

Ключевые слова: атмосферные осадки, стабильные изотопы, изотопная гидрология, локальная линия меторных вод, дейтерий, δ^2H , кислород-18, $\delta^{18}O$, Ташкент.

STABLE ISOTOPES IN ATMOSPHERIC PRECIPITATION OF TASHKENT CITY

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Abstract. The article presents the findings of a study of the of deuterium (2H) and oxygen- 18 (^{18}O) stable isotopes in atmospheric precipitation collected during 2022-2023 at the meteorological station Tashkent-Observatory in Tashkent city. It was revealed that during the study period the values of δ^2H in precipitation were within the range of $+16.41\div-122.73\%$, and the values $\delta^{18}O$ were between $+1.95\div-16.34\%$, the maximum values were observed in April 2022, the minimum values - in January 2022. A local meteoric water line (LMWL) for Tashkent was established as $\delta^2H = 7.33 \cdot \delta^{18}O + 5.27\%$, reflecting regional precipitation characteristics. The Tashkent-Observatory meteorological station is part of the Global Network of Isotopes in Precipitation (GNIP), a collaborative effort between the International Atomic Energy Agency and the World Meteorological Organization. These results provide valuable insights for understanding atmospheric circulation, water resources formation, and role of stable isotopes in hydrological processes.

Keywords: precipitation, stable isotopes, isotope hydrology, local meteoric water line, deuterium, δ^2H , oxygen-18, $\delta^{18}O$, Tashkent city.

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УДК: 502.3

CURRENT ISSUES IN AIR PROTECTION AND GREENING OF TERRITORIES FOR CLIMATE CHANGE MITIGATION IN UZBEKISTAN

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Abstract. The article discusses critical issues related to air quality protection and the greening of territories in the context of mitigating climate change in Uzbekistan. The paper highlights the increasing impact of climate change on key sectors, including public health, biodiversity, and economic development. It addresses both natural and anthropogenic contributors to air pollution, including

emissions from vehicles and industrial enterprises. The article reviews national initiatives such as the transition to a green economy, renewable energy development, and tree planting programs aimed at climate adaptation and mitigation. The importance of international cooperation, policy reforms, and economic mechanisms to reduce greenhouse gas emissions is emphasized. Furthermore, the article outlines challenges in air quality monitoring, the inefficiency of dust and gas purification systems, and the need for localized production of environmental technologies. The study also covers Uzbekistan's strategic goals of reducing greenhouse gas emissions by 2030, alongside efforts to expand green spaces and address illegal deforestation.

Keywords: *air quality protection, greening, climate change mitigation, Uzbekistan, greenhouse gas emissions, sustainable development, renewable energy, climate adaptation, international cooperation, environmental policy, industrial emissions, green economy.*

Introduction. As is well known, climate change negatively impacts all key aspects of sustainable development, posing a direct threat to public health, wildlife, flora, and the economic development of a country. In recent years, the adverse effects of climate change have intensified. In the Central Asian region, including Uzbekistan, the consequences of climate change are becoming increasingly evident.

The global climate change effects manifest through changes in the length of seasons, drastic shifts in precipitation patterns and landscape structures, worsening conditions for several sectors of the economy due to water shortages (for instance, in agriculture), increased water consumption and evaporation (including through higher plant transpiration) due to rising temperatures, and ecological migration driven by the unsuitability of certain areas for human habitation [Alikhanov et al., 2024; Alikhanov et al., 2021; Uzbekov et al., 2021]

In our republic, the intensity of climate change is observed to be twice the global average, with the number of hot days doubling, the area of glaciers shrinking by 32% [Petrov et al., 2017], dust and sandstorms becoming more frequent, atmospheric pollution increasing, biodiversity declining, and other factors worsening [Alikhanov et al., 2024].

In this context, under the framework of consistently and progressively implemented reforms, Uzbekistan has prioritized the transition to a "green economy," addressing climate change, mitigating its negative effects, protecting the atmosphere, and expanding green areas.

The President of the Republic of Uzbekistan, Shavkat Mirziyoyev, during prestigious international forums and from the high rostrum of the United Nations, has called on the global community with initiatives to prevent climate change and combat its adverse impacts, urging for joint and coordinated efforts [Mirziyoyev, 2024].

In particular, at the UN International Climate Change Conference (COP 28) held in the UAE, the proposals highlighted the importance of global climate adaptation, a fair transition to a low-carbon economy, and innovative approaches to environmental challenges, including the use of scientific advancements. The role of international cooperation in climate initiatives was emphasized, including the organization of conferences and the establishment of specialized centers and programs.

First, the country supports the swift agreement on the Global Framework for Climate Adaptation under the Paris Agreement and is developing an Adaptation Strategy within the platform of the Central Asian Climate Dialogue, highly appreciating the establishment of the "Loss and Damage" Fund.

Second, Uzbekistan advocates for a fair, transparent, and inclusive global transition to a low-carbon economy, considering the interests of developing countries, and suggests addressing this issue within the formats of the G7 and G20.

Third, the country aims to transform the Aral Sea region from an ecological crisis zone into an innovation zone and invites collaboration for the creation of an International Expo Hub for Climate Technologies.

Fourth, Uzbekistan calls for the wide application of scientific achievements in the fight against climate change and plans to organize a Climate Science Forum in Tashkent.

Fifth, the country plans to hold a conference on climate migration in 2024 in cooperation with the UN, proposes developing a "Green Employment" program with the International Labour Organization, establishing a Modeling Center, and organizing a Youth COP Conference.

Special attention was given to the First Samarkand International Forum, scheduled for March 2024 in Samarkand, themed "Central Asia in the Face of Global Climate Threats: Solidarity for Common Prosperity."

It is noteworthy that Uzbekistan organized a National Pavilion at this event for the first time, showcasing reforms, promising "green" projects, and legislative changes being implemented in the republic. This is particularly relevant in the context of global challenges, as climate change has a negative impact on the world economy.

