CLIMATE

STUDY OF THE AIR TEMPERATURE REGIME OF THE EASTERN ZANGEZUR ECONOMIC REGION

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Abstract

The article studies the general trends in the temperature regime of the Kalbajar, Lachin, Gubadli, Jabrayil and Zangilan regions, which are currently included in the Eastern Zangezur economic region, based on the MERRA-2 (Modern-Era Retrospective analysis for Research and Applications, Version 2) reanalysis data for the period 1980-2022. During the study, an increasing trend in average annual and seasonal temperatures was detected for the area during the period under review. The temperature increase by seasons and by annual period is statistically significant at the 5% level of confidence. The calculations showed that the average annual air temperature in Kalbajar and Lachin regions increased by 0.9°C in the period 2001-2022 compared to the period 1980-2000. This increase was recorded in Gubadli, Jabrayil and Zangilan regions by 1.1°C. These results are consistent with the results obtained in other regions of the republic. When looking at the temperature changes by months for both periods in the regions, the largest average temperature increases by months in Kalbajar and Lachin regions were recorded in February (1.7 °C), March (1.8 °C) and October (1.3 °C). In Gubadli, Jabrayil and Zangilan regions, the temperature increased by 2°C in February, by 2.6 °C in March, and no changes were recorded in April.

1. Introduction

The territory of the Kelbajar and Lachin districts, which are part of the Eastern Zangezur Economic Region, is primarily mountainous, while Gubadli, Zangilan, and Jabrayil include both mountainous and flatland area [3].

According to data obtained from the Istisu Hydrometeorological Station in the Kelbajar district, located at an elevation of 2257 meters above sea level, for the period 1961-1990, the average annual temperature was 4.0°C. Based on the data from the Lachin Hydrometeorological Station, located at an elevation of 1099 meters above sea level, for the same period, the average annual temperature was 10.0°C. The coldest month was January (Kelbajar -5.3°C, Lachin 0°C), and the hottest month was July (Kelbajar 13.5°C, Lachin 21.0°C) [2].

In the Jabrayil district, according to data from the Jabrayil Hydrometeorological Station, the average annual temperature for the 1961-1990 period was 13.0°C. In the Zangilan district, based on data from the Mincivan settlement Hydrometeorological Station, the average annual temperature for the same period was 14.4°C. The coldest month was January (Jabrayil 2°C, Zangilan 3.6°C), and the hottest month was July (Jabrayil 24.9°C, Zangilan 26.1°C).

Due to the occupation of the area by Armenian armed forces between 1993-2020, no observational data is available for these years. Therefore, to determine the impact of recent climate changes on the temperature regime of the area, it is advisable to use alternative data sources and re-search methods, including satellite and reanalysis data.

The main goal of the study is to identify the changes in the temperature regime of the Eastern Zangezur Economic Region, particularly in the Kelbajar-Lachin and Gubadli-Jabrayil-Zangilan districts, during the recent years (1991-2022).

2. Materials and research methodology

In the study, monthly reanalysis data from MERRA-2 (Modern-Era Retrospective Analysis for Research and Applications, Version 2) for the

period 1980-2022, with a resolution of 0.5º, was used (https://giovanni.gsfc.nasa.gov). Since the resolution indicator is relatively low, temperature data was not obtained for the individual areas of each district. Instead, the areas of Kelbajar-Lachin and Gubadli-Jabrayil-Zangilan were selected, and average values were calculated. Therefore, these areas were marked on the map located on the Giovanni electronic portal, and with the help of specific calculations, the averaged temperature values for each month of the year were obtained. Based on the acquired data, temperature change trends for the years and seasons were determined according to the respective trend lines. The statistical significance of these trends was calculated based on the following inequality:

$$R/s_R \geq s, \qquad (1)$$

Here, the R-correlation coefficient, and sR, which represents the random mean square error [8]. The random mean square error is calculated based on the following formula:

$$\sigma_R = (1 - R^2)/\sqrt{(n-1)} \qquad (2)$$

n is the number of time series limits. For a 5% significance level and n = 40, s = 2.02.

