

ANALYSIS OF AIR POLLUTION IN NAMANGAN CITY CAUSED BY CHEMICAL GASES AND AEROSOLS

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Abstract. *This article presents an analysis of air pollution in Namangan city, focusing on the increasing presence of chemical “emissions” and aerosols. The city has been zoned based on the level of atmospheric pollution, and a corresponding pollution map has been developed. The study also proposes several recommendations aimed at reducing air pollution levels in the city.*

Keywords: *PM-2.5, dust, carbon monoxide, green areas, exhaust gases, asphalt surfaces, effective pollution, volatility.*

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Introduction. Atmospheric air is considered an integral part of natural resources and is regarded as a common asset protected by the state. While a human can survive for several days without water and even a month without food, they can live only 2–3 minutes without air.

Due to its harmful effects on human health, atmospheric air pollution has always been a source of concern. Air pollution negatively impacts human well-being and is considered one of the primary causes of allergies and respiratory system disorders. Therefore, ensuring the quality of the air we breathe is of critical importance.

The main part. It is well established that air pollution contributes to a range of human health conditions, including respiratory tract infections, cardiovascular

diseases, and lung cancer, and in some cases, may even result in premature mortality [36, 37]. According to data from the World Health Organization, the annual mortality rate attributable to air pollution in Uzbekistan stands at 81.1 per 100,000 population. By comparison, this figure is 58.3 in Romania and 61.8 in Bulgaria.

In order to identify the main pollutants contributing to atmospheric air pollution in Namangan region and to assess their changes over time, a study was conducted on the primary pollutants present in the atmosphere of Namangan city, which is considered the most polluted area in the region. For this purpose, data from three monitoring stations established by the Namangan Regional Hydrometeorological Center to observe and assess air pollution levels in the city were utilized. These monitoring stations primarily measure the concentrations of particulate matter, sulfur dioxide, carbon dioxide, and nitrogen dioxide. An analysis of the data on these pollutants for the period from 2012 to 2021 revealed the following trends.

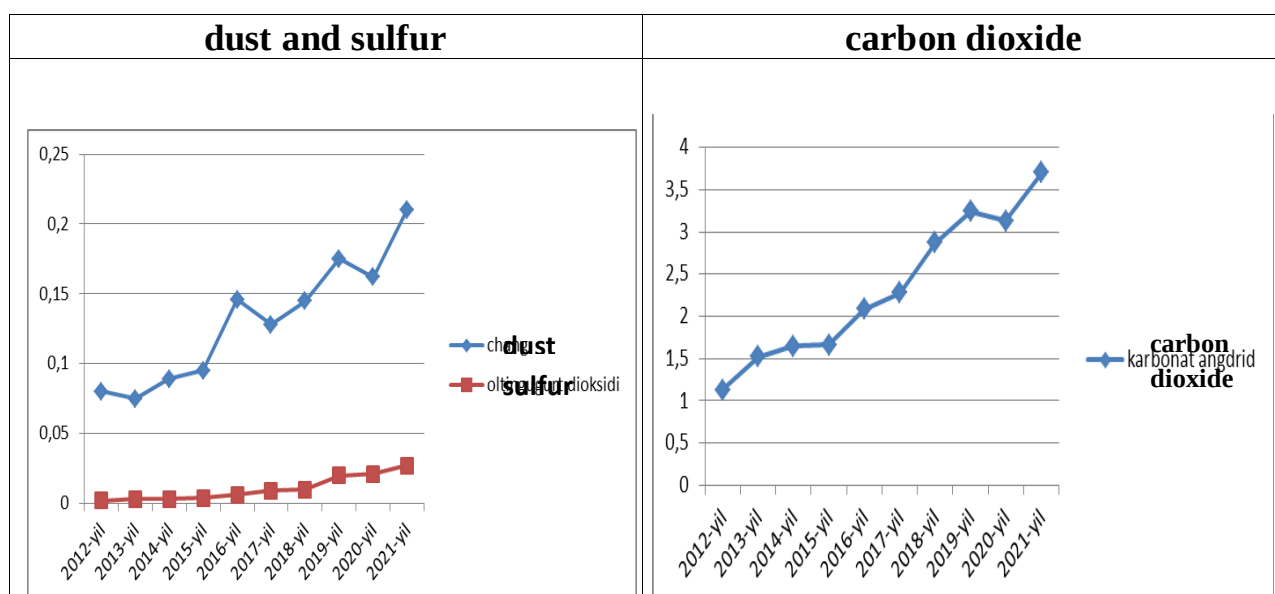


Figure 1. Increase in the amount of harmful substances released into the atmosphere in Namangan city.

As observed from the diagram, the concentrations of particulate matter, sulfur dioxide, nitrogen dioxide, and carbon dioxide increased steadily from 2012 to 2021.

The quantity of chemical gases and aerosols in the atmosphere increases significantly during warmer periods due to the rise in volatility. The concentration of carbon monoxide rises particularly during the hot summer months. This is primarily due to higher temperatures and increased vehicle traffic. Although the quantity of emissions released into the atmosphere during winter and summer may be nearly the same, the volatility caused by high temperatures in summer extends the persistence of these substances in the air up to 3–5 days. Consequently, pollution levels appear to reoccur and effectively intensify.

