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Air Quality Monitoring and Pollution Mitigation Strategies in Aerocity,Delhi : A Case Study of PM10 & PM 2.5 Control Measures

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Abstract: In recent years, New Delhi and its surrounding districts have experienced a significant increase in air pollution, especially during the winter season, with the construction sectors identified as a major contributor. Large-scale construction projects in Aero city, New Delhi, combined with airport operations result in a significant amount of particulate matter and other pollutants, which are adversely impacting the air quality in the region. This study examines the pre-construction pollution levels of an under-construction site in Aerocity and evaluates the efficacy of various pollution control techniques employed during the construction period. The research demonstrates how airport operations and building activities both seriously endanger the health of the local population and contribute to environmental degradation. This research analyses the alterations in air quality prior to and during mitigation initiatives, offering essential insights into the efficacy of current measures and their impact on human health. The results highlight the necessity for improved pollution control strategies and regulatory measures to reduce the environmental impact of urban development in high-traffic areas.

Keywords: Air Pollution, Construction Pollution, Particulate Matter (PM), Air Quality Monitoring, Pollution Mitigation

I. Introduction

Air pollution is one of the most pressing environmental concerns, particularly in increasingly urbanizing regions. In cities like New Delhi, where industrial activities, construction, and increasing vehicular emissions converge, air quality often deteriorates to hazardous levels, especially during the winter months. Among the contributors to this pollution, the construction sector plays a significant role, releasing large amounts of particulate matter (PM10 and PM2.5) into the atmosphere.

India has enacted various rules and regulations aimed at managing air quality in response to the escalating pollution challenge. The primary legislation governing air pollution in the nation, the **Air (Prevention and Control of Pollution) Act, 1981**, aimed at preventing, controlling, and abating air pollution across the country. Furthermore, to protect public health, the Central Pollution Control Board (CPCB) created the **National Ambient Air Quality Standards (NAAQS),** which regulate allowed levels for a variety of pollutants, including particle matter. In regions like New Delhi, the **Graded Response Action Plan (GRAP)** is also enacted, particularly during winter, to control emissions based on pollution levels, with specific actions targeting construction activities and vehicular emissions. The Aerocity area of New Delhi, with its large-scale construction projects and proximity to Indira Gandhi International Airport, has become a focal point for examining the intersection of urban development and air pollution.

The ongoing construction of extra runways and infrastructure has raised questions about how the surrounding air quality might get compromised posing hazards to the public's health as well as the environment.

- **Construction Sector's Role in Pollution**: Large-scale construction projects in Aerocity generate significant amounts of particulate matter, which contributes to an existing serious air quality issue in New Delhi.
- **Health and Environmental Risks:** Increased levels of PM10 and PM2.5 have an adverse impact on public health, elevating the risk of respiratory disorders and long-term health problems.

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- **Construction in High-Traffic Zones:** The combination of construction activity and airport operations creates a unique challenge in mitigating pollution in such a densely trafficked area.
- **Relevant Regulations:** The Air Act, NAAQS, and GRAP form the regulatory framework addressing air pollution in Delhi, with specific provisions for controlling emissions from construction activities.
- **Measures of Mitigation:** A major emphasis of this research is how well-effective the present dust mitigation techniques are at lowering particle matter.

II. Research Problem

In recent years, Delhi and its surrounding areas have experienced a significant increase in pollution levels during the winter months, primarily driven by the construction sector. This study examines the pre-construction pollution levels at a construction site that is currently under way and assesses the efficacy of air pollution reduction strategies that have been put in place.

III. Objective

The objective of this research is to comprehensively analyse the sources of air pollution in the Aerocity region, examining the processes that lead to the production of pollution. This research additionally aims to evaluate the efficacy of preventive measures in addition to the application of the National Green Tribunal (NGT) guidelines, the Air (Prevention and Control of Pollution) Act of 1981, and other pertinent legislative frameworks.

The goal of the research is to further comprehend these contributing factors with the objective provide proposals for improving air quality management measures in the region and increasing regulatory compliance.

IV. Methodology

The methodology for this research is designed to provide a structured approach to air quality evaluation, incorporating the following key steps:

- **Location Selection:** Identify and select strategic sites in the Aerocity area for sensor placement, focusing on heavy-traffic and areas under construction.
- **Process of Monitoring Air Quality:** Analyse the technologies and procedures employed to monitor air quality, including the various types of sensors used and data collection protocols.
- **Pollution Source Identification:** Investigate and categorize the various sources of air pollution, such as construction activities, vehicular emissions, and industrial outputs.
- **Monitoring Frequency:**
  Determine the optimal frequency for air quality measurements in order to record temporal fluctuations, particularly during peak construction phases.
- **Control Measure Evaluation:** Examine current and prospective controls intended to reduce the adverse impacts of air pollution in the construction sector.
- **Collaboration with NABL-Approved Agencies:** Engage NABL-accredited external agencies to provide quality control for data validation and monitoring procedures.