3. Analysis and discussion

Table 1 presents the main statistical indicators of air temperature by month and annually for the Kelbajar-Lachin districts**.**

When examining temperature changes in the Kelbajar-Lachin region, as shown in Table 1, a 0.9°C increase in the average annual temperature was recorded in the period 2001-2022 compared to the 1980-2000 period. An increase in average temperature was observed in all months except April. Significant temperature increases were recorded in February, March, June, August, September, and October. No changes in tempe-rature were observed in April, and no significant increase was recorded in July, November, and December.

The greatest increase in the average maximum temperature was recorded, with the largest temperature increases observed in March and December, while the smallest increases occurred in February, April, and May.

In terms of minimum average temperature, a decrease was observed in January and April, while a sharp increase was recorded in October (3.5°C).

The annual average temperature increase trend in the Kelbajar-Lachin regions during the studied period is also visible in Figure 1. As shown in the figure, the linear trend indicating the increase is statistically significant according to formulas (1) and (2), and it amounts to 0.4°C per decade. The lowest temperature was recorded in 1992, and the highest temperature was recorded in 2010, which is consistent with the trends observed in other regions of Azerbaijan [7].

Table 2 shows the main statistical temperature indicators of air temperature by month and annually for the Gubadli, Jabrayil, and Zangilan regions.

Table 1

Main Statistical Indicators of Air Temperature by Month for the Periods 1980-2000 and 2001-2022 in the Kelbajar-Lachin Region, ºC

Tempe-rature, ºC	Months												Annually
	1	2	3	4	5	6	7	8	9	10	11	12	
	1980-2000												
Average	-5,7	-5,2	-1,0	5,8	10,0	14,6	17,7	17,0	13,2	6,9	1,0	-3,4	5,9
Max	-2,6	-1,7	2,0	8,6	12,5	17,0	20,2	19,8	15,3	9,0	3,6	-0,3	7,1
Min	-8,8	-8,7	-4,2	3,2	7,3	12,1	16,1	14,9	11,1	2,5	-4,2	-7,1	4,2
	2001-2022												
Average	-5,0	-3,4	0,8	5,8	10,7	15,5	17,9	17,9	14,2	8,2	1,6	-3,1	6,8
Max	-2,0	-1,3	4,8	9,0	12,9	18,0	20,7	20,9	16,4	10,1	4,7	1,6	8,2
Min	-9,5	-7,9	-3,9	3,0	8,2	13,3	16,6	15,0	11,3	6,0	-3,8	-7,1	5,4
	Temperature anomalies												
Average	0,7	1,7	1,8	0,0	0,7	1,0	0,2	0,9	1,0	1,3	0,5	0,4	0,9
Max	0,6	0,4	2,7	0,4	0,4	1,0	0,5	1,0	1,1	1,1	1,1	1,9	1,0
Min	-0,6	0,8	0,2	-0,2	0,9	1,2	0,5	0,1	0,3	3,5	0,4	0,0	1,2

