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Investigation of elements of the water regime phases of rivers belonging to the middle part of Zeravshan river basin

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Abstract: in the article, in the result of analysis of the mean long-term discharge values of the rivers belonging to the middle part of Zeravshan river basin there were selected the years of characteristic water availability. The quantitative changes of the flood elements were determined for the years of characteristic water availability.
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Key words: rivers, river basin, discharge, phases of water regime, high-water, low-water, characteristic years, high-water years, medium-water years, low-water years, elements of phases of water regime.

Introduction

According to data of United Nations Organization, at present, 1,2 bln. people of more than 7 bln. of the Earth population need fresh drinking water or 2,3 bln. of people are forced to use water which does not meet the fixed sanitary norms. One problem is that 4 persons of 10 ones of the world population live on the territories with the fresh drinking water deficit. Nowadays, in different countries of the world everybody uses from 3 to 790 l of water everyday. In the developed countries every person uses up to 550-600 l daily; in the developing countries this amount equals 60-150 l, while in the rural areas this amount decreases to 15-25 l (Khikmatov et. al., 2015, Getu S.A., 2015).

More than 80 % of water resources being consumed in the Republic of Uzbekistan are formed by the small water sources from snow cover and glaciers located in mountains of Kyrgyzstan and Tajikistan. During the recent years a good deal of work is being conducted for the rational use of available water resources in Uzbekistan. For this purpose special government programs were worked out and adopted, and their timely execution is being provided. In particular, in Strategy of Actions for the development of the Republic of Uzbekistan for 2017-2021 the important tasks on "adoption of systemic measures for mitigation of negative impact of the global climate change and drying out of the Aral Sea on the development of agriculture and life activity of population" are outlined (Denisov, 1965). In the execution of these tasks the investigation of hydrological regime of the rivers of Uzbekistan and adjacent territories, as well as studies directed to the improvement techniques for assessment of the main hydrological characteristics are of special timeliness.

The first studies devoted to investigation of the processes of flow formation in the river basins, of their water regime phase, peculiar features of characteristics of flow during flood were carried out by B.D. Zaikov, M.I. Lvovich, L.K. Davydov, G.P. Kalinin and others. These issues are considered in the works of V.L. Schults, O.P. Scheglova, Yu.M. Denisov, I.R. Alimukhammedov, Yu.N. Ivanov, A.R. Rasulov, F. Khikmatov and others (Khikmatov, 2016, In-Kyun Jung, 2010) on the example of the rivers of Central Asia, and in particular, the biggest rivers of Uzbekistan. However, this problem is not considered as independent object on the example of small rivers belonging to the middle part of Zeravshan river basin.

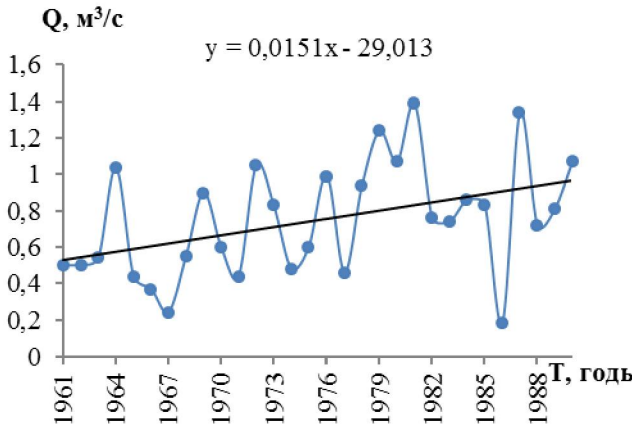
The main purpose of this work is to investigate the change of elements of the water regime phases of small rivers and temporary water courses in the years with characteristic water availability, and to develop scientifically based proposals and recommendations on the rational use of their water resources on the base of obtained results.

