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ANALYZING THE AIR QUALITY IN THE URBAN AREAS: STUDY, SOURCES AND SOLUTIONS

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ABSTRACT

Urban areas face significant challenges when it comes to air pollution and its impact on public health. This dissertation aims to study the air pollution levels in urban areas, identify the major sources of pollution, and propose measures to improve air quality and protect public health.
To achieve this, comprehensive air quality monitoring will be conducted in selected urban areas, collecting data on various pollutants such as particulate matter, nitrogen oxides, and volatile organic compounds. The data will be analyzed to determine the pollution levels and their spatial and temporal variations.
Next, a thorough investigation will be carried out to identify the major sources of air pollution in these urban areas. This will involve analyzing emission inventories, conducting source apportionment studies, and considering factors such as industrial activities, vehicular emissions, and residential sources.
Based on the findings, a set of measures will be proposed to mitigate air pollution and improve air quality. These measures may include stricter emission standards for industries and vehicles, promoting the use of cleaner energy sources, implementing effective transportation management strategies, and raising public awareness about the importance of reducing pollution.
The proposed measures aim to not only reduce air pollution levels but also safeguard public health. By improving air quality in urban areas, we can create healthier living environments, reduce the risk of respiratory diseases, and enhance the overall well-being of urban residents.

Keywords: *air quality, urban areas, pollution sources, public health, emission reduction measures.*

INTRODUCTION

Urbanization has led to unprecedented growth and development in cities worldwide, transforming them into hubs of economic activity, innovation, and cultural exchange. However, this rapid urban expansion has come at a cost, with air pollution emerging as a significant environmental and public health challenge in many urban areas. The city of Ahmedabad, situated in the western state of Gujarat, India, exemplifies this complex interplay between urbanization and air quality degradation.

Ahmedabad, once renowned for its rich cultural heritage and vibrant economy, has experienced rapid population growth and industrialization over the past few decades. This urban transformation has brought about profound changes in the city's landscape, characterized by the proliferation of industrial zones, vehicular traffic congestion, and construction activities. While these developments have contributed to the city's economic prosperity, they have also exerted immense pressure on its air quality, posing serious risks to the health and well-being of its residents.

To address the pressing need for a comprehensive understanding of air quality issues in Ahmedabad, this research paper aims to analyze various facets of urban air pollution, ranging from sources of pollution to potential solutions for mitigation. By drawing upon multidisciplinary expertise and empirical evidence, this study seeks to shed light on the underlying drivers of poor air quality in Ahmedabad and provide actionable insights for policymakers, researchers, and stakeholders.

Throughout this paper, we will explore the diverse sources of air pollution in Ahmedabad, including industrial emissions, vehicular exhaust, construction activities, and agricultural

practices. We will examine the health impacts of poor air quality on the city's residents, with a particular focus on vulnerable populations such as children, the elderly, and low-income communities. Furthermore, we will analyze the effectiveness of existing government policies and interventions aimed at mitigating air pollution in Ahmedabad, while also exploring the role of community engagement and technological innovations in addressing this critical issue.

In undertaking this research, we recognize the importance of collaboration and knowledge exchange among diverse stakeholders, including government agencies, academic institutions, non-governmental organizations (NGOs), and the local community. By working together to better understand the complexities of urban air pollution in Ahmedabad, we can develop evidence-based strategies and interventions to safeguard public health, promote environmental sustainability, and enhance the quality of life for all residents.

India AQI categories and its effect (Central Pollution Control Board, New Delhi, 2020).

