733.0	45318.1
Increase comparing to 1998 (%)	1.5	-6.0	-8.7	13.3	9.5	6.0	-2.3
Transfer of power in 1999 (mln.kWh)							
Import	2507.9	132.1	1161.1	-	-	-	1214.7
Received from Northern Kazakhstan:	454.4	137.4	317.0	-	-	-	-
Export	2507.9	-	-	1901.2	187.8	418.9	-
Transferred to Northern Kazakhstan	-	-	-	-	-	-	-
Transferred to Afganistan	23	-	-	-	-	-	23
Consumption of power. mln.kWh	90386.8	4613.0	4123.6	11218.1	15608.2	8314.1	46509.8
Increase comparing to 1998 (%)	1.5	-3.3	-11.6	12.6	6.4	3.0	0.9
Length of 110+kV lines - 01.01.2000 (km)	5911.6	15086		7262	5282	9174	22312
Increase compared to 1998 (%)	1.05	-		-	-	5.3	0.7

Table 2.1.2.7.
Quantity of Power Plants with Their Grouping by the Estimated Capacity as of 01.01.2000 (units)

Name of power systems	Total	Quantity of power plants in power systems of Central Asia and Kazakhstan (RU)													Число эл.станций др.Министерств и ведомств				
		TPP						HPP							TPP			HPP	
		Total	2000 MWt and more	1000 - 1999	600 - 999	100 – 599	10 - 99	Total	2000 MWt and more	1000 - 1999	600 - 999	100 - 599	10 - 99	5-9	Total	10-99 MW	5-9	Total	100 - 599
EPP CA	81	28	2	4	1	12	9	47	1	1	3	9	19	14	3	2	1	3	3
Kazakhstan APC and TATEK JSC	7	4	-	-	-	3	1	3	-	-	-	1	2	-	-	-	-	-	-
URDTs JSC «KEGOC»	7	6	-	1	-	2	3	-	-	-	-	-	-	-	-	-	-	1	1
“Kyrgyzenergo” JSC	11	2	-	-	-	1	1	8	-	1	1	3	2	1	1	1	-	-	-
GAHK «Barki Tochik»	9	2	-	-	-	2	-	7	1	-	1	2	3	-	-	-	-	-	-
GETK «Kuvvat»	5	5	-	1	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Ministry of Power of the Republic of Uzbekistan	42	9	2	2	1	2	2	29	-	-	1	3	12	13	2	1	1	2	2

Table 2.1.2.8
Power generation by EPP CA by quarters for 1998-1999 (mln.kWh)

Name of the item	I quarter		II quarter		III quarter		IV quarter		Year	
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
CPS of Central Asia	25205.2	25021.6	19526.0	20426.8	20294.0	20520.4	23561.8	23986.6	88587.0	89955.4
TPP	17963.2	15990.6	11755.0	11882.6	11107.5	10668.7	14949.9	15008.8	55075.6	53550.7
HPP	7942.0	9031.0	7771.0	8544.2	9186.5	9851.7	8611.9	8977.8	33511.4	36404.7
incl. power plants of RU	24909.8	24665.0	18982.4	19836.6	19607.7	19969.7	23149.5	23645.0	86649.4	88116.3
TPP	17214.6	15949.8	11721.1	11850.7	11077.8	10644.2	14912.4	14978.6	54925.9	53423.3
HPP	7695.2	8715.2	7261.3	7985.9	8529.9	9325.5	8237.1	8666.4	31723.5	34693.0
Block-plants	295.4	356.6	543.6	590.2	686.3	550.7	412.3	341.6	1937.6	1839.1
TPP	48.6	40.8	33.9	31.9	29.7	24.5	37.5	30.2	149.7	127.4
HPP	246.8	315.8	509.7	558.3	656.6	526.2	374.8	311.4	1787.9	1711.7
K a z a k h s t a n	2259.6	2189.9	1440.2	1551.7	1460.7	1416.1	2242.4	1831.3	7402.9	6989.0
Incl. APC & TATEK JSC	1533.5	1322.4	932.8	960.2	933.3	911.2	1216.9	1149.7	4616.5	4343.5
TPP	1286.7	1005.4	594.3	396.4	299.6	321.7	814.0	820.3	2994.6	2543.8
HPP	246.8	317.0	338.5	563.8	633.7	589.5	402.9	329.4	1621.9	1799.7
URDTs JSC KEGOC	625.4	745.4	343.1	447.5	381.0	415.8	907.4	582.5	2256.9	2191.2
Shardara HPP	100.7	122.1	164.3	144.0	146.4	89.1	118.1	99.1	529.5	454.3
Kyrgyzenergo JSC	3947.2	4367.8	1907.6	2325.4	2333.1	2650.0	3382.1	3776.1	11570.0	13119.3
incl. power plants of RU	3947.2	4367.8	1907.6	2325.4	2333.1	2650.0	3382.1	3776.1	11570.0	13119.3
TPP	706.4	511.5	412.0	104.5	143.3	55.5	369.4	310.4	1631.1	981.9
HPP	3240.8	3856.3	1495.6	2220.9	2189.8	2594.5	3012.7	3465.7	9938.9	12137.4

Name of the items	I quarter		II quarter		III quarter		IV quarter		Year	
	1998	**1999**	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**
GAHK Barki Tochik of Rep. Tajikistan	3306.4	3657.9	3429.9	3731.1	3899.6	4385.4	3782.3	4021.6	14418.2	15796.0
incl. power plants of RU	3306.4	3657.9	3429.9	3731.1	3899.6	4385.4	3782.3	4021.6	14418.2	15796.0
TPP	125.4	187.3	16.9	63.1	1.5	-	127.0	119.6	270.8	370.0
HPP	3181.0	3470.6	3413.0	3668.0	3898.1	4385.4	3655.3	3902.0	14147.4	15426.0
GETK Kuvvat of Turkmenistan	2944.4	2478.4	1975.0	1922.1	1903.4	1953.2	2459.1	2379.3	9281.9	8733.0
incl. power plants of RU	2944.4	2478.4	1975.0	1922.1	1903.4	1953.2	2459.1	2379.3	9281.9	8733.0
TPP	1943.8	2477.7	1972.9	1920.3	1902.0	1952.3	2458.8	2378.7	9277.5	8729.0
HPP	0.6	0.7	2.1	1.8	1.4	0.9	0.3	0.6	4.4	4.0
Ministry of Power of the Rep. Uzbekistan	12747.6	12327.6	10773.3	10896.5	10697.2	10115.7	11695.9	11978.3	45914.0	45318.1
incl. power plants of RU	12552.9	12093.1	10394.0	10450.3	10157.3	9654.1	11401.7	11735.8	44505.9	43933.9
TPP	11526.9	11022.5	8381.9	8918.9	8350.4	7898.9	10235.8	10767.1	38495.0	38607.4
HPP	1026.0	1070.6	2012.1	1531.4	1806.9	1755.2	1165.9	968.7	6010.9	5325.9
Block-plants	194.7	234.5	379.3	446.2	539.9	461.6	294.2	242.5	1408.1	1384.8
TPP	48.6	40.8	33.9	31.9	29.7	24.5	37.5	30.2	149.1	127.4
HPP	146.1	193.7	345.4	414.3	510.2	437.1	256.7	212.3	1258.4	1257.4

Table 2.1.2.9
Power Generation by the EPP CA by months of 1999 (mln.kWh)

Name of the systems	January	February	March	I quarter	April	May	June	II quarter	July	August	September	III quarter	October	November	December	IV quarter	Year
EPP CA	9170.4	7705.5	8145.7	25021.6	6890.0	6863.8	6673.0	20426.8	7103.4	7147.3	6269.7	20520.4	6798.9	8129.7	9058.0	23986.6	89955.4
Kazakhstan	845.9	683.4	660.6	2189.9	564.8	493.1	493.8	1551.7	468.4	493.8	453.9	1416.1	468.9	613.5	748.9	1831.3	6989.0
Incl. APC and TATEK JSC	478.6	405.0	438.8	1322.4	342.7	304.0	313.5	960.2	306.0	316.1	289.1	911.2	294.0	392.0	463.7	1149.7	4343.5
URDTs JSC KEGOC	327.6	244.9	172.9	745.4	163.6	146.8	137.1	447.5	127.4	143.2	145.2	415.8	150.1	187.0	245.4	582.5	2191.2
Shardara HPP	39.7	33.5	48.9	122.1	58.5	42.3	43.2	144.0	35.0	34.5	19.6	89.1	24.8	34.5	39.8	99.1	454.3
Kyrgyzenergo	1640.7	1327.1	1400.0	4367.8	998.8	664.4	662.2	2325.4	1092.8	1021.0	536.2	2650.0	803.6	1356.3	1616.2	3776.1	13119.3
Barki Tochik	1463.9	1195.7	998.3	3657.9	867.3	1432.5	1431.3	3731.1	1482.2	1516.7	1386.5	4385.4	1239.1	1330.0	1451.7	4021.6	15796.0
GETK "Kuvvat"	870.8	766.9	840.7	2478.4	683.0	612.3	626.8	1922.1	675.7	680.4	597.1	1953.2	696.4	828.0	854.9	2379.3	8733.0
Ministry of Power of the Rep. of Uzbekistan	4349.1	3732.4	4246.1	12327.6	3776.1	3661.5	3458.9	10896.5	3384.3	3435.4	3296.0	10115.7	3590.9	4001.1	4386.3	11978.3	45318.1

Table 2.1.2.10
Consumption of power by EPP CA by months of 1999 (mln.kWh)

Name of the systems	January	February	March	I quarter	April	May	June	II quarter	July	August	September	III quarter	October	November	December	IV quarter	Year
EPP CA	9307.8	7773.8	8269.4	25351.1	6934.0	6867.9	6662.5	20464.4	6994.2	7080.0	6287.7	20361.9	6827.0	8164.2	9218.3	24209.5	90386.8
Kazakhstan	1084.9	853.4	866.4	2804.7	656.6	559.6	512.6	1728.8	538.9	561.5	545.7	1646.1	670.7	862.0	1024.3	2557.0	8736.6
Incl. APC and TATEK JSC	547.5	455.5	488.7	1491.7	352.6	294.0	270.7	917.4	279.1	287.1	277.5	843.7	360.9	469.0	530.3	1360.2	4613.0
URDTs JSC «KEGOC»	537.4	397.9	377.7	1313.0	304.0	265.6	241.9	811.4	259.8	274.4	268.2	802.4	309.8	393.0	494.0	1196.8	4123.6
Kyrgyzenergo	1614.1	1300.8	1317.7	4232.6	881.1	608.7	515.9	2005.7	528.7	528.3	508.9	1565.8	696.7	1195.5	1521.8	3414.0	11218.1
Barki Tochik	1475.5	1221.5	1235.0	3932.0	1101.0	1303.3	1330.7	3735.0	1344.4	1356.4	1219.0	3919.8	1239.3	1329.6	1452.2	4021.4	15608.2
Kuvvat	806.9	684.7	728.9	2220.5	647.8	633.5	625.9	1907.2	657.4	678.4	597.3	1933.1	651.1	772.3	829.9	2253.3	8314.1
Ministry of Power of the Republic of Uzbekistan	4326.4	3713.4	4121.4	12161.2	3647.5	3762.9	3677.5	11087.9	3924.8	3955.3	3416.8	11296.9	3569.2	4004.8	4389.8	11963.8	46509.8

2.1.2.3. Management of Energy Systems

The regulation of the EPP CA is carried out by the Unified Dispatch Center "Energy" (UDC Energia) on the basis of the 1999 multilateral agreement about the simultaneous operation of the EPP CA, and the Charter of International Enterprise for Regulation of the EPP CA, as well as the simultaneously operating power plants of other departments.

All power systems operating simultaneously under the EPP CA are inter-related by a single technological process of generation and distribution of power. Regulation of the power systems of South Kazakhstan is carried out through the Dispatching Center of the Kazakhstan Electric Grid Operating Company (JSC "KEGOC"). From January to August, and in December of 1999, the power systems of North Kazakhstan were included into the EPP CA. Simultaneous operation with the power systems of North Kazakhstan favorably affects the operation of the Northern part of the EPP CA. UDC Energia also regulates all 500 kV lines, except for L-508, 531, and 530, which are controlled by the UDC, as well as the main inter-system 220 kV lines. The UDC Energia controls the main intra-system transit 220 kV lines with relay protection and automatics, influencing the reliability of simultaneous operation of the power systems of the EPP CA. The scheme of regulation of the EPP CA is presented below (see Figure 2.1.2.1).

The regime of operation of the EPP CA is currently determined according to contractual and agreed balanced power transfers. According to the agreement between the parties on sale and purchase of power, the contractual balanced transfers of power, and full balances of power are developed. Almost all power supply transfers were carried out through third parties, with whom additional agreements are signed on the payment for the power transit.

2.1.2.4. Current Tendencies for Regional Electricity Market Development

Currently, the developing market for power in the countries of Central Asia includes the following power systems with different types of ownership: power systems of South Kazakhstan; "Kyrgyzenergo" JSC of the Jyrgyz Republic; GAHK "Barki Tochik" of Tajikistan; TGETK "Kuvvat" of Turkmenistan; Ministry of Power of the Republic of Uzbekistan.

Power systems of South Kazakhstan

In order to carry out economic reforms in the Republic of Kazakhstan, restructuring and privatization of the branches and enterprises of the power complex has been carried out. In 1995, 28 power plants were privatized by large foreign companies, KEGOC was created, the regional electricity distribution companies (REC) and the regional electricity networks (REN) were transferred into independent enterprises. More than 70% of power generation facilities are private as a result of the reforms.

South Kazakhstan, which joins four oblasts with the complex power network, does not have enough power resources, but it has connections with the power system of North Kazakhstan, which cannot fully provide its reliability and sustainability. This region is connected with the power systems of Kyrgyzstan, Uzbekistan, and is a part of the EPP CA.

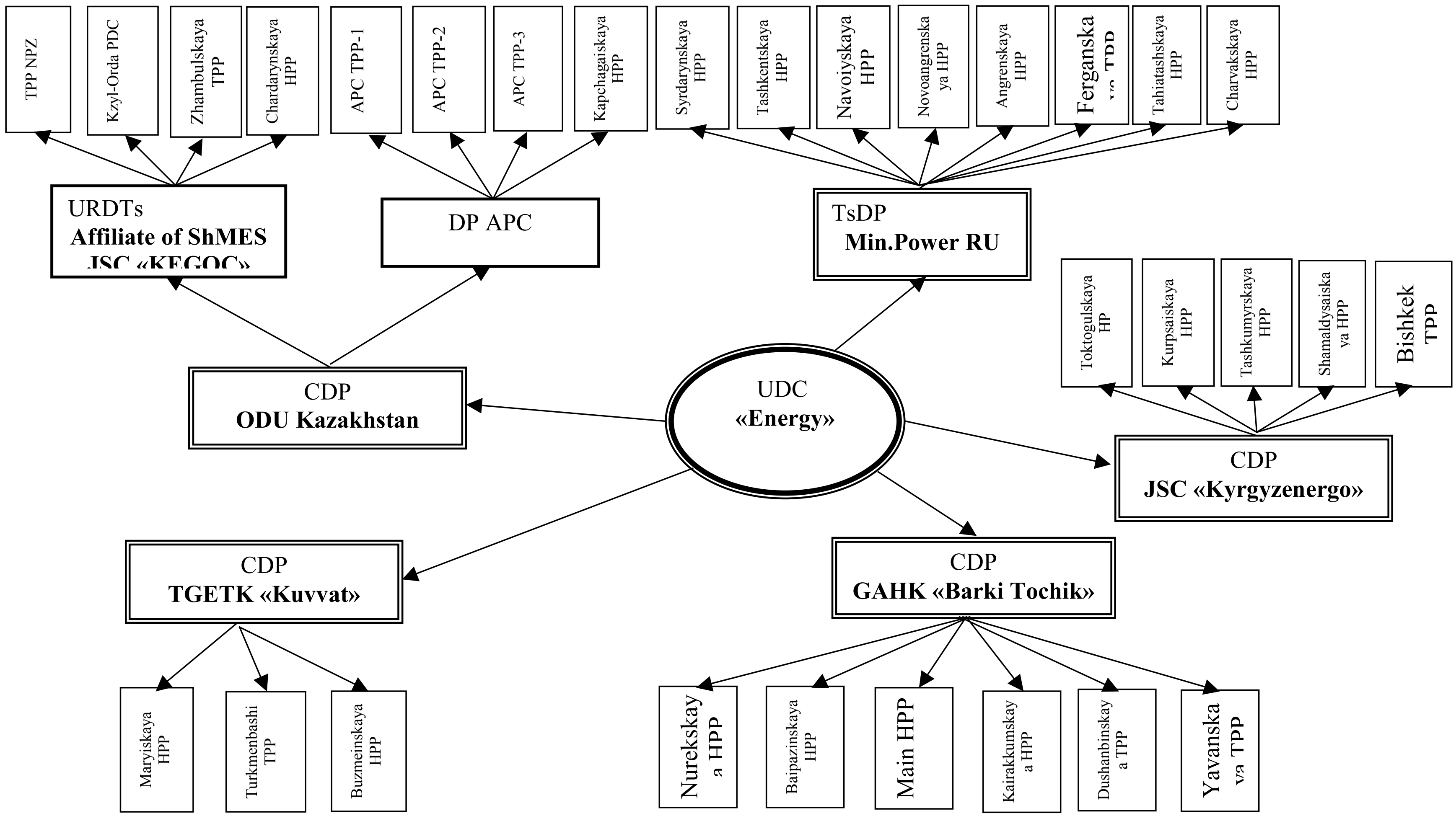


Figure 2.1.2.1. Scheme of regulation of the EPP CA.

