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MODERN CLIMATIC CONDITIONS OF THE STEPPE LANDSCAPES OF THE NORTH CAUCASUS AGAINST THE BACKDROP OF A CHANGING CLIMATE

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Abstract. *The article assesses the climate changes observed in the steppe landscapes of the North Caucasus. The assessment was based on data from ten representative weather stations from 1961 to 2020. It was revealed that in the steppe landscapes of the North Caucasus there is an increase in annual air temperature and precipitation. An indicator of territory moisture, such as the hydrothermal coefficient G.T. Selyaninov, remained within the normal range, therefore, there are no prerequisites for changing the boundaries of the steppe landscapes of the North Caucasus.*
Key words: *modern climate changes, landscape, temperature, precipitation, hydrothermal coefficient.*

The World Meteorological Organization first issued a statement on the threat of global climate change back in 1976. In 1979 and 1990, the World Climate Conferences were held at which the existing threats of global climate change were identified and strategies were outlined for society to adapt to the consequences of climate change. Today, there are many international programs for global climate research. To provide scientific support to the UN Framework Convention on Climate Change, an Intergovernmental Panel on Climate Change (IPCC) has been created, whose tasks include the most complete and objective assessment of observed and expected climate changes and the role of anthropogenic factors. To date, six IPCC assessment reports have been prepared. In these reports, the information presented touches on processes of a global and continental nature. Regional aspects are considered rather superficially.

The North Caucasus occupies a special position in modern Russia, since it is one of the most comfortable regions of the country for living in terms of natural conditions. It has been inhabited for quite a long time and currently an agricultural and recreational specialization of the economy has developed here, which is important for the whole of Russia. Therefore, the assessment of modern climate changes is of not only theoretical, but also great practical interest.

Many authors have studied climate change in the North Caucasus and its regions [1-9 and others].

Materials and methods. Climate change is reflected in changes, first of all, in such climatic parameters as temperature and precipitation. To assess moisture, along with precipitation, various coefficients and indices are used. The most famous of them are the hydrothermal coefficient, proposed by G.T. Selyaninov. Data from the USSR Climate Handbook, reflecting climatic conditions for 1931-1960, are used as the norm [10].

To analyze the modern climatic conditions of the steppe landscapes of the North Caucasus, we selected the reference weather stations Izobilny, Stavropol, Gudermes, Grozny, Aleksandrovskoye, Gigant, Armavir, Krasnodar, Anapa, Primorsko-Akhtarsk for 1961-2020.

Results and discussion. Average annual air temperature for the period from 1961 to 2020. in steppe landscapes was 11.1°C. There is an increase in annual air temperature over the period under review by an average of 0.98°C (Table 1). All σ (standard deviation) values fall within the confidence interval. The warmest year for the period under review was 2010. All weather stations report the maximum annual air temperature this year. The main contribution to the increase in average annual air temperature was made by the months of the cold period.

Within the steppe landscapes of the North Caucasus, precipitation falls from 482 to 711 mm. On average, over the period under review, the upward deviation from the norm was 72 mm. A negative deviation from the norm is observed only in Stavropol, where there is a shortage of precipitation in all months, this is especially noticeable in the warm period of the year. While other weather stations show an excess of precipitation compared to the norm. Precipitation increased significantly (more than 10% of the norm) in Izobilny and Primorsko-Akhtarsk (10%), Gudermes, Krasnodar and Armavir (11%), Aleksandrovsky (16%), Gigant (27%), Anapa (39%).

