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Contemporary characteristics of air temperature distribution in the territory of Azerbaijan

Jamal Surkhay Huseynov *

Azerbaijan Airlines CJSC, Azeraeronavigation ATD, Baku, Azerbaijan

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Abstract

In the article, the distribution of air temperature in the territory of the Republic of Azerbaijan in 1961-2020 and its dynamics compared with 1881-1960 are determined. As a result of mathematical, statistical, and cartographic analyses, it was confirmed once again that the temperature regime of the republic has characteristics of change from the north to the south and from the plain to the highlands. In addition to this, multi-year average, seasonal indicators of temperature quantity in individual regions of the territory of the republic were determined. The maximum indicators of the perennial average temperature quantity were observed in the Kura-Araz plain in the range of 14.6-15.4 0C. The results of the research can be used in the future in the research of the climate regime, and its changes, during the creation of agriculture, tourism industry, and other large-scale industries in the area.

1. Introduction

All climate parameters, including pressure, wind, evaporation, and precipitation, are distributed completely differently on the non-uniformly heated Earth's surface (Huseynov, 2011). Each region is characterized by its own climate character. The complexity of the relief of the Republic of Azerbaijan, located in the Southern Caucasus region, and its location on the shores of the Caspian Sea play a major role in the creation of diversity in climate distribution (Atlas, 2014; Tanriverdiyev et al. 2015). According to A.M. Shikhlinsky, 8 of the 11 climate types distinguished by V.P. Keppen exist in the territory of the republic (Shikhlinsky, 1968).

By studying the temperature regime in the territory of the Republic, A.M. Shikhlinsky, A.A. Madatzade, A.M. Ayyubov, G.A. Hajiyev, A.S. Mammadov, Said H. Safarov, Surkhai H. Safarov, R.N. Mahmudov, N. Sh. Huseynov and other scientists were engaged.

The current global climate changes affect the climate of all regions. The increase in the effects of climate change and the time series of observations makes it necessary to conduct new research in this direction.

2. Method

The analyzes were carried out based on the primary data of 58 operating in Azerbaijan, including the main 32 hydrometeorological stations with complete observation series for the years 1961-2020. Mathematical, statistical, and geographical methods were used in the research. The statistical significance of the series was checked (Imanov, 2011). SBSS and Stokstat programs were used in the statistical analyses. Tables, histograms, and graphs from the obtained results were processed in Microsoft Excell, electronic map ArcGIS software.

2.1. The second level headings

The purpose of the study is to determine the regularities of the territorial distribution of changes in the temperature regime over a long period of time in the influence of regional climate changes in the territory of Azerbaijan. One of the main goals is to revise the characteristics of the vertical and horizontal distribution of air temperature and map their results with modern cartographic methods.

2.2. The second level headings

The moderating effects of the Caspian Sea can always be felt in the coastal regions of Azerbaijan. The maritime factor moderates the harsh effects of air masses from the north (cold), east (warm, dusty), and south (warm, dry) throughout the year on coastal plains, islands, and peninsulas.

In the northeastern slope of the Greater Caucasus region, the average annual temperature from 1961 to 2020 decreases from 12.9^{0}C to -5.1^{0}C from the coastal plains to the highlands. In 1881-1960, the average annual temperature for the area was determined in the range of 12.2-4.5^{0}C.

* **Corresponding Author**

*(camal_huseynov_88@mail.ru) ORCID ID 0000-0002-7878-578X

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3. Discussion

This also indicates that there was an increase of 0.6-1.1⁰C in the average annual temperature index from 1961-2020. There is a different temperature regime in the south of the Greater Caucasus region. Starting from the low mountains and reaching the height of 1500-1600 m, the average annual temperature decreases in the range of 13.3-6.4 ⁰C.