Power system of the Kyrgyz Republic

In order to increase the effectiveness of the enterprises of the power complex in the Kyrgyz Republic, a program of restructuring and privatization was developed which, due to the necessity of preliminary structural transformations, consists of several stages and the formation of economically independent objects to be privatized in the future. During the first stage (1996-1997) Joint Stock Compnay (JSC) "Kyrgyzenergo" was created, which carries out generation, transfer, and distribution of electricity, the planning departments were transferred into independent JSCs, a regulatory body was created – the State Energy Agency. During the second stage, the Kyrgyz Government approved the "Financial model of restructuring of "Kyrgyzenergo" JSC" which will restructure Kyrgyzenergo and transfer the distribution enterprises and small HPPs into independent JSCs with their privatization in the future. During the third stage, state companies for generation and transferring of power will be created from Kyrgyzenergo.

JSC "Naryn Cascade" includes the Bishkek and Osh TPPs, while JSC "National Power Network" includes the dispatch center, high power transmission lines with all sub-plants, and the material-technical provision enterprises.

Power system of Tajikistan

Recent breakage of international relations, and civil war lead to significant economic difficulties in Tajikistan. Under such conditions, electricity generation remained the only sector which was operating and providing power to consumers with no interruptions. In order to support the sector, a set of reformations and restructuring of GAHK "Barki Tochik" are planned with the following stages:

- During the first stage (1998-99), the power plants and electricity networks will be separated from the central power networks of the Cascade of Varzobskie HPPs, with the creation of several joint stock companies – including JSC "Cascade of Varzobskie HPPs", and JSC "Power networks of the regions with republican significance." Privatization of the unfinished objects, which do not participate in power generation, transfer, and distribution, is planned, as well as the transfer of Nurek city from the balance of Barki Tochik.
- During the second stage (1999-2000), joint stock companies will be created with the purpose of construction of HPPs and the 500 kV line "South-North", and to separate the power plants and power networks into JSCs, providing them with the right to choose the producers of power for the consumers.

Power system of Turkmenistan

The power complex of Turkmenistan is owned by the government; however, some preparations can be seen for implementation of different types of ownership.

Power system of Uzbekistan

Since 1997, privatization of the heating network companies has been underway in Uzbekistan. On the basis of the enterprises and organizations which were carrying out design and exploration, construction, building, and repairs, 13 JSCs were created, and the governmental share of their stock is controlled by the Ministry of Energy of the Republic of Uzbekistan.

Restructuring of the main power objects which are owned by the Government is planned in two stages. During the first stage, the enterprises which are included in the power system and serve as structure items will be transformed into independent objects. During the second stage, the Ministry of Energy will be transformed into a holding company on the basis of restructuring of the above objects.

As one can see, the power sector of the Central Asian countries is in a difficult, transition period. Under the current conditions, each of the countries, while having enough power resources, is trying to achieve power independence, because it has a developed power system which can fully provide for its own demand for power. However, in all countries there have occurred limits for the municipal and industrial consumers under difficult conditions, which leads to economic losses and social tension. One of the main causes of such problems is the low level of fulfillment of contractual obligations, and lack of payments by consumers for supplied electricity and heating, and related debts on both national and international levels.

All these causes affect the economic effectiveness and reliability of the developing electricity market in Central Asia.

2.1.2.5. Formation of the Electricity Market in Central Asia

Currently, further development of the regional electricity market is taking place in Central Asia. The regulation of the electricity market continues to follow the previously developed basis of the EPP CA. This allows the market to function in a satisfactory manner under the current conditions. However, the transition to a competitive market is related to the specific political, legal, and technical measures instituted in the sphere of regulation, membership, legal development, and operational control. The planned organizational structure of regulation of the electricity market of Central Asia is shown in Figure 2.1.2.2.

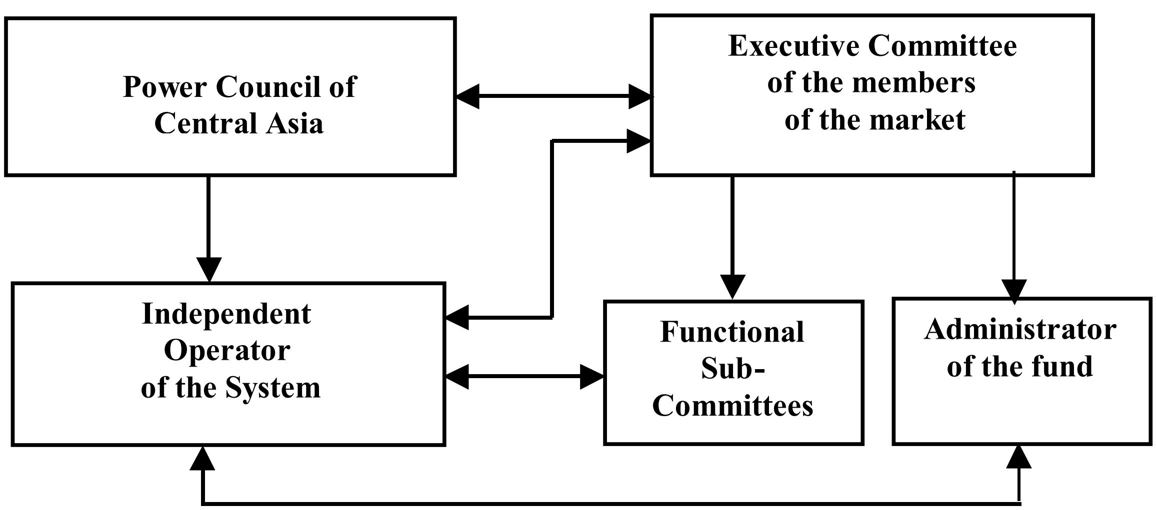


Figure 2.1.2.2. Planned organizational structure of regulation of the electricity market of Central Asia.

The regional electricity market of Central Asia is being developed taking into account mutual planning of the CA countries, a centralized dispatcher, cooperation in the sphere of solving environmental problems and agreed upon construction, agreed upon power supply considering consumer demand and means of transfer, establishment of regional tariffs for transferring power, while supporting free access and effective coordination with other regional zones. The market has the following purposes:

- To provide satisfactory standards of reliability for wholesale electricity supply in the zone of dispatcher regulation of Central Asia;
- To create and support free, non-discriminatory, competitive, functionally restructured electricity markets, and markets for facilities and accompanying services;
- Creation of the most profitable economy, satisfying the reliability standards, and supporting competitiveness of the markets;
- To provide access to competitive markets within the zone of dispatcher regulation of Central Asia and neighboring regions;
- To provide fair distribution of related liabilities, advantages, and costs.

However, in order to achieve these goals, all participants in the market must follow the provisions of future agreements signed under goodwill, cooperate with all the other participants, and not use, independently or together with the other participants, any of the future agreements to damage the other participants.

Currently, the participants of the electricity market in Central Asia are all the power systems of the EPP CA, taking into account their new structures, that is, in Kazakhstan – KEGOC, APC, PDCs, etc.; in Kyrgyzstan – Kyrgyzenergo; in Tajikistan – Barki Tochik; in Turkmenistan – Energochemmachexport with Kuvvat; and in Uzbekistan – the Ministry of Energy. In the emerging market there are company–intermediaries, and company-buyers and there are certain difficulties with some of them in terms of fulfillment of obligations under contracts.

The relations between the participants of the electricity market in Central Asia are based on bilateral and multilateral deals, contracts, and agreements (like the 1998 Agreement "On the Use of Water and Energy Resources of the Syrdarya Basin"). There is a certain degree of order also in the market of accompanying services. Methods for calculating compensation for the costs for regulation have been developed and they continue to be improved. Methods for determining the amount of transit of power through the 500 kV networks have been approved.

The Power Council of Central Asia and its Working Groups are actively participating in the realization of necessary changes. In particular:

- In the political sphere:

The new draft "Agreement on Simultaneous Operation of Electricity Systems in Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan" is ready to be signed, including the regulation carried out by the UDC Energia in Tashkent. Currently, this Agreement is ready to be signed on the inter-governmental level (Interstate Council of CAEC). This will provide warranties to the participants of each country, the right to participate in the market, and to fulfill obligations under the Agreement.

- In the legal and regulation sphere

The conditions of the multilateral Agreement between participants of the electricity market are being developed. This Agreement will be an international agreement, which will provide all participants of the market with legal sanctions according to international law.

- In the technical sphere:

  - A draft bilateral agreement has been developed on the supply of energy and capacity, where all requirements necessary for operative fulfillment of the agreement are provided;
  - Methods have been agreed upon for determining the amount of transit of power through the 500 kV network;
  - Work on further improvements of the methods of registering regulation services is being carried out;
  - Work continues on providing authenticity of the currently used systems of commercial accounting, telemetry, and in some cases implementation of modern means – according to the abilities of each of the power systems.

One of the most important and complicated problems in Central Asia is the operation of the market of hydro-power resources, which covers the power systems of four countries – Kyrgyzstan, Uzbekistan, Tajikistan, and Kazakhstan (Turkmenistan has little or no hydro-power facilities).

Currently, the institution responsible for regulation of water resources of the Syrdarya basin on the regional level is the ICWC and its permanent bodies the BVO Syrdarya and SIC ICWC, whose functions include development of limits of water use, operational distribution of water, and perspective planning. The operational regulation of the energy systems of the countries in the basin is carried out by the UDC Energia, which provides simultaneous functioning of the national energy systems, and fulfillment of the contractual, balanced transfers.

In 1995, Inter-Governmental Agreements began to be signed between the Republic of Kazakhstan, Kyrgyz Republic, the Republic of Uzbekistan, and during the last years the Republic of Tajikistan. In these Agreements, political, legal, and technical issues, as well as the issue of regulation of the hydro-power market are reflected. They provide the amounts of vegetation period releases from Toktogul reservoir to satisfy the demands of irrigated agriculture in the basin, and determine the amounts of compensatory supply of energy carriers (natural gas, electricity, fuel oil, coal) from Uzbekistan and Kazakhstan to the Kyrgyz Republic during the autumn-winter period in exchange of the extra power transferred to them, generated by the HPPs on additional releases of water during the summer period.

However, operation of the hydro-power market has demonstrated, that the current scheme of relationships in the water-power sector is not optimal, which leads to the necessity of creating an appropriate, new model. Before the development and implementation of an economically well-grounded long-term mechanism of use of water and energy resources, work is necessary in the technical, legal, and organizational spheres in order to join the national legislation and legal acts, regulating the issues of the relations between the participants with different types of ownership.

2.1.3. Use of Basin Water Resources for Irrigation and Energy Purposes

2.1.3.1. Water Diversion Limits of the Basin Countries, Including the Aral Sea Demands

Since 1992, international water distribution in the basins of the Amudarya and Syrdarya rivers is carried out taking into consideration the creation of the sovereign Central Asian countries in 1991. The limits of water withdrawal of each country are established by the ICWC. In the Agreement between the Central Asian countries on the use of water resources of the Aral Sea basin and exploitation of water use objects (February 18, 1992), the aspiration to respect the historically developed structure of water use and the principles of distribution of water resources were provided.

Taking into account the above ideas, limits were established for water distribution among the countries – the water users. The Aral Sea received the same rights, while the inflow from the Syrdarya to the Aral Sea was equal to 4-5 km^3 during recent years, 1 km^3 of this takes place during the vegetation period. The withdrawal limits are approved by the ICWC at the beginning of each water year (1 October), and they are reconsidered before the beginning of each vegetation period (1 April). In case of unexpected changes in the situation (low water, etc.), the limits are corrected based on corresponding grounds, for example, in the low-water year of 1995. The Syrdarya basin water withdrawal limits, and the share (in percent) of each country of the total amount of transboundary water resources of the basin, for an average flow year, are presented in Table 2.1.3.1.

Table 2.1.3.1.
Limits for withdrawal of water from the Syrdarya River for each country of the basin for an average flow year

Country	Withdrawal Limit (km3)	%
Republic of Uzbekistan	11.15	51.69
Republic of Kazakhstan	8.20	38.02
Kyrgyz Republic	0.22	1.02
Republic of Tajikistan	2.00	9.27
Total	21.57	100.00

Analysis of the dynamics of withdrawal of water in the Syrdarya basin and its main tributaries – the Karadarya and Chirchik Rivers, is presented in figures for the period of existence of the BVO Syrdarya separately for vegetation and non-vegetation periods (see Figures 2.1.3.1 - 11), where the actual withdrawal of water is compared to the limits presented in Table 2.1.3.1. Limits are not established for the Chirchik and Karadarya Rivers, and the analysis includes only the consideration of the dynamics of actual withdrawal of water during the whole period.

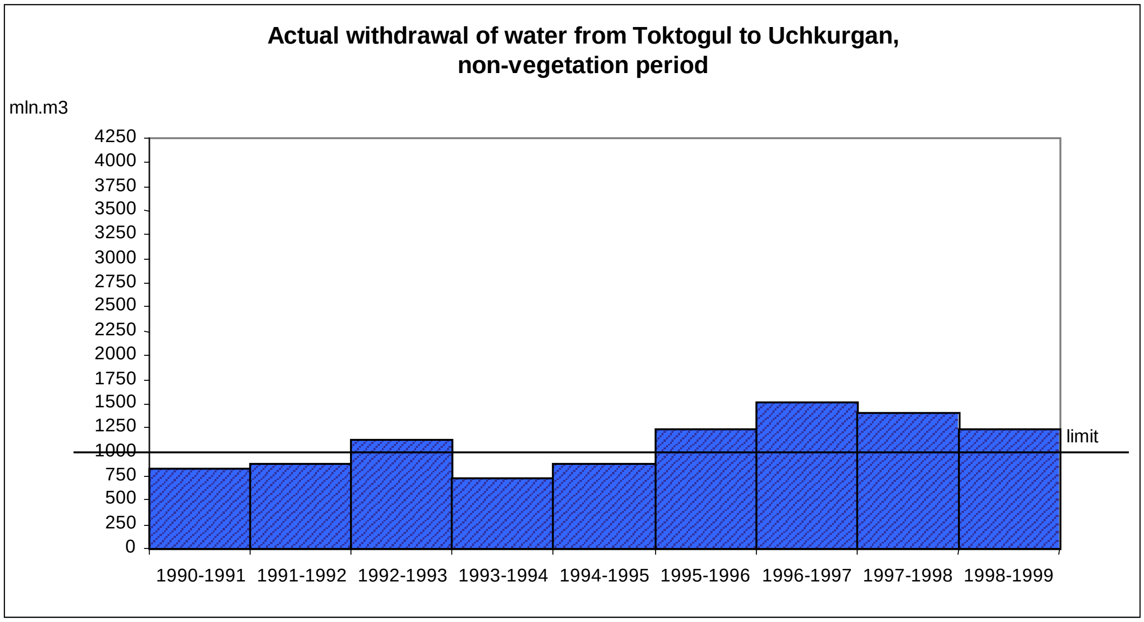
Consider the part of the river from Toktogul reservoir to Uchkurgan (Figure 2.1.3.1); comparison of the vegetation and non-vegetation periods leads to the idea, that a change in the structure of crops may have occurred in the territory, because during the vegetation periods since 1994 less water is withdrawn than provided by the limits, and, visa versa, during non-vegetation periods the limits are exceeded starting from the same year. Of course, within the boundaries of this report, it is possible only to give an overview of the general tendencies, and to point out the main directions of the process. In any case, within the areas irrigated from the part of the river from Toktogul to Uchkurgan, an increase in the amount of cereals (winter crops) has taken place, the demand of irrigation water for which is especially high in October-December, together with a decrease in the amount of cotton, leads to a decrease in the amount of water withdrawn during the vegetation periods. Exploring the mentioned tendencies in terms of the countries (Figures 2.1.3.2 - 3), the general tendency is shown by the data from the Republic of Uzbekistan.

From Uchkurgan (on the Naryn River), Uchtepe (on the Karadarya) to Kairakum reservoir (Figures 2.1.3.4 - 6), about 6% of the total withdrawal in the basin occurs. More than a half of the withdrawal takes place in Tajikistan, where machine irrigation prevails, which, as we can see, explains how Tajikistan consumes the water devoted to it in an economic manner (Figure 2.1.3.6).

A largest withdrawal of water from the Syrdarya River is withdrawn from Kairakum reservoir to Chardara reservoir (Figures 2.1.3.7 - 9). Recently, withdrawal of water during the vegetation period has decreased, while an increase of withdrawal of water during the non-vegetation periods is obvious (Figure 2.1.3.7). In the analysis of the data for separate countries (vegetation period, Figure 2.1.3.9), decrease in withdrawal can be seen in Tajikistan and Kazakhstan. The cause of the decrease in Tajikistan are the same as for the upper region. The decrease for Kazakhstan is due to the fact that during recent years the republic fulfills less and less obligations under the international agreements with the Kyrgyz Republic on compensatory fuel supply necessary to ensure needed releases from Toktogul reservoir; unfortunately, the worst consequences take place as a result. For example, in July 1997, less than 30 m^3/s of water were delivered to the Kazakhstan part of the Dostlik canal, while the demand was 70-90 m^3/s, resulting in drying up of significant areas where cotton is cultivated. The largest increase in withdrawal of water during the non-vegetation period takes place in Uzbekistan (Figure 2.1.3.8), related to the increase in cereal fields. This does not lead to significant difficulties in water supply, because the increase in releases from Toktogul reservoir during the autumn-winter period provides excess water, and the inflows to Arnasai depression prove that.

In the basin of the Karadarya River (Figure 2.1.3.10), during the last three-four years, an obvious increase in withdrawal of water can be seen – during both the vegetation and non-vegetation periods. In the first case the cause is clear and was described above (an increase in winter cereal crops), but during the vegetation period such an increase is related to rice cultivation, which has also increased during the last few years.

