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Ecological condition of cities and problems of population health

Condición ecológica de las ciudades y problemas de salud de la población

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Abstract: BACKGROUND AND OBJECTIVES: The relevance of the topic is to study the sources of air pollution, as they lead to an increase in morbidity and mortality among the population. This in turn requires radical lifestyle changes, as well as the adoption of specific measures to ensure a reduction in air pollution levels. In this regard, the aim of the study was to analyze the state of air pollution in the Republic of Uzbekistan and in particular the city of Tashkent to determine the consequences of its impact on public health. **METHODS:** To achieve the set goals, empirical research methods were used: empirical description and comparison. There was also an analysis of pollutant emission into the atmosphere indicators in general for the Republic of Uzbekistan and by region, carried out with a detailed study of morbidity in the general population and the incidence of cardiovascular diseases in the Republic of Uzbekistan, on whose basis a correlation and regression analysis was carried out. **FINDINGS:** As a result of our research, respiratory diseases with an increase in total emissions; diseases of the endocrine system, eating disorders, and metabolic diseases; diseases of the blood, and hematopoietic organs; and some diseases related to the immune system have been found. Circulatory system diseases and general morbidity have also increased, and these factors are interrelated. **CONCLUSION:** The article outlines the following measures to ensure a reduction in the level of air pollution: modernization of industrial enterprises, improvement of transport infrastructure, use of alternative energy sources, strengthening control over emissions that pollute the atmosphere, as well as rational placement of industrial facilities. The practical significance of the study lies in the optimization of environmental monitoring data on urban air pollution in the Republic of Uzbekistan, where in general there is a high level of pollutants in the atmosphere, which in turn affects the health of the population.

Keywords: Atmosphere, General mortality, Pathological condition, Public health, Urbanization.

Resumen: ANTECEDENTES Y OBJETIVOS: La relevancia del tema yace en estudiar las fuentes de

contaminación del aire, ya que provocan un aumento de la morbilidad y mortalidad en la población. Esto, a su vez, requiere cambios radicales en los estilos de vida, así como la adopción de medidas específicas para garantizar una reducción de los niveles de contaminación del aire. En este sentido, el objetivo del estudio fue analizar el estado de la contaminación del aire en la República de Uzbekistán y en particular en la ciudad de Tashkent para determinar las consecuencias de su impacto en la salud pública. **MÉTODOS:** Para lograr los objetivos se utilizaron métodos de investigación empíricos: descripción empírica y comparación. También se analizaron los indicadores de emisiones de contaminantes a la atmósfera en general para la República de Uzbekistán y por región; se realizó un análisis detallado de la morbilidad general de la población de la República de Uzbekistán y la incidencia de enfermedades cardiovasculares, sobre cuya base se realizó un análisis de correlación y regresión. **HALLAZGOS:** Como resultado de nuestra investigación, se encontraron enfermedades respiratorias con un aumento en emisiones totales; enfermedades del sistema endocrino, trastornos alimentarios y enfermedades metabólicas; enfermedades de la sangre y de los órganos hematopoyéticos y algunas enfermedades relacionadas con el sistema inmunológico. Se ha hallado además que las enfermedades del sistema circulatorio y la morbilidad general también aumentan y estos factores están interrelacionados. **CONCLUSIÓN:** El artículo describe las siguientes medidas para asegurar una reducción en el nivel de contaminación del aire: modernización de las empresas industriales, mejora de la infraestructura de transporte, uso de fuentes de energía alternativas, fortalecimiento del control de las emisiones que contaminan la atmósfera, así como la ubicación racional de instalaciones industriales. La importancia práctica del estudio radica en la optimización de los datos de seguimiento ambiental de la contaminación del aire urbano en la República de Uzbekistán, donde en general hay un alto nivel de contaminantes en la atmósfera, lo que a su vez afecta la salud de la población.

Palabras clave: Atmósfera, Mortalidad general, Condición patológica, Salud pública, Urbanización.

Introduction

In the modern era of globalization in the world, urbanization processes are becoming increasingly intense. Of particular importance are issues related to improving the environmental situation in cities, ensuring environmental sustainability, as well as improving the quality of life of the urban population. Goal 11 of the UN 2030 Agenda for Sustainable Development, "Ensuring that cities and human settlements are inclusive, safe, resilient and environmentally sustainable" sets goals for creating a more stable, safe and comfortable urban living environment population, taking into account social, economic and environmental aspects. Therefore, it is necessary to optimize the issues of air pollution, climate change, widespread use of energy-efficient energy sources, water pollution, soil conditions, biodiversity conservation, noise reduction, prevention of pollution of urban areas by industrial and household waste, as well as improving public health.

In order to create environmentally friendly cities around the world, many measures are being implemented to support the activities of international organizations and departments, and to further strengthen industrial scientific research. Particular attention is paid to the development and implementation of safe technologies for modern urban planning, intensification of the activities of specialized specialists, a new approach to the system of advanced training, cooperation with environmental organizations, and further improvement of environmental education. Along with this, priority is also given to finding optimal solutions for the complete development of the individual, including issues of physical and spiritual well-being, improving social conditions, increasing access to health services and creating a safe and healthy living environment.

Our country is implementing a number of reforms aimed at improving ecology and environmental protection, further strengthening public health, modernizing healthcare, and reducing the ever-growing groups and types of diseases. In particular, the Development Strategy of New Uzbekistan for 2022-2026 defines important tasks in the 80th goal: "Protection of ecology and the environment, improvement of the ecological condition of cities and regions, implementation of the national project "Green Region". Organization in cities and regional centers of "public parks" for every 50 - 100 thousand people".

According to Barwise and Kumar (2020), studies conducted over many years around the world show a link between exposure to air pollution and the occurrence of various health effects. Children (including during fetal development), persons with existing cardiovascular and respiratory diseases, diabetes mellitus, obesity, low socio-economic status, and the elderly are especially susceptible to the effects of pollution. Exposure to air pollution is associated with increased mortality and reduced life expectancy, even at relatively low pollutant concentrations.

In addition, Y. Barwise and P. Kumar (2020) note that over the past 10 years it has been established that the negative impact of air pollutants is especially characteristic of large cities. According to their data, air pollution causes more than 40 thousand deaths per year.

Research by scientists such as K. Degirmenci, K.C. Desouza, W. Fieuw, R.T. Watson and T. Yigitcanlar (2021) showed that among the population living near chemical plants, the incidence is 2-4 times higher, especially diseases of the circulatory system, including myocardial infarction. It has been noted that the number of hospitalized residents of such areas is several times higher than in other regions where there are no industrial enterprises.

According to the American Heart Association, an increase in the amount of dust particles smaller than 2.5 microns in the atmosphere for several hours a week can lead to an increase in mortality in the population.

