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RESEARCH RESULTS OF FLOW HYDRAULIC AND SLUDGE SEDIMENT REGIME IN A RIVER WITHOUT A DAM

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A B S T R A C T	*K E Y W O R D S*
Abstract. In this article, the analysis of the results of the field research conducted to assess the hydraulic and turbidity regime of the water flow in the area of the damless water intake project in the middle stream of the Amudarya, and the speed of the sedimentation processes of the turbidity in the river to the head of the water intake channel, based on the hydrodynamic parameters of the river in order to prevent deformation processes, was determined.	stvor, uzan, water level, depth, hand lot, reka, discharge, downstream.

Introduction

Amudarya is one of the largest rivers of Central Asia and flows north and north-west from the eastern slopes of the Hindikush Hills in Afghanistan. Amudarya originates from the confluence of the Vakhsh, Bakhandarya, Pamir and Panj rivers and flows through the territories of Tajikistan, Turkmenistan and Uzbekistan. The rivers flow at a distance of 1437 km from the confluence and flow into the Aral Sea. The total area of the Amudarya basin is 465,000 km2. The catchment area is 216,000 km2. One of the important tasks of channel hydraulics is to predict the hydrodynamic properties of the water intake structure without a dam in Amudarya. In the case of water intake without a dam, the development of the seepage process has a negative effect on the reliability and operation of the water intake facility.
Calculation of the operating mode of the water intake channel, which has completely exhausted its resources and has been repaired several times, and is working under severe conditions, based on the operating conditions of the irrigation system objects, determining the laws of change of the reliability indicators of the hydromechanical conditions in the structure, the effect on the pumping devices of the sewage water transfer system, cleaning the sewage removal technologies and in the scientific works performed on improving the techniques, justifying the parameters of the treatment device, the issues of taking into account the composition, sizes and flow period of the effluents, and ensuring the water level in the vane chamber are not sufficiently studied until now.
The area where field research was conducted is located in the middle stream of the Amudarya basin, the bed of which passes through rapidly leaching soils, and it is considered the water intake area of the Karshi Main Canal, which supplies water to the irrigation fields of the Kashkadarya region of the Republic.

Research Methodology

The research methods are theoretical and practical, and the methods of calculating the hydraulic and turbid sediment regime of the flow in the area of the damless water structure were chosen as the main goal of the research. In the research process, geodetic and hydrometric measurement works, field-observation methods, generally accepted methods in hydraulics, mathematical models based on the laws of hydromechanics are created and used.

Analysis and Results

Studying the dynamics of turbid sediments along the length of the head of the channel in the catchment area of the river without a dam and identifying the areas of rapid sedimentation. Based on the results of scientific research, develop schemes for the optimal placement of earthworks in the riverbed, reduce silt sedimentation by adjusting the flow, identify and eliminate areas with a high probability of coastal washing and negative processes that occur in the water transfer channel, and develop appropriate recommendations for the working conditions of the water intake facility without a dam. consists of improvement.

Main Part

The research object is located in the middle stream of the Amudarya basin, which flows through rapidly leaching soils, and is considered the catchment area of the Karshi Main Canal, which supplies water to the irrigation fields of the Kashkadarya region of the Republic. First, it is necessary to study the main characteristics of Amudarya.

Hydrometric measurement works were carried out in the area of water intake without the opposite highway dam. Information on the solid flow regime, its annual and multi-year variability, sediment size, fractional and chemical composition is of great importance in the design, construction and effective operation of reservoirs, main channels, sluices and other river sediment control facilities, and in predicting channel deformation.

First, hydrological water measurement sites were selected for this purpose. Measurement walls were marked at the selected water measurement site. Water level, water depth, water speed, water turbidity level and other hydrometric measurement works as well as meteorological observation works were carried out in the designated dams in the area of water intake without dams.