The situation in the Chirchik basin is different (Figure 2.1.3.11). The lands of the highly populated Tashkent oasis are used intensively, and there are no free areas, that is why the amount of water withdrawn depends on the level of water available in a specific year, and the amounts withdrawn increased during the high water vegetation periods of 1993, 1994, and 1998. A significant share of vegetables and fodder in the crop yields leads to increases in withdrawal even during non-vegetation periods during the last years.



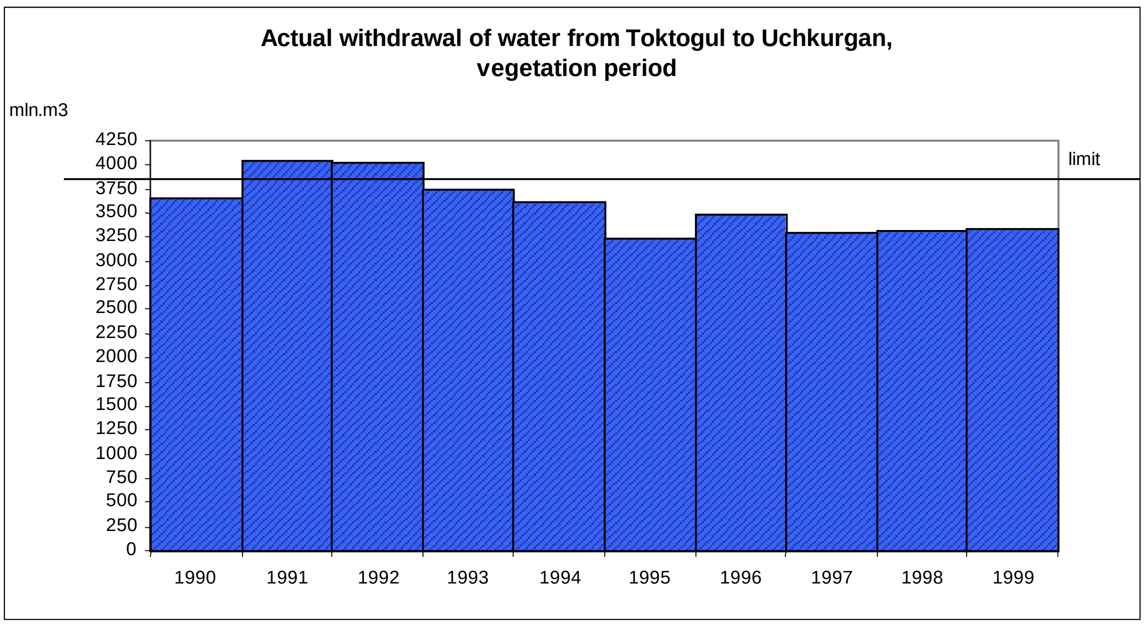
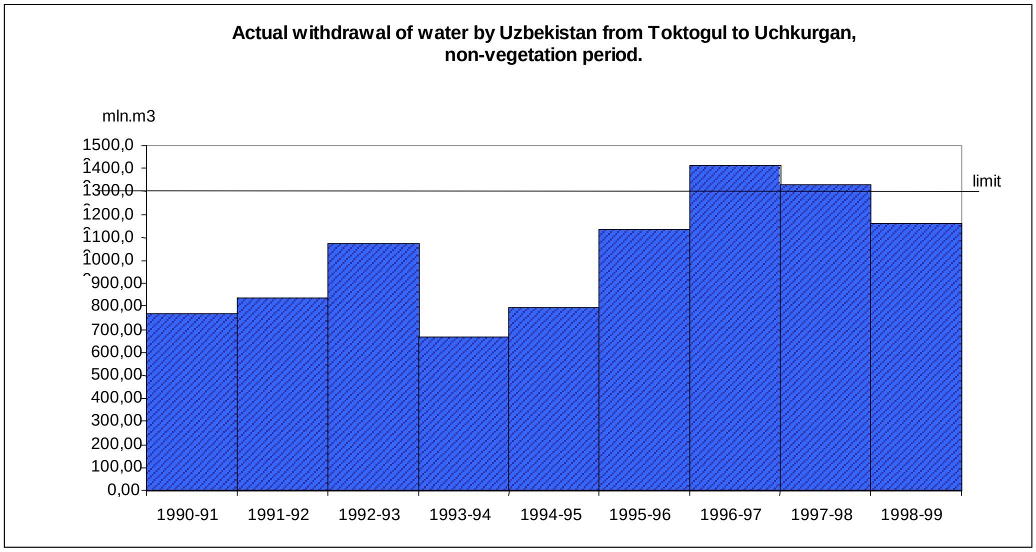
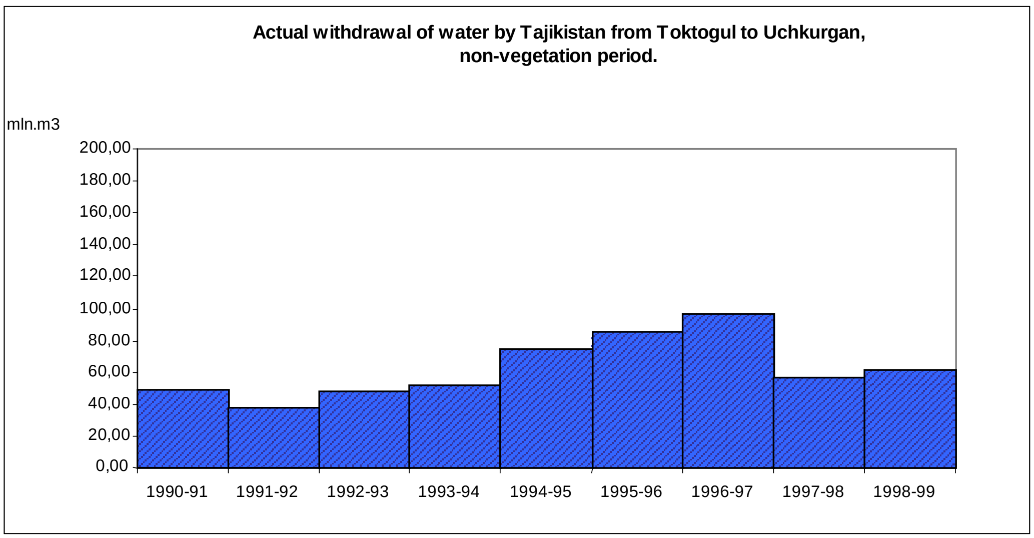


Figure 2.1.3.1. Comparison of the vegetation and non-vegetation periods for the part of the Naryn River from Toktogul reservoir to Uchkurgan.





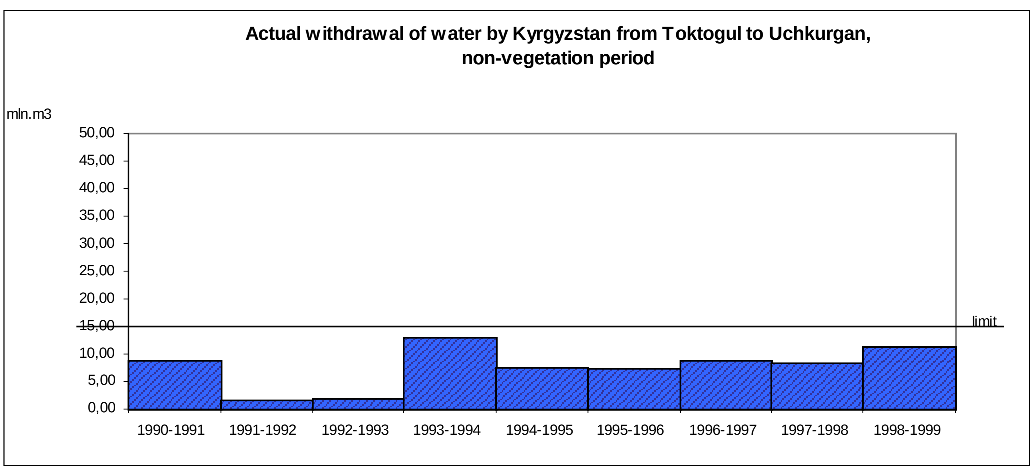


Figure 2.1.3.2. Withdrawal of water by Uzbekistan, Tajikistan, and Kyrgyzstan on the Naryn River from Toktogul to Uchkurgan in the non-vegetation period.

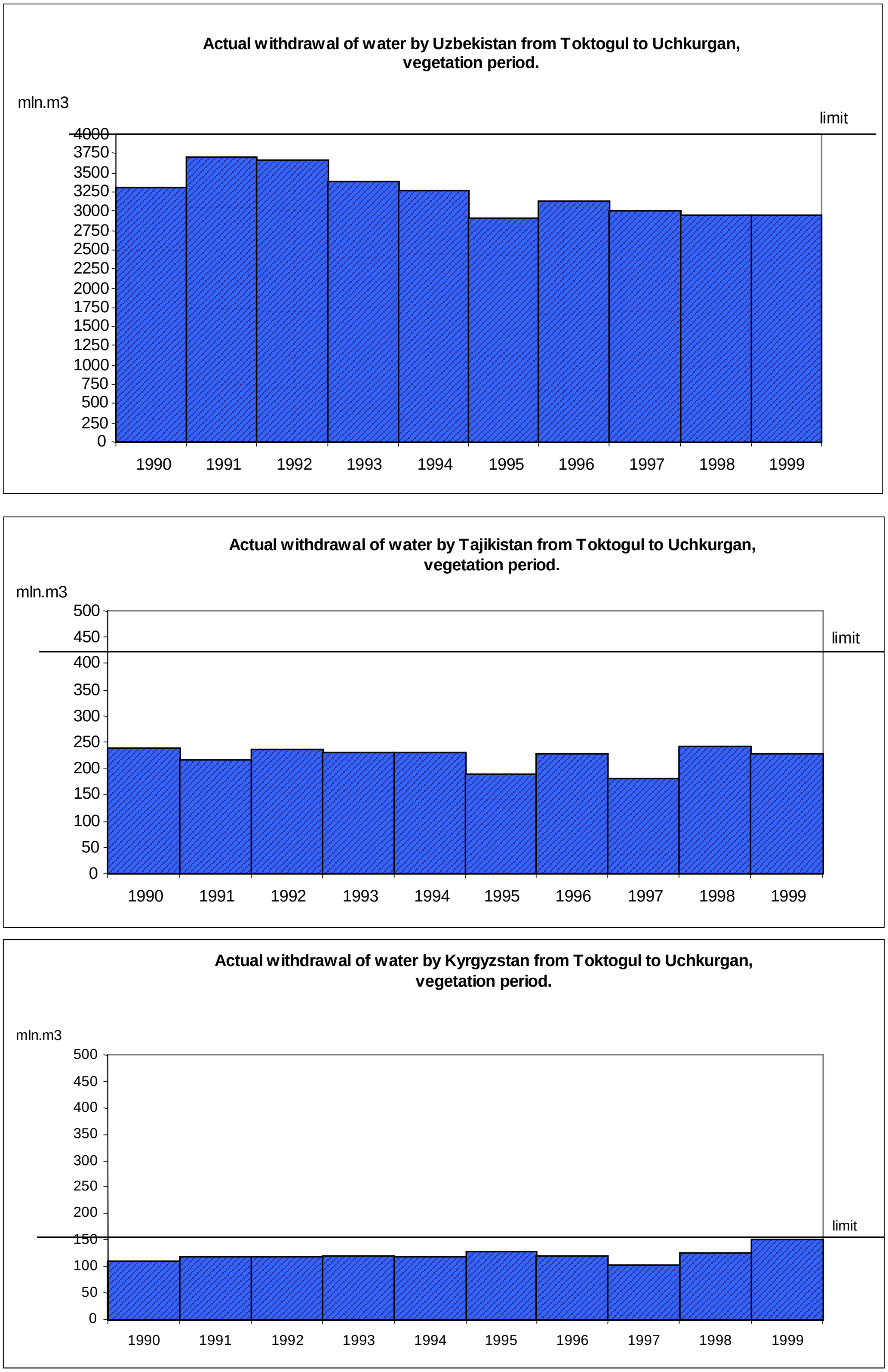
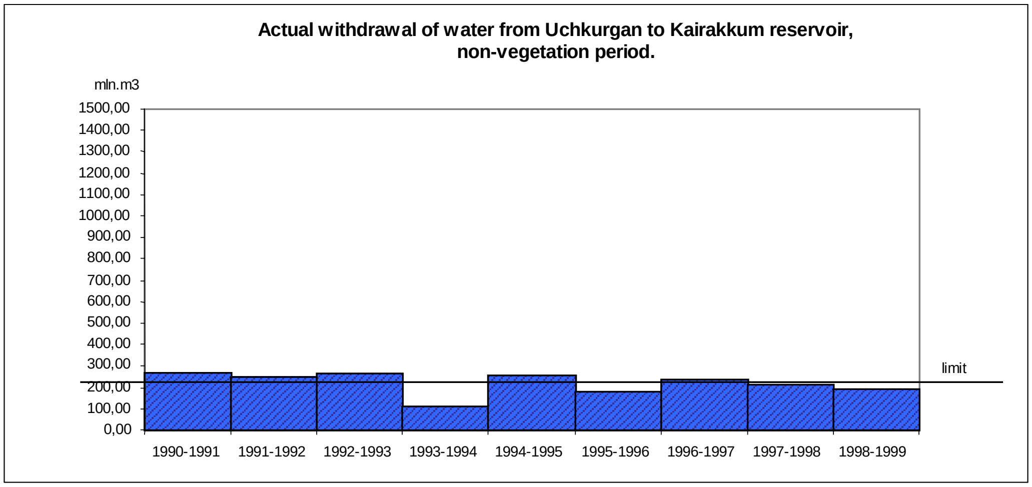


Figure 2.1.3.3. Withdrawal of water by Uzbekistan, Tajikistan, and Kyrgyzstan on the Naryn River from Toktogul to Uchkurgan in the vegetation period.



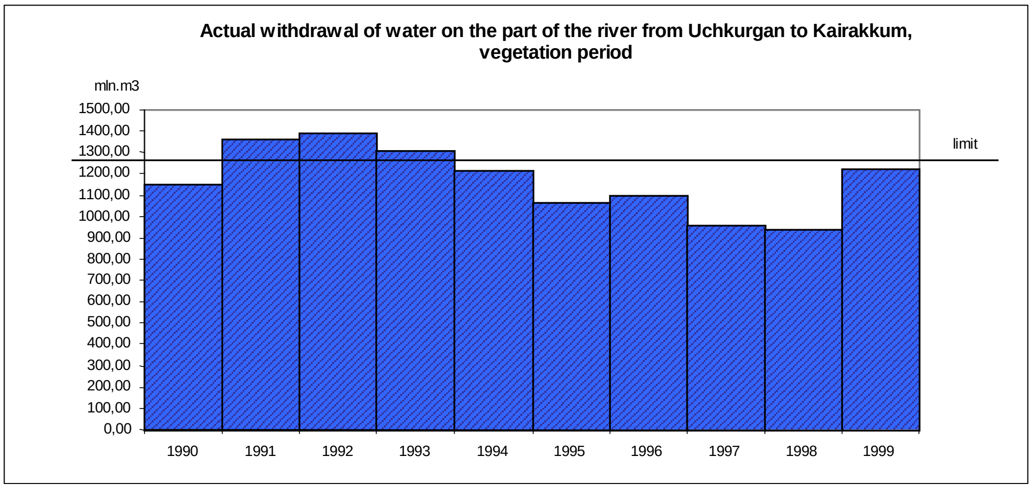
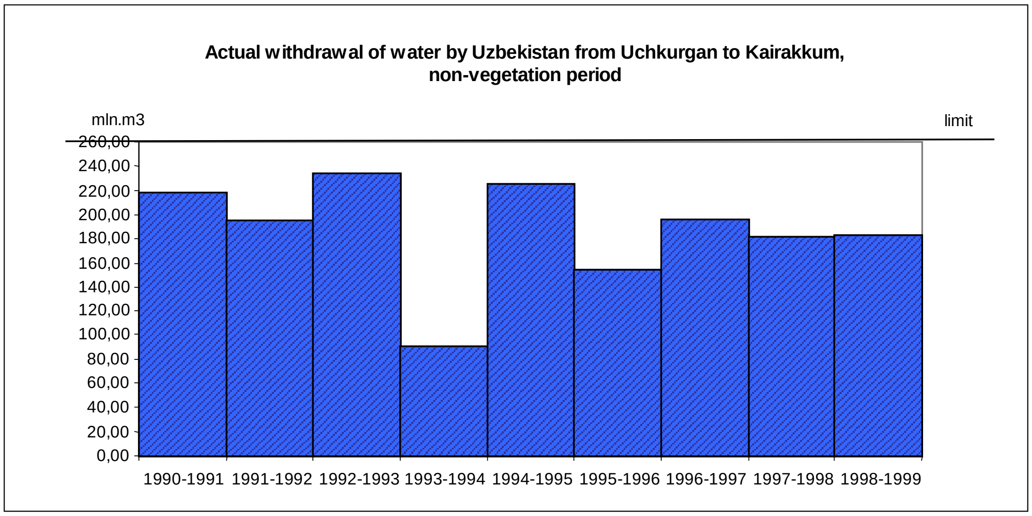
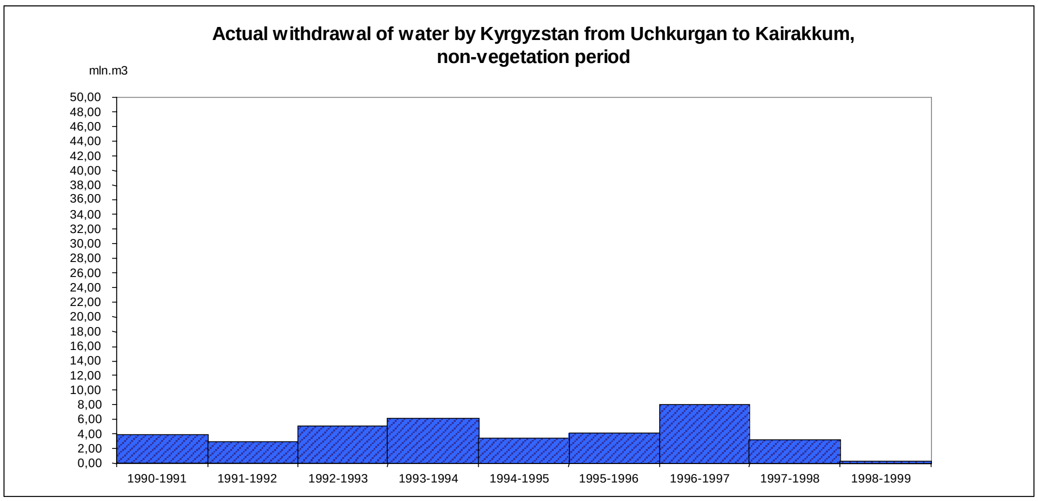


Figure 2.1.3.4. Withdrawal of water on the Syrdarya River from Uchkurgan to Kairakum reservoir.





