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FIELD STUDIES OF THE DYNAMICS OF THE CHANNEL PROCESS ON THE AMUDARYA RIVER BELOW THE TUYAMUYUN

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Abstract
In this article, the reasons for carrying out riverbed correction works in rivers with a changing course, the analysis of the results of scientific research carried out by foreign and our republican researchers on the issues of ensuring the stability of the corrected riverbed section are covered.

Keywords: River, channel, coast, protection, hydrotechnical structure, water speed, straightening structures, water intake without dam, spur.

Introduction

In the period of increasing global water scarcity, in order to effectively use the existing fresh water resources, managing them with the help of reservoirs and large hydroelectric networks, protecting the river banks and straightening the riverbed are one of the main issues. Well-known researchers from the developed countries of the world: the USA, Australia, the Netherlands, Austria, Germany, China, Russia, Kazakhstan, Kyrgyzstan, Uzbekistan and other countries are dealing with the issue of water resources management and the study of problematic processes occurring in the river bed. They are focusing on carrying out scientific research on issues such as complex use of water resources, improvement of hydroelectric operation, management of processes taking place in the riverbed.

Methodology

In practice, constructions of various types are used to straighten the river bed or protect its banks. Until today, in technical literature and magazines, S.X. Abalyants [1], T.F. Avrova [3], S.T. Altunin [4], M.R. Bakiev [5;6], N.B. Barishnikov [7], X.A. Irmuxamedov [8], A.M. Muxamedov [13], O.A. Qayumov [14], M.N. Karyukin [15], and others shows that the use of transverse embankments built from local soil is the most effective way to straighten (protect) the coast

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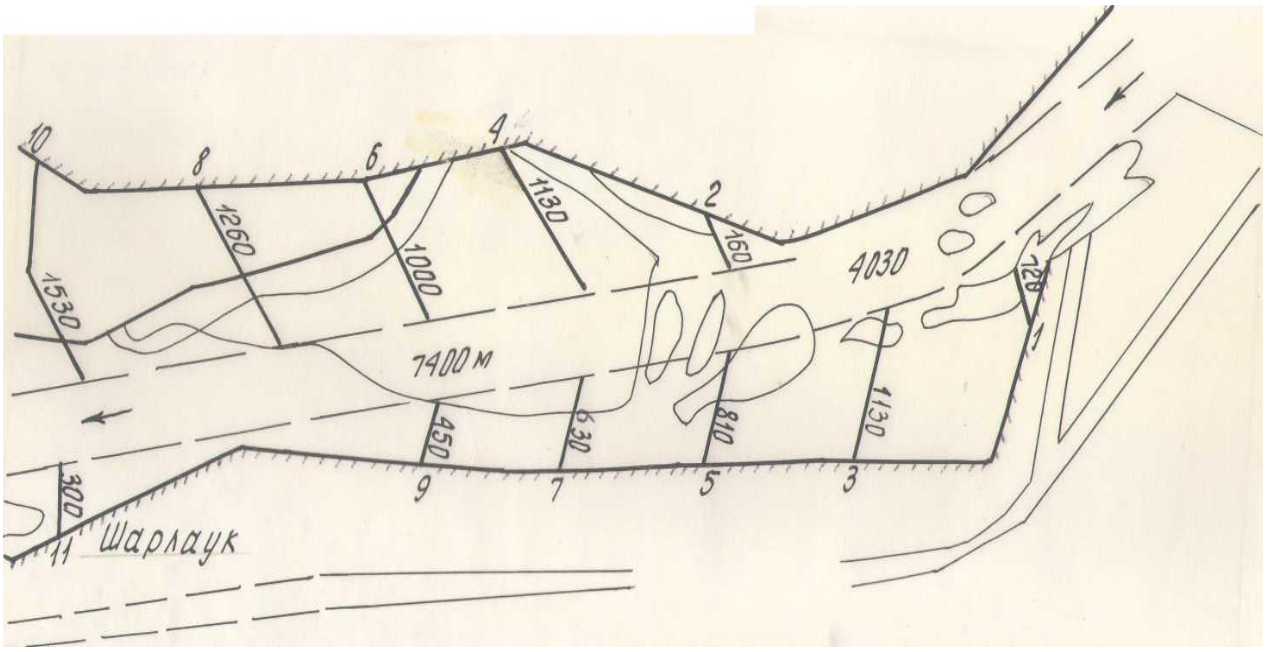
The Amudarya River in the flat part has a wide valley, low floodplain banks, and an unstable bed. Figure 1 shows the plan of the regulated channel of the study area within the bedrock banks based on aerial photography taken in September 2015.

