



## **Air Pollution and It's Causes in Dhaka City: A Comprehensive Analysis**

<sup>1</sup> *Maruf A Hasan*, <sup>2</sup> *Md. Samiul Islam Shanto*

Veterinary Medicine and Animal Science, Bangabandhu Sheikh Mujibur Rahman Agricultural, University, Gazipur-1706

DOI: <https://doi.org/10.55248/gengpi.4.1123.113134>

### **ABSTRACT**

Air pollution is a significant environmental problem in Dhaka City, Bangladesh, with severe implications for public health and the overall quality of life. This research paper provides a comprehensive analysis of air pollution in Dhaka City, focusing on its causes, sources, and potential solutions. Through the examination of various pollutants, their health effects, and the city's unique geographical and sociodemographic characteristics, this study seeks to shed light on the complex nature of air pollution in Dhaka. Additionally, we explore policy measures and technological interventions to mitigate air pollution and improve air quality in the city.

*Keywords:* Air pollution, causes, Dhaka city, Bangladesh

### **Introduction**

Clean air is among nature's most precious gifts, without which humankind would perish on the planet. However, air pollution is a serious concern. Today, air pollution is slowly harming humanity all across the world, particularly in urban areas. Bangladesh has been plagued by elevated levels of particulate matter in its air for nearly three decades. Recently, Dhaka came in second on the list of cities with one of the worst air quality. The average air quality index (AQI) for the city was 162, which is deemed "unhealthy." Dhaka City, the capital of Bangladesh, has emerged as one of the most densely populated megacities in the world, characterized by rapid urbanization and industrialization. As the city has grown, so has its air pollution problem, making it a critical environmental and public health concern. The sources of air pollution in Dhaka are multifaceted, encompassing vehicular emissions, industrial activities, construction projects, agricultural practices, and even indoor pollution. The population's increasing reliance on fossil fuels for transportation and power generation has exacerbated the issue, leading to elevated levels of pollutants such as particulate matter (PM), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), and ozone (O<sub>3</sub>).

These pollutants pose significant health risks to the city's residents, contributing to a range of respiratory and cardiovascular diseases. Additionally, the adverse effects of air pollution extend beyond health, impacting the environment, climate, and overall quality of life in Dhaka. Thus, understanding the causes and sources of air pollution in Dhaka City is imperative for formulating effective strategies to mitigate this crisis.

### **Objectives**

This research paper seeks to achieve the following objectives:

1. To comprehensively analyze the state of air pollution in Dhaka City: This includes an assessment of air quality, the identification of major pollutants, and an exploration of their health implications.
2. To identify the primary causes of air pollution: This involves investigating the various sectors and activities responsible for emitting pollutants, such as transportation, industry, construction, agriculture, and indoor sources.
3. To explore the sources of pollution within each sector: This entails a detailed examination of the sources and processes within these sectors that contribute to air pollution, providing insights into the underlying mechanisms.
4. To review existing policy measures and technological interventions: This involves an evaluation of the current regulatory framework, government initiatives, and technological solutions aimed at addressing air pollution in Dhaka.
5. To suggest recommendations and future directions: Based on the analysis and findings, this paper aims to propose actionable recommendations for policymakers, urban planners, and stakeholders to mitigate air pollution and improve air quality in Dhaka City, thereby enhancing the overall well-being of its residents and safeguarding the environment.

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## Literature Review

### *Global Air Pollution Trends*

Air pollution is a global challenge that transcends geographical boundaries and affects urban areas worldwide. In recent decades, urbanization, industrialization, and increased vehicular traffic have led to a surge in air pollution levels in many cities across the globe. While Dhaka City faces unique challenges in managing its air quality, it is essential to contextualize its air pollution issues within the broader global trends.

Urban centers worldwide have witnessed escalating levels of air pollutants, including particulate matter (PM), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), and ozone (O<sub>3</sub>). These pollutants are not only harmful to human health but also contribute to climate change, acid rain, and the degradation of ecosystems.