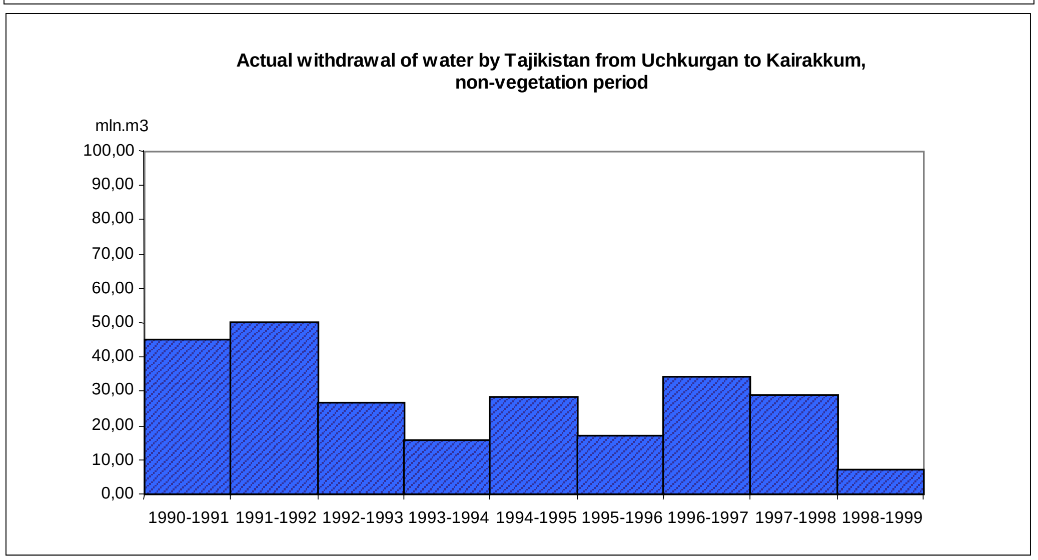
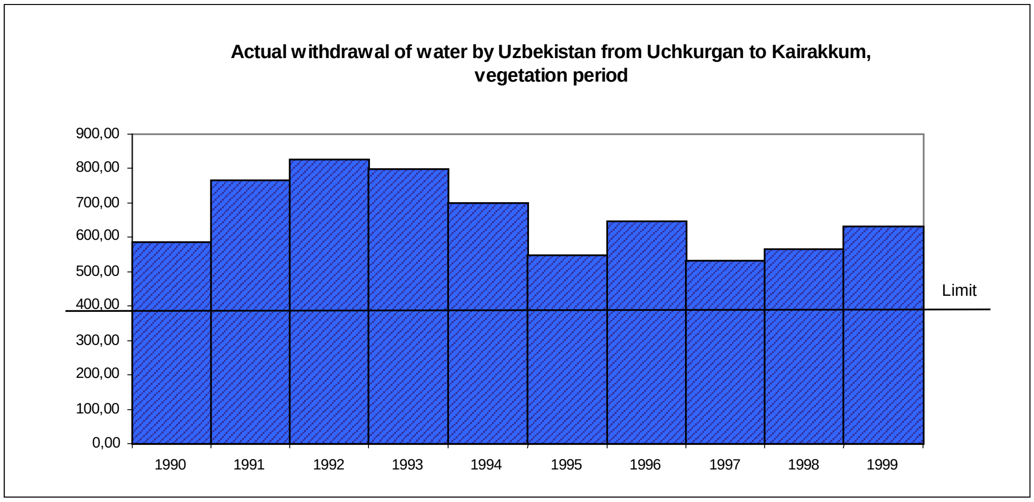
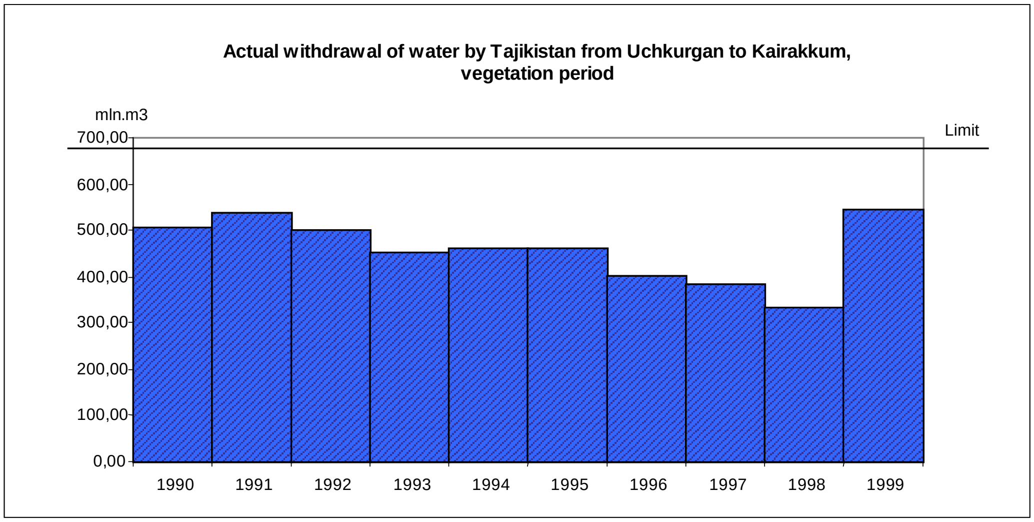


Figure 2.1.3.5. Withdrawal of water by Uzbekistan, Tajikistan, and Kyrgyzstan on the Syrdarya River from Uchkurgan to Kairakum reservoir in the non-vegetation period.





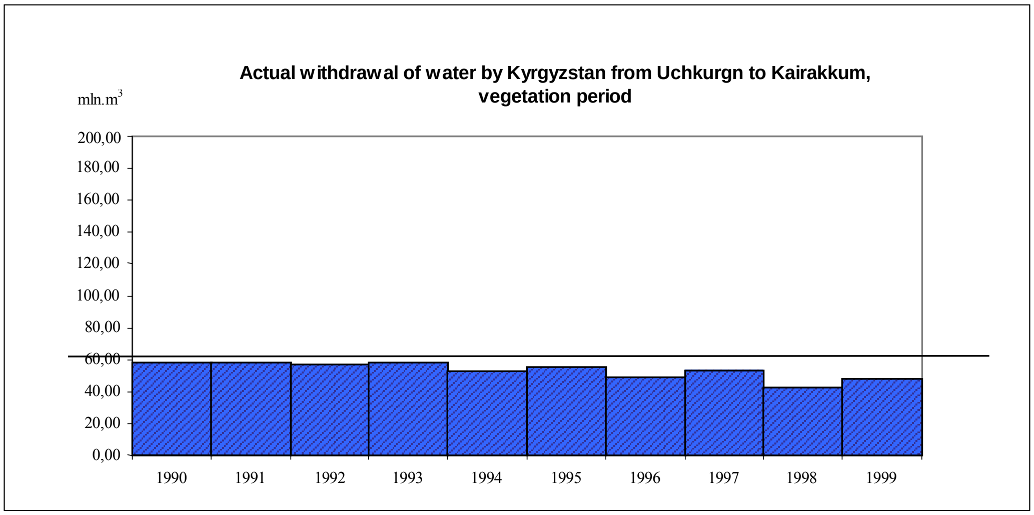
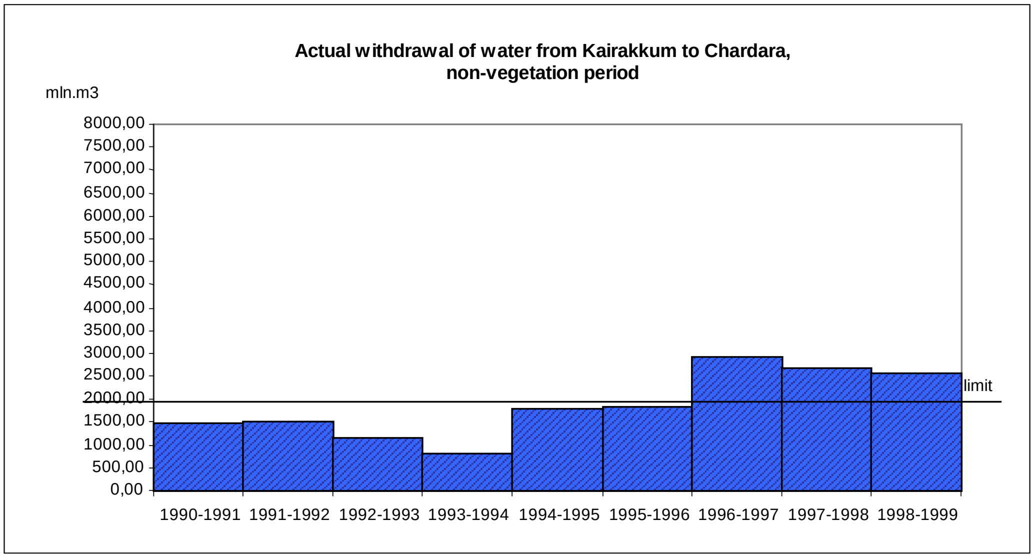


Figure 2.1.3.6. Withdrawal of water by Uzbekistan, Tajikistan, and Kyrgyzstan on the Syrdarya River from Uchkurgan to Kairakum reservoir in the vegetation period.



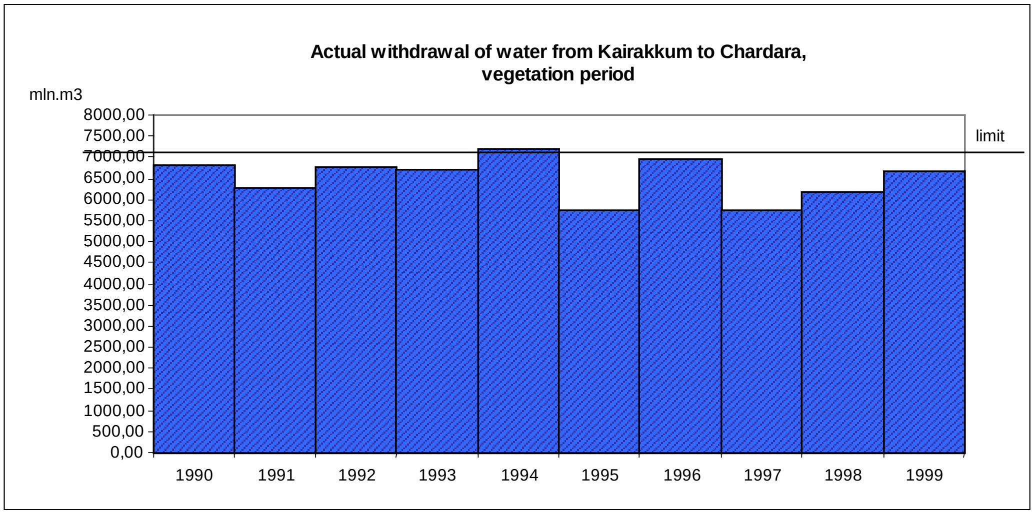
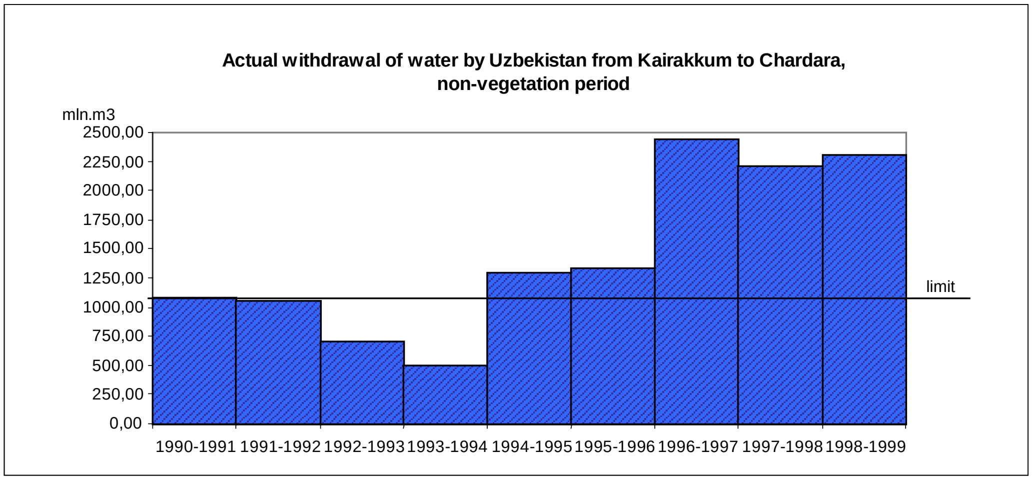
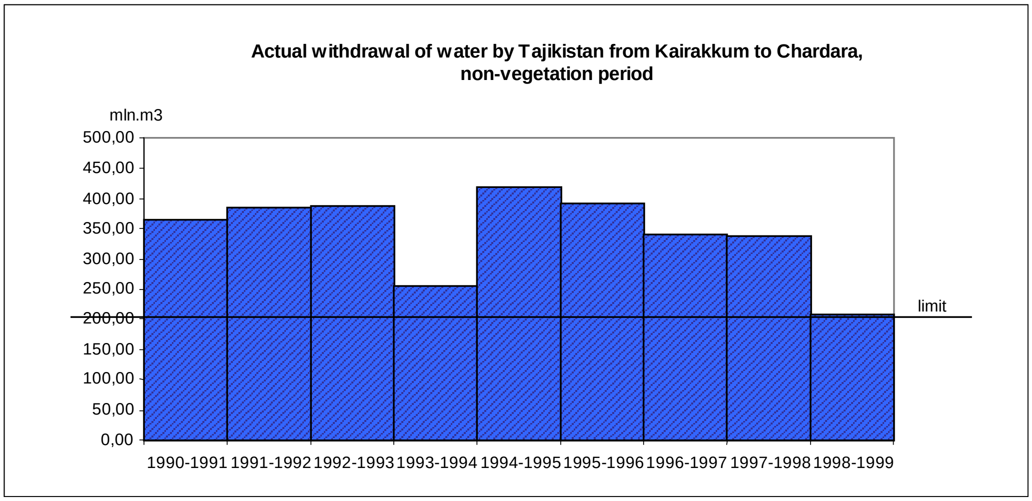


Figure 2.1.3.7. Withdrawal of water on the Syrdarya River from Kairakum reservoir to Chardara reservoir.





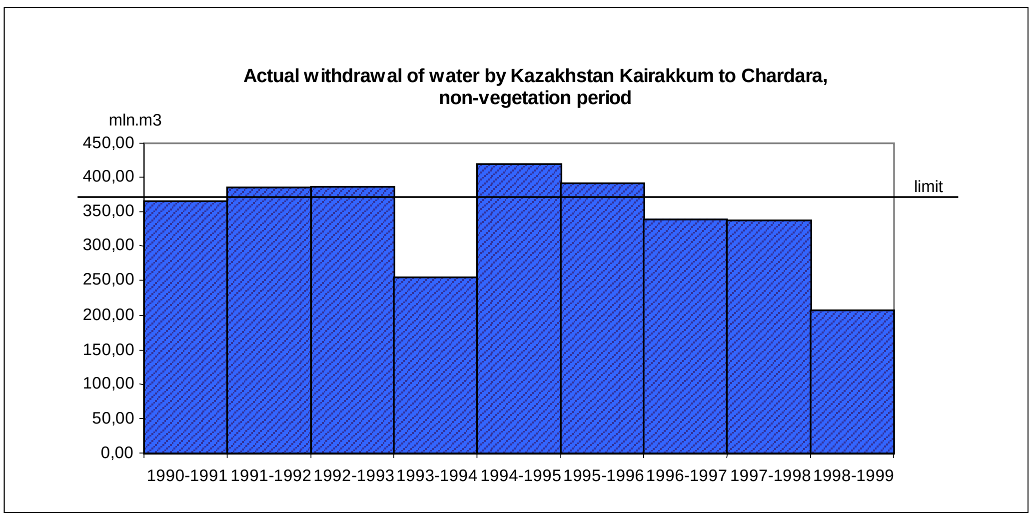


Figure 2.1.3.8. Withdrawal of water by Uzbekistan, Tajikistan, and Kazakhstan on the Syrdarya River from Kairakum reservoir to Chardara reservoir in the non-vegetation period.

