1st INTERNATIONAL CONFERENCE
„The Holistic Approach to Environment"
Sisak, September 13th-14th, 2018

ASSESSMENT OF THE IMPACT OF GLOBAL CLIMATE CHANGE ON THE SURFACE RUNOFF OF THE UPSTREAM OF THE CHIRCHIK RIVER

Kodirov Sobirjon M.*

*Tashkent institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan
smqodirov@gmail.com

ABSTRACT

The Charvak Reservoir is the largest reservoir in the territory of the Republic of Uzbekistan. It is surrounded by The Tien Shan Mountains. The Chirchik River begins from the dam of the reservoir (mean annual flow rate 208 m^3/s) and it is one of the biggest right tributaries of The Syr Darya River. The Chatkal River (long term flow rate 108 m^3/s) is the biggest tributary of The Chirchik River. On the basis of long-term data from 8 hydrological and meteorological stations, intra annual surface runoff distribution was evaluated. Main hydrologic features of The Chatkal River, detection and removing of linear trends, test for homogeneity, longterm fluctuations of the time series, calculation of annual stream flow under different frequency distributions were estimated The data set of statistical characteristics and their standard errors are estimated, for average flow rates the error does not exceed 10%, for the coefficient of variation; the error does not exceed 15%. To describe frequency distribution The Gumbel Distribution was applied.
*(**Keywords**: The Chatkal River; The Charvak Reservoir; hydrology; intra-annual runoff distribution; average flow rate.)*

INTRODUCTION

1.1 General information about focusing area

The article deals with features of the hydrological regime of the Chatkal River which is located in the territory of Uzbekistan and Kyrgyzstan. Chatkal – is a mountain river and it begins from a nameless moraine lake in the territory of Kyrgyzstan [1]. It flows mainly to the west along the westernmost part of The Tien Shan Mountains. Near to the Burchmulla village (Tashkent region, Uzbekistan), it flows into The Charvak reservoir. Length of the river is 217 km (until 1965 223 km) and catchment area is 6580 km^2 (7110 km^2 until 1965) [1]. The study of the hydrological regime of the Chatkal River is necessary for effective regulation of water resources. *The objective* of the research is to study the hydrological regime of the Chatkal River and to evaluate the main characteristics of the intra-annual distribution of river surface runoff.
As observation data, we used a series of meteorological and hydrological characteristics for 8 stations and we set up hydrological series of the average monthly, daily annual water

discharge data set. *All meteorological stations of the study* area considered being high mountain stations in terms of altitude and all rivers surrounding The Charvak Reservoir format Charvak reservoir catchment area. The nearest meteorological station to the Charvak reservoir is Chimgan and it is located on 1265 m above the sea level, the farthest station Oigaing, on the other hand, located on 2175 m above the sea level.
Hydrologic and meteorological stations opened the last century. After filling the Charvak reservoir The Chatkal River – hydrologic station at Charvak village closed. At present, the nearest hydrological station to The Charvak Reservoir is located upstream of the mouth of The Khudoydodsay River [2].

MATERIALS AND METHODS

2.1 Initial data

The paper, we used the average monthly and average annual water discharge data from 4 hydrological stations of the focusing area. Location of the hydrologic stations given in table 2.1. The data of annual flow rates received from the department of water cadaster and meteorological measurements, Centre of Hydrometeorological Service at Ministry of Emergency Situations of The Republic of Uzbekistan and hydrologic yearbooks of the library of Russian State Hydrometeorological University.

Table 2.1 – Hydrological stations of the Chatkal River.

