

## ASSESSMENT OF MODERN AGROCLIMATIC CONDITIONS OF THE NORTH CAUCASUS IN THE CONTEXT OF CLIMATE CHANGE

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**Abstract.** *The North Caucasus region exhibits a high population density and an established industrial and agricultural production. Consequently, investigating the effect of climate change in this area promptly represents a practically significant task. The research aims to evaluate the contemporary change in climate on various landscape types in the North Caucasus region and their influence on agroclimatic conditions.*

*This work establishes a database spanning from 1961 to 2020, focusing on temperature and precipitation data from 28 meteorological stations. Employing statistical and mathematical methods, we processed the data using electronic spreadsheets such as Excel. Our analysis incorporated both traditional methods from climatology and agroclimatology, as well as modern GIS technologies.*

*The analysis unveiled that, on average, the air temperature in the North Caucasus region increased by 0.9°C from 1961 to 2020. Temperature variations varied across different landscape types, with the highest annual air temperature increase occurring in foothills (1.2°C) and the lowest in mountainous landscapes (0.5°C). Additionally, there were increases in the sums of active temperatures above 5, 10, and 15°C. Precipitation, on average, increased by 56 mm, with the most significant rise observed in steppe landscapes (72 mm) and the least in semi-desert and desert landscapes (36 mm). Certain regions show unchanged precipitation levels. The increase in precipitation primarily occurred during the vegetation period, while precipitation during the cold period, conversely, decreased. Exceptions to this pattern were observed in mountainous landscapes, which exhibited an opposite trend. The hydrothermal coefficient of G. Selyaninov, characterizing moisture during the vegetation period, remained within the natural fluctuation range.*

*Our research results affirm that the change in climate in the North Caucasus region has contributed to the improvement of the territory's thermal and humidity conditions. Despite alterations in humidity, the values of moisture indicators persist within the characteristic range for each landscape type. Consequently, conditions conducive to landscape transition and the cultivation of more hygrophilous crops are not discernible.*

**Keywords:** *Modern climatic changes, agro-climatic conditions, temperature, precipitation, hydrothermal coefficient.*

### Introduction

According to the latest published data from the Intergovernmental Panel on Climate Change, global surface air temperatures in 2011-2020 increased by 1.1°C compared to the last century [4].

While global climate change and its impact on the natural environment and human activity are being studied quite actively, little attention is paid to regional studies. The Russian part of the Caucasus is usually called the North Caucasus. This is a fairly densely populated region of the Russian Federation, characterized by industrial and agricultural specialization. In addition, the North Caucasus has a wide landscape and biological diversity. In this regard, the study of climate changes in a given territory and timely adaptation to them is an urgent task of great practical interest. The purpose of the study is to assess current climate changes in various types of landscapes found in the North Caucasus and their impact on agroclimatic conditions.

## Materials and Methods

The study was carried out within the framework of the state task “Assessment of the variability of agroclimatic conditions of the North Caucasus in connection with global climate change”. The estimates are based on data from the Roshydromet observation network at 28 weather stations representative of a certain type of landscape. Observation period from 1961 to 2020. For comparison, data from the USSR Climate Guide [3] (observation period from 1881 to 1960) are used as the long-term average value (norm). Data processing and interpretation were carried out using Excel spreadsheets and GIS technologies.

To assess the current agroclimatic conditions of the study area, indicators traditionally used in agroclimatology were considered [1,2].

## Results

Analysis of the materials showed that on average in the period from 1961 to 2020 air temperature in the North Caucasus compared to the norm (1881-1960) increased by 0,9°C. However, the increase in air temperature is uneven throughout the territory. It increased maximally in foothill landscapes by 1,2°C, minimally in mountain landscapes – by 0,5°C (table 1).

**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
Steppe	1,4	1,6	1,6	1,5	0,5	0,8	0,4	0,4	0,7	0,1	0,9	1,3	1,0
Foothill	1,6	1,6	1,2	1,1	0,4	0,7	0,6	0,4	0,7	0,2	1,1	1,4	1,2
Mountain	1,0	0,8	0,7	0,7	0,1	0,4	0,4	0,3	0,4	0,1	0,5	0,8	0,5
Semidesert and	1,3	1,3	1,6	1,5	0,5	0,6	0,3	0,3	0,8	0,2	0,7	1,0	0,9

The sum of active temperatures exceeding 5°C increased by 4-7%, the sum of active temperatures exceeding 10°C increased by 5-9% (table 2). Average temperatures in January and July also increased, with winter temperatures increasing significantly more than summer temperatures (table 2). The transition of the average daily temperature through 0, 5, 10°C occurs earlier in spring, and later in autumn. Accordingly, the duration of the period after 0°C increased by an average of 15 days; after 5°C – for 8 days; after 10°C – for 9 days.

**Table 2. Sum of active temperatures. Average temperatures in January and July.**

	Sum of active temperatures exceeding 5°C	Sum of active temperatures exceeding 10°C	Average January temperature, °C	Average temperature in July, °C
Steppe	+ 262	+304	+1,4	+0,3
Foothill	+240	+267	+1,4	+0,1
Mountain	+217	+181	+1,5	+0,6
Semidesert and	+93	+92	+1,1	+0,5

Precipitation between 1961 and 2020 compared to the norm, they increased on average by 56 mm, the largest increase in cages was observed in foothill and mountain landscapes (by 72 mm) (table 3).

**Table 3. Precipitation 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
Steppe	9	6	7	4	6	5	-3	1	5	6	6	10	72
Foothill	7	5	11	14	18	16	10	14	5	9	8	8	72
Mountain	13	4	9	8	-7	-1	-5	1	-3	6	11	10	45
Semidesert and deser	4	6	3	-1	6	1	0	0	-1	3	-1	4	36

Hydrothermal coefficient G.T. Selyaninova (GTK), which directly depends on the amount of precipitation during the growing season, is widely used to identify zones of different moisture supply in order to determine the feasibility of growing certain crops. According to the study, in the period from 1961 to 2020 the HTC value in semi-desert landscapes varies from 0,5 to 0,7, which corresponds to a dry steppe, in steppe landscapes – from 0,7 to 1,1, which corresponds to steppe-forest-steppe, in foothill landscapes from 1 to 2,2, which corresponds forest-steppe is an excessively humid zone, in mountains – from 0,9 to 3,6, which corresponds to the arid zone (Akhty) – an excessively humid zone. All deviations of the HTC from the norm are within the limits of natural fluctuation.

## Conclusions

Thus, the ongoing climate changes in the North Caucasus in the period from 1961 to 2020 proceed according to the scenario of an increase in air temperature by an average of 0.9 ° C and an increase in precipitation by an average of 56 mm. Agroclimatic indicators characterizing the heat and moisture supply of the territory have improved. However, the HTC indicators, which characterize the ratio of incoming heat and moisture, are within the limits of natural fluctuation; accordingly, the prerequisites for changing the boundaries of landscapes have not developed, as well as the conditions for growing new types of agricultural crops.

**Acknowledgments:** The work was carried out within the framework of the state assignment of Millionshchikov Grozny State Oil Technical University FZNU-2024-0001 «Assessment of the impact of modern climate change on natural and natural-anthropogenic complexes (using the example of the Chechen Republic)».

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