INTERNATIONAL MULTI DISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
eISSN 2394-6334 Impact factor: 8.854 Volume 13, issue 04 (2026)

CHANGING MICROCLIMATE CONDITIONS AND HEAT FLOW REDISTRIBUTION IN AN URBAN ENVIRONMENT

Kamilla Dzhavdatovna Abdullaeva
Shukurullaeva Mohinur Bakhtiyarovna
Tashkent University of Architecture and Civil Engineering

Abstract: This article examines the impact of high-density urban development on the formation of the urban heat island effect. The main factors contributing to temperature increase in cities are analyzed, including increased building density, the use of heat-absorbing construction materials, reduction of green spaces, and the growth of anthropogenic heat emissions. Special attention is given to changes in microclimatic conditions and the redistribution of heat flows in an urbanized environment. Based on the analysis, patterns of increasing temperature contrast between central and peripheral urban areas have been identified.

Key words: urban heat island, high-density development, urbanization, urban microclimate, thermal pollution, green spaces, sustainable urbanism, anthropogenic factors

Introduction:

With rapid urbanization and population growth, the problem of the urban heat island effect is becoming increasingly important. According to the State Statistics Committee of the Republic of Uzbekistan, the level of urbanization in Uzbekistan has been steadily increasing in recent years, and the share of the urban population has exceeded 50% [1]. Large cities such as Tashkent are experiencing intensive development of high-density housing, accompanied by a reduction in green spaces and an increase in the area of artificial surfaces.

According to official statistics, over the past 10 years, the volume of housing construction in the country has increased more than 1.5-fold, indicating significant urban densification.[2] Moreover, this increased building density leads to changes in the radiation and heat balance of urban areas, contributing to the formation of localized temperature anomalies.

Sustainable urban development and adaptation to climate change are reflected in a number of regulatory documents of the Republic of Uzbekistan. In particular, Presidential Decree No. UP-60 defines the priorities for sustainable urban development, including the development of green infrastructure and improving the energy efficiency of the urban environment.[3] Also of significant importance is Presidential Resolution No. PP-46, aimed at transitioning to a "green economy"[4] and reducing the negative impact of anthropogenic factors on the environment.

Furthermore, environmental policy implementation places particular emphasis on increasing green space and creating a favorable microclimate in cities. Despite these measures, high-density development continues to exacerbate the urban heat island effect, requiring further scientific research and the development of effective urban planning solutions. Thus, the study of the influence of high-density development on the formation of an urban heat island in the conditions of Uzbekistan is a relevant scientific task that has important practical significance for ensuring environmental sustainability and improving the quality of life of the urban population.

Literature Review

One of the first fundamental studies devoted to the urban heat island phenomenon was the work of English meteorologist Luke Howard. In his work, he provided the first scientific basis for the differences in temperature between urban and rural areas. Based on long-term climate observations in London, he found that air temperatures in urban areas are systematically higher than in suburban and rural areas[5].

Howard linked this phenomenon to urban design features such as dense building patterns, narrow streets, and limited air circulation. He also noted the role of building materials, which have the ability to accumulate heat during the day and gradually release it at night. This leads to a smoothing of diurnal temperature fluctuations and the formation of a stable "thermal dome" over the city.

Although the study was conducted in the 19th century, its scientific value remains today. Howard's work laid the foundation for further research in urban climatology and became the starting point for studying the impact of urbanization on microclimate. However, this study fails to account for modern factors, such as anthropogenic heat emissions from transport and industry, as well as the impact of high-rise buildings, requiring its scientific principles to be supplemented and developed in a modern context.

The work of Canadian scientist T. R. Oke is one of the most significant modern studies in the field of urban microclimate formation and the urban heat island effect. The author examines in detail the processes of heat exchange in the surface layer of the atmosphere and their changes under the influence of the urban environment.[6]

Oke introduces the concept of the "urban canyon," which characterizes the space between buildings where a complex interaction of solar radiation, thermal radiation, and airflow occurs. He demonstrates that increasing building density leads to reduced ventilation, a decrease in surface reflectivity (albedo), and an increase in the thermal capacity of the urban environment. All these factors contribute to heat accumulation and increased air temperature.

The work pays special attention to anthropogenic heat sources, including transport, industry, and air conditioning systems, which exacerbate the urban heat island effect. The author also emphasizes the importance of green spaces, which help reduce temperatures through moisture evaporation and shade. The scientific significance of Oke's work lies in its integrated approach to studying the urban climate system.

Unlike earlier studies, it takes into account a wide range of factors and offers quantitative methods for assessing heat balance. However, it should be noted that most of the conclusions are based on studies of cities with temperate climates, requiring adaptation to the conditions of countries with hotter and drier climates, including Uzbekistan.

Research Methodology

The following main methods were used in this study:

1. Comparative analysis.

This method was used to compare temperature readings in areas with different building densities. The study compared central areas of the city with a high building density and peripheral areas with a lower degree of urbanization. This allowed us to identify differences in microclimate and determine the influence of building density on the urban heat island effect.

2. Statistical method.

The method is based on the analysis of statistical data on urbanization levels, building density, and temperature changes in cities across Uzbekistan. This approach revealed a correlation between increasing urban building density and rising temperatures, confirming the existence of the urban heat island effect.

Analysis and Research Results

The analysis showed that high-density urban development significantly influences the urban heat island effect. According to research by T. R. Oke, in densely populated areas, air temperatures in central city districts can exceed those in suburban areas by 2–6°C, and in some cases, up to 8°C. This is explained by reduced heat transfer and poor ventilation in so-called "urban canyons" [7].