№	River – station	*F*, km	The period of observation	observations, year
1	Chatkal River – at Khudoydodsay station	6580	1965-2014	50
2	Chatkal River – at Nayzatukay station	5520	1933-1963	26
3	Chatkal River – at Ters station	4090	1933-1975	39
4	Chatkal River – at Charvak village station	7110	1932-1963	35

2.2 Extension of the records and observations

The manner in which the various models available for filling in missing data and extension of records of the annual stream flow, corresponding to the availability and the length of data are based on the following methods commonly used methods: 1) for a long period of observations, the calculation is carried out directly from the observation data; the time period from this dataset is used in computations if its duration is 50-60 years and more; 2) if observation is short it should be filled relatively to a longer period of observation by applying the method of hydrological analogy (river analog); 3) in the case of a series of observations very short or no data at all, annual runoff is determined by generalizations of the results of studied river or the water balance equations are used [3].
For design at a site where data are available the method of *hydrological analogy* was applied. A hydrological station, where it is necessary to fill the gaps of records of The Chatkal River, the parameters of the linear regression equation for the connection of average annual discharge is calculated. Average-flows gauged in the Khudoydodsay station are related to contemporaneous data for the Charvak village station, enabling average-flow characteristics for the Charvak village station to be transferred through the relation to the Khudoydodsay

station. *Fig. 2.2 shows average flow rate relationship between two hydrologic stations. Statistically, correlation coefficient should be at least 0.7. In our case it was 0.95.*

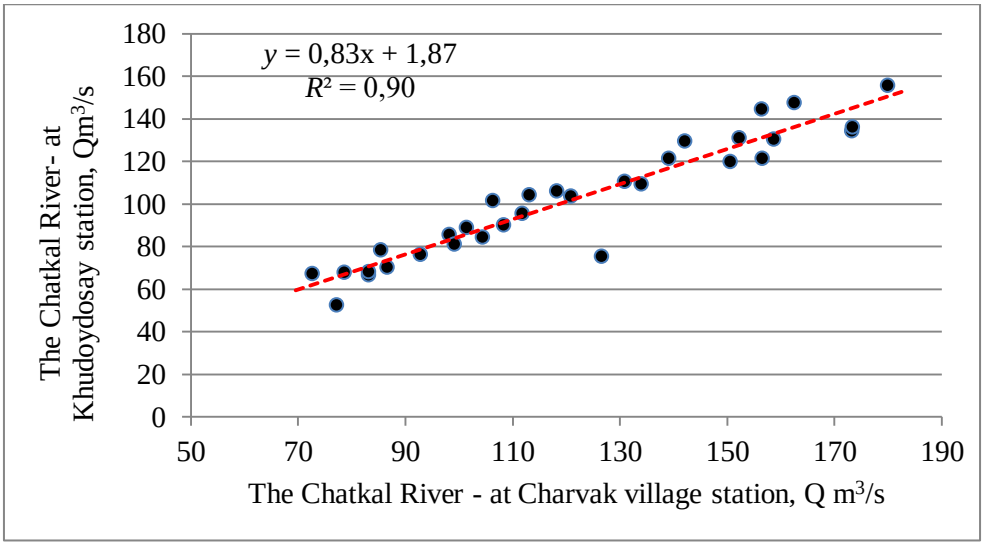

Figure 2.2 - Average-flow correlations between two The Chatkal River streams, Khudoydodsay station and Charvak village station, 1933-1966.

Table 2.2 – The parameters of the average-flow correlations plot of the annual discharge values between two stations of The Chatkal River – at Khudoydodsay station and The Chatkal River – at Charvak village station

Characteristics	Value
estimated river (*Y*)	Chatkal River – at Khudoydodsay station
analog-river (*X*)	Chatkal River – at Charvak village station
Observations (*n*)	32
The correlation coefficient (*R*)	0,95
Standard error of R (σ_R)	0,04
R/σ_R	23,3
the coefficient of regression (*a*)	0,83
Standard error *a* (σ_a)	0,05
a/σ_a	16,65
Independent member (*b*)	1,87
Regression Equation	$Y = 0,83 * x + 1,87$

For practical estimation the correlation coefficient (*R*) ought to be at least 0.7 and in case table 2.2 this parameter is 0.95., that means we have excellent relationship. Also for better result it is necessary to use at least six years of simultaneous observations and in our example it was 32 years.

RESULTS

3.1 Extension of data set

The initial dataset for The Chatkal River – at Khudoydodsay station was from 1965 to 2014 (Fig. 3.1). After recovery is was extended to 32 years and became 1933-2014.