Table 1. The perennial average temperature trend at hydrometeorological stations from 1961-2020, ⁰C

№	Station	Altitude, m	1961-2020	1881-1960
1	Khachmaz	27	12,9	12,2
2	Guba	550	10,7	9,6
3	Gyryz	2071	5,1	4,5
4	Altiaghaj	1099	9,0	8,1
5	Sumgait	-20	14,7	13,6
6	Mashtagha	27	14,5	13,5
7	Pirallahi	-25	14,8	14,0
8	Chilov	-17	14,7	14,0
9	Oil Rocks	-17	14,8	14,0
10	Alibey	1540	6.4	5.7
11	Zagatala	487	13,3	12,5
12	Shaki	639	12,6	12,0
13	Gabala	679	11,7	10,6
14	Maraza	775	11,1	10,5
15	Mingachevir	93	15,5	14,8
16	Yevlakh	13	15,3	14,6
17	Goychay	107	15,1	14,2
18	Kurdamir	2	15,3	14,5
19	Zardab	-5	15,2	14,3
20	Beylegan	62	14,7	14,0
21	Japharkhan	-16	14,7	14,0
22	Hajigabul	-7	15,5	14,5
23	Bilasuvar	75	15,0	14,2
24	Neftchala	-24	15,2	-
25	Lankəran	-20	14,5	14
26	Gadabay	1480	8,2	7,4
27	Ganja	312	13,9	13,2
28	Aghstafa	331	13,2	12,2
29	Shamkir	404	14,2	12,9
30	Nakhchivan	875	12,7	12,7
31	Shahbuz	1205	11,7	11,2
32	Ordubad	861	13,9	11,6

According to the vertical temperature variation (0.65⁰C/100 m), it takes values below 0⁰C at an altitude of 2400-2500 m. Temperature indicators in the region for the period 1961-2020 differ by an increase of 0.8⁰C compared to the period 1881-1960 (Table 2).

The average annual temperature in the Absheron aquatorium during the research period was 14.7⁰C in the peninsula. Compared to the years 1881-1960, the average annual temperature increased by 0.8⁰C during the multi-year period. The temperature rises slightly towards the south of the province.

Since the Kura Valley depression physical-geographical region is surrounded by mountains from the northeast and southwest, the influence of air masses coming from the Iranian plateau from the south, the Caspian Sea from the southeast, and the Jeyranchol plain from the northwest is dominant. Although the humid air masses formed over the sea affect the coastal areas, they cannot enter the interior of the plain (Shikhlinsky, 1968; Safarov et al. 2022). The northwestern part of the province is relatively high and the average annual temperature is 13.2⁰C, the average annual temperature in the Kura-Araz plain is 15.1⁰C (14.6-15.5⁰C). From 1881-1960, the average annual temperature for these areas was 14.3⁰C (14.0-14.8⁰C), however, now this indicator has increased by 0.8⁰C (Mahmudov, 2018; Pykhtunova, 1966).

The perennial (1961-2020) average temperature of the Lesser Caucasus Mountains, located in the west of the country, was in the range of 14.3-7.5⁰C from lowland (300-400 m) to mid-mountain (1450-1650 m) in the west. Considering the vertical zonation, the average annual temperature is below 00C at an altitude of about 2900 m. The average annual temperature here has increased by 1.0⁰C compared to 1881-1960. The influence of hot and dry air masses coming from the south is felt throughout the year in the eastern and southeastern parts of the Lesser Caucasus region (Huseynov, 2022). The average annual temperature in the lowlands (150-200 m) is 14.6⁰C, 15⁰C in the Arazboyu (areas along the Araz River) area in the south, 13-14⁰C in the lowlands, 12⁰C in the lower parts of the middle highlands, and 11⁰C in the upper part of the middle highlands. Compared to the years 1881-1960, the increase in the area was 0.80C. At an altitude above 3000 m, which is the permanent frost zone of the Lesser Caucasus, the temperature is below 0⁰C in all seasons of the year [2].

Starting from the Sharur-Ordubad plain in Nakhchivan province, the area surrounded by mountains plays a major role in the large gradient distribution of temperature along the slope. The average annual temperature in the Sharur-Ordubad plain in 1961-2020 is 2.6-13.9⁰C. In the high altitude zone of the highlands (2100-2200 m), this quantity decreases to 7.2⁰C. The multi-year average temperature is below 00C starting from 3300 m altitude. Compared to the previous period, the average annual temperature in the region increased by 0.9⁰C from 1961-2020.

The Talysh mountain ranges (Talysh, Peshtasar, and Burovar) located to the west of the coastal plains in the Lankaran natural province prevent the westward movement of the humid air mass evaporating from the sea (Tanriverdiyev, 2015). A temperate warm climate type with evenly distributed rainfall in all seasons is widespread on the sea coast of the area. Thus, the perennial average temperature decreases from 14.6⁰C to 8.9⁰C from the coastal plains to an altitude of 1500-1600 m. There is no permanent frost zone in the Talysh mountains. Although for the years 1881-1960 [9, 10], the average annual temperature in these areas was 12.8⁰C, from 1961-2020, it increased by 0.8⁰C to 13.6⁰C.

