Alinteri J. of Agr. Sci. (2021) 36(2): 252-256
e-ISSN: 2587-2249
info@alinteridergisi.com

http://www.alinteridergisi.com/
DOI:10.47059/alinteri/V36I2/AJAS21140

RESEARCH ARTICLE

Statistical Assessment of the Runoff Variability of Small Rivers in the Middle Zeravshan Basin

Khikmatov Fazliddin[1*] • Ganiev Shahob[2] • Ziyaev Rahmat[3]

[1*]*Professor, Doctor of Geographical Sciences at the National University of Uzbekistan. President of the Geographical Society of Uzbekistan, Uzbekistan.*

[2]*Teacher, Department of Hydrometeorology, Faculty of Geography and Ecology, Samarkand State University, University Bulv, Samarkand City, Samarkand Region, Uzbekistan. E-mail: shaxobganiyev88@gmail.com*

[3]*Teacher, Faculty of Geography and Nature Resources, National University of Uzbekistan named after Mirzo Ulugbek, Tashkent, Uzbekistan.*

ARTICLE INFO

Article History:
Received: 02.09.2021
Accepted: 20.09.2021
Available Online: 01.10.2021

Keywords:
River Basin
River
Flow Rate
Series of Random Variables
Flow Variability
Coefficient of Variability
Statistical Assessment

ABSTRACT

The article deals with the issues of statistical assessment of the variability of the runoff of small rivers in the Middle Zeravshan basin. For this purpose, the average monthly and annual water discharges were used, taken into account at 11 hydrological stations located on small rivers and water resources in the Middle Zeravshan basin. Calculations to estimate the coefficient of variability of river runoff were carried out for two periods: the first calculation period includes the base climatic period (1961-1990), and the second calculation period includes 1991-2018. Based on the analysis of the results obtained, an increase in the value of the coefficient of variation (Cv) in the second calculation period relative to the first calculation period was revealed.

Please cite this paper as follows:

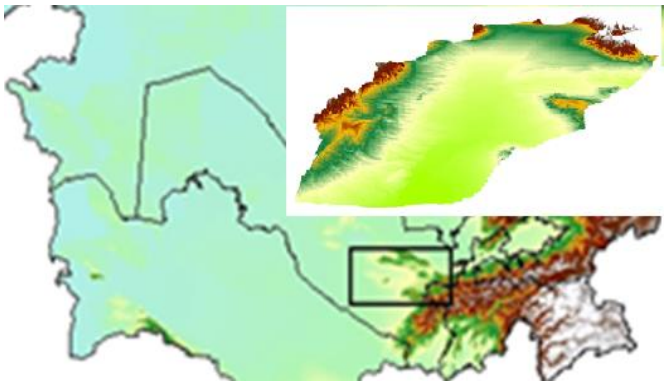
Fazliddin, K., Shahob, G. and Rahmat, Z. (2021). Statistical Assessment of the Runoff Variability of Small Rivers in the Middle Zeravshan Basin. *Alinteri Journal of Agriculture Sciences, 36*(2): 252-256. doi: 10.47059/alinteri/V36I2/AJAS21140

Introduction

Today, as a result of the process of global climate change, the shortage of water resources on our planet, especially in its arid regions, is becoming more and more noticeable. Since the second half of the twentieth century, global climate change, or more precisely, global warming, has been observed. As a result, the air temperature rises, and under the influence of this process, the flow-generating efficiency of atmospheric precipitation decreases. Such changes apply to the Central Asian region, including the Zarafshan river basin. At the same time, these changes also affect the variability of river flow [1, 2, 8].

In the effective organization of the use of small rivers and streams of the Middle Zarafshan basin in water resources, the assessment of the variability of their flow is one of the current hydrological issues. Due to this, the issues of river flow variability have been considered in the research of many scientists. In particular, studies performed by K.P. Voskresensky, V.L. Shults, O.P. Sheglova, V.E. Chub, Z.S. Sirlibaeva, F.H. Hikmatov, L M. Karandaeva, S.A. Haydarov aimed at studying this problem on the example of rivers of the Aral Sea basin [15, 16, 17]. However, in these studies, the issue of river flow variability has not been studied in detail in the example of small rivers and streams in the Middle Zarafshan basin. [1, 2, 4, 5].