According to the United Nations, over 40% of the global population is becoming increasingly vulnerable to climate changes. The World Bank forecasts that by 2050, nearly 216 million people could become "climate refugees" due to climate change. As a result of climate change and its consequences, the global economy could suffer losses of \$8 trillion in the next 30 years. By 2050, this could lead to a 3% reduction in global GDP (and an 11% reduction in Central Asia's GDP) [Pörtner et al., 2024].

Central Asia is particularly sensitive to the effects of climate change, and over the past 30 years, the temperature in the region has risen by 1.7 degrees, which is twice the global average.

Countries in the region have signed more than 25 UN environmental conventions and, by joining the Paris Agreement, have committed to reducing greenhouse gas emissions by 2030 (Uzbekistan by 35%, Kazakhstan by 15%, Kyrgyzstan by 14%, and Tajikistan by 10-20%).

In our country, climate change issues have been integrated into sectoral development strategies, as well as the National Sustainable Development Goals and Targets. Within the framework of the Paris Agreement (Paris, December 12, 2015), Uzbekistan took on additional obligations to reduce greenhouse gas emissions by 35% by 2030 compared to 2010 levels per unit of gross domestic product [Presidential Decree No. 436, 2024].

By 2030, the creation of 27 gigawatts of renewable energy capacity is planned, with the goal of increasing the share of renewable energy in the country's energy system to 40%. Practical steps have been taken towards the production of "green" hydrogen.

In addition, under the "Green Space" program, the planting of 1 billion trees is planned by 2026. Forests have already been established over an area of approximately 1.8 million hectares on the dried-up bed of the Aral Sea. Currently, "green belts" are being created around industrial enterprises of high and medium environmental risk [Presidential Decree No. 171, 2023; Presidential Order No. 199, 2023].

It is important to note that in recent years, the republic has maintained a relatively high level of atmospheric pollution emissions from stationary sources and vehicles (see Diagram 1).

The total volume of all atmospheric emissions in 2020 amounted to 2,255.0 thousand tons (including 1,330.7 thousand tons from vehicles and 924.4 thousand tons from industrial enterprises). In 2021, the total was 2,179.3 thousand tons (1,270.3 thousand tons from vehicles and 909.0 thousand tons from industrial enterprises), and in 2022, it was 2,170.9 thousand tons (1,296.9 thousand tons from vehicles and 874.0 thousand tons from industrial enterprises) (see Diagrams 2 and 3).

Of course, there are objective reasons for maintaining such high emission levels. These are related to the rapid growth of the national economy, the increase in the number of vehicles, and the fact that in recent years, our country has become a large construction site.

Indeed, most of the harmful emissions polluting the air are attributed to vehicles. In the city of Tashkent and the Tashkent region, the share of emissions from vehicles remains high. The

largest amount of harmful emissions from industrial enterprises is concentrated in the Tashkent region (438.0 thousand tons in 2022) and the Kashkadarya region (116.0 thousand tons in 2022). For 2023, the total emissions were 2,138.3 tons (1,279.9 thousand tons from vehicles and 858.4 thousand tons from industrial enterprises).

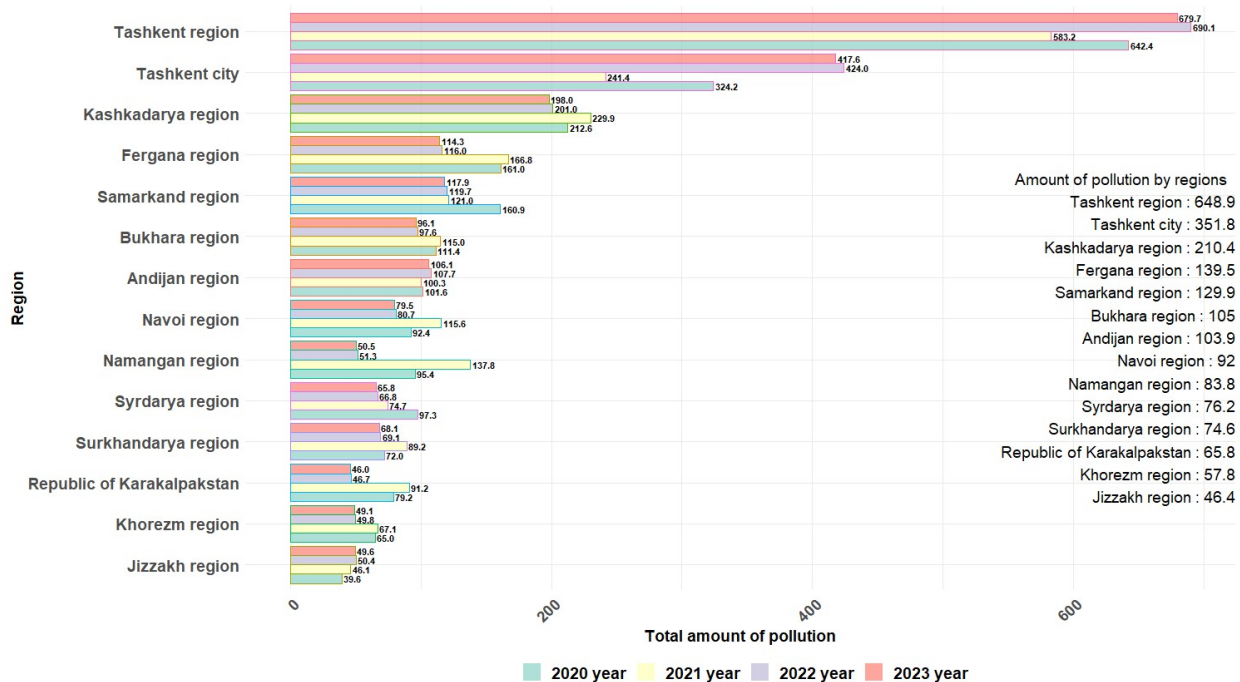


Fig. 1. Dynamics of the total amount of pollutant emissions into the atmosphere (thousand tons)