Plan

Scale 1: 45000



Rice. 1. Regulation of the river bed. Amudarya traverse dams

From these figures it is clear that from Tuyamuyun to the water intake into the Tashsaka canal, which is 16.5 km long, the width of the channel varies from 2.0 to 3.0 km. In the first section of the diagram, the plan of which is shown in Fig. 1, the river bed is regulated as follows. From the Tuyamuyun dam at the beginning there is a curved section of the channel 4050 m long. In this curved section, the flow flows along the right main bank. Here, traverse dams are located only on the left bank of the riverbed.

The continuation is a straight section of the channel with a length of 7740 m. In this section, traverse dams are located on both sides of the river.

Below, on a segment 4460 m long, the regulated channel is located along the left uneroded bedrock bank. This section of the channel has a curvilinear outline in plan and ends at the water intake into the Tashsaka canal. In this section, traverse dams are located only along the right bank of the channel. As a result of channel regulation in the first section, the conditions for water intake into the Tashsaka canal have been improved. In this section, traverse dams are located only along the right bank of the channel. As a result of channel regulation in the first section, the conditions for water intake into the Tashsaka canal have been improved.

Below the Tashsaka channel, a section of the channel 9230 m long has a curved outline in plan with the channel turning to the left.

Below the Tashsaka channel, traverse dams are located symmetrically on both banks, and the regulated channel is located in the middle of the river bed. On all straight sections of the regulated channel, the traverse dams are parallel to each other and are located against the flow at an angle of 600 to the regulated channel, and on curved sections at an angle of 600 to the tangent of the regulated channel. The width of the regulated channel in the constraint section is assumed to be 600 m with the calculation of the passage of 3,500 ... 4,000 m3/s of water. The results of field observations and experiments on eroded models showed that the deformation of regulated channels occurs mainly in the zone of transit flow, where the velocities are the highest. In the zone of intense turbulent mixing, sediment is suspended, brought by the flow and from erosion products, which are captured by transverse currents into the eddy zone and deposited in the inter-dam space. Due to the inclusion of the inter-dam space and the deepening of the bottom of the regulated channel, after 2. 3 years of operation of the traverse dams, a new coastline is formed. Studies have shown that the area of entry and the shape of the newly formed coastline depend on the distance between the dams and the configuration of the regulated channel in plan. And with a distance between the dams of 900... 1,000 m and the curved section of the river. Amu Darya, during 5 years of operation of the traverse dams located in front of the Tashsakinsky hydroelectric complex, the inter-dam space is up to 90% filled with sediment and the flow flows along a regulated channel, which is located along the left non-eroded native bank. Based on the materials of the planned survey in February 2020, a plan was drawn up for the section extending from dam No. 29 to No. 35, which is shown in Fig. 2, which shows the position of the channel, the area of siltation between the traverse dams, the location of the constructed dams and the bank lines. As can be seen from Fig. 2, the position of the newly formed bank in plan has a curvilinear outline and is similar in shape. In plan view, the maximum ordinate of curvature was observed closer to the underlying dam and a pocket formed in front of it. This is also evidenced by photographs taken in 2020 (Fig. 3). The maximum ordinate of the pocket relative to the head in terms of the dams, as can be seen from Fig. 2, depends on the distance between the dams. With a decrease in the inter-dam distance, the ordinate of the pocket and its area in the inter-dam space decrease, and accordingly the development coefficient increases. Based on the analysis of the results of surveying the coastline and the plan of the regulated channel, obtained from aerial photography, empirical dependencies were obtained to determine the maximum ordinate of the possible depth of erosion of the pocket in the plan and its area, in the following form:

