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Improvement of the Volume Determination and Operating Regimes of Reservoirs

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Abstract: The climatic, geographic, and demographic conditions of Uzbekistan have necessitated the development of water management, hydraulic engineering, and hydro-energy since ancient times. Approximately 6,000 years ago, in Uzbekistan, rainwater collection for irrigation (liman irrigation) involved constructing artificial ponds to regulate and properly distribute existing water resources, thus ensuring small areas of land were irrigated.

The experience of transferring water from one region to another to improve water supply was also acquired.

The task of creating and maintaining water reserves to ensure the timely and uninterrupted supply of water to consumers and users from reservoirs is also crucial. Currently, it is required to know the exact volume of water that can be accommodated in any reservoir during its operation, especially if the reservoir has been in use for many years.

Taking this into account, the Namangan region Reservoir Utilization Administration and the Scientific-Research Institute of Irrigation and Water Issues "Scientific-Research Consulting Center for Water-Saving Technologies" concluded a contract on May 16, 2023, for the performance of research work No. 8. In 2023, research was carried out by the "Scientific-Research Consulting Center for Water-Saving Technologies" to determine the current volume of the Eskiyer Reservoir.

To determine the current volume of the reservoir and the amount of sediment in the basin, modern GPS-equipped SONTEC S5

Doppler-profiler echo-sounders, Deeper CHIRP+ profiler GPS devices, HD-MAX echo-sounders, Garmin Etrex Vista GPS devices, and Sprinter 250 M levels manufactured by Leica, along with their GSS111 No. 741882/1 and No. 741882/2 (five-meter) barcode staff gauges, were used.

1. Components of the Eskier Reservoir Hydroengineering Structures:

The Eskier Reservoir's hydroengineering structures include the following components: Reservoir Basin; Dam; Water Intake Structure; Water Supply Channel (from Namangansoy River); Water Supply Channel (from the Great Namangan Channel); Water Discharge Channel; Low Pressure Dam.

Reservoir Basin: At the normative water retention level (NWRL), the reservoir basin has the following morphometric elements (projected): - Total reservoir volume – 185 million m3; - Basin length – 13 km; - Maximum width – 225 km; - Maximum depth – 23 m; - Area – 172 km2; - Area with depths up to 2 meters – 0.2 km2; The total length of the reservoir's shoreline is 144 km.

At OSS (operational storage): - Volume – 0.6 million m3; - Area – 0.35 km2. According to 2002 measurements: - Total water volume – 178 million m3; - Useful water volume – 172.5 million m3; - Dead water volume – 0.55 million m3; - Surface area at NWRL – 172 km2; - Sediment volume – 0.7 million m3. According to 2023 measurements: - Total water volume – 151.06 million m3; - Useful

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water volume – 145.74 million m3; - Dead water volume – 0.532 million m3; - Surface area at NWRL – 174 km2; - Sediment volume – 3.394 million m3.

2. Equipment and Devices Used in the Measurements and Research:

To determine the amount of sediment in the Eskier Reservoir basin, the following equipment was used: SONTEC S5 Doppler profiler with GPS for depths up to 15 meters, Deeper CHIRP+ profiler for depths beyond 15 meters, and Leica Sprinter 250 M electronic leveler for dry parts of the basin. The equipment used in the measurements is shown in Figure 1.

Sonar - Deeper CHIRP+

SANTEC S5 doppler profilograph used in experimental studies

Modern Leica Sprinter 250 M digital level

GPS - Etrex Vista (Garmin)

Lodochny motor Yamaha 2

Figure 1. Devices used to determine turbidity in the water tank.

A draft topographical map of the reservoir was found for measurement and research in determining the amount of turbidity in the reservoir basin (chasha). The design bank length, maximum width, maximum depth, etc. of the reservoir tank. parameters such as

Based on the map of the surface of the chasha at the current MDS mark, 7 dams were constructed from the side of the dam at every 200 m interval to the beginning of the chasha (water inlet).

Measurements were taken from the first bank of each river to the second bank using special devices. Geodetic and topographical measurements were carried out using Leica-Sprinter 250 M electronic levels in the dry part of the chasha, where there was no water while measurements were taken in the walls.

