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CLIMATE RESOURCES OF BUKHARA REGION AND DYNAMICS OF THEIR CHANGE

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Abstract: In this article, climate resources of Bukhara region and their dynamics of change are studied. Average, maximum, minimum temperatures and trends of their change dynamics were analyzed in the research based on meteorological observation data of the last ten years. The change of temperature in the cross-section of the seasons and the dynamics of the general increase or decrease have been determined. Based on the statistical results, the stability and long-term changes of the region's climate were studied. The obtained results are of scientific and practical importance in terms of impact on agriculture, use of water resources and environmental safety.

Key words: maximum temperature, wind energy, solar energy, sunlight, climate, natural resource, solar radiation, temperature, average temperature, amplitude, minimum temperature, solar heat.

The United Nations Sustainable Development Program until 2030 has 17 "goals", so the 15th goal is aimed at solving the tasks of "Protection and restoration of terrestrial ecosystems, their rational use, rational management of forests, combating desertification, stopping land degradation and preventing the loss of biological diversity." Climate change is recognized by the world community as one of the most urgent and serious global problems facing humanity today, and this process directly affects all aspects of human life, requiring immediate practical measures to reduce its negative consequences and adapt to new climate conditions. The adoption of the laws "On the use of renewable energy sources" and "On public-private partnership" in the Republic of Uzbekistan created a solid legal and regulatory basis for accelerating the process of introducing renewable energy sources through the construction of solar and wind power plants. Complex natural geographical research on the climate of Bukhara region was carried out by A.G. Boboyev, T.V.Zvonkova, M.Umarov (1967), S.B.Abbasov, A.S.Saidov, I.Q. Nazarov, U.Nurov, Yu.B.Rakhmatov, H.R.Toshov, M.K.Ergasheva, G.S. Halimova, I.E.Mirzayeva and other scientists. The territory of Bukhara region (40.3 thousand square km) is located in the desert zone. This area consists of desert-oasis and desert-pasture areas according to the level of human development. The climate of Bukhara region has its own characteristics. By studying the long-term changes in air temperature in the Bukhara region, it becomes possible to determine the impact of climate change on the territory of the region, to assess the ecological stability of agro-landscapes. These results will help to make practical decisions in agriculture, water resources and regional development. In such

climatic regions, the spring season (average temperature of April in Bukhara region is +18°C) is hotter than the autumn season (average temperature of October is +28,55°C), and in the maritime climate (see the example of the Black Sea coast) autumn is hotter (average temperature of October is +16,2°C), spring is hotter than spring (average temperature of April is +11,5°C). will be [3]. Therefore, despite the location of the arid and maritime climate countries at the same geographical latitude, they are not the same in all seasons.

Average indicators of air temperature in Bukhara region

Table 1

Years and months	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Average
January	2,6	5,8	2,5	0,2	5,9	2,3	1,6	4,2	-3,2	4,8	2,67
February	6,2	6,4	2,3	4,0	6,2	7,5	7,6	7,4	6,3	4,4	5,83
March	8,3	13,4	8,2	13,9	12,1	12,4	9,6	9,4	16,7	10,8	12,2
April	18	16,7	16,3	16,7	16,7	17,6	18,6	21,4	19,2	18,8	18
May	24,5	24,6	25,2	22,9	24,3	24,3	26,3	23,9	23,8	22,4	24,22
June	30,1	29,1	28,8	28,5	28,3	29,4	30,5	29,9	30,4	30,1	29,51
July	30,9	30,4	30,7	31,9	32,5	31,0	31,7	31,0	31,6	30,7	31,24
August	27,2	28,4	27,7	27,5	28,0	27,6	29,0	29,4	28,4	28,8	28,2
September	21,9	24,2	22,8	22,0	21,8	20,7	23,5	23,7	21,8	21,5	22,39
October	14,3	12,5	15,6	14,4	16,1	13,4	12,3	15,5	16,9	15,0	28,55
November	7,4	7,9	10,0	5,5	5,0	4,6	6,6	9,6	12,9	9,4	7,89
December	4,9	4,5	1,4	4,0	5,7	-0,6	6,4	0,7	4,4	1,5	3,29

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

The above table shows the dynamics of average monthly temperatures in the Bukhara region between 2015 and 2024. According to the data, during these 10 years, the lowest temperatures were recorded in January and February, while the highest temperatures were recorded in June-July. Temperatures in the winter months (December, January, February) The average temperature of January was +2,67 °C, the lowest figure was -3,2 °C in 2023, and the highest figure was +5,9 °C in 2019. In February, the average value is 5,83 °C, and in 2016 +6,4 °C was recorded. The average temperature in December was 3,29 °C, the lowest value was -0,6 °C in 2020, and the highest was 5,7 °C in 2019. These results show that there are significant annual fluctuations in winter temperatures, but the overall mean values are positive, indicating that the region has relatively warm winters [1,2]. Temperatures in spring months (March, April, May): the average temperature of March is 12,2 °C, the highest value was +13,9 °C in 2018, the lowest value was +10,8 °C in 2024. In April, a stable temperature of +18 °C is observed, which confirms the relatively warm spring season. The average temperature of May is +24,2 °C, almost in all years it is in the range of +24–25 °C. In spring,