REVIEW

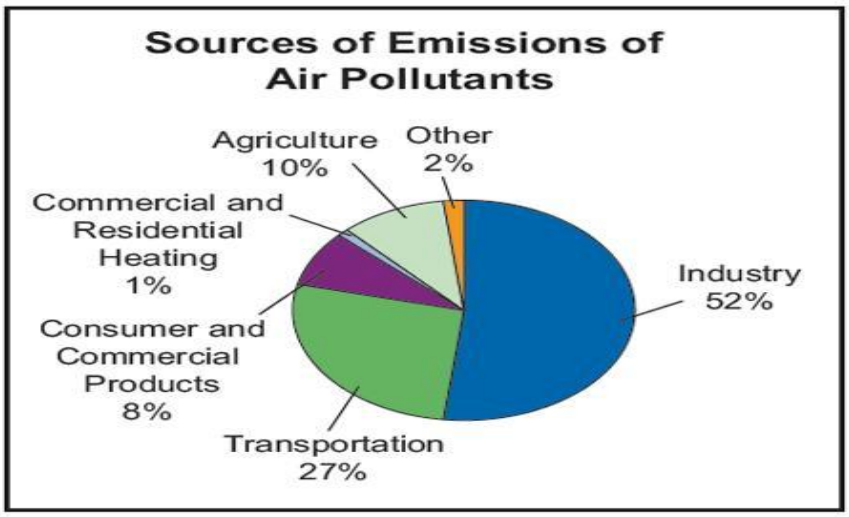
Urban air pollution is a global challenge with significant implications for public health, environmental sustainability, and socioeconomic development. In the context of Ahmedabad, several studies have investigated various aspects of air quality, shedding light on the sources, impacts, and mitigation strategies associated with urban air pollution. This review synthesizes key findings from relevant literature, providing insights into the dynamics of air quality in Ahmedabad and highlighting areas for further research and intervention.

Sources of Air Pollution

Studies have identified multiple sources of air pollution in Ahmedabad, ranging from industrial emissions to vehicular exhaust and biomass burning. **Gupta et al. (2020)** conducted an air quality assessment in Ahmedabad and identified industrial activities as a major contributor to particulate matter (PM) and gaseous pollutants in the city's ambient air. The study highlighted the importance of stringent emission standards and pollution control measures for mitigating industrial pollution.

Similarly, **Patel et al. (2019)** focused on vehicular emissions and their impact on urban air quality in Ahmedabad. Through a comprehensive analysis of vehicle emissions data, the study revealed the significant role of transportation sector in contributing to air pollution, particularly in terms of nitrogen oxides (NOx) and volatile organic compounds (VOCs). The

findings underscored the need for promoting cleaner transportation technologies and improving traffic management strategies to reduce vehicular emissions.



Health Impacts

The health effects of poor air quality in Ahmedabad have been extensively studied, with research indicating a strong association between air pollution exposure and respiratory diseases, cardiovascular ailments, and other adverse health outcomes. **Desai and Shah (2018)** conducted a comprehensive review of air pollution and its health effects in Ahmedabad, synthesizing findings from epidemiological studies and health impact assessments. The review highlighted the disproportionate burden of air pollution on vulnerable populations, including children, the elderly, and individuals with pre-existing health conditions.

Government Policies and Interventions

In response to growing concerns about air pollution, both at the national and local levels, several policy initiatives and interventions have been implemented in Ahmedabad. The National Clean Air Program (**NCAP**), launched by the Ministry of Environment, Forest and Climate Change (**MoEFCC**), includes Ahmedabad as one of the priority cities for air quality improvement measures (**MoEFCC, 2021**). The NCAP action plan for Ahmedabad outlines a series of measures, including stricter emission standards, enhanced vehicular inspections, and promotion of cleaner fuels, aimed at reducing air pollution levels in the city.

Community Engagement and Participation

Community engagement and public participation have emerged as crucial components of air quality management strategies in Ahmedabad. NGOs, community organizations, and citizen groups have been actively involved in air quality monitoring, awareness campaigns, and advocacy efforts. These initiatives have helped raise awareness about the health impacts of air pollution and mobilize support for policy changes and pollution control measures.

Technological Solutions and Innovations

Advancements in technology offer promising opportunities for improving air quality in Ahmedabad. Smart city solutions, such as real-time air quality monitoring systems and data-driven decision-making tools, can provide valuable insights for policymakers and urban planners. Additionally, the deployment of clean energy technologies, such as solar power and electric vehicles, can help reduce reliance on fossil fuels and mitigate air pollution emissions.

Source (Review)

Study Area

Ahmedabad is the largest city in Gujarat State with a population of 6.5 million15. It is the leading industrial and commercial capital of the State. The city lies on 230 1' North Latitude

and 720 37' East Longitude on the bank of River of Sabarmati. The city is well connected by rail, roads and airways with all the important cities of the country. It is the seventh largest city of the country with an area of 464 Square Kms14.
Ahmedabad is administered by Ahmedabad Municipal Corporation (AMC), which was established in July, 1950 under the Bombay Provincial Corporation Act, 1949. The peripheral area surrounding the city is under the administration of Ahmedabad Urban Development Authority. The municipal corporation area has been divided into 6 zones.

