



ENVIRONMENTAL IMPACT OF THE NAVOI MINING AND
METALLURGICAL COMBINE

Saitqulova Zaynura Umidjonovna

*National University of Uzbekistan named after Mirzo Ulugbek Faculty of Geography and
Geoinformation Systems 3rd-year student, Geography Department*

Abstract: *This article analyzes the environmental impact of the Navoi Mining and Metallurgical Combine (NMMC), particularly its effects on atmospheric air, the aquatic environment, soil degradation, and the level of ecological risk. The aim of the study is to identify the anthropogenic load in the Muruntau–Zarafshan industrial zone, examine pollution sources, and assess their impact on the ecological sustainability of the region. The paper provides a scientific analysis of landscape transformation, hydro-ecological problems, ecological risks, and their effects on public health resulting from NMMC activities. The research findings serve as a basis for improving environmental monitoring, reducing waste emissions, and developing sustainable development measures.*

Keywords: *Navoi Mining and Metallurgical Combine, anthropogenic load, ecological risk, landscape transformation, aquatic environment, soil degradation, air pollution, hydro-ecological problems, sustainable development, monitoring.*

In recent decades, the rapid development of the mining and metallurgical industry worldwide has become one of the key drivers of economic growth; however, the pressure it exerts on the environment has increased proportionally. In particular, open-pit mining, ore beneficiation, and metallurgical processing are recognized as major anthropogenic sources of atmospheric air pollution, contamination of water resources, and soil degradation. These processes contribute to the degradation of natural ecosystems, reduction of biodiversity, and the intensification of ecological risks that threaten public health.

In the Republic of Uzbekistan, the mining and metallurgical sector is one of the leading industries, with the Navoi Mining and Metallurgical Combine (NMMC) occupying a central position. NMMC is among the world's leading companies in gold production. Major deposits such as Muruntau, Myutenbai, and Amantaitau provide the bulk of the country's gold output. This significantly increases the economic importance of NMMC, while simultaneously intensifying the ecological burden in the regions where it operates.

Technogenic impacts associated with NMMC activities—particularly dust and gas emissions released into the atmosphere, chemically contaminated wastewater discharged into water bodies, and large volumes of mining waste—have disrupted ecological balance in the Muruntau–Zarafshan industrial area. This region is classified as a zone of high anthropogenic load within Uzbekistan's ecological zoning system, where the levels of air, water, and soil pollution significantly exceed national average indicators.

