SIR Publishers
CENTER FOR INTERNATIONAL SCIENTIFIC PUBLICATIONS
JOURNAL OF AGRICULTURE AND LIFE SCIENCES
ISSN(Online): 2984-6706
Volume-9, Issue-02, Published |24-04-2026|

FACTORS AFFECTING URBAN ECOLOGY AND ATMOSPHERIC AIR QUALITY: A CASE STUDY OF TERMEZ CITY

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ABSTRACT

Urban ecology has become one of the most important scientific and practical directions in the context of rapid urbanization, population growth, transport intensification, construction expansion, and climate-related environmental pressure. This article examines the main factors affecting atmospheric air quality in Termez city, located in the southern part of Uzbekistan. The study is based on a systematic analysis of natural-climatic, demographic, transport, industrial, construction, and green infrastructure factors. The relevance of the topic is determined by the fact that air quality in Termez cannot be explained only by industrial emissions or transport activity. The city is influenced by a combination of anthropogenic and natural pressures, including hot and dry climate, dust storms, transboundary dust movement, motor vehicle emissions, construction dust, fossil fuel use, and insufficient ecological regulation of urban growth. According to the analyzed material, the population of Termez reached 207,326 people at the beginning of 2025, while industrial production and construction activities also showed significant growth. These processes create additional environmental pressure on the urban atmosphere.

Keywords: urban ecology, atmospheric air, Termez city, PM2.5, PM10, dust storm, Afghan wind, urbanization, transport emissions, construction dust, industrial emissions, environmental monitoring, green belt, public health.

INTRODUCTION

Urban ecology studies the city not merely as a geographical settlement, but as a complex ecological system where natural conditions, population density, economic activity, engineering infrastructure, transport networks, public health, and environmental governance interact with one another. In this system, atmospheric air is one of the most sensitive and important components because it immediately reflects the combined pressure of transport, industry, construction, fuel consumption, land cover change, climate conditions, and green infrastructure.

The issue of atmospheric air quality is especially relevant for cities situated in dry and hot climatic zones. Termez city, the administrative and economic center of Surkhandarya region, represents such a case. It is located in the southern part of Uzbekistan, close to transboundary environmental influences, and is characterized by hot summers, low precipitation, dry soils, and frequent dust-related atmospheric processes. These natural conditions increase the vulnerability of the city to air pollution, especially when they interact with anthropogenic sources such as motor vehicles, construction works, industrial activities, and domestic heating.

The relevance of the problem is strengthened by recent demographic and economic trends. According to the source material, the permanent population of Termez reached 207,326 people as of January 1, 2025. In addition, the city demonstrated high levels of industrial production and construction activity: industrial output reached 1,417.9 billion Uzbek soums in January–September 2025, while construction works reached 2.8 trillion Uzbek soums in January–August 2025. These indicators show that Termez is not a static urban area but a dynamically developing city. However, economic growth, if not accompanied by ecological planning, can intensify pressure on the urban environment.

The central scientific problem of this article is that atmospheric air pollution in Termez cannot be correctly understood through a single-factor explanation. It would be methodologically weak to attribute the problem only to industry, only to transport, or only to natural dust storms. The ecological situation is multi-layered. Natural dust and dry climatic conditions create background pressure, while transport, construction, heating, industry, and urban density add permanent anthropogenic pressure. Therefore, the issue requires an integrated urban ecological approach.

The aim of this article is to analyze the main factors affecting atmospheric air quality in Termez city and to propose scientifically grounded directions for improving urban environmental management. The object of the study is the urban ecological environment of Termez city. The subject of the study is the system of natural and anthropogenic factors influencing atmospheric air quality. The research tasks are: to describe the ecological characteristics of Termez city; to identify the key sources of atmospheric pressure; to analyze the interaction between natural-climatic and anthropogenic factors; and to develop practical recommendations for sustainable air quality management.

METHODOLOGY

This study uses a qualitative-analytical methodology based on the DPSIR framework: Driving Forces, Pressures, State, Impacts, and Responses. This model is suitable for urban ecological analysis because it allows the researcher to connect socio-economic development with environmental consequences and management measures.

In the context of Termez city, the driving forces include population growth, urbanization, industrial activity, construction expansion, transport mobility, and increasing demand for energy and services. These forces are not negative by themselves. They represent development processes. However, when they are not supported by ecological planning, they generate environmental pressures.

The pressure block includes vehicle emissions, road dust, construction dust, industrial emissions, fuel combustion, domestic heating, open soil surfaces, and transboundary dust flows. The state block refers to the actual condition of atmospheric air, including particulate matter concentration, chemical pollutants, visibility reduction, and meteorological conditions affecting pollutant dispersion. The impact block includes health risks, especially respiratory and cardiovascular effects, reduced urban comfort, increased ecological vulnerability, and possible economic costs related to public health and environmental degradation. The response block consists of monitoring, regulation, technological modernization, transport policy, green infrastructure, public awareness, and regional cooperation.

