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ARTICLE

Spatio-Temporal Change of Atmospheric Precipitation on Territory of North-West of Ukraine

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ABSTRACT

The direction of the trend of precipitation over time is an important characteristic for both theoretical and practical use. The presented study is devoted to the analysis of changes in the territory of the trend of precipitation over the year over time. At the present stage of climate change in the north-west of Ukraine, there is a general tendency to increase rainfall over the year. This trend is not the same across the territory and depends on the height and latitude of the area. The amount of precipitation varies both in space and in time, however, the distribution of the characteristics of the rains themselves (intensity, duration and others) continue to remain similar throughout the territory. The revealed features of changes in the amount of precipitation in space and time can be useful in studying the unevenness of wetting, forecasting floods, changes in erosion activity, etc.

1. Introduction

Modern climate changes are expressed both in changes in air temperatures and in the amount and distribution of precipitation over the territory. The results of such changes are reflected in the formation of flash floods with flooding of significant territories, intensification of erosion processes, etc.

The importance and versatility of the influence and interaction of factors determining the formation of showering processes were reflected in numerous studies [1-19 and others]. Both questions about the nature of precipitation and the possibility of predicting their characteristics were studied. Thus, the characteristics of precipitation in the warm season are largely determined by the direction of the moving air masses [1]. The largest contribution to the amount of precipitation during the warm period for the territory of Ukraine is made by precipitation associated with the northwestern fronts and cyclone centers [2].

In [3] noted that, in general, during the warm period over the steppe zone of Ukraine (May-August 1981-1984), precipitation is observed during western transport of air masses. The spatial variability of precipitation is inversely related to their duration [4]. According to [5], with an increase in the precipitation layer, the fraction of the area occupied by them decreases. According to [2], during the warm period, the position of the station has a significant effect on the fields of intramassual precipitation, i.e. remoteness from the sea. This confirms the influence of breezes on intramassular precipitation and the position of cyclone trajectories on cyclonic precipitation. The sea

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does not significantly affect the distribution of frontal sediments; it is determined by the aggravation of the front and the distance from the center of the cyclone.

In [6] found that the greatest amount of precipitation is associated with western and southwestern processes, and the smallest - with northwest and private cyclones. The maximum daily precipitation is observed in Polesie and the forest-steppe zone of Ukraine. In general, precipitation decreases across the territory of Ukraine in the east and south-east direction.

According to [7] for the period from 1967 to 1990. On the UTS south of 60 ° N precipitation increased significantly, the most significant increase occurred in the summer season. Precipitation was mainly of frontal origin.

There is an opinion [8] that in the process of regional climate warming, the contribution of intense precipitation to their total amount does not increase. On the contrary, in most of the territory of Ukraine, where surface temperature growth is recorded, significant negative trends are noted in the time course of GI.

In general, in Ukraine, there is a significant difference in the temperature and humidity regime between the decades of the late 20th and early 21st centuries [9].

According to [10], the moistening of the territory of the East European Plain, in the change of which atmospheric precipitation plays a decisive role, is subject to strong interannual variability. She identified and investigated the spatial structure of the response of seasonal precipitation on the East European Plain to long-term changes in atmospheric processes over the North Atlantic. They have the most significant effect on the formation of the long-term average rainfall in the East European Plain in spring and summer. The regions most sensitive to this influence are located in the southeast of the plain.

All these studies show that the direction of the trend in the amount of precipitation over time is an important characteristic that allows predicting the development of adverse hydrometeorological phenomena (floods, droughts, intensive soil erosion, etc.), and use the calculation results in the design of various drainage and soil protection structures etc. The presented study is devoted to the analysis of changes in the territory of the trend of precipitation over the year over time.

