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Research Article

Experimental Research of the Water Flow Motion Area in the Large Irrigation Canals

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Relevance

Knowledge of the structure of water flow in irrigation canals, including changes in the area of velocities at different water flow rates, is important information for predicting the formation and dynamics of hydraulic processes. Therefore, an experimental study of the flow structure in irrigation canals is of great importance.

In recent years, modern technical means, including acoustic doppler profiling, will make it possible to effectively measure the hydraulic parameters of the flow in large irrigation canals.

Research results. This article presents the results of natural studies of the velocity field of the water flow in the sections (PK138-PK290 and PK290-PK508) of the Big Namangan Canal in various hydrological conditions (during the vegetation and non-vegetation seasons), carried out in 2018-2019. To study the velocity field of flow was used an acoustic doppler-profilograph SonTeke-S5 model.

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This modern scientific instrument consists of a SANTEC S5 ADP M9 speedometer with acoustic doppler and Sontek RiverSurveyor Live software for equipment control, data collection and analysis (Fig. 1).

Fig. 1. Hardware-software complex SonTeke-S5

The device moves along the viewing platforms in a dynamic mode, quickly measures the distribution of velocities along the cross-section of the stream, changes in the direction of the stream with an accuracy of 0.1-0.4 m and the depth of the stream along the deck, as well as automatically calculates the water flow rate.

The horizontal distance between the points, measured along the channel cut-off line, is 1-2 meters, depending on the swimming speed of the apparatus. The inertial structure of the device and a high-precision GPS receiver, magnetic compass, linear and angular acceleration sensor determine the spatial position and speed of water particles in the water environment.

In 2018, field research was carried out on the section of the canal between the PK138-PK290 and PK290-PK508 pickets of the Big Namangan Canal, in 2019 on the section of the canal between the PK362 + 93-PK642 + 09 pickets.

Based on the results of field studies, important from a hydrometric point of view, data on the flow structure in the channel sections were obtained.

The length of the first section of the canal is 15.2 km, and the length of the second - 21.8 km.

To increase the level of accuracy of the measurement results, 18 measurement points are allocated at each section of the channel. Measurements were carried out on streams from top to bottom in alternating rows. To check the measurement results, the results were compared with the results of measurements carried out at the bridge-type hydrological station (Fig. 2).

Fig. 2. General view and position of the measuring alignments

To measuring the area of the water flow rate, the state of the water level was measured. In addition, the water discharge at the initial and final sections of the stork canal was determined. In total, two series of experiments were carried out: May 20-27 and October 11-15 of 2018 and May 11-14 and November 22-30 of 2019 (Fig. 3).

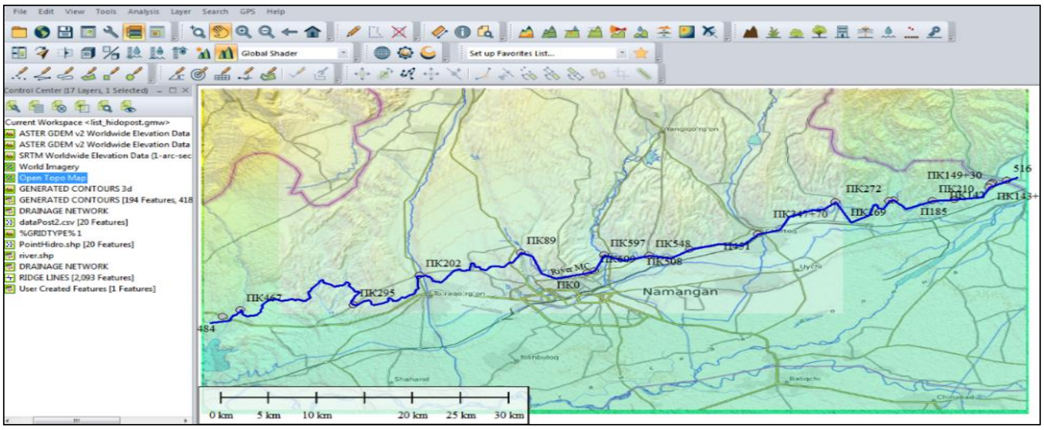

Fig. 3. Location of the sections where measurements were made.

Experimental data on the level, water flow rate and discharge of water in the station, determined in the cross-sections of the channels, are presented in Figures 4-8.

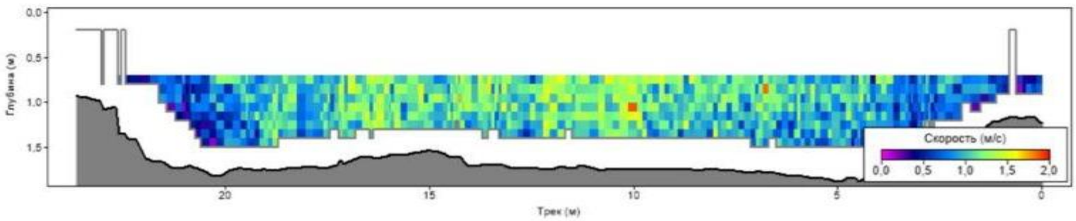

Fig. 4. The head section of the Big Namangan Canal, PK138.