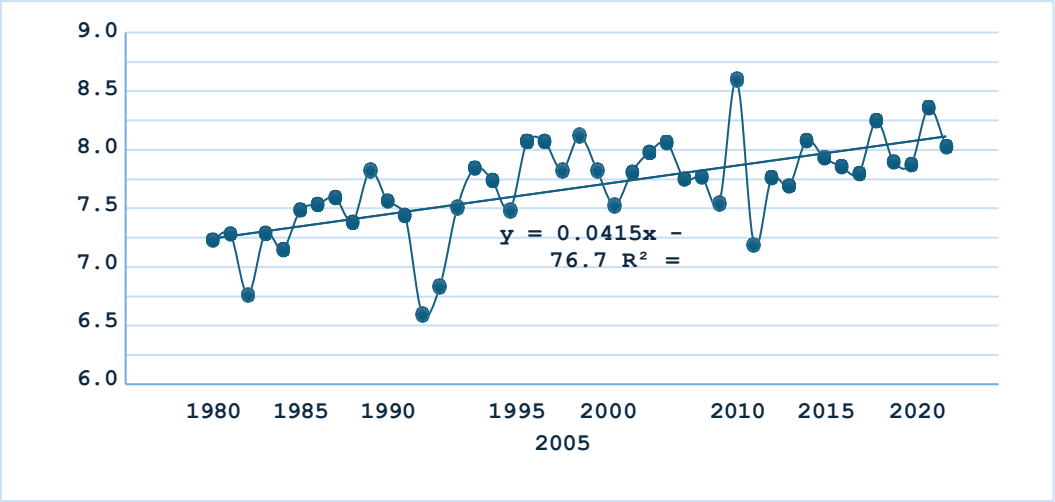

Figure 1: The time series of the average annual temperature of the Kelbajar-Lachin Region from 1980 to 2022

Table 2

Main statistical ındicators of air temperature by month and annually for the Gubadli-Jabrayil-Zangilan regions

Tempe-rature, ºC	Months												Annually
	1	2	3	4	5	6	7	8	9	10	11	12	
	1980-2000												
Average	-0.2	0.4	4.1	11.6	16.0	20.6	23.1	22.2	18.2	12.0	6.1	1.6	11.3
Max	2.7	4.6	6.8	15.6	18.8	22.9	25.5	25.8	20.3	15.4	9.2	5.0	12.8
Min	-3.0	-3.9	1.2	8.3	12.6	17.8	21.1	20.0	16.3	6.4	-0.2	-3.2	9.7
	2001-2022												
Average	0.6	2.4	6.6	11.6	17.0	21.8	23.6	23.2	19.3	13.6	6.7	2.0	12.4
Max	3.7	4.9	11.1	15.9	19.5	24.2	26.6	26.2	21.5	16.5	9.8	6.6	13.7
Min	-4.1	-1.6	2.8	8.4	14.0	18.8	22.0	20.3	17.1	10.4	1.4	-3.0	10.9
	Temperature anomalies												
Average	0.8	2.0	2.5	0.0	1.0	1.1	0.4	1.1	1.1	1.5	0.6	0.4	1.1
Max	1.0	0.4	4.3	0.3	0.6	1.3	1.1	0.4	1.2	1.1	0.6	1.6	1.0
Min	-1.1	2.4	1.6	0.1	1.5	1.0	0.9	0.3	0.8	4.0	1.7	0.2	1.2

Let's look at the temperature changes recorded for the Gubadli-Jabrayil-Zangilan regi-ons. As shown in Table 2, compared to the temperature indicators of the 1980-2000 period, the average annual temperature increased by 1.1°C during the 2001-2022 period. An increase in the average temperature was observed in all months except for April. The highest temperature increase occurred in March (2.5°C), while the smallest increases were recorded in July, November, and December. Temperature increases were also observed in the maximum average temperature indicators. The highest temperature increase occurred in March (4.3°C), while the smallest increases were recorded in February, April, and August. In January, the minimum average temperature decreased by 1.1°C. The greatest increase was recorded in October, while the smallest increases were observed in April, August, and December. The annual average temperature increase trend for the area during the mentioned period is shown in Figure 2. As seen in the figure, the linear trend indicating the increase is statistically significant according to formulas (1) and (2), and it amounts to 0.4°C per decade. The lowest temperature was recorded in 1992, and the highest temperature was recorded in 2010, which is consistent with the trends observed in other regions of Azerbaijan [7].