Currently, in the part covered by water, measurements were made using a SONTEC S5 doppler-profilograph and echolot-Deeper CHIRP+ profilograph.

3. To clarify the current water capacity of the water tank

According to the project, the period of filling the dead water volume of the reservoir with muddy sediments is set as 50 years.

We use the following expression to find the current volume of water by calculating the data obtained on the basis of measurements carried out in 2023:

$$W_{\text{умумий ҳажм}} = W_{\text{ств }_1\text{ҳажм}} + \cdots + W_{\text{ств }_n\text{ ҳажм}},\ (\text{млн.м}^3) \quad (1)$$

Бу ерда:

$$W_{\text{ств ҳажм}} = \frac{A_1 \cdot \sum S_{\text{ств}} + A_2 \cdot \sum S_{\text{ств}}}{1\,000\,000},\ (\text{млн.м}^3) \quad (2)$$

Here: A1 is the first lateral distance of the beam (m);

A2 is the second lateral distance of the beam (m). $\sum S_{\text{ств}} = S_{\text{ств}_1} + \cdots + S_{\text{ств}_n},\ (\text{м}^2)$ (3)

$\sum S_{\text{ств}}$ – sum of living cross-sectional area in MDS of the tree (m2).

$$S_{\text{ств}} = L_\Delta \cdot H_\Delta,\ (\text{м}^2) \quad (4)$$

Here: L_Δ – distance at each measurement point, (m);

$$H_\Delta = H_{\text{мдс}} - H_i,\ (\text{м}) \quad (5)$$

$H_{\text{мдс}}$ – standard humidified level, (m);

H_i – depth found at measurement point (m);

Calculation of the volume of water in the tank of the reservoir according to the 1st frame based on the data obtained from the measurement studies:

$W_{\text{ств-1 ҳажм}}$= 60*1017755,6+100*1696259,4/1000000=2,714 млн.м^3.

The volume of water in each tank was calculated by this method and the following result was obtained.

$W_{\text{умумий ҳажм}}$= 2,714+… $W_{\text{ств-2 ҳажм}}$+ $W_{\text{ств-3 ҳажм}}$+...$W_{\text{ств }_n\text{ ҳажм}}$= $W_{\text{умумий ҳажм}}$

4. Indicators of water capacity by levels in the reservoir cup

By calculating the data obtained on the basis of research-measurements, the length of the walls and the water capacity between each of the walls were calculated. The calculation results are presented in Table 1.

Table 1.The length of the shafts and the water capacity between the shafts are determined by calculating the survey data.

№	Wall №	Wall length, m	Wall length, m
1	Stvor-1	1176,5	2,991
2	Stvor-2	1190,7	3,584
3	Stvor-3	1258,1	3,502
4	Stvor-4	1090,3	2,314
5	Stvor-5	1776,0	1,717
6	Stvor-6	1118,0	0,998
Total water volume of the reservoir, million m3			**15,106**

Based on the results of the research, it can be noted that the total water volume of the reservoir at the standard wet water level mark is 15.106 million m3, and at the dead water level mark it is 0.532 million m3. Table 2 shows the size of the reservoir cup and its dependence on the water level (Fig. 2), while Table 3 shows the water volume and its dependence on the water surface area (Fig. 3).

Table 2.The ordinates of the curve relating the volume of the reservoir cup to the water level.

Symbol N, (m)	Volume, million m3	
	Projective	Measurement in 2023
720	18,50	15,106
719	16,50	12,730
718	15,00	11,369
717	13,20	10,169
716	11,80	9,263
715	10,60	8,317
714	9,50	7,545
713	8,10	6,716
712	7,05	5,919
711	6,00	5,084
710	5,25	4,428
709	4,40	3,779
708	3,80	3,186
707	3,10	2,592
706	2,40	2,090
705	1,90	1,684
704	1,40	1,327
703	0,90	0,824
702	0,60	0,532
701	0,30	0,288

