

AIR POLLUTION IN NORTH DELHI: CAUSES, IMPACTS AND MITIGATION STRATEGIES

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Abstract

The research paper explores the critical issue of air pollution in North Delhi, focusing on its causes, impacts on public health, and mitigation strategies. Vehicular emissions are identified as a primary source of pollution, leading to various health problems. Despite mitigation efforts, air quality standards are often breached, necessitating international collaboration for effective solutions. The study emphasizes the urgent need for comprehensive measures to combat air pollution's global implications.

Keywords

Air pollution, causes, impacts on public health, air quality standards.

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Introduction

Air pollution is a global challenge, and in the heart of North Delhi, it has manifested as a critical concern with severe implications for public health and environmental well-being. The city, like many others worldwide, is at the epicenter of rapid urban development, marked by exponential growth in population and an ever-increasing fleet of motor vehicles. However, the consequences of this urban transformation extend far beyond the confines of the cityscape, affecting the lives of millions and leaving an indelible mark on the environment.

The crux of the issue lies in vehicular emissions, which have emerged as a predominant source of urban air pollution in North Delhi. These emissions encompass a menacing cocktail of particulate matter, greenhouse gases, and an array of pollutants, casting a shadow over the city's air quality. The densely populated and economically vibrant urban centers, including Delhi, have seen a significant rise in the volume of vehicular pollutants, creating a hazardous cocktail that looms ominously over the city.

The repercussions of this atmospheric contamination are manifold, affecting public health in myriad ways. Respiratory ailments, cardiovascular diseases, skin disorders, and other health-related issues have become alarmingly prevalent, impacting the lives of residents. The insidious nature of air pollution reaches deeper, contributing to severe afflictions such as birth defects, immunosuppression, and even cancer. These adverse health outcomes have catapulted air pollution to the forefront of public health concerns, demanding immediate attention.

To address this mounting crisis, an array of measures and mitigation strategies have been put into effect in North Delhi. These include the implementation of stringent

emission standards for vehicles, the promotion of public transportation systems, and regulatory measures aimed at controlling industrial activities. However, despite these conscientious endeavors, air quality standards, particularly concerning particulate matter and other pollutants, often continue to be breached, leading to a higher incidence of premature deaths in the region.

This research embarks on a comprehensive exploration of the multifaceted challenge of air pollution in North Delhi. Drawing on findings from studies conducted across the globe, it delves into the intricate connection between air pollution and its deleterious effects on public health. High concentrations of PM_{2.5}, coupled with long-term exposure to air pollution, have been unequivocally linked to an elevated risk of stroke and neurological diseases, adding urgency to the call for intervention.

Megacities and large urban centers, epitomized by North Delhi, present a complex labyrinth of challenges in combating air pollution. These metropolitan giants have been witness to explosive population growth, surging industrial activities, and escalating energy demands, all of which have collectively conspired to erode air quality. While commendable strides have been made in curbing air pollution, it is evident that a holistic and multidisciplinary approach is imperative to effectively manage air quality in these urban landscapes.

In conclusion, air pollution in North Delhi is not merely a regional concern; it is a global issue with far-reaching implications. The battle against air pollution demands a united effort, encompassing rigorous regulatory measures, technological innovations, and heightened public awareness. The complexity of the problem underscores the necessity for international cooperation and collaborative endeavors to effectively mitigate air pollution in this critical region. This research endeavors to shine a light on the multifaceted challenge of air pollution in North Delhi, shedding insight into its causes, impacts, and the strategies employed to curb its alarming rise.

Study Area

North Delhi is an administrative district of the National Capital Territory of Delhi in India.

North Delhi is bounded by the Yamuna River on the east and by the districts of North West Delhi to the north and west, West Delhi to the southwest, Central Delhi to the south, and North East Delhi to the east across the Yamuna.



Source : Maps of India

North Delhi has a population of 887,978 (2011 census), and an area of 59 km², with a population density of 13,019 people per km².

The district has a population density of 14,973 inhabitants per square kilometer (38,780/sq mi). Its population growth rate over the decade 2001-2011 was 13.04%. North Delhi has a sex ratio of 871 females for every 1000 males, and a literacy rate of 86.81%.