Studies conducted in California, USA, and also in China have shown that increased levels of dust in the atmosphere also lead to increased morbidity and mortality from heart failure, coronary heart disease and stroke.

It is important to note that air pollutants include not only greenhouse gases - mainly carbon dioxide, but also methane, nitrous oxide and others, but they overlap in many ways, often interacting with each other. According to research by H. Iravani, V. Rao, P. Newman, J. Kenworthy, air pollution, dust and noise, especially in cities, are the biggest and most direct threat to public health, examples of which were also reflected in the study.

Another confirmation of the study, which studied the effect of air pollution on the development of asthma and respiratory diseases, is given in the works of G.J. Holst et al. Scientists show that adults are more likely to experience severe breathing problems on days when air pollution levels are high and prolonged exposure to smog and harmful substances can aggravate asthma symptoms and cause acute attacks.

The problems of interaction of urban structures with the natural environment were also studied by such foreign scientists as C. Boyden, B. Commoner, F. Fester, R. Leggett, L. Kratzer. Charles W. Boyd studied urban environmental problems in the second half of the 20th century and developed approaches to sustainable urban development. He focused on the need for a balanced use of natural resources and maintaining the environmental sustainability of cities. Barry Commoner (Commoner, 1992) conducted research in the field of ecology and the impact of industry on the environment. He was one of the first scientists to pay attention to the relationship between industrial processes and environmental problems in urban environments. Commoner became a well-known and recognized scientist in the 1960s and 1970s through his research and publications, where he advocated environmental protection and warned the public against the negative consequences of industrial activity. His work emphasized the importance of the social aspects of environmental problems and the impact of pollution on people's health and well-being.

Richard LeGates (2022) was a geographer who studied urban ecology and the impact of urban planning on the environment. He studied issues of sustainable urban development, including problems of transport, land use and nature conservation.

G. M. Lappo (1997) notes the need to take into account the relationships between the city and its surrounding area when studying and planning the urban environment. Cities do not exist in isolation, and their functioning and development depend on many factors present in the surrounding area. A comprehensive analysis includes studying the geographical location, studying climatic factors, assessing the availability of natural resources, analyzing transport and communication links, as well as taking into account social and economic aspects. Thus, analysis and planning of the urban environment require special consideration of the relationships between the city and its surrounding area. This makes it possible to create cities that take full account of the natural and geographical features of their surroundings, promoting sustainable development and efficient use of resources.

The concept of the American scientist Lewis Mumford (2001) about the three stages of urban development from an environmental point of view has wide applicability not only to American cities, but also to cities in general. This three-stage retrospective of urban history, proposed by Lewis Mumford (2001), demonstrates how cities face environmental challenges over time and how it is important to manage their development in order to achieve sustainability and maintain balance with the environment. This concept is applicable to cities in different countries and helps to recognize the need for sustainable development and taking measures to reduce the negative impact of cities on the environment.

The first major study in the field of urban social ecology was the work of Robert Park. Robert Park, an American sociologist, conducted research on the social structure and organization of the city of Chicago, applying methods from sociology and anthropology to study the interaction of people and their environment in urban environments. In the research program "The City as a Social Laboratory", authors Robert Park, Ernest Burgess and Roger Mackenzie (Komilova, Egamkulov, Hamroyev, Khalilova and Zaynutdinova, 2023), presented the book "The City: Proposals for the Study of Human Behavior in the Urban

Sphere" (1925), which reflected methodological dualism. They viewed the city as a social organism and emphasized its “naturalness” in the origin and development of the urban community. The authors attached great importance to the study of urban processes as “social facts”, developing according to their own laws and independent of human will and consciousness. The concept of urban development, in their opinion, was based on social atomism, spatial mobility and social interaction. It is important to note that the works of Robert Park, Ernest Burgess and Roger Mackenzie represent a classic direction in the study of urban processes and human behavior in the urban environment. They developed the concentric model of urban structure in 1929. This model was one of the first attempts to describe the typical organization of cities and the social processes associated with it.

In the works of V. L. Glazychev (2012), the city is considered from different points of view and as different objects of study, as: 1-the focus of the driving forces of history (historical-economic, historical-political and historical-cultural research); 2-complex social organism within the framework of sociological research (sociological research considers the city as a complex social structure, analyzing the interaction and organization of people, social groups, institutions and social processes in the urban environment); 3-node of the settlement system in the field of geographical research (geographical research considers the city as part of a broader settlement system and studies its place in space and relationships with other settlements, analysis of the geographical location, territorial location, impact on the environment and spatial organization of the city); 4-autonomous ecosystem or element of the enveloping ecosystem in bioecological studies (bioecological studies consider the city as an ecological system, analyzing the interaction between urban organisms, the environment and biological processes in the urban environment); 5-object of design, planning and regulation in the theory of organization and management (the city is considered from the point of view of its functional organization, infrastructure, spatial development, rational use of resources and regulation of socio-economic processes).

All these approaches explore the city from different angles, reflecting its complexity and multifaceted nature. Each of them contributes to the understanding of urban environmental problems and the development of appropriate strategies and solutions for sustainable development of the urban environment.

There is currently a global trend of people moving to cities, leading to the growth of urban settlements and increasing pressure on the environment. Studying the environmental situation of cities allows us to understand how the urban environment affects ecosystems, resources and human health. Understanding the environmental situation also makes it possible to determine how well a city complies with the principles of sustainable development, and what measures can be taken to achieve a balance between the needs of people and the preservation of the environment.

Researchers are interested in how life in cities affects people's livelihoods and well-being, as well as the ecological state of the environment. They study the relationships between urban processes such as urban planning, transport infrastructure, resource use and emissions, and their impact on quality of life, public health, biodiversity and climate conditions. Public or social ecology has a close relationship with social geography. The emergence of social ecology as a scientific discipline is associated with the development of ideas and concepts presented at the General Congress of International Sociologists in 1966. This congress was an important moment for the development of public ecology and raised problems of the relationship between society and the natural environment.

Human ecology, which is an important branch of social ecology, developed as a result of the joint research of geographers at the University of Chicago and sociologists. The city of Chicago in the USA is considered one of the centers of development of human ecology. This stems from research conducted in Chicago at the beginning of the 20th century, which examined the interaction between the urban environment, society and people's quality of life. Urban ecology was emerging as an important branch.

Urban ecology (from the Latin *urbos* - city, *oikos* - house and *logos* - science) is a new integrative complex direction in ecology, the subject of which is the vital activity of human populations in the urban environment, included in the natural biogeocenotic complex (Manankov, 2022). Urban ecology has as its subject a clearly defined "man-city-nature" system, which arose historically and is in continuous spatial movement with a rapidly growing number of problems.