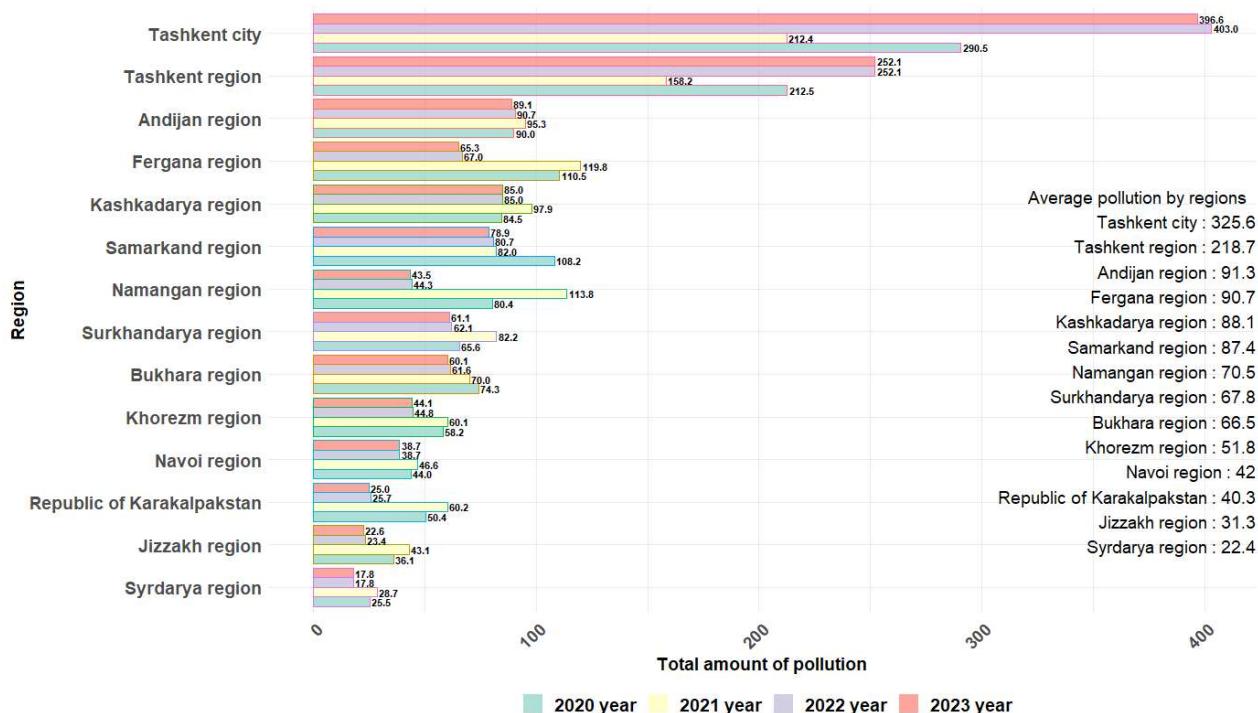


Fig. 2. Dynamics of emissions of pollutants from vehicles into the atmosphere from 2020 to 2023 (thousand tons)

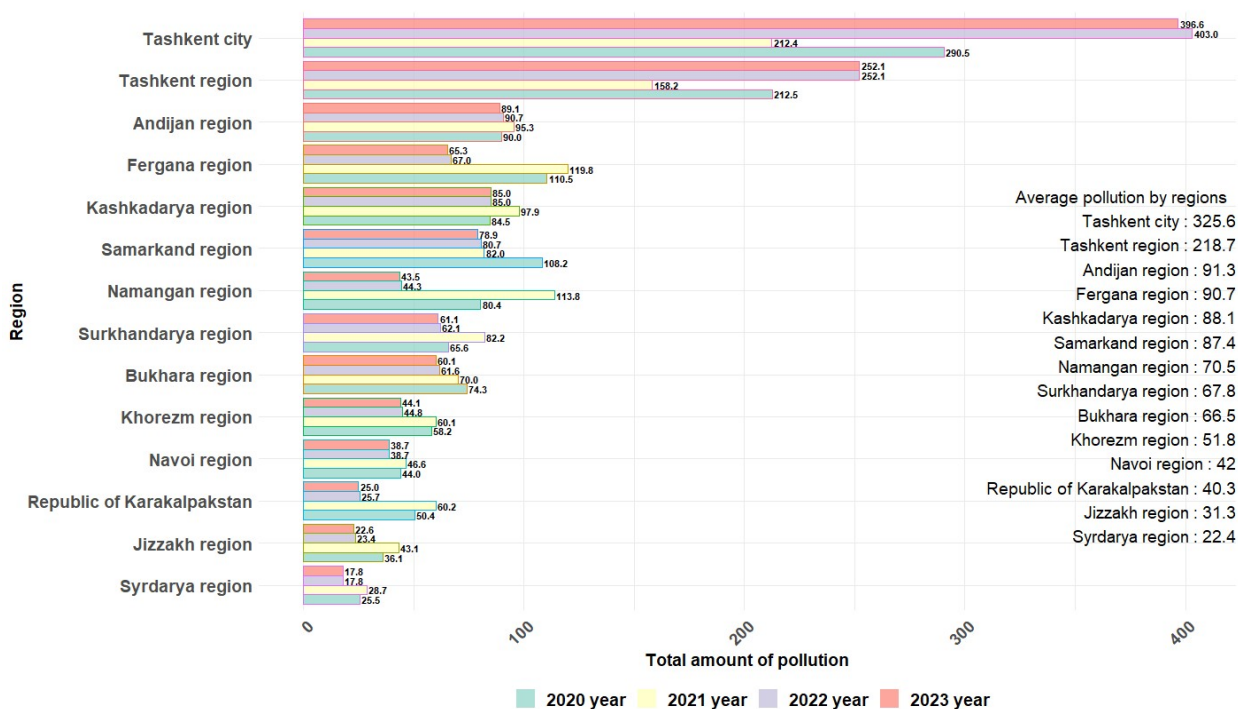


Fig. 3. Dynamics of pollutant emissions from stationary sources into the atmosphere from 2020 to 2023 (thousand tons)

Air pollution in the republic is caused by both natural (dry climate, saline and sandy soils) and anthropogenic (transport, industrial, and construction emissions) factors. In large urban agglomerations, a combination of factors, including the lack of precipitation and wind, temperature inversions, contributes to the natural increase in air pollution levels. Poor air circulation, low-quality fuel, congested roads, active construction, and a lack of green spaces further exacerbate the situation. These aspects, along with meteorological conditions and human activities, result in significant atmospheric pollution in cities.

