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Ergasheva M.K., associate professor on Geographical sciences (PhD)
Isayeva M. N., basic doctoral student of Bukhara State University
Temirova M. A., master student of Bukhara State University
Republic of Uzbekistan. Bukhara

CHANGES IN TEMPERATURE INDICATORS IN THE BUKHARA REGION AND THEIR UTILIZATION OPPORTUNITIES

Abstract: This article analyzes the trends of and minimum temperatures in the Bukhara region based on meteorological observations from the last ten years. Seasonal temperature variations and the overall dynamics of increase or decrease have been identified. Based on statistical data, the stability of the region's climate and its long-term changes have been assessed. The obtained results have scientific and practical significance in terms of their impact on agriculture, water resource utilization, and environmental safety.

Keywords: Minimum temperature, wind energy, solar energy, climate, natural resources, solar radiation, temperature, amplitude of solar radiation, solar heat.

ИЗМЕНЕНИЕ ТЕМПЕРАТУРНЫХ ПОКАЗАТЕЛЕЙ В БУХАРСКОЙ ОБЛАСТИ И ВОЗМОЖНОСТИ ИХ ИСПОЛЬЗОВАНИЯ

Аннотация: В данной статье на основе метеорологических наблюдений последних десяти лет проанализированы тенденции минимальных температур в Бухарской области. Определены сезонные изменения температуры и общая динамика её повышения или понижения. На основании статистических данных оценена стабильность климата региона и его долгосрочные изменения. Полученные результаты имеют научно-практическое значение с точки зрения влияния на сельское хозяйство, использование водных ресурсов и обеспечение экологической безопасности.

Ключевые слова: Минимальная температура, энергия ветра, солнечная энергия, климат, природные ресурсы, солнечная радиация, температура, амплитуда солнечного излучения, солнечное тепло.

Introduction (Literature Review). Climate change is recognized by the global community as one of the most urgent and serious global challenges facing humanity today, directly affecting all aspects of human life. It requires the immediate implementation of practical measures to mitigate its negative consequences and to adapt to new climatic conditions. In the Republic of Uzbekistan, the adoption of the laws "On the Use of Renewable Energy Sources"

and “On Public-Private Partnership” has created a solid legal and regulatory foundation for accelerating the introduction of renewable energy sources through the construction of solar and wind powerplants.

Literature Review. Significant efforts are being made to ensure climate stability in the Bukhara region. Comprehensive natural-geographical studies of the region’s climate have been carried out by scholars such as N.A. Kogay (1971), F.N. Milkov (1990), A.G. Boboyev (1996), T.V. Zvonkova (1962, 1965), A.G. Isachenko (1998, 2003), M. Umarov (1967), N.N. Nigmatov (2004), S.B. Abbasov, A.S. Saidov, I.Q. Nazarov, U. Nurov, Yu.B. Rakhmatov, Kh.R. Toshov, M.K. Ergasheva, G.S. Khalimova, I.E. Mirzayeva and others [1,2,3].

Research Methodology. The territory of the region (40.3 thousand sq. km) is located in the desert zone. According to the degree of human development, the area consists of desert-oasis and desert-pasture zones [5]. The climate of Bukhara region has its own distinctive features. By studying long-term changes in air temperature, it becomes possible to determine the impact of climate change on the territory of the region. These findings help in making practical decisions in agriculture, water resource management, and regional development.

Analysis and Results. The climate of the Bukhara region is sharply continental, dry, and characterized by extremely hot summers and short, unstable winters. The average temperature in January is about −2°C, while in July it exceeds 40°C. The average annual temperature is 14.2–15°C. The annual temperature amplitude ranges from 68–72°C, indicating high climatic variability in the region. Each year, about 140–150 kcal of heat per 2 cm² of the Earth's surface is received, showing the abundance of thermal energy resources. The number of sunny hours per year ranges from 2800 to 3000. The sum of effective temperatures (daily average above 10°C) is 4800–5100°C, which creates favorable conditions for agriculture and renewable energy development. However, the annual precipitation amount is around 130–150 mm, typical of an arid (dry) climate. Most of the precipitation occurs in winter and spring, while in summer it is almost absent (0–1 mm). The humidity coefficient ranges between 0.03–0.2, and evaporation significantly exceeds precipitation [5].

Table 1

Buxoro viloyati havo haroratining minimal ko’rsatkichlari

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Yanvar	-9.5	-3.9	-1	-16.6	-2.3	-5.6	-9.6	-5.2	-21.2	-5.5	-8.04
Fevral	-2.5	0.8	-1.5	-8.1	-3.7	-3.6	-11.1	-4.1	-7.4	-7.2	-4.84

