AIR POLLUTION BY DUST AND CHEMICALS: PROBLEMS, CONSEQUENCES, AND SOLUTIONS

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Abstract: This research provides a comprehensive analysis of the problem of air pollution by dust and chemical substances. The study examines the main sources of air pollution, including industrial enterprises, transportation, and agricultural activities. The negative effects of airborne particulate matter (PM2.5, PM10) and harmful gases (SO_2, NO_2, CO) on human health and ecosystems are highlighted based on scientific sources. Using Uzbekistan as a case study, the consequences of the Aral Sea desiccation and the impact of major industrial centers on atmospheric air quality are analyzed. The study proposes practical recommendations for technological, legal, and socio-economic measures aimed at improving air quality and reducing pollution.

Keywords: atmospheric air, dust pollution, PM2.5, chemical pollutants, ecology, Uzbekistan

Air pollution is one of the most serious global environmental threats, directly affecting human health, quality of life, and environmental sustainability. Rapid industrial development, intensified urbanization, and the increase in the number of vehicles have led to concentrations of harmful substances in the air exceeding permissible levels. According to the World Health Organization, the majority of the

global population lives in conditions with air quality below recommended standards, resulting in millions of premature deaths annually.

In Uzbekistan, air pollution is particularly severe in industrialized areas, densely populated cities, and the Aral Sea region. Air pollution arises from both natural and anthropogenic sources, with human activities being the predominant contributor. The main pollutants include:

- **Suspended particulate matter (PM2.5, PM10):** generated from fuel combustion, construction activities, and transportation;
- **Sulfur dioxide (SO_2) and nitrogen oxides (NOx):** released from power plants and industrial facilities;
- **Carbon monoxide (CO):** emitted by internal combustion engines;
- **Ground-level ozone (O_3):** formed through photochemical reactions.

Industrial facilities, power plants, and boilers are considered stationary sources, while motor vehicles are the primary contributors to urban air pollution. Agricultural activities, including the use of pesticides, mineral fertilizers, and organic waste, also release harmful gases into the atmosphere.

Air pollution has significant health impacts. Harmful substances enter the body through the respiratory system, causing various diseases. Fine particulate matter (PM2.5) penetrates deep into lung alveoli, triggering inflammatory processes that can lead to bronchial asthma, chronic obstructive pulmonary disease (COPD), and lung cancer. Nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) irritate the respiratory tract, exacerbating bronchitis and asthma attacks. Carbon monoxide (CO) binds with hemoglobin 200–300 times more strongly than oxygen, causing hypoxia, which is particularly dangerous for patients with cardiovascular diseases. Long-term exposure can lead to ischemic heart disease, stroke, neurodegenerative disorders (Alzheimer's, Parkinson's), and impaired cognitive development in children.

Air pollution also harms ecosystems. SO_2 and NOx react with water vapor to form sulfate and nitrate acids, leading to acid rain. Acid rain increases soil and water acidity, causing plant mortality, forest degradation, and the death of aquatic organisms. Ground-level ozone (O_3), a strong oxidant, damages plant leaf cells, slows photosynthesis, and reduces crop yields. Dust and soot particles settle on plant leaves, hindering respiration and sunlight absorption. Pollution also accelerates the corrosion of buildings, historical monuments, and metal structures.

Combating air pollution in Uzbekistan requires a comprehensive approach. Effective measures include:

1. **Technological modernization:** replacing outdated industrial technologies with modern, low-emission ones, and improving the efficiency of dust and gas collection equipment; increasing the use of natural gas in power plants and expanding alternative energy sources (solar, wind).

2. **Legislative improvement:** aligning permissible emission limits with international standards, strengthening ecological control, and enforcing the “polluter pays” principle.

3. **Transport reform:** developing public transport (electric buses, metro), creating cycling infrastructure, introducing higher ecological standards for vehicles (Euro-5 and above), and promoting the use of electric cars.

4. **Urban planning and greening:** planning cities with green zones and properly locating industrial areas, creating “green belts,” continuing national tree-planting initiatives, and implementing phytoremediation in the dried Aral Sea region with salt-tolerant plants.

In conclusion, air pollution by particulate matter and chemical substances is a serious global environmental problem with significant negative effects on human health, ecosystem stability, and economic development. The primary sources are industrial,

energy, and transport sectors. In Uzbekistan, this problem is particularly acute in major industrial centers and the Aral Sea region. Its effective solution requires a complex approach combining technological, economic, legal, and social measures. Modernizing industry, adopting “green” technologies, strengthening ecological control, developing public transport, and large-scale greening are key directions for improving air quality. Implementing these measures requires coordinated efforts from the government, businesses, and civil society. Clean air is not only an ecological necessity but also a social value and a responsibility to future generations.

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