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The influence of sedimentation reservoir on hydraulic parameters of irrigation channels

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Abstract. The article describes the influence of the exploitation condition of the reservoirs on the hydraulic parameters of the Big Fergana main channel in Fergana valley. Fractional and variable chemical composition of the sediments flowing with the water into the reservoir as well as their changes during the growing season is considered to be the main factor of this process. As a result of field experiments, it was found that the main share of sediments flowing into the reservoir consists of sand particles with a size of 0.01-0.1 millimeters. Analysis of the working effectiveness of the reservoir showed that 45-50% of these particles are kept within the reservoir, while the other pass further to the channel. Surveillance and experimental studies on the reservoir are mainly based on sedimentary particles of 0.10-0.05 and 0.05-0.01 mm and their water content is around 71-85.4%, with a larger size of 0.1 mm. and sediments with a diameter greater than the average for most of the aquifer. The obtained results indicate the influence of the sedimentary water reservoir on the hydraulic parameters and functioning capacity of the Big Fergana channel.

1. Introduction

Surface water resources of Uzbekistan carry sediments, which are rich with the elements of the mineral fertilizers. However, the hydrotechnical facilities constructed with the aim of sediment controlling, water regulation and water use, do not regulate the sediments in a proper way. Also, modern sediment management facilities were planned to regulate and control sediment flow in a laminar flow regime, which does not always take place.

The analysis of theoretical and experimental studies on the study of sediment movements in open rivers shows that the work in this direction is mainly carried out during the laminar flow movement and that there is little research on the distribution of sediments during uneven, turbulent movement [1–4].

One of the important factors in the study of the sediment flow and washing processes in the river is the determination of the regularity of the flow distribution of sediments during uneven movement [5–7].

It is important to study the sedimentation process that forms the basis of the projection of irrigation sedimentation reservoir and irrigation channels. An analysis of existing methods for calculating sediment length distribution shows that these methods have been developed mainly for adjustable structures with constant cross-section, with the mean flow rate assumed to be constant along the length of the river bed [8–12].

Long-term observations, experimental and field studies, and theoretical conclusions show that the main cause of fluctuations in the flow rate is the change in flow rates. This, in turn, depends on the change of flow cross-section area [13, 14].

1.1. Object of research and problem solving

The Kuyganyor sedimentation reservoir was designed to control river sediments at the head part of the Big Fergana Channel (BFC, Uzbekistan) (figure 1). Kuyganyor is a two-chamber hydraulic periodic flush gasket, built in 1962 to drain water from the Big Fergana Channel into the Karadaria. The kettle starts at the Kuyganyor hollow and ends at the water intake facility with a total length of 2.7 km.

Figure 1. Satellite image of the Kuyganyor sedimentation reservoir

The sedimentation reservoir has concrete slabs up to 110 m from the original chamber and up to 140 m in the second chamber. The average water velocity in the quencher is 0.35 m/s and during the washing, it is expected to reach 1.8 m/s with a volume of 200,000 m^3. Once a year, when the Big Fergana channel is under maintenance or when the water flow in the channel stopped, washing the cooler will take place at the end of December. Washing processes are carried out periodically, 100 m^3/s water consumption is given for 10-12 days during each cycle and thus the washing project is envisaged.

The amount of river sediments per cubic meter of water flowing from the Karadaria into the Kuyganyor reservoir, and their fractional composition, as well as the effects of these sediments on the hydraulic parameters of the Big Fergana Channel, is unreasonable.

1.2. The purpose of the study

Estimation of the performance of the sedimentation reservoir and its impact on the hydraulic parameters of the Big Fergana channel by examining the fraction composition of the sediments entering the Kuyganyor reservoir to control river sediments.

2. Methods

The methods used in hydraulics and hydrology were used in the study, mathematical models based on the laws of mechanics, and mathematical and statistical methods for processing experimental data.

3. Results and Discussions

Variations in sediment volume, fractional composition, hole lengths, and other hydraulic parameters were investigated following the above methods [15–18]. Field experiments have shown that the water level of river sediments along the length of the hole varies according to the following graph (figure 2).