In the work, for execution of the defined objective we have selected small rivers of the Middle Zeravshan river basin, in particular, Amankutansai, Aktepasai and Beglarsai rivers. The data of standard observations of the mean annual and mean monthly discharge values recorded at the hydrological gaging stations of Uzgidromet were used as reference data. Calculations were made for the basic climatic period, i.e., from 1961 to 1990. Missed mean annual and mean monthly discharge values were restored using approved hydrological methods. In the result of this, hydrological data series were reduced to a single rated period. In the process of performing this work we have

also used the techniques of geographic generalization, mathematical statistics, hydrological calculations and forecasts, while in the calculations and drawing graphs the up-to-date standard software of computer technology was applied.

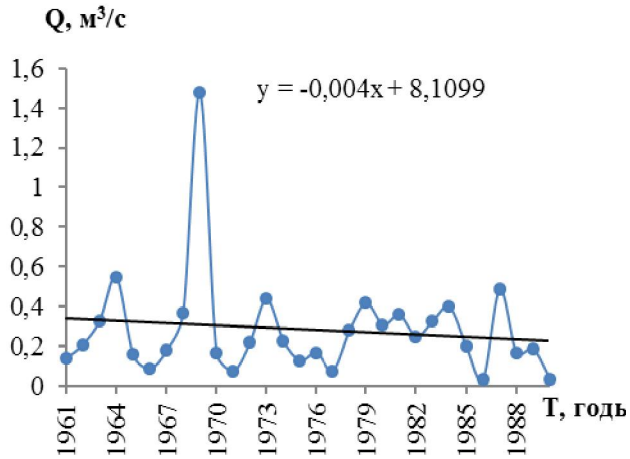
Main results and their discussions. Basing on the purpose and tasks of investigation, it was necessary to determine characteristic (high-water, low-water and medium-water) years depending on water availability. Further, on the base of application of standard software, the graphs of the long-term variations of the mean annual discharge values for the studied rivers were drawn (fig.1).

a)



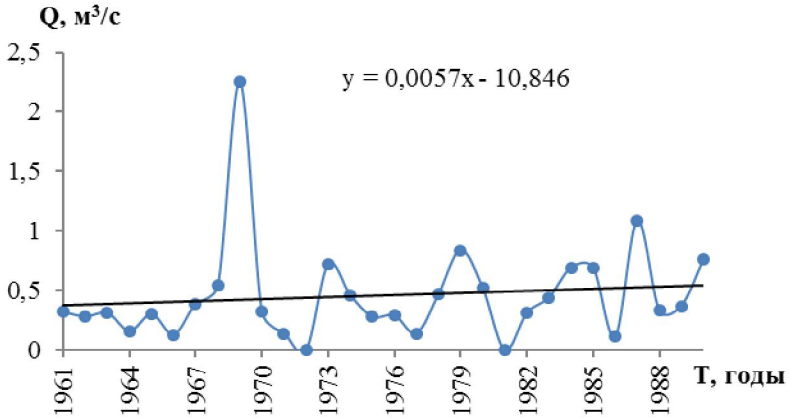
Amankutansai – Amankutan vil.

b)



Aktepasai – Aktepa vil.

c)



Beglarsai – Yangi Akchab vil.

Рис.1. Long-term variations of the mean annual discharge values

As it is seen from the graphs of the long-term variations of the mean annual discharge values, their trend variations have different values. For example, for the selected rated period the variations of the mean annual discharge values are positive which means that the gradual rise of the mean annual discharge values takes place. From the calculations it was found out that for the rated period the increase of discharge values of Amankutansai river is 32 % in relation to their mean long-term value (fig.1, a).

The main thing is that this graph made it possible to determine characteristic years by discharge values of Amankutansai river. As it is seen from the graph (fig. 1, a), for the considered rated period the year of 1981 was high-water year, when the value of the mean annual discharge was 1,3 m^3/s. For the considered basic period 1982 was the lowest-water year (0,18 m^3/s). Mean annual discharge value in 1982 was 0,76 m^3/s, and it was approximately equal to the mean value for the rated period. It should be noted that despite the majority of rivers, the maximum mean

annual discharge value was not recorded in 1969. This is determined by the peculiar features of the flow formation in Amankutansai river basin (Siddikov, 1976, Schults, 1965, Scheglova, 1960, Khikmatov, 2017).

