ANALYSIS OF HYDROLOGICAL CONDITIONS IN THE SYRDARYA AND AMUDARYA BASINS OVER THE GROWING SEASON 2017

1 Syrdarya River Basin

The actual inflow to the upstream reservoirs (Toktogul, Andizhan, and Charvak reservoirs) in the Syrdarya basin was 26.21 km³ or 124% of the forecast and 142% of the norm for the growing season. The total lateral inflow to the Naryn and Syrdarya (in the reaches up to the Shardara reservoir) was 16.19 km³.

By the beginning of the growing season, the upstream reservoirs (Toktogul, Andizhan, and Charvak) have accumulated 14.44 km³ (total capacity); active capacity was 8.36 km³ (total capacity minus dead storage). In the Toktogul reservoir, the total capacity was 12.78 km³ and active capacity - 7.28 km^3. The in-stream reservoirs, Bakhri Tochik and Shardara, have accumulated 7.96 km^3 (total capacity); active capacity was 6.52 km³.

By the end of the growing season, the total capacity in the upstream reservoirs was 22.37 km³ or 101% of the BWO Syrdarya schedule; active capacity was 16.3 km³, including 19.59 km³ of total capacity and 14.09 km³ of active capacity in the Toktogul reservoir. The in-stream reservoirs, Bakhri Tochik and Shardara, have accumulated 4.6 km³ (total capacity); active capacity was 3.16 km³.

Water releases from the Toktogul reservoir were 6.57 km³ or 101% of the BWO Syrdarya schedule. Analysis of operation of the Toktogul reservoir shows that water supply to the reservoir was 1.7 km³ more than the forecast and amounted to 137% of the norm during the growing season. Water releases from the reservoir were 1.6 km³ more than scheduled (planned) by BWO Syrdarya. An amount of 18.5 km³ was accumulated in the reservoir by the end of June, whereas by the end of July, the total capacity was 19.5 km³. Consequently, larger inflow to the reservoir given high water levels allowed higher water releases from the reservoir.

The inflow to the Bakhri Tochik reservoir was 11.34 km³ and water releases into the river amounted to 10.85 km³. Analysis of operation of the Bakhri Tochik reservoir and HEPS shows that water supply to the reservoir was 5 km³ more than planned by BWO Syrdarya; water releases from the reservoir by 3.8 km³ more than scheduled by BWO Syrdarya. Consequently, higher inflow to the Bakhri Tochik reservoir allowed not only fulfilling the plan on water releases, but also maintaining the total capacity in the amount of 3.1-3.3 km³. This, in turn, allowed producing more electricity than planned.

The inflow to the Shardara reservoir was 9.8 km³; water releases from the reservoir were 14.28 km³, including 12.04 km³ into the river. According to BWO Syrdarya (KazHydroMet), 1.39 km³ were released into the Arnasay reservoir from the Shardara hydroscheme. According to the Aralo-Syrdarya Basin Water Administration, the Koksarai reservoir accumulated water in the amount of 73 mcm only in April, while in other months it discharged the earlier accumulated flow in the amount of 2,339 mcm.

The total water intake from the Naryn and Syrdarya Rivers was 11.19 km³ or 96% of the limit in the reaches up to the Shardara reservoir. Over the growing season 2017, water withdrawal was 0.49 km³ less than planned by BWO Syrdarya. Water shortage (against the limit) was not observed in the Republic of Kazakhstan (along the Dustlik canal). However, it was 58 mcm in the Kyrgyz Republic, 313 mcm in the Republic of Tajikistan, and 127 mcm in the Republic of Uzbekistan. Water availability was uneven by state and river reach (Table

1.1). The highest water shortage (% of the limit) was in the middle reach Bakhri Tochik reservoir-Shardara reservoir – 6%.

Water availability was 99% for the Republic of Uzbekistan and 101% for the Republic of Kazakhstan. The lowest water availability was in the Kyrgyz Republic – 76%. In the Republic of Tajikistan, it was higher than in the Kyrgyz Republic. However, it was rather uneven in the river reaches: 1) Toktogul-Uchkurgan – 45%; 2) Uchkurgan-Bakhri Tochik – 119%; 3) Bakhri Tochik-Shardara – 78%.