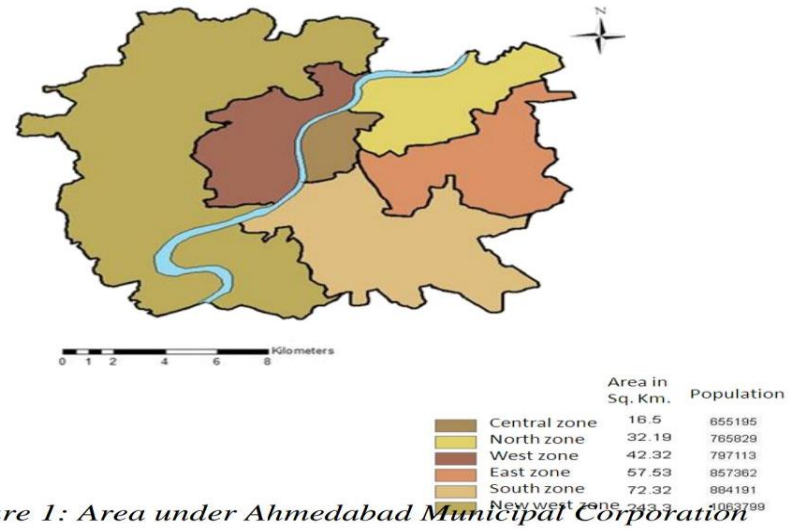
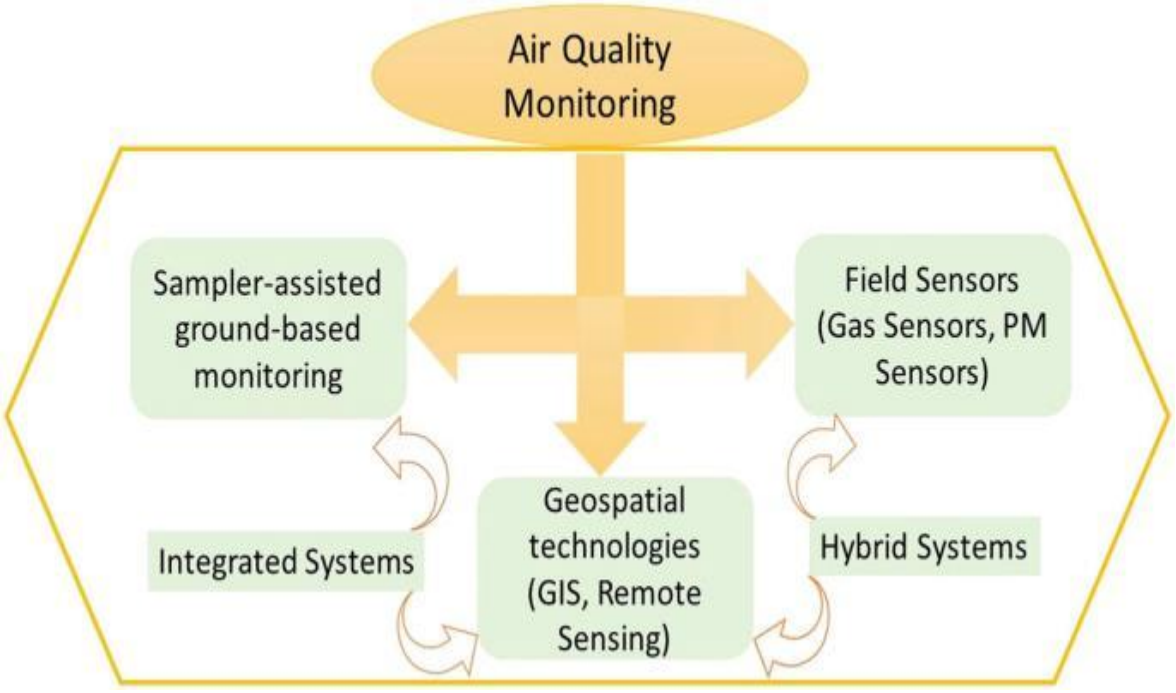