It should be noted that since January 1, 2022, the import of vehicles that do not meet the Euro-4 environmental standards with gasoline and diesel engines has been banned. To reduce the negative environmental impact of vehicles, customs duties and other mandatory payments for importing electric vehicles into the country have been abolished. The number of electric vehicles has increased sharply, and today there are more than 31,000 electric vehicles in the republic.

In the past two years, 3,148.2 km of railway lines have been electrified, replacing diesel locomotives with electric ones. It is noteworthy that considering the fuel consumption of diesel locomotives of the 2TE10M/2TE10V type, which ranges from 450 to 900 liters per hour, each train prevents the burning of up to 7.8 million liters of fuel annually, which in turn prevents the emission of thousands of tons of various pollutants into the atmosphere.

To ensure high-quality environmental monitoring, by the end of 2024, first-category economic entities, and by the end of 2025, second-category entities that affect the environment are required to install automatic monitoring stations to analyze emissions from priority stationary (organized) pollution sources and to equip their sanitary protection zones with stationary automatic observation posts.

In 2023, the Ministry of Ecology, Environmental Protection, and Climate Change conducted an inventory of economic entities classified as Category I and II, sending warning letters to 2,000 enterprises regarding the need to install automatic monitoring stations.

The number of analytes (pollutants) measured by analytical laboratories increased from 30 in 2020 to 33 in 2021, 38 in 2022, and 41 in 2023 (see Diagram 4). Of course, this is insufficient, given that hundreds of pollutants are emitted into the atmosphere.

Air quality in cities is influenced by the complex interaction of natural and anthropogenic factors. Currently, Uzhydromet monitors background atmospheric pollution in 26 cities, including Almalyk, Angren, Andijan, Bekabad, Bukhara, Kagan, Gulistan, Kokand, Mubarek, Navoi, Namangan, Nukus, Samarkand, Sariosiyo, Tashkent, Ferghana, Chirchik, Denau, Termez, Urgench, Karshi, Nurafshan, Margilan, Kitob, and Shakhrisabz, where 74 stationary monitoring posts are located, including 16 automatic stations.

At stationary monitoring posts, samples are taken three times a day (at 7:00, 13:00, and 19:00), and online monitoring is conducted at automatic stations. In Tashkent, 13 air pollution monitoring posts are in operation. In 2022, two automated atmospheric air pollution monitoring stations were installed in Tashkent, and in 2023-2024, in cooperation with the International Public Foundation "Zamin," modern automated air pollution monitoring stations by Horiba were installed in Nukus, Urgench, Navoi, Samarkand, Bukhara, Karshi, Termez, Jizzakh, Gulistan, Andijan, Namangan, Ferghana, Nurafshan and Tashkent increasing their total number to 16.

Monitoring and control of major pollutants such as sulfur dioxide, carbon monoxide, nitrogen oxides and dioxides, as well as particulate matter (dust), are carried out across the republic. Depending on the specific characteristics of the emission sources, concentrations of formaldehyde, ammonia, phenol, hydrogen fluoride, and heavy metals such as copper, lead, zinc, and cadmium are also measured. Since 2011 in Tashkent and Nukus monitoring of fine particles PM10 and PM2.5 has been conducted.

Since 2021 in Tashkent, since 2023 in Gulistan, Jizzakh, Samarkand, Termez, Nukus and Urgench, Since 2024 Navoi, Bukhara, Karshi, Andijan, Namangan, Ferghana and Nurafshan monitoring of fine particles PM10 and PM2.5 has been conducted by using automated atmospheric air pollution monitoring stations.

In 2021, 12,941 violations were identified, and fines amounted to 3,228 million soums. In 2022, 14,084 violations were recorded, with fines totaling 3,000 million soums.

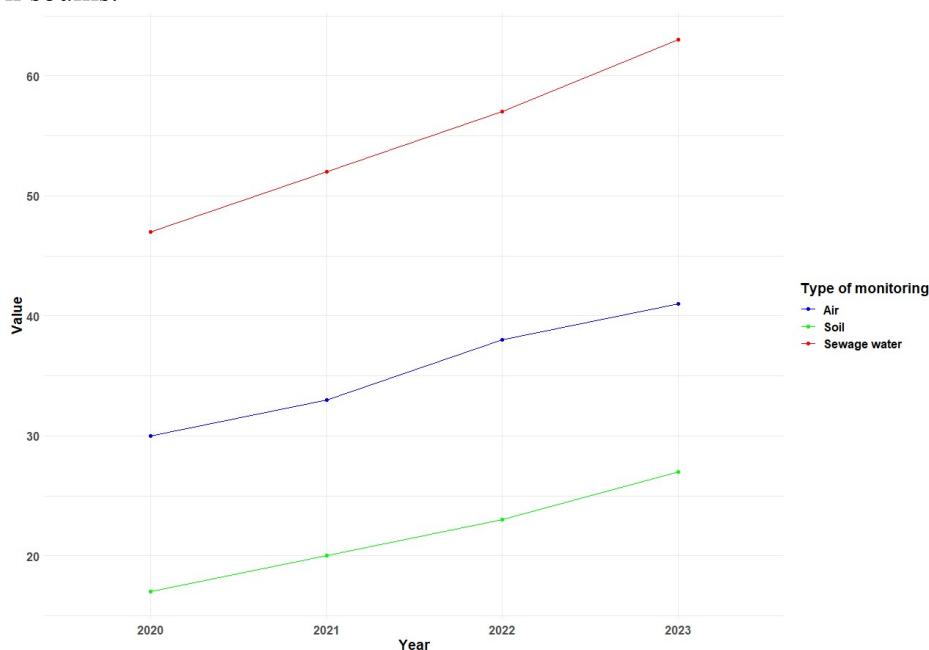


Fig. 4. Indicators of the amount of ingredients covered in accordance with the monitoring program for atmospheric air, wastewater and soil

The number of violations in 2022 decreased by 3,255 or 16% compared to the previous year, while the total amount of fines increased by 164 million soums or 22% (see Diagram 5).