North Delhi selected villages for the study include; Dhaka, Dheerpur, Bhalaswa, Jhangirpuri, Wazirabad, Jagatpur, Azadpur, Narela, Badli, Samaipur Badli.

Causes of Air Pollution and Data Sets and Methodology

The causes of air pollution in North Delhi are diverse and multifaceted, and supporting our research paper with data, statistics, and case studies can provide a comprehensive understanding of the issue. Here are some key causes with relevant data, statistics, and case studies:

Vehicular Emissions : The exponential growth in the number of motor vehicles is one of the primary contributors to air pollution in North Delhi. The combustion of fossil fuels in cars, trucks, and two-wheelers releases a plethora of pollutants, including particulate matter (PM_{2.5} and PM₁₀), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and volatile organic compounds (VOCs). According to the Central Pollution Control Board (CPCB) of India, vehicles are a major contributor to air pollution in Delhi, accounting for approximately 40% of total PM_{2.5} emissions.

Industrial Activities : The presence of industries and manufacturing units in and around North Delhi adds to the burden of air pollution. These facilities release emissions from processes, machinery, and transportation, resulting in the discharge of various pollutants, such as sulfur compounds, heavy metals, and volatile organic compounds.

Construction and Dust : Urban development and construction activities contribute significantly to airborne dust and particulate matter. Unpaved roads, construction sites, and road resurfacing generate large quantities of dust, especially during dry and windy seasons, which become suspended in the air.

Waste Burning: Improper disposal of solid waste, including plastics and other materials, often leads to open burning, releasing harmful pollutants into the atmosphere. This practice is not only a source of particulate matter but also releases toxic chemicals.

Agricultural Practices : Agriculture in the surrounding regions can contribute to air pollution through the use of fertilizers, pesticides, and stubble

burning. This releases ammonia, methane, and various volatile organic compounds into the atmosphere.

Meteorological Factors : North Delhi's geographical and meteorological conditions can exacerbate air pollution. Stagnant air masses, temperature inversions, and low wind speeds can trap pollutants close to the ground, leading to the formation of smog and worsening air quality.

Household Sources : Inadequate combustion practices in households, such as the use of solid fuels for cooking and heating, can also contribute to indoor and outdoor air pollution, emitting pollutants like PM2.5 and carbon monoxide.

Construction and Urbanization : The rapid pace of urbanization and infrastructure development can lead to increased land use changes, deforestation, and changes in land cover. These alterations can disrupt local ecosystems and affect air quality.

Traffic Congestion : Heavy traffic congestion, especially during peak hours, can result in a concentration of vehicle emissions. Vehicles idling in traffic jams are a major source of localized air pollution.

Delhi's Geographical Location : North Delhi's geographical location, situated in the Indo-Gangetic Plain, is prone to the trapping of pollutants due to its topography. The surrounding areas also contribute to pollution that can be transported into the city.

Understanding these multifaceted causes is vital for formulating effective mitigation strategies and public policies to address the critical issue of air pollution in North Delhi.

Table 5.22: Air Quality in Million Plus Cities of India under NAMP (Manual Stations)