V. V. Vladimirov (1999) gives the following definition of the scientific direction: "urboecology is a complex of urban planning, medical-biological, geographical, social, economic and technical sciences that, within the framework of human ecology, study the interaction of industrial and non-productive activities of people with the natural environment on the territory of populated areas and their systems" (Forman, 2008).

The study of the environmental situation of cities is based on scientific and methodological principles and approaches that make it possible to systematize and analyze data on the state of the environment in the city. The integrative approach to studying urban environmental conditions is a widely used research approach. Among foreign scientists who have studied the integrative approach to the ecological state of cities is Richard Forman (Forman, 2008), a professor of geography at Harvard University, known for his research in the field of urban ecology and urban design. He developed the concept of an "urban ecological network" that connects green areas, parks, rivers and other natural elements in an urban environment.

Data on emissions of harmful substances from industrial enterprises, vehicles and other sources of pollution are also analyzed. Water quality in cities is also of particular importance for environmental studies. Parameters such as pollutants (e.g., heavy metals, pesticides, fecal contaminants), dissolved oxygen levels, pH values, and other water characteristics in rivers, lakes, reservoirs, and groundwater are considered. Soil conditions are also included in the analysis of urban environmental conditions. Indicators such as nutrient content, heavy metal contamination, presence of chemical pollutants are studied, and overall soil fertility is assessed. Noise level is another aspect considered in the integrative approach. The noise level from transport, industrial facilities, construction work and other sources is measured.

Data on excess noise levels that may have a negative impact on the health and well-being of citizens are analyzed. Biodiversity assessment is also an important aspect of the integrative approach. The species diversity of plants, animals and microorganisms in the urban environment, as well as their distribution and the state of ecosystems are studied. This allows us to assess the degree of conservation of the city's natural heritage and determine measures for its conservation and improvement. In general, an integrative approach to conducting research on the ecological state of cities allows for a comprehensive assessment and analysis of the state of the environment. This is important for developing strategies and solutions aimed at improving the environmental situation in cities and ensuring sustainable development.

Monitoring and data collection are important components of studying the environmental status of cities. Systematic collection of information allows obtaining objective and up-to-date data on various aspects of the environment. This may include installing weather stations, air quality sensors, water monitoring and other information collection methods.

The collected data is then used to analyze and assess the environmental condition of the city. James Wiseman (Komilova *et al.*, 2023), professor of geography at California State University, emphasizes that regular data collection is the basis for analyzing and understanding environmental processes and trends in urban environments. For example, installing air quality sensors allows you to measure the concentration of various pollutants in the air, such as particulate matter, nitrogen oxides, hydrocarbons and others.

These data help assess the level of air pollution and its potential impacts on the health of city residents. In addition, surveys and sociological studies are conducted to obtain data on the opinions, preferences and behavior of citizens regarding environmental issues. This allows us to assess the population's awareness of environmental issues, their attitude towards environmental problems and their willingness to take part in environmental initiatives. It is important to note that monitoring and data collection methods can be used in combination, depending on the specific aspects of a city's environmental status that require study. The collected data is then analyzed and used to make decisions on environmental protection and sustainable urban development.

Many scientists and researchers recognize the importance of using geographic information systems (GIS) when studying the environmental condition of cities. GIS technologies provide a powerful tool for integrating, analyzing and visualizing geographic data that relates to environmental aspects of the urban environment and also helps in the construction of maps.

Michael Goodchild (2007), a professor of geography at California State University, is a leading expert in the field of geographic information systems and their applications in various disciplines. He conducts research on the use of GIS to study environmental issues in cities, including pollution assessment, land use analysis, and urban infrastructure planning.

Helena Mitchell, Professor of Geography and Director of the Center for Geoinformation Sciences at the University of Bristol (UK), specializes in the application of GIS to urban ecology and planning. Her research focuses on the use of GIS to model urban environments, assess environmental sustainability, and develop strategies for sustainable urban development (Komilovaand Latipov, 2022a).

Mark Birkin (2007), Professor of Geography at the University of Leeds (UK), conducts research on the use of GIS to model urban environments and study their impact on public health and well-being. He develops spatial models that help analyze environmental factors and optimize urban planning.

The study of the ecological state of cities includes a system analysis, which allows us to consider the urban environment as a complex system that includes interconnected components and processes. Systems analysis helps identify the causes of environmental problems, assess their impact, and develop effective strategies for improving the environmental situation. Many scientists and researchers recognize the importance of systems analysis when studying the ecological state of cities.

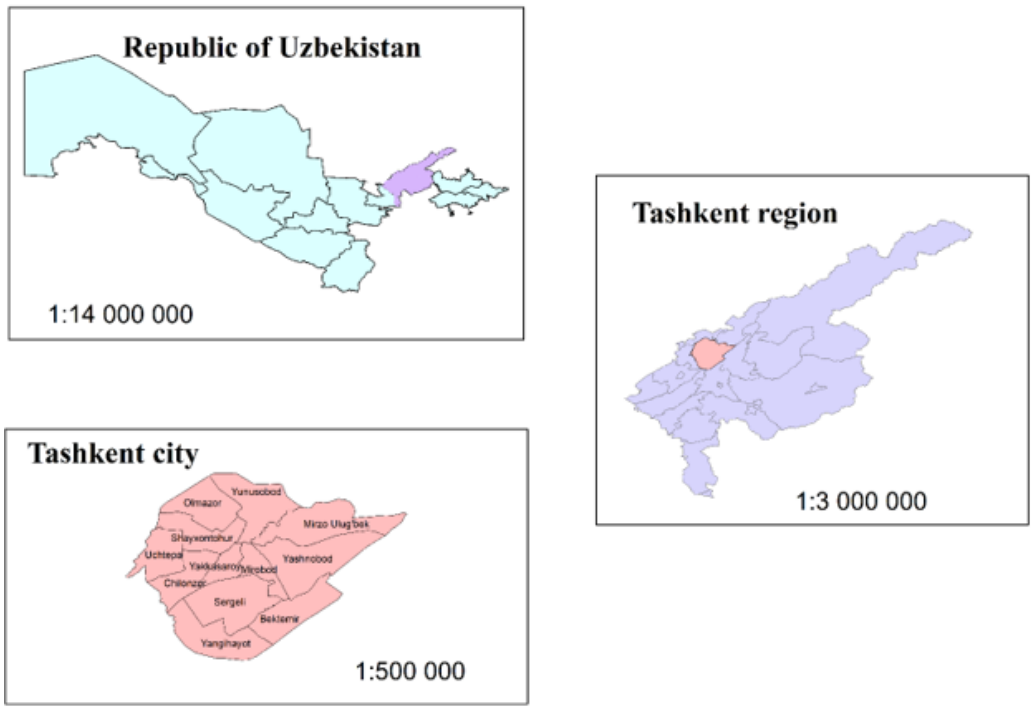
Herbert Girardet (2004), a German scientist, conducts systematic analysis of the ecological state of cities and develops strategies for creating environmentally sustainable urban systems. His book Cities People Planet: Liveable Cities for a Sustainable World is a significant contribution to the study of the connections between cities, people and the planet. The author explores urban environmental issues, the impact of urbanization on the environment and proposes innovative strategies and solutions to achieve sustainable cities.

