

Air Quality Index (AQI) and its Environmental and Health Impacts in Delhi

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Abstract: *This study looks at Delhi's Air Quality Index (AQI) and how it affects the environment and human health. Due to high PM_{2.5} and PM₁₀ levels, vehicle emissions, industrial pollution, construction dust, and seasonal biomass burning, Delhi's air quality is still bad. The study demonstrates that although Delhi's air quality significantly improved in 2025, there were still severe pollution incidents during the winter, based on the uploaded research information and revised 2025–2026 reports. The detrimental impacts of low AQI on plants, urban ecosystems, and human health are also highlighted in the paper. Overall, the results demonstrate that regional cooperation, cleaner transportation, and more regulatory enforcement are required for long-term progress.*

Keywords: AQI, Delhi, air pollution, PM_{2.5}, PM₁₀, environmental impact, health impact, pollution management

I. INTRODUCTION

Delhi is one of the most polluted cities in India, with regional transportation, pollutants, and weather all influencing the ambient air quality. Because it breaks down pollution data into categories that are relevant to public health, AQI is an essential communication tool. According to the submitted dataset, Delhi regularly has poor to severe AQI, especially during the winter when pollutants are trapped by inversion and sluggish conditions. According to recent studies, the city continued to experience severe pollution episodes and remained far from health-protective air-quality limits even though 2025 showed substantial improvement. Delhi is therefore a very pertinent case for environmental-health studies and AQI evaluation. Rapid urbanization, heavy traffic, industrial emissions, and seasonal agricultural residue burning in neighboring areas have all contributed to Delhi's air pollution, which has become a serious environmental and public health emergency. The AQI assists in transforming pollution data into an easily comprehensible scale for the general public and policymakers. Delhi's AQI levels fluctuate throughout the year and typically worsen in the winter due to low wind speeds and temperature inversions that trap pollutants close to the ground. 2025 reports indicate some progress with additional There were fewer severe days and days with good and satisfactory air quality than in previous years, but the pollution levels were still unhealthy. In 2026, Delhi's terrible air quality persisted. The World Health Organization claims that air pollution causes millions of premature deaths globally, making Delhi's persistent pollution a major environmental and health concern.

II. LITERATURE REVIEW

Previous research has consistently shown that PM_{2.5} and PM₁₀ are the main pollutants causing Delhi's AQI to deteriorate, with primary causes including traffic, dust, industry, and biomass burning. According to meteorological research, Delhi's AQI peaks are significantly influenced by wind speed, boundary-layer height, and winter inversion. According to government data from 2025, there has been some improvement in the AQI, indicating that good dispersion conditions, policy changes, and enforcement can lower particulate concentrations. Safe thresholds for particle matter are significantly lower than levels commonly found in dirty Indian cities, according to the WHO guideline framework. Additionally, the project file that was supplied offers helpful information on AQI interpretation



and pollutant-specific monitoring. A multifactorial model of Delhi pollution is supported by the research when taken as a whole.

Objectives

- To evaluate Delhi's AQI changes using current and secondary data.
- To determine the primary contaminants causing the decline in the AQI.
- To investigate the effects of air pollution on the environment and human health
- To assess AQI management techniques and governmental policy.
- To offer recommendations and findings focused on publication.

AQI

- AQI stands for Air Quality Index. It is a numerical scale used to describe how clean or polluted the air is at a particular time . The AQI categories generally include Good, Satisfactory, Moderate, Poor, Very Poor, and Severe . The overall AQI is usually determined by the pollutant with the highest sub-index . This makes AQI a useful tool for governments, researchers, and the general public.

