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ON THE INTERRELATIONSHIP BETWEEN AVERAGE ANNUAL AND GROWING SEASON STREAMFLOW OF RIVERS IN THE CHIRCHIK-OHANGARON BASIN

Abstract. *The article is devoted to the study of the relationship between the average annual and vegetation period flows of the rivers of the Chirchik-Akhangaron basin. For this purpose, rivers with a natural hydrological regime located in this basin were selected and they were brought into a single hydrological series. The average (hydrological) annual and vegetation period water flows were determined for each river. The correlation graphs of the hydrological year and vegetation period water flows were drawn. Regression equations of these relationships were constructed, and it was found that the values of the correlation coefficients vary in the range* r_0*=0,978±0,004÷0,991±0,001.*

Keywords: *mountain rivers, vegetation period, hydrological series, hydrological year, water discharge, regression equation, correlation coefficient, estimation.*

Introduction. The problems of forecasting the flow of mountain rivers during the vegetation period are of great practical importance in agriculture, in ensuring the stable and efficient operation of water management systems, in hydropower and in other sectors of the economy that use water and are water consumers. Therefore, the first studies aimed at studying this problem were carried out by E. M. Oldekop, L. K. Davidov, P. M. Mashukov, E. I. Girnik, A. M. Ovchinikov, B. A. Apollov, E. G. Popov, N. K. Lukina, N. F. Befani, I. P. Druzhinin, V. E. Chub and others. Currently, research in this area is being continued at the Hydrometeorological Research Institute of the Agency of the Republic of Uzbekistan - Uzhydromet - GMITI, by L.M. Karandaeva, and by researchers such as F.H. Hikmatov, G.H. Yunusov, and R.R. Ziyaev, D.M. Turgunov at the National University of Uzbekistan.

However, in these studies, the issues of correlation between the average annual and vegetation period flows of mountain rivers were neglected by researchers.

The main purpose of this work is the description of the relationship between the average annual and vegetation period flows of mountain rivers and their application in practice. In order to achieve the aim of the work, the following tasks were defined: to select rivers with a natural hydrological regime located in the Chirchik-Ohangaron basin and bring them to the same hydrological series; determination of average (hydrological) annual and vegetation water consumption for each selected dayo; draw graphs of interrelation of hydrological year and vegetation water consumption ($Q_{gy}=f(Q_v)$); to determine the regression equations and correlation coefficients of these associations.

Analysis and results. In accordance with the purpose of the research and the tasks defined in it, 7 natural regime rivers in the Chirchik-Ohanagaron basin were selected as research objects (table 1).

Table 1

Some of the rivers of the Chirchik-Ohangaron basin hydrological indicators

T.r.	River – Station	F*, km²	H**, m	Observations		Recharge type***
				years	count	
1	Chotqol – Khudoydotsoy v.	6580	2660	1965-2021	56	S
2	Ugom – Khojakent v.	869	2700	1961-2021	60	S
3	Piskom – Mullala v.	2540	2740	1965-2021	56	SG
4	Oygaying – Confluence	1010	3010	1961-1968 1970-1997 2001-2021	56	SG
5	Maydontol – Confluence	471	3130	1961-2021	60	SG
6	Qizilcha – Ertosh v.	51,6	2340	1961-2021	60	S
7	Ohangaron – Ertosh r.c.	1110	2600	1971-2021	50	SR

Note: *F* - water catchment (basin) area; H** - average height of the basin; *** - according to the classification of O.P.Shcheglova: QM - snow-ice, Q - snow, QYo - snow-rainwater.*

The data in the table above shows that there are some breaks in the years of observation. For example, in the Chatkal (Khudoydotsoy) and Piskom (Mullala) rivers, observations began in 1965, while in the Ahangaran (Ertosh) river, they began in 1971. There are breaks in the observation series in the Oigaing River in 1969, 1998-2000. In order to restore them, the relationships between the average monthly and annual water discharges of the Ugam River, which has a long series, and the short-range Chatkal, Piskom, Oigaing, and Ahangaran rivers were statistically evaluated (Figure 1). The correlation coefficients of the relationships between the average monthly and annual water discharges of the rivers were calculated (Table 2).