* Corresponding author: Khikmatov Fazliddin



Middle Zerafshan basin (in the Uzbekistan territory)[1]

Goals and objectives of the work. The main purpose of this study is to statistically assess the variability of the average monthly and annual flow rates of small rivers and streams in the Middle Zarafshan Basin. In achieving the goal set in the study, we used perennial water consumption data observed at 11 hydrological posts on rivers belonging to the Middle Zarafshan Basin (Table 1). These hydrological data series were primary processed and generalized. The series of general observations was divided into two periods, the first - the basic climatic period (1961-1990) and the second - the accounting periods for 1991-2018.

Materials and Methods

The data of the Center of the Hydrometeorological Service of the Republic of Uzbekistan, hydrometeorological stations and posts, scientific research on the Middle Zarafshan basin were used. The study used geographical comparisons, mathematical statistics, modern methods of hydrological calculations and forecasts, as well as computer technology.

Key Results and Discussion

The amount of river flow varies from year to year, meaning that if a river has a lot of water in one year, it may have less in the second year. These changes are mainly due to climatic factors, including air temperature and the amount of atmospheric precipitation. It should be noted that these changes are not subject to a specific law. However, the monthly or annual flow rate fluctuates around the average amount, calculated for a series consisting of multi-year observations. The amplitude of oscillations of these quantities has different values in different rivers, depending on the type of saturation of the rivers [18, 19].

Table 1. Information on small rivers and creeks in the Middle Zeravshan basin

№	River-observation point	F, km²	H, m	observation years	Q_{max} observed months
1	Urgutsoy – Urgut town	25,1	1710	1949-89, 2006-2018	II-IV
2	Omonkutansay - village Omonkutan	57,8	1601	1969-2018	II-VI
3	Okdaryo – village Ogalik	70,9	1384	1985-2018	II-V
4	Sazagansay – village Sazagan	26,8	1456	1949-2002	II-V
5	Tegirmonsoy – village Sagishmon	39,3	1143	1959-1984	III-V
6	Tusunsoy -	1100	939	1938-1962, 1976-2018	III-V
7	Oktepasoy – village Ocha	43,8	1570	1964-1987, 2000-2018	II-V
8	Karagachsay – village Mavlon	34,7	1257	1978-2018	II-V
9	Kuksaroysoy – from the mountain	247	1070	1976-1985	II-V
10	Maydonsoy – village Olmaota	62,5	1138	1983-2002	II-IV
11	Beglarsoy – village Yangi Okchob	180	1340	1964-2018	II-V

The variability of the annual flow rate of rivers, i.e. the coefficient of variation, characterizes the degree to which the annual flow rate (Q_i, m^3 / s) changes relative to its norm (Q_0, m^3 / s). It is calculated using the following expression:

$$C_v = \sqrt{\frac{\sum_{i=1}^{n}(K_i-1)^2}{n-1}},$$

in this expression: K_1- is the modulus coefficient of the current, the value of which is calculated by the expression $K_i = \frac{Q_i}{Q_0}$ [3, 9, 10, 14]. In the initial phase of the study, the average annual water consumption in the studied rivers was brought to the same observation years as the corresponding accounting periods. At the same time, the existing interruptions in the rows were restored using various methods. The average annual water consumption was then calculated for each accounting period as well as for the total follow-up series (Table 2).

[1]https://earth.google.com/web/@39.67080204,66.87110598,940.71437204a,148982.28001049d,35y,0h,0t,0r/data=ChIaEAoKL20vMDNoM244MRgBIAE6AwoBMA?authuser=0

Table 2.
Mean annual water discharges of small rivers of Middle Zeravshan basin

№	River-observation point	Q_{med}, m^3/s		
		I	II	III
1	Urgutsoy – Urgut town	0,395	0,467	0,432
2	Omonkutansay- village Omonkutan	0,748	1,029	0,884
3	Okdaryo – village Ogalik	0,830	0,950	0,875
4	Sazagansay – village Sazagan	0,322	0,364	0,342
5	Tegirmonsoy – village Sagishmon	0,286	0,353	0,318
6	Tusunsoy - pour	1,457	1,394	1,427
7	Oktepasoy – village Ocha	0,303	0,314	0,308
8	Karagachsay – village Mavlon	0,223	0,371	0,298
9	Kuksaroysoy – from the mountain	0,805	1,00	0,899
10	Maydonsoy – village Olmaota	0,414	0,600	0,503
11	Beglarsoy – village Yangi Okchob	0,492	0,666	0,579