The maximum flow depth is 1.87 meters, the maximum water flow rate is 2.1 m/s, and the water discharge is 27.901 m^3/s.

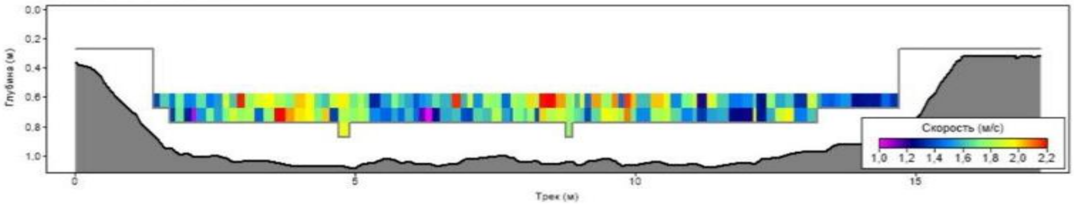

Fig. 5. Picket PK451 of the Big Namangan Canal.

The maximum flow depth is 1.05 meters, the maximum water flow rate is 2.2 m/s, the water discharge is 19.641 m^3 /s.

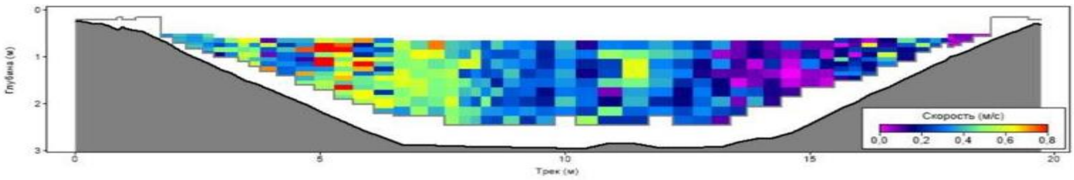

Fig. 6. Picket PK597 + 89 of the Big Namangan Canal.

The maximum flow depth is 2.94 meters, the maximum water flow rate is 0.8 m/s, and the water discharge is 9.942 m^3/s.

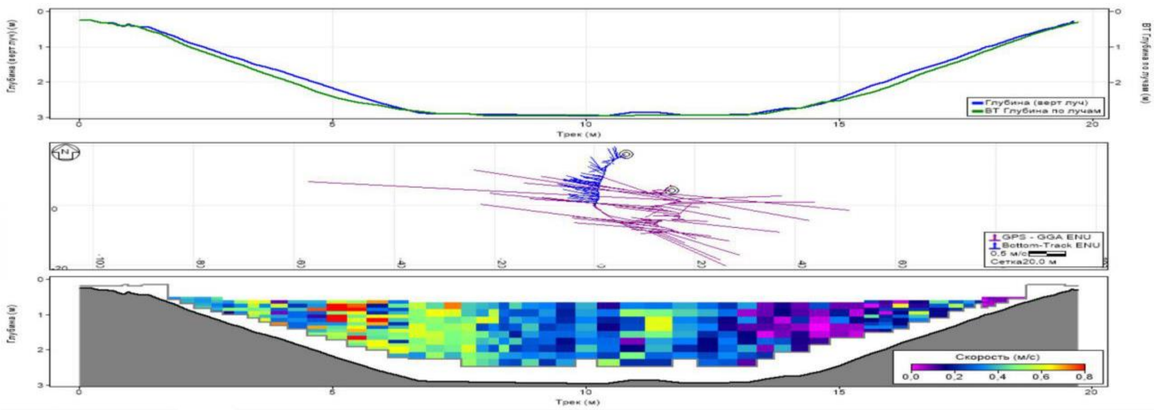

Fig. 7. Picket PK362 + 93 of the Big Namangan Canal.

The maximum flow depth is 2.6 meters, the average water flow rate vector is 0.5 m/s, and the water discharge is 10.65 m^3/s.