2. Materials and Methods

The territory of the study was the north-west of Ukraine, more precisely, the Western Bug and Pripyat river basins. For analysis, 25 meteorological stations located in this territory and adjacent to it were taken. A list of the part of meteorological stations for which the materials were taken for analysis is presented in Figure 1. The area under study is approximately 77 thousand km^2, the distance between the extreme parallel meteorological stations Kamenka-Bugskaya and Kiev is about 450 km. The materials of observations of the Ukrainian Hydrometeorological Service for precipitation were used: processed measurements of the amount of precipitation by precipitation gauges and records of pluviographs from the beginning of observations at the meteorological station until 2016-2017. The trends in atmospheric precipitation at weather stations over time were analyzed (Figure 1). For convenience of analysis, for each meteorological station, the communication equation was determined y = ax + b (straight line), where a is the angular coefficient of the line, it is equal to the tangent of the angle between the straight and positive direction of the Ox axis.

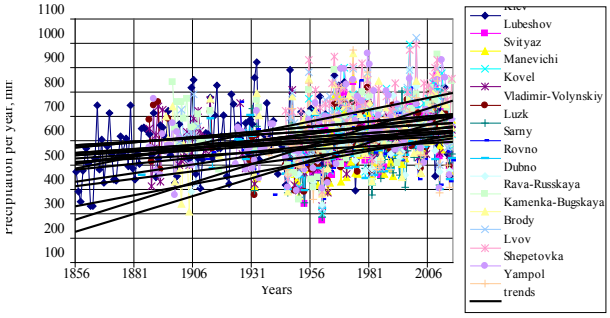

Figure 1. Trends in time of precipitation over the year for a number of meteorological station s in the north-west of Ukraine

The range of changes in precipitation characteristics in the study area is presented in Table for two meteorological station: the extreme western in this area - Kamenka-Bugskaya and the extremely eastern - Kiev.

Table 1. The range of variation of precipitation

Precipitation	Meteorological stations	
	Kamenka-Bugskaya	Kiev
Total precipitation observation period (number of years of observation) / observation period using pluviographs, years	1894 – 1905,1932-1934, 1946-2016 (85) / 1963-1985, 1988-2017	1856-2016 (158) / 1950-1980, 1993-2016
Average annual precipitation per year, mm	660	617
Maximum precipitation per year, mm	959	925
Minimum precipitation per year, mm	311	331
Range of average rainfall over 10 mm, mm	10-98,5	10-82,4
The range of average rainfall intensity is more than 10 mm, mm / min	0,01-1,58	0,01-0,06
Range of maximum intensity of rainfall over 10 mm, mm / min	0,03-2,62	0,013-7,1
Duration of rainfall over 10 mm, min	11-2505	26-1610

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3. Results

The studies show that at all meteorological station s studied, the direction of the trend in the amount of precipitation is positive, i.e. there is an increase in precipitation over time (Figure 1). However, this upward trend in precipitation is not equally intense at all meteorological stations. By analyzing the slope angles of the trend lines (Figure 1), the distribution of the growth rate of precipitation over the study area is obtained (Figure 2). It was revealed that the angle of the trend line depends on the height of the terrain and the latitudinal position of the meteorological station (Figure 3).

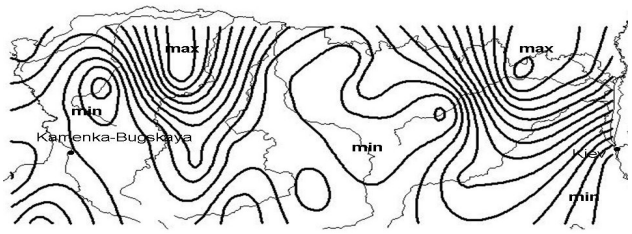

Figure 2. The change in the territory of north-west of Ukraine, the growth trend of rainfall over the year

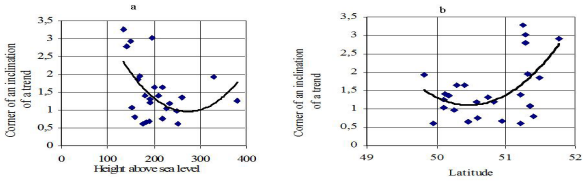

Figure 3. Dependence of the angle of the trend on the height above sea level (a) and the latitudinal position of the meteorological station (b)

It was revealed that between the weather stations there is a tendency to change in the ratio of the amount of precipitation during the year, if at the beginning of joint observations (end of the 19th century) the amount of precipitation in meteorological station Kiev exceeded the amount of precipitation in meteorological station Kamenka-Bugskaya, then at the moment it's in Kamenka-Bugskaya recorded a greater amount of precipitation than in Kiev (Figure 4).