Note: I - the first basic climatic period (1961-1990); II - the second climatic period (1991-2018); III - general climatic period (1961-2018)

As shown in this table, the average perennial water consumption for the accounting periods in all rivers except the Oktepasay (Ocha village) and Sazagonsay (Sazagonsoy village) rivers differs significantly. The reason for this can be explained by the increasing influence of the human factor on their flow from year to year [19, 21]. The variability of the average annual water consumption of all studied rivers of the Middle Zarafshan basin was statistically assessed. The values of the coefficient of variation (C_v) for the annual flow series of each river were calculated using the above expression (Table 3).

Table 3.
Coefficient of variation (Cv) of annual runoff of therivers of Middle Zeravshan basin

№	River-observation point	C_v^*	I climatic period	II climatic period	III general climatic period
1	Urgutsoy – Urgut town	0,531	0,617	0,378	0,500
2	Omonkutansay- village Omonkutan	0,588	0,438	0,464	0,484
3	Okdaryo – village Ogalik	0,523	0,333	0,523	0,477
4	Sazagansay – village Sazagan	0,459	0,550	0,474	0,512
5	Tegirmonsoy – village Sagishmon	1,64	1,511	0,827	1,157
6	Tusunsoy - pour	1,02	0,895	0,899	0,888
7	Oktepasoy – village Ocha	0,797	0,878	0,550	0,725
8	Karagachsay – village Mavlon	0,422	0,581	0,840	0,837
9	Kuksaroysoy – from the mountain	-	0,609	0,485	0,549
10	Maydonsoy – village Olmaota	0,746	0,706	0,526	0,627
11	Beglarsoy – village Yangi Okchob	0,739	0,822	0,622	0,720

note: C_v^* - V.E. Chub (2007) data; I, II, III – *author's data*

The values of the coefficients of variation we determined were compared with the results of other researchers. It is known that V.E. In Chub's 2007 monograph, the coefficient of variability (C_v) was calculated for all small rivers in the Central Zarafshan basin [7, 10, 11, 12, 13, 22]. The largest values of the coefficient of variability in it are Tegirmonsoy - Sagishmon q. (C_v = 1.64) and Tusunsoy - tributaries (C_v = 1.02). In contrast, in Sazagonsay and Karagachsay we can see that C_v <0.5. According to the results of our calculations, the first value of the coefficient of variability in the first calculation period, i.e. 1961-1990, fell on Tegirmonsoy (C_v = 1,511). In the second accounting period (1991-2018), the calculated values of the coefficient of variability met the condition C_v <1.0 in all rivers. During this calculation period, the value of the coefficient of variability in Urgutsay, Tegirmonsoy and Beglarsay decreased compared to the first accounting period. In contrast, in rivers such as Akdarya and Qayragachsay, the values of the coefficient of variability increased compared to the first accounting period.

No significant changes were observed in the calculated values of the coefficient of variability for the total calculation period, i.e. in 1961-2018. These results were compared with the results of calculations performed for both accounting periods in the example of small rivers of the Middle Zarafshan basin. These comparisons show that the values of C_v decreased in Tosinsoy and slightly increased in Qayragachsay. This process can be explained by the impact of the reservoir built in Tosinsoy. In Kayragachsay, this situation is due to changes in its flow formation zone.

Analysis of the results of the calculations showed that the values of the coefficient of variability in the remaining rivers varied in the range of 0.477÷1.157. In general, the values of the coefficients of variability determined by different authors for different accounting years are close to each other. In the study, based on the identified tasks, the coefficients of variability of the flow of months with high water content during the flood period in the rivers of the study area were also calculated (Table 4).