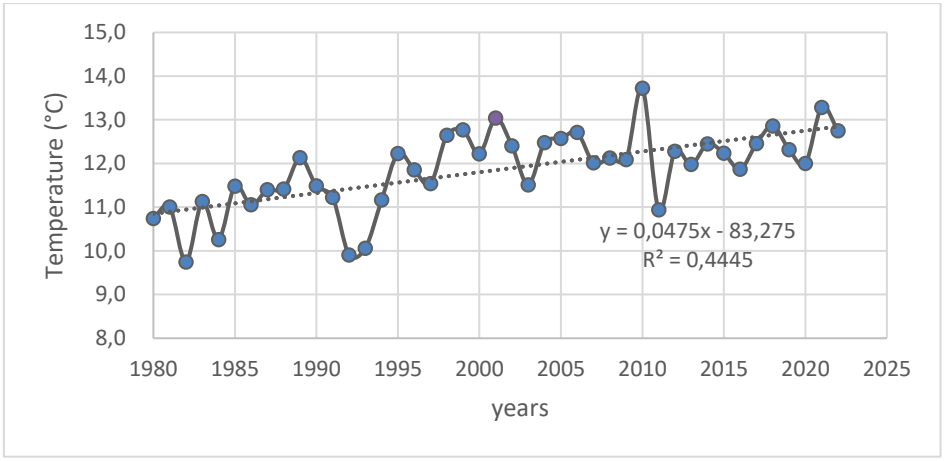

Figure 2. The time series of the average annual temperature in the Gubadli, Zangilan, and Jabrayil districts from 1980 to 2022

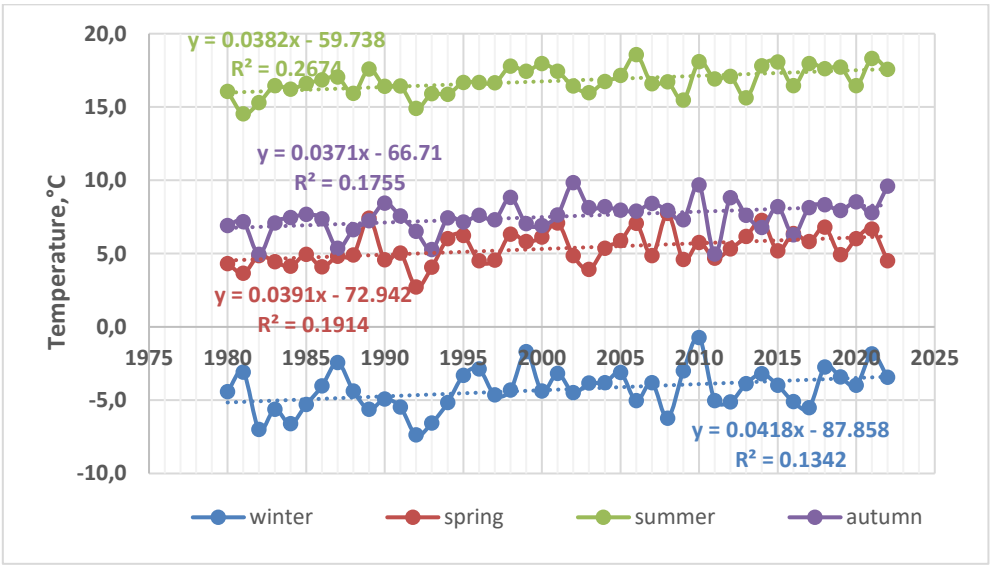

Figure 3. the time series of the average temperature by season in the Kelbajar-Lachin Region from 1980 to 2022