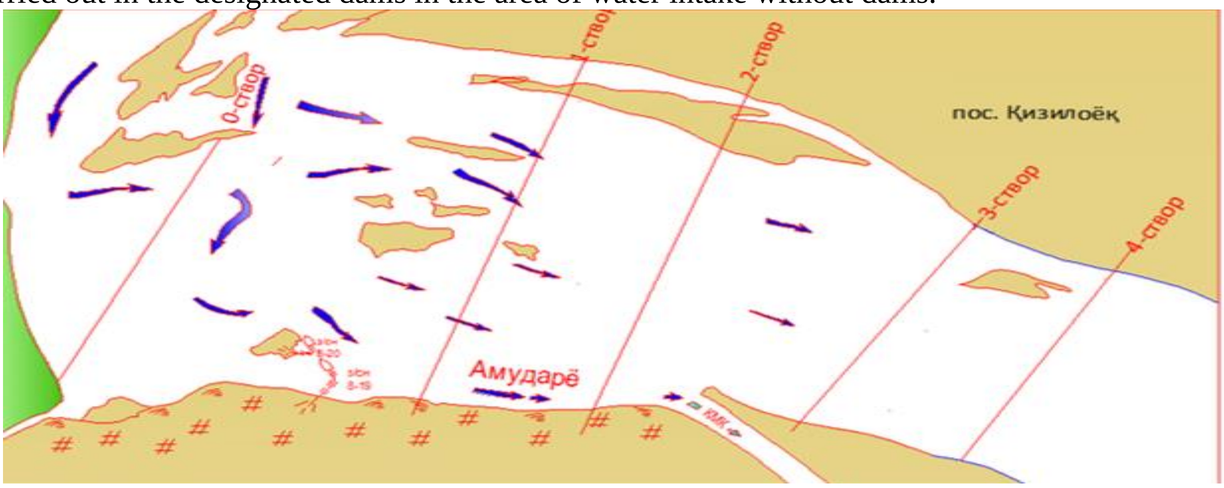

Figure 1. Measuring towers in the water intake area of BCR

Water levels were monitored three times a day at 8:00, 12:00 and 18:00. In order to compare the observed water levels, they were brought to a conditional horizontal plane, this plane is called the "0" graph of the hydrological water measurement site.

Figure 2. Water level gauge

Added the calculated value from the water gauge to determine the level of the water level relative to the "0" graph. The average daily water level was taken as the arithmetic mean of the measured quantities:

$$H_{ўрт} = \frac{H_{06} + H_{12} + H_{18}}{3} \quad (1)$$

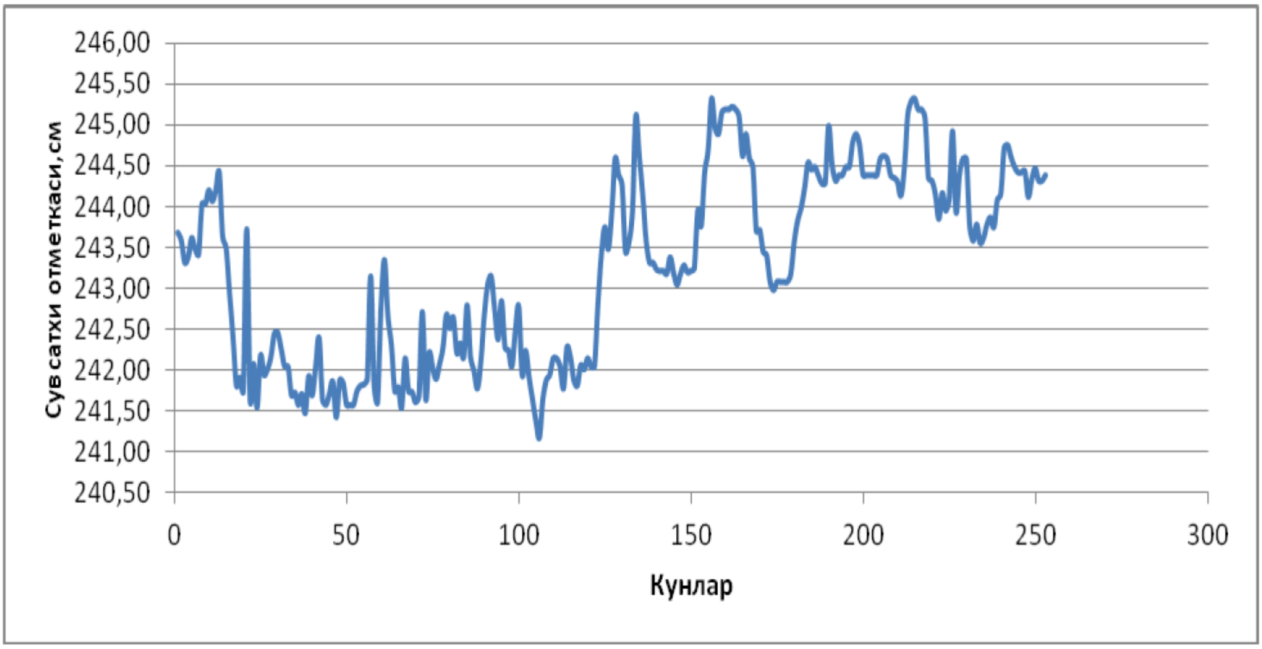

Figure 3. Average daily water level change graph. BCR in the input field

Depth measurement works in the water intake area of Amudarya BCR were carried out using topographical maps mainly in 4 areas. The purpose of the depth measurement works is to determine the structure of the river bottom in the area of water intake without dams and to study the dynamics of riverbed processes, as well as to improve the water intake conditions of BCR. Depth measurement works were carried out every 5 days on stvors. Initially, the depth of all walls was measured using a hydrometric bar and a hand lot on longitudinal and transverse cuts. A hand lot with a standard weight of 4.5 kg, a diameter of 56 mm and a length of 100 mm and a length of hemp rope of 15 m was used for the depth measurement.


Figure 4. Preparation of hydrometric bar and depth measurement works


Figure 5. Depth measurement works in the catchment area of BCR

It was necessary to increase the weight of the hand lot when the water flow rate was high in the river at certain times. In order to better reflect the complex situation of the river bed, the depth measurement was carried out twice (from the left bank to the right bank and vice versa).

Based on the measured depth data, the morphometric parameters of the river were determined. The width of the river $B = b_1 + b_2 + ... + b_n$ is equal to. The sum of the distances between verticals measured across the width of the river in the 3rd stvor is $B = 712$м. The cross-sectional surface of the river was determined as follows.

$$F = \frac{h_1 \cdot b_1}{2} + \frac{h_1 + h_2}{2} b_2 + ... + \frac{h_{n-1} + h_n}{2} b_{n-1} + \frac{h_n b_n}{2} \qquad (2)$$

According to him, he organized the 3rd stvor $F = 1565{,}3\ m^2$.

The average depth of the river is as follows $H_{ўрт} = \frac{F}{B} = 2{,}2\ m.$

Based on the measured depth data, calculations were made for 4 walls.

The slope of the water level curve in the research area was 0.0002 : 0.00025.