AQI in Delhi

For the majority of the year, Delhi's AQI stays high, particularly during the winter months. According to government data, Delhi's January–August average AQI improved from 187 in 2024 to 172 in 2025, indicating modest progress. Winter circumstances including low wind speed, temperature inversion, and stagnant air trap pollutants and exacerbate the issue. The city is still experiencing severe air pollution stress, though, since the yearly average AQI in 2025 was still 191. Eight Severe to Severe+ days indicate that hazardous air events are still happening

Health Impacts: Both immediate and long-term health impacts are associated with poor AQI. Coughing, wheezing, eye discomfort, throat irritation, and dyspnea can all result from brief exposure. Chronic exposure raises the risk of heart disease, bronchitis, asthma, and decreased lung function. The most vulnerable groups are children, the elderly, expectant mothers, and those with pre-existing medical disorders. Recurrent winter pollution in Delhi increases the severity and frequency of these dangers.

Environmental Impacts:

The environment is also harmed by poor air quality. Particulate matter and dust limit the amount of sunlight that reaches plant surfaces, which can diminish photosynthesis. SO₂ and NO₂ can harm leaves, lower chlorophyll, and impede plant growth. Ground-level ozone damages crops and urban plants. Deterioration of the AQI also makes it harder to see and puts more strain on urban ecosystems. As a result, poor air quality has an impact on plant life, environmental stability, and human health.

Government Policies

Dust control, traffic management, improved public transportation, and regional collaboration are just a few of the methods Delhi has implemented to improve AQI. Delhi apparently had its greatest AQI results in years in 2025, demonstrating the potential benefits of governmental action. By reducing cars and dust, the 2026 action plan also aims to significantly reduce the average AQI. However, because air quality is still impacted by regional fires, winter weather, and enforcement gaps, policy gains are still modest.

Statistical Interpretation

From 187 in 2024 to 172 in 2025, the January–August AQI improved by around 8%. Although this indicates improvement, the yearly AQI of 191 is still subpar. Eight Severe to Severe days indicate that the city still experiences



extremely dangerous incidents, but the increase in Good–Satisfactory days to 79 is encouraging. As a result, Delhi's pollution issue is gradually becoming better but is yet unsolved.

Research Gap	Description
Recent Data Deficiency	Limited peer-reviewed studies incorporating 2025–2026 AQI data and post-pandemic pollution patterns <small>gov +1</small>
GRAP Effectiveness Quantification	Insufficient rigorous evaluation of GRAP's post-COVID implementation (2022–2025) with high-resolution temporal analysis <small>society</small>
Health-Policy Linkage	Limited integration of cardiovascular health data with specific policy intervention timelines <small>indiatoday</small>
Botanical Impact Quantification	Inadequate longitudinal studies on Delhi's urban vegetation response to varying AQI levels <small>wiley +1</small>
Regional Comparative Analysis	Sparse comparative analysis between residential (Dwarka) and industrial (Mundka) zones during GRAP implementation <small>copernicus</small>
Secondary Pollution Mechanisms	Limited investigation of secondary pollutant formation and atmospheric reactivity changes during GRAP implementation <small>society</small>
Tree Species Selection Framework	Absence of evidence-based tree species selection guidelines considering Air Quality Impact Index (AQII) for urban planning <small>economictimes</small>

III. METHODOLOGY

This study uses a descriptive-analytical research design with secondary data. The main background source for AQI patterns, contaminant descriptions, and monitoring techniques was the submitted PDF. Public news and official environmental sources pertaining to Delhi AQI and policy measures were used to gather updated data for 2025–2026. The study is predicated on policy evaluation, health-risk interpretation, and trend comparison. According to the working hypothesis, particle emissions and winter weather have a significant impact on Delhi's AQI, and policy initiatives help to ameliorate it somewhat but not completely.