Table 4.
Coefficients of variation of monthly water discharges of rivers of the Middle Zeravshan basin during the flood period

T/p	months	variation coefficients C_v										
		1	2	3	4	5	6	7	8	9	10	11
1	February	0,636	0,715	0,837	0,762	2,200	0,745	1,018	0,851	0,523	0,794	0,824
2	March	0,480	0,725	0,632	0,644	2,038	1,673	1,136	0,750	0,505	0,717	1,012
3	April	0,611	0,561	0,604	0,591	1,852	1,600	0,967	0,703	0,320	0,743	0,886
4	May	0,411	0,595	0,756	0,610	1,914	1,161	0,943	0,663	0,414	0,771	0,856
5	June	0,479	0,577	0,887	0,817	1,321	1,302	0,782	0,751	0,300	0,803	1,026

Note:1,2,3... numbers indicate the order of the rivers in the Table 1.

The coefficients of variability of the flood period of small rivers of the Middle Zarafshan basin varied in February, March and April in the range of 0,320÷2,200 (Figure 1).

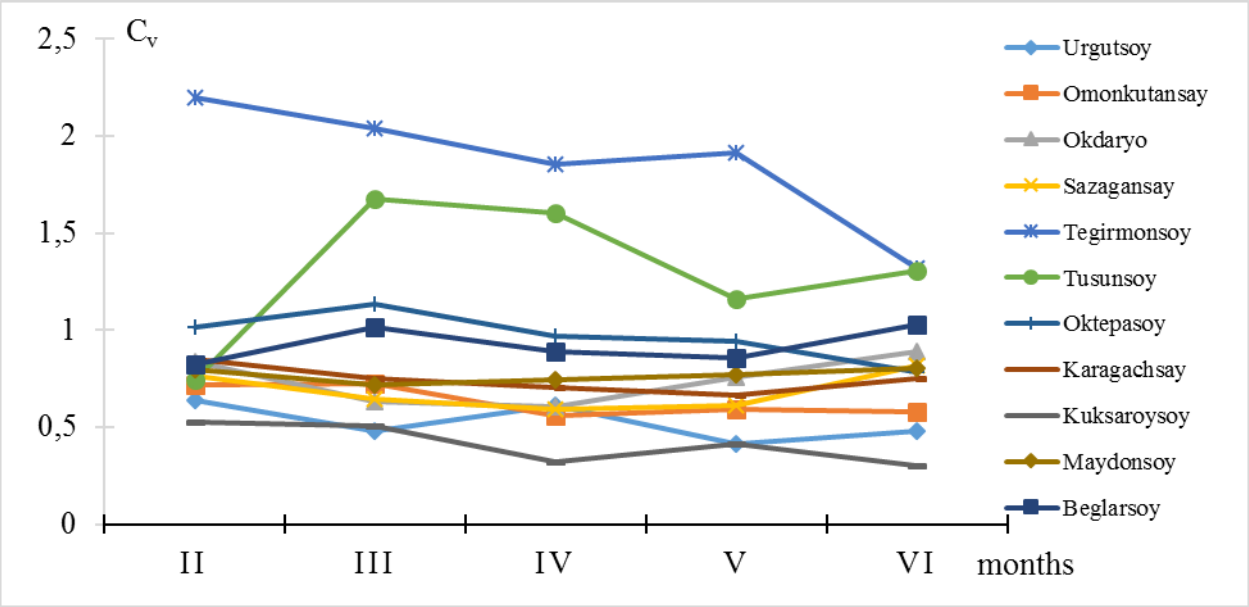


Fig. 1. Changing of coefficient of variation of the monthly discharges of rivers of the Middle Zeravshan basin during the flood period

In the following May and June, the values of C_v decreased. However, in some rivers, such as Kayragachsay and Maidonsay thee values of S_v increased. This, in our opinion, is due to the heavy rains that are sometimes observed in May and June. In Urgutsoy, the change in the coefficients of variation decreased slightly in March and rose again in April, while in Tegirmonsoy the values of Sv decreased by months, i.e. from February to June.

Conclusion

1. The issues of inter-annual fluctuations of the average monthly and annual flows of rivers and streams formed in the Middle Zarafshan basin were studied. Their variability was statistically assessed by calculating the coefficient of variation;
2. The coefficients of variation of the average annual water consumption of rivers for the last 1991-2018 will vary in the range of 0.378÷0.899, and the values calculated for the total for 1961-2018 will vary in

the range of 0.477÷1.157. These values of the coefficients of variation were compared with the E.V.Chub data. With a few exceptions, it was shown that the difference was not significant;

3. The main part of the average annual flow of all small rivers and streams formed in the Central Zarafshan basin flows between February and May. Their flow decreases sharply during the summer months, and sometimes their streams dry up.