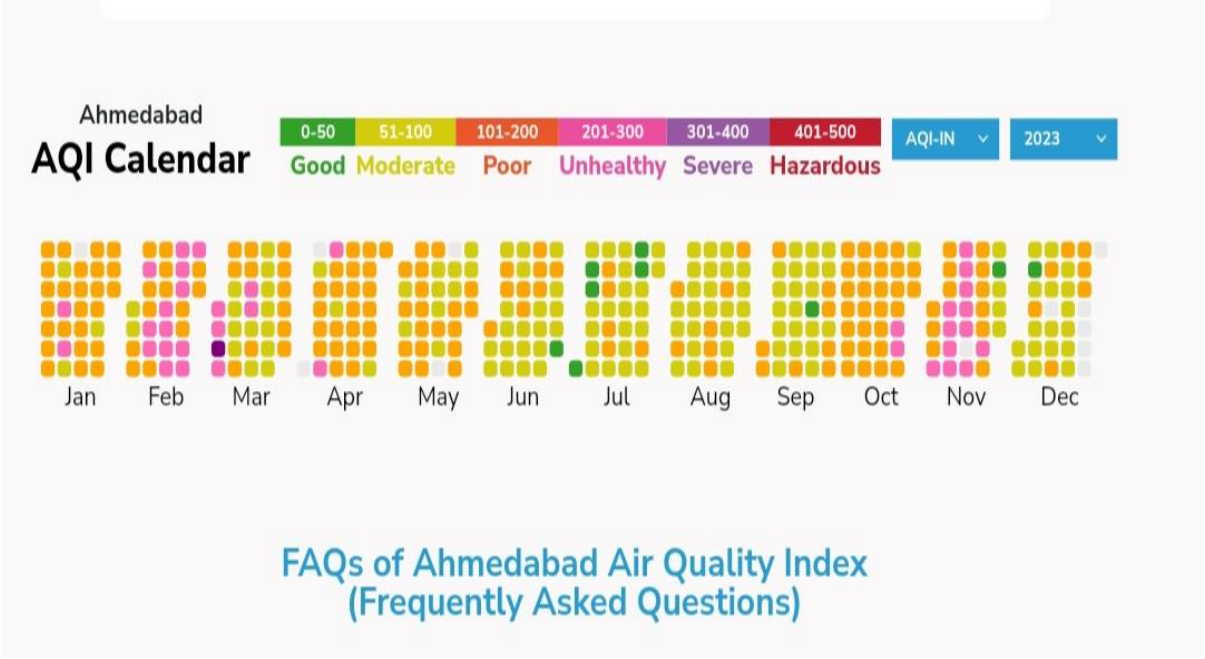
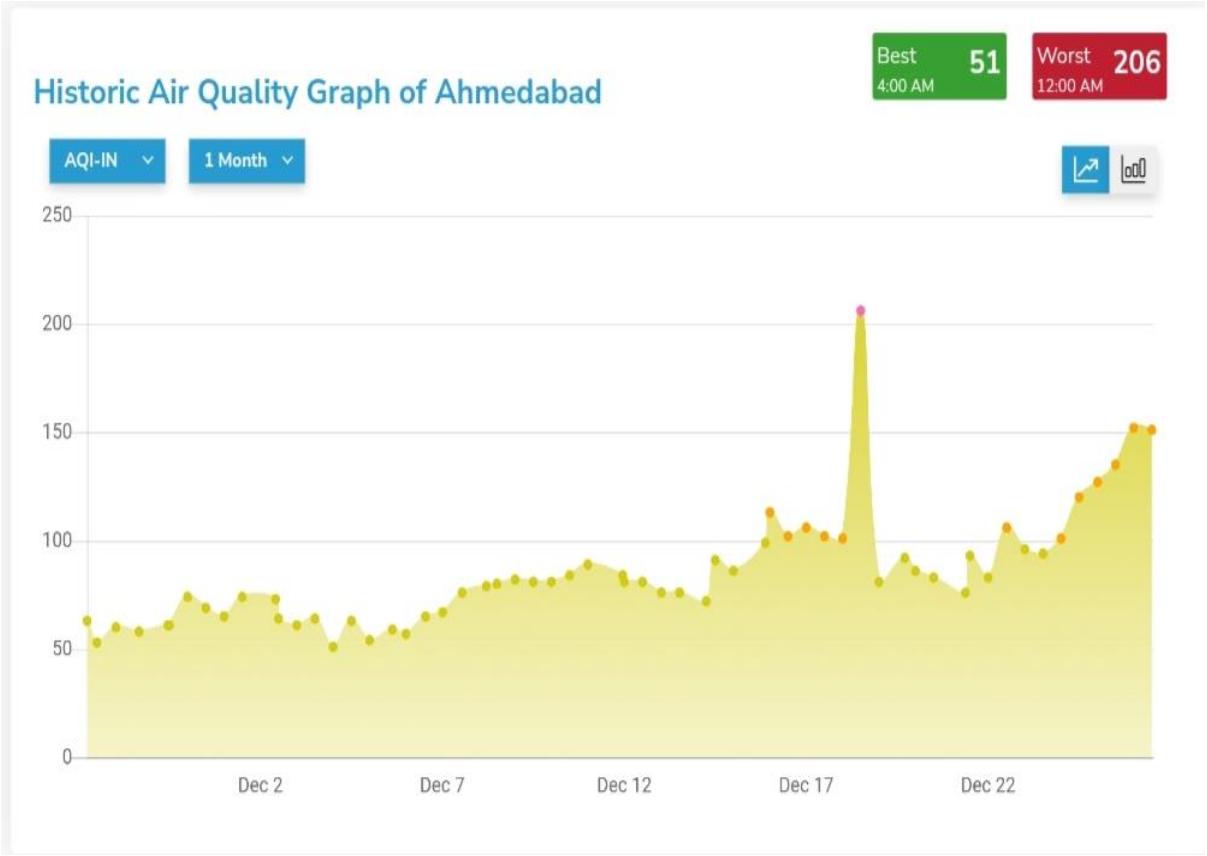