Analysis of water balance in basin's reservoirs (Table 1.3) has detected unrecorded inflow of 1.04 km³ to the Shardara reservoir, losses in other reservoirs in the total amount of 0.97 km^3, including 0.64 km^3 in the Charvak reservoir and 0.31 km³ in the Bakhri Tochik reservoir.

Water losses in open river channel in the Toktogul-Shardara reach were 1.4 km³ or 6% of regulated runoff. In the lower reaches, runoff utilization was 10.08 km³ (including water intake, losses, minus lateral inflow).

According to KazHydroMet, water supply to the Aral Sea and Prearalie (Karateren GS) was 4.22 km³ for the growing season. (According to the Committee for Water Resources of the Republic of Kazakhstan, it was 4.43 km³).

Table 1.1

Water availability in the Syrdarya River basin countries over the growing season 2017

Water user	Water volume, km^3		Water availability %	Deficit (-), surplus (+), km^3
	BWO schedule/ Limit	Actual	Season	Season
1 Total water withdrawal up to Shardara reservoir	11.68	11.19	96	-0.492
2 By state:				
– *Kyrgyz Republic*	0.25	0.19	76	-0.058
– *Uzbekistan*	8.80	8.67	99	-0.127
– *Tajikistan*	1.91	1.59	84	-0.313
– *Kazakhstan*	0.73	0.74	101	0.01
3 By river reach				
3.1 Toktogul reservoir – Uchkurgan hydroscheme	3.95	3.77	95	-0.18
including:				
– *Kyrgyz Republic*	0.16	0.12	72	-0.05
– *Tajikistan*	0.24	0.11	45	-0.13
– *Uzbekistan*	3.55	3.55	100	0.00
3.2 Uchkugran hydroscheme – Bakhri Tochik reservoir	1.08	1.17	109	0.09
including:				
– *Kyrgyz Republic*	0.08	0.07	85	-0.01
– *Tajikistan*	0.45	0.54	119	0.09
– *Uzbekistan*	0.54	0.56	103	0.02
3.3 Bakhri Tochik reservoir – Shardara reservoir	6.66	6.25	94	-0.41
including:				
– *Kazakhstan*	0.73	0.74	101	0.01
– *Tajikistan*	1.22	0.95	78	-0.27
– *Uzbekistan*	4.71	4.56	97	-0.14
4 Additionally:				
– Inflow to Shardara reservoir	5.44	9.80	180	4.36
– Discharge into Arnasay	0.00	1.39		1.39
– Water supply to the Aral Sea and Prearalie	1.36	4.22	310	2.86

Table 1.2

Syrdarya River channel water balance for the growing season 2017

Balance item	Water volume, km^3		Deviation (actual - plan)
	Forecast/plan	Actual	
1 Inflow to the Toktogul reservoir	11.70	13.38	1.68
2 Lateral inflow in the river reach of Toktogul reservoir – Shardara reservoir (+)	14.00	16.19	2.18
including:			
– *Discharge from the Karadarya river*	3.15	3.24	0.09
– *Discharge from the Chirchik river*	3.85	3.78	-0.07
– *Lateral inflow from CDF and small rivers*	7.00	9.17	2.17
3 Flow regulation in the reservoirs: inflow (+) or withdrawal (-)	-6.02	-7.20	-1.18
including:			
– *Toktogul reservoir*	-6.73	-6.82	-0.08
– *Bakhri Tochik reservoir*	0.71	-0.38	-1.09
4 Regulated flow (1+2+3)	19.69	22.37	2.69
5 Water withdrawal in the Toktogul – Shardara reach (-)	-11.68	-11.19	0.49
6 Water losses (-) or unrecorded inflow to the river channel (+) in the Toктogul-Shardara reach	-2.56	-1.38	1.18
Including % of regulated flow	13	6	
7 Inflow to the Shardara reservoir	5.44	9.80	4.36
8 Flow regulation in the Shardara reservoir: inflow (+) or withdrawal (-)	2.86	4.48	1.62
9 Water releases from the Shardara reservoir	8.30	14.28	5.98
10 Including water releases into the river	7.10	12.04	
11 Flow regulation in the Koksaray reservoir: inflow (+) or withdrawal (-)	1.68	2.27	0.58
12 Runoff discharge (water intake-lateral inflow+losses)	7.41	10.08	2.67
13 Water supply to the Aral Sea and Prearalie	1.36	4.22	2.86