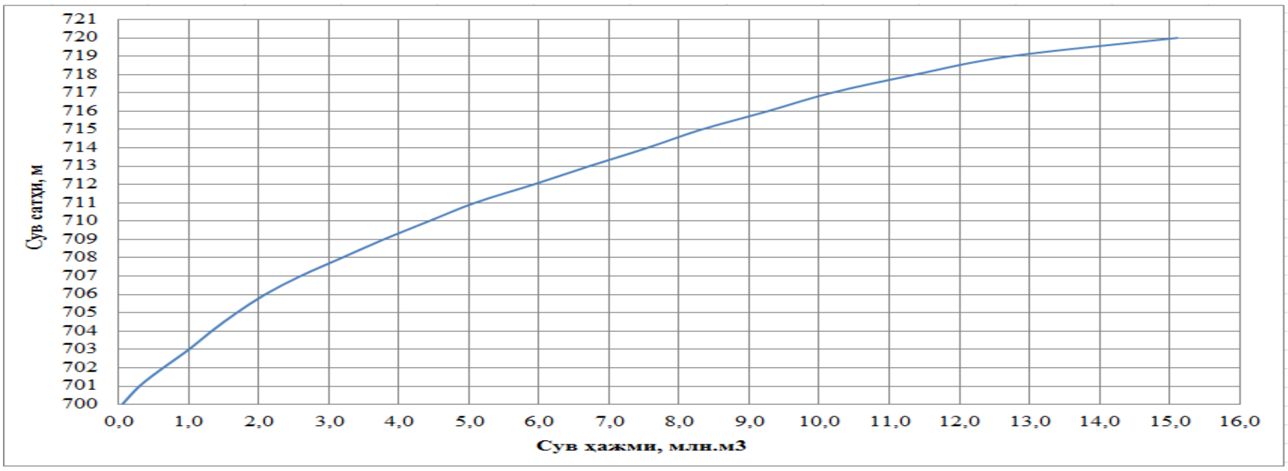

Figure 2. Reservoir water level versus water volume graph.

Table 3.Reservoir water level water water surface майдонига боғлиқлик ординаталари.

Symbol N, (m)	Projected	water table area, km2 (2023)
700	0,21	0,16
701	0,28	0,21
702	0,35	0,30
703	0,42	0,37
704	0,50	0,48
705	0,57	0,56
706	0,64	0,65
707	0,71	0,73
708	0,78	0,81
709	0,85	0,88
710	0,92	0,93
711	0,99	0,99
712	1,06	1,08
713	1,13	1,14
714	1,20	1,22
715	1,29	1,30
716	1,37	1,39
717	1,45	1,48
718	1,54	1,55
719	1,63	1,65
720	1,72	1,74