State	S.No	City/Town/Village	2018				2019				2020			
			SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SO ₂	NO ₂	PM ₁₀	PM _{2.5}
Andhra Pradesh	1	Vijaywada	5	21	77	29	5	19	73	27	5	17	56	22
	2	Vishakhapatnam	10	20	77	49	8	19	76	33	8	19	78	32
	3	Patna	5	51	207		3	51	237		3	29	146	
	4	Chandigarh	2	17	102	50	2	19	97	63	2	15	92	60
	5	Bilaspur	6	12	42	20	6	12	47	27	5	12	55	30
	6	Durg-Bhilainagar	8	19	84	-	7	17	79	42	6	10	60	31
	7	Raipur	14	20	65	-	16	30	69		13	23	53	
Delhi	8	Delhi	6	73	223	121	5	70	199	141	4	68	210	116
	9	Ahmedabad	16	29	236	73	20	25	135	37	14	18	102	28
Gujarat	10	Rajkot	19	23	203	64	20	25	127	35	14	17	97	27
	11	Surat	22	29	176	57	23	27	128	40	20	25	100	37
	12	Vadodara	20	25	188	60	20	26	131	37	15	18	91	26
Jharkhand	13	Dhanbad	14	37	264	-	14	35	237	-	14	35	182	-
	14	Jamshedpur	37	46	128	-	38	47	138	-	30	37	104	-
Karnataka	15	Bangalore	2	30	90	47	3	25	74	32	2	24	66	29
	16	Kochi	3	16	57	-	3	14	46	32	2	11	43	29
Kerala	17	Kollam	3	5	47	-	3	6	45	-	3	6	45	-
	18	Kottayam	3	13	44	-	3	13	35	-	2	12	37	-
	19	Kozhikode	2	10	54	6	2	5	44	14	2	5	30	15
	20	Malapuram	2	26	31	-	2	15	35	-	2	13	28	22
	21	Thiruvananthapuram	9	24	49	-	9	16	42	-	7	11	37	35
	22	Thissur	3	9	41	-	3	5	38	-	2	5	35	-
	23	Bhopal	7	14	135	59	8	17	161	69	8	19	172	64
	24	Gwalior	13	21	134	62	13	24	139	58	18	24	142	65
	25	Indore	10	19	88	41	9	18	77	37	11	20	75	33
	26	Jabalpur	7	17	119	43	7	16	84	-	7	16	77	31
Maharashtra	27	Aurangabad	13	35	70	-	13	36	74	-	18	43	74	-
	28	Bidapur	24	67	144	-	27	60	108	-	18	38	64	-
	29	Mumbai	2	21	166	46	2	27	125	40	2	32	216	86

Annual Report

State	S.No	City/Town/Village	2018				2019				2020			
			SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SO ₂	NO ₂	PM ₁₀	PM _{2.5}	SO ₂	NO ₂	PM ₁₀	PM _{2.5}
	30	Nagpur	10	28	103	44	10	32	101	39	7	27	78	29
	31	Nashik	12	21	85	-	10	22	63	-	6	23	38	-
	32	Pune	37	75	106	-	37	87	143	-	15	55	106	-
	33	Thane	17	44	108	-	20	37	128	-	20	30	83	-
Punjab	34	Amritsar	13	34	177	-	13	34	170	-	13	32	166	-
	35	Ludhiana	9	32	162	-	12	26	153	-	8	25	161	-
Rajasthan	36	Jaipur	8	32	165	-	7	27	141	-	7	24	132	-
	37	Jodhpur	7	24	223	-	7	26	240	-	5	24	160	-
Tamilnadu	38	Kota	7	28	152	-	7	24	129	-	6	24	102	-
	39	Chennai	9	16	78	34	9	19	73	36	8	18	55	25
	40	Coimbatore	6	23	54	32	7	18	57	37	7	17	52	21
	41	Madurai	12	20	84	34	13	18	79	26	12	16	57	20
Telangana	42	Hyderabad	5	30	105	55	5	37	99	40	4	41	80	30
Uttar Pradesh	43	Agra	4	22	209	106	4	24	186	110	4	22	174	107
	44	Allahabad	4	45	231	-	5	42	222	-	3	36	180	-
	45	Ghaziabad	21	43	245	103	13	35	208	102	10	34	203	103
	46	Kanpur	7	43	210	83	6	40	198	66	8	42	201	40
West Bengal	47	Lucknow	7	30	217	108	7	31	208	-	7	34	187	101
	48	Meerut	7	58	177	-	9	213	-	9	42	190	-	
	49	Varanasi	9	34	189	-	9	184	-	7	30	145	-	
West Bengal	50	Asansol	13	35	146	58	15	184	81	14	32	114	65	
	51	Kolkata	6	44	148	86	8	104	56	8	49	116	61	