Table 1.3

Water balance of the Syrdarya River basin reservoirs for the growing season 2017

Balance item	Water volume, km³		Deviation (actual - plan)
	Forecast/Plan	Actual	
1.Toktogul reservoir			
1.1 Inflow to the reservoir	11.70	13.38	1.68
1.2 Water volume in the reservoir:			
– beginning of the season (1 April 2017)	12.78	12.78	0.00
– end of the season (1 October 2017)	19.45	19.59	0.13
1.3 Water releases from the reservoir	4.97	6.57	1.60

Balance item	Water volume, km³		Deviation (actual - plan)
	Forecast/Plan	Actual	
1.4 Unrecorded inflow (+) or losses (-)	-0.06	0	-0.06
% of inflow to the reservoir	0	0	0
1.5 Flow regulation: inflow (+) or withdrawal (-	-6.73	-6.82	-0.08
2.Andizhan reservoir			
2.1 Inflow to the reservoir	3.24	4.13	0.89
2.2 Water volume in the reservoir:			
– beginning of the season (1 April 2017)	1.10	1.10	0.00
– end of the season (1 October 2017)	1.04	1.02	-0.02
2.3 Water releases from the reservoir	3.75	4.19	0.44
2.4 Unrecorded inflow (+) or losses (-)	0.45	-0.02	-0.47
% of inflow to the reservoir	14	0	14
2.5 Flow regulation: inflow (+) or withdrawal (-)	0.51	0.06	-0.45
3.Charvak reservoir			
3.1 Inflow to the reservoir	6.17	8.69	2.52
3.2 Water volume in the reservoir:			
– beginning of the season (1 April 2017)	0.56	0.56	0.00
– end of the season (1 October 2017)	1.75	1.77	0.01
3.3 Water releases from the reservoir	4.97	6.84	1.88
3.4 Unrecorded inflow (+) or losses (-)	-0.02	-0.65	-0.63
% of inflow to the reservoir	0	7	7
3.5 Flow regulation: inflow (+) or withdrawal (-)	-1.21	-1.85	-0.64
4 Bakhri Tochik reservoir			
4.1 Inflow to the reservoir	6.36	11.34	4.98
4.2 Lateral inflow	0.30	0.25	-0.05
4.3 Water volume in the reservoir:			
– beginning of the season (1 April 2017)	3.33	3.33	0.00
– end of the season (1 October 2017)	2.10	3.40	1.30
4.4 Water releases from the reservoir	7.37	11.21	3.84
including:			
– *Water releases into river*	6.89	10.85	3.96
– *Water withdrawal from reservoir*	0.48	0.36	-0.12
4.5 Unrecorded inflow (+) or losses (-)	-0.52	-0.31	0.21
% of inflow to the reservoir	8	3	5
4.6 Flow regulation: inflow (+) or withdrawal (-)	0.71	-0.38	-1.09
5 Shardara reservoir			
5.1 Inflow to the reservoir	5.44	9.80	4.36
5.2 Lateral inflow	0.00	0.00	0.00
5.3 Water volume in the reservoir:			
– beginning of the season (1 April 2017)	4.63	4.63	0.00
– end of the season (1 October 2017)	1.13	1.19	0.07
5.4 Water releases from the reservoir	8.30	14.28	5.98
including:			
– *Discharge into Arnasay*	0.00	1.39	1.39