V. Area Study

This research focuses on the Aerocity region of New Delhi, a rapidly developing urban area located adjacent to the Indira Gandhi International Airport. The area is known for its enormous construction activities that contribute significantly to air pollution, compounded by emissions from air traffic. The severe degradation of air quality, particularly during the winter months, poses significant public health risks. The purpose of this research is to evaluate the air quality challenges faced by Aerocity and evaluate the effectiveness of existing mitigation measures.

VI. Machinery Used

PM10 Samplers:

A PM10 sampler is a device used to collect particulate matter with a diameter of 10 micrometres or smaller (PM10) from the air.

PM10 samplers are made to collect airborne particulates by a variety of techniques, including impaction and filtering. They typically operate by

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drawing ambient air through a filter that captures particles while allowing larger particles to pass through. PM10 particles can penetrate the respiratory system and may cause various health issues, including asthma, cardiovascular diseases, and other respiratory problems. PM10 samplers are crucial instruments for tracking air quality, evaluating health hazards to the environment, and guiding the formulation of air pollution control strategy.

Figure 1: Depicts the PM10 sampler, which is employed to monitor air quality by capturing PM10 particles from the atmosphere.

PM2.5 Samplers:

A PM2.5 sampler is a device designed to collect particulate matter with a diameter of 2.5 micrometres or smaller (PM2.5) from the air.

These fine particles can originate from various sources, including combustion processes, industrial pollutants, automobile exhaust and are known to have significant health impacts. The concentration and content of the gathered particles can then be ascertained through analysis.

PM2.5 sampling adheres to standards set by regulatory bodies like the U.S. Environmental Protection Agency (EPA) and the World Health Organization (WHO) to ensure accuracy and reliability. PM2.5 particles can penetrate deep into the respiratory system and are associated with serious health effects, including respiratory and cardiovascular diseases, and may contribute to premature mortality.

Figure 2: Represents the PM2.5 sampler, highlighting its role in assessing air quality and understanding pollution impacts.

VII. Investgation & Analysis

Monitoring at Aerocity Area

- All vehicles operating in phases 1 and 2 of Aerocity are certified under the Pollution Under Control (PUC) program.
- Surveillance cameras and environmental sensors have been strategically installed at three key locations within Aerocity:
- Near the Exit Gate of Aerocity
- Along Manhattan Road
- On North Avenue Road
- BSES supply meters have been installed to monitor energy consumption and facilitate effective resource management.

VIII. Dust Mitigation Measures In Aerocity Phase 2

This section describes the many tactics and procedures used to reduce dust emissions when Aerocity Phase 2 was being built. In order to reduce the negative effects on the environment and protect public health, efficient dust mitigation techniques are essential given the substantial building activity occurring in the area.

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- **Water Sprinkling:** To reduce dust and keep it from becoming airborne, water is sprayed over building sites on a regular basis.
- **Use of Dust Suppressants:** In order to reduce the amount of dust produced by unpaved areas, chemical dust suppressants are applied to surfaces.
- **Covering Material Stockpiles:** To prevent dust from escaping, make sure that loose materials include sand and gravel are covered.
- **Traffic Management:** In order to reduce the amount of dust produced by moving cars, speed limits for on-site and access roads should be implemented.
- **Vegetation and Barriers:** Planting vegetation or building barriers around construction sites can serve as windbreaks and reduce the amount of dust that is dispersed.

Figure 3 a: Dust mitigation measures are taken at the under-construction area of Aerocity

Figure 4b: Dust mitigation measures are taken at the under-construction area of Aerocity

Figure 4c: Dust mitigation measures are taken at the under-construction area of Aerocity

IX. RESULTS

PM10 SAMPLER

January-2024

- **Significant Exceedance**: The baseline level of 430 µg/m³ significantly exceeds the NAAQ limit of 100 µg/m³ by 330 µg/m³. This indicates a serious air quality issue in the Aerocity region.
- **Health Implications:** The local population may be significantly at risk for respiratory disorders, cardiovascular diseases, and other health problems as a result of these high PM10 levels. Children, the elderly, and people with underlying medical disorders are among the vulnerable categories who are more vulnerable.
- **Environmental Concerns:** When the NAAQ standards are exceeded, it is possible that the region is suffering from negative environmental effects, such as damage to the biodiversity and local ecosystems as a result of excessive particulate matter levels.
- **Policy Implications:** The data may necessitate action from regulatory authorities to implement stricter regulations, enhance monitoring, and enforce compliance among local industries and construction activities.