temperatures do not vary greatly from year to year, seasonal stability is observed. Temperatures in the summer months (June, July, August): The average value of June is +31,2 °C. The months with the hottest days are observed. The highest average temperature was +31,8 °C in July, the maximum value in 2019 was +32,5 °C. The average temperature in August is +28 °C, with a slight decrease at the end of the summer season. This is mainly due to the change of seasons. In the summer, there are stable high temperatures, especially in June and July, average values above +30°C indicate that the climate is hot and dry. Temperatures in the autumn months (September, October, November) in September, the temperature is around +22,5 °C, and the transition from summer to autumn is smooth. In October, the average value is +15,85 °C, during which the temperature starts to drop sharply. The average value of November is +7,89 °C, which is a clear indication of the transition to the cold season. Annual average values: Annual average temperatures ranged from +15,85 °C to +17,43 °C in 2015–2024. The lowest annual average temperature was recorded in 2020 (+15,85 °C), and the highest in 2023 (+17,43 °C). The average annual temperature for the general period is +17,83 °C (Table 1).

In the spring months, minimum temperatures in Bukhara begin to stabilize. Although it is usually around -5 °C in March, it dropped to -8,3 °C in 2021, and in some years it was recorded as positive. Late frosts this spring may have a negative impact on the region's agriculture, particularly fruit trees and dairy products. The absolute positive temperature from April means the beginning of the growing season. In May, minimum temperatures are in the range of 9-17 °C, which creates favorable conditions for the active development of crops. Summer is the most special period of Bukhara, and according to the table, the minimum temperatures are extremely high. The fact that the minimum temperature was 23,4 °C in July 2016 indicates that heat waves were strongly manifested in the region. In general, minimum temperatures in June and July range from 15–23 °C, indicating insufficient nighttime cooling and increasing heat stress for humans and animals. From August, the temperature gradually decreases, but still remains high. This indicates that the summer season will be prolonged in the region. In autumn, the temperature gradually decreases in Bukhara. Although the minimum temperature in September is usually around 10-11°C, in October this indicator drops sharply, and in some years positive and negative values were recorded in some years. For example, it was -0,8 °C in October 2020, and 1,4 °C in 2021. In November, the first frosts of winter begin in Bukhara region, and the minimum temperature drops to -11,8 °C in some years. And in December, the region enters the cold winter period, when -14 °C was recorded in 2016 and -14,9 °C in 2023, indicating that anomalous severe frosts were observed in the region. The dynamics of changes in average annual minimum temperatures also provide important scientific conclusions. In 2016, the average minimum temperature was the highest with 5,7 °C, and in 2020, the lowest value was observed with 2,68 °C. This shows that the climate of Bukhara region is highly variable and the temperatures are unstable from year to year. In recent years (2022–2024), average minimum temperatures are relatively low, which means that winters are coming colder [4]. In general, such

dynamics of minimum temperatures in the Bukhara region during 2015-2024 indicate the instability of climatic resources. The frequency of abnormal cold and heat waves is increasing, and these processes directly affect the agricultural activity of the region, water resources, living conditions and health of the population. In particular, severe frosts in the winter months increase the load on the electricity and heat supply system, and high night temperatures in the summer months increase the use of water resources. Therefore, there is a need to develop adaptation measures and establish a sustainable development policy based on the climatic data of Bukhara region.

Solar panels are being installed for agricultural facilities in Bukhara region, such as greenhouses, pumping stations and water extraction facilities. This reduces the load on the central grid by meeting energy needs at the local level. In particular, the use of solar energy in water pumps makes groundwater extraction cheaper and more sustainable [5].

Effective use of solar and wind energy, especially in sunny regions such as Bukhara region, creates opportunities for increasing environmental sustainability and economic efficiency. Through the above examples, we can see that the implementation of the project not only ensures the production of ecologically clean energy, but also brings great economic benefits. Investments in solar energy provide long-term economic returns and help reduce dependence on raw materials and energy resources. Taking into account the climate and natural resources of Bukhara region, expanding the use of solar energy can play an important role in combating climate change. Development of positive utilization projects and ensuring their implementation will help not only to ensure energy security, but also to create new jobs and protect the environment. Also, when evaluating the use of climatic resources, it is necessary to consider the ecological and economic efficiency together. When assessing the possibilities of effective use of solar and wind energy, it is necessary to increase their production capacity and update it with technological innovations. Thus, the development of solar energy for the Bukhara region will make a great contribution to economic development. In general, the evaluation of the state of use of climatic resources and the effective analysis of the results serve as an important factor for achieving sustainable development in regions such as Bukhara region [6].

In conclusion, we can say that the region has a relatively mild climate in the winter months, with average positive temperatures. In the spring, temperatures rise steadily and reach +24 °C in May. The summer season is quite hot and dry, and average values above +30 °C are recorded in June-July. In the autumn, temperatures gradually decrease and fall to 7–8 °C by November. The conducted analyzes show that the trend of gradual warming of the climate continues in the Bukhara region.

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