Analysis of the data obtained from the air quality monitoring network indicates low levels of air pollution in some monitored cities across the republic. However, over the past three years, the cities of Angren, Andijan, Samarkand, Navoi, Urgench, Nukus, and Tashkent have shown an increase in the average monthly levels of dust. Navoi and Tashkent have experienced rising levels of nitrogen dioxide, while Namangan has seen an increase in carbon monoxide levels.

In densely built-up areas and megacities with developed road networks, the primary sources of air pollution are transportation, energy, and the construction industry.

As of today, methodologies are being developed for determining additional components in laboratory analyses of atmospheric air, water resources, wastewater, and soil.

In atmospheric air: sulfur dioxide, ammonia, gasoline, kerosene, carbon monoxide, gaseous fumes, dust, nitrogen oxide, nitrogen dioxide, formaldehyde, fluorides, hydrocarbons, vanadium-5, hydrogen chloride, arsenic, lead, acetic acid, copper, hydrogen sulfide, iron.

In water and wastewater: hardness, sulfates, calcium, ammonium, copper, dry residue, chlorides, nitrites, nitrates, pH, iron, chemical oxygen demand (COD), biological oxygen demand (BOD), oils, petroleum products, suspended solids, chromium (+6), chromium (+3), fluorides, temperature, oxygen, manganese, zinc, phosphates, turbidity.

In soil: copper, humus, chlorides, petroleum products, magnesium chlorate (defoliant), sulfates, calcium, magnesium, chromium, zinc, chlorides, nitrates, phosphorus, manganese, cadmium.

In the area of air protection, approximately 9,000 violations of pollution level exceedances were identified in the first 10 months of 2023, with fines totaling 2,764 million soums.

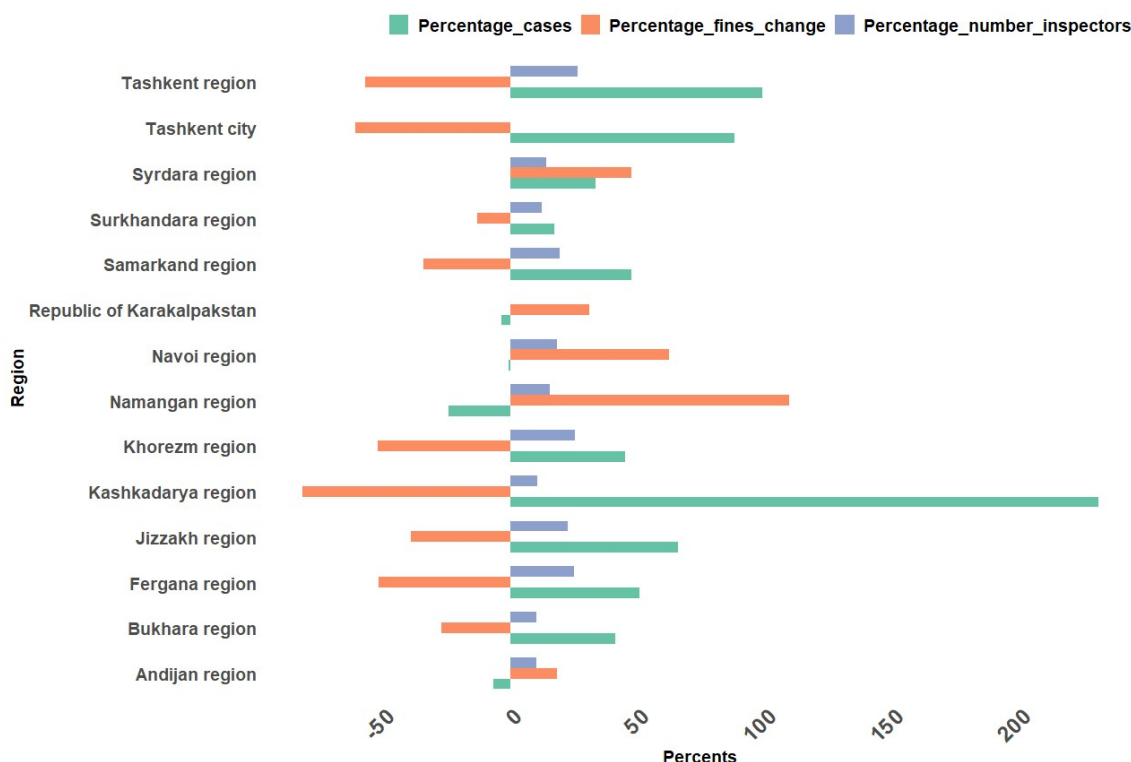


Fig. 5. Changes in violation rates, number of inspectors and fine amounts for 2022-2023

Environmental air quality control has decreased in several districts and cities in Uzbekistan. For example, compared to the previous year, air quality control efforts in Ulugnor District and the city of Andijan have dropped by 19-48%. In Andijan District and the city of Andijan, each inspector handled an average of only eight administrative cases related to air quality, whereas the regional average in the Andijan region was 13 cases.

Currently, the majority of vehicles in use rely on AI-80 gasoline, and there is an increasing number of passenger and freight vehicles entering Tashkent (160,000-300,000 per day). As a result, the volume of pollutant emissions from vehicles in Tashkent was 212.4 thousand tons in 2021 and 403 thousand tons in 2022, marking an increase of 190.6 thousand tons (47.3%). Forecasts for 2023 predicted that emissions from transport will reach 396.6 thousand tons.

Additionally, uncoordinated freight transport in Tashkent, especially amid traffic congestion, exacerbates the problem. The city registers around 50,000 freight vehicles, and about 7,000 freight vehicles from other regions enter Tashkent daily.

