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"Assessment of Air Pollution in Kharagpur"- A Case Study of Urban Air Quality

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***Abstract*— Today air pollution is a common major problem in urban cities where different source of emission is concentrated. Kharagpur, is a major industrial and educational city, recognized as the state's fourth-largest city by area and a crucial transportation hub. This study evaluates air quality in kharagpur during the year of 2024 to 2025, focusing on pollutants such as $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and O_3. These five criteria air pollutants are playing an important role to established air quality standards to protect public health and the environment. From the year 2022-2026, the highest AQI is observed on November,2025 and lowest AQI on July, 2022. Data was sourced from secondary sources including CPCB and analyzed using statistical tools like mean, median, mode, and standard deviation. While AQI levels mostly remained within the moderate range, elevated levels of CO and particulate matter posed potential health risks. Findings emphasize the importance of continued monitoring and policy interventions for sustainable urban living.**

***Keywords*—Air pollution, AQI, $PM_{2.5}$, PM_{10}, CO, urban environment.**

I. Introduction

Air is essential for sustaining life, but its quality is increasingly threatened by factors like urban expansion, rising vehicle emissions, and growing industrial activities. In India, air pollution has become a critical concern, particularly in fast-developing areas such as Kharagpur. It serves as a critical junction for commerce, education, and transport in the region and it is the state's fourth-largest city. Industrial development in Kharagpur began in the late 19th century and after that rapidly increasing in the field of retail, metal, cement, and others. To monitor and report air quality, the Central Pollution Control Board (CPCB) introduced the Air Quality Index (AQI), which provides a simplified numerical representation based on key pollutants including $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and O_3. These pollutants can adversely affect human health by triggering respiratory illnesses, cardiovascular problems, and causing broader environmental harm.

Kharagpur air quality has generally fluctuated with in moderate to poor categories over last few years, with notable, sustainable rise in pollution between 2022 to 2025 due to respectively expansion of industrial activities.

Urbanization and industrialization are the major cause of degradation of air quality in urban cities. Air Quality Index (AQI) is a system to measure air pollutants concentration, into one easy-to- understand scale clearly represent the health risk posed by ambient air pollution. The index formula usually considers up to 6 main pollutants ($PM_{2.5}$, PM_{10}, carbon monoxide, sulfur dioxide, nitrogen dioxide and ground level ozone), and calculates the respective health risk (or AQI number) for each one at any given time. Annual average AQI trends show significant jump from the year 2022 to 2025 indicating increasing pollution. Of six criteria air pollutants, particulate matter and ground level ozone are pose widespread health threats.

According to the World Health Organization, there are 7 million premature deaths every year due to the combined effects of outdoor and household air pollution– with millions more people falling ill from breathing polluted air. More than half of these deaths are recorded in developing countries. This study focuses on analyzing the air quality of Kharagpur during the year of 2024-2025. By examining AQI levels and pollutant trends, it aims to contribute to informed policy making and raise public awareness about air pollution.

II. Scope

The study focuses on the following areas-

- Major criteria air pollutant- $PM_{2.5}$, PM_{10}, carbon monoxide, sulfur dioxide, nitrogen dioxide and ground level ozone
- Emission status of six major criteria air pollutant in Kharagpur
- Major causes of pollution in urban city
- Industrial expansion and environmental pollution
- Health impacts of the urban city

III. Methodology

Kharagpur, located in Paschim Medinipur, West Bengal, spans approximately 127 km² and lies at 22.3302° N, 87.3237° E. It features a tropical climate and hosts a variety of land uses including residential, academic, and industrial zones. Its dense railway network and moderate population

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make it an ideal location for AQI studies. This study utilized secondary data from platforms such as CPCB, NAQI, and SAFAR. Data for 2024-2025 year were collected and statistically analyzed. Observations were recorded during three daily intervals: 8-9am, 2-3 pm, 9-10 pm, through 2024- 2025.

Steps Involved:

- Data Collection: From government databases.
- Data Cleaning: To handle inconsistencies.
- Statistical Analysis: Using mean, median, mode, and standard deviation.
- Standards Comparison: Against CPCB permissible limits.
- Visualization: Graphs and charts to show trends and extremes.