$$P = 0{,}34\,L;$$

$$\omega = \left(\frac{L}{212}\right)^2,$$

where P is the maximum value of the possible depth of shore erosion in plan (pocket erosion depth);

ω - pocket area;

L is the distance between dams.

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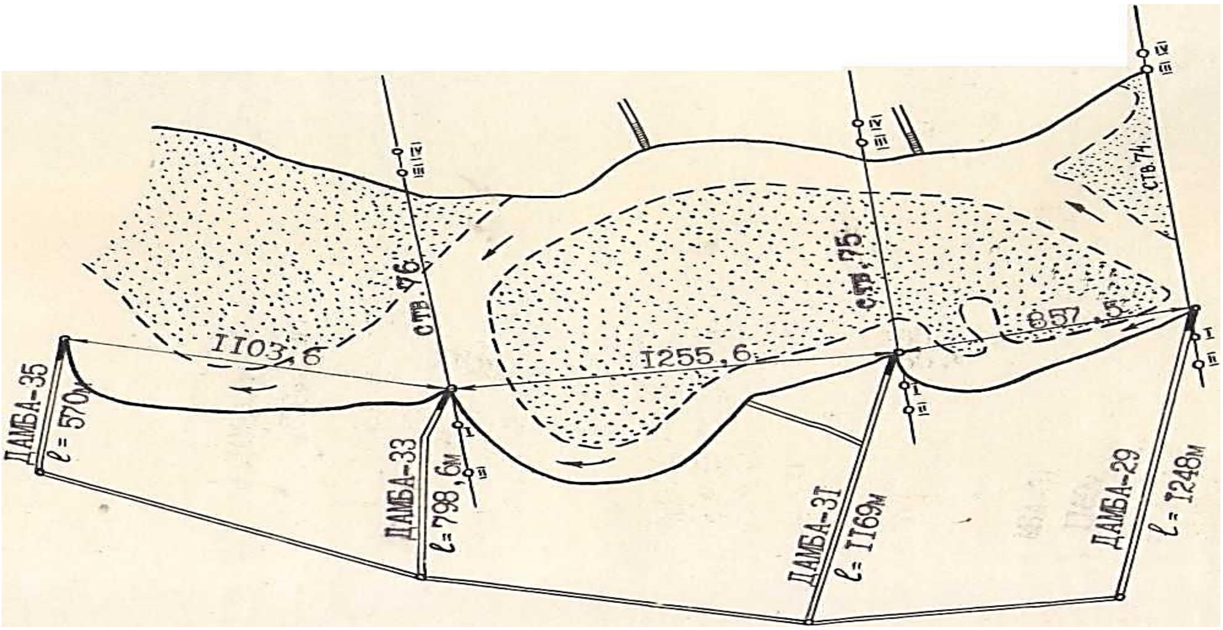
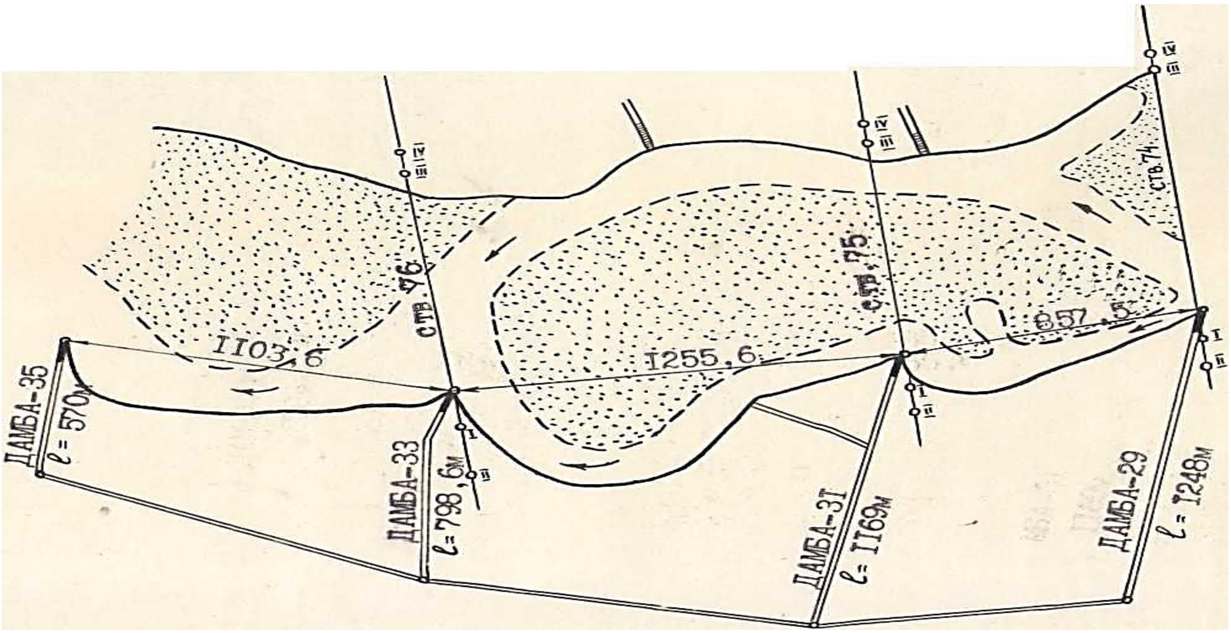
PLAN
Scale 1: 20000