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PM10 (µg/m3)					
	Aerocity				
Monitoring Date	03-01-2024	10-01-2024	17-01-2024	24-01-2024	31-01-2024
Jan-24	339	355	439	354	133
Baseline	430				
NAAQ Limit	100	100	100	100	100

Table 1 – PM 10 Results Jan-2024

PM10 (µg/m3)				
	Aerocity			
Monitoring Date	07-02-2024	14-02-2024	21-02-2024	28-02-2024
Feb-24	165	327	154	123
Baseline	430			
NAAQ Limit	100	100	100	100

Figure 4 PM-10 Results Graph Jan-2024

PM2.5 SAMPLER

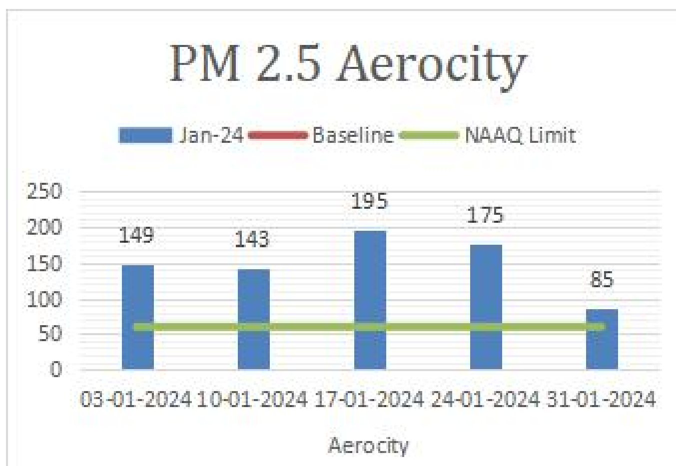
Similar to the PM10 results, the PM2.5 values indicate that the baseline concentration of PM2.5 in Aerocity is 218 µg/m³, while the National Ambient Air Quality (NAAQ) limit for PM2.5 is 60 µg/m³.

- **Significant Exceedance:** The baseline PM2.5 level of 218 µg/m³ is 158 µg/m³ higher than the 60 µg/m³ NAAQ limit. This large exceedance suggests that the Aerocity area is experiencing a serious air quality problem.
- **Health Implications:** Numerous health conditions including as respiratory disorders, cardiovascular diseases, and higher death rates, are linked to high levels of PM2.5. People who suffer from asthma, heart problems, or other long-term ailments are more at risk.
- **Environmental Concerns:** Increased PM2.5 concentrations can aggravate environmental problems

such acid rain, decreased vision, and damage to flora and fauna. Additionally able to enter the circulation and go deep into the lungs, fine particulate matter can have an impact on the health of the ecosystem as a whole.

PM2.5(µg/m3)					
	Aerocity				
Monitoring Date	03-01-2024	10-01-2024	17-01-2024	24-01-2024	31-01-2024
Jan-24	149	143	195	175	79
Baseline	218				
NAAQ Limit	60	60	60	60	60

Table 5 – PM 2.5 Results Jan-2024



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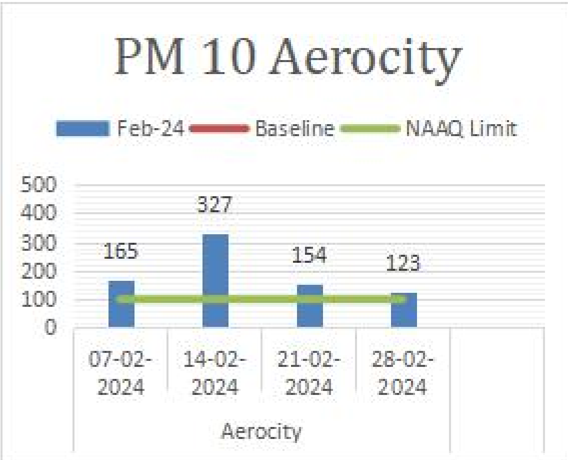
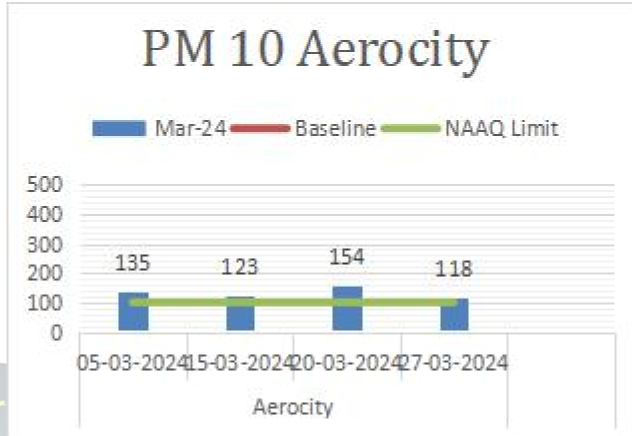
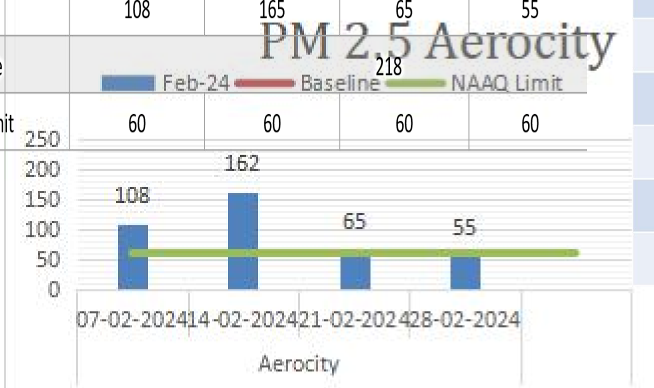