Several key global trends contribute to the worsening air quality in urban areas:

1. **Rapid Urbanization:** The world's urban population is growing at an unprecedented rate, leading to increased energy consumption, transportation demands, and industrial activities concentrated in cities. This urban sprawl intensifies air pollution.
2. **Growing Vehicle Fleet:** The proliferation of automobiles, particularly those powered by fossil fuels, significantly contributes to air pollution. The emissions from vehicles release pollutants into the atmosphere, particularly in densely populated cities.
3. **Industrialization:** The expansion of industrial sectors, often reliant on fossil fuels, results in elevated emissions of pollutants such as SO<sub>2</sub> and NO<sub>2</sub>. These industrial emissions further exacerbate air quality concerns.
4. **Climate Change Impacts:** Climate change itself can worsen air quality by influencing weather patterns, atmospheric circulation, and the dispersion of pollutants. This dynamic interplay between climate change and air pollution creates additional challenges for urban areas.
5. **International Transport:** Long-distance transportation of goods and people via ships and airplanes can also introduce pollutants to urban areas, impacting air quality.
6. **Global Air Mass Movement:** The movement of air masses can transport pollutants over long distances, affecting air quality in regions far from the source of pollution.

Understanding these global air pollution trends is crucial for Dhaka City and other urban areas grappling with similar challenges. It underscores the importance of international collaboration, innovative technologies, and effective policy measures to address the complex and interconnected issue of urban air pollution. Dhaka can draw lessons from global experiences while tailoring solutions to its specific context to improve the quality of life for its residents.

### *Previous Studies on Dhaka's Air Quality*

Numerous research endeavors have focused on assessing and understanding the air quality in Dhaka City, shedding light on the city's air pollution issues, their causes, and their impacts. Some notable findings and key studies on Dhaka's air quality include:

**World Health Organization (WHO) Reports:** The WHO has conducted comprehensive studies on air quality in Dhaka, highlighting the city's persistently high levels of particulate matter (PM) and other pollutants. These reports emphasize the significant health risks posed by Dhaka's air pollution, including links to respiratory diseases and premature mortality.

1. **Department of Environment (DoE), Bangladesh:** The DoE has been actively involved in monitoring and assessing air quality in Dhaka. Their reports provide valuable data on pollutant concentrations, pollution sources, and regulatory efforts to combat air pollution.
2. **BRAC University's Air Quality Monitoring Program:** BRAC University in Dhaka has undertaken extensive research on air quality, including real-time air quality monitoring. Their studies have contributed to a better understanding of the sources of pollution, seasonal variations, and spatial distribution of pollutants in Dhaka.
3. **International Center for Diarrheal Disease Research, Bangladesh (icddr,b):** icddr,b has conducted research linking air pollution to health outcomes, particularly in vulnerable populations, such as children and the elderly, emphasizing the need for targeted interventions.
4. **Academic Research:** Numerous academic institutions and researchers in Bangladesh and abroad have conducted studies on various aspects of Dhaka's air quality, including the impact of vehicular emissions, industrial activities, and construction on air pollution levels.
5. **NGO Reports:** Non-governmental organizations (NGOs) in Dhaka have produced reports highlighting the consequences of air pollution, including its effects on disadvantaged communities and advocacy for cleaner air.

These previous studies collectively underscore the severity of Dhaka's air pollution problem and the urgent need for mitigation measures. They have informed policy discussions, advocacy efforts, and regulatory actions aimed at improving air quality in Dhaka. Nevertheless, the evolving nature of the city's urbanization and industrialization necessitates ongoing research to stay abreast of emerging challenges and assess the effectiveness of pollution control strategies.