The observations of flow of Aktepasai river began in 1963 and continued without interruption up to 1987 inclusively. The mean annual discharge for that period was 0,31 m^3/s. As it was mentioned above, the missed values in observation data were reconstructed. The trend line constructed for the accepted rated period shows that the mean annual discharge values of Aktepasai river are gradually decreaing. Характерные representative values of the mean annual discharge are referred to as follows: 1969 – high-water year, 1980 – low-water year, 1986 – medium-water year. For the period of observations the values of the mean annual discharge were within the range of 0,036-1,48 m^3/s. For the considered rated period, similar to Amankutansai river gradual increase of values of the mean annual discharge was recorded.

On Beglarsai river the values of the extreme discharge, i.e., high-water, low-water and medium-water years also corresponds to the years which were recorded on Aktepasai river. Mean annual discharge value for Beglarsai river for the rated period was 0,63 m^3/s.

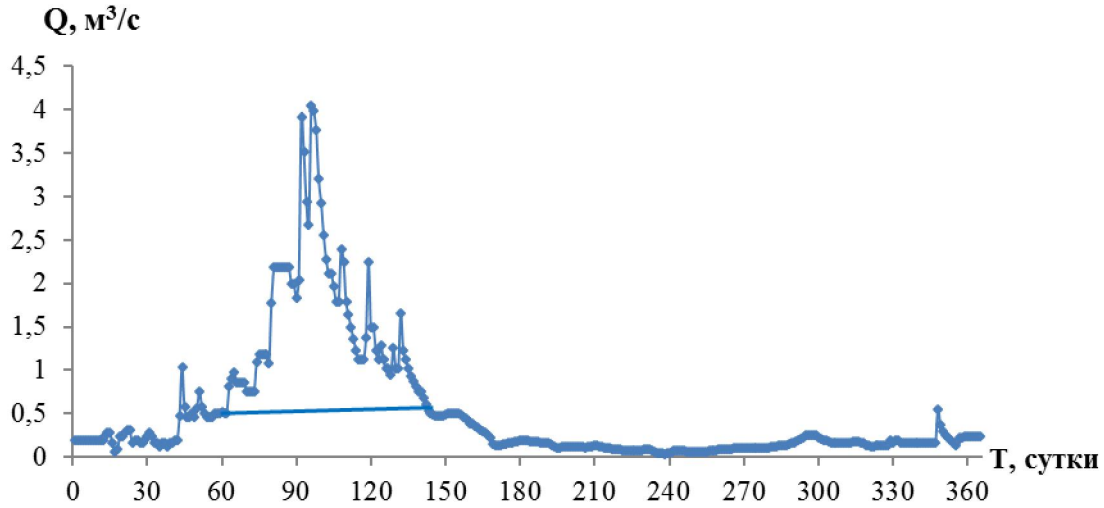


Fig. 2. Hydrograph of Beglarsai river, medium-water year of 1980

For the years being characteristic by their water availability determined in the result of analysis the hydrographs of all studied rivers were made. One of these graphs is presented on Fig. 2. These hydrographs made it possible to estimate the shifts of the beginning and end of the high-water period, as well as the changes of its overall duration.

The analysis of hydrograph shown above (fig.2) has revealed that in the medium-water year of 1980 the beginning of flood on Beglarsai river corresponds to the middle of the first decade of March. Maximum daily discharge value for the flood period was recorded on 5 April. According to hydrograph, flood period on Beglarsai river continued up to the end of May. Since June the decrease of discharge is recorded, and this process continues up to the end of May. Since June the decrease of discharge values is recorded, and this process continues up to the end of calendar year. In a number of cases, i.e., in early spring or in autumn short-time floods due to the rain and snow or of mixed genesis are also observed on the river, as well. The main causes of their occurrence are rain precipitation on the basin surface or the intensive melting of snow cover in the result of the air temperature increase. These are similar hydrological conditions which exactly determine the formation of the above mentioned floods in the basins of small mountain rivers of Uzbekistan and adjacent territories.

Basing on the objective of this work, the elements of flood were calculated on the example of rivers selected as the object of investigation (Amankutansai, Aktepasai, Beglarsai). With this, the main attention is focused on definition of time of the beginning, end and overall duration of flood, as well as of corresponding discharge values and flow volume in years with the high- and medium-water (table 1). Regarding the low-water years it should be mentioned that relevant calculations were not made. The reason of this is that during low-water years the rivers dry out in majority of cases.