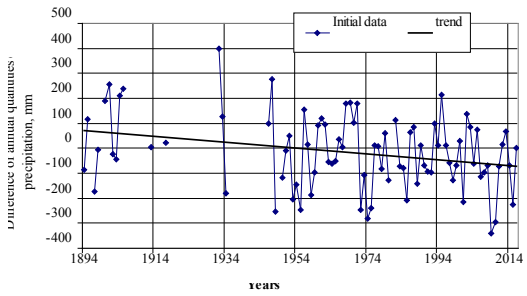

Figure 4. The dynamics of the difference in precipitation between meteorological station Kiev and Kamenka-Bugskaya

This trend is also confirmed by the fact that the amount of rain more than 10 mm at the Kamenka-Bugskaya meteorological station was recorded more than at the Kiev meteorological station (Figure 5) (observations of the course of the rains with the help of pluviographs began after the 50-60s of the 20th century). The annual rainfall is also higher at the Kamenka-Bugskaya meteorological station (Figure 6). However, the characteristics of the characteristics of the rain (intensity, duration, etc.) at both meteorological station are almost identical (Figure 7).

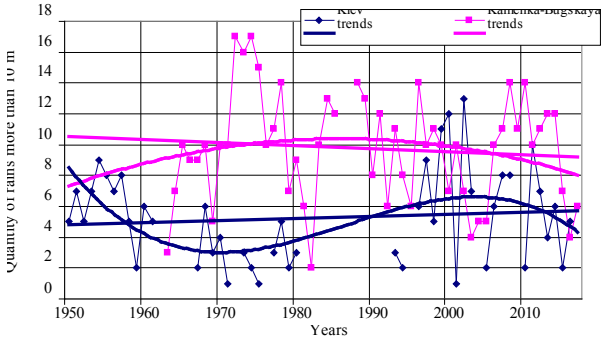

Figure 5. Rains at meteorological stations Kiev and Kamenka Bugskaya with rains over 10 mm

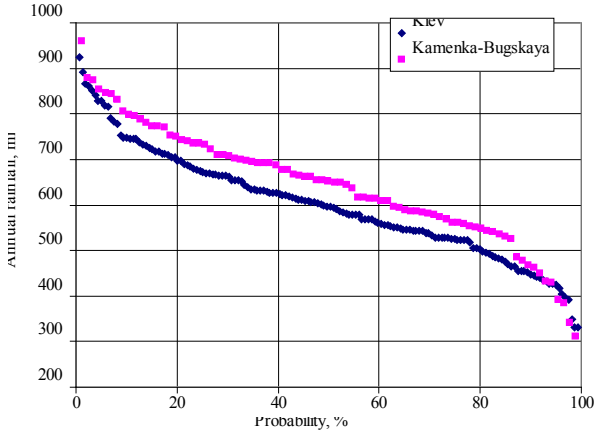

Figure 6. Probability of annual rainfall at meteorological stations Kamenka-Bugskaya and Kiev

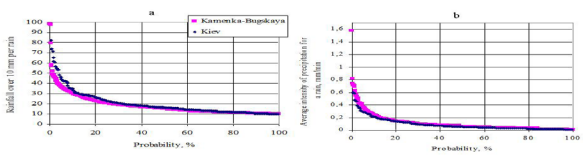

Figure 7. Probability of quantity (a) and average intensity (b) of rainfall over 10 mm at meteorological stations Kamenka-Bugskaya and Kiev

4. Conclusion

At the present stage of climate change in the north-west

of Ukraine, there is a general tendency to increase rainfall over the year. This trend is not the same across the territory and depends on the height and latitude of the area. The amount of precipitation varies both in space and in time, however, the distribution of the characteristics of the rains themselves (intensity, duration and others) continue to remain similar throughout the territory.

The revealed features of changes in the amount of precipitation in space and time can be useful in studying the unevenness of wetting, forecasting floods, changes in erosion activity, etc.

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