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## Methodology

To conduct a comprehensive analysis of air pollution and its causes in Dhaka City, a multi-faceted methodology was employed. The research methodology encompassed data collection, data analysis, and a review of existing literature, as outlined below:

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### Data Collection

1. **Air Quality Monitoring:** Real-time air quality data was collected from various monitoring stations strategically placed throughout Dhaka City. These stations measured key pollutants such as particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), and ozone (O<sub>3</sub>). Historical data spanning several years was obtained to assess temporal trends and seasonal variations in air quality.
2. **Surveys and Interviews:** Surveys and interviews were conducted with residents, experts, and relevant stakeholders to gather qualitative data regarding the perceived impacts of air pollution, public awareness, and insights into potential pollution sources and causes.
3. **Government and NGO Reports:** Reports from government agencies, non-governmental organizations (NGOs), and research institutions were reviewed to access official air quality data, policy measures, and initiatives taken to combat air pollution in Dhaka.
4. **Satellite Imagery:** Satellite imagery was utilized to assess land use changes, urban sprawl, and their potential implications on air quality over time.

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### Data Analysis

1. **Statistical Analysis:** Statistical techniques such as trend analysis, correlation analysis, and regression modeling were employed to examine air quality data, identify pollution trends, and assess potential relationships between pollutants and their sources.
2. **Geospatial Analysis:** Geographic Information System (GIS) tools were used to create maps depicting air quality hotspots, pollutant concentrations in various city sectors, and proximity to pollution sources.
3. **Literature Review:** A comprehensive review of existing literature was conducted to gather information on previous studies, policy initiatives, and technological solutions related to air pollution in Dhaka City.

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### Review Existing Literature

A thorough review of published research papers, reports, policy documents, and academic studies provided valuable insights into the state of knowledge on air pollution in Dhaka. This literature review helped contextualize the research findings and identify gaps in existing research that required further investigation.

By employing a combination of data collection methods, statistical and geospatial analysis, and a review of existing literature, this research aimed to provide a holistic understanding of air pollution in Dhaka City, its causes, sources, and potential solutions, ultimately contributing to informed policy recommendations and strategies for mitigating the city's air quality challenges.

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### Major Air Pollutants in Dhaka

Dhaka City, the capital of Bangladesh, is confronted with persistent and severe air quality challenges that significantly impact the health, well-being, and daily lives of its residents. This overview provides a snapshot of the air quality conditions in Dhaka:

1. **Particulate Matter (PM<sub>2.5</sub> and PM<sub>10</sub>):** Dhaka consistently records high levels of particulate matter, especially PM<sub>2.5</sub> (particles with a diameter of 2.5 micrometers or smaller) and PM<sub>10</sub> (particles with a diameter of 10 micrometers or smaller). These fine and coarse particles originate from various sources, including vehicular emissions, industrial activities, construction dust, and biomass burning. Elevated PM levels are a major concern, as they can penetrate deep into the respiratory system, leading to respiratory diseases, cardiovascular problems, and even premature death.
2. **Nitrogen Dioxide (NO<sub>2</sub>):** Nitrogen dioxide is a key air pollutant in Dhaka, primarily stemming from vehicular emissions and industrial processes. High levels of NO<sub>2</sub> are associated with respiratory issues, inflammation of airways, and increased susceptibility to respiratory infections.
3. **Sulfur Dioxide (SO<sub>2</sub>):** Sulfur dioxide is released into the atmosphere from industrial activities, including the burning of fossil fuels containing sulfur. While SO<sub>2</sub> levels in Dhaka are relatively lower than some other pollutants, they still pose health risks, including respiratory symptoms and aggravation of pre-existing lung conditions.
4. **Carbon Monoxide (CO):** Carbon monoxide is a byproduct of incomplete combustion, primarily from vehicles and industrial sources. It can lead to reduced oxygen transport in the blood, causing headaches, dizziness, and potentially more severe health effects at high concentrations.

5. Ozone (O<sub>3</sub>): Ground-level ozone is a secondary pollutant formed by chemical reactions between precursor pollutants in the presence of sunlight. Dhaka experiences elevated ozone levels, particularly during hot and sunny days. While ozone in the upper atmosphere protects us from harmful UV radiation, ground-level ozone can irritate the respiratory system, exacerbating respiratory conditions.