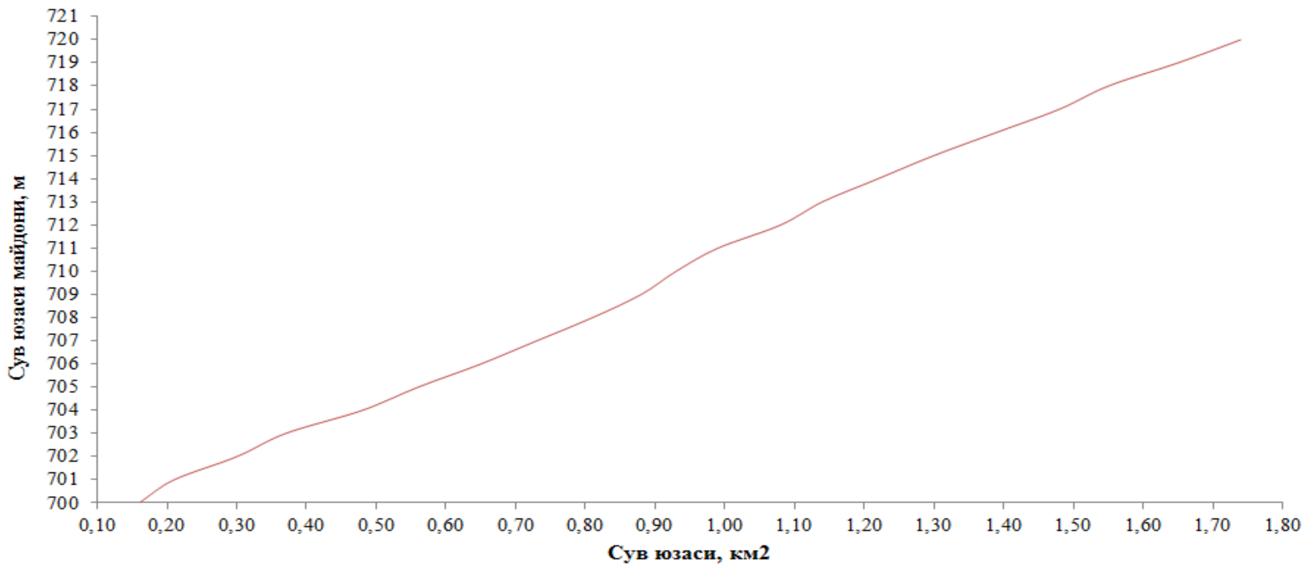

Figure 3. A graph of the relationship of the water surface to the reservoir water level.

Summary By calculating, processing and analyzing the data of the results of measurement research, the following is concluded:

- at present, the total water volume of the water reservoir at the level of the standard wetted water level is 15,106 million m3.
- the water capacity at the dead water level is 0.532 million m3.

- the surface area of water at the mark of the standard wetted water level of the water tank is 1.74 km2.
- the water surface area at the dead water level mark of the reservoir cup is 0.30 km2.
- the amount of muddy sediments in the water tank is equal to 3,394 million m3.

5. Reservoir filling and emptying schedule

It is necessary to save and efficiently use the water in reservoirs. Especially in our region, i.e., in areas where grain and cotton are planted, irrigation works are carried out almost all year round.

For this, it is necessary to strictly control the water supplied from the reservoir. This can be achieved annually, at the beginning of the year, by drawing up a dispatching schedule of the use of the reservoir. When drawing up the graph, it is necessary to take into account the flow of water in the river supplying the reservoir, the volume of water collected in the reservoir until the beginning of the year, and the plan to deliver water to consumers in the accounting year.

First, on the basis of 15-30 years of hydrological observations on the river supplying the reservoir, the change of water flow is studied, and from these years, those with a lot of water, average and low water are found.

Then, the input and output of the ten-day water balance of the water reservoir of these years are considered. After all the data is collected, a dispatch schedule is created to efficiently fill and empty the reservoir.

Changes to the schedule during the accounting year can be made only due to a possible error in the preliminary calculation of the annual flow to the reservoir.

The dispatching schedule will consist of reservoir filling and water supply boundary lines. Based on the measurement data in 2023, the water level marks and water volumes corresponding to the ordinates of the reservoir filling boundary line constructed using the data of the Reservoir Utilization Department are presented in Table 4 and graphically.

The ordinates of the water discharge limit line are presented in Table 5 and graphically in Figure 4.

Table 4.Water level marks corresponding to the ordinates of the boundary line of reservoir filling

Months	Water volume, million m3	Water level mark, m
January	10,812	717,4
February	13,026	719,1
March	15,106	720,0
April	12,259	718,9
May	10,088	716,9
June	10,622	717,3
July	13,831	719,4
August	10,642	717,3
September	9,522	716,2
October	7,925	714,4
November	9,057	715,8
December	9,726	716,5

Table 5.Water level marks corresponding to the ordinates of the demarcation line of the reservoir

Months	Water volume, million m3	Water level mark, m
January	1,905	705,6
February	2,465	706,8
March	3,062	707,7
April	2,791	707,1
May	2,05	706,0
June	1,971	705,8
July	1,822	705,6
August	0,911	702,7
September	1,043	703,0
October	0,532	702,0
November	1,043	703,0
December	1,271	703,8