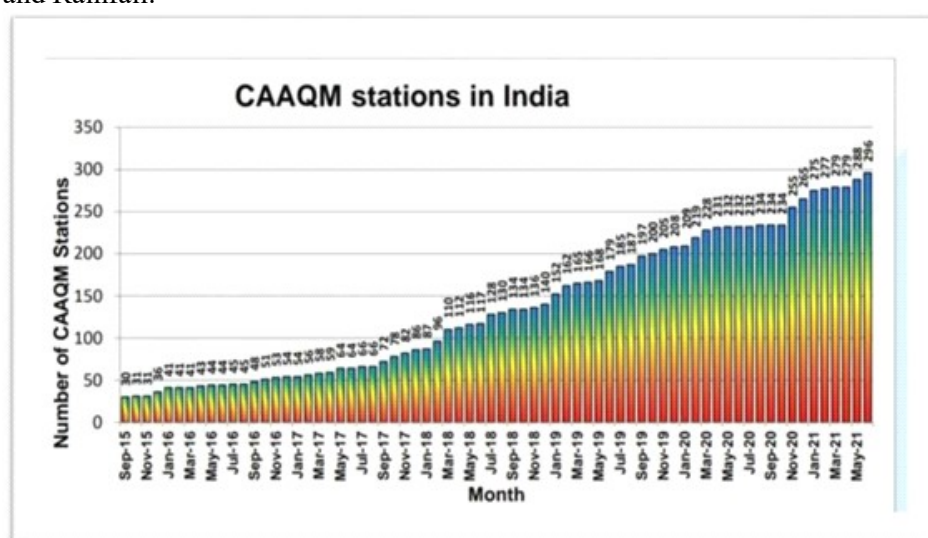
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Note: National Ambient Air Quality Standard (NAAQS) for Residential, Industrial, Rural and others Areas (Any) for SO₂ = 50 µg/m³, NO₂ = 40 µg/m³, PM₁₀ = 60 µg/m³ & PM_{2.5} = 40 µg/m³ and SO₂ = 20 µg/m³, NO₂ = 30 µg/m³, PM₁₀ = 60 µg/m³ and PM_{2.5} = 40 µg/m³ for Ecologically Sensitive Areas (ESA)

Source : Annual report by Central Pollution Control Board, GOI, 2020.

Continuous Ambient Air Quality Monitoring Stations in the Country

Under CAAQMS the Particulate Matter (PM10 & PM2.5), Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Ammonia (NH₃), Carbon Monoxide (CO), Ozone (O₃) and Benzene (C₆H₆) are being monitored at all locations. The CAAQM stations are also equipped with sensors to measure meteorological parameters such as Wind Speed, Wind Direction, Ambient Temperature, Relative Humidity, Solar Radiation and Rainfall.



Source : Report by Central Pollution Control Board, GOI, 2020.

Impacts of Air Pollution in North Delhi

Air pollution in North Delhi has extensive and diverse impacts on health, economics, the environment, society, cognition, visibility, and ecosystems. Respiratory diseases, such as asthma and bronchitis, are prevalent due to high pollution levels, affecting the well-being of residents. Long-term exposure to pollutants, notably PM2.5 and NO₂, is linked to cardiovascular issues, including heart diseases and hypertension, posing a significant health risk. Vulnerable populations, such as children and the elderly, experience reduced lung function and development, contributing to increased mortality rates. The economic impact is notable, with substantial healthcare costs incurred for treating pollution-related illnesses and reduced labor productivity due to workforce absenteeism.

Environmental consequences encompass vegetation damage, water pollution from airborne pollutants, and contributions to climate change through greenhouse gas emissions. Socially, poor air quality diminishes the overall quality of life,

particularly affecting outdoor activities, and exacerbates health inequalities, disproportionately impacting vulnerable communities. Recent research indicates potential cognitive impacts, with air pollution potentially affecting memory and IQ, particularly in children. Reduced visibility, a safety concern, leads to an increased risk of road accidents and transportation delays. Ecosystems face biodiversity loss, and cultural heritage sites and landmarks may deteriorate due to exposure to pollutants like sulfur dioxide (SO₂). In summary, the multifaceted impacts of air pollution underscore the urgency of comprehensive mitigation strategies to safeguard public health, the economy, and the environment in North Delhi.