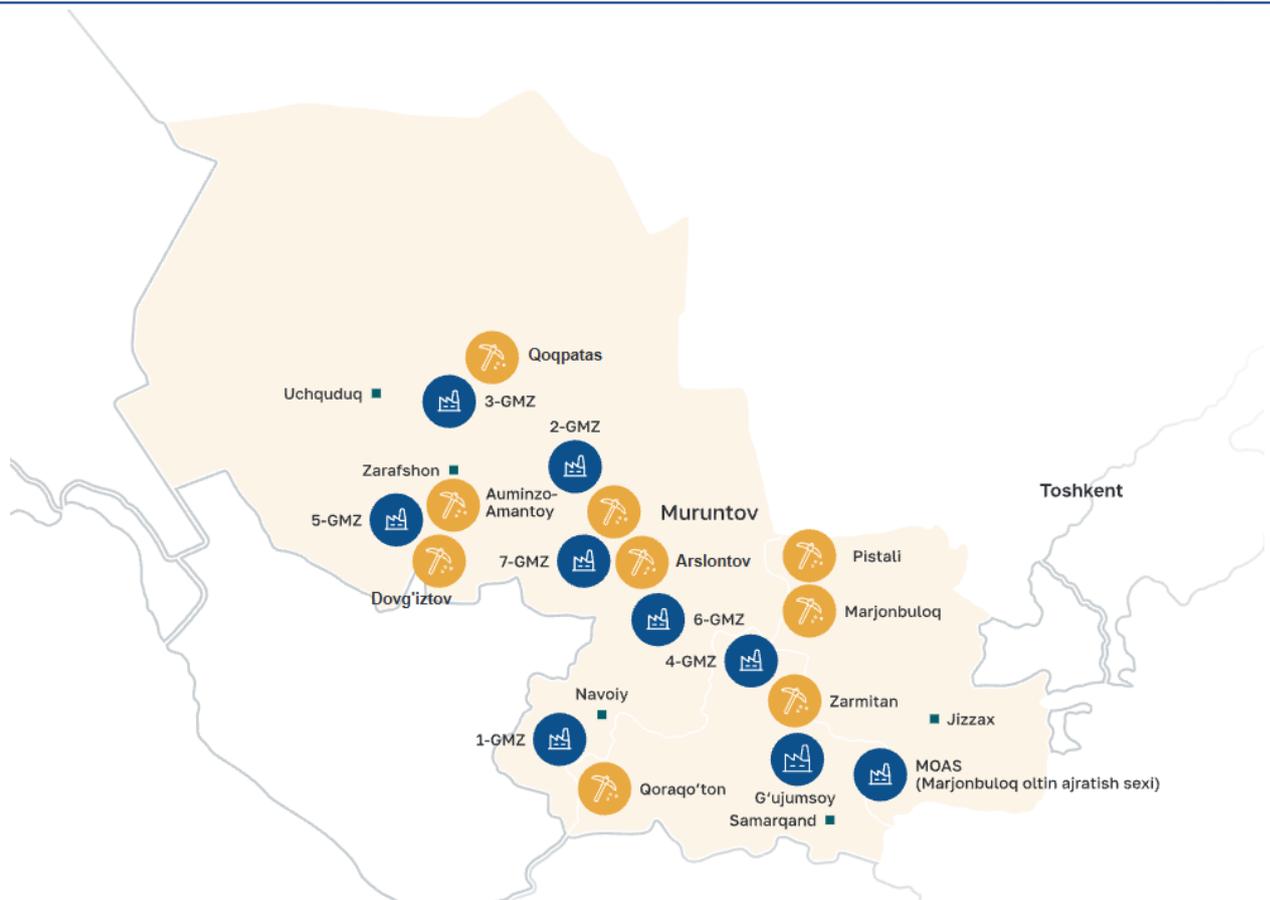


Figure 1: Map of mines belonging to NMMC

Source: <https://www.ngmk.uz/uz/>

Moreover, the environmental situation developing within the NMMC zone affects not only natural ecosystems but also social and demographic processes. The increasing prevalence of respiratory diseases, cardiovascular disorders, and certain oncological diseases among the population indicates a strong link with environmental factors. This necessitates a comprehensive assessment of NMMC activities not only from an economic perspective but also from ecological and social risk viewpoints.

The main objective of this study is to scientifically assess the level of ecological risk formed under the influence of the Navoi Mining and Metallurgical Combine, analyze the characteristics of atmospheric, water, and soil pollution, and identify the key factors affecting the ecological sustainability of the region. The results of this research may serve as a scientific basis for improving environmental monitoring, strengthening environmental protection measures, and implementing sustainable development principles within the NMMC area.

Atmospheric air pollution formed within the Navoi Mining and Metallurgical Combine zone is considered one of the primary determinants of ecological risk in the Muruntau–Zarafshan industrial region. Large volumes of dust–gas mixtures are released into the atmosphere during open-pit mining operations, blasting processes, ore crushing, beneficiation, and metallurgical processing stages. The main pollutants generated by these processes include particulate matter (PM₁₀ and PM_{2.5}), sulfur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO), as well as aerosols enriched with heavy metals.

Atmospheric monitoring results indicate that the concentration of fine particulate matter (PM_{2.5}) in the area ranges between 46–58 µg/m³, which is 1.8–2.3 times higher than the limits established by the World Health Organization. Seasonal PM₁₀ levels reach 120–160 µg/m³, significantly increasing the overall aerodynamic load of the air. The presence of toxic elements such as mercury, arsenic, lead, and cadmium in these particles further enhances their biological hazard.

Among gaseous pollutants, sulfur dioxide (SO₂) concentrations are recorded at 78–92 µg/m³, exceeding the permissible maximum levels by 1.5–1.8 times. Nitrogen dioxide (NO₂) concentrations range from 65–72 µg/m³, increasing the probability of photochemical smog formation in the region. Elevated carbon monoxide (CO) concentrations are considered one of the factors contributing to oxygen deficiency and general intoxication conditions.



Figure 2: Gold mining process

Source: <https://actual.ngmk.uz/uz/>

Such levels of atmospheric air pollution have a significant negative impact on public health. Epidemiological observations show that the incidence of bronchial asthma, chronic bronchitis, and allergic respiratory diseases in the region is 1.4–1.6 times higher than national average indicators. PM_{2.5} particles penetrate deep into the alveolar layers of the lungs, intensifying inflammatory processes and increasing the risk of cardiovascular diseases, stroke, and myocardial infarction. Long-term exposure to heavy metal aerosols significantly increases the likelihood of nervous system damage, impaired kidney function, and the development of oncological diseases.

For this reason, protecting atmospheric air, modernizing exhaust gas purification technologies, strengthening dust suppression systems, and expanding continuous environmental monitoring in the NMMC area are considered essential conditions for ensuring sustainable development.