Karen Seto (2014), a professor at Yale University, specializes in developing strategies to mitigate the negative effects of urbanization. The concept of sustainable urban development that she explores seeks to achieve a balance between the socio-economic needs of people, economic development and the preservation of the ecological integrity of the environment. Urban environmental research plays an important role in assessing how well a city meets these principles, and identifying measures to achieve a balance between human needs and environmental protection. Scientists and researchers also study the impact of urban development, infrastructure, energy systems, transportation and other aspects of the urban environment on the environment and people's quality of life.

Young Ho Hong, a professor at Seoul National University (South Korea), studies the interactions between urban systems, economics, and environmental sustainability, and develops strategies to balance these aspects (Young Ho and Gong, P., 2008).

In this research work, population health and its socio-geographical aspects were analyzed in the city of Tashkent as of 2023 (Fig.1).

Fig. 1
Geographical location of the study area in Tashkent, Uzbekistan



Materials and methods

When writing the article, data from the State Statistics Committee of the Republic of Uzbekistan (Official website of the State Statistics Committee of the Republic of Uzbekistan) and the Statistics Department of the Tashkent were used. The theoretical, methodological and information base of the study is based on the decrees of the President of the Republic of Uzbekistan, regulations, decrees of the Government of the Republic of Uzbekistan, legislative and regulatory acts, strategic documents aimed at controlling the situation of air pollution, in particular, the Law of the Republic of Uzbekistan “On the Protection of Atmospheric Air” "(1996), "On the sanitary and epidemiological welfare of the population" (2015), and the Concept of Environmental Protection adopted in 2019. Also, the theoretical basis of the study was data from scientific works on the influence of industry on urban air pollution and human health, respectively.

In addition, the study used official data from the State Committee of the Republic of Uzbekistan on Statistics (Official website of the State Committee of the Republic of Uzbekistan on Statistics), annual reports of Health Statistics of Uzbekistan (Official website of Health Statistics of Uzbekistan), official data from Internet resources of the Ministry of Health of the Republic of Uzbekistan (Official website of the Ministry of Health of the Republic of Uzbekistan).

To achieve the set goals, empirical research methods were used, namely: empirical description (when recording data on urban air pollution and human health), as well as comparison (when comparing the impact of urban air pollution on human health). This study analyzes the indicators of emissions of pollutants into the atmosphere in general for the Republic of Uzbekistan and by region. Also, during the study, a detailed analysis of the general morbidity rate of the population of the Republic of Uzbekistan and the incidence rates of cardiovascular diseases of the population in particular for 2000-2022 was carried out, on the basis of which a correlation and regression analysis was carried out to determine the significance value. In addition, an analysis of the incidence rates of the population in the entire Tashkent region with respiratory diseases and eye diseases was carried out, and measures were considered to reduce the level of air pollution in large industrial cities.

The study analyzed the theoretical provisions of scientific works of scientists on the relationship of man-made emissions from air pollution, as well as a systematic multifactorial analysis of the impact of the current situation on the health of the population, as a result of which the problem, purpose and methods of research were highlighted, a scientific research plan was drawn up, analysis and formation were carried out, results were obtained in the course of scientific work and conclusions were systematized.

Results and discussion

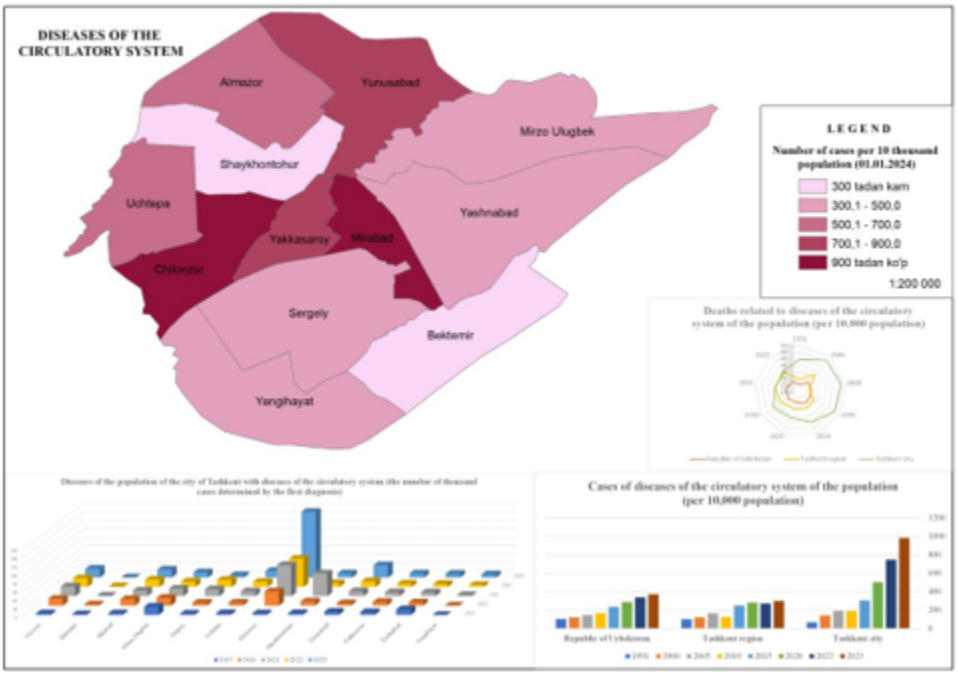
It is known that the emergence of the ancient city of Tashkent is closely connected with the natural-economic and historical-geographical features of the Central Asia. The city of Tashkent has been the administrative, economic and cultural center of the Republic of Uzbekistan since 1940. The city is located in the north-east of Uzbekistan, on the left bank of the middle course, in the central part on a vast, slightly hilly foothill plain, with a slope from southeast to northwest, at an altitude of 730 meters above sea level.