6. Seasonal Variations: Dhaka City exhibits seasonal variations in air quality. The winter months (November to February) are characterized by increased levels of PM pollutants due to temperature inversions and reduced dispersion. In contrast, the monsoon season (June to October) brings temporary relief as rainfall helps cleanse the air by reducing pollutant concentrations.

7. Health Impacts: The poor air quality in Dhaka has significant health implications. Residents, particularly vulnerable groups such as children, the elderly, and individuals with pre-existing health conditions, are at risk of respiratory illnesses, cardiovascular diseases, and reduced life expectancy due to long-term exposure to air pollution.

8. Environmental Consequences: Air pollution also affects the environment in Dhaka, contributing to smog, acid rain, and damage to vegetation. It poses a threat to biodiversity, water bodies, and the overall ecological balance.

Addressing Dhaka City's air quality challenges requires a multifaceted approach, including stringent emissions regulations, investment in public transportation, the promotion of cleaner technologies, public awareness campaigns, and urban planning strategies that prioritize sustainability and green spaces. Monitoring, research, and data-driven policies are essential for improving air quality and enhancing the overall quality of life in this bustling metropolis.

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## Causes of Air Pollution

Dhaka City, the capital of Bangladesh, faces severe air pollution, and its major causes are multifaceted. Here are some of the primary causes of air pollution in Dhaka City:

1. Vehicular Emissions: Dhaka's rapidly growing population has led to a significant increase in the number of vehicles on the road. The emissions from cars, buses, trucks, and motorcycles, especially those powered by fossil fuels, contribute significantly to air pollution. These emissions release pollutants such as carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), volatile organic compounds (VOCs), and particulate matter (PM).

2. Industrial Activities: Dhaka hosts a wide range of industries, including textile manufacturing, brick kilns, and small-scale factories. These industrial processes often rely on outdated and inefficient technologies, leading to emissions of pollutants like SO<sub>2</sub>, NO<sub>x</sub>, VOCs, and particulate matter.

3. Construction and Demolition: Construction activities in Dhaka are constant due to urban development and infrastructure projects. Dust and particulate matter generated from construction sites, coupled with emissions from construction vehicles, significantly contribute to air pollution.

4. Agricultural Practices: The outskirts of Dhaka are characterized by agriculture, which can lead to emissions of ammonia (NH<sub>3</sub>) and methane (CH<sub>4</sub>) from farming practices, including the use of fertilizers and rice paddies.

5. Solid Waste Management: Inadequate solid waste management and the open burning of garbage release harmful pollutants into the air. Landfills and waste incineration, when not properly managed, can also contribute to air pollution.

6. Brick Kilns: The numerous traditional brick kilns surrounding Dhaka City often use highly polluting technologies, emitting substantial amounts of particulate matter, SO<sub>2</sub>, and CO<sub>2</sub>.

Residential Heating and Cooking: The use of solid fuels such as wood, coal, and biomass for heating and cooking in residential areas releases pollutants like PM and carbon monoxide, especially in areas where cleaner alternatives are unavailable.

7. Traffic Congestion: Dhaka is known for its severe traffic congestion, leading to vehicles idling for extended periods. This exacerbates emissions and contributes to poor air quality.