The "Toshshakhartransxizmat" bus fleet currently operates 2,017 vehicles, of which around 700 (33%) run on diesel, over 1,000 (50%) on natural gas, and more than 300 (17%) are electric. In 2024, the fleet is set to be upgraded with 200 electric buses. From 2024 to 2030, an additional 1,200 electric buses are planned to be purchased, with a transition of buses to natural gas.

There are 4.4 million vehicles owned by individuals in the republic, 24% of which run on gasoline, 2% on diesel, and 74% on gas.

As part of the national "Green Space" project, aimed at preventing climate change and capturing dust particles, "green belts" are being established around industrial enterprises with high environmental impact. In the fall of 2023, 189 industrial enterprises organized the planting of 1.8 million trees. Specifically, in Tashkent, over 60,000 trees were planted in and around 18 large industrial enterprises during the autumn of this year.

According to estimates, by 2024, the planted trees will grow to an average height of 5 meters within five years. Taking this into account, starting from 2029, the trees planted over 243,000 hectares, totaling more than 200 million trees (of which 170 million have a high survival rate), will absorb 60,750 tons of carbon dioxide annually. From 2024 to 2030, these trees are expected to absorb an average of 425,250 tons of CO₂ per year.

In Navoi region, in the fall of 2023, 15 large industrial enterprises planted over 214.9 thousand trees. In Tashkent, in 2022-2023, 14 operating industrial enterprises installed dust and gas purification equipment with an efficiency of at least 95.0%, while 10 new industrial enterprises installed equipment with an efficiency of at least 99.5%.

In 2022, the "Network Schedule" was adopted in the Republic, outlining the installation of automatic stations and stationary observation points at industrial enterprises with a high environmental risk, funded by the enterprises themselves.

At 44 industrial enterprises with high air pollution risk, 69 automatic stations were installed for sampling and analysis, along with 27 stationary observation points in adjacent areas, all funded by the enterprises. Specifically, at the Almalyk Mining and Metallurgical Combine, one "Siemens" automatic station from Germany was installed and integrated into the "Unified Geoinformation Database"

This year, the Ministry of Internal Affairs, in collaboration with the Ministry of Ecology, Environmental Protection and Climate Change conducted a two-phase "Clean Air" campaign lasting a month. According to estimates, by the beginning of the year, 4.187 million vehicles were registered in the Republic. During the campaign, 320,000 vehicles (8% of the total) underwent environmental inspections, and 8,652 vehicles (2.75%) were found to exceed the permissible levels of pollutants in exhaust gases. As a result, by temporarily halting the

movement of 2,914 vehicles that exceeded national standards for pollutants, 210,000 tons of pollutants were prevented from entering the atmosphere.

As part of the "Green Space" national project, 90.4 million saplings have been planted and confirmed on the electronic platform "yashilmakon.eco" (106% of the plan). In various regions, 893 artesian wells were drilled, and 1,058.7 km of irrigation systems were laid. In regions lacking water sources for irrigation, 610 specialized machines were deployed to water the saplings.

Using stereophotography methods from aerial imagery, a digital tree map was created in the Syrdarya region, covering 12.2 million trees.

Additionally, the "Green Space" electronic platform has been improved with the introduction of a tree registry system. Using specialized tablets, inspectors input information about tree types, locations, conditions, and photographs.

An algorithmic model has been developed to account for trees using satellite imagery and artificial intelligence. This model has enabled the commencement of a nationwide inventory of trees, determining their locations and quantities, and the creation of a digital map.

In Tashkent, as part of a pilot project, work has begun on procuring devices for the passportization of trees, with their digitalization. The results of tree passportization will be displayed on the "Green Space" electronic platform. The tree registry system, created on the "Green Space" platform, is used by state inspectors in all regions of the Republic for the regular accounting of trees.

During the tree inventory process, including abandoned ones, trees are assigned to responsible parties based on official records. These responsible parties receive electronic copies of the documents regarding their assigned trees through the tree registry on the "Yashil Makon" electronic platform.

To ensure price stability for saplings, 721 fairs and sales points were organized in each district and city, involving businesses engaged in sapling planting.

From the fund of 91 forestry enterprises, the Forestry Agency selected land plots totaling 1.3 thousand hectares for nursery establishment. Nurseries with drought-tolerant plants suitable for the region's climate were created on 650 hectares.

Of the 1,225 tons of collected seeds, 541 tons were used for reforestation activities, while the remaining 684 tons were sown. Additionally, 12.221 million cuttings of trees and shrubs prone to vegetative propagation were prepared. Last year, 32 million young saplings were transferred to nurseries.

During the growing season, nurseries conducted agro-technical measures such as irrigation, fertilization with mineral and local fertilizers, weed control, and other activities.

As a result, saplings and seedlings of 30 species of fast-growing and deciduous trees, 15 species of fruit trees, 8 species of conifers, 4 species of nut-bearing trees, 6 species of desert plants, and 13 species of ornamental shrubs were successfully cultivated.

The Forestry Agency expanded the nursery area to 1.3 thousand hectares across 91 forestry enterprises, growing over 120 million saplings.

As part of the national "Green Space" project, in the fall of 2023, the Forestry Agency delivered 135,493 thousand decorative and fruit saplings free of charge to the Republic of Karakalpakstan, districts and cities in various regions, mahallas, and preschools.

Despite the ongoing activities, certain challenges and shortcomings remain in the area of air quality protection. In particular, due to insufficiently effective measures to reduce emissions, the amount of pollutants released has reached nearly 2.2 million tons. Of the more than 6,000 existing dust and gas purification systems at enterprises, 60% have an average efficiency of only 86.5%.

The work to equip air quality monitoring stations with automatic measuring devices that provide real-time information has not been completed. In many major industrial cities, automatic

measuring instruments for fine particulate matter (PM₁₀ – PM_{2.5}) have not been installed. There is also an insufficient number of permanent air quality monitoring stations, as well as limited analytical determination of pollutants from stationary sources.

During the “Clean Air” campaigns, only 8.8% of vehicles underwent inspections.