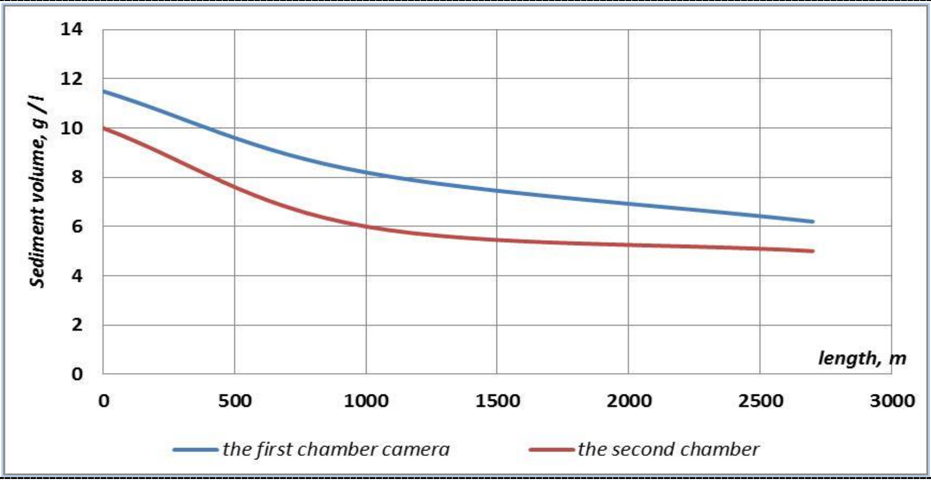

Figure 2. Sediment distribution in sedimentation reservoir

Visual analysis of this graph shows that the level of sedimentation in the starter is very high. If this indicator is 11.5 g/l in the first chamber, we can see that the water in the second chamber is 10 g/l. At the bottom of the sink, the water turbidity was slightly reduced, meaning that the sediment was not fully submerged and that the flow to the channel was 6.2 g/l.

The fractional composition of river sediments varies throughout the year, and in August the sediments with a diameter greater than 0.1 mm are decreasing, and the amount of sediment varies depending on the sediment content in the river water. Laboratory analysis of water samples at different times of the vegetation period shows that the bulk of the sludge in the water is particles with a diameter of 0.10-0.05 and 0.05-0.01 mm and their proportion in the water changes to 71-85.4%. possible (Table 1, figure 3).

Table 1. Dynamics of the fractions in the channel sediments during vegetation period

Sediment diameter d, mm		0.25-0.1	0.1-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001
May	%	25.6	37.5	33.5	1	2.1	0.4
August		-	31.5	54.9	3.8	5	3.7

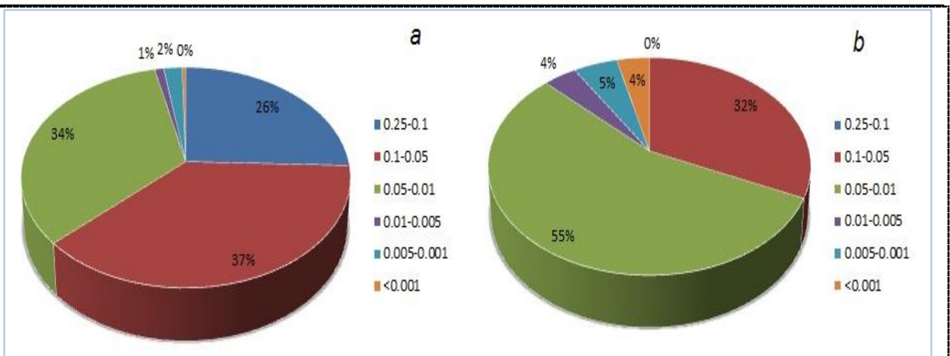

Figure 3. Fraction composition of sediments in Kuyganyor sedimentation reservoir (2018) (a-may, b-august)

When analyzing the sediment fraction in accordance with the assessment system of the United States FAO Research Center [19], we have the following table (Table 2). That is, the bulk of the sediments were sandstone (*d* = 0.05-2mm) in May (63.1%), and in August they were dusty (*d* = 0.002-0.05 mm) (63.7%)).

Table 2. Fraction composition of sediments in sedimentation reservoir (triangle USA)

Month	Value of fractions (mm) in %			Name according to FAO	
	Sand 0.05-2 мм	Dust 0.002-0.05	Clay <0.002		
May	63.1	36.6	0.4	SL	Sandy Loam
August	31.5	63.7	3.7	L	Loam

Because the Big Fergana channel is the main irrigation network for arable land in the central region of Uzbekistan, agrochemical sediments have been studied to assess the irrigation importance of the channel (Table 3).