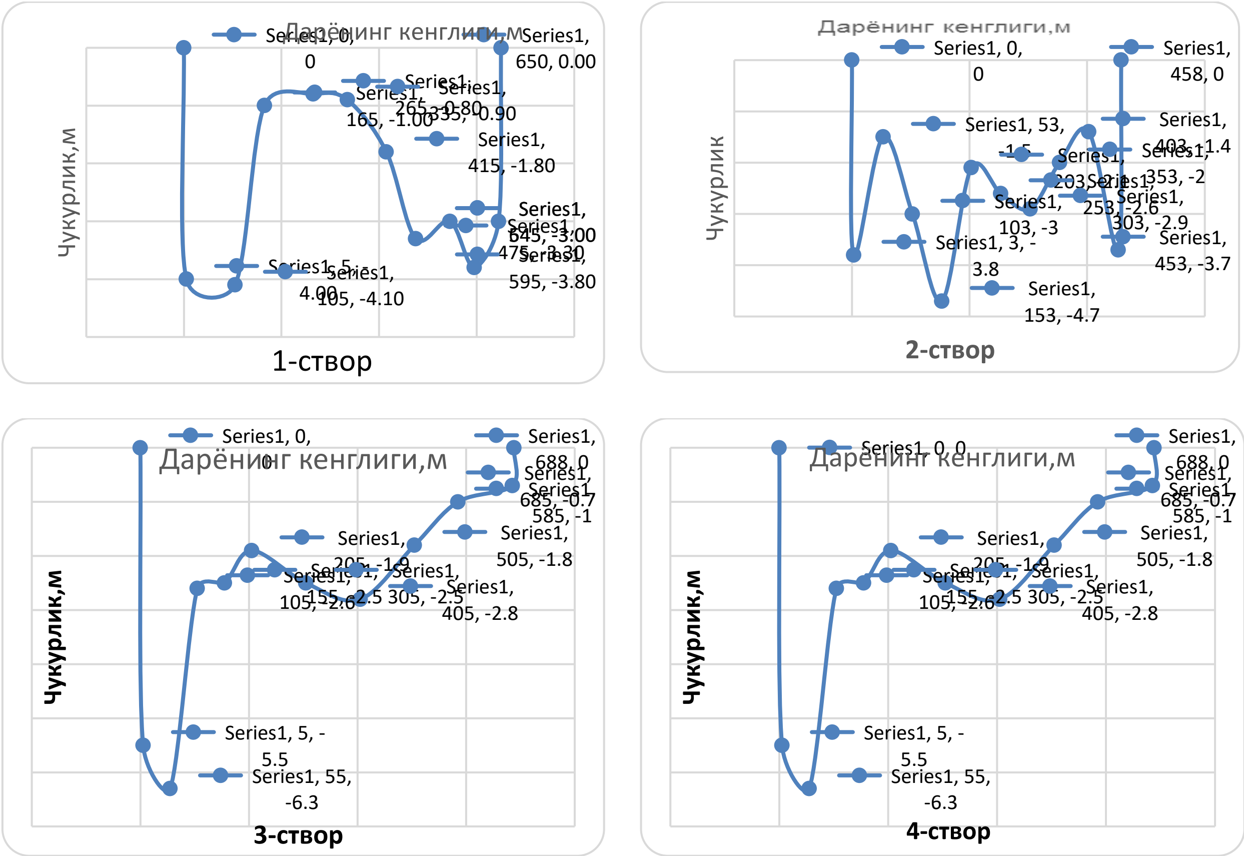

Figure 6. Dynamics of the bottom cross-section of the lower part of the Amudarya basin in the catchment area without dams of BCR

In field studies, it was found that erosion is the most important of the physical-geographical factors, because it determines the shallowing of the river. At the same shallowing of the river, the longitudinal profile of its bottom can change on different scales, depending on the curvature of the river, like a snake's track. This curvature is related to some form of fluid consumption. An increase in runoff requires a standard value of bed slope, which is determined based on all possible erosion to transport these runoff from the stream. In this case, it is observed that the core is in the right shape and it is straightened in its crooked areas.

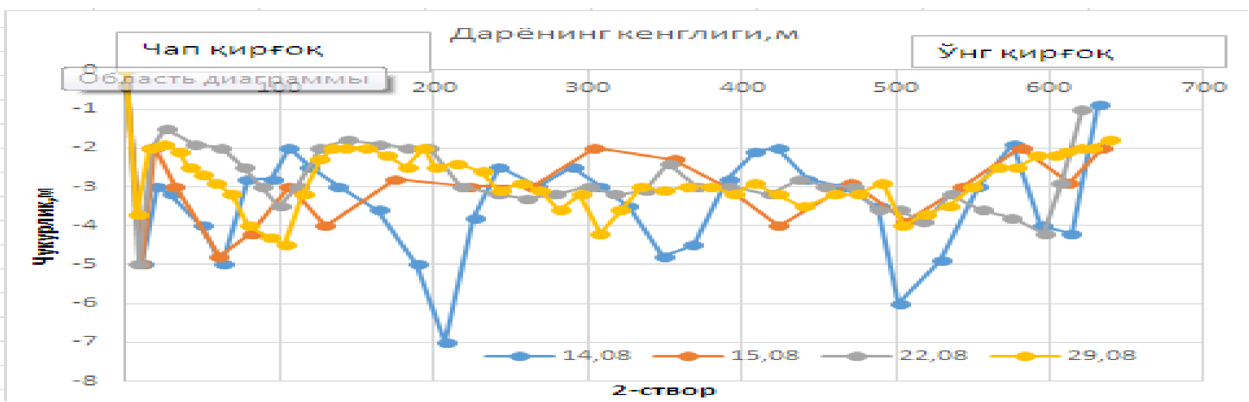

Figure 7. Changes in depths in the BCR catchment area in 2 dimensions

It should be noted that Amudarya is the second most turbid river in the world. Taking this into account, a very large amount of nanoparticles are dragged along the bottom of the channel, sometimes hitting it, sometimes breaking off and entering the channel suspended in the water flow. A certain part of these discharges reaches the cultivated fields through the irrigation channel. This also complicates the operation mode of pumping stations.