Impact on atmospheric air (Table 1)

Indicator	Permissible (µg/m ³)	Actual (µg/m ³)	Exceeding the norm
PM ₂	25	46-58	1.8-2.3x



SO ₂	50	78-92	1.5-1.85x
NO ₂	40	65-72	1.6-1.8x

The state of the water environment in the Navoi Mining and Metallurgical Combine zone exerts significant pressure on hydro-ecological stability in the Muruntau–Zarafshan industrial region.

Large volumes of water are utilized during ore beneficiation, hydrometallurgical processing, and technological cooling processes, disrupting the natural balance of both groundwater and surface water in the area. High water consumption in certain sections leads to a lowering of the groundwater table, intensification of desertification processes, and degradation of vegetation cover.

Wastewater contains cyanide compounds, sulfate and nitrate ions, as well as heavy metals such as arsenic, mercury, and lead, which deteriorate the hydro-ecological condition of the Zarafshan River and its connected water bodies. Monitoring results show that cyanide concentrations in the water environment exceed normative values by 2–3 times. This situation enhances bioaccumulation in aquatic organisms, reduces fish biomass, and disrupts the trophic structure of aquatic ecosystems.

Soil degradation in the NMMC area represents another significant component of ecological risk. Open-pit mining, the formation of tailings, and the deposition of dust-aerosol materials disrupt the soil's mechanical structure, reduce humus content, and increase salinization processes. The accumulation of heavy metals such as lead, arsenic, and mercury in the soil transforms the area into a biogeochemical hazard zone, reducing the ecological quality of agricultural lands.

These hydro-ecological problems and soil degradation processes decrease the natural resource potential of the region and negatively affect public health and economic activities. Therefore, protecting water resources, implementing advanced wastewater treatment, reclaiming soils, and improving continuous ecological monitoring are considered priority directions for ensuring sustainable environmental development in the NMMC area.

The level of ecological risk formed in the Navoi Mining and Metallurgical Combine zone is classified as high based on a comprehensive assessment approach. Combined pollution of atmospheric air, water, and soil components sharply increases the integral ecological load in the region. According to monitoring and analytical evaluation results, the Muruntau–Zarafshan industrial region is categorized as a high anthropogenic pressure zone in Uzbekistan's ecological zoning system. Concentrations of pollutants exceeding permissible limits by 1.5–3 times justify its classification as a region with low ecological sustainability.

The high level of ecological risk is expressed not only in the degradation of natural environmental components but also in its impact on public health. The incidence of respiratory diseases, cardiovascular disorders, and certain oncological conditions in the area is higher than the national average, directly correlating with environmental factors. Therefore, implementing comprehensive protective measures aimed at reducing ecological risk—such as minimizing waste, introducing modern purification technologies, and strengthening continuous monitoring—is considered a priority in the NMMC region.



Mining and metallurgical activities conducted in the Navoi Mining and Metallurgical Combine (NMMC) area exert a significant anthropogenic pressure on the atmospheric, water, and soil environments. In the Muruntau–Zarafshan industrial region, pollutant concentrations exceed permissible limits several times, justifying its classification as a zone of low ecological stability and high environmental risk. Elevated levels of PM_{2.5} and SO₂ in the atmosphere, cyanide and heavy metals in water, as well as mercury and lead in soil, have severe negative impacts on local ecosystems and public health.

Therefore, enhancing environmental monitoring, reducing the release of pollutants, protecting water and soil resources, and implementing comprehensive landscape reclamation measures in the NMMC area are essential factors for ensuring sustainable regional development.

REFERENCES:

1. Navoi Mining and Metallurgical Combine official website. “Fact Sheet 2025.” <https://www.ngmk.uz>
2. World Health Organization (WHO). Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide. Geneva, 2021.
3. En.wikipedia.org. “Muruntau mine.” https://en.wikipedia.org/wiki/Muruntau_mine
4. Metal Ukraine. “Uzbekistan: Navoi Mining and Metallurgical Company produces goods worth 60.8 trillion sums in H1 2025.” 2025.
5. State Committee for Environmental Monitoring of the Republic of Uzbekistan. Regional Environmental Monitoring Data, 2024.
6. Karimov, A., & Tursunov, B. “Anthropogenic Impact of Mining Activities on the Central Asian Desert Ecosystems,” *Journal of Environmental Science*, 2022, Vol. 14, No. 2, pp. 45–60.
7. FAO. Water Use in Mining and Metallurgy: Guidelines for Sustainable Practices. Rome, 2023.