In the analysis, the dynamics of average annual air temperatures of hydrometeorological stations in the country from 1961-2020 were investigated. The multi-year trend graphs of some of them are given below (Figure 1).

If we refer to the graph, it can be said that the average annual temperature in all stations during 1961-2020 changed mostly synchronously. It can also be observed that the air temperature was colder in 1964, 1969, 1976, 1982, 1993, 2004, and 2011, and warmer in 1966, 1971, 1989, 1995, 1998, 2010, and 2017. The linear trends of the trend curves indicate an increase in average annual temperature at all stations over the perennial period.

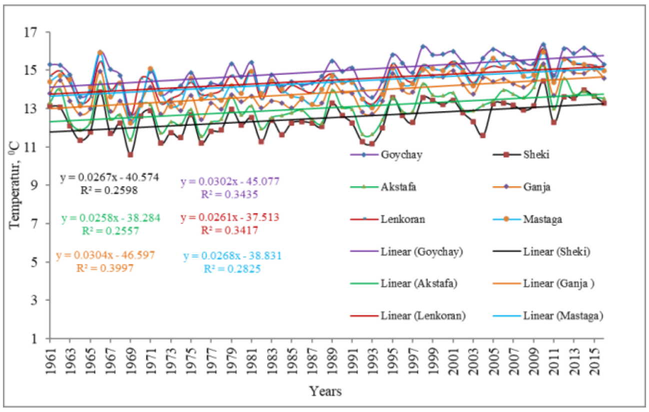

Figure 1. Average annual temperature changes at hydrometeorological stations from 1961-2020

Figure 2 indicates the distribution of perennial average annual temperature by area. The representation is illustrated by means of the IDW model of interpolation in the ArcGIS program. As can be seen from the figure, the higher temperature quantity is typical in the Absheron peninsula, coastal plains, Kura-Araz lowland, Jeyranchol, and Arazboyu plains. The average annual temperature decreases from the plains to the highlands.

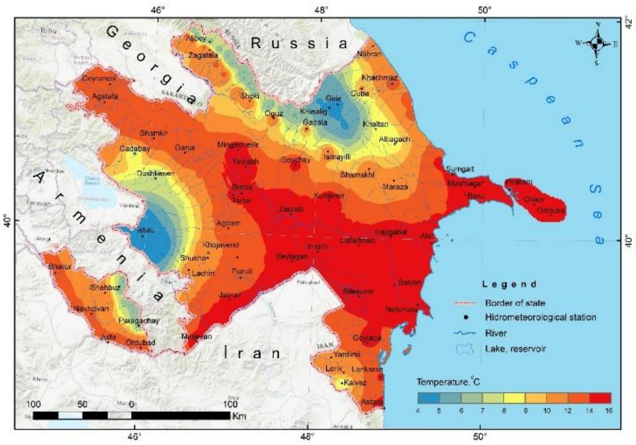

Figure 2. Distribution of average annual temperature over the period 1961-2020

4. Conclusion

A number of results were obtained during the study of the distribution of average multi-year quantities of temperature in the territory of the Republic of Azerbaijan from 1961-2020.

In the territory of Azerbaijan, the average annual air temperature decreases from the sea coast to the west and towards the mountainous belt. During the period 1961-2020, an increase in the average annual air temperature is observed in the territory of the country. Compared to 1881-1960, the average multi-year temperature in 1961-2020 increased by 0.8⁰C across the country. The highest quantity of the average temperature of the country was 15.0-15.4⁰C and it was observed in the south of Lankaran province, Kur-Araz plain, Arazboyu.

The results obtained during the conducted climate research can be used during the formation of the economy in the country in the future. In areas with high-temperature values, global warming will further accelerate its effects and vulnerabilities such as salinization, scouring, and lowering of the underground water level will appear in these lands. An increase in the annual amplitude is expected in the middle and high mountain zone. In connection with the hardening of the climate, it can be recommended to cultivate livestock and plant species that will tolerate the harsh continental climate.

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