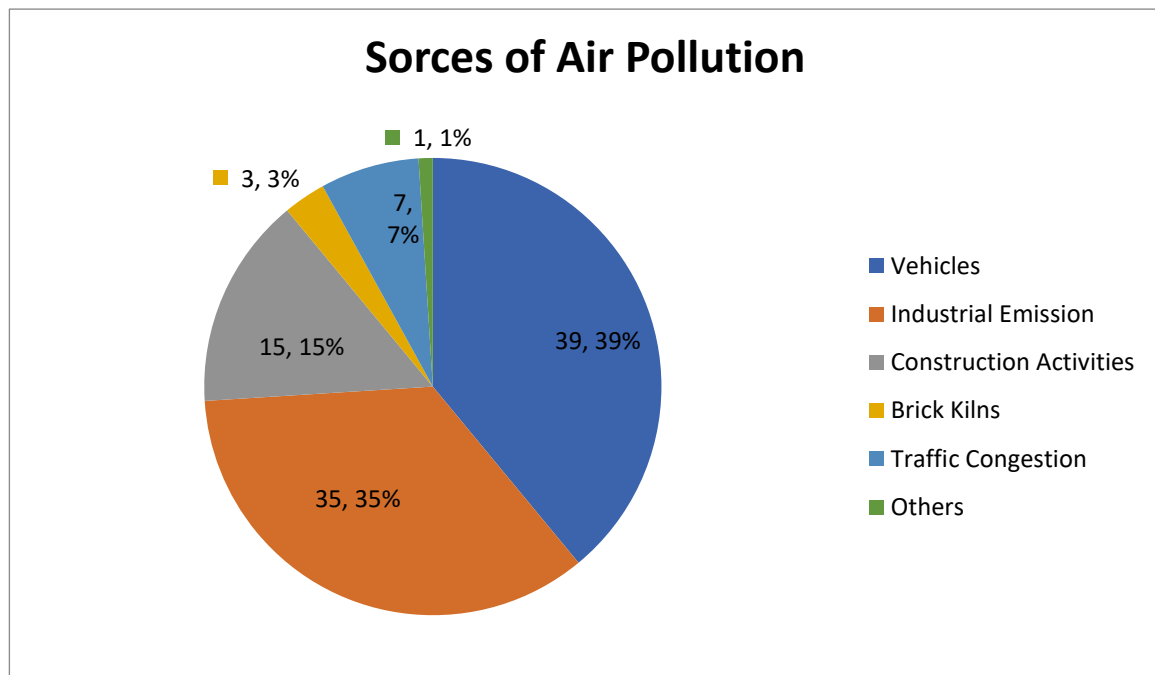
8. Natural Events: Natural events, such as dust storms and seasonal variations in weather conditions, can worsen air quality in Dhaka.

9. Lack of Green Spaces: The city's rapid urbanization has led to a reduction in green spaces and vegetation, which can help absorb pollutants and improve air quality.

10. Topographical Factors: Dhaka's topography and weather patterns, including temperature inversions, can trap pollutants near the ground, exacerbating pollution in certain areas.

11. Lack of Adequate Regulations and Enforcement: While regulations exist to control emissions, enforcement can be lax, allowing some industries and vehicles to operate without adhering to pollution control measures.

Addressing air pollution in Dhaka City requires a concerted effort, including stricter regulations, the promotion of cleaner technologies, investment in public transportation, improved urban planning, and public awareness campaigns. Sustainable development practices and transitioning to cleaner energy sources are vital steps in mitigating air pollution and improving the overall quality of life in the city.

**Figure 2:****Sources of Air Pollution in Dhaka****Policy Measures and Interventions**

Addressing air pollution in Dhaka City requires a multifaceted approach involving policy measures and interventions at various levels of government and society. Here are some key policy measures and interventions that can help mitigate air pollution in Dhaka City:

**Government Initiatives**

The government of Bangladesh, at both the national and local levels, has initiated several measures to address air pollution in Dhaka City and improve air quality. Some key government initiatives include:

- 1. National Clean Air Action Plan:** The government of Bangladesh, in collaboration with international organizations and donors, has developed a National Clean Air Action Plan (NCAAP). This plan outlines a comprehensive strategy for addressing air pollution, setting targets for reducing emissions from key sources and improving air quality. It includes measures to control vehicular emissions, industrial pollution, and solid waste management.
- 2. Air Quality Monitoring Network:** The government has established an air quality monitoring network in Dhaka City, consisting of several monitoring stations that measure various pollutants in real time. This network provides critical data for assessing air quality, identifying pollution sources, and informing policy decisions.
- 3. Vehicle Emission Control:** The government has introduced stricter emission standards for vehicles and implemented measures to reduce vehicular emissions. These include mandatory vehicle inspections, the promotion of compressed natural gas (CNG) as a cleaner fuel, and the encouragement of electric vehicles (EVs).
- 4. Public Transportation Investment:** The government is investing in the expansion and improvement of public transportation systems in Dhaka. This includes the development of mass transit projects like the Dhaka Metro Rail and Bus Rapid Transit (BRT) systems to reduce traffic congestion and encourage the use of public transport.
- 5. Promotion of CNG:** The government has promoted the use of CNG as an alternative fuel for vehicles, which is considered cleaner than traditional gasoline or diesel. CNG refueling stations have been established throughout the city.
- 6. Industrial Emission Control:** The government has implemented stricter regulations for industries, particularly in sectors known for high emissions, such as brick kilns and textiles. These regulations aim to reduce emissions of pollutants like SO<sub>2</sub>, NO<sub>x</sub>, and particulate matter.
- 7. Waste Management Initiatives:** Efforts have been made to improve solid waste management practices, including waste collection, recycling, and waste-to-energy projects, to reduce open burning and landfill emissions.

8. Urban Planning: The government is working on urban planning initiatives to reduce traffic congestion and improve overall city design. This includes the development of green spaces and the promotion of mixed land-use planning.

9. Public Awareness Campaigns: The government, in collaboration with NGOs and civil society organizations, conducts public awareness campaigns to educate residents about the health impacts of air pollution and ways to reduce exposure. These campaigns encourage eco-friendly practices.

10. Renewable Energy Promotion: The government is promoting the use of renewable energy sources, such as solar and wind power, both for residential and industrial use. Incentives and policies support the installation of solar panels and renewable energy projects.

11. Air Quality Index (AQI) Implementation: The government has introduced an Air Quality Index (AQI) to provide the public with easily understandable information about air quality. This helps raise awareness and allows individuals to make informed decisions based on daily air quality conditions.

12. International Collaboration: Bangladesh collaborates with international organizations and neighboring countries to address transboundary air pollution issues. It participates in regional and global initiatives aimed at improving air quality and reducing greenhouse gas emissions.

These government initiatives reflect a commitment to addressing the complex issue of air pollution in Dhaka City. However, the challenge remains substantial, and ongoing efforts and collaborations with various stakeholders are essential to achieving sustained improvements in air quality and public health.

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## Regulatory Framework

The regulatory framework for addressing air pollution in Dhaka City involves a set of laws, regulations, and standards aimed at controlling emissions from various sources and safeguarding air quality. Here is an overview of the regulatory framework:

### 1. The Bangladesh Environment Conservation Act (BECA), 1995:

BECA serves as the overarching environmental law in Bangladesh, providing the legal foundation for addressing various environmental issues, including air pollution.

It empowers the Department of Environment (DoE) to formulate policies, standards, and guidelines to control and manage air pollution.

### 2. National Ambient Air Quality Standards (NAAQS):

The DoE establishes National Ambient Air Quality Standards, setting permissible limits for key air pollutants such as sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>), carbon monoxide (CO), and ozone (O<sub>3</sub>). NAAQS provide a benchmark against which air quality in Dhaka City is measured and regulated.

### 3. Environmental Conservation Rules, 1997:

These rules under BECA empower the DoE to regulate air quality, emission standards, and environmental impact assessments for various projects and industries. Industries are required to obtain environmental clearance certificates, ensuring compliance with emission standards and pollution control measures.

### 4. The Bangladesh Environment Conservation Rules, 1997 (Amended in 2002 and 2007):

The rules specify emission standards for different industries, including power plants, brick kilns, textile mills, and other potential sources of air pollution. They outline procedures for obtaining environmental clearance and require industries to implement pollution control measures.