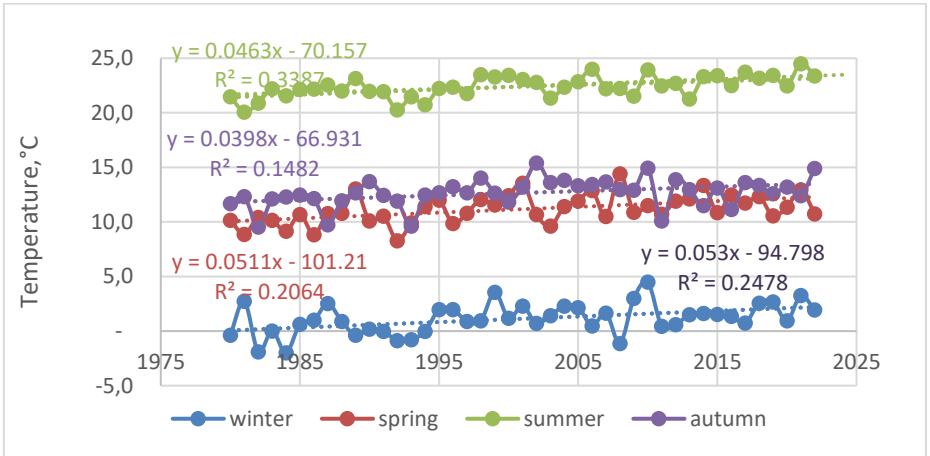

Figure 4. The time series of the average temperature by season in the Gubadli-Jabrayil-Zangilan region from 1980 to 2022.

Based on Figure 1 and Figure 2, and using formula (1), we can calculate the σR (random mean square error) as follows:

$$\sigma_R = (1 - 0.44)/\sqrt{(40 - 1)} \approx 0.0897, \qquad (3)$$

Then, by substituting the obtained result into formula (1), we can determine that the trend in Figure 1 and Figure 2 is statistically significant.

Table 3

The difference in average temperatures by season for the periods 2001-2022 and 1980-2000 in the Kelbajar-Lachin and Gubadli-Jabrayil-Zangilan districts, ºC.

	Kelbajar-Lachin				Gubadli-Jabrayil-Zangilan			
Seasons	**Winter**	**Spring**	**Summer**	**Autumn**	**Winter**	**Spring**	**Summer**	**Autumn**
Average	0.9	0.8	0.7	1.0	1.1	1.2	0.9	1.1
Max	1.0	0.3	0.6	1.0	0.9	1.4	1.0	1.4
Min	1.2	1.2	0.9	0.0	0.9	1.3	1.2	0.6

The study of changes in the temperature regime by season is also of great interest. In Figures 3 and 4, the time series of the average temperatures for different seasons in the Kelbajar-Lachin and Gubadli-Jabrayil-Zangilan regions are presented separately. As shown, temperature changes in all seasons exhibit an increasing trend, and according to the respective linear trends based on formulas (1) and (2), they are statistically significant at a 5% confidence level.

Table 3 presents the differences in average, maximum, and minimum temperatures by season for the periods 2001-2022 and 1980-2000 in the Kelbajar-Lachin and Gubadli-Jabrayil-Zangilan regions. As shown in the table, the highest temperature anomalies in the Kelbajar-Lachin regions were recorded in the winter and summer seasons (with a minimum average temperature of 1.2°C), while in the Gubadli-Jabrayil-Zangilan regions, the highest anomalies were observed in the summer and autumn seasons (with a maximum average temperature of 1.4°C).

Conclusion

An increasing trend in the temperature regime of the Eastern Zangezur Economic Region has been observed from 1980 to 2020. According to the calculations, the average annual temperature increased by 0.9°C in the Kelbajar-Lachin districts and by 1.1°C in the Gubadli-Jabrayil-Zangilan districts. The largest temperature increase in the economic region was observed in February, March, and October. When looking at seasonal changes, the most significant temperature changes were recorded in the winter and summer months. The temperature changes observed in the Eastern Zangezur region are consistent with the trends observed in other regions of Azerbaijan.

REFERENCES

1. Climate of Azerbaijan (edited by A.A. Madatadze and E.M. Shikhlinsky). (1968). Baku, 343 p.

2. Khalilov, S.H., Safarov, S.H. (2001). Monthly and Annual Norms of Air Temperature and Atmospheric Precipitation in the Republic of Azerbaijan (1961-1990). Baku, 2001, 109 p.