Table 2

Correlation coefficients of connections between average monthly and annual water consumption of rivers

T.r.	River	Ugom – Khojakent v.												
		Q_I	Q_{II}	Q_{III}	Q_{IV}	Q_V	Q_{VI}	Q_{VII}	Q_{VIII}	Q_{IX}	Q_X	Q_{XI}	Q_{XII}	Q_y
1	Chotqol	0,484	0,544	0,732	0,827	0,743	0,636	0,811	0,826	0,662	0,503	0,684	0,501	0,801
2	Ugom	0,609	0,551	0,580	0,789	0,733	0,728	0,910	0,786	0,669	0,642	0,717	0,517	0,853
3	Oygaying	0,503	0,409	0,351	0,371	0,660	0,885	0,915	0,775	0,430	0,487	0,811	0,482	0,882
4	Ohangaron	0,576	0,691	0,867	0,659	0,608	0,656	0,819	0,711	0,408	0,379	0,558	0,787	0,741

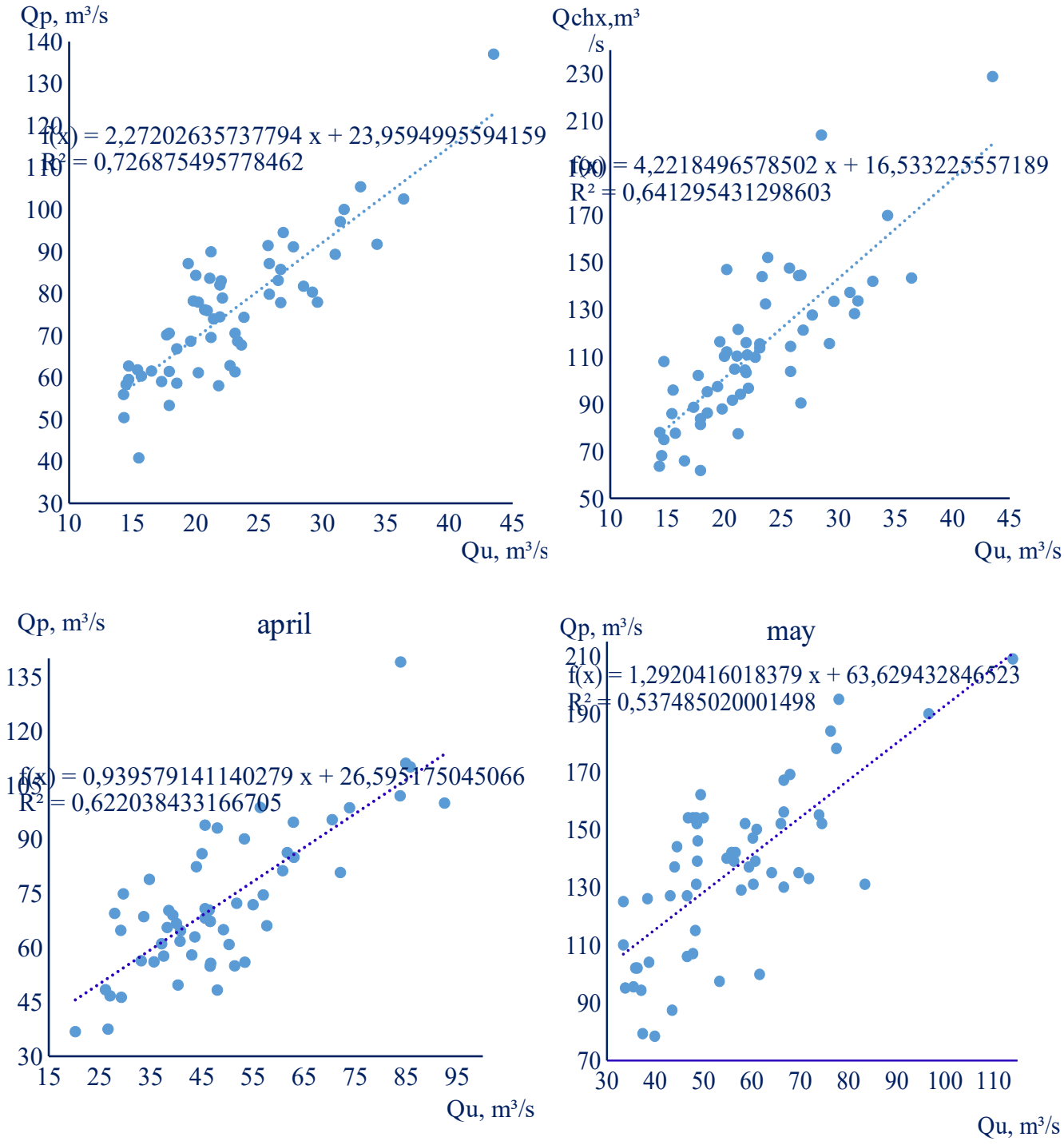
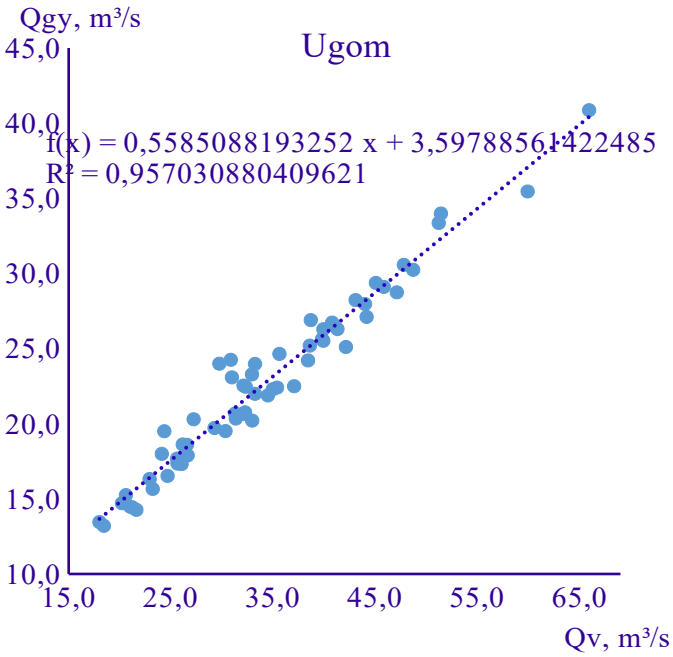
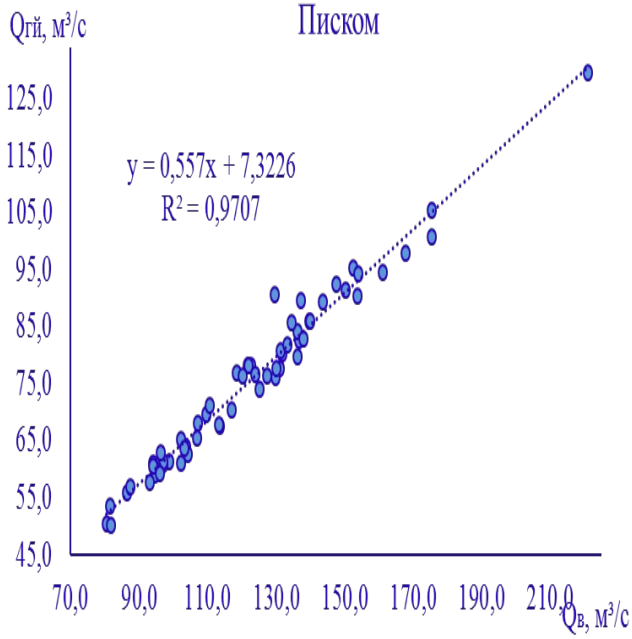