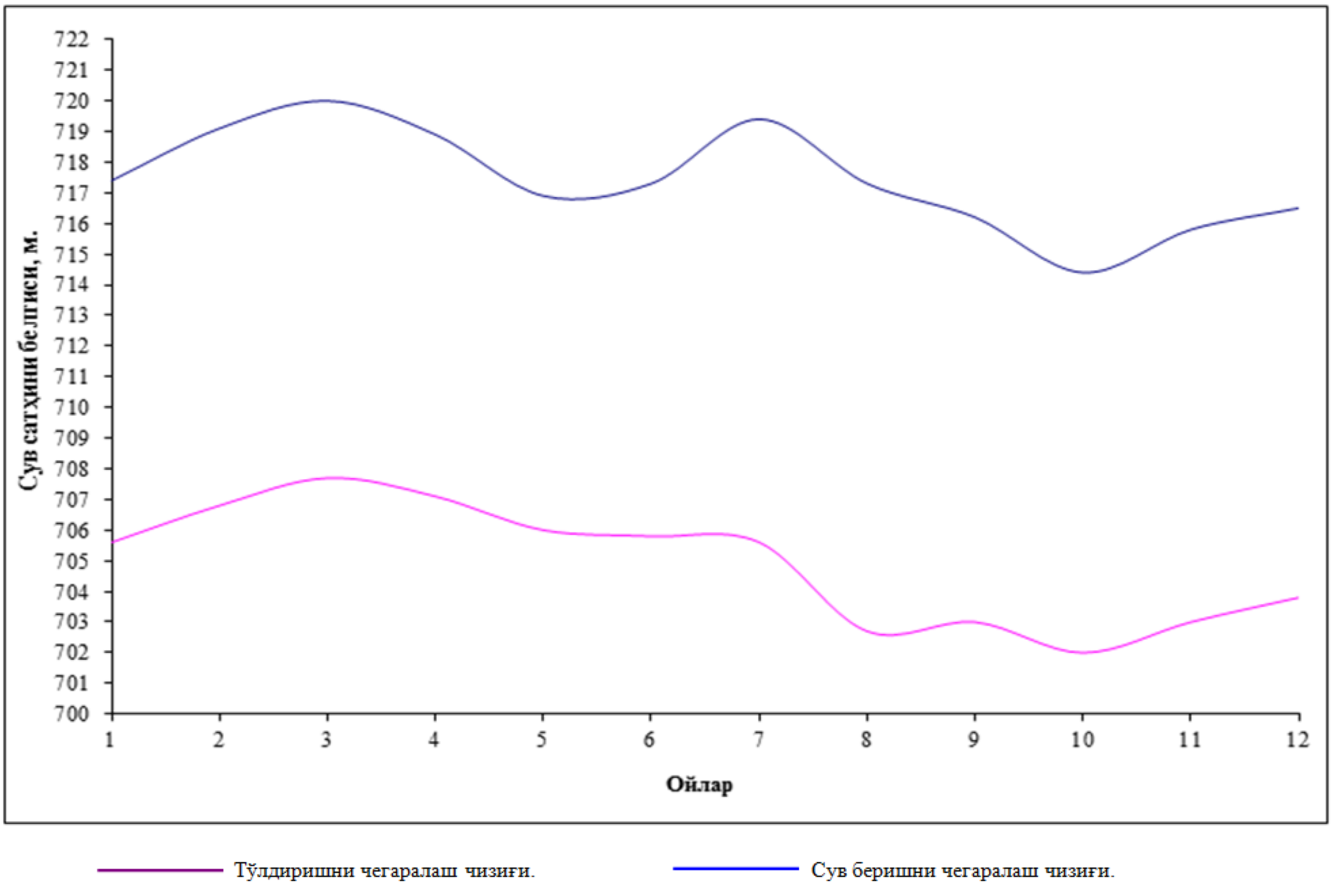

Figure 4. Filling and emptying (dispatching) graph of the reservoir.

Ушбу the use of a dispatching schedule, which takes into account all the variable conditions of the year in the flow of water, makes it possible to reliably supply water to all consumers.

In the years of low water, the redistribution of water will reduce the negative impact of the limited amount of water, so that the economic damage will be the least.

In the years of high water, the dispatching schedule makes it possible to prevent accidents by excluding unnecessary water supply.

If water reservoirs are planned and operated based on the above measures, malfunctions and accidents occurring in them will be prevented, water reservoir operation will be further improved, and the water in the reservoir reserve will be used efficiently.

List of used literature

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