Figure 1: Area under Ahmedabad Municipal Corporation

Air Quality Monitoring Data
To analyze the air quality in Ahmedabad, we utilized data obtained from multiple sources, including government-operated air quality monitoring stations, research institutions, and academic studies. The air quality monitoring data encompassed parameters such as particulate matter (PM10 and PM2.5), nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), ozone (O3), and volatile organic compounds (VOCs). The data spanned multiple years to capture temporal variations and seasonal trends in air pollution levels.



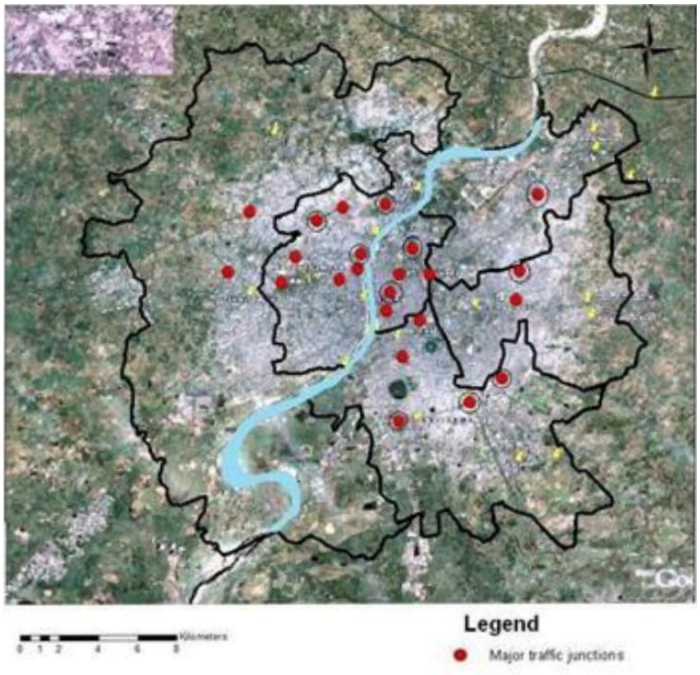

Ahmedabad
AQI Calendar
0-50
51-100
101-200
201-300
301-400
401-500
Good
Moderate
Poor
Unhealthy
Severe
Hazardous
AQI-IN
2023
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
FAQs of Ahmedabad Air Quality Index
(Frequently Asked Questions)


Historic Air Quality Graph of Ahmedabad
Best
51
4:00 AM
Worst
206
12:00 AM
AQI-IN
1 Month
250
200
150
100
50
0
Dec 2
Dec 7
Dec 12
Dec 17
Dec 22