An increase in the inflow of sediments into the well causes a decrease in the depth of the flow of water moving in the well and an increase in the width of the well. This situation, in turn, leads to the emergence of a dynamic balance. The expansion of the channel width leads to an increase in the width of the flow front and ensures their transport. The change in depth was compared in the water catchment area of BCR.

According to the results of depth measurement, it is explained by the fact that the current in the area is very unstable and highly mobile, and in a short period of time, large river bed processes can occur. This indicates that the hydraulic regime of the river significantly redistributes the speed, depth and width of the flow.

In the course of our research, we used reduced and detailed methods of water consumption in the analytical calculation of turbid waste consumption. Instruments used to measure water turbidity were sampled using a bathometric bottle. Measurements of water turbidity were carried out every five days at designated river banks.

Analytical calculation of consumption of cloudy discharges: 1) one-point and two-point; 2) along the entire vertical; 3) the section was carried out using surface methods.

The turbidity at each point was determined by the following formula. $\rho \; \frac{P_i \cdot 10^6}{V_n}; \quad g/м^3$

(3)

Here P_i - cloudy liquid weight, in grams; V_n - sample size in ml.

Unit consumption was determined by multiplying the velocity at the point by the turbidity.

$$\alpha = \rho \cdot \vartheta; \quad g/м^2 сек \qquad (4)$$

The average unit costs in the vertical were determined for two points as follows:

$$\alpha_{ўр} = 0{,}5(\alpha_{0{,}2h} + \alpha_{0{,}8h}); \quad g/м^2 сек \qquad (5)$$

After determining the average unit costs in each vertical, the suspended effluent costs were determined. The consumption of suspended solids flowing through the river is analytically calculated using the following formula:

$$R = 0{,}001\left[k\alpha_1 f_1 + \left(\frac{\alpha_1 + \alpha_2}{2}\right) f_2 + \ldots + \left(\frac{\alpha_n + \alpha_{n+1}}{2}\right) f_{n+1} + k\alpha_n f_n\right]; \quad кг/сек \qquad (6)$$

Here $\alpha_1, \alpha_2, \ldots \alpha_n$ - average unit costs in verticals - a coefficient, this coefficient is chosen depending on the distribution of the flow speed in the coastal part, $k = 0{,}7$ and $f_1, f_2, \ldots, f_n$ - areas between verticals.

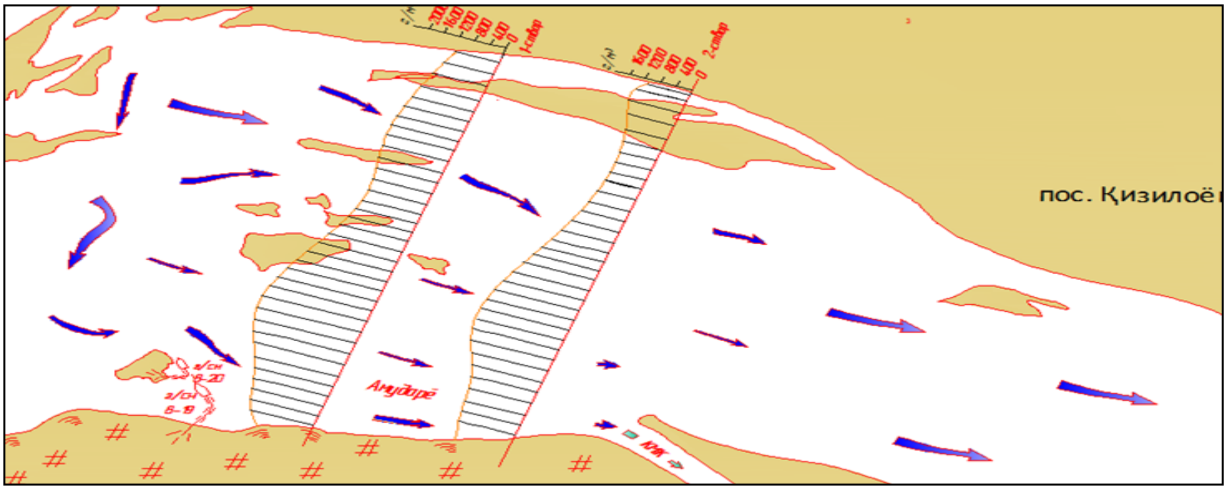

Figure 8. Distribution of turbidity in the catchment area of BCR by streams

As can be seen from Figure 8, under the influence of the damless water intake structure, the flow is redistributed, the height of the river bed in the right and middle tributaries rises, and the tributaries are undergoing a process of reshaping.