The average annual precipitation is 328 mm, and there is usually no stable snow cover. In Tashkent, northeast, east and southeast winds (54% of winds in all directions) prevail throughout the year, and in summer, east and southeast. The average annual wind speed in the city is low and ranges from 1.4 m/sec. up to 2 m/sec. Strong winds are observed mainly in the months of February-April, especially in March (50% of the annual number of strong winds). Another type of unfavorable climatic phenomenon is thunderstorms, which occur in Tashkent more often than in the lower reaches of Zeravshan. Thunderstorms occur mainly in spring and occasionally in June. These climatic features are of great importance for the environment and the lifestyle of city residents, and can also influence various aspects of the city's infrastructure and economy. The area of the city of Tashkent (land area) is 336 thousand square meters. km. with a population of 6 million people (according to the statistics department of the Tashkent region as of October 1, 2023), the share in the region is -14.0%.

Today Tashkent is a multifunctional city, which with its history and culture occupies a special place in our republic. The city is not only the center of the region, but also an important historical and tourist city in Central Asia. Although the tourist city is unique in its architecture and historical conditions of development, many years of anthropogenic activity have somewhat changed the ecological situation of the city. The high level of concentration of population, industry, transport, and construction led to a further increase in the load on the environment and changes in the microclimate.

A medical-geographical assessment of the morbidity status of the population of the city of Tashkent was carried out in the context of 12 family clinics of the city based on statistical data from the Tashkent City Medical Association, the Tashkent Regional Health Department and the State Statistics Committee of the Republic of Uzbekistan for the period from 2010 to 2022

Fig.2
Diseases of the circulatory system in Tashkent



The study analyzed all classes and types of diseases, as well as the general morbidity of the population. For example, if in 2014 the incidence rate per 1,000 people was 483.6 cases, then in 2018 it was 594.3 cases, and in 2021 it reached a maximum of 1184.3 cases. It is especially important to note that the incidence of diseases of the circulatory system in the population of the city of Tashkent has shown an alarming increase since 2014, when this figure was 7.6 cases per thousand population, to 51.5 cases per thousand population in 2021. Atmospheric pollution, noise , vibration, living conditions, electromagnetic fields, quality of drinking water, biogeochemical features of the area, pollution with pesticides and pesticides, as well as natural and climatic conditions negatively affect not only the state of the cardiovascular system, but also the respiratory system, malignant tumors, classes of infectious and parasitic diseases, as well as population mortality.

The city under study has developed heavy and light industries, which are not found in other regions of the republic. The main sources of air pollution in the city of Tashkent are industrial enterprises and vehicles, such as Euro Asia Lift JSC, the former Elevator Plant (built in 1967), Tashkimyo JSC (Tashkent Chemical Plant was commissioned in 1954 g.), the Tashkent-NPK plant (commissioned in 2016 on the basis of Samarqandkimyo JSC). Also, the Tashkent Porcelain Factory, the Tashkent Knitting Factory, now the Open Joint Stock Company "Bofanda", the Tashkent Wine Factory named after Khovrenko, the scientific and production association "ELXOLDING" (established in 1988) factory, etc.

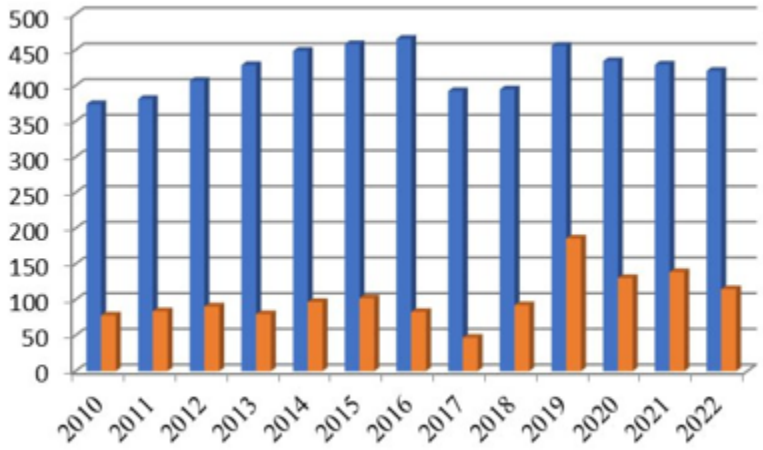
During the study, the environmental situation of the city was monitored, and analyzes related to atmospheric air, soil, water, noise levels, and the amount of waste were carried out. The main goal is to increase attention to ensuring sustainable urban development and a healthy environment, to study the impact of industrial, transport and other factors on the environment, and to study the relationship between the environment and public health. Analysis of the structure of atmospheric air, water resources and soil cover makes it possible to assess the impact of human activities on the unique natural environment of Tashkent.

We have established that respiratory diseases lead in the structure of general morbidity among the population in the city of Tashkent. The respiratory organs play a key role in protecting the body from the adverse effects of environmental factors, and therefore their condition is of great importance for the general health of the population. It should be emphasized that in the period from 2010 (when 78.1 cases were registered per thousand population) to 2021 (when 138.8 cases were registered per thousand population) there is an alarming growth trend in respiratory pathologies.

Thus, the number of affected citizens is growing from year to year. This indicates serious problems associated with air quality, climatic conditions, as well as changes in the lifestyle of the population.

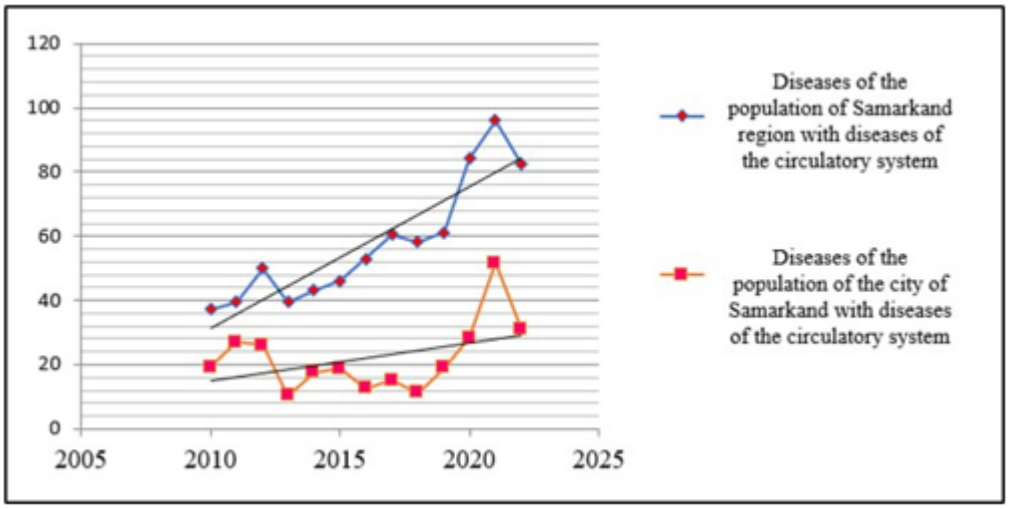
Table 1

The number of cases of respiratory diseases in the Tashkent region and the city of Tashkent (per 1,000 people).