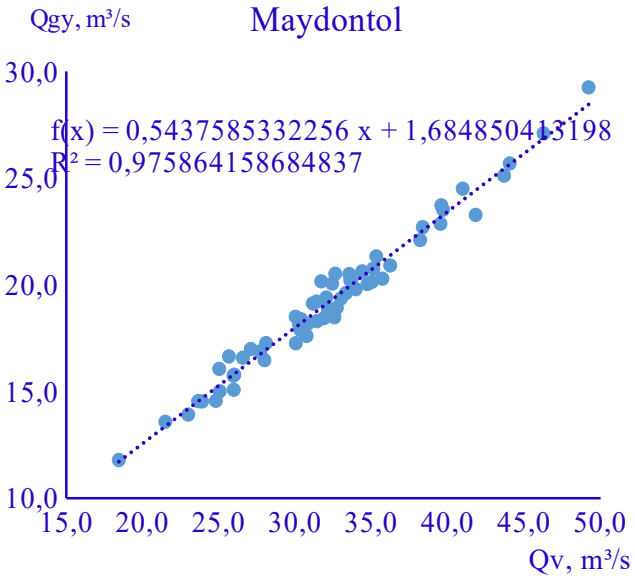
Figure 1. Correlation of average annual and monthly water discharges between short-series (Q_P, Q_{Chx}) and long-series (Q_U) analog rivers.

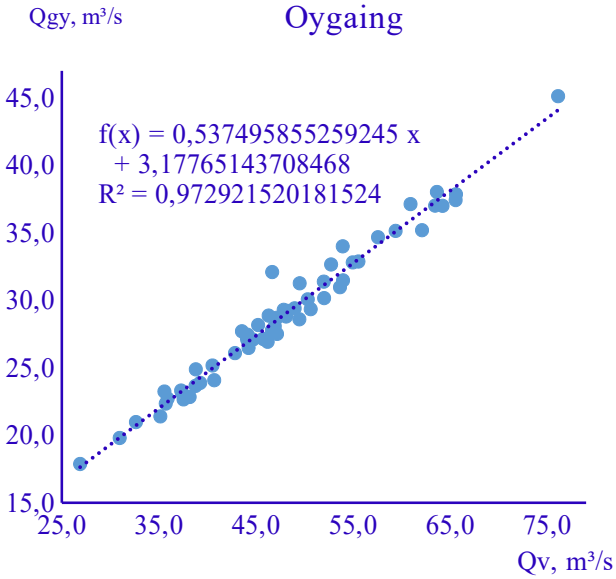
Note: *Q_P – Pskem (Mullala), Q_{Chx} – Chotqol (Khudoydotsoy), Q_U – Ugam (Khojikent).*

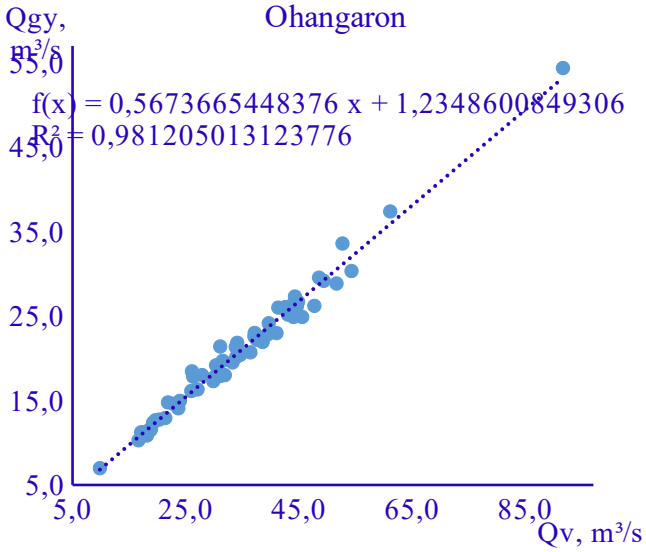
The pairwise correlation coefficients of the above-mentioned relationships and their error values were in the range of r=0,371±0,075÷0,915±0,014. The accuracy of these relationships fully meets the requirements for the accuracy of empirical equations recommended for use in hydrological calculations.