3. Museyibov, M.A. (1998). Physical Geography of Azerbaijan. Baku: "MAARİF" Publishing House. 400 p. (in Aze.).

4. Safarov, S.H., Akhlimanova, I., Safarov, E.S. (2022) Investigation of temperature and precipitation regimes of Shusha city in 1991-2020 by reanalysis data/ The modern problems of the geography. The integration of science and education. Baku, pp. 26-32.

5. Safarov, S.H., Majidzade, A. (2023) The impact of climate change on the temperature regime of the Kelbajar and Lachin regions of the Republic of Azerbaijan /7th Intercontinental Geoinformation Days (IGD) November 18-19 2023 (University of Peshawar, Pakistan -Mersin Turkey). p. 131-133.

6. Safarov, S.H., Huseynov, C.S., Ibrahimova, I.V. (2018). Features of Long-Term Temperature Changes in the Western Regions of the Republic of Azerbaijan. Scientific Works of the National Aviation Academy, Baku, 2018, No. 1, pp. 108-115.

7. Safarov, S.H., Huseynov, J.S., Ibrahimova, I.V., Safarov, E.S. (2018). The Main Features of Temperature Changes, Occurring Over the Territory of Caspian Sea in Azerbaijan. Understanding the Problems of Inland Waters: Case Study for the Caspian Basin (UPCB). Baku, pp. 85-89.

8. Sikan, A.V. (2007). Methods of Statistical Processing of Hydrometeorological Data. St. Petersburg: RGGMU, 279 p.

ŞƏRQİ ZƏNGƏZUR İQTİSADİ RAYONUNDA HAVANIN TEMPERATUR REJİMİNİN TƏDQİQİ

S.H.Səfərov, A.H.Məcidzadə

Xülasə. Məqalədə 1980-2022-ci illər dövrü üzrə MERRA-2 (Modern-Era Retrospective analysis for Research and Applications, Version 2) reanaliz məlumatlarına əsasən hazırki Şərqi Zəngəzur iqtisadi rayonuna daxil olan Kəlbəcər, Laçın, Qubadlı, Cəbrayıl və Zəngilan rayonları ərazisinin temperatur rejimində baş vermiş ümumi tendensiyalar tədqiq edilmişdir. Tədqiqat zamanı ərazi üzrə baxılan dövrdə orta illik və fəsillər üzrə temperaturlarda artım trendi aşkarlanmışdır. Fəsillər və illik dövr üzrə temperatur artımı 5%-lik təminat səviyyəsində statistik əhəmiyyətlidir.

Aparılan hesablamalar göstərmişdir ki, Kəlbəcər və Laçın rayonu üzrə 1980-2000-ci illər dövrünə nisbətən 2001-2022 dövründə havanın orta illik temperaturu 0,9 °C artmışdır. Qubadlı, Cəbrayıl və Zəngilan ra-yonları üzrə bu artım 1,1 °C qeydə alınmışdır. Bu nəti-cələr respublikanın digər regionlarında alınan nəticə-lərə uyğundur. Rayonlar üzrə hər iki dövrə görə aylar üzrə temperatur dəyişmələrinə nəzər yetirdikdə Kəl-bəcər və Laçın rayonları üzrə aylara görə ən böyük orta temperatur artımları fevral (1,7 °C), mart (1,8 °C) və oktyabr (1,3 °C) aylarında qeydə alınmışdır. Qubadlı, Cəbrayıl və Zəngilan rayonlarında isə temperatur fevral ayında 2°C, mart 2,6 °C artmışdır, aprel ayında isə heç bir dəyişiklik qeydə alınmamışdır.

Açar sözlər: Şərqi Zəngəzur, reanaliz, havanın temperaturu, iqlim dəyişmələri, temperatur anoma-liyası.