It is extremely important to note that the incidence of diseases of the circulatory system in the population of the city of Tashkent shows an alarming increase since 2014, when this figure was 7.6 cases per thousand population, to 51.5 cases per thousand population in 2021 (Fig. 4). This is a serious problem for the region and public health.

Table 2
Number of people sick with diseases of the circulatory system in the Tashkent region and the city of Tashkent (per 1,000 people).



Atmospheric pollution, noise, vibration, living conditions, electromagnetic fields, quality of drinking water, biogeochemical features of the area, pollution with pesticides and pesticides, as well as natural and climatic conditions negatively affect the general condition of the cardiovascular system and increase the risk of developing such diseases. Diseases of the cardiovascular system represent an important medical and social problem for the modern healthcare system. These diseases rank first among all other diseases in terms of prevalence worldwide, and they are also the leading cause of human death. According to the World Health Organization (WHO), more than 16 million people die from cardiovascular diseases every year worldwide, accounting for an average of 31% of all deaths. The increase in risk factors in modern urban environments plays a key role in the increase in the incidence of cardiovascular diseases, since urban air pollution is directly related to the increased risk of this type of disease.

Noise, as an integral part of modern life in cities, has a variety of effects on the human body. Noise sources such as traffic, workplaces and others cause stress, fatigue, anxiety, hearing loss and other negative effects. Together with specialists from the department of sanitary-epidemiological welfare and public health of the Tashkent region, work was carried out using the GNNS system technology on Mirzo Ulugbek, Gagarin and Rudaki streets in Tashkent. Measurements were taken using a sound level meter and it was found that the noise level increases significantly during periods of heavy vehicle traffic.

The analysis shows that recently, especially in late autumn and early spring, due to small dispersed particles associated with climate change, as well as due to the activation of mold spores, strong allergic reactions have occurred among certain segments of the population. This situation is observed not only in Tashkent, but also in other cities. It is worth noting that the results of the expert survey are valuable material, especially in conditions of insufficient information and the presence of stationary environmental monitoring posts in Tashkent.

The sociological survey was conducted in November-December 2022 (from November 24 to December 3, 2022) in family clinics, the central hospital and its departments located in the city of Tashkent. A total of 315 respondents living in these administrative-territorial units, differing from each other in natural-ecological, microclimatic and medical-demographic conditions, took part in the survey.

The following locations were selected for the study: the city of Tashkent and three subordinate towns — Kimyogarlar (in the west of the city), Farhod (in the northeast of the city, adjacent to its main territory) and Sulim (in southwestern part of the city). Based on 15 questions, respondents' answers were obtained and summarized.

The study carried out an analysis to identify correlations between environmental factors and diseases of the population. In this case, a linear correlation coefficient was used. The linear correlation coefficient takes values from –1 to +1. Connections between characteristics can be weak and strong (close). Their criteria are assessed on the Chaddock scale: 0.1 < |rxy|< 0.3: weak; 0.3 < |rxy|< 0.5: moderate; 0.5 <|rxy|< 0.7: noticeable; 0.7 <|rxy|< 0.9: high; 0.9 <|rxy|< 1: very high (Table 3).

Initially, the following notation was introduced:

Y - Total amount of emissions, (thousand tons);
Y1- Emissions from mobile sources, (thousand tons);
X1 - Mortality (1000 people);
X2 - Respiratory diseases (1000 people);
X3 - Neoplasms (1000 people);
X4 - Diseases of the endocrine system, nutritional disorders and metabolic disorders (1000 people);
X5 - Diseases of the blood, hematopoietic organs and certain disorders involving the immune mechanism (1000 people);
X6 - Diseases of the circulatory system (1000 people);
X7 - General incidence (1000 people)

Table 3
Correlation matrix

	Y	Y_1	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y	1								
Y_1	0,742	1							
X_1	-0,388	-0,035	1						
X_2	-0,682	-0,397	0,072	1					
X_3	-0,246	-0,305	0,161	-0,263	1				
X_4	-0,605	-0,463	0,334	0,121	-0,008	1			
X_5	-0,739	-0,423	0,072	0,925	-0,053	0,127	1		
X_6	-0,674	-0,441	0,504	0,401	0,332	0,375	0,378	1	
X_7	-0,845	-0,551	0,397	0,742	0,129	0,377	0,729	0,845	1

Note: The table was compiled by the authors during the research

The table below shows general data on the correlation between the obtained factors (Table 4):

Table 4

Correlation between selected factors

№	Factors	Correlation coefficient	Significance	Confidence interval for *r*
1	Y and X_1	-0,388	not significant	(-1;0.351)
2	Y and X_2	-0,682	significant	(-1;-0.086)
3	Y and X_3	-0,246	not significant	(-1;0.395)
4	Y and X_4	-0,605	significant	(-1;-0.225)
5	Y and X_5	-0,739	significant	(-1;-0.11)
6	Y and X_6	-0,674	significant	(-1;-0.0147)
7	Y and X_7	-0,845	significant	(-1;-0.279)

Note The table was compiled by the authors during the research.

It is known that forecasting is an assessment or forecast of the future state of socio-economic phenomena and processes by analyzing their trends and relationships. One of the effective forecasting methods is the exponential smoothing method. The advantage of the exponential smoothing method is that when using the results of the last observation, some entities, that is, indicators, are omitted. This method is based on the idea of using exponentially weighted moving averages to analyze the latest values of a time series (Komilova and Latipov, 2022b).

The purpose of this study is to predict the environmental situation in the city of Tashkent, taking into account its impact on public health. We chose to use exponential smoothing to account for trends and recent values in the data, providing accurate and relevant forecasts for important environmental and public health decisions.

An important method for stochastic forecasts is the exponential smoothing method. This method consists in smoothing the dynamics series using a moving average, in which the weight obeys an exponential law. This average is called the exponential average and is denoted St. It is a characteristic of the last values of the dynamics series, which are assigned the greatest weight. The exponential average is calculated using the recurrent formula:

$$S_t = \alpha * Y_t + (1- \alpha)\, S_{t-1}$$

where St - is the value of the exponential average at time t; St-1 - the value of the exponential average at the moment (t = 1);

As for the initial parameter S0, in problems it is taken either equal to the value of the first level of the series y1, or equal to the arithmetic mean of the first few terms of the series.

Yt - is the value of the exponential process at time t; α - is the weight of the t-th value of the dynamics series (or smoothing parameter).

Consistent application of the formula makes it possible to calculate the exponential average through the values of all levels of a given dynamics series. The most important characteristic in this model is α, the value of which is used to practically make a forecast. The closer the value of this parameter is to 1, the more the forecast takes into account the influence of the last levels of the dynamics series.