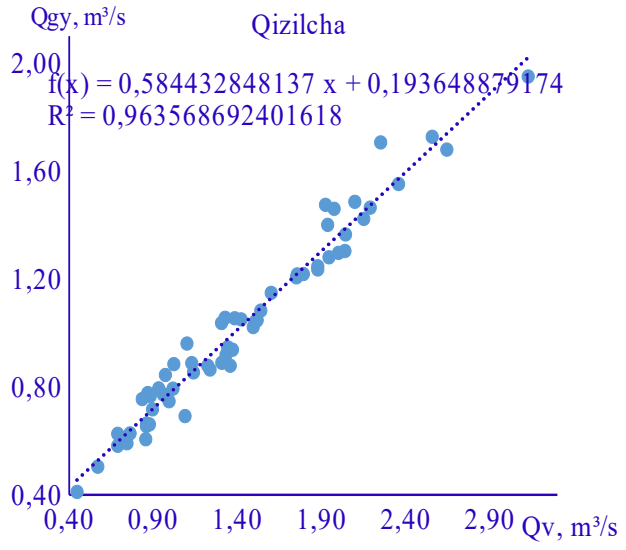


Figure 2. Graphs showing the relationship between water discharge rates for

Taking into account this positive result, regression equations for all pairs were constructed. With their help, the existing discontinuities in the water discharges of the Chatkal, Piskom, Oigaing and Ahangaran rivers were restored. As a result, the water discharge data of the studied rivers were brought into a hydrological series covering the same calculation period, that is, 1961-2021. Based on the goals and objectives set in the study, the correlations between the hydrological year and the vegetation period water discharges for each river under study ($Q_{gy}=f(Q_v)$) were statistically evaluated (Fig. 2). Regression equations for these relationships were constructed, correlation coefficients were calculated, and their accuracy and error were assessed (Table 3).

Table 3

Regression equations and their accuracy

T.r.	River – Station	Regression equations	$r_0 \pm \sigma_{ro}$
1	Chotqol – Khudoydotsoy v.	$Q_{gy}=0,5585 \cdot Q_v +3,5979$	0,988 ± 0,002
2	Ugom – Khojakent v.	$Q_{gy}=0,756 \cdot Q_v +0,458$	0,978 ± 0,004
3	Piskom – Mullala v.	$Q_{gy}=0,557 \cdot Q_v +7,3226$	0,985 ± 0,003
4	Oygaying – Confluence	$Q_{gy}=0,756 \cdot Q_v +0,458$	0,986 ± 0,003
5	Maydontol – Confluence	$Q_{gy}=0,5438 \cdot Q_v +1,6849$	0,988 ± 0,002
6	Qizilcha – Ertosh v.	$Q_{gy}=0,756 \cdot Q_v +0,458$	0,982 ± 0,003
7	Ohangaron – Ertosh r.c.	$Q_{gy}=0,756 \cdot Q_v +0,458$	0,991 ± 0,001

Note: *$r_0 \pm \sigma_{ro}$ is the correlation coefficient and its error.*

The correlation coefficients of the regression equations presented in the table above varied in the following range: $r_o=0,978 \pm 0,004 \div 0,991 \pm 0,001$. Thus, their accuracy fully meets the requirements for expressions recommended for use in hydrological calculations and forecasts.

Conclusion. The results obtained in this study, carried out on the example of the rivers of the Chirchik-Akhangaron basin, have a certain scientific and practical significance. They can be used to solve issues related to hydrological calculations and forecasts related to the rivers of this basin. In the future, their importance will increase in predicting the amount of water discharged by rivers from existing and future reservoirs in the basin.

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