Furthermore, there have been some shortcomings in the implementation of the "Green Space" project. During the spring season, out of the 127.7 million saplings planted, about 1.8 million were not assigned to responsible persons for maintenance and care. In regions without irrigation systems, permission was granted to plant 7.3 million saplings.

To address these shortcomings, environmental authorities issued 10,860 mandatory instructions to those responsible for the watering and care of 10.238 million planted saplings. For failing to comply with these instructions, 484 violators were fined a total of 1.085 billion soums in administrative penalties.

In Tashkent, 10,448 trees were registered at 331 construction sites during the period. Mandatory instructions were given to construction organizations to ensure their preservation, and guarantee letters were obtained.

As part of current tasks, it is essential, in line with international agreements and commitments, to reduce greenhouse gas emissions by 35% and methane emissions by 30% per unit of gross domestic product by 2030. It is also important to reduce air pollution levels to acceptable standards across all regions of the Republic.

There is a need to revise the existing legal and regulatory documents in the environmental field, taking climate change issues into account. Special attention should be given to attracting grants and investment projects from "Green Growth," "Green Climate," the "Global Environment Facility," and other international financial institutions.

It is necessary to complete the installation of automatic measuring devices at air pollution monitoring stations to enable real-time data collection.

In the industrial, energy, oil and gas, construction, and other sectors, there is a lack of equipment for capturing gaseous pollutants. A system for the automatic sampling of pollutants from these sources needs to be implemented.

The placement of stationary monitoring posts in major cities, industrial zones, and construction areas should be reconsidered. In general, it is necessary to reassess enterprises categorized as I and II in terms of environmental hazards.

Around 60% of total atmospheric emissions and 85-90% of emissions in large cities come from vehicles. It is crucial to expand the scope of the “Clean Air” campaigns by introducing new mechanisms, improve traffic management systems, and focus on increasing the number of environmentally friendly vehicles.

Over the past 10 years, the amount of pollutants emitted into the atmosphere by industrial enterprises in the Republic has increased by 11% and now averages 900 thousand tons per year. Approximately 60% of the more than 6,000 dust and gas purification systems in operation at enterprises have been in use for more than 10 years, and their cleaning efficiency is low (86.5%). This is due to the absence of production of such systems in our country and the high cost of their import. Therefore, it is necessary to take measures to localize the production of air purification systems and their components within our country.

According to standards, the ash content in coal should be below 34% for lignite and 29% for bituminous coal. Currently, the ash content of coal from the Angren field used in cement production is 50-60%. Therefore, higher quality coal must be used in cement production.

As a result of the operation of the Republic's thermal power plants, about 18 million tons of ash and slag have accumulated at landfill sites covering a total area of 246.0 hectares. Based on this, the Novoangren TPP should implement a dry dust disposal method and use the removed ash as a partial substitute for clinker in cement grinding [S. Li et al., 2017].

According to international experience, such waste is widely used in construction, road building, agriculture, and the production of various fillers and additives.

It is necessary to apply economic mechanisms to the main sources of pollutant emissions and reflect this in relevant laws and regulations [D. Austin, 1999].

In the future, the coverage of the "Clean Air" campaigns should be expanded based on new mechanisms, the traffic management system should be improved, and special attention should be paid to increasing the number of environmentally friendly vehicles.

In the regions, it is essential to complete activities for the creation of "green parks of the hokimiyats" and to allocate land for tree planting, organized by the mahalla administrations.

In the implementation of the "Green Space" project, it is important to consider the geographical location of the regions, climatic factors, the availability of irrigation systems, the assignment of responsible parties for planted trees, and the agro-technical care of the trees.

It is advisable to accelerate the expansion of green zones along urban and highway roads and the creation of "green belts" around large cities and industrial enterprises.

Illegal tree cutting, which significantly contributes to the deterioration of the environmental situation, must be completely stopped.

There is a need to establish a system of training and retraining specialists in all sectors and fields, taking into account environmental factors.

Undoubtedly, the implementation of these tasks, ensuring environmental sustainability in our country, mitigating the negative effects of climate change, adapting to climate change, and fulfilling international obligations on these issues will require the development of a long-term and medium-term strategic document on climate change for the Republic of Uzbekistan until 2030. This will be of great importance in showcasing our country's example to the international community.

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**АКТУАЛЬНЫЕ ВОПРОСЫ ОХРАНЫ АТМОСФЕРНОГО ВОЗДУХА И
ОЗЕЛЕНЕНИЯ ТЕРРИТОРИЙ В ЦЕЛЯХ СМЯГЧЕНИЯ ИЗМЕНЕНИЯ КЛИМАТА****Б. АЛИХАНОВ¹, Ж. КАЗБЕКОВ², Б. ХОЛХОДЖАЕВ²,
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Аннотация. В статье рассматриваются актуальные вопросы охраны атмосферного воздуха и озеленения территорий в контексте смягчения последствий изменения климата в Узбекистане. В работе подчеркивается возрастающее влияние изменения климата на ключевые сектора, включая общественное здравоохранение, биоразнообразие и экономическое развитие. Обсуждаются как природные, так и антропогенные факторы загрязнения воздуха, включая выбросы от транспортных средств и промышленных предприятий. В статье анализируются национальные инициативы, такие как переход к "зеленой экономике", развитие возобновляемых источников энергии и программы по высадке деревьев, направленные на адаптацию и смягчение последствий изменения климата. Подчеркивается важность международного сотрудничества, реформ в области политики и экономических механизмов для сокращения выбросов парниковых газов. Также статья освещает проблемы мониторинга качества воздуха, низкую эффективность пылегазоочистных установок и необходимость локализации производства экологических технологий. В исследовании рассматриваются стратегические цели Узбекистана по сокращению выбросов парниковых газов к 2030 году, а также усилия по расширению зеленых зон и борьбе с незаконной вырубкой лесов.