Acknowledgments

The authors did not spare their help and scientific advice in the preparation and approbation of this scientific article. Expresses his deep gratitude to F.H. Hikmatov. Professor of the Department of Land Hydrology of the National University of Uzbekistan named after Mirzo Ulugbek.

References

Resurrection K.P. *Rate and variability of the annual flow of rivers in the Soviet Union.* L.: Gidrometeoizdat, 1962.246.

Ziyaev R.R., Hikmatov F.H., Mardiev I.A., Yuldoshova Z.O. Statistical assessment of the impact of climatic factors on the formation of the Zarafshan river floodplain. *Information of the Geographical Society of Uzbekistan*. Volume 56, 2019, 211-215.

Rasulov A.R. Hikmatov F.H., Aytbaev D.P. *Fundamentals of hydrology*. -Tashkent: University, 2003, 110-113.

Ratkovich D. Ya. *Long-term fluctuations in river flow*. L.: Gidrome-teoizdat, 1976, 255.

Chub V.E. *Climate change and its impact on hydrometeorological processes, agroclimatic and water resources of the Republic of Uzbekistan.* -Tashkent: "VORIS NASHRIYOT", 2007. -133.

Shults V. L., Mashrapov R. *Hydrography of Central Asia*. –Tashkent, 1969.128-134.

Shiklomanov I.A. *Investigation of land water resources: results, problems, prospects.* L.: Gidrometeoizdat, 1988.-152.

Hikmatov F.H. and others. *Hydrometeorological conditions and water resources of the Zarafshan basin. Monograph*. -Tashkent: Science and Technology, 2016. -275.

Hikmatov F.H. and others. *Hydrometeorological conditions and water resources of the Zarafshan basin.* -Tashkent: Science and Technology, 2016.-276.

Hikmatov F.H., Aytbaev D.P. *Statistical methods in hydrometeorology*. -Tashkent: University, 2007, 88.

Hikmatov F., Haydarov S.A., Hakimova Z.F., Ganiev Sh. R., Erlapasov N.B. Assessment of the flow rate of the Zarafshon river according to climatic factors. *International Journal of Psychosocial Rehabilitation*. May, 2020, Volume 24. - Issue, 2020, 5438-5449.

Hydrological knowledge. Volume 14. Central Asia. Issue 3. Bass. R. Amu Darya. L.: Gidrometeoizdat, 1967 323.

Irrigation of Uzbekistan. Volume III. Tashkent: Fan, 1979, 357.

Ganiev Sh.R., Valieva Sh. Ravotkhodzhinskoe water distribution structure and canals that take water from it. Young scientist. Science Magazine.–Kazan, ISSN: 2072-0297 No. 8 (88) April 2015.

Ganiev Sh.R., Isaeva M.M. Annual shaking of the stream of rivers (As an ehample of middle Zarafshan). Young scientist. *International scientific journal* - Kazan, ISSN: 2072-0297 No. 11 (91) June 2015.

Ganiev Sh.R. The meteorologikal study of the vater basin of the middle Zerefshan Rivers. Young scientist. *International scientific journal* - Kazan, ISSN: 2072-0297 No. 12 (116) June 2016.

Ganiev Sh. R. The average perennial statement of the stream flows in the mountains and their evaluations. *Young scientist. International Scientific Journal* - Kazan, ISSN: 2072-0297 No. 10 (196) March 2018.

Irrigation of Uzbekistan. Volume IV. Tashkent: Fan, 1979.357.

Shirinboev D.N., Ganiev SH.R., R.R. Ziyaev Hydrological Regime of Irrigation Canals in Zarafshan Oasis. *International Journal of Advanced Research in Science, Engineering and Technology*. 2021 volume 8, Issue 4, ISSN: 2350-0328.

Chub V.E. *Climate change and its impact on the natural resource potential of the Republic of Uzbekistan.* Tashkent: NIGMI, 2000.252.

Shirinboyev D.N., Ganiyev Sh., Hikmatov F., Haydarov S. *Assessment of the impact of anthropogenic networks on changes in the flow of the Zarafshan River*. TEST Engineering & Management. 2019. –P. 15137-15145.

CA Water-Info. URL: http://www.cawater-info.net.html