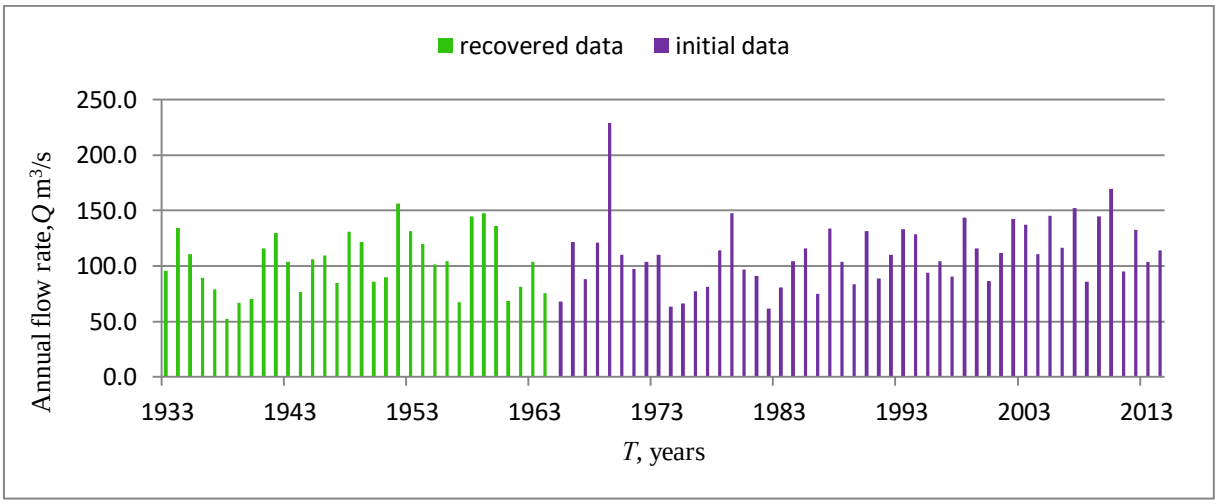

Figure 3.1 - Histogram of annual stream flow for the Chatkal River – at Khudoydodsay station, initial with the recovered data set.

3.2 Results of the estimation of main hydrological characteristics

Table 3.2 gives results for all analyzed hydrological stations of The Chatkal River modulus of flow (amount of water that is originating from unit area per second in liters) varies within 15-17 l / s km^2, the coefficient of variation - C_v varies between the of 0.21-0.27. At the same time, the statistical error of the average annual water flow is 8-9% and the error of C_v does not exceed 15%.

Table 3.2 Outcomes of the estimations of the main hydrological characteristics

Hydrological Station	Catchment area, km^2	Q_m, м^3/с	Q_m, l/s km^2	C_v	C_s	C_s/C_v	Relative error, %		
							Q_m	C_v	C_s
The Chatkal River-Nayzatukay	**5520** (1932-1964)	82,8	15,0	0,21	0,22	1,03	4,2	14,2	108
The Chatkal River-Ters	**4090** (1915-1962, 4290)	64,0	15,6	0,23	0,26	1,12	4	12	61
The Chatkal River-Khudoydodsay	**6580** (1965-2015)	108	16,4	0,27	0,87	3,21	8,7	8,1	32
The Chatkal River-village Charvak	**7110** (1933-1967)	121	17,0	0,25	0,22	0,85	4	12	85
Average value	–	–	16	0,24	0,39	1,53	5,15	11,5	71,5

3.3 The probabilistic methods of calculation of the average annual streamflow

This section provides computations of several families of distributions which are widely used in hydrology. Based on recovered data set of The Chatkal River at Khudoydodsay Station,

mean annual stream flow is estimated and exceedance probability distribution plotted for the following families of distributions: Normal, Lognormal, Gumbel and Kritskiy-Menkel [4]. For a calculated return period annual flow rate is given in fig. 3.2.