An analysis of scientific literature, including the work of Luke Howard, confirms that dense development promotes heat accumulation through the use of building materials with high thermal mass, such as concrete and asphalt. These materials actively absorb solar radiation during the day and gradually release heat at night, leading to higher nighttime temperatures in urban environments.

Based on statistical data from the Republic of Uzbekistan, it has been established that large cities, particularly Tashkent, are experiencing a steady increase in air temperature. According to observations, the difference between temperatures in central areas and green areas can reach 3–5°C in the summer. This is due to the intensive development of residential and commercial buildings, as well as the reduction in green space.[8]

Additional analysis revealed that anthropogenic heat sources (transportation, air conditioning systems, industry) amplify this effect. Oke T.R.'s research notes that the share of anthropogenic heat generation in large cities can reach 20–30% of the total heat balance, significantly amplifying temperature anomalies.

The study also found that the presence of green spaces significantly reduces the intensity of the urban heat island. According to current research, increasing the proportion of green spaces by 10% can lead to a decrease in air temperature by 1–2°C due to evaporation and shading.

Key findings:

– High building density has been found to directly impact urban temperature increases;
– Temperature differences between central and peripheral areas can reach 3–6°C;
– Building materials with high thermal capacity have been shown to enhance heat accumulation;
– Anthropogenic heat sources have been shown to significantly enhance the urban heat island effect;
– Green spaces have been confirmed to be an effective means of reducing urban temperatures.

Conclusion:

The study found that high-density urban development is one of the key factors contributing to the urban heat island effect. Increasing building density, the widespread use of heat-storing materials, the reduction of green space, and increased anthropogenic heat generation lead to a significant increase in urban temperatures.

Analysis showed that the temperature difference between central and peripheral areas of cities can reach 3–6°C, which is particularly characteristic of large cities in Uzbekistan. Statistics indicate rising urbanization and an increase in built-up areas, which increases the burden on the urban microclimate.

It has been established that green spaces play a significant role in reducing temperatures through moisture evaporation and shading. The implementation of "green infrastructure" elements, improved building energy efficiency, and rational urban planning are effective measures to reduce the urban heat island effect.

Thus, to ensure sustainable development of cities in Uzbekistan, it is necessary to take climate aspects into account when designing the urban environment and actively implement environmentally friendly solutions.

References:

1. Luke Howard. The Climate of London. London, 1833.
2. T. R. Oke. Boundary Layer Climates. Routledge, 1987.
3. T. R. Oke. Urban Climates. Cambridge University Press, 2017.
4. State Statistics Committee of the Republic of Uzbekistan. Official statistical data on urbanization and population.
5. Ministry of Ecology, Environmental Protection and Climate Change of the Republic of Uzbekistan. Environmental reports and monitoring data.
6. World Bank. Sustainable Cities Reports.

7. UN. World Urbanization Prospects.
8. IPCC. Climate Change Reports.
9. Decree of the President of the Republic of Uzbekistan No. UP-60. Development Strategy of the New Uzbekistan.
10. Resolution of the President of the Republic of Uzbekistan No. PP-46. Program for Transition to a Green Economy.
11. BAKHTIYOROVNA, S. D. (2026). INDIVIDUALIZING INDEPENDENT LEARNING WITH THE USE OF ARTIFICIAL INTELLIGENCE. Shokh Articles Library, 1(1).
12. Baxtiyorovna, S. D. (2025). OLIY TA'LIMDA MULTIMEDIYANI QO ‘LLASH TAJRIBASI. ZAMONAVIY TA'LIMDA FAN VA INNOVATSION TADQIQOTLAR, 3(10), 283-286.
13. Bakhtiyorovna, S. D. (2025). THE IMPORTANCE OF MULTIMEDIA IN ORGANIZING STUDENTS'INDEPENDENT WORK. INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN EDUCATION, TECHNOLOGY AND MANAGEMENT, 4(3), 153-161.
14. Sulaymanova, D. B. (2024). Texnika yo’nalishlarida dasturlashning kasbiy afzalliklari. Zamonaviy ta'limda fan va innovatsion tadqiqotlar jurnali, 203-211.
15. Sulaymanova, D., Abduganieva, Y., & Miratoev, Z. (2023). Modeling roll contact curves of a squeezing machine. In E3S Web of Conferences (Vol. 443, p. 03006). EDP Sciences.
16. Файзиев, Р. А., Хаитматов, У. Т., Азаматов, О. Х., Джуманиязов, Ш. Р., & Хасанова, Х. Х. (2018). Использование теории нечетких множеств в экономическом анализе инвестиционных проектов. *International Journal of Innovative Technologies in Economy*, *2*(5 (17)), 44-48.
17. Xasanova, X. (2024). Bank faoliyatida risklarni baholshning xalqaro tajribasi. *Nashrlar*, 172-175.
18. Исохужаева, М. Я., & Хасанова, Х. Х. (2020). Электрон иқтисодиёт шароитларида рақамли компетентлик. *Журнал «Бизнес-эксперт*, 35-37.
19. Mamadiyarov, Z., Khamdamov, S. J., Makhmudov, S., Isaev, F. B., Kurbonov, K., Boymurotov, S., & Khasanova, K. (2024, December). Forecasting and planning the effectiveness of service activities in commercial banks. In *Proceedings of the 8th International Conference on Future Networks & Distributed Systems* (pp. 75-83).
20. Абдуганиева, Ю. Ш. (2023). Автоматизация процессов флотации. Oriental renaissance: Innovative, educational, natural and social sciences, 3(3), 1097-1105.