Ключевые слова: охрана атмосферного воздуха, озеленение, смягчение последствий изменения климата, Узбекистан, выбросы парниковых газов, устойчивое развитие, возобновляемые источники энергии, адаптация к изменениям климата, международное сотрудничество, экологическая политика, промышленные выбросы, зеленая экономика.

**ИҚЛИМ ЎЗГАРИШИНИ ЮМШАТИШ МАҚСАДЛАРИДА АТМОСФЕРА
ҲАВОСИНИ МУҲОФАЗА ҚИЛИШ ВА ҲУДУДЛАРНИ ЯШИЛЛАШТИРИШНИНГ
ДОЛЗАРБ МАСАЛАЛАРИ****Б. АЛИХОНОВ¹, Ж. КАЗБЕКОВ², Б. ХОЛХЎЖАЕВ²,
Э. ОМОНОВ¹, Т. САБИТОВ²**¹ Ўзбекистон Республикаси Сенати² Экология, атроф-муҳитни муҳофаза қилиш ва иқлим ўзгариши вазирлиги

Аннотация. Мақолада Ўзбекистонда иқлим ўзгариши оқибатларини юмшатиш контекстида атмосфера ҳавосини муҳофаза қилиш ва ободонлаштиришнинг долзарб масалалари муҳокама қилинган. Мақолада иқлим ўзгаришининг асосий тармоқларга, жумладан, соғлиқни сақлаш, биологик хилма-хиллик ва иқтисодий ривожланишга таъсири ортиб бораётгани таъкидланган. Атмосфера ифлосланишининг табиий ва антропоген омиллари, жумладан, транспорт воситалари ва саноат корхоналари ажратмалари муҳокама қилинган. Мақолада яшил иқтисодиётга ўтиш, қайта тикланадиган энергия манбаларини ривожлантириш ва иқлим ўзгаришига мослашни ва юмшатишга қаратилган дарахт экиш дастурлари каби миллий ташаббуслар кўриб чиқилган. Иссиқхона газлари чиқиндиларини камайтириш бўйича халқаро ҳамкорлик, сиёсий ислохотлар ва иқтисодий механизмлар муҳимлиги таъкидланган. Шунингдек, мақолада ҳаво сифатини мониторинг қилиш муаммолари, чанг ва газни тозалаш иншоотлари самарадорлигининг паслиги, экологик технологияларни ишлаб чиқаришни маҳаллийлаштириш зарурлиги ҳақида сўз борган. Тадқиқотда Ўзбекистоннинг 2030-йилгача иссиқхона газлари чиқиндиларини камайтириш бўйича стратегик мақсадлари, шунингдек, яшил майдонларни

кенгайтириши ва ўрмонларни ноқонуний кесилишга қарши курашиши борасидаги саъй-ҳаракатлар кўриб чиқилган .

Калит сўзлар: атмосфера ҳавосини муҳофаза қилиши, кўкаламзорлаштириши, иқлим ўзгариши оқибатларини юмишатиши, Ўзбекистон, иссиқхона газлари ажратмалари, барқарор ривожланиши, қайта тикланадиган энергия манбалари, иқлим ўзгаришига мослашиши, халқаро ҳамкорлик, атроф-муҳит сиёсати, саноат чиқиндилари, яшил иқтисодиёт.

УДК: 631.6.02:574

ҚОРАҚАЛПОҒИСТОН РЕСПУБЛИКАСИ ҚИШЛОҚ АҲОЛИСINI ИЧИМЛИК СУВИ БИЛАН ТАЪМИНЛАШНИНГ ҲОЗИРГИ ҲОЛАТИ

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Аннотация. Мақола Қорақалпоғистон Республикаси аҳолисини ичимлик суви билан таъминлаш ҳамда қишлоқ аҳолисини марказлашган ва марказлаштирилмаган маиший-хўжалик ичимлик суви таъминоти тизимлари фаолиятини баҳолаш натижаларини ўрганишга бағишланган. Шунингдек, сув таъминоти тизимларининг санитария-техник самарадорлиги ва ичимлик суви сифати ўрганилган.

Калит сўзлар: ичимлик суви, сув сифати, кимёвий ва бактериологик кўрсаткичлар, аҳоли, сув таъминоти, санитария меъёрлари, гигиеник талаблар.

Кириш. Қорақалпоғистон Республикаси доимий аҳолиси сони 2020 йил 1 октябрь ҳолатига 1 916 124 кишини ташкил этиб, 2019 йил бошидан 1777,3 кишига ёки 0,9% га ўсган. Жумладан, шаҳар аҳолиси сони 938 658 кишини (жами аҳоли сонидаги улуши 49,0%, қишлоқ аҳолиси сони 977 466 кишини 51,0%) ташкил этган бўлиб, аҳолиси зичлиги ҳар квадрат километрга 11,33 кишини ва майдони 166600 км² ни ташкил қилади.

Қорақалпоғистон Республикаси ҳудудига аҳолига сифатли ичимлик суви етказиб бериш ҳамда ичимлик суви манбаларининг минерализация миқдорининг ортиши [Small, 2001], гигиеник талабга жавоб бермаслиги инсон саломатлиги учун энг катта хавф бўлиб қолмоқда.

ЖССТ ҳисоботига кўра (2001), Қорақалпоғистон аҳолисининг 32% ичимлик сувининг асосий манбаи сифатида ичимлик суви таъминоти тизимларидан фойдаланса, 57% ер ости сувларини насос орқали ҳамда очик қудуқлардан фойдаланади, атига 2% аҳоли тоза ичимлик суви сотиб олади [Lall, 2012].

Ичимлик суви сифатини назорат қилиш давлат санитария назорати вазифаларини бажариш тартибида Ўзбекистон Республикаси Санитария-эпидемиологик осойишталик ва жамоат саломатлиги хизмати ҳудудий марказларининг лабораториялари томонидан амалга оширилади

Сув сифатини назорат қилиш ва унинг белгиланган талабларга мувофиқлигини баҳолаш сув қувурининг тарқатиш тармоғига тушишидан аввал, сув таъминоти манбаларидан сув олиш иншоотларида ва сувни тарқатиш тармоғининг турли нуқталарида

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