Table 2. Delhi AQI Trend Snapshot

Period	AQI Value / Trend	Interpretation
July 2025	78	Best July AQI in years; satisfactory category. <small>gov</small>
Jan–Aug 2025	172	Best Jan–Aug average in 8 years, but still elevated. <small>pib</small>
Annual 2025	191	Poor overall annual air quality. <small>x +1</small>
Dec 2025	351	Very poor winter pollution episode. <small>gov +1</small>
Early 2026	166–168	Unhealthy air continues in Delhi. <small>aqi +1</small>



Table 1. AQI Classification and Health Implications

AQI Range	Category	Air Quality Meaning
0–50	Good	Air quality is satisfactory and poses little or no risk.
51–100	Satisfactory / Moderate	Air quality is acceptable for most people.
101–200	Moderate	Air quality may begin to affect sensitive groups.
201–300	Poor	Air quality is unhealthy for prolonged exposure.
301–400	Very Poor	Air quality is highly polluted.
401–500+	Severe	Air quality is hazardous and dangerous.

Table 3. Major Pollutants and Their Sources

Pollutant	Main Sources	Main Effect
PM2.5	Vehicles, dust, biomass burning, industry	Deep lung penetration, risk. amazonaws +1
PM10	Road dust, construction, traffic	Breathing irritation and visibility. amazonaws
NO2	Vehicle exhaust, combustion	Respiratory irritation and atmospheric pollution.
SO2	Industrial fuel burning	Respiratory problems and injury. amazonaws +1
CO	Incomplete combustion, vehicles	Reduces oxygen transport body. amazonaws
O3	Sunlight-driven chemical reactions	Damages lungs and plants. amazonaws +1



Pollutant levels, policy indicators, and AQI averages are among the data. According to official reports, Delhi's yearly average AQI in 2025 was 191, but its January–August average AQI improved from 187 in 2024 to 172 in 2025. Eight Severe to Severe+ days and 79 Good–Satisfactory days were reported in the same study. Tables and explanations regarding AQI trends and the measurement of PM_{2.5}, PM₁₀, SO₂, NO₂, CO, and O₃ using standard instruments are included in the uploaded PDF. Because the available data is secondary and in a variety of formats, the analysis focuses on descriptive interpretation.

Data Type	Source	Time Period	Parameters
AQI Data	CAQBM, PIB	2018–2025	Monthly/Annual AQI, categories <small>gov +1</small>
PM Concentrations	CPCB CAAQMS	2019–2025	PM _{2.5} , PM ₁₀ (µg/m ³) <small>nih</small>
Health Data	Delhi Hospitals	2024–2026	Cardiovascular admissions <small>indiatoday</small>
GRAP Implementation	CAQM Orders	2022–2025	Stage-wise implementation <small>aqi +1</small>
Botanical Data	DU Studies	2023–2025	Chlorophyll, PSMS <small>wiley +1</small>
Meteorological Data	IMD	2018–2025	Wind speed, temperature, humidity <small>gov</small>

IV. RESULT AND DISCUSSION

The results indicate that although Delhi's AQI somewhat improved in 2025, pollution was still a significant issue. An improvement of about 8% is represented by the January–August average AQI falling from 187 to 172. Nonetheless, poor air quality and ongoing health risk are still indicated by the yearly average AQI of 191. Because emissions build up in stationary air conditions, winter occurrences continue to produce severe pollution. These results imply that Delhi's air pollution issue is only partially under control.

V. CONCLUSION

Although Delhi's AQI has somewhat improved in 2025, the city still has severe air pollution. Traffic, industry, dust, burning, and winter stagnation are the primary reasons. The urban environment, plants, and human health are all severely impacted. AQI is still a crucial tool for comprehending and controlling Delhi's air pollution problem, but long-term improvement will need tighter enforcement, cleaner transportation, and regional cooperation. Some recommendation Boost public alerts and AQI monitoring. Implement dust control measures in areas designated for construction. Increase the usage of cleaner transportation especially electric buses.

Reduce burning of biomass by coordinating at the regional level. In times of severe AQI, raise public awareness. Boost pollution barriers and urban vegetation. Future studies should create predictive models using satellite aerosol measurements, daily AQI data, weather indicators, and medical records. In Delhi's urban flora, botanical research can assess species vulnerability, leaf damage, and chlorophyll decrease. Hospital admissions, school absences, and financial stress can all be linked to AQI trends through a more robust interdisciplinary approach.

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