

# Assessment of Water Content in Hydrologic Time Series Using Difference Integral Curves (Example of Pskem River)

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DOI 10.2412/mmse.22.57.371 provided by [Seo4U.link](http://Seo4U.link)

**Keywords:** Pskem river, Chirchik river, hydrology, long-term fluctuations, average flow rate.

**ABSTRACT.** The Pskem River (mean annual flow rate 79.6 m<sup>3</sup>/s) is one of the biggest tributaries of The Chirchik River. The Chirchik River is the biggest right tributary of The Sirdarya River in the territory of Uzbekistan. On the basis of long-term data from hydrological and station (The Pskem River, at hydrological station Mullala, 85 years of observation), long-term fluctuations was evaluated in terms of watery of the year i.e. how changes mean annual flow rate from year to year. The data set of statistical characteristics and their standard errors are estimated, for average flow rates statistical error does not exceed 2.5 %, for the coefficient of variation; the error does not exceed 6 %. To describe long-term fluctuations in water content for a given period method of normalized values applied.

## Introduction.

**General information about focusing area.** The article considers feature of the hydrological regime of the Pskem River, which is located in the territory of Uzbekistan. Pskem – is a mountain river and it begins from Talas Alatau Mountains in Kazakhstan [1]. It flows mainly to the south-west between Pskem and Ugom Mountain Ranges. Near to the Mullala village (Tashkent region, Uzbekistan), it flows into The Charvak reservoir. The length of the river is 70 km and catchment area is 2540 km<sup>2</sup>. The study of the hydrological regime of The Pskem River is important for rational regulation of water resources of the region. The objective of the research is to overview the hydrological regime of The Pskem River and to evaluate the long-term fluctuations in the hydrological time series in terms of watery.

As initial data, we used a series of hydrological dataset for 85 years of observations. The place where our hydrological station located is considered to be high mountain stations in terms of altitude.

## Materials and Methods. Initial data and methods

To estimate long-term fluctuations of the annual flow rates of analyzing rivers, the difference integral curves are plotted (DIC).

In order to plot the curves, at very beginning of the dataset we need to add one more years and indicate it as a first serial number 0-zero. Because curve is always starts with zero and ends at zero. For example, assuming for a certain year, the annual stream flow is higher than the expected value, then the DIC rises. If lower than the average value, then it decreases respectively [2].

Afterwards mean annual flow rate and its standard deviation of the hydrological dataset must be determined.

The following equation is used to calculate normalized annual flow rates:

$$t = \frac{Q_i - \bar{Q}}{\sigma} \quad (1)$$

where  $t$  – normalized values of mean water discharge;

$Q_i$  – annual flow rates;

$\bar{Q}$  – mean long-term flow rates;

$\sigma$  – standard deviation of dataset.

The values for  $\sigma$  – can be determined from the square root of variances:

$$\sigma = \sqrt{D} \quad (2)$$

### Results. The evaluation of the long-term fluctuations

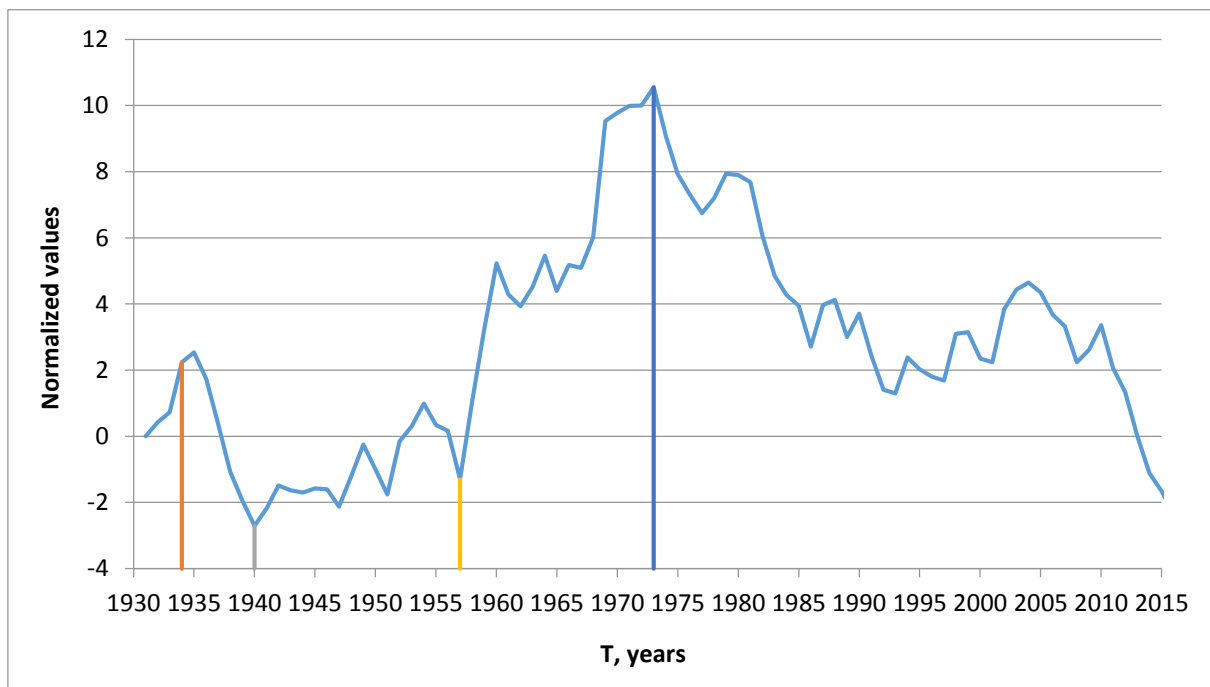


Fig. 1. Difference integral curves of annual flow rates of The Pskem River- at Mullala hydrological station.