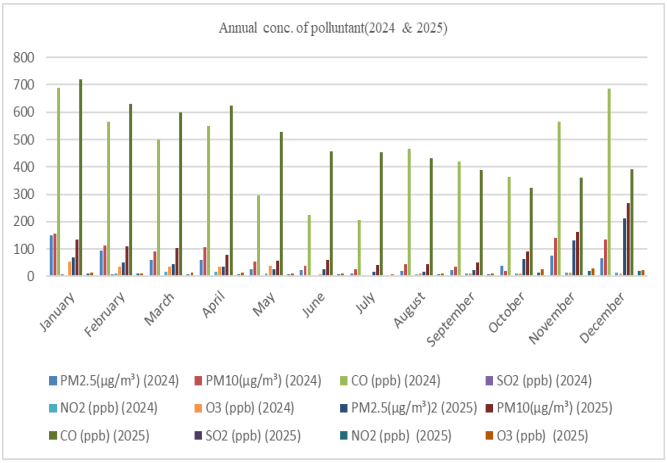
IV. Result And Observation

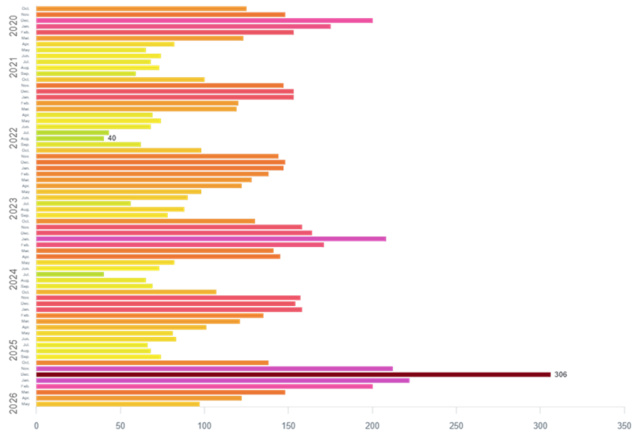
TABLE I
Average Concentration of pollutants

Pollutant	$PM_{2.5}$(µg/m³)		PM_{10}(µg/m³)		CO (ppb)		SO_2 (ppb)		NO_2 (ppb)		O_3 (ppb)	
Month	2024	2025	2024	2025	2024	2025	2024	2025	2024	2025	2024	2025
January	**150**	69	**157**	135	**689**	**720**	**9**	**6**	5	12	**53**	13
February	94	52	112	109	565	630	**9**	5	10	10	35	12
March	60	45	92	103	501	599	5	5	**18**	9	36	14
April	60	35	106	78	549	623	5	5	**18**	8	36	13
May	26	25	54	56	297	529	3	4	10	7	38	12
June	24	26	37	59	225	456	2	4	3	7	8	11
July	12	17	25	42	205	454	1	5	2	6	5	9
August	20	18	44	46	466	432	2	3	9	8	10	11
September	24	22	35	52	420	388	3	3	11	8	11	11
October	39	62	20	90	364	324	1	**6**	12	14	12	27
November	75	131	140	161	564	361	4	4	15	**20**	13	**30**
December	67	**212**	135	**268**	685	391	6	4	14	**20**	11	24

**Average highest value is marked.*

Annual average major criteria air pollutant concentration of 2024 and 2025





Source: AQI- Real time Air pollution, Dashboard

Fig: AQI graphical presentation from 2020-2026

V. Discussion

From the analysis it is clear to understand that the air quality drastically degraded because increasing the emission of the five major air pollutant from different industries of Kharagpur. In the year of 2024-2025 the $PM_{2.5}$ & PM_{10} frequently exceeded 24-hour NAAQS limits.

Average annual limit of $PM_{2.5}$~55 µg/m³ and 60 µg/m³, PM_{10}: ~87 µg/m³ and 100 µg/m³. Most polluted December 2025 for emission of $PM_{2.5}$ & PM_{10}.

Carbon monoxide (CO) is a major primary air pollutant, and another important criteria air pollutant posing serious health effects and it is essential for National Ambient Air Quality Standard. Annual carbon monoxide emission in 2024 is 523ppb and 491ppb in 2025. The highest average CO emission observed on January 2024 (689ppb) and January2025 (720ppb) which indicate unsafe level.

The average annual NO_2 and SO_2 emission level also high. In 2024 and 2025, the annual trend of SO_2 is 5ppb and NO_2 annual trend is 14ppb in 2024 and 11ppb in 2025 which is indicate unsafe for human.

Ground level O_3 Showed occasional peaks during high solar radiation. Most annual trend of ground level ozone on February 2024 is 53ppb. Statistical distribution analysis also revealed a pattern of greater air pollution variation during the evening hours.

The mean, median, and mode values generally indicated a moderate to poor level of air quality. However, carbon monoxide (CO) concentrations often