The results of calculations presented in table 1, demonstrate that in the high-water year of 1981 the

flood on Amankutansai river began on 19th of February, and exactly since that date the rise of the discharge value is recorded. Increase of discharge values was observed up to the first decade of March. Maximum discharge value during flood period was observed on 4th of March, and that day the mean daily discharge value was 9,31 m^3/s. Beginning since the middle of March the decrease of discharge was recorded, and that process continued up to the second decade of May; the end of the flood period corresponds to 18th of May of the high-water year of 1981. That year the overall duration of the flood period was 89 days, while calculated volume of that flood was 27,4 $\cdot 10^6$ m^3 (table 1).

Table 1. Values of the flood elements for the rivers of the middle part of Zeravshan river basin for the years with characteristic water availability

Years with characteristic water availability	Date		Duration, days	Discharge, m^3/s			Volume, $10^6 m^3$
	beginning	end		*)maximum	minimum	mean	
Amankutansai – Amankutan vil.							
High-water year of 1981	19.II	18.V	89	9,31 / 04. III	1,44	3,56	27,4
Medium-water year of 1982	13.III	15.V	64	5,58 / 20. III	0,92	1,95	10,78
Aktepasai – c.Ача							
High-water year of 1969	5.III	7.VI	94	14,8 / 17. III	0,78	5,04	40,93
Medium-water year of 1980	3.III	23. IV	52	2,07 / 25. III	0,55	1,41	6,33
Beglarsai – Yangi Akchab vil.							
High-water year of 1969	6.III	6.V	62	20,5 / 9. III	3,78	9,27	49,66
Medium-water year of 1980	29.II	21.V	83	4,04 / 5. IV	0,52	1,59	11,40

*Notes: *)in numerator – discharge value, in denumerator – date of observation.*

In 1982 on Amankutansai river the mean annual discharge was 0,76 m^3/s, and that value was approximately equal to the value of its mean long-term discharge. That year on the investigated river the flood began earlier (13, 03), in comparison with the high-water year of 1981. Just after beginning of flood on the river the intensive rise of discharge is being recorded, and the maximum value of 5,58 m^3/s was reached up to the 20th of March. The end of flood corresponds 15th of May, while its overall duration is 64 days. Calculated value of the flood volume was 10,78 $\cdot 10$ m^3. Thus, during the flood period in the high-water year of 1982 in Amankutansai river the amount of the passed water was equal to that volume. Similar results were obtained also for Aktepasai and Beglarsai rivers (table 1).

Conclusions. Summarizing the results of conducted investigation the following conclusions can be made:

1. Long-term flow variation of the rivers belonging to the middle part of Zeravshan river basin for the basic climatic period (1961-1990) was investigated. During that period the increase of the value of the mean annual flow was recorded for Amankutansai and Beglarsai rivers, while, on the contrary, regarding Aktepasai river the trend of the mean annual discharge values was negative;

2. The analysis of chronological graphs of the mean annual discharge values of the studied rivers was made; the years characteristic by their water availability were determined. It was found out that on Beglarsai and Amankutansai rivers, both in extreme (high- and low-water), and medium-water years the discharge values coincided. It should be noted that despite other investigated rivers, the year of 1981 turned to be the high-water one for Amankutansai river which is determined by hydrometeorological conditions of flow formation of that river in 1981;

3. Principle elements of flood for the rivers of the studied basin in characteristic years are calculated. In the high-water year the flood on Amankutansai river began in the end of the second decade of February, while on the other two rivers – in the first decade of March. This is determined by the difference between the high-water year situation on Amankutansai river and two other rivers. Regarding the flood duration,

Aktepasai river is distinguished where it lasted 94 days in the high-water year of 1969. On all investigated rivers the flood is observed, mainly in March – May period, when that time 55-70 % of the annual flow of rivers passes. This result indicates a lot of possibilities of regulation of flow of investigated rivers by means of construction of water storages with the aim of more rational use of their water resources in different areas of national economy.

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