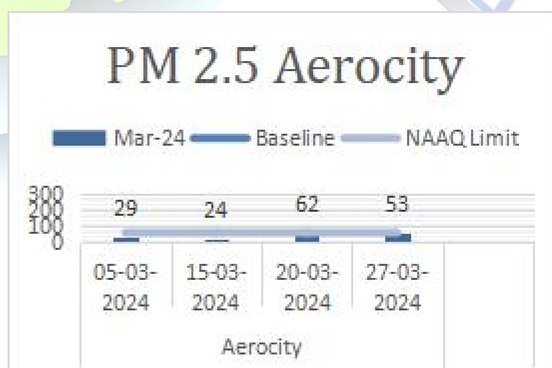


PM2.5(µg/m3)				
	Aerocity			
Monitoring Date	07-02-2024	14-02-2024	21-02-2024	28-02-2024
Feb-24	108	165	65	55
Baseline	218			
NAAQ Limit	60	60	60	60



PM2.5(µg/m3)				
	Aerocity			
Monitoring Date	05-03-2024	15-03-2024	20-03-2024	27-03-2024
Mar-24	29	24	80	52
Baseline	218			
NAAQ Limit	60	60	60	60

March-2024 Observations



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PM10 (µg/m3)				
	Aerocity			
Monitoring Date	05-03-2024	15-03-2024	20-03-2024	27-03-2024
Mar-24	70	55	118	105
Baseline	430			
NAAQ Limit	100	100	100	100

X. Conclusion

This dissertation has thoroughly examined the critical aspects of air quality monitoring, emphasizing its vital role in public health, environmental sustainability, and policy development. Through an in-depth analysis of various monitoring technologies, data collection methods, and statistical techniques, the research has yielded several key findings and recommendations.

Firstly, the integration of advanced sensor technology and IoT (Internet of Things) systems has revolutionized air quality monitoring, allowing for real-time data collection and more precise spatial and temporal resolution. The deployment of low-cost sensors in combination with traditional monitoring stations has been demonstrated to enhance the accuracy and coverage of air quality data, making it more accessible.

Secondly, the study underscores the importance of data quality assurance and the need for robust calibration and validation processes. High-quality, reliable data is crucial for accurate assessment and modeling of air pollution, which in turn informs effective policy and intervention strategies. The dissertation's case studies illustrate the successful implementation of calibration techniques and their impact on improving data reliability.

Thirdly, statistical analysis and machine learning models have proven to be invaluable in interpreting complex air quality datasets. These tools facilitate the identification of pollution sources, trends, and patterns, enabling more targeted and efficient mitigation measures. Predictive models, in particular, have shown potential in forecasting pollution events, thereby providing early warnings and allowing for proactive public health responses.

Moreover, the research emphasizes the role of public engagement and community-based monitoring initiatives. Empowering surrounding (Aerocity) citizens with the tools and knowledge to monitor air quality can foster greater environmental awareness and drive grassroots-level advocacy for cleaner air policies. Due to the dust mitigation measures such as covering of loose pulverized materials and continuous sprinkling along with the strict monitoring of the vehicles pollution emission it is evident from the finding of the investigation that the PM-10 & PM-2.5 levels are below the baseline. In conclusion, this dissertation contributes to the growing body of knowledge on air quality monitoring by providing comprehensive insights into technological advancements, data management practices, and analytical methodologies. Future research should continue to explore the integration of emerging technologies such as AI and machine learning, the expansion of monitoring networks, and the development of more sophisticated models to predict and mitigate air pollution. Through collaborative efforts between scientists, policymakers, and the public, significant strides can be made towards achieving cleaner air and healthier environments.

XI. Abbreviations & Acronyms

- **PM10 and PM2.5** are terms used to describe particulate matter in the air, specifically referring to particles with diameters of 10 micrometers (µm) or less (PM10) and 2.5 micrometers or less (PM2.5). These particles are small enough to be inhaled into the respiratory system and can have various adverse health effects.
- **NAAQ - National Ambient Air**

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Quality

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