It is important to note that PM_{2.5} refers to fine particulate matter that is 40 times smaller than a human hair and is invisible to the naked eye. Its prolonged presence in the air at high concentrations poses significant risks to human health, including diseases caused by the particles entering the bloodstream through lung tissue, as well as respiratory illnesses, allergies, irritation of the eyes' mucous membranes, skin conditions, and even cancer.

The climatic characteristics of the Fergana Valley are shaped by several factors, including Arctic air masses from the north, moderate and dry air flows originating in Central Asia, and tropical air masses from the south. In particular, the arrival of Arctic air masses during autumn and winter causes a sharp drop in air temperature and a noticeable increase in precipitation. During summer, moderate dry and tropical air masses lead to dry and hot conditions. As a result, the amount of dust in the air increases. In Namangan city, this increase in atmospheric dust is influenced by factors such as the growing number of vehicles, expansion of housing construction, and changes in levels of sulfur, carbon, and nitrogen oxides. These changes are largely explained by increased fuel consumption during the colder seasons, growing traffic congestion, and other contributing elements.

According to experts, sulfur oxides generated from fuel combustion are not absorbed or neutralized easily; they are released directly into the air along with other gases. Unless washed away by rain or carried out of the city by strong winds, these gases remain in circulation between ground and upper atmospheric levels. In

valley cities, this rhythmic air circulation is continuously supported by heavy urban traffic. The fine particles released during combustion rise from asphalt surfaces, further polluting the air. Such pollution remains persistent during warm periods of the year due to the lack of consistent anticyclones or convection processes. In addition, chaotic and unregulated urban development, deforestation, elimination of water bodies, and desertification (notably from Kazakhstan) contribute to the increase in airborne dust masses.

Sulfur content varies depending on the type of vegetation and soil in the area. When sulfur interacts with atmospheric oxygen, it forms sulfur dioxide, which has harmful effects on human respiratory systems, lungs, and liver. In children, its impact manifests as coughing, colds, eye irritation, and nausea. The sulfur found in fuel can also combine with metal parts in vehicle engines, forming compounds like ferrum sulfide that can pose additional health risks—especially for young children—due to the increased volatility of these compounds.

Low atmospheric circulation in valley cities, heavy urban traffic, road congestion, widespread construction, deforestation, limited irrigation of green spaces and highway landscapes—all of these contribute to adverse meteorological conditions and increased anthropogenic burden, exacerbating air pollution levels. Such spatial variation in pollution levels within cities can lead to the formation of specific pollution zones. In valley regions, pollution is predominantly observed in urban areas. In contrast, rural regions experience little to no pollution due to low population density, minimal vehicular traffic, absence of major industries, and extensive greenery. However, some suburban and large rural settlements situated near cities may experience localized ('pendulum-type') pollution, especially along major roads during summer.

Therefore, the focus of this study was on valley cities. Among them, Namangan city was selected due to its demographic density and size. Based on analytical observations, GIS tools, and survey data, Namangan city was divided into zones based on pollution levels. The zoning process used data collected during

the first ten days of June. GIS technologies and cartographic methods were used to construct the map:

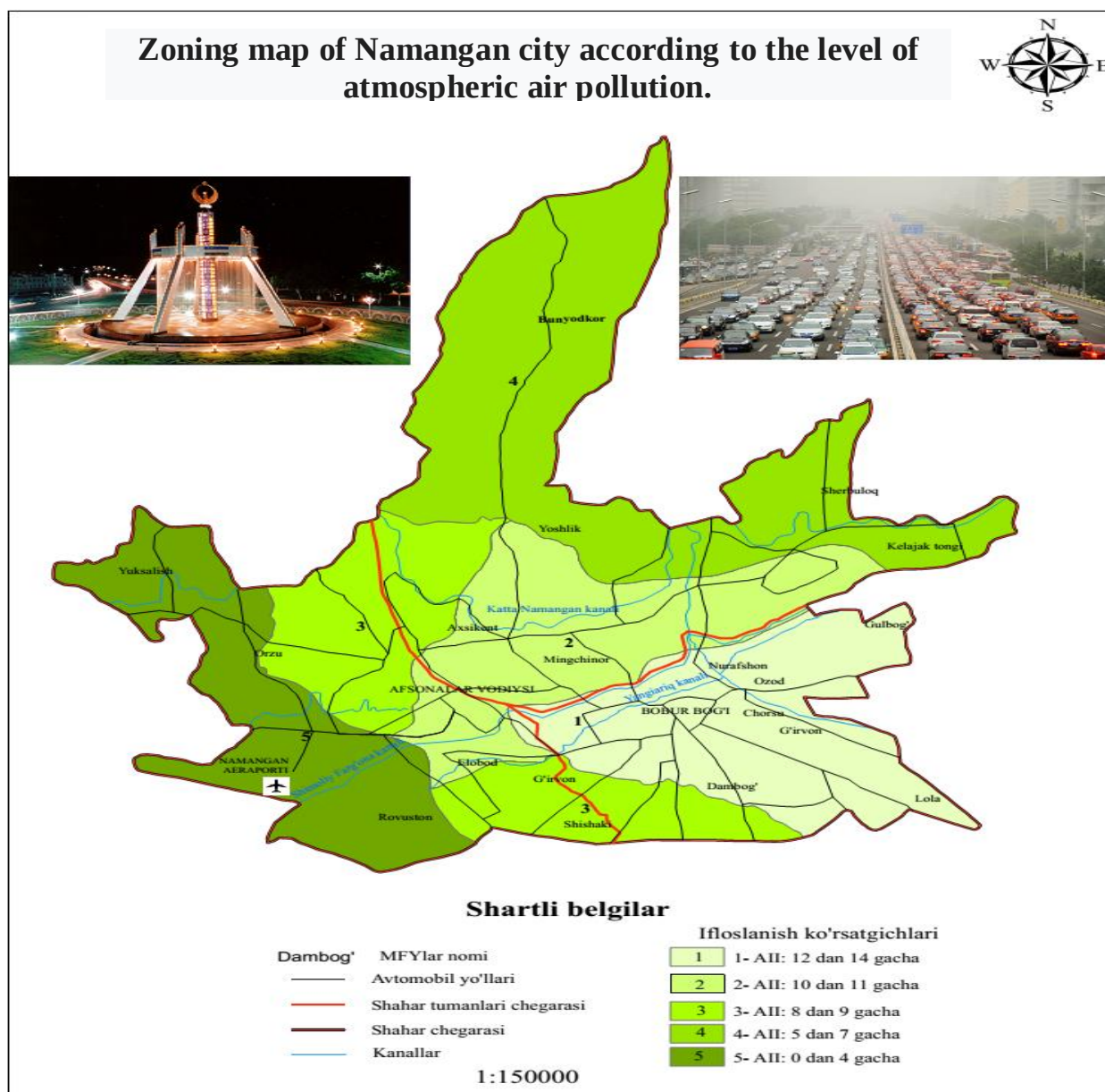


Figure 2. Map created by the author based on data and visuals from <https://earth.nullschool.net> and supplementary sources such as <https://monitoring.meteo.uz> and <https://hydromet.uz/uz/node/20>

As seen in the above map, Namangan city is divided into five zones based on air pollution levels. The highest pollution levels were recorded in the central parts of the city, especially areas like Chorsu and Sardoba markets, where vehicle traffic is heaviest. Although the industrial zone has a high output of pollutants, due

to topography and wind direction, a significant portion of emissions are carried into Zone 1, increasing its pollution level further.

Other zones within the city also differ in pollution levels based on greenery, traffic volume, population density, residential housing, industrial activity, and wind patterns. The least polluted areas were located in the southwestern parts of the city (such as the Airport and Rovuston neighborhoods). Areas in the northern and elevated parts of the city, including Bunedkor, Yoshlik, and Sherbuloq, also experienced lower pollution levels.

In recent days, high levels of nighttime air pollution have been observed in Namangan and Andijan cities. This is mainly due to temperature inversions during the evening and night, which cause a sudden drop in temperature and increased atmospheric stability, allowing pollutants to accumulate in the lower atmosphere.

In this context, the following proposals and recommendations have been developed to protect the atmospheric air of the city and reduce the volume of waste emissions:

a) Regulate the movement of freight transport by introducing scheduled operating hours and route management systems.

b) Reduce the use of gasoline-powered vehicles. For example, gas-fueled buses emit only 0.1% toxic gases during operation, whereas gasoline-powered vehicles emit 2–3%. Thus, switching from gasoline to gas can reduce pollution by a factor of 20–30.

c) Ensure that cities maintain adequate green spaces to provide a healthy and breathable environment. Green areas should have sufficient vertical and horizontal dimensions; for example, tree height should be at least 5–7 meters and canopy volume over 15 m³ to be effective.

d) Establish green buffer zones consisting of vegetation belts with a width of at least 100 meters—ideally extending to several kilometers—between residential areas and industrial zones for maximum protective effect.

e) Consider prevailing wind directions in urban architectural planning to avoid obstruction of natural air circulation by buildings.

f) Relocate markets such as Chorsu and Sardoba away from major transportation nodes and arterial roads. Optimize the layout of these marketplaces and increase the amount of green space around them.

g) Plant long-living, large-canopy ornamental trees such as sycamore, elm, chestnut, paulownia, cedar, oak, and white poplar to enhance urban greenery and ecological resilience.

h) Construct multi-level underground and above-ground parking facilities in major commercial centers and densely populated areas. Provide tax incentives and subsidies to private investors willing to develop such infrastructure.

Conclusion. In addition to these measures, it is crucial to raise public awareness across the Fergana Valley about the importance of: avoiding the burning of fallen leaves; refraining from using faulty or non-compliant vehicles; and adopting modern, internationally standardized heating technologies for buildings.

Improving ecological literacy and environmental responsibility in these areas will play a critical role in reducing pollution and ensuring sustainable urban development.

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