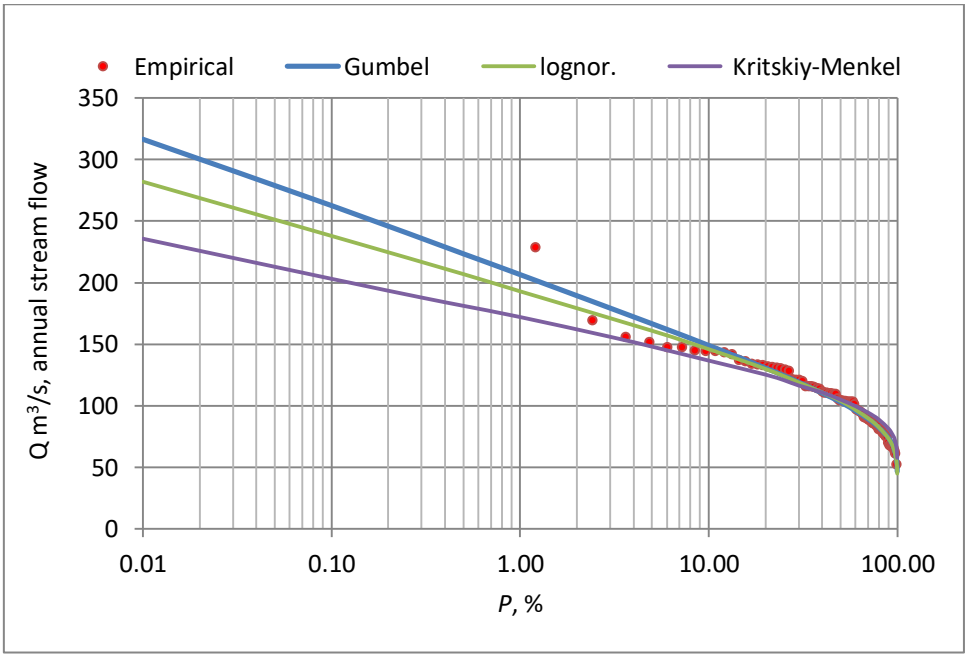

Figure 3.3 Comparative illustration of the average annual water flow of the exceedance probability distributions Normal, Lognormal, Gumbel and Kritskiy-Menkel.

As an example, it was the Gumbel (Generalized Extreme Value Distribution Type-I) was chosen. In the empirical distribution plot, one observation year is strongly deviates from the others. This is the average annual water discharge for 1969, which was extremely high due to heavy snowfall and relatively long winter. The Gumbel distribution best fits because it lays more close among others to this point, hence it illustrates fits the maximum average annual flow rate.

CONCLUSIONS

As a result of the work done, the following conclusions can be drawn:

1. Filling in missing observations and extension of records were fulfilled.
2. For all data set, statistical characteristics and their errors are estimated, for average flow rates the error does not exceed 10%, for the coefficient of variation, the error does not exceed 15%.
3. The empirical and Gumbel security curves were plotted. As an analytic Gumbel curve was chosen for analysis.
4. The impact of Global Climate Change to Tien-Shan mountains is obvious, but this impact still keeps the figures within statistically allowed interval or statistically insignificant.

5. REFERENCES

[1] Gulomov P.N., Vakhobov H., Barotov P., Mamatkulov M. «Physical geography of Uzbekistan and The Central Asia», Publishing and polygraph creative house «O'qituvchi», Tashkent – 2013. – 160 p. (in Uzbek).

[2] Shultz V.L. the Rivers of the Central Asia. – Leningrad: Publishing House of Hydrometeorology, 1965. – 691 p. (in Russian).

[3] Sikan A.V. Methods of statistical processing of hydrometeorological information. Tutorial. For fields «Ecology and Environment». Specialty «Geoecology». – Saint-Petersburg.: Publishing House of RSHU. 2007, – p. 278. (in Russian).

[4] Orlov V.G., Sikan A.V. Basics of engineering hydrology. Tutorial. For fields «Ecology and Environment». Specialty «Geoecology». – Saint-Petersburg.: Publishing House of RSHU. 2003, – pp. 187. (in Russian).