Rice. 2. Plan of the Amudarya River in the area of traverse dams No. 29 ... 35 (the survey was carried out along the left bank of the river)

PLAN
Scale 1: 20000



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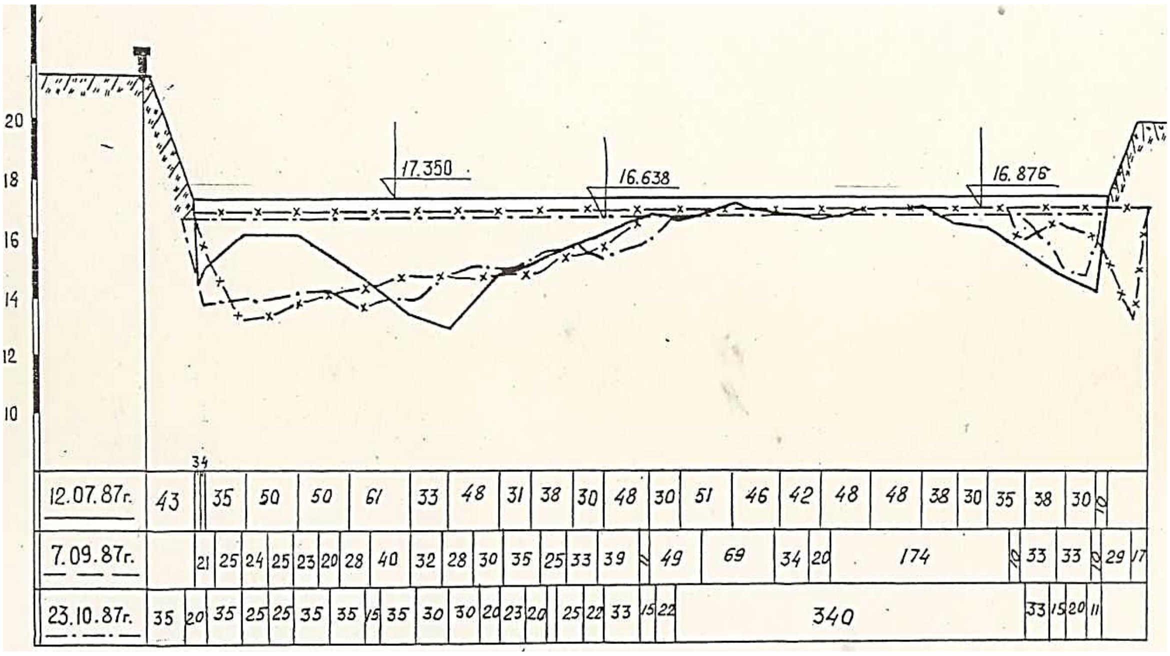