Table 1. Air temperature deviation for the period from 1961 to 2020. from the long-term average value.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Izobilny													
average	-1,5	-0,2	4,7	11,8	17,0	21,0	23,2	22,3	17,0	10,6	5,0	0,6	10,9
difference	1,4	1,9	2,0	1,5	0,3	0,7	-0,2	-0,1	-0,2	-0,4	0,3	0,7	0,6
σ	2,9	3,1	2,6	2,4	2,1	1,7	1,7	2,4	2,7	2,7	2,9	2,6	1,1
Stavropol													
average	-2,9	-2,2	2,4	9,8	15,4	19,6	22,3	21,7	16,3	9,5	3,7	-0,7	9,5
difference	0,8	0,8	0,8	1,2	0,2	0,6	0,4	0,2	0,3	-0,5	0,3	0,4	0,4
σ	2,9	3,3	2,4	2,1	1,9	1,9	1,7	2,0	1,9	2,6	2,8	2,3	1,1
Gudermes													
average	-1,8	-0,6	4,6	11,3	17,3	22,1	24,9	24,1	19,1	11,9	5,6	0,5	11,6
difference	1,2	1,0	1,5	1,4	0,5	0,9	0,5	0,3	0,9	0,1	0,8	0,8	0,8
σ	2,9	3,1	2,2	1,8	1,4	1,5	1,5	1,7	1,5	1,8	1,9	2,3	1,0
Grozny													
average	-2,3	-1,4	4,1	11,0	16,9	21,1	24,0	23,5	18,4	11,2	4,8	-0,1	10,9
difference	1,3	0,9	1,7	1,7	0,4	0,3	0,2	0,3	1,0	0,2	0,8	1,1	0,8
σ	3,0	3,3	2,1	1,7	1,4	2,8	1,2	1,6	1,5	1,8	2,0	2,2	0,9
Aleksandrovskoye													
average	-3,1	-2,1	2,7	10,2	16,1	20,2	23,0	22,0	16,5	9,5	3,6	-0,8	9,8
difference	1,6	1,9	1,8	1,7	0,5	0,3	0,1	-0,1	0,5	0,1	0,8	1,4	0,9
σ	3,0	3,4	2,5	1,9	1,6	1,7	1,4	1,9	2,0	2,3	2,5	2,2	1,0
Gigant													
average	-3,6	-2,8	2,7	10,9	16,9	21,3	24,1	23,3	17,5	10,2	3,7	-0,8	11,1
difference	1,9	2,0	2,1	1,7	0,6	1,0	0,6	0,6	0,9	0,6	1,2	2,0	2,1
σ	3,4	3,6	2,6	1,9	1,7	1,8	1,7	2,0	1,8	2,1	2,3	2,4	1,0
Armavir													
average	-1,6	-0,3	4,7	11,6	16,8	20,6	23,3	22,9	17,8	11,3	5,4	0,8	11,1
difference	1,8	2,2	1,6	1,4	0,6	1,0	0,6	0,8	0,9	0,3	1,1	1,8	1,2
σ	2,7	3,0	2,3	1,8	1,6	1,6	1,4	1,8	1,8	2,0	2,1	2,3	1,0
Krasnodar													
average	-0,1	1,1	5,6	12,3	17,6	21,5	24,1	23,6	18,6	12,0	6,5	2,4	12,1
difference	1,7	2,0	1,4	1,4	0,8	1,1	0,9	0,9	1,2	0,4	1,4	2,0	1,3
σ	3,1	3,3	2,4	1,8	1,7	1,6	1,6	2,0	2,1	2,0	2,3	2,3	1,1
Anapa													
average	2,3	2,9	5,9	11,0	15,8	20,7	23,6	23,5	18,8	13,2	8,4	4,8	12,6
difference	1,0	1,3	0,8	1,1	0,5	1,1	0,7	0,7	0,8	0,0	0,9	1,0	0,8
σ	2,7	2,7	1,9	1,4	1,4	1,5	1,4	1,7	1,7	2,0	2,3	2,3	1,0
Primorsko-Akhtarsk													
average	-1,4	-0,5	4,2	11,4	17,6	22,1	24,6	23,9	18,5	11,6	5,5	1,2	11,5
difference	1,4	1,9	1,8	1,4	0,6	0,7	0,3	0,5	0,7	0,2	0,9	1,6	0,9
σ	3,0	3,1	2,4	1,7	1,7	1,6	1,5	1,7	1,6	1,9	2,2	2,2	1,0

Note: average is the average temperature of the month and year, °C; deviation from the norm – the difference between the data for the period under consideration and the data from [16]; σ – standard deviation.

The assessment of moisture supply indicators was carried out on the basis of an analysis of the hydrothermal coefficient of Selyaninov G.T., which characterizes the ratio of incoming heat and moisture during the growing season. In general, the value of the hydrothermal coefficient varies from 0,7 to 1,1, which corresponds to the steppe – forest-steppe. According to table. 2, the hydrothermal coefficient decreased significantly in Stavropol due to a decrease in precipitation during the warm period. The hydrothermal coefficient increased significantly in Izobilny (by 0,1) and in Anapa (by 0,11). At all other weather stations there is a natural fluctuation of the hydrothermal coefficient.

Table 2. Deviation of moisture indicators from the long-term average value for the period from 1961 to 2020

weather station	hydrothermal coefficient	σ	weather station	hydrothermal coefficient	σ
Izobilny	0,10	0,3	Gigant	0,06	0,3
Stavropol	-0,3	0,3	Armavir	0,07	0,3
Gudermes	0,05	0,3	Krasnodar	0,06	0,3
Grozny	0,02	0,3	Anapa	0,11	0,3
Aleksandrovskoye	0,09	0,3	Primorsko-Akhtarsk	-0,08	0,3

Conclusions

Climatic changes in the steppe landscapes of the North Caucasus as a whole are proceeding according to the scenario of increasing air temperature and precipitation. The increase in annual air temperature occurs mainly due to the months of the cold period. Despite the increase in precipitation, there is a multidirectional change in its amount. For example, in Stavropol they generally decreased, but this decrease can be associated with local atmospheric circulation. The hydrothermal coefficient has undergone virtually no changes, therefore, there are no prerequisites for changing the boundaries of landscapes.

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