Comparative analysis of the annual runoff distribution of the left-bank and right-bank tributaries of the Siverskyi Donets River Basin

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SUMMARY

The calculation of the annual runoff distribution of the Siverskyi Donets River Basin is extremely important for the industry needs and water supply, especially in times of current climate change. During the research, two periods were considered - before the tipping point in 1989 and after. Three water year types (wet year, average year and dry year) were reviewed. The significant differences in the annual runoff distribution of the left-bank and right-bank tributaries of the Siverskyi Donets are revealed. Left-bank tributaries are characterized by a decrease in the proportion of spring months in annual distribution and an increase in the proportion of winter and summer-autumn months. Right-bank tributaries have a slightly different distribution of annual runoff: the share of spring and summer-autumn runoff increases, and the proportion of winter runoff decreases. It is established that during the current climate change, the annual runoff distribution has undergone significant changes.
Introduction

River water management is based on calculations of the annual runoff distribution. Performing hydrological calculations, it is almost always necessary to have information about the annual runoff distribution of the river. The results obtained are of great practical importance and can be used for the industrial and agricultural needs, also for designing reservoirs (Grebin, 2010). The research of the distribution of annual rivers runoff of the Siverskyi Donets Basin is relevant, given the industrial character of the region and the problem of scarcity of fresh water. It is important to establish patterns of annual runoff distribution both from the practical point and from the point of the general study of the Ukrainian rivers regime in the current period.

Method and/or Theory

The annual runoff calculating methods involve determining the distribution of annual river runoff by seasons and months in different water year types. Given the sufficient duration of the hydrological data series, real-year method was used for the research. The annual runoff distribution calculations have been performed since the high water (spring) season (Dubnyak, 2005). We used 3 water year types for the research: wet year, average year and dry year.

To investigate the annual runoff distribution for the Siverskyi Donets Basin, we used the average monthly water discharges for 12 stream gauges for the entire observation period up to 2018. The estimated rivers were divided into 2 groups (belonging to one or the other part of the basin - left-bank tributaries, right-bank tributaries) and 2 periods (before the beginning of current climatic changes and after the tipping point -1989).

Results

On the first stage of the research, the annual runoff distribution for the left-bank and right-bank tributaries of the Siverskyi Donets Basin was considered for the entire observation period. The largest share of annual runoff occurs in March, April for the left-bank tributaries and in February for the right-bank tributaries of the Siverskyi Donets. The lowest runoff from the annual is the summer-autumn period for both groups. 37% of annual runoff of right-bank tributaries and 26% of left-bank tributaries account for winter.

The second stage of the work is compare the runoff distribution up to 1989 (the point of the beginning of current climate change in the territory of Ukraine) for the three water year types. The share of spring in the annual distribution of left-bank tributaries decreased from 78% to 50% at the present stage, but the share of summer-autumn period increased significantly from 10% to 39% (Figure 1).

![Figure 1 Annual runoff distribution by months and seasons of the left-bank tributaries of the Siverskyi Donets River (wet year)](image)
Right-bank tributaries are also characterized by a decrease in the proportion of spring in the annual distribution and an increase in the role of the summer-autumn period. A feature of current runoff distribution is the shift of the peak from February to April, as well as a significant decrease in the share of runoff that falls from 48% to 27% in winter (Figure 2).

Figure 2 Annual runoff distribution by months and seasons of the right-bank tributaries of the Siverskyi Donets River (wet year)

For the average year and dry year, right-bank and left-bank tributaries have significant differences in the distribution of annual runoff (Figures 3, 4, 5, 6).

Figure 3 Annual runoff distribution by months and seasons of the left-bank tributaries of the Siverskyi Donets River (average year)

Figure 4 Annual runoff distribution by months and seasons of the right-bank tributaries of the Siverskyi Donets River (average year)
Average and dry years are characterized by a decrease in the proportion of spring and an increase in the proportion of dry periods in the annual distribution of the left-bank tributaries of the Basin (Figure 3, 5). Unlike the left-bank tributaries, the right bank is characterized by a decrease in the proportion of winter at the present stage (Figure 4, 6).

**Figure 5** Annual runoff distribution by months and seasons of the left-bank tributaries of the Siverskyi Donets River (dry year)

**Figure 6** Annual runoff distribution by months and seasons of the right-bank tributaries of the Siverskyi Donets River (dry year)

**Conclusions**

Analyzing the results, it was found that in distribution of runoff left-bank and right-bank tributaries significantly differ, which is due to factors of the underlying surface and the intensity of anthropogenic loading. The share of spring runoff for the left-bank tributaries of the Siverskyi Donets River Basin decreased, while for the right-bank tributaries of the basin it did not change significantly. The winter runoff of the left-bank tributaries of the current period is characterized by an average increase of 10%. Right-bank tributaries of the basin are characterized by a decrease in winter runoff. The share of summer and autumn runoff in the period 1989-2018 exceeds by 5-10% to compare of runoff in the period up to 1988. At the present stage, the passage of the highest water discharges for the right-bank tributaries has shifted from February to April.

In the course of the research it was found that according to the considered water year types the left-bank tributaries are characterized by a decrease in the proportion of spring months in the annual distribution and an increase in the share of dry (summer-autumn and winter) months. Right-bank tributaries have a slightly different annual distribution of runoff: the share of spring and summer-autumn runoff increases, and the proportion of winter runoff decreases.
Thus, with the onset of current climate change, the annual runoff distribution of the Siverskyi Donets River Basin has undergone significant changes.

References