In the figure, it is shown that the turbidity in the flow does not change its direction relative to the dynamic axis of the main flow. In these walls, it can be seen that the significant curvature of the turbidity flows towards the entrance channel and begins slightly earlier than the curvature of the streamlines. 2, the above-mentioned regularity is preserved - current lines have a greater curvature and are deformed in the main body much wider than on the right side of the coast.

The fractional composition of suspended solids in the stream in the area of the water intake facility for the Karshi main canal of Amudarya was studied based on the Efremov method. The result of the analysis showed that they are distributed in percentage shares as follows:

$$d \succ 0{,}25\ мм \quad (W > 26\ {}^{мм}/_{c});$$

$$d = 0{,}25 - 0{,}05\ мм \quad (W = 26 - 2\ {}^{мм}/_{c});$$

$$d = 0{,}05 - 0{,}015\ мм \quad (W = 2 - 0{,}2\ {}^{мм}/_{c});$$

$$d = 0{,}016 - 0{,}005\ мм \quad (W = 0{,}2 - 0{,}02\ {}^{мм}/_{c});$$

$$d < 0{,}005\ мм \quad (W = 0{,}02\ {}^{мм}/_{c}).$$

Table 1 The content of suspended solids in the Amudarya water flow

Measurements	Fractional composition, %				
	> 0,25 мм	0,25-0,05	0,05-0,015	0,016-0,005	0,005
1	3	4	5	6	7
21.05	0,29	19,10	56,81	21,32	2,58
21.05	1,46	30,87	49,91	14,76	3,00
21.05	0,32	27,05	49,32	19,33	3,98
21.05	0,53	24,90	53,59	17,43	3,55
17.06	1,74	35,32	41,45	17,85	3,64
17.06	1,65	31,60	44,16	20,47	2,12
17.06	0,22	29,42	41,03	25,38	3,98
19.06	2,39	34,58	40,85	31,38	3,79
19.06	5,13	46,70	18,39	13,80	2,99

The distribution of discharges in the flow in this area for the current period is presented in Table 1 above. In this, the amount of sand fraction changed from $(d > 0{,}25\,мм)$ 0,29 % to 2,39 %. The amount of fine particles mixed with sand and dust changed $(d = 0{,}25 \div 0{,}05\,мм)$ from 19,10 % to 50,94 %. The amount of dusty discharge $(d = 0{,}05 \div 0{,}015\,мм)$ from 31,38 % to 56,81 %, and the amount of dust emissions changed $(d < 0{,}05\,мм)$ from 2,12 % to 3,98 %.
The studies of leading scientists were analyzed to compare the dynamics of the fractional composition of suspended solids.

Table 2 Fractional composition of suspended effluents in the middle stream of Amudarya according to Rogov's research

The season	Number	Particle size, mm; fractional content, %			
		0,25 мм	0,25-0,05 мм	0,05-0,01 мм	0,01 мм
1	2	3	4	5	6
winter (XII - II)	16	0,01	18,9	27,2	53,8
spring (III -V)	29	0,04	15,6	26,1	58,2
summer (VI -VIII)	35	0,06	13,2	30,9	55,8
autumn (IX - XI)	33	0,01	18,4	28,3	53,2

Table 3 Fractional composition of suspended effluents in the middle reaches of the Amudarya according to Shapiro's research.