Rice. 4. Combined transverse profiles of the channel at section 74.

Based on the materials of depth measurements, combined transverse channel profiles were compiled (Fig. 4). From the presented cross-sections of the channel, it can be judged that as water flows change and levels fluctuate, the planned and transverse shapes of the channel change. In the studied sections of the river, during the period of flood flow, the flow flowed filling the entire width of the channel between the dams. During this period, there was simultaneous erosion of the bottom and a rise in the water level.

After the decline of the flood and during the low-water period, the flow wandered, islands were formed, side streams were formed, and the channel was divided into separate branches (see Fig. 2). The reason for the partial wandering of the flow during the period of recession and low water can be explained by the fact that the intended width of the regulated channel, designed to pass water in the amount of 3,500 ... 4,000 m3 / s, turned out to be more than the required value when passing the river flow during low water.

To verify the reliability of the results of experimental studies in situ, the depth of the erosion funnel and the length of the flow on the pressure side of the dam slope were measured. And also for comparison, the results of field studies by employees of the SANIIRI riverbeds department were used (9...12). From Fig. 5, it is clear that the values of the erosion depth are in situ and calculated values determined by dependence (1).

$$H_{\max} = 10{,}4\,\frac{\left(\frac{\alpha^{0}}{90}\right)^{1/7}\cdot(\cos\theta)^{1/2}}{(1-n)\cdot\xi^{1/6}{}_{85\%}(1+0{,}09\rho)}\cdot\frac{h_{м}Fr^{0{,}5}{}_{м}}{(1+1{,}35Fr_{м})^{3/2}}, \quad 1$$

θ - angle of deviation of the pressure face of the dams from the vertical plane;

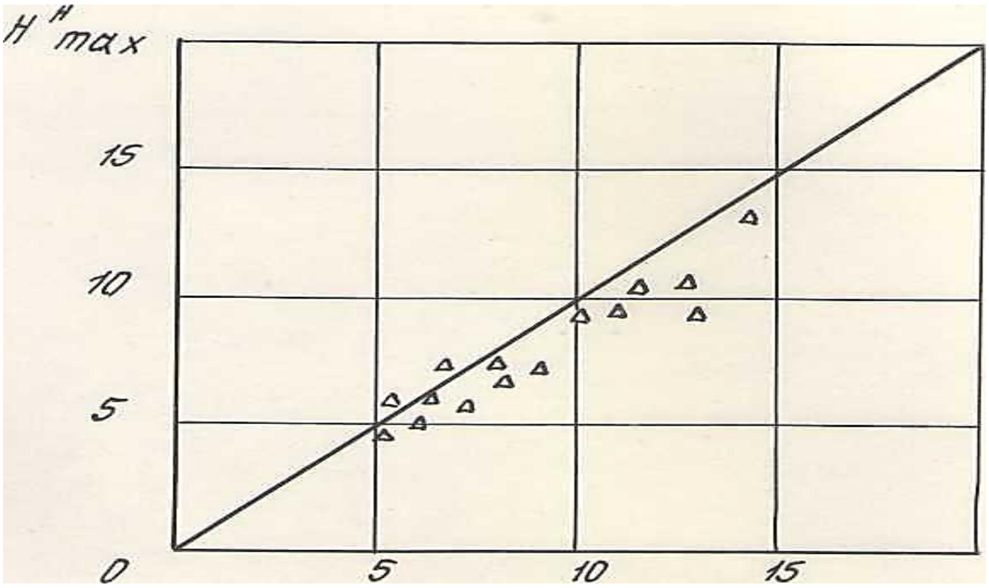
$\xi_{85\%} = \frac{\alpha_{85\%}}{\alpha_{50\$}}$ - soil heterogeneity coefficient;