The article is based on the synthesis of the uploaded material, official statistical indicators included in the source, and scientific interpretations related to urban ecology and atmospheric air protection. The study does not treat Termez as a city affected by only one source of pollution. Instead, it analyzes the interaction of several factors. This is a stronger methodological position because the ecological situation of Termez is shaped by overlapping natural and anthropogenic processes.

A limitation of the study is that some transport-related numerical data in the source material are not fully internally consistent. For this reason, the article uses transport figures primarily to identify the general tendency of motorization and fuel dependence, rather than to make overly precise statistical claims. This is important for academic reliability. A scientific article must not force weak data into strong conclusions. Where exact numerical accuracy is uncertain, the interpretation should remain cautious.

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RESULTS

The results confirm that the air quality problem in Termez is complex and cannot be solved by a single administrative measure. The most common mistake in such discussions is to simplify the issue. Some may argue that the main problem is dust storms. Others may blame only transport or industry. Both positions are incomplete. Dust storms may create extreme pollution peaks, but transport, construction, heating, and industry maintain everyday background pressure. A serious ecological policy must distinguish between peak pollution episodes and permanent background pollution.

For peak dust episodes, Termez needs meteorological forecasting, early warning systems, public health recommendations, temporary restrictions on dust-producing activities, and regional information exchange. Since some dust flows may have a transboundary character, local measures alone will not be enough. Cooperation with regional meteorological and environmental institutions is necessary.

For background pollution, the main tools are different. The city must improve transport policy, strengthen construction dust control, regulate fuel quality, modernize public transport, increase green buffers, and expand air monitoring. These measures are more difficult because they require long-term governance rather than one-time campaigns.

Transport policy should be treated as an environmental and public health issue. Termez needs gradual modernization of public transport, stricter technical inspection of vehicles, incentives for low-emission vehicles, improved traffic flow, and restrictions on highly polluting transport in central areas. “Car-free day” initiatives and public campaigns can be useful, but they will not solve the problem unless supported by reliable public transport.

Construction regulation must become stricter. Construction sites should be required to use water spraying, covered transportation of materials, temporary surface covering, wheel-washing points, and dust barriers. These are not luxury measures. In a dry city, they are basic environmental requirements. Without such rules, every new construction project adds to the particulate pollution burden.

Monitoring is another weak but decisive point. One or two monitoring points cannot fully explain air quality in a city with different traffic corridors, residential zones, industrial areas, and construction sites. Termez needs a denser monitoring network that includes roadside areas, residential neighborhoods, background zones, and dust-prone corridors. Data should be transparent and regularly communicated to the public. Without reliable data, environmental governance becomes reactive and vague.

Green infrastructure should be redesigned as a functional ecological system. The city should not measure success only by the number of planted trees. The correct indicators are survival rate, canopy cover, dust interception capacity, irrigation reliability, and strategic location. For Termez, green belts along highways and dust corridors may be especially important. However, poor maintenance or unsuitable species selection can turn greening campaigns into statistical decoration rather than real ecological improvement.

The health dimension must also be emphasized. Fine particles and polluted air affect the respiratory system, cardiovascular system, and overall quality of life. Children, elderly people, and individuals with chronic diseases are more vulnerable. Therefore, air quality management is not only an environmental task. It is also a public health policy. Schools, hospitals, and residential areas should be considered priority zones for air quality improvement.

CONCLUSION

The case of Termez city demonstrates that urban atmospheric air quality is shaped by a combination of natural and anthropogenic factors. Hot and dry climate, dust storms, transboundary dust movement, transport emissions, construction dust, industrial activity, domestic heating, population growth, and insufficiently developed green infrastructure act together. For this reason, the ecological situation of Termez cannot be explained by a simple linear model.

The main conclusion is that clean air policy in Termez should be based on integrated urban management. Separate measures such as tree planting, vehicle inspection, or construction control are useful, but they will remain limited if they are not connected into one system. The city needs a coordinated strategy that includes air quality monitoring, public transport modernization, construction dust regulation, fuel and emission control, green belt development, early warning systems for dust storms, and public ecological education.

The most realistic approach is to treat atmospheric air quality as an indicator of sustainable urban development. If the air becomes cleaner, this means that transport, construction, energy use, greening, monitoring, and public administration are working better together. If air quality worsens, it signals deeper problems in urban governance. Therefore, the protection of atmospheric air in Termez is not only an environmental requirement but also a strategic condition for public health, urban comfort, and long-term sustainable development.

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