Mart	-5.2	-0.2	-4.2	-2.3	1.9	-2.4	-8.3	0.1	1.9	-1.8	-2.05
Aprel	1	4	9.5	3.6	2.8	0.8	1.2	8.9	3.8	5.8	4.14
May	11.4	17.2	9.3	8.2	10.6	11	14.4	12.6	11.1	10.3	11.61
Iyun	20.5	17.4	20.5	15.5	16.3	13.8	17.5	16.7	17.8	16.8	17.28
Iyul	18.7	23.4	18.2	18.9	18.2	18.2	18.3	18.4	19.1	17.5	18.89
Avgust	13.6	20.7	19.6	14.6	12.7	15.6	15.6	15	12.8	14.2	15.44
Sentabr	10.1	11.3	1.6	10.2	10.2	8.2	11.1	9.2	10.3	10.3	9.25
Oktabr	-0.1	5.7	2.8	-1	4.7	-0.8	1.4	4.8	2.3	1.4	2.12
Noyabr	-2.8	-14	-2.2	-7.2	-11	-11.8	-6.3	-2.1	-0.4	-3.5	-6.13
Dekabr	-6.9	-14	-7.2	-2.8	-3.8	-11.2	-5.2	-10.5	-14.9	-11	-8.75
O’rt.	4.025	5.7	5.45	2.75	4.71	2.68	3.25	5.31	2.93	3.94	4.07

Note: The table was compiled based on 10-year data from the Bukhara meteorological station.

During 2015–2024, the minimum temperature indicators observed in the Bukhara region once again confirm that the region has a sharply continental climate. Overall, winters in Bukhara are very cold, while summers are extremely hot. As shown in the table, temperatures drop sharply during the winter months, and in some years, anomalous cold spells have been recorded. For instance, in January 2023, the temperature fell to –21.2°C, indicating the severe and harsh nature of winters in the Bukhara region. Meanwhile, in January 2016 and 2017, minimum temperatures of –3.9°C and –1°C were recorded, suggesting comparatively mild winters. This process reflects that cold waves vary in strength and frequency from year to year. Significant differences are also observed in February: in 2016, the minimum temperature was 0.8°C, while in 2021 it dropped to –11.1°C. Such variations show that winters in the region are unstable — in some years, the climate may be unusually mild, while in others, extremely cold. During the spring months, the minimum temperatures in Bukhara begin to stabilize. In March, the average minimum temperature is around –5°C, though in 2021 it dropped to –8.3°C, while in some years it was recorded as positive. These late spring frosts can negatively affect agriculture, particularly fruit trees and vegetable crops. From April onwards, consistently positive temperatures indicate the beginning of the

vegetation period. In May, minimum temperatures range between 9°C and 17°C, creating favorable conditions for crop growth.

Summer is the most distinctive season in Bukhara. According to the data, even the minimum temperatures remain very high. In July 2016, the minimum temperature reached +23.4°C, showing the strong manifestation of heat waves in the region. Generally, in June and July, minimum temperatures range between +15°C and +23°C, which indicates insufficient nighttime cooling and an increased level of heat stress for both humans and animals. From August, temperatures gradually begin to decline, though they remain relatively high, indicating an extended summer season in the region.

In autumn, temperatures in Bukhara gradually decrease. In September, the minimum temperature is usually around +10–11°C, but in October it drops sharply — in some years remaining positive, while in others becoming negative. For example, in October 2020, it was –0.8°C, and in 2021, it was 1.4°C. In November, the first winter frosts begin, with minimum temperatures dropping to as low as –11.8°C in some years. By December, the region enters the cold winter period — for instance, temperatures of –14°C in 2016 and –14.9°C in 2023 indicate anomalously severe cold conditions. The dynamics of average annual minimum temperatures also provide important scientific insights. In 2016, the highest average minimum temperature was recorded at 5.7°C, whereas in 2020 it dropped to 2.68°C — the lowest value in the period. This demonstrates the strong variability and instability of Bukhara's climate from year to year. In recent years (2022–2024), average minimum temperatures have tended to be lower, indicating that winters are becoming colder (Table 1).

Figure 1

The 10-Year Dynamics of Minimum Air Temperature in the Bukhara Region

In general, the dynamics of minimum temperatures in the Bukhara region during 2015–2024 indicate that the region's climatic resources are unstable. The frequency of anomalous cold and heat waves is increasing, and these processes directly affect the region's agricultural activities, water resources, living conditions, and public health. In particular, severe frosts in winter increase the load on electricity and heating systems, while high nighttime temperatures in summer intensify the use of water resources. Therefore, based on the climatic data of the Bukhara region, it is necessary to develop adaptation measures and implement a sustainable development policy for the future. The following diagram illustrates the 10-year dynamics of minimum temperatures in the Bukhara region (Figure 1).

Conclusion and Recommendations. The diverse distribution of bioclimatic conditions over different years is associated with the characteristics of air masses entering Central Asia. Based on the statistical analysis of observational data from meteorological stations located in the Bukhara region for the period 2015–2024, the climatic characteristics of the region were examined. In conclusion, it can be stated that the region generally experiences relatively mild winters, with predominantly positive average temperatures. The development of solar energy in the Bukhara region would make a significant contribution to economic growth. Overall, the assessment of the utilization of climatic resources and the effective analysis of the results serve as important factors for achieving sustainable development in regions such as the Bukhara region.

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