ρ - sediment saturation of the stream;

Fr_M - Froude number of approach flow;

h_M - average depth of the fall on the approach to the dam;

α^0 - dam installation angle.



H^p_{max}

Rice. 5. Graph of comparison of full-scale and calculated values of the depth of maximum erosion.

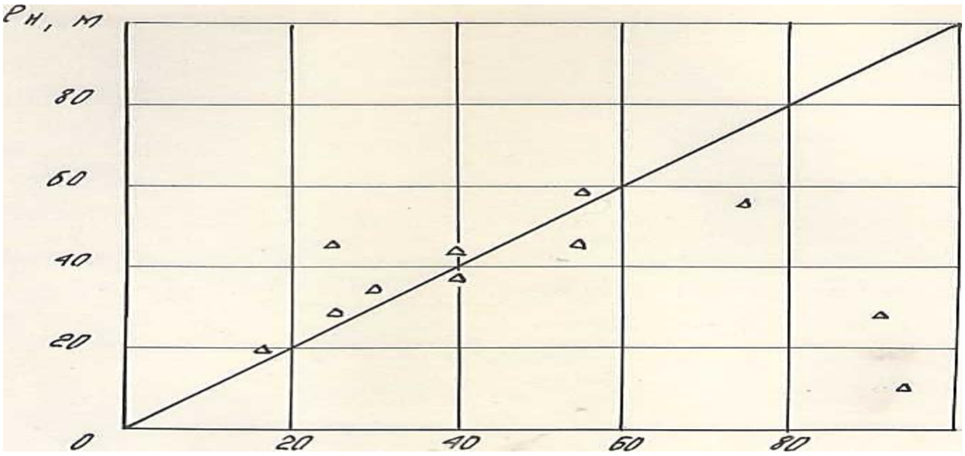
and the length of the flow action on the pressure side of the dam slope (Fig. 6), determined by dependence (2), coincide.

$$\lg \frac{\ell_k}{\ell_\partial \sin\alpha} = -\left(\frac{0{,}5\sin\alpha}{1+\cos\alpha}\right), \qquad (2)$$

where: l_k – slope fastening length;

l_d – dike length;

α - dam installation angle.



lp

Rice. 6. Graph of comparison of full-scale and calculated values of the working part of the pressure slope of traverse dams

SUMMARY

The valley of the Amudarya River for 186 km, starting from the Tuyamuyun reservoir and to the Kipchak hydroelectric complex on the banks of the Amudarya, is controlled by dams. The amount of water flowing from the Tuyamuyun reservoir is radically different from its natural regime. Due to the reformation of the channel and silting of the natural floodplain of the Amudarya River, new banks of the floodplain part of the river are formed. As a result, 46,000 hectares of land are created that could be used for agriculture. Field research was carried out to protect the new banks formed as a result of managing the Amu Darya channel and ensuring the strength of the constructed dams, and materials obtained over the years by other researchers on this topic were also collected. As a result of a joint analysis of the available data, the dynamics of erosion of the Amudarya riverbed was studied and equations were obtained to determine its parameters. The results obtained can be used in drawing up projects for managing rivers whose beds consist of easily washed away soils.

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