Balance item	Water volume, km³		Deviation (actual - plan)
	Forecast/Plan	Actual	
– *Water releases into river*	7.10	12.04	4.95
– *Water withdrawal from reservoir*	1.21	0.85	-0.35
5.5 Unrecorded inflow (+) or losses (-)	-0.64	1.04	1.69
% of inflow to the reservoir	12	11	1
5.6 Flow regulation: inflow (+) or withdrawal (-)	2.86	4.48	1.62
TOTAL Flow regulation by reservoirs: inflow (+) or withdrawal (-)	-3.85	-4.50	-0.65
TOTAL losses (-), unrecorded inflow (+)	-0.78	0.07	0.85

2 Amudarya River Basin

The actual water content in the Amudarya River at the nominal Atamyrat gauging station (upstream of intake to Garagumdarya) was 50.3 km³ or 11.57 km³ less than expected by the BWO Amudarya schedule (Table 2.2). The inflow to the Nurek HEPS amounted to 21.89 km³ and turned to be higher of the forecast by 1.46 km³. Water releases from the reservoir were 18.05 km³ or 1.44 km³ more than planned. Water withdrawal from the river through accumulation in the Nurek reservoir amounted to 3.84 km³ (Table 2.3).

Given such hydrological conditions, the established limit of water withdrawal into canals in the Amudarya River basin was 96% provided (Table 2.1). The total water withdrawal amounted to 38 km³, including 31 km³ downstream of Atamyrat gauging station (starting from intake to Garagumdarya). During the growing season, the average water availability was 86% for the Republic of Tajikistan, 96% for Turkmenistan and 100% for the Republic of Uzbekistan; in the lower reaches water availability was 87% for Turkmenistan, 100% for the Republic of Uzbekistan, and 85% for the Surkhandarya province (Table 2.1)

Water supply to TMHS was 11.4 km³ more than expected. This allowed accumulating about 2.1 km³ in the TMHS reservoirs over the growing season. In this period of time, the total water intake by the Nurek reservoir and TMHS reservoirs from the Vakhsh and Amudarya Rivers amounted to 5.9 km³.

Water losses in open channel of the Amudarya River at the nominal Atamyrat g/s to Bir-Ata g/s were calculated by the balance method and amounted to 4.27 km^3 or about 9 % of runoff at Atamyrat g/s. Water losses in the lower reaches (in the reach Tuyamuyun GS – Samanbay GS) were 2.63 km³ or 13% of runoff in the Tuyamuyun GS. Water losses along the Amudarya River (from the nominal Atamyrat GS-Samanbay GS) were approximately 9 km^3 or 18% of water content in the river.

An amount of 9.42 km³ (Amudarya runoff at Samanbay g/s plus collector-drainage flow) was supplied to Prearalie and the Aral Sea during the growing season.

Table 2.1

Water availability in the Amudarya River basin countries over the growing season 2017

Water user	Water volume, km³		Water availability %	Deficit (-), surplus (+) km³
	Limit/ schedule	Actual	Season	Season
1. Total water withdrawal	**39.7**	**38.00**	**96**	**-1.7**
2. By state:				
Kyrgyz Republic	-	-	-	-
Republic of Tajikistan	6.9	6.0	86	-1.0
Turkmenistan	15.5	14.8	96	-0.7
Republic of Uzbekistan	17.2	17.2	100	0.0
3. Downstream of Atamyrat g/s *)	**31.5**	**31.0**	**98**	**-0.5**
of which:				
Turkmenistan	15.5	14.8	96	-0.7
Republic of Uzbekistan	16.0	16.2	101	0.1
4. By river reach:				
Upper reaches	**8.14**	**7.00**	**86**	**-1.1**
of which:				
Kyrgyz Republic	-	-	-	-
Republic of Tajikistan	6.94	5.98	86	-1.0
Surkhandarya province, Uzbekistan	1.20	1.02	85	-0.2
Middle reaches	**16.28**	**16.42**	**101**	**0.1**
of which:				
Turkmenistan	10.51	10.51	100	0.0
Republic of Uzbekistan	5.77	5.91	102	0.1
Lower reaches	**15.24**	**14.58**	**96**	**-0.7**
of which:				
Turkmenistan	4.99	4.33	87	-0.7
Republic of Uzbekistan	10.25	10.25	100	0.0
5. **Additionally:**				
Emergency and environmental water releases to canals within lower reaches	0	0		
of which:				
Turkmenistan	0	0		
Republic of Uzbekistan	0	0		
Supply to the Aral Sea and Prearalie **	2.10	9.42	449	