Period	Number of analyses	Fractional composition, %		
		0,05 mm	0,05-0,01 mm	0,01 mm
1	2	3	4	5
for 4 years	100	24,91	65,68	9,41
April	7	21,3	72,2	6,5
May	16	20,2	65,2	14,6
June	27	24,1	67,2	8,3
July	19	24,8	67,0	8,2
August	13	24,1	69,5	6,4
September	15	12,2	75,8	11,9
October	3	20,2	60,4	19,4

Table 4 Fractional composition of discharges moving along the bed of Amudarya stream

The date	Fractional composition %				
	Hydraulic size, mm/sec				
	0,25	0,25-0,05	0,25-0,016	0,015-0,005	0,005
1	3	4	5	6	7
21.07	5,06	72,39	15,99	5,63	0,93
21.07	12,40	83,32	2,84	1,10	0,34
21.07	25,87	70,50	2,62	0,80	0,21
21.07	1,88	49,10	40,90	7,19	0,93
21.07	0,72	55,54	34,52	8,37	0,85
21.07	1,16	35,52	52,71	9,05	1,56
17.08	20,92	74,40	1,00	1,90	1,78
17.08	6,86	45,42	33,2	12,35	1,95
17.08	11,80	41,08	30.37	14,72	2,08
17.08	3,14	66.48	10,79	18.57	1,02
17.08	39,65	50,36	6,43	3,22	0,34
17.08	50,17	48,98	0,09	0,42	0,34
17.08	1,49	27,50	46,10	19,68	5,23
17.08	1,35	27,24	49,77	16,13	5,51
17.08	55,35	42,79	1,14	0,38	0,34

The comparative analysis of charts based on Tables 1-2 and 3 is showed that large $(d > 0,05\ мм)$ and small $(d < 0,01\ мм)$ the fractional composition of the particles varies dramatically. In first table $(d > 0,05\ мм)$ while the amount of fractions is 16-20%, in table 3 this amount has changed to 30-35%. Amount of small fractions $(d < 0,01\ мм)$ in third table showed 50 %, the fractions in fourth table $(d > 0,05\ мм)$ 24,9%, $(d < 0,01\ мм)$ and 9,41%.

But it is appropriate to take into account the difference between the methods of determining fractional contents.

Therefore, tables 2-4 can be compared with each other. This comparison showed an increase of 10% despite a decrease in the amount of sandy discharge.

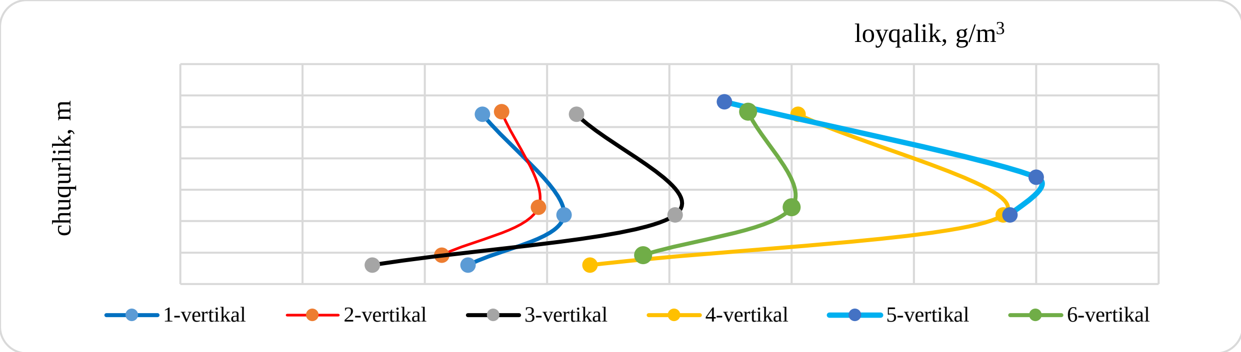

Figure 9. Dependence of water turbidity on depth in BCR water intake area without dam (22.08.21)