Criteria Air Pollutants – Emission Sources and Major Effects			
Criteria Pollutants	Emission sources		Health Effects
	Natural Sources	Anthropogenic Sources	
Sulfur dioxide (SO₂)	Volcanic emissions	Burning of fossil fuels, metal smelting, petroleum refining etc.	Respiratory problems, heat and lung disorders, visual impairment
Nitrogen dioxide (NO₂)	Lightning, forest fires etc.	Burning of fossil fuels, biomass and high-temperature combustion processes	Pulmonary disorders, increased susceptibility to respiratory infections
Particulate matter (PM)	Windblown dust, pollen spores, photochemically produced particles	Vehicular emissions, industrial combustion processes, commercial and residential combustion, construction industries	Respiratory problems, liver fibrosis, lung/liver cancer, heart stroke, bone problems
Carbon monoxide (CO)	Animal metabolism, forest fires, volcanic activity	Burning of carbonaceous fuels, emissions from IC engines	Anoxemia leads to various cardiovascular problems, Infants, pregnant women and elderly people are at higher risk
Ozone (O₃)	Present in the stratosphere at 10-50 km height	Hydrocarbons and NO _x upon reacting with sunlight results in O ₃ formation	Respiratory problems, asthma, bronchitis etc.
Lead (Pb)	–	Metal processing plants, waste incineration, automobile exhausts, lead-acid batteries, industrial effluents etc.	Serious effects on the central nervous system since it is absorbed rapidly in the bloodstream, anemia, toxic for soft tissues and bones

Fig. : Health Impacts by Major Pollutants.

Mitigation Strategies

Mitigation strategies and policies for air pollution in North Delhi encompass a comprehensive approach targeting various sources of pollution. The implementation of Bharat Stage Emission Standards for vehicles mandates cleaner technologies, addressing vehicular emissions. The promotion of public transport systems and the Odd-Even Scheme aims to reduce private vehicle emissions and manage traffic congestion. Encouraging electric mobility through initiatives like FAME contributes to lowering exhaust emissions. Regulatory measures, such as pollution control boards and environmental standards, monitor and control industrial emissions. Effective waste management practices minimize open burning, while regulations on construction and demolition waste control dust pollution. Urban greening initiatives and green building norms integrate environmental considerations into urban planning for improved air quality.

Establishing air quality monitoring stations provides real-time data for informed decision-making. The Graded Response Action Plan (GRAP) serves as an emergency response, implementing measures during deteriorating air quality. The promotion of renewable energy facilitates a clean energy transition, reducing reliance on fossil fuels. Public awareness campaigns educate the public about the health impacts of air pollution. Cross-border collaboration involves regional agreements to address pollution across borders. Healthcare infrastructure improvements ensure adequate facilities for treating air pollution-related illnesses. These strategies collectively form a robust framework to combat air pollution in North Delhi.

Improvement of Air Quality Index in Delhi : Improvement was noted in the year 2021 in comparison to 2018 with the number of **Good**, **Satisfactory** and **Moderate** days increasing to 197 against 159 since 2018 and the number of **Poor**, **Very Poor** and **Severe** days decreasing to 168 against 206.

Year (no. of days)	2018	2019	2020	2021	2018	2019	2020	2021
Category	(365)	(365)	(366)	(365)				
Good (0–50)	0	2	5	1	159	182	227	197
Satisfactory (51–100)	53	59	95	72				
Moderate (101–200)	106	121	127	124	206	183	139	168
Poor (201–300)	113	103	75	80				
Very Poor (301–400)	73	56	49	64				
Severe (>401)	20	24	15	24				

Source : Report by Central Pollution Control Board, GOI, 2020.

Conclusion

The research paper on air pollution in North Delhi provides a comprehensive overview of the issue, encompassing causes, impacts, and mitigation strategies. It highlights the multifaceted sources of pollution, including

vehicular emissions, industrial activities, and waste burning. The government's interventions, coupled with the identified impacts on health, economics, environment, society, cognition, visibility, and ecosystems, emphasize the severity of the problem.

Mitigation strategies, backed by policies like emission standards and the Odd-Even Scheme, are crucial for addressing this challenge. However, the research acknowledges persistent challenges and the need for ongoing efforts. In summary, the paper underscores the urgent call for

collaborative actions, international cooperation, technological innovations, and sustained public awareness to combat air pollution effectively and secure a healthier future for North Delhi.

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