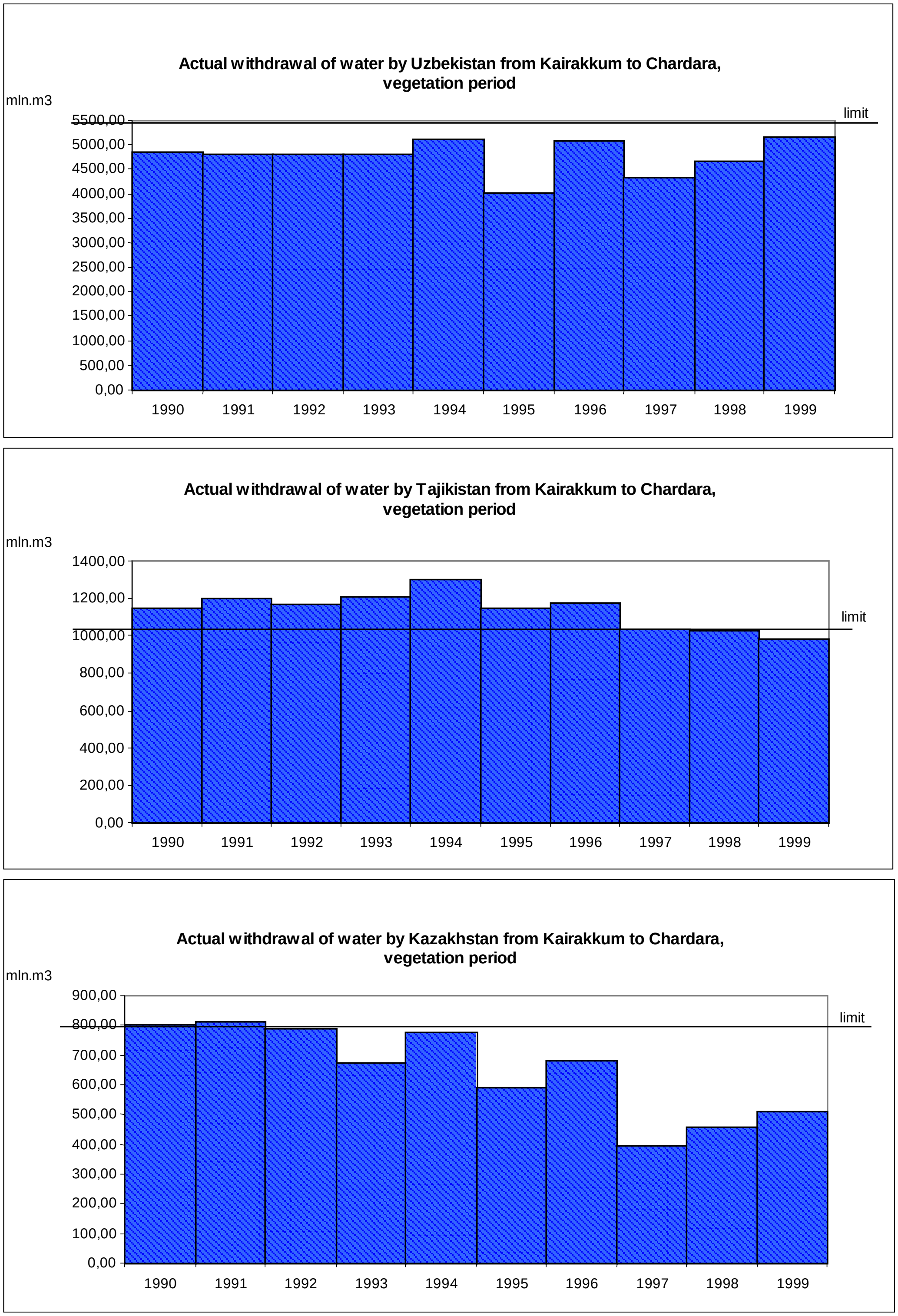
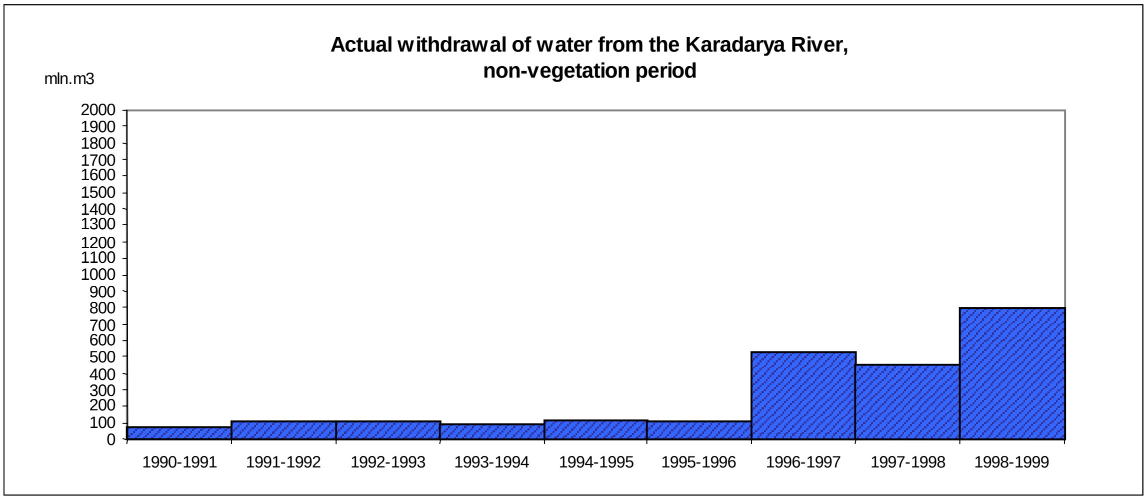


Figure 2.1.3.9. Withdrawal of water by Uzbekistan, Tajikistan, and Kazakhstan on the Syrdarya River from Kairakum reservoir to Chardara reservoir in the vegetation period.



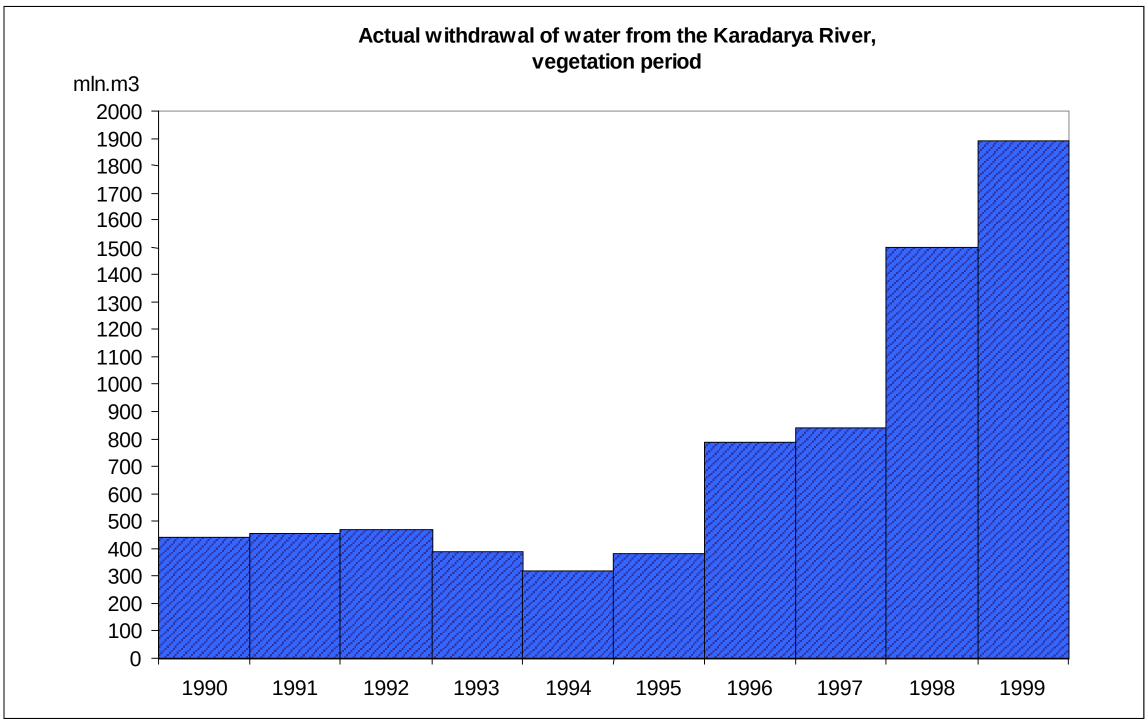
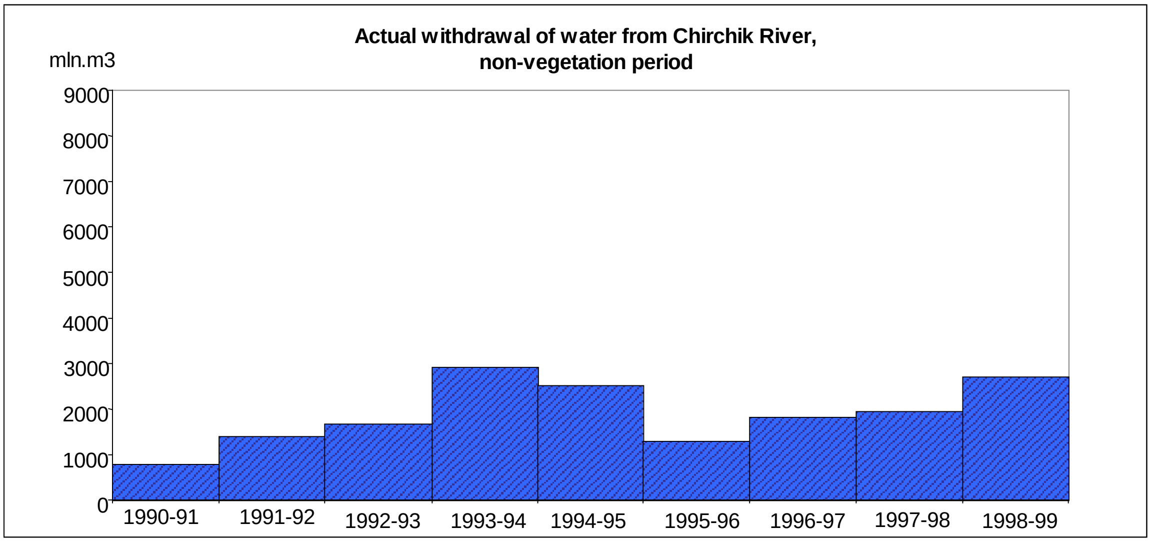


Figure 2.1.3.10. Withdrawal of water on the Karadarya River.



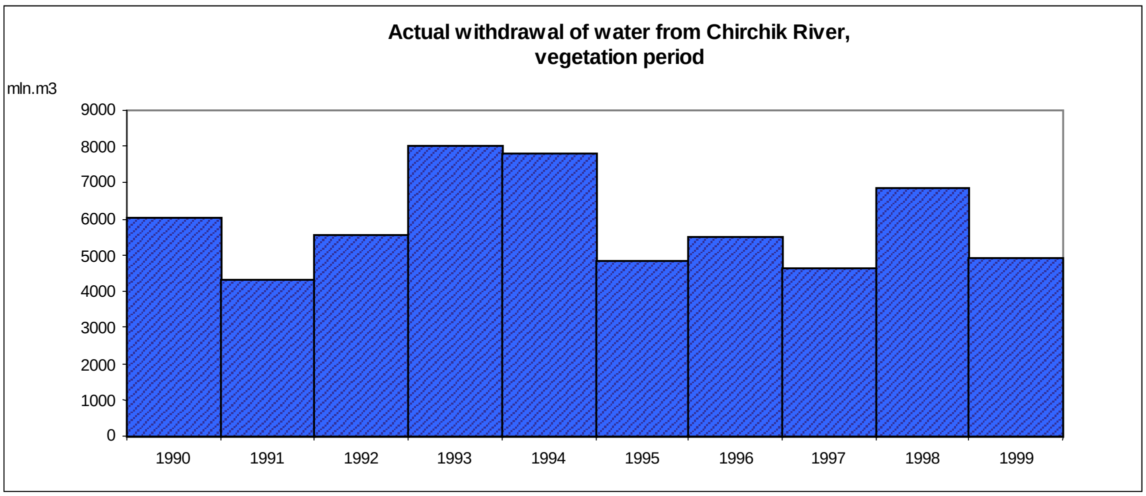


Figure 2.1.3.11. Withdrawal of water on the Chirchik River.

2.1.3.2. HPP Purpose and Role in Generating Electricity and Grid Frequency Control within Reservoir Operating Modes Agreed Upon by the Water Management Bodies

Simultaneous operation of the energy systems in the EPP CA provides an optimal regime of operation of HPPs and TPPs, and rational use of water and energy resources of the Syrdarya basin. Since 1995, the energy, fuel, and water use agencies of Kazakhstan, Kyrgyzstan, Uzbekistan, and currently Tajikistan have considered the developed and predicted water and energy regimes at their meetings. They have agreed on proposals to the Governments of the republics which serve as the basis for annual international agreements on operation of the Naryn-Syrdarya Cascade of reservoirs.

In order to support the agreed upon regimes of operation of HPPs and reservoirs of the Naryn-Syrdarya cascade, and to carry out water supply for irrigation, it is necessary to annually plan, coordinate, and make decisions on releases, power generation and transfer, as well as on compensation for losses of power resources on an equal basis. Implementation of the agreed water-power operation plans is carried out by BVO Syrdarya and UDC Energia.

The estimated capacity of HPPs in the EPP CA is equal to 35.6% of the total estimated capacity of the complex. Power generation by the EPP CA was equal to 89,955.4 mln.kWh in 1999, which is 1.5% more than in the previous year. Power generation by HPPs increased by 8.6%, and is equal to 36,404.7 mln.kWh, or 40.4% of the total generation by the EPP CA plants. The loading schedule of the EPP CA has a sharply peaking character.

The HPPs of Tajikistan's Barki Tochik and Kyrgyzstan's Kyrgyzenergo have the leading role in covering the peak loads during the maximum hours, as well as unloading during the hours of nightly minimum load of the EPP CA. The dynamics of the monthly regulation range of the HPPs of the EPP CA are presented in the Table 2.1.3.2. The monthly range for the HPPs is 60-70% of the total regulation range of the complex. The range of regulation of the HPPs varies from 1,980 MW (June) to 2,679 MW (September), while the regulation range for TPPs varies from 1,189 MW (August) to 1,852 MW (October).

The leading role in frequency regulation in the complex is taken by the HPPs of Kyrgyzenergo and Barki Tochik. In order to stimulate the operation of the frequency-regulating power systems, UDC Energia developed the "Methods for compensation of expenses for regulation of frequency." The frequency regulation services provided by the frequency-regulating power systems are paid for by the buyers of the regulating capacity. The latter can be power systems, or separate consumers of power systems. However, some power systems do not have agreements for provision of frequency regulation services, which brings up additional difficulties in the implementation and planning of the regimes of the EPP CA. Table 2.1.3.3 shows the power generation by HPPs of the EPP CA by quarters of 1999 (mln.kWh).

Table 2.1.3.2.
Maximum and Minimum Loads (MW) of Power Plants, and the Regulation Range for the EPP CA During the Maximum Days, by the Months of 1999.

Day, month average daily frequency		Load of power plants (MW)		Regulation ranges (MW)
		Maximum	Minimum	
January 29.01. f av.daily= 49.86 Hz	CPS	15205	11202	4003
	TPP	8855	7117	1738
	HPP	6350	4085	2265
February 02.02 f av.daily= 49.97 Hz	CPS	14842	11139	3703
	TPP	8642	6865	1777
	HPP	6200	4274	1926
March 20.03. f av.daily= 49.88 Hz	CPS	14259	10970	3289
	TPP	8433	7524	909
	HPP	5826	3446	2380
April 08.04. f av.daily= 49.70 Hz	CPS	13341	8789	4552
	TPP	8131	5971	2160
	HPP	5210	2818	2392
May 11.05. f av.daily.= 50.07 Hz	CPS	11997	7865	4132
	TPP	6502	5167	1335
	HPP	5495	2698	2797
June 17.06. f av.daily = 50.04 Hz	CPS	11770	8159	3611
	TPP	6048	4287	1761
	HPP	5722	3872	1850
July 23.07. f av.daily= 50.07 Hz	CPS	11974	8318	3656
	TPP	5352	4316	1036
	HPP	6622	4002	2620
August 17.08 f av.daily= 50.17 Hz	CPS	12316	8513	3803
	TPP	5648	4185	1463
	HPP	6668	4328	2340
September 06.09. f av.daily= 50.09 Hz	CPS	11846	7308	4538
	TPP	6486	4228	2258
	HPP	5360	3080	2280
October 28.10. f av.daily= 49.99 Hz	CPS	12911	8629	4282
	TPP	7778	5869	1909
	HPP	5133	2760	2373
November 29.11. f av.daily= 49.94 Hz	CPS	14972	10106	4866
	TPP	8663	6555	2108
	HPP	6309	3551	2758
December 29.12. f av.daily= 49.93 Hz	CPS	15048	11065	3983
	TPP	8663	7045	1618
	HPP	6385	4020	2365

Table 2.1.3.3.
Power generation by HPPs of the EPP CA, by quarters of 1999 (mln.kWh)

Name	Actual per quarter				Actual per year
	I	II	III	IV	
Ministry of Power of the Republic of Uzbekistan	1070.6	1531.4	1755.2	968.7	5325.9
Incl. cascade of Middle-Chirchik HPPs	515.5	943.1	1230.7	430.6	3119.9
GAHK "Barki Tochik" of the Republic of Tajikistan	3470.6	3668.0	4385.4	3902.0	15426.0
Incl. Nurek HPP	2359.5	2600.7	3188.5	2804.2	10952.9
Baipazin HPP	551.4	553.4	693.5	568.5	2366.8
Kairakkum HPP	256.1	183.6	126.8	197.8	764.3
"Kyrgyzenergo" JSC	3856.3	2220.9	2594.5	3465.7	12137.4
incl. Toktogul HPP	1635.9	795.1	1047.1	1513.3	4991.4
Kurpsai HPP	1105.3	628.6	691.9	926.7	3352.5
Uchkurgan HPP	299.2	267.2	193.6	266.4	1026.4
Tashkumyr HPP	577.1	323.9	426.3	523.3	1850.6
Shamaldysai HPP	187.6	149.7	162.3	185.1	684.8
APC and TATEK JSC	317.0	563.8	589.5	329.4	1799.7
Incl. Kapchagai HPP	272.2	491.8	499.4	280.9	1544.3
TGETK "Kuvvat" of Turkmenistan	0.7	1.8	0.9	0.6	4.0
Chardara HPP of the Ministry of Water of Kazakhstan	122.1	144.0	89.1	99.1	454.3
Ministry of Water of the Republic of Uzbekistan	193.7	414.3	437.1	212.3	1257.4
Andijan HPP	61.9	261.9	252.9	76.2	652.9
Tuyamuyun HPP	141.8	152.4	184.2	136.1	614.5
Total for the EPP CA	9031.0	8544.2	9851.7	8977.8	36404.7

2.2. National and Regional Interests of the Syrdarya Basin Countries in Water and Energy Uses

2.2.1. Use of Reservoir Water Resources for Irrigation and Electricity Generation, and National Interests of Kyrgyzstan, Uzbekistan, Tajikistan, and Kazakhstan

Due to specific natural and climatic conditions, the Syrdarya basin is a typical arid zone, where agriculture without irrigation is almost impossible. Hydro-power generation is an important component, that is why water use in the basin is complex with irrigation and power generation the primary purposes. The use of water resources in the Syrdarya basin is directly related to the economies of four independent countries (Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan), and it is determined by the developed demand (amount and timing) for water. This demand is controversial in inter-branch and international terms.