As Figure 3.1 depicts, the average annual flow rates from 1934 to 1940 rises relatively to the average value-0, and from 1940 to 1957, the DIC remains stable that refers during this period is close to mean flow rates (annual flow rates are relatively close to the expected value). Moreover, from 1958 till 1974, the average annual water discharge rises again relatively to the average value. In addition, consequently, this is considered as a high water period.

However, from 1975 till nowadays we are observing long duration of low watery interval. The intra-annual distribution of precipitation is shown in Figure 3.2. As can be seen from this figure, 64-65% of the annual amount of precipitation falls from January to May, the smallest part (5-6%) falls during the period of June-September months [3]. This figure provides the information relating watershed characteristics such as elevation influences to formation of more liquid precipitation. The analysis of seasonal patterns of precipitation for a period of 1981-2010 at lower stations Yangikurgan and Brichmull shows the increase during spring months.

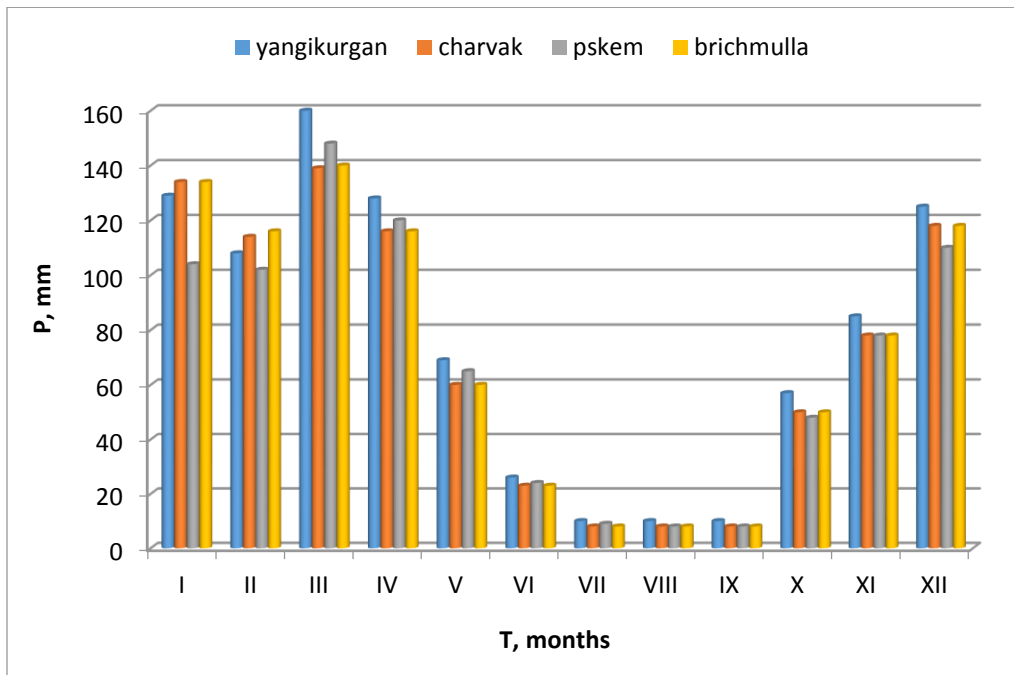


Fig. 2. Average long-term monthly precipitation at Pskem meteorological station.

The average long-term amount of annual precipitation for each meteorological station is presented in the table 1.

Table 1. Average long-term annual precipitation, mm [4].

№	Meteorological station	Precipitation, mm	
		For a period of 1961- 1990	For a period of 1981- 2010
1	Chatkal	555	574
2	Chimgan	533	559
3	Pskem	546	572
4	Oigaing	523	538

For all the stations during 1981-2010 precipitation is increasing in the hot season (May-August). Nevertheless, this growth is within 3-5%, which does not exceed 9% statistical error. It was also determined about 44% of the annual amount of precipitation falls in liquid form, 26% mixed precipitation and 30% in the form of snow.

**Summary.** Difference integral curves provide a compact graphical summary of long-term streamflow variability. It is simple and effective way of evaluating long-term hydrological time series. For example, they illustrate how watery of the time interval for a taken period. For our focusing area starting from 1975 till 2016 low water content period is observing. This can be explained with precipitation characteristics i.e. during this time the overall amount of precipitation is changing statistically insignificant (3-5 %) however alteration of type of the precipitation is occurring. This refers to observation of more rainfall than snowfall processes. Hence less snow cover remains in catchment area and it corresponds to shift of the type of the river from snow-glacier nourishment to snow (mostly seasonal not permanent) nourishment by classification of Shultz V.L. [5].

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