If α is close to 0, then the weights by which the levels of the dynamics series are weighed decrease slowly, i.e. when making a forecast, all past levels of the series are taken into account.

In the specialized literature it is noted that usually in practice the value of α is in the range from 0.1 to 0.3. The value of 0.5 is almost never exceeded.

Exponential smoothing is applicable primarily for constant consumption (α = 0.1 - 0.3). At higher values (0.3 - 0.5), the method is suitable when the consumption structure changes, for example, taking into account seasonal fluctuations.

As S0 we take the arithmetic mean of the first 5 values of the series.

$$S0 = (42.81 + 42.382 + 42.959 + 42.81 + 42.074)/5 = 42.61$$

Table 5

t	y	S_t	Formula	$(y - S_t)^2$
2010	42,81	42.749	(1 - 0.3)*42.81 + 0.3*42.61	0.00371
2011	42,382	42.492	(1 - 0.3)*42.382 + 0.3*42.75	0.0121
2012	42,959	42.819	(1 - 0.3)*42.959 + 0.3*42.49	0.0196
2013	42,81	42.813	(1 - 0.3)*42.81 + 0.3*42.82	0.0000
2014	42,074	42.296	(1 - 0.3)*42.074 + 0.3*42.81	0.0491
2015	41,711	41.886	(1 - 0.3)*41.711 + 0.3*42.3	0.0308
2016	42,476	42.299	(1 - 0.3)*42.476 + 0.3*41.89	0.0313
2017	42,034	42.114	(1 - 0.3)*42.034 + 0.3*42.3	0.00633
2018	41,834	41.918	(1 - 0.3)*41.834 + 0.3*42.11	0.00703
2019	40,161	40.688	(1 - 0.3)*40.161 + 0.3*41.92	0.278
2020	38,773	39.348	(1 - 0.3)*38.773 + 0.3*40.69	0.33
2021	38,46	38.726	(1 - 0.3)*38.46 + 0.3*39.35	0.0709
2022	38,39	38.491	(1 - 0.3)*38.39 + 0.3*38.73	0.0102
				0.849

Forecasting data using exponential smoothing. Forecasting methods called smoothing account for the effects of outliers much better than methods using regression analysis. The basic equation is:

$$S(t+1) = S(t)(1 - \alpha) + \alpha Y(t)$$

S(t) – is the forecast made at time t; S(t+1) eflects the forecast in the time period immediately following time t

$$S\ (13+1) = 38.491(1 - 0.3) + 0.3 * 38.39 = 38.461$$

The standard error (error) is calculated using the formula:

$$e_t = \sqrt{\frac{\sum (y_i - S_{i-1})^2}{n-1}}$$

where i = (t - 2, t)

$$e_t = \sqrt{\frac{0.849}{13-1}} = 0.266$$

Forecasting data using linear trend. The linear trend equation is y = bt + a. We find the parameters of the equation using the least squares method. System of equations of least squares:

$$an + b\sum t = \sum y$$
$$a\sum t + b\sum t^2 = \sum yt$$

Table 6

t	y	t^2	y^2	ty
2010	42.81	4040100	1832.696	86048.1
2011	42.382	4044121	1796.234	85230.202
2012	42.959	4048144	1845.476	86433.508
2013	42.81	4052169	1832.696	86176.53
2014	42.074	4056196	1770.221	84737.036
2015	41.711	4060225	1739.808	84047.665
2016	42.476	4064256	1804.211	85631.616
2017	42.034	4068289	1766.857	84782.578
2018	41.834	4072324	1750.084	84421.012
2019	40.161	4076361	1612.906	81085.059
2020	38.773	4080400	1503.346	78321.46
2021	38.46	4084441	1479.172	77727.66
2022	38.39	4088484	1473.792	77624.58
26208	536.874	52835510	22207.497	1082267.006
Average	**41.298**	**4064270**	**1708.269**	**83251.308**

For our data, the system of equations has the form:
13a + 26208b = 536.87
26208a + 52835510b = 1082267.01
From the first equation we express a and substitute it into the second equation. We get:

$$a = 827.516,\ b = -0.39$$

Trend equation:

$$y=-0.39\cdot t+827.516$$

Let's determine the root mean square error of the predicted indicator.

$$Uy = yn+L \pm K$$

where,

where,

$$K = t_a \cdot Sy \cdot \sqrt{1 + \frac{1}{n} + \frac{3(n+2L-1)^2}{n(n^2-1)}}$$

L - lead period; yn+L - point forecast from the model at the (n + L)th point in time; *n* - number of observations in the time series; Sy - standard error of the predicted indicator; Ttable - table value of the Student's test for the significance level α and for the number of degrees of freedom equal to n-2. Using the Student's table we find Ttable

Ttable (n-m-1; α/2) = (7;0.05) = 2.593

Point forecast, t = 2023: y(2023) = -0.39*2023 + 827.516 = 38.57

$$K_1 = 2.593 \cdot 0.85 \sqrt{1 + \frac{1}{13} + \frac{3(13+2\cdot 1-1)^2}{13(13^2-1)}} = 2.56$$

38.57 - 2.56 = 36.01; 38.57 + 2.56 = 41.13

Interval forecast: t = 2023: (36.01;41.13)
Point forecast: t = 2024: y (2024) = -0.39*2024 + 827.516 = 38.18

$$K_2 = 2.593 \cdot 0.85 \sqrt{1 + \frac{1}{13} + \frac{3(13+2\cdot 2-1)^2}{13(13^2-1)}} = 2.64$$

38.18 - 2.64 = 35.54; 38.18 + 2.64 = 40.82

Interval forecast: t = 2024: (35.54;40.82)
Point forecast, t = 2025: y (2025) = -0.39*2025 + 827.516 = 37.79

$$K_3 = 2.593 \cdot 0.85 \sqrt{1 + \frac{1}{13} + \frac{3(13+2\cdot 3-1)^2}{13(13^2-1)}} = 2.73$$

37.79 - 2.73 = 35.06; 37.79 + 2.73 = 40.52

Interval forecast: t = 2025: (35.06;40.52)
Point forecast, t = 2026: y (2026) = -0.39*2026 + 827.516 = 37.4

$$K_4 = 2.593 \cdot 0.85 \sqrt{1 + \frac{1}{13} + \frac{3(13+2\cdot 4-1)^2}{13(13^2-1)}} = 2.82$$

37.4 - 2.82 = 34.58; 37.4 + 2.82 = 40.22

Interval forecast: t = 2026: (34.58;40.22)
Point forecast, t = 2027: y (2027) = -0.39*2027 + 827.516 = 37.01

$$K_5 = 2.593 \cdot 0.85\sqrt{1+\frac{1}{13}+\frac{3(13+2\cdot 5-1)^2}{13(13^2-1)}} = 2.92$$

37.01 - 2.92 = 34.09; 37.01 + 2.92 = 39.93

Interval forecast: t = 2027: (34.09;39.93)

Table 7
Forecast values

Years	Forecast	Linear trend	Interval forecast
2023	38.57	38.546	(36.01;41.13)
2024	38.18	38.156	(35.54;40.82)
2025	37.79	37.766	(35.06;40.52)
2026	37.4	37.376	(34.58;40.22)
2027	37.01	36.986	(34.09;39.93)

Note: The table was compiled by the authors during the research

During the study, an analysis of the time dependence of the variable Y on time t was carried out (Table 7). By specifying the model, a linear trend was selected and its parameters were estimated using the least squares method. The results showed that the model parameters are statistically significant, which confirms the adequacy of the selected functional form.