Table 3. Agrochemical composition of sediments

Name of the place	Agrochemical composition			Humus carbon, %	Humus, %
	$N\text{-}NH_4$, mg/kg	K_2O, mg/kg	P_2O_5, mg/kg		
Kuyganyor reservoir	14.9	149	14.8	0.44	0.76

There was a slight amount of fuzziness in the upper and middle sections (figure 4), based on the measured and projected parameters of the BFC. Large particles enter the channel because the sedimentation reservoir is filled with turbidity and there is no sediment washing [14 – 17].

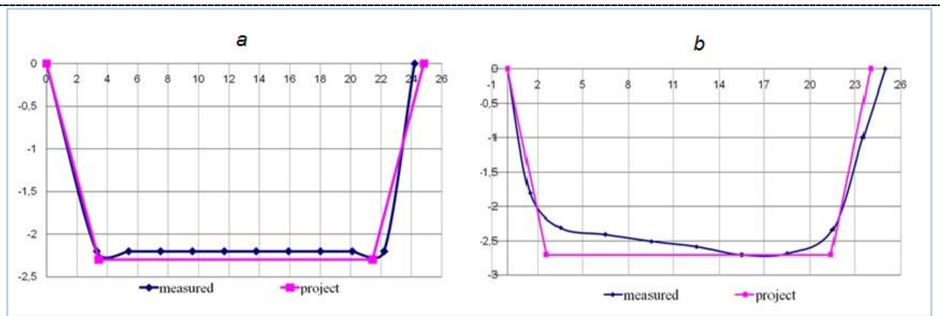

Figure 3. Cros section of channel (a-PC-930, b- PC-1500)

To assess the effect of the operation of the controller on the hydraulic parameters of the channel, the water consumption, and the amount of water turbidity in the Big Fergana channel across the Fergana region were studied. At the same time, the decrease in water consumption in the channel can be seen in the reduction of water turbidity (figure 5).

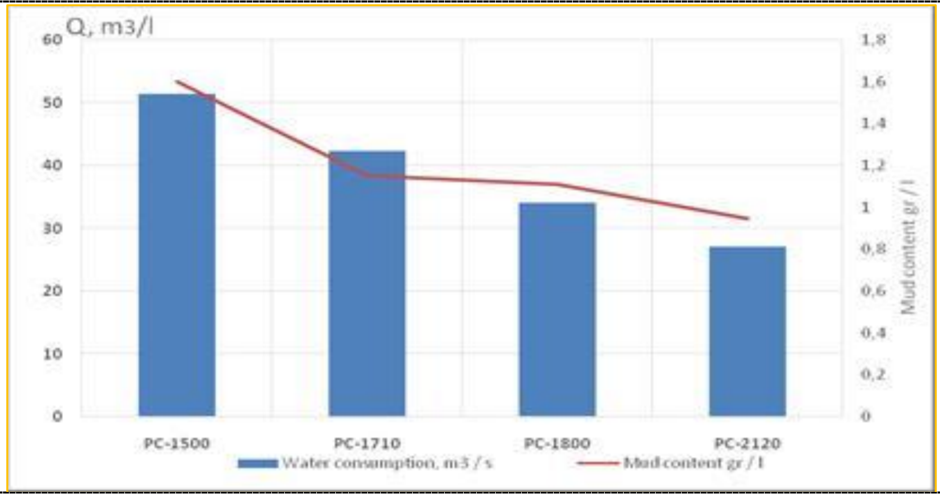

Figure 4. Water discharge and sedimentation relation of Big Fergana channel

4. Conclusions

Monitoring and experimental studies on the burner are mainly based on sedimentary particles of 0.10-0.05 and 0.05-0.01 mm and their water content is around 71-85.4%, with a larger size of 0.1 mm. and sediments with a diameter greater than the average for most of the aquifer (April-May). In the agrochemical composition of the sediments, it was found that the proportion of K2O in water is relatively high. A study of the dependence of water flow on the Big Fergana channel found that: When the amount of water in the reservoir is reduced, the efficiency of the discharge increases, resulting in a direct link between the runoff and the sediment flow in the channel.

Based on the results, we can conclude that sediments, which have not been completely submerged in the burner, go through the channel and extend along its length. This process results in a decrease in the efficiency of the operation of the channel and hydro-technical structures over the years.

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