Specific landscape conditions of the region predetermine the concentration of potential hydro-power resources, and the location of HPPs in the mountain area (for the Naryn they all are located in Kyrgyzstan). The irrigated lands, visa versa, are concentrated in valleys, first of all in Uzbekistan and Kazakhstan, which leads to automatic transformation of the inter-branch controversies over the operation of basin reservoirs into international controversies (after 1991). But, mutual use of water resources is always related to the determination of rights and priorities, and compensation for possible losses by the branches which do not receive sufficient amounts of water. A reliable mechanism of compensation was developed and used by the Soviet Union until 1991, and the approach to the problem was based on the fact that Central Asia was the main supplier of cotton, vegetables, and fruits in the country, and because of that the priority for water use from the rivers was given to irrigated agriculture, while the power needs of upper-stream areas were compensated during autumn and winter by supplying them with heating and power resources. Thus, the mechanism of compensation of resources was well-developed. The controversy mentioned above significantly sharpened after the collapse of the Soviet Union in 1991, and became the cause of international and inter-departmental confrontation. First of all, this related to the regime of operation of Toktogul hydro-station and reservoir.

According to the project design, the main purpose of Toktogul reservoir is to provide multiyear regulation of river flow in the Naryn-Syrdarya basin with the aim of increasing water supply to 918 thous.ha of irrigated lands, and to add 400 thous.ha of new irrigated lands in the Syrdarya basin, as well as to generate power in the amount of 4.1 bln.kWh per year. The project stated that the operation of Toktogul reservoir is based on provision of guaranteed water supply to the republics (water users) in agreed upon amounts of withdrawal from the Syrdarya which allows sustainable yields of agricultural crops. This required that three quarters of the annual releases from the reservoir (9.43 km^3) be made during the vegetation period (April – September). According to the design, Toktogul reservoir must not release more than 180 m^3/s during the non-vegetation periods (2.85 km^3 during October - March), which produces the minimum generation capacity of the HPP during this period. This irrigation regime, while providing support for maximum volumes, and, consequently, levels of water in the reservoir, provides the maximum power generation not only during a given year, but also – what is the most important – during the whole hydrologic period of alternating high- and low-water years. When the design operating rules are fulfilled, a regime of river flow and sanitary releases is achieved which is close to the natural regime to the maximum extent, which not only creates sustainable and favorable environmental conditions, but also creates conditions for that support the irrigation regime of the territories located near the river.

Under the design regime, the power not generated in winter was compensated by the above mentioned supplies of heating and energy resources from Russia, Kazakhstan, and Uzbekistan in order to load the TPPs of Kyrgyzstan (Bishkek and Osh TPPs), as well as by the transfer of electricity through the EPP CA. In summer, during maximum releases from the reservoir, the power generated by Toktogul HPP was partially compensated by means of a backwards transfer through the power system mentioned above.

Since its completion in 1974, Toktogul reservoir could not be filled for a long period of time and the amount of water in the reservoir did not exceed 5-6 km^3 until the high-water years of 1987-88. The maximum volume of water (19.5 km^3) in the reservoir was achieved in August 1988, and the reservoir started to provide maximum releases. Also, in 1988, the first signs of changes in the regime of Toktogul reservoir appeared, related to the decrease in the supply of coal to Kyrgyzstan, and a simultaneous increase in the supply of gas from Uzbekistan, which was compensated by power generated at Toktogul reservoir by means of increased releases from the reservoir (up to 3.9 km^3 during non-vegetation periods in 1989-90, 4.9 km^3 in 1990-91, 5.1 km^3 in 1991-92), and power generation by Toktogul HPP increased twice in comparison to the preliminary period (1985-87) – up to 5 mln.kWh. Such changes remained during the following several years, but they did not significantly affect the amount of water in Toktogul reservoir, because they occurred during the period between two high-water peaks – 1987-88 and 1993-94.

After the collapse of the Soviet Union, the tendencies developed during the previous few years became much more clear. Simultaneously with the creation of five independent sovereign countries, production decreased, leading to a decrease in heat generation, and coal extraction significantly decreased in Kyrgyzstan; at the same time economic relations between departments and countries collapsed. During the same period, parts of the water use complexes of the Amudarya and Syrdarya Rivers became the property of sovereign countries, which started to use them in order to satisfy current needs, based on the necessity to use only national abilities. In 1992, supplies of fuel and energy resources to Kyrgyzstan from the other countries significantly decreased, which lead to a decrease in power generation by heating power plants of the republic; lack of natural gas and coal lead to a significant increase in municipal demand for power in the Kyrgyz Republic. In order to cover the increased demand, Toktogul hydro-station was transferred to a power generation regime of operation, which completely changed the situation of water supply for the water users in the Syrdarya basin. At that time, the maximum power generation by HPPs occurred in winter (releases of 6-8.5 km^3), and the releases during the vegetation periods decreased to 4.5-6.5 km^3 in order to accumulate water in the reservoir. The situation improved during the high-water year of 1993-94, but worsened in the low-water year 1995. These changes in the regime of operation of Toktogul reservoir lead to significant lack of water for irrigation and large inflows to the Arnasai depression. At the same time, a decrease in summer releases from the reservoir created difficult environmental and sanitary-epidemiological conditions in the basin, especially during the low water years. The flow of water in summer is minimal in some parts of the river, or almost completely disappears; and lack of water in the river during summer, when the temperature is 70-75 deg.C in the sun, opens the way for infections and epidemics, which do not recognize any borders or sovereigns. Finally, Toktogul reservoir inevitably empties when operating under the power generation regime, loosing its ability to regulate the flow of the Syrdarya in the long term.

In this sense, the irrigation regime of operation of Toktogul reservoir is much more effective, because it coincides with the natural hydrologic regime of the river. Along with that, the schedule of operation of the reservoir which was developed during the last few years is completely deformed, and, consequently, the same thing happened to the regimes of operation of the river bed reservoirs, of the cascade, and the regime of the river itself. While the average annual natural river flow during the autumn-winter period is 2.5 km^3, it doesn't achieve the recently released amounts of 8.0-9.0 km^3, 2-3 times more than the natural amount. The summer regime also changed in the same manner: the average annual flow in summer is 9.0-11.0 km^3, while the releases from the HPP are now 4.5-6.5 km^3, or 1.4-2.4 times less than the natural index. Therefore, we can say, that winter and summer replaced each other, which leads to floods in winter, and artificial low water in summer, and both of these phenomenon are artificial.

While recognizing the reasons causing the Kyrgyz Republic to change the Toktogul reservoir operation regime, this operation can lead to a crisis situation, economic losses, and a decrease in the health of the local population, which cannot be measured by money.

Regulation of the Naryn-Syrdarya cascade of reservoirs became more complicated during the last few years, because of the increasing inter-departmental and international controversies. Governmental bodies, which control Toktogul, Charvak, and Kairakum reservoirs, do not always follow the operating regime approved by the ICWC.

The national interests of Tajikistan are related to Kairakum reservoir. Before the collapse of Soviet Union this reservoir operated in concert with the other reservoirs of the basin, and fulfilled the role of seasonal regulator of irrigation water, providing Tajikistan with the established limit of water flow (about 2 km^3/year) during all kinds of water years. While the power generated in summer was a surplus for Tajikistan (including power generated by Nurek HPP) which was transferred to the other republics, it was transferred back in winter. Under the irrigation regime of operation, the maximum power generation by Kairakum HPP occurred in the summer, while in winter it operated at minimum capacity. Such a scheme, in the opinion of the power departments of Tajikistan, does not satisfy the current power requirements of the country, and is the main cause of lack of power in the winter in Tajikistan. At the same time, the national interests of Tajikistan require a correction of the operating regime of Toktogul reservoir, with the approval of Uzbekistan, in order not to cause a lack of water in the middle-stream, avoid possible conflicts between the countries, and establish corresponding limits for the use of water resources in the neighboring republics.

2.2.2. Aral Water Delivery Problems and Measures to Prevent Water Wastes into the Arnasai Depression

Chardara reservoir is the last large river bed reservoir on the way of Syrdarya water to the Aral Sea. It was created by two hydro-stations – Chardara in the river bed of the Syrdarya, and Arnasai at the entrance to Arnasai depression. Currently, the active capacity of the reservoir is 4.2-4.4 km^3, its length is 80 km, average width is 15 km, average depth is 6.3 m (maximum depth at the dam is 22 m), and surface area is 900 km^2. The reservoir is based on a ground alluvial dam made of small-granular sand, the length of which is about 4.8 km. The reservoir accumulates winter inflow, which is re-regulated for the summer period for irrigation needs, that is, its operation completely depends on the irrigation schedule – it is filled from October to March, then the water is used from April to September. In addition to that, the reservoir provides power generation from the HPP which has a capacity of 100 MW (4 aggregates). Finally, the other purpose of Chardara reservoir is to avoid floods and freshets of populated areas, lands and railroads in the down-stream region of the the Syrdarya, caused by high flows in summer and ice buildup (zahor phenomenon) in winter.

Arnasai junction consists of a ground dam (sandy and loamy soil) with a length of 2.1 km, and water canal with an estimated capacity of 2100 m^3/s (five gates, 10 m each). The depression is used as a reservoir to receive surplus water and winter releases exceeding the levels which cause flooding conditions in the down-stream region of the river.

As early as the design stage of the project, calculations and modeling showed, that even before Toktogul and Charvak hydro-stations began operation, Chardara reservoir would not be able to operate without releases to Arnasai. The necessity of such releases is related to:

- in summer – limited capacity of the Chardara hydro-station;
- in winter – impossibility of releases to the downstream region of the Syrdarya in excess of 400-450 m^3/s – because of the threat of the zahor phenomenon, damaging agriculture, the Tashkent-Orenburgh railroad, populated areas, and Kzyl Orda city.

In the calculations to determine the maximum estimated capacity of Arnasai depression, hydrological conditions were taken into account corresponding to a 10% water provision (plus the estimated flooding flows of 0.1% provision). Calculations were carried out for a period of ten years, because it was estimated that during that time Toktogul and Charvak reservoirs would be put into operation, and after that releases to Arnasai would significantly decrease or completely disappear. Under these conditions, and taking into account the maximum releases to the down-stream region of the Syrdarya River of 1500 m^3/s in summer and 400 m^3/s in winter, as well as the estimated evaporation from Arnasai of 500 mm, filling of Arnasai can be carried out according to Table 2.2.2.1.

Table 2.2.2.1
Schedule of Filling of Arnasai Depression.

Year of filling	Water level (m)	Volume (km^3)
5th year		
9th month	237.8	16.6
3rd month	238.5	18.1
10th year		
9th month	239.5	20.3
3rd month	240.0	21.3

According to the calculations, the designers recommended putting the limit at the level of 240 m within the boundaries of the orifice (under the conditions of release of the estimated catastrophic amount of 1700 m^3/s); under these conditions, the total area of the inundated lands would be 287.35 thous.ha. During this 10-year period Arnasai depression was used once in the extremely high water year of 1968-69 (such level of water occurred only twice during the whole period of observation – first in 1921-22), when Arnasai depression received more than 18 km^3 of water.

A completely different situation developed after the collapse of Soviet Union in 1991, which nobody could predict in advance, where, after twenty years the problem of releases to Arnasai would return during a period when the degree of flow regulation in the Syrdarya River had achieved such a high level. During these years, irrational use of water resources appeared again, but at the time when the lack of water significantly increased compared to the late 1960-s, the demands and amounts of water flow increased, and, unfortunately, the quality of water resources decreased. While in 1969 a natural extreme event occurred (extremely high water year), and now, for the 8th year we face an artificial phenomenon in the winter, and the water, which could be used for the national economies, is lost twice: idle releases during the non-vegetation periods, which damage the flooded areas of Navoiy and Dzhizak oblasts; while during the vegetation period, there is not enough water for agricultural irrigation; also, part of this water could go to the Aral Sea and the Aral Region.

During the last years, because operation of Toktogul reservoir was transferred from the irrigation regime to the power generation regime, winter releases to Chardara reservoir have significantly increased, and the small capacity of the down-stream river bed of the Syrdarya in winter lead to forced releases of part of the flow from Chardara reservoir to Arnasai depression. During 1992-2000, about 27 km^3 of water were releases into Arnasai lake, including, by years and seasons:

Table 2.2.2.2
Releases to Arnasai Lake, by Year and Season During 1992-2000 (km^3)

Water-year	Non-vegetation (1.10 - 31.3)	Vegetation (1.4 - 30.9)	Total
1992-93	1.2	1.2	2.4
1993-94	8.1	1.0	9.1
1994-95	3.9	-	3.9
1995-96	1.0	-	1.0
1996-97	1.2	-	1.2
1997-98	2.2	1.0	3.2
1998-99	3.1	-	3.1
1999-2000	2.8	-	2.8
Total	23.5	3.2	26.7

Analysis of the period 1993-99 shows that the largest inflows to Arnasai occurred in January-March, when Chardara reservoir was already full. At the same time, in January-March, the guaranteed resources for filling Chardara reservoir were available, and there was no need to begin filling up this reservoir as early as October.

The first consequence of inflows to Arnasai is the loss of precious water resources. If 1 to 8 km^3/year are put into Arnasai depression, then, with the general limit of 21.57 km^3/year provided by ICWC to the countries (in a normal water year), 5 to 40% of the Syrdarya water resources are lost, which the countriEPP CAn not afford. It is also necessary to remember, that part of the water flowing to Arnasai could go to the Aral Sea and the pre-Aral region, which means that, again, we face non-returnable resource losses, which we cannot use at the current level of development of hydro-techniques and current economic conditions in the region.

As a rerult of the excess flows to Arnasia, there has been flooding of large territories in the Uzbekistan (first of all, Navoiy oblast), located near the Arnasai depression, where villages, pastures, roads, communication networks, power networks, and other infrastructure objects are located. Filling of Arnasai depression leads to increased head on the outlets of drainage water collectors carrying water out of Golodnaya steppe; lack of outflow of salted ground water leads to worsening of melioration conditions of the lands in Golodnaya and Dzhizak steppes - this will occur over a long period, which cannot be estimated exactly at this time, but it is inevitable.

Degradation of soils flooded by releases from Chardara reservoir takes place; even if Arnasai depression were to be partially emptied of water in the future, re-cultivation of the soil is a long, extremely expensive and difficult process.

The following are also consequences of the change in the regime of operation of Toktogul reservoir:

- environmental damages to natural systems of the basin of the Syrdarya River; transfer of flows to winter, and lack of water in summer leads to degradation of water and soil complexes of the basin, and the desiccation of the river bed in summer leads to creation of crisis epidemic situations in the region during the hot periods; and
- the river bed of the Syrdarya is a natural channel, which, being full of water in winter during the last years, can not fulfill its natural role as a drainage channel, which drains the territories located nearby.

Avoiding releases to Aranasai is, first of all, the task of rational management of water and energy resources of the basin, requiring correction of the operation of the main reservoirs located on Naryn, Syrdarya, Karadarya, and Chirchik Rivers. Based on the experience of the last few years, we provide some recommendations which may lead to the decrease of the releases to Arnasai:

- The main condition is that releases from Toktogul reservoir during the non-vegetation period should not exceed 6.0 km^3;
- It is necessary to support the flow regime downstream from Chardara reservoir, which provides maximum possible flows in the river bed of the Syrdarya in winter, and filling of the reservoir at the end of non-vegetation period. In order to do so, it is necessary to create an “icy pipe” in the down-stream part of the river within the appropriate time by means of keeping the releases from Chardara reservoir in the range of 500-600 m^3/s as early as in October, and 400-600 m^3/s in November-December;
- Kairakum reservoir should be completely emptied to the dead volume at the beginning of non-vegetation period (October) – to the “reserve” volume (about 800 mln.m^3), which was kept during the vegetation period for the operation of Makhram pumping station. Releases in October should not be less than 600-700 m^3/s. The further filling of Kairakum reservoir should support a slight increase in the releases down-stream from the reservoir from 400-500 m^3/s in October to 600 m^3/s in December-February: and
- Releases to Arnasai can be decreased (by 20-30%) through more rational regulation of releases from Andijan and Charvak reservoirs. Winter releases from these reservoirs can achieve significant amounts, and, if it is possible, it is necessary to decrease them.