An economic interpretation of the model parameters is carried out, and their importance for understanding the dynamics of the Y variable over time is revealed. In this case, with each time period t the average value of Y decreases by 0.39 units of measurement. This allows us to draw conclusions about the deterioration trend of the Y variable during the study period. It has also been found that the resulting regression equation estimates can be used to predict the Y variable. The least squares method provides accurate parameter estimates, which improves the quality of forecasts and provides a basis for making informed decisions in the control of the Y variable.

These results provide the basis for further research and development of strategies to reduce the level of variable Y, which in turn can have a positive impact on the environmental situation and public health.

Conclusion

The results of the research conducted allow us to formulate the following main conclusions:

1. It is known that in scientific sources scientists have given many definitions to the concept of urban ecology. Based on the analysis and generalization of the content of these definitions, the author's definition was proposed in the research work. Urban ecology is a science that studies the interaction between the population, the city and the natural environment, combining socio-geographical and environmental studies aimed at studying the impact of urban infrastructure, transport, construction and other aspects of urban life on the environment, quality of life and human health;
2. From time immemorial, the city of Tashkent has been distinguished by its picturesque nature: favorable climate, highly fertile soils, water and raw material resources, diverse flora and fauna. The tourist city stands out in Central Asia for its architecture and historical monuments. However, many years of anthropogenic activity have somewhat changed the nature of the city. The high level of concentration of population, industry, transport, and construction has led to a further increase in the load on the environment. First of all, this was manifested in a decrease in the number of landscape and fruit trees available in the city, the development of existing garden areas, atmospheric air pollution with mechanical impurities, industrial gases, vehicles, as well as an increase in the intensity of noise and vibration. Therefore, the study of the environmental situation of the city of Tashkent is extremely important, since it has a great impact on the quality and level of living of the population, their health, life expectancy and comfortable conditions;
3. The most important aspect affecting the environmental situation of the city of Tashkent is man-made air pollution, which includes emissions from industrial enterprises, vehicles and other sources that negatively affect the environment. These pollutants cause serious problems such as allergic diseases (especially allergic rhinitis, dermatitis), increased susceptibility to malignant tumors due to an increase in the amount of carcinogens, mutagenic (causing genetic changes), teratogenic (changes associated with pregnancy, premature birth). It should be noted that the main factor of environmental pollution in the city is road transport, and in 2022, a total of 38,392 thousand tons of harmful substances were emitted from all stationary (18,117 thousand tons) and mobile sources (20,282 thousand tons) into the atmosphere of Tashkent. According to statistics, despite relative stability, in the last few years (2019-2022) there has been a decrease in emissions, but indicators related to public health remain high;
4. The waste problem in Tashkent is complex and multifaceted, the main aspects of which include the volume and growth of waste, infrastructure problems, environmental threats, ineffective recycling, and the need for innovation. According to statistical data for 2022, in Tashkent, non-recyclable toxic waste amounted to 16,992 tons, and recyclable toxic waste amounted to 146,354 tons. Solving the problem of waste disposal requires an integrated approach, including modernization of infrastructure, introduction of new technologies, active participation of the population (increasing public awareness of the rules of separate waste collection) and government support to create a more sustainable and clean urban environment;

5. Analysis of urban-ecological and medical-geographical situations showed the presence of certain diseases in the population of the city of Tashkent, such as circulatory diseases, respiratory diseases, blood and hematopoietic organs, endocrine system, nutritional disorders, metabolic disorders. The study found that among the existing classes of diseases among the urban population, the incidence of acute respiratory (airborne), digestive and metabolic disorders increased sharply over the next ten years. In particular, cases associated with the respiratory system, considered the most sensitive to negative environmental changes, showed a significant upward trend between 2010 (78.1 cases per thousand population) and 2021 (138.8 cases per thousand population). In 2021, the absolute incidence rate of this class of diseases in the city of Tashkent was 120,171 people, of which 8,191 were allergic rhinitis (pollinosis), 804 were bronchial asthma. This condition indicates problems with air quality, climate, as well as ongoing changes in the quality of life of the population;
6. In order to study the environmental situation of the city of Tashkent, as well as the socio-geographical problems of the population, expert and sociological surveys were conducted. As experts, the opinions of specialists were taken into account, such as Doctor of Medical Sciences, Professor Kobilov E.E., Ph.D. Professor Akhmedov Yu.M., Ph.D. Shadieva Kh.N., Ph.D., Associate Professor Rabbimova D.T., Associate Professor Dalilov A.Kh., Ph.D. Turdieva N.S. The analysis shows that recently, especially in late autumn and early spring, due to small dispersed particles associated with climate change, as well as due to the activation of mold spores, strong allergic reactions have occurred among certain segments of the population.
7. During the study of the environmental situation of the city of Tashkent in order to determine the relationships associated with the morbidity of the population, a correlation was identified between the number and main classes of diseases of the population and harmful substances emitted into the atmosphere. This correlation was 0.879 on the Chaddock scale. It was also found that the city has somewhat high rates of circulatory, respiratory and allergic diseases. According to the results of a medium-term forecast calculated until 2027, an increase in the incidence of cardiovascular, respiratory and endocrine diseases was noted among residents of the city of Tashkent;
8. In order to improve the environmental situation of the city of Tashkent and the health of the population, it is recommended to gradually introduce a transition to a low-emission public transport system, strict control over emissions from industrial enterprises by introducing modern technologies and equipment to reduce emissions of harmful substances, conducting regular monitoring, strengthening the system of collecting fines for violation of standards emissions, expansion of observation stations for operational monitoring of air quality, expansion of parks and green areas in the city, attraction of investments in alternative energy sources such as solar and wind energy, as well as conducting courses and lectures on ecology in schools and universities, educating the population. It is advisable to organize activities to improve environmental culture.

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Conflict of interest

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

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