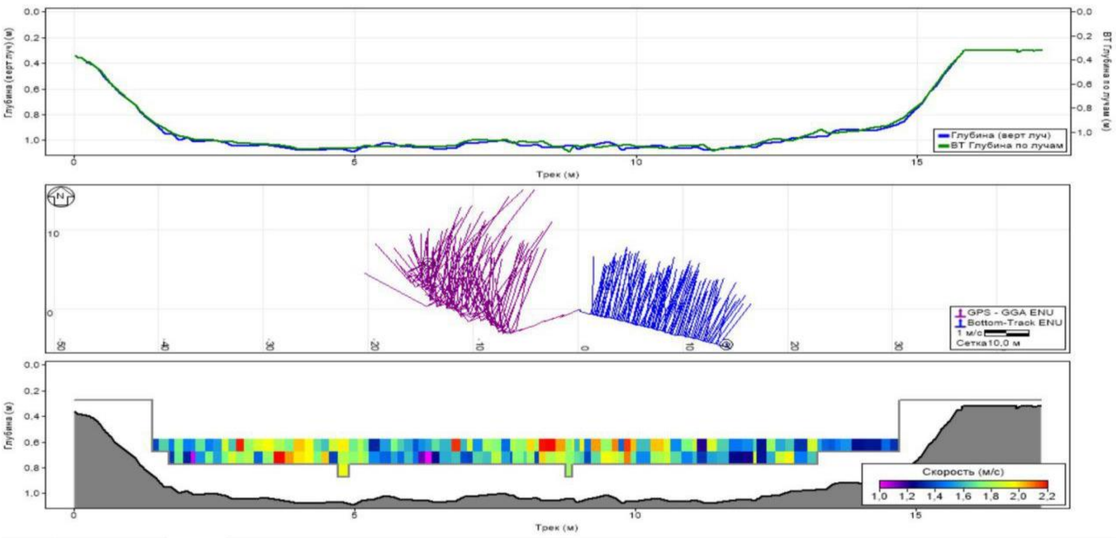

Fig. 8. Picket PK642 + 09 of the Big Namangan Canal.

The maximum flow depth is 0.75 meters, the average water flow rate vector is 1 m/s, and the water discharge is 10.31 m^3/s.

By ensuring the time constant of the flow parameters in the laboratory, it is possible to investigate the spatially non-uniform distribution of the velocity field in the flow. However, it is impossible to provide such stationary conditions in the field. However, the results of the experiment using a modern profiler showed that the water level has changed significantly: a maximum of 124 cm (7.8%). It should be noted that due to the violation of the operating mode of Uchkurgan HPP, the values of the water level in the measurement strata differ sharply. The chamber work of analyzing the results of the field experiments showed that although there were no water intakes between the storks, the difference between the water levels in the two observation sections in downstream part of the canal was 1.3 m.

At the same time, the inflow and outflow monitoring of water intake from the canal through the pumping station "Kizilravot" (PK144 + 53) 19.6 m3 / s, 5.1 m3 / s through the domestic pumping stations PK208 + 90 and PK238 + 27 the difference in the value of water discharge at the inlet and outlet observation sections was 6.2%.

According to the results of the work carried out on May 21 to measure the water discharge in this area, the difference in water discharge at a study area was 6 m^3/s, the water discharge from the monitoring section was 3 m^3/s, the instability of the flow was 21%. Analysis of the experimental results shows that the movement of the water flow on the second observation deck of the Big Namangan Canal is unsteady. With the help of a modern acoustic profiler, a three-dimensional image of the water flow rate of the study area was obtained in the measurement storages.

Due to the fact that the water flow rate in the canal and the channel width were sufficiently large, the trajectory line of the floating measuring device, the error from a certain section line averaged 0.7 meters, maximum 1.3 meters. The measuring point range was 1.5-2 meters. In connection with the above, base points were plotted on the deflection line with a step of 2 m, each of which reflected the measurement data at a real point. The results of studies on measuring the depth and flow rate at the base points of observation platforms are presented in Figures 7 and 8.

It should be noted that the results of the experiment carried out under the same hydrological conditions were very close to each other. Based on the results of the experiment, special attention was paid to the following case. In other words, it was noticed that in the sections of the channel, turned at an angle of 200 meters, at a distance of at least 200 meters, there are flooding zones. This effect was observed mainly in the terrestrial parts of the channel. The lack of forward movement of the water mass in the area of water accumulation caused the formation of turbidity in this area.

It should also be noted that in downstream area of the channel, the dynamic axis of the flow has shifted relative to the left bank. The displacement of the dynamic axis of the flow is observed up to a distance of about 815 meters.

Field studies carried out in two sections of the canal revealed the presence of small sections of the velocity region in sections of considerable depth. According to field studies carried out near the dam site in the downstream part of the canal site, the velocity fields are almost evenly distributed in both direction and size. This indicates that dirt is accumulating in areas of low water flow rate, moving the dirt along the way.

In general, the results of the study made it possible to obtain the necessary information about the main hydraulic parameters of the Big Namangan Canal and draw practical conclusions about the impact of the operation of the Uchkurgan HPP on the Big Namangan Canal.

Conclusion

Using the SANTEC S5 acoustic Doppler profiler, experimental studies of the flow rate and flow depth were carried out, as well as measurements of water flow in the section between the pickets of the Big Namangan Canal (PK138-PK290 and PK290-PK508) in various hydrological conditions. The results of the experimental study showed that as a result of the negative operating mode of the Uchkurgan HPP, unstable water movements arose in the first and second sections of the canal, as a result of which a complex hydraulic situation was formed associated with abrupt changes in the water horizon.

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