2.3. Main Problems of Relations Between the Syrdarya Basin Countries in the Sphere of Joint Use of Water and Energy Resources. Operating Regimes of the Naryn-Syrdarya Cascade of Reservoirs

2.3.1. Negotiations Between the Basin Countries, Search for the Ways of reaching Mutual Understanding and Agreement

After the collapse of the USSR in 1991, the main rivers of the region became transboundary rivers. A necessity appeared to create a regional mechanism for regulation of water resources, to replace the old centralized system of coordination and control which existed during the Soviet period. In October 1991, five independent countries of Central Asia agreed upon the development of such a mechanism, and in 1992 they signed the Agreement about collaboration in the sphere of mutual regulation of the use and protection of water resources from international sources, the creation of the International Coordination Water Commission (ICWC), and on the principles of regulation of water resources of the region. The Agreement of February 18, 1992 included as key provisions: (1) that the distribution of water resources shall be based on the principles of the "existing water use"; and (2) that the functions of regulation of the basin shall be carried out by the Basin Management Organizations (BVOs) controlled by ICWC. In March 1993, the heads of the countries approved the 1992 Agreement at their meeting in Kzyl Orda.

In January 1994, the heads of the Central Asian countries met in Nukus with the aim of considering and agreeing upon the general provisions of a Program of the Basin of the Aral Sea (PBAS). Taking into account the developed structure and principles of distribution of the international water resources, the Central Asian countries agreed to carry out measures to solve environmental problems related with the desiccation of the Aral Sea, and to supply guaranteed amounts of water to the delta of the Syrdarya River and to the Aral Sea. It was decided to develop a joint strategy of water distribution, protection of water resources, and rational water use; and to develop, on the basis of this strategy, drafts of inter-governmental legislative and normative acts for the regulation of issues related to the use and protection of water resources, as well as with social and economic development of the region. In 1996, the Interstate Council for the Aral Sea (ICAS, in 1997 it was merged into the International Fund for Protection of Aral Sea, IFAS) decided, that the existing distribution of water among the countries (under the Agreement of 1992) shall be enforced until a regional strategy of regulation of water resources is formulated, which reflects the new realities, and which will determine more objective mechanisms and principles of distribution of water, and its rational use.

The countries of the Central Asian Economic Community – CAEC (known as the ICKKU, or Interstate Council of the Republic of Kazakstan, Kyrgyz Republic, and Republic of Uzbekistan, before the joining of Tajikistan), since 1995, demonstrated interest in an agreed policy for development and use of water and energy resources in Central Asia, directed to avoiding conflicts between the countries in this sphere, and to decrease the negative influence over the environment.

To overcome the controversies that appeared, the countries have taken measures to decrease the demand for water, and they have signed international protocols and agreements, in which the amounts of compensatory supplies of energy resources from Uzbekistan and Kazakhstan to the Kyrgyz Republic are determined, and the amounts of vegetation period water releases from Toktogul reservoir (6.5 km^3) are established, which satisfies the needs of agricultural irrigation in the region during normal water years. While Kyrgyzstan provides the above releases, Uzbekistan carries out deliveries of power in winter and supplies Kyrgyzstan with gas, and Kazakhstan supplies it with coal from Karaganda; in summer, the power generated by Toktogul HPP is delivered to Uzbekistan and Kazakhstan. The amounts of winter water releases were not determined by the agreements (until 1998). Such a decision is not necessarily optimal, because it was made in order to overcome a crisis situation by means of supplying the irrigated lands with water during the vegetation period, but the problem itself was not solved. Moreover, the situation improved due to the fact, that the last several years (1992-94, and 1998) were high water years, so an incorrect opinion developed, that the regulatory role of Toktogul reservoir can be ignored, because there is sufficient water. At the same time, the high water years, while improving the situation during the vegetation period, worsen the situation during non-vegetation period: together with the increased winter releases from Toktogul reservoir, natural high water leads to rapid filling of the downstream reservoirs (often as early as December). With the limited capacity of the river downstream from Kzyl Orda, and given the ice conditions in the downstream region of the Syrdarya, water must be released to Arnasai depression, leading to the above negative consequences.

In 1998, the four-party Agreement about the use of water and energy resources of the Syrdarya basin was signed, and the principles of compensatory supplies of fuel and power were established. In January 2000, the Government of the Republic of Uzbekistan and the Government of the Republic of Tajikistan signed a bilateral Agreement on cooperation in the sphere of rational use of water and power resources, creating the conditions for accumulation of water in Kairakum reservoir, releases from that reservoir, and mutual transfers of electricity into the power systems of the republics (during the period of accumulation of water in Kairakum reservoir, Tajikistan imports power, and during release periods – it exports). The CAEC countries signed an Agreement about cooperation in the sphere of hydro-meteorology, as well as the regional agreement about simultaneous operation of power systems of the countries of Central Asia. All these agreements, in one way or another, are directed to solving the issues of regulation of water resources.

All these measures are partial and have served mainly to provide limited water in summer, but to carry out unlimited releases in winter if compensatory fuel supplies are not delivered to Kyrgyzstan. The experience of the last few years shows, that the minimum release (6.5 km^3) is compensated, which can be enough during a normal flow year for vegetation season irrigation of the lands in the Syrdarya basin. However, the experience of 1995 shows, that in case of low water years, 6.5 km^3 released from Toktogul reservoir is not enough for vegetation irrigation. During the winter, given the absence of compensatory fuels, Kyrgyz power generators developed their own schedule, based on the satisfaction of power demand in the Kyrgyz Republic, for which it is necessary to release at least 8-8.5 km^3 of water from Toktogul reservoir. Such a regime during several normal flow years inevitably leads to reducing of the reservoir to its dead volume in this case of double operating load –summer irrigation releases and in winter power releases.

A long-term agreement for the basin is not drafted and signed yet which will regulate all major issues of rational use and protection of water resources in the region, solve issues of conflict, optimal regulation of water and energy resources of transboundary rivers, provide sustainability of water relations between the countries, taking account of environmental, social, and economic factors, as well as strategic interests of the nations of the region. In order for the Basin Agreement to be formulated, it is necessary to develop:

- a strategy of rational regulation, use, and protection of water resources of the region, including the principles, approaches, and criteria, as well as programs of preliminary measures and perspective planning;
- a set of standards, instructions, methods and instruments (models, computer programs), which will allow the formulation of regulatory effects, to choose and well ground decisions on the regulation of water resources, their use, and protection. It is important to know how to evaluate the economic, social, and environmental interests of each of the countries, to predict possible conflict situations, to determine effective ways for their resolution, to have instruments for financial influence on water users in case of violation of the established regimes and limits of water-use, to determine effects, costs, damages, and corresponding fines and compensations when carrying out mutual economic payments between the countries; and
- a set of legislative documents on the mutual water-using activities of the countries in the region, and for the regulation of water relations, taking into account the specific features of the existing water legislation of the Republics, which determine the rights and obligations of the water users, as well as legal liabilities for violations.

The currently existing system of Agreements signed between Kazakhstan, Kyrgyzstan, and Uzbekistan on the issues of rational use of water and energy resources of the Naryn-Syrdarya cascade of reservoirs needs improvement. Under these agreements, Kyrgyzstan, during the vegetation period, must release 6.5 km^3 of water from Toktogul reservoir, while Kazakhstan and Uzbekistan must receive the resulting 2.2 bln.kWh of surplus electricity and compensate Kyrgyzstan for the loss of wintertime hydro-power generating capacity with electricity, coal, and gas.

These days, only timely signing of agreements between the countries, and strict fulfillment of all agreements can increase the effectiveness of regulation and use of river flow. These requirements are a necessary, but not the only, condition to guarantee non-conflicting mutual use of water and energy resources in the basin. The agreements themselves require improvements, such as:

- Releases from Toktogul reservoir must be determined for the whole water year, not for separate seasons, that is, the autumn and winter releases must be related to the spring and summer releases. The obligations to fill Kairakum reservoir must be supported by a schedule of releases, which provide filling of the reservoir, in other words, the water users located downstream must know the consequences of the obligation to fill the reservoir.
- An amendment to the agreement should be developed which includEPP CAlculations of the key economic figures of the agreement, taking into account the possible functioning of the water-use complex in the future, as well as evaluation of possible damages in case of failure to follow the agreement. The mechanism of compensation of damages, which occur due to failure by the countries to fulfill the obligations provided by the agreement, should be developed.

- Coordination of mutual activities of water-use, and fuel and energy departments in the region should be developed on the basis of common approaches and methods. In order to have agreed upon policy and mutually beneficial activities in the sphere of water and energy relations, to avoid possible failures to fulfill the agreements, an international consortium on the use of water and energy resources in the region should be created. The consortium should become the financial and "insurance" mechanism which guarantees sustainable water and energy exchanges provided by the agreements. It should have means and instruments (including mathematical models and corresponding software) in order to ground the correctness and effectiveness of the decisions taken.

2.3.2. Fuel and Energy Delivery Problems

The operating regime of Toktogul reservoir over the last few years cannot bear any critics, and can lead to a catastrophe both in hydro-power generation and irrigation water supply. The compensation mechanism for the foregone winter power generation is also not acceptable. On one hand, it is obviously not sufficient, because it does not provide a reduction in winter releases, as was done before 1991, when Toktogul reservoir was used as an important regulator of the Syrdarya flow. On the other hand, even the shortened task of compensating for the summer releases, which was faced by the governmental structures responsible for the supply of heat and power resources, has not been performed adequately, because the political and economic situation in the region has completely changed.

The attempt to solve all issues through governmental structures under the new conditions has lead to some negative results. That is why the inter-governmental agreements providing compensatory supplies of heat and power resources often are not fulfilled or they are not fulfilled in the full amount: for example, the Republic of Kazakhstan, during the 1995-96 water year, supplied only 200 thousand tons of Karagnda coal out of 600 thous. tons established in the agreement; further agreements also were not fulfilled. We present Figures 2.3.2.1 - 3 as an example, where the obligations of Uzbekistan and Kazakhstan to receive electricity generated by the Naryn HPPs cascade are compared with their actual fulfillment. Recall that in all agreements, Uzbekistan and Kazakhstan were obliged to receive 1.1 bln.kWh of electricity in summer; it can be seen in the figures what actually happened. First of all, the reception of electricity was carried out unevenly, which consequently affected releases from Toktogul reservoir. A significant increase in the reception of electricity in July 1995 lead to an increase in releases to 900 m^3/s and more, but it was too late (Figure 2.3.2.1), and this measure did not bring the expected results. Starting from 1997, Kazakhstan, due to several reasons, significantly decreased the amount of electricity received from Kyrgyzstan compared to the amount established in the Agreements (Figures 2.3.2.2 - 3); the consequences occurred within a short period of time, which was mentioned above: the flows through the Dustlik canal were less than half of the limits for withdrawal of water, and part of the areas in that zone were dried up. The consequences of these failures are obvious, and in summer the releases from Toktogul reservoir have been lower, but in autumn they have been higher than required by the inter-governmental Agreements. Such lack of executive discipline and fulfillment of obligations are especially unacceptable when using water resources, because the planned activitiEPP CAnnot be carried out in the future: the water went away, time is lost, and it is impossible to return the resource which is gone.

Another specific difficulty in the regulation of water resources is that the countriEPP CAn agree between each other, not taking into account the obstacles in the way of water deliveries such as other countries (or parties, or departments), which take their part and burden the implementation of agreements; as an example, recall the vegetation periods of 1995 and 1999, when the water, which was released from Toktogul reservoir under the Agreement between Uzbekistan, Kazakhstan, and Kyrgyzstan, was not passed and was stopped at Kairakum reservoir. By the way, Agreements between Uzbekistan and Tajikistan on compensation for operation of Kairakum reservoir have been signed for three years so far, but their fulfillment is also not perfect. Here is the last example: in March-April 2000, releases from Kairakum reservoir were 900 m^3/s, what made it impossible for Tajikistan to fulfill its obligation to fill the reservoir by May 31. Trying to fulfill its obligations at any cost, Barki Tochik decreased the releases to 200 m^3/s in the second decade of April, and almost lead to a crisis in the irrigated areas located in the middle-stream of the Syrdarya, and the operation of Farkhad HPP.

Thus, a paradox occurs, which is typical for this transition period – the conditions changed, but the methods of functioning remained the same, and these are not acceptable in the current situation. That is why such an effective mechanism as compensatory supplies does not always save the situation.

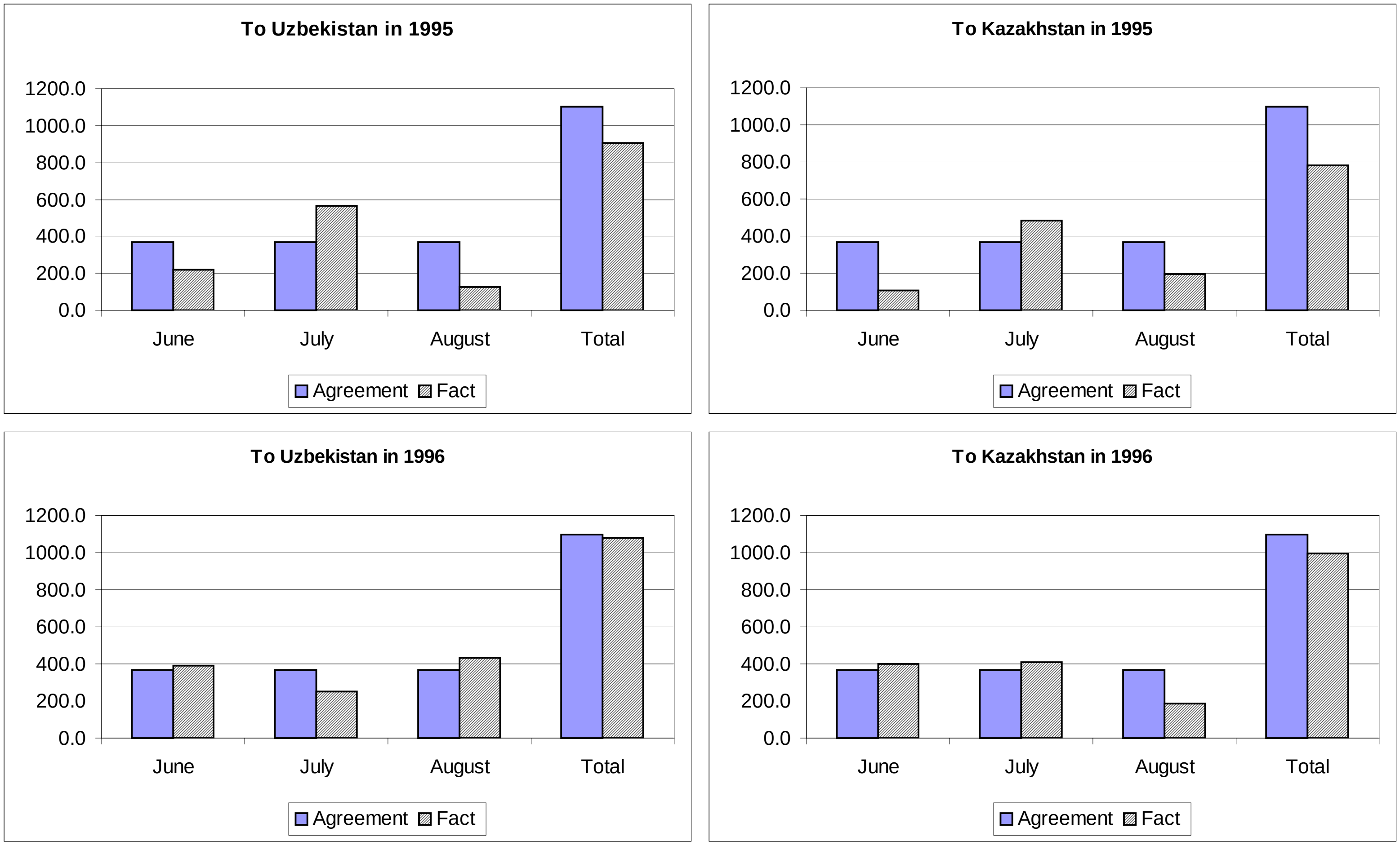


Figure 2.3.2.1. Dynamics of the electricity transfers from Kyrgyzstan to Uzbekistan and Kazakhstan during summer (1995 – 96).

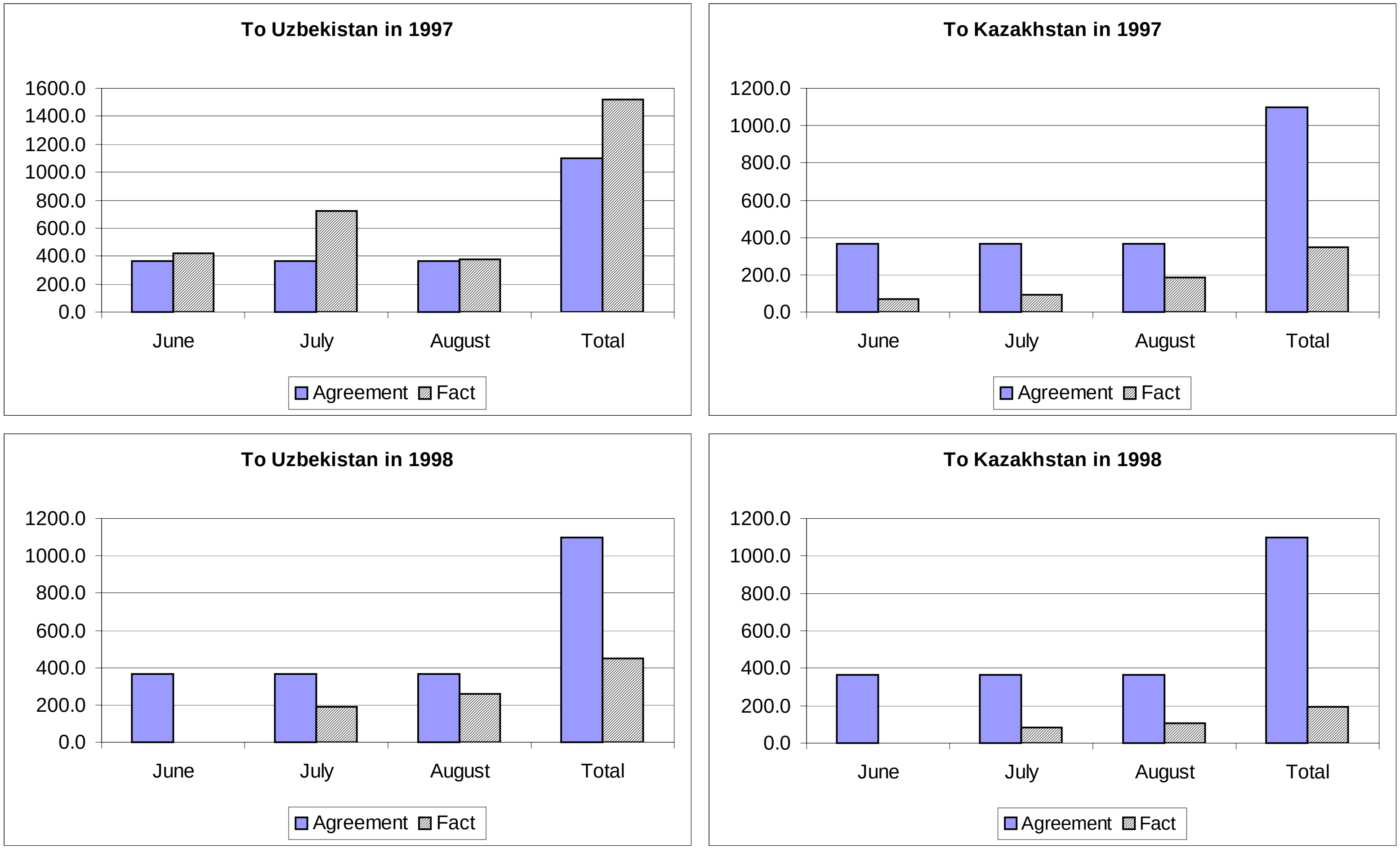


Figure 2.3.2.2. Dynamics of the transfers of power from Kyrgyzstan to the Uzbekistan and Kazakhstan during summer (1997 – 98).

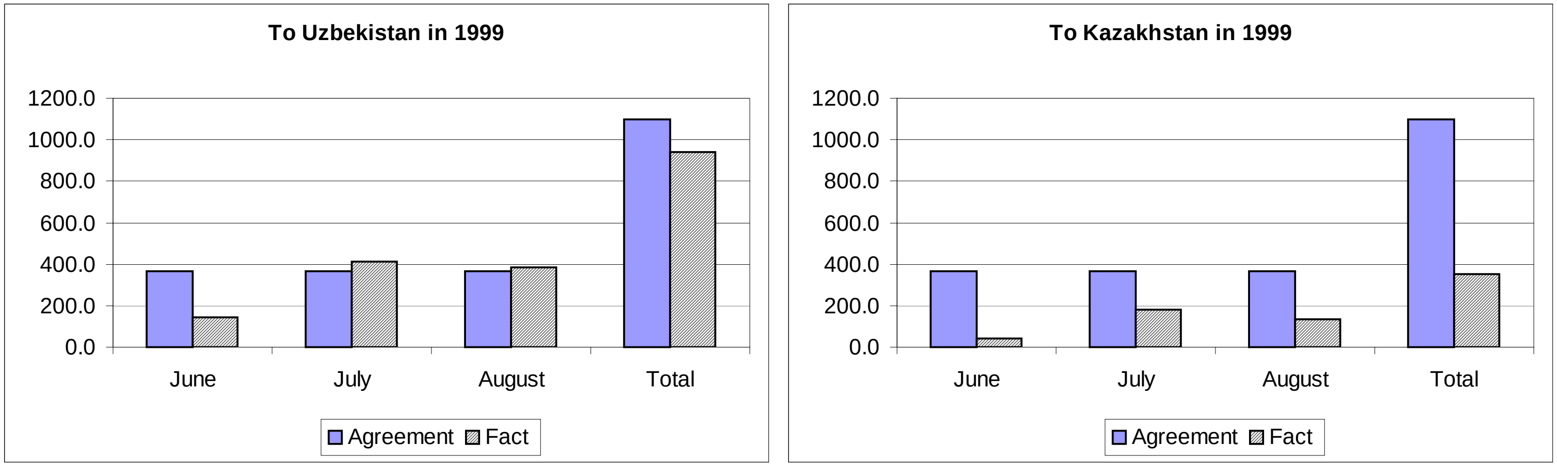


Figure 2.3.2.3. Dynamics of the transfers of power from Kyrgyzstan to Uzbekistan and Kazakhstan during summer (1999).

When considering the largest reservoir of the Syrdarya basin – Toktogul reservoir – the water year should be considered as the sole period, and its operating regime should not be separated by the periods of the year, like in 1995-97, when immediate problems were being solved – to provide vegetation releases without correction of the winter regime, which finally lead the reservoir to full flow, putting both irrigation and hydro-power generation in the way of a catastrophe. First of all, it is necessary to ground the regime of releases from Toktogul reservoir during non-vegetation periods, and to compensate Kyrgyzenergo for the water kept in the reservoir during this period. By controlling the winter releases from Toktogul reservoir, it will be also possible to avoid releases from Chardara reservoir to the territory of Uzbekistan (i.e., Arnasai depression). That is why BVO Syrdarya recommended for the 1997-98 water year the amounts of autumn and winter releases from Toktogul, so that it would be possible to start accumulation of water in the reservoir. The calculations showed, that in this case the amount of non-vegetation releases from Toktogul should not exceed 5.5 km^3. These recommendations were taken into consideration in the corresponding inter-governmental agreements, which established the releases from Toktogul at 6 km^3 during non-vegetation period, and 6.5 km^3 during vegetation period, while the Kyrgyz Republic announced the decrease in its national demand for electricity by 10% compared to 1997. But the agreements were signed too late, and they were not completely fulfilled within the provided terms and in the full amounts. As a result, the releases from Toktogul reservoir were more than the projected amount by 1 km^3; and, because of deviations in the operation of Kairakum reservoir from the planned schedule, excessive releases from Toktogul reservoir, and increased side inflows between Kairakum and Chardara reservoirs, 2.2 km^3 of water were put into Arnasai depression during the non-vegetation period. At the beginning of the vegetation period, 7.2 km^3 of water were stored in Toktogul reservoir – slightly more than 1.5 km^3 above the dead volume.

Along with this, emptying Toktogul reservoir to its dead volume lead us to a situation, which took place soon after putting it into operation, when water was accumulating in the reservoir. But now a situation can occur, when the reservoir, due to operation in the power generating regime during the last few years, will have to consume its dead volume in order to generate electricity during non-vegetation period, and the damage in such a case will not be covered by the benefits from agricultural irrigation. With the current approaches to the situation in the basin, we cannot ignore such a possibility.

However, the water-using situation during the 1998 vegetation period significantly improved because it was a high-water year; the volume of water stored in Toktogul increased to more than 15 km^3, and good perspectives appear for the recreation of the role of the reservoir as a multiyear regulator of Syrdarya flow – that is the main positive result of the 1998 vegetation period. Significant reserves of water also were saved in Charvak and Andijan reservoirs. It is important to notice that, even during the hottest months of the period under consideration, the regime of sanitary releases was maintained in the middle- and down-stream of the Syrdarya, which supported a favorable environmental and epidemic situation in the basin. At the same time, the inflows to the Aral Sea increased – 3.54 km^3 compared to the ICWC established vegetation period flow of 1 km^3 – during the last 10-year period, and for the first time the Aral Sea received more water during the vegetation period than during the previous non-vegetation period.

Unfortunately, in the next year (water year 1998-99) history repeated: the agreements were signed 7 months late, and instead of the established release of 6.8 km^3 for the non-vegetation period, the releases from Toktogul reservoir were equal to 8 km^3, 10.5 km^3 remained stored in the reservoir at the beginning of vegetation period, and 3.1 km^3 of Syrdarya water went to the Arnasai depression.

As one might think, signing of inter-governmental agreements on the rational use of water and energy resources of the Syrdarya basin avoided the difficulties of the previous non-vegetation period, but their implementation was not carried out fully, because the power systems of Uzbekistan and especially Kazakhstan were receiving electricity from Kyrgyzstan in an amount less than planned according to the agreement: Uzbekistan received total of 943 mln.kWh during summer, and Kazakhstan received 350 mln.kWh, or three times less than the obligation (Figure 2.3.2.3). The power system of Uzbekistan was receiving in June an average of 4.5-5.0 mln.kWh per day instead of the required 15-17 mln.kWh, and achieved the necessary amounts only in July and August. In Kazakhstan, realization of the agreement started only after signing of the protocol decision on 2 July 1999 in Almaty about the reception of electricity, the amount of which should not exceed 5-7 mln.kWh per day. As a result, the releases from Toktogul reservoir during the vegetation period were 5.10 km^3 instead of 6.8 km^3 established by the ICWC schedule.

During the last few years, the regime of operation of the other two upstream reservoirs of the Naryn-Syrdarya cascade was stable and favorably corresponds to the operation of Toktogul reservoir in general. It is much more important to consider the operation of the midstream reservoirs of the cascade – Chardara and especially Kairakum, the operation of which, under the current conditions and tendencies, according to the project design also could not provide optimal use of water resources of the Syrdarya basin. The change in the operating regime of Toktogul reservoir directly affects the functioning of Kairakum and Chardara reservoirs. That is why in the 1987-88 water year the inflows (and inevitably – releases) of both reservoirs increased. But, because non-vegetation period releases from Toktogul reservoir during that period (till 1992) did not exceed 5 km^3, there were no idle losses of Syrdarya water (i.e., to the Arnasai depression).

The margin was crossed in the 1992-93 water year, when about 6.1 km^3 passed through Toktogul hydro-station during the non-vegetation period, leading to releases to Arnasai; in the next few years this index increased even more, reaching 8.3 km^3 (in 1994). But the direction of the previous regime of operation of the midstream reservoirs remained the same, and the inflows still exceeded the releases. In 1998, the inflow to Kairakum reservoir increased to 8-9 km^3 comparing to 4-5 km^3 during the previous period (correspondingly, the releases increased from 3.5-6 k^3 to 6-8 km^3); since 1992, inflows and releases reached 10-12 km^3.

The nature of operation of Chardara reservoir was analogous, however, due to the limits downstream (the ice conditions in the estuary, and regulating construction for withdrawal of water to the Aitek canal), the releases could not increase proportionally to the increased inflow, and the difference was thrown into the Arnasai depression. Inflows to Chardara reservoir increased from 3-6 km^3 to 7-9 km^3 (in 1987-91), and up to 10-15 km^3 (from 1992-99); while the releases increased from 1-3 km^3 (1974-87) to 4-6 km^3 (1987-92), and then up to 5-8 km^3 (during the last few years). But, along with the increases in winter releases from Toktogul reservoir by 2-3 times, the midstream reservoirs did not need to store water during non-vegetation periods, because with the increased inflow, Kairakum reservoir sometimes was full as early as December, after which the releases often exceeded 1000 m^3/s. Even higher flows were coming to Chardara reservoir, and inflows to Arnasai became inevitable. Changes in the regime of the midstream reservoirs during the non-vegetation periods, taking account of the new conditions, of course, is not a universal panacea, but it can soften the situation. During the normal-flow years it can help minimize, if not eliminate, releases to the Arnasai depression (this is possible only in case of fulfillment of the inter-governmental agreements on compensatory supplies).

The active capacity of Kairakum reservoir has had to be decreased to support the operation of floating Makhram pumping station. The currently allowed minimum water level is 343.50 m, corresponding to a reservoir volume of 1,716 mln.m^3, which is half of the full capacity of Kairakum reservoir (3418 mln.m^3). From now until the end of the vegetation period, the volume of the reservoir must be kept above 1.0 km^3, but the water remains here even after October 1 – obviously, for hydro-power generation purposes. Meanwhile, this operation is not necessary, because with the power regime of Toktogul reservoir during the last years, Kairakum reservoir is full as early as mid-winter, and after that it transfers to a regime where its releases are equal to the inflows. That is why the amount of water stored during and after the vegetation period becomes an additional load, and when the reservoir is full, the water must be passed downstream, increasing the inflow on Chardara reservoir, and then this water finally ends up in Arnasai depression. These are the additional difficulties related with Kairakum reservoir. If the water stored during the vegetation period for Makhram releases at the beginning of the non-vegetation period, then the empty volume could be the reserve in January-March. That is why, for Kairakum reservoir, the task during the non-vegetation period is to:

- Release, within the initial period, the volume, or at least part, which was kept during the vegetation period for the Makhram pumping station, thus creating reserve empty volume; and
- Change the reservoir operation in such a way that its filling does not occur unevenly, increasing in February and March and increasing the releases from the reservoir up to 1000 m^3/s and more as it was after 1992; an increase in the releases during the first half of the non-vegetation period will decrease their amount in the second half.

Such leveling and reducing the releases in the second half of the non-vegetation period is beneficial in terms of minimizing the idle releases through the hydro-station, because the maximum flow through the turbines is 850-900 m^3/s.

The situation at Chardara reservoir, which is empty at the end of the vegetation period, is different. In order to achieve the optimum releases, it is necessary to create a so-called "icy pipe" of maximum possible size downstream from Kzyl Orda in a timely manner. For this it is necessary to maintain a permanent release from Chardara in December-February, of no more than 400 m^3/s because of the capacity of the Aitek hydro-station.

Since 1995, inter-governmental agreements have been signed between the Republic of Kazakhstan, Kyrgyz Republic, and the Republic of Uzbekistan on the use of water and energy resources in the Syrdarya basin. They reflect the vegetation releases from Toktogul reservoir in order to satisfy the demands of irrigation, and the amounts of compensatory supplies of energy resources (natural gas, electricity, fuel oil, coal) from Uzbekistan and Kazakhstan transferred to the Kyrgyz Republic during autumn and winter in exchange for the surplus electricity transferred to them, generated by the HPP by the additional summer water releases. Annually, the amount of possible supplies is considered preliminarily by work groups of the participating republics at the level of the heads of interested branches - power sector, water sector, fuel industry, and the regional departments of UDC Energia, and BVO Syrdarya. Then the developed proposals are fixed by annual inter-governmental agreements. During the last five years, 7.2 bln.kWh of electricity generated by the HPPs of the Naryn-Syrdarya cascade were transferred from the Kyrgyz Republic to the neighboring countries in the vegetation periods. During the same period, the Republic of Uzbekistan and the Republic of Kazakhstan supplied during autumn and winter 1.5 bln.kWh of electricity, as well as energy sources: natural gas – 1.73 bln.m^3, Karaganda coal – 2.17 mln.ton, and heating oil for loading the Bishkek TPP in winter.

For the year 2000, an inter-governmental protocol was signed by the Kyrgyz Republic and the Republic of Uzbekistan on the use of water and energy resources. The inter-governmental document to be signed by the Republic of Kazakhstan is under development.

Due to incomplete fulfillment of obligations, a difficult situation may occur in the power sector of the Kyrgyz Republic, as well as for water users in the neighboring countries due to non-balanced use of water resources of the Naryn river in the long-term. For example, in 1999, due to the hydrological and weather conditions in the basin, which decreased the demand for irrigation water, the releases from Toktogul reservoir during the vegetation period were 5.06 km^3 instead of the planned 6.5 km^3. In general, at the end of the vegetation period, the debt of Kyrgyzenergo to the Republic of Uzbekistan for natural gas was US$11.8 mln. That is why in September Uzbekistan stopped supplies of natural gas according to the inter-governmental agreement to the Bishkek TPP. This affected the power generation by Kyrgyzenergo during the autumn and winter, because it was forced to load the Toktogul cascade HPP additionally in order to satisfy the national demand for electricity. Lack of a mechanism of compensation for damages by the parties due to failure to fulfill obligations under the Agreement, as well as changes in the water-use situation lead to complicated problems, which affect the operation regime of the EPP CA, and lead to decreases in the reliability and sustainability of power systems. Therefore, in order to eliminate such problems, the inter-governmental Agreement should include civilized mechanisms for its successful realization taking into account international experience.

In order to carry out rational use of water and energy resources, improvement of water supply to agriculture, balanced power generation and flow, it is reasonable to create an International Water and Power Consortium (IWPC) to deal with the full and rational use of water and energy resources of the Syrdarya basin, which can consist of the ICWC with the BVO Syrdarya and the SIC ICWC, the Power Council of Central Asia, and the UDC Energia.