***)** Atamyrat g/s nominal – section of the Amudarya River upstream of water intake to Garagumdarya

**) include the discharged collector-drainage water

Table 2.2

Amudarya River channel water balance for the growing season 2017

Balance item	Water volume, km^3		Deviation (actual-plan)
	Forecast/Plan	Actual	
1. Water content in the Amudarya River - non-regulated flow at Atamyrat g/s nominal	61.88	50.30	-11.57
2. Flow regulation in the Nurek reservoir: accumulation (+) or withdrawal (-)	-3.81	-3.84	-0.03
3. Water withdrawal in the middle reaches (-)	-16.28	-16.42	-0.14
4. Return flow (collector-drainage) in middle reaches (+)	1.93	1.95	0.02
5. Water losses (-) or unrecorded inflow to the channel (+)	-4.57	-4.27	0.29
% of flow at Atamyrat g/s nominal	8	9	1
6. River flow at Bir-Atal g/s	39.15	27.73	-11.42
7. Flow regulation in Tuyamuyun hydroscheme: accumulation (+) or withdrawal (-)	-7.00	-2.07	4.92
8. Releases from Tuyamuyun hydroscheme (including withdrawal from reservoir)	32.15	25.66	-6.50
9. Withdrawal in lower reaches, including withdrawal from Tuyamuyun hydroscheme (-)	-15.24	-14.58	0.66
10. Return flow (collector-drainage) in lower reaches (+)	0.00	0.00	0.00
11. Emergency and environmental water releases to canals (-)	0.00	0.00	0.00
12. Flow losses (-) or unrecorded inflow to the channel (+)	-6.67	-2.63	4.03
% of flow at Tuyamuyun g/s	25	13	-12.50
13. Supply to Prearalie and the Aral Sea (Samanbay g/s)	10.25	8.45	-1.80
TOTAL losses:	-18.23	-8.98	9.25
% of river water content	29	18	-11

Table 2.3

Water balance of the Amudarya River basin reservoirs for the growing season 2017

Balance item	Water volume, km^3		Deviation (actual-plan)
	Forecast / plan	Actual	
1 Nurek reservoir			
1.1 Inflow to the reservoir	20.42	21.89	1.46
1.2 Water volume in the reservoir:			
– beginning of the season (1 April 2017)	6.00	6.73	0.73
– end of the season (1 October 2017)	10.54	10.57	0.03
1.3 Water releases from the reservoir	16.61	18.05	1.44
1.4 Lateral inflow (+) or water losses (-)	0.73	0.00	-0.73
% of inflow to the reservoir	4	0	-3.58
1.5 Flow regulation: accumulation (+) or withdrawal (-)	-3.81	-3.84	-0.03
2 Tuyamuyun hydroscheme reservoirs			
2.1 Runoff at Bir-Ata g/s	39.15	27.73	-11.42
2.2 Water volume in the reservoirs:			
– beginning of the season (1 April 2017)	2.59	2.59	0.00
– end of the season (1 October 2017)	5.93	4.67	-1.26
2.3 Water releases from the hydroscheme	32.15	25.66	-6.50
of which:			
– releases into the river	26.61	20.98	-5.63
– withdrawal	5.54	4.67	-0.87
2.4 Unrecorded inflow (+) or water losses (-)	-3.65	0.01	3.66
Including % of inflow to the reservoir	9	0	-9
2.5 Flow regulation: accumulation (+) or withdrawal (-)	-7.00	-2.07	4.92
TOTAL flow regulation by the reservoirs: accumulation (+) or withdrawal (-)	-10.81	-5.91	4.90
TOTAL losses (-),unrecorded inflow (+)	-2.91	0.02	2.93