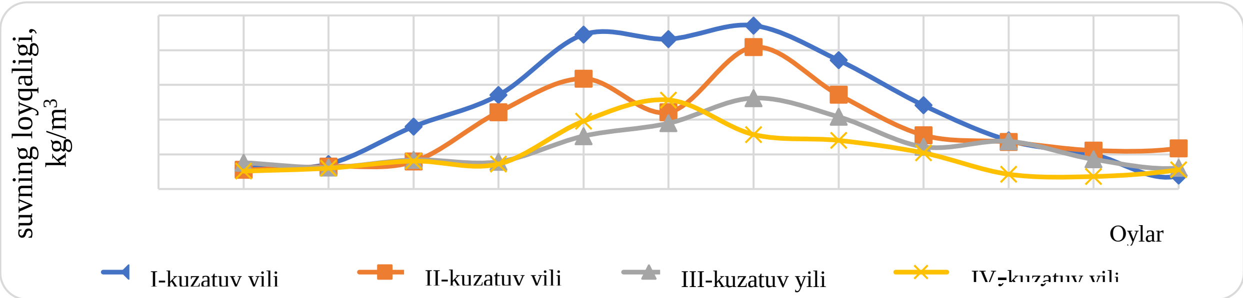

Figure 10. Changes in the turbidity of Amudarya water over the years

The turbidity of the current reaches its maximum values in the spring and summer periods. It was observed that the water flow is maximally clear in autumn and winter. The results of several years of studies have shown that the depth change dynamics increases when the water level rises, and decreases during low water periods.

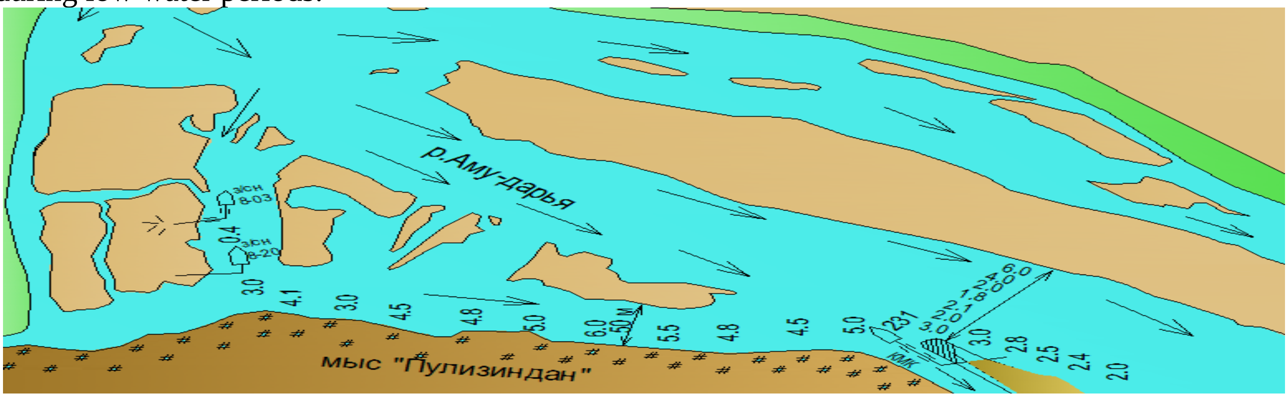

Figure 11. BCR damless water catchment situational scheme and proposed earthworks location scheme

The fact that the height of the riverbed and river bottom remain almost unchanged for many years can be explained by the high saturation of the stream with discharges. The analysis of field research data shows that the flow velocity of the river is lower than at the surface, the flow particles in the bottom have less inertia compared to those of the surface, and they are more affected by the flow deflection. This is explained by the fact that the flow at the bottom is more widespread near the entrance channel than the flow at the surface.

Conclusion

1. According to the results of the field study conducted in the water intake area of the Amudarya River without a dam, the water flow is redistributed under the influence of the main water intake structure without a dam, the height of the river bed is rising in the right and middle tributaries, and the process of reshaping of the tributaries is underway.
2. In order to ensure the reliability of the water intake facility without a dam, it is necessary to develop hydraulic and structural schemes based on methods that ensure the reduction of the volume of muddy sediments entering the water intake channel.
3. In order to prevent defamation processes in the riverbed, it is necessary to build the first temporary measures, that is, the system of embankments and spurs. Taking into account the costs of production and transportation of reinforced concrete products, it is recommended to strengthen and build local dams (spurs) with reinforced concrete structures in the future.

As a result of the accumulation of muddy sedimentary rocks on the right bank above Pulizindan hill, it is possible to observe that the flow almost slows down and moves towards the left bank. Such a change in river processes is creating unfavorable conditions for obtaining water without dams in BCR. During the low water period of winter, the minimum value of the water level near Pulizindan Hill is 242.75 m, which complicates the situation of water intake. In this case, the planned water intake will not be provided in the BCR.

The method of determining the speed of deformation processes has been improved, taking into account the hydrological regime of the river in the area of the damless water intake structure of BCR.

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