RESULT AND DISCUSSION

Data Analysis

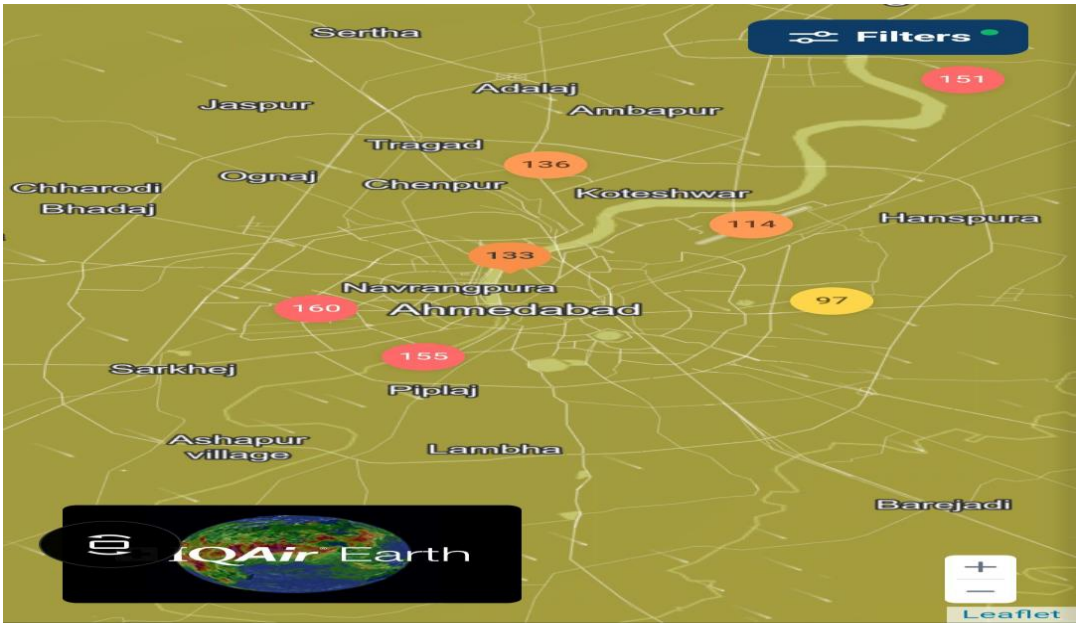
The air quality data were analyzed using statistical methods and geographic information system (GIS) techniques to assess spatial distribution patterns and identify hotspots of air pollution in Ahmedabad. Descriptive statistics, including mean, median, and standard deviation, were calculated for each pollutant to characterize their concentration levels.



Temporal analysis involved examining daily, monthly, and seasonal variations in air quality parameters to identify trends and fluctuations over time.

Spatial Mapping

GIS-based mapping techniques were employed to visualize the spatial distribution of air pollution across different areas of Ahmedabad. Spatial interpolation methods, such as kriging and inverse distance weighting (IDW), were used to generate interpolated surfaces of air quality parameters, providing insights into the spatial patterns and gradients of pollution levels within the city.