### 5. Motor Vehicle Emission Standards:

The government has established emission standards for vehicles to control air pollution from the transportation sector. These standards set limits for pollutants emitted from vehicles, and compliance is mandatory for vehicle registration and operation.

### 6. CNG Conversion Policy:

The government has implemented a policy promoting the use of Compressed Natural Gas (CNG) as a cleaner alternative to traditional fuels in vehicles. The policy encourages the conversion of vehicles to CNG and the establishment of CNG refueling stations.

### 7. Industrial Policies and Guidelines:

Specific policies and guidelines are in place for various industries, prescribing emission standards and pollution control measures. Industries are required to submit environmental management plans, detailing measures to minimize environmental impacts, including air pollution.

### 8. The Building Construction Act (Amendment), 2006:

This legislation addresses construction activities and requires developers to adopt dust control measures during construction projects to minimize air pollution.

### 9. Waste Management Regulations:

Regulations exist for the proper management and disposal of solid waste to prevent open burning and reduce air pollution associated with waste.

#### **10. Legal Provisions for Penalties and Enforcement:**

The regulatory framework includes provisions for penalties and legal action against individuals, industries, or entities violating environmental laws and standards.

The DoE is responsible for monitoring and enforcing compliance.

#### **11. Air Quality Index (AQI) Implementation:**

The introduction of the AQI system provides a simplified way to communicate air quality information to the public, facilitating regulatory enforcement and public awareness.

#### **12. International Agreements and Commitments:**

Bangladesh has committed to international agreements and protocols aimed at addressing regional and global air quality issues, reflecting its recognition of the transboundary nature of air pollution.

Effective implementation, enforcement, and regular updates to these regulations are crucial for ensuring that the regulatory framework remains responsive to the evolving challenges of air pollution in Dhaka City. Continuous collaboration between government agencies, stakeholders, and the public is essential for achieving sustainable improvements in air quality.

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### **Future Directions and Recommendations**

Looking ahead, addressing air pollution in Dhaka City requires a comprehensive and sustained effort. Strengthening and enforcing existing regulations is paramount, necessitating periodic reviews and updates to align with evolving environmental challenges. Simultaneously, substantial investments in public transportation infrastructure, such as the completion of mass transit projects and the promotion of electric vehicles, can significantly reduce vehicular emissions. Industrial practices must undergo a technological shift towards cleaner alternatives, supported by financial incentives and capacity-building programs. Waste management should embrace advanced strategies, emphasizing waste-to-energy projects and community-based initiatives. Green urban planning, incorporating more green spaces and sustainable building practices, can mitigate pollution from construction activities and enhance overall air quality. Engaging communities through awareness campaigns and encouraging local participation in initiatives like tree planting fosters a sense of shared responsibility. Additionally, prioritizing research and innovation in pollution control technologies will drive sustainable solutions. Ultimately, a collaborative approach, involving government agencies, businesses, communities, and individuals, is essential for Dhaka City to realize these future directions and create a healthier and more sustainable urban environment.

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### **Conclusion**

In conclusion, the air pollution challenges in Dhaka City demand immediate attention and concerted efforts to safeguard the well-being of its residents and the environment. The multifaceted nature of air pollution requires a holistic approach encompassing stringent regulations, sustainable urban planning, and proactive public engagement. Despite the progress made through existing initiatives, the city must focus on strengthening regulatory frameworks, particularly in the areas of industrial emissions, vehicular pollution, and construction practices. Investments in efficient public transportation systems, the promotion of electric vehicles, and advancements in waste management are critical for mitigating pollution from major sources. Green urban planning and the integration of green spaces can contribute significantly to improving air quality and enhancing the overall quality of life. Moreover, fostering public awareness and community engagement is essential in creating a collective consciousness about the importance of individual actions in reducing pollution. As Dhaka City navigates towards a sustainable future, collaboration among government agencies, businesses, academia, and citizens will be pivotal in implementing these recommendations and creating a cleaner, healthier, and more resilient urban environment for generations to come.

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