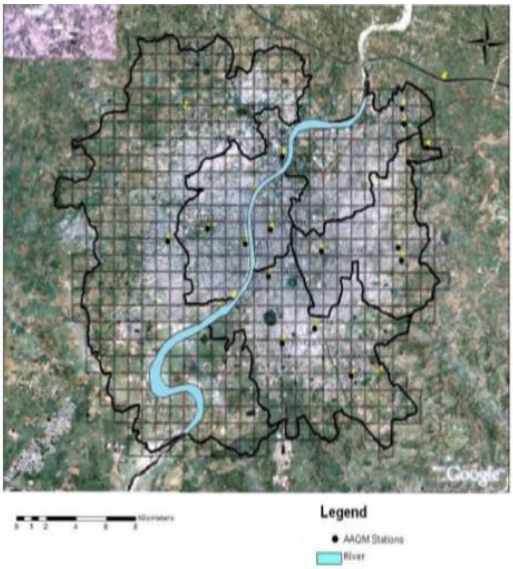


Figure 9: Formation of grid on city area

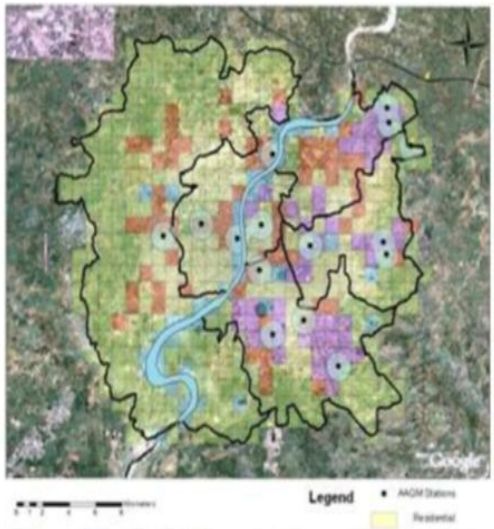


Figure 11: 1 km buffer around monitoring stations Influence zone – 37 sqm

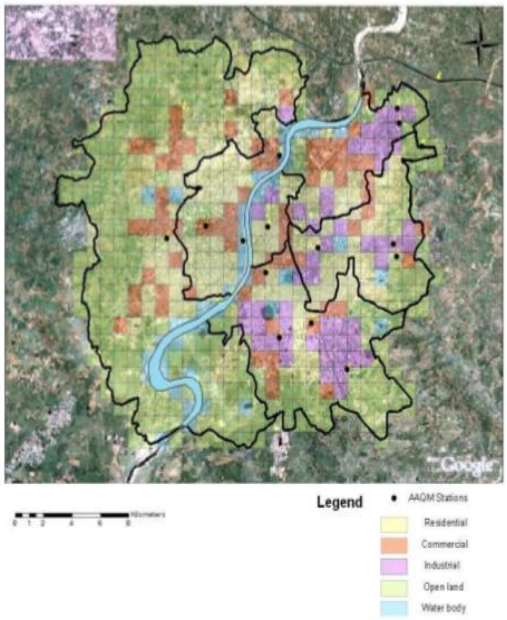


Figure 10: Landuse and grid

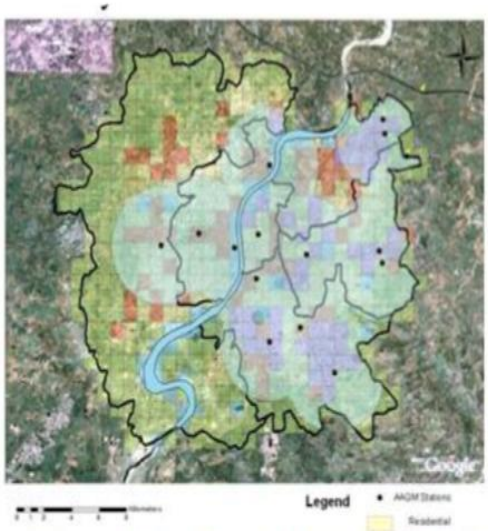
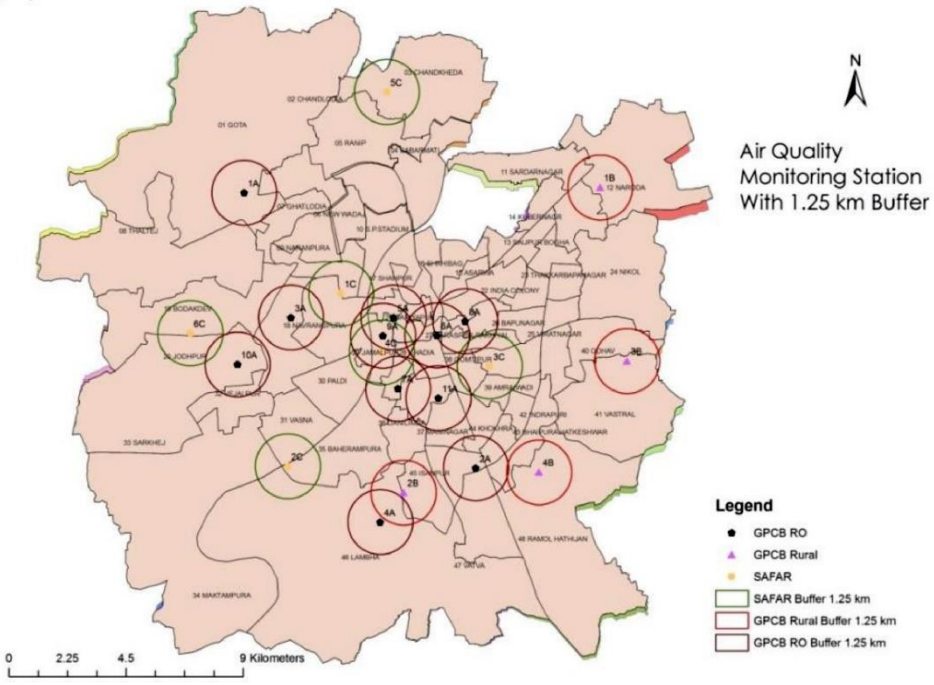


Figure 12: 4 km buffer around monitoring stations Influence zone – 282 sqm

Comparison with Regulatory Standards

The air quality data were compared with national and international regulatory standards, including the National Ambient Air Quality Standards (NAAQS) issued by the Central Pollution Control Board (CPCB) of India and guidelines established by the World Health Organization (WHO). This comparison facilitated the assessment of air quality compliance levels and identification of pollutants exceeding permissible limits.



Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, and Other Areas	Ecologically Sensitive Area (notified by Central Government)
Sulphur dioxide (SO_2), µg/m³	Annual 24 hours	50 80	20 80
Nitrogen dioxide (NO_2), µg/m³	Annual 24 hours	40 80	30 80
Particulate matter (< 10 µm) or PM_{10}, µg/m³	Annual 24 hours	60 100	60 100
Particulate matter (< 2.5 µm) or $PM_{2.5}$, µg/m³	Annual 24 hours	40 60	40 60
Ozone (O_3), µg/m³	8 hours 1 hour	100 180	100 180
Lead (Pb), µg/m³	Annual 24 hours	0.50 1.0	0.50 1.0
Carbon monoxide (CO), mg/m³	8 hours 1 hour	02 04	02 04
Ammonia (NH_3), µg/m³	Annual 24 hours	100 400	100 400
Benzene (C_6H_6), µg/m³	Annual	05	05
Benzo(α)Pyrene (BaP) – particulate phase only, ng/m³	Annual	01	01
Arsenic (As), ng/m³	Annual	06	06
Nickel (Ni), ng/m³	Annual	20	20

Health Implications

The high levels of air pollution in Ahmedabad have serious implications for public health, with numerous studies linking exposure to air pollutants with respiratory diseases, cardiovascular ailments, and adverse pregnancy outcomes . The vulnerable populations, including children, the elderly, and individuals with pre-existing health conditions, are particularly susceptible to the health impacts of poor air quality. Urgent action is required to mitigate the health risks associated with air pollution and protect the well-being of the city's residents.

Policy Implications and Recommendations

Addressing the air quality challenges in Ahmedabad requires a multi-faceted approach, encompassing regulatory measures, technological innovations, and community engagement strategies. Stringent enforcement of emission standards for industries and vehicles, promotion of clean energy alternatives, and implementation of sustainable transportation policies are essential steps towards improving air quality in the city (Ministry of Environment, Forest and Climate Change [MoEFCC], 2021). Furthermore, public awareness campaigns and citizen engagement initiatives can empower communities to take proactive measures to reduce air pollution and promote environmental sustainability.

Solutions

In conclusion, the analysis of air quality in Ahmedabad underscores the urgent need for concerted efforts to address the pervasive issue of urban air pollution. Through comprehensive examination of sources, impacts, and potential solutions, this study has provided valuable insights into the complexities of air quality management in the city.

The findings reveal alarming levels of pollution, with significant implications for public health and environmental sustainability. Industrial emissions, vehicular exhaust, and other anthropogenic activities contribute to elevated concentrations of pollutants such as particulate matter, nitrogen dioxide, and sulfur dioxide, posing serious health risks to residents, particularly vulnerable populations.

Despite regulatory measures and policy interventions, challenges remain in enforcement, compliance, and public awareness. Collaborative efforts involving government agencies, researchers, NGOs, and the community are essential to effectively address the root causes of air pollution and safeguard public health.

Moving forward, it is imperative to prioritize sustainable development strategies, promote clean energy alternatives, and integrate air quality considerations into urban planning initiatives (MoEFCC, 2021). Ongoing monitoring, research, and stakeholder engagement are critical to track progress, identify emerging challenges, and implement evidence-based solutions.

By working together towards a shared vision of cleaner air and healthier communities, we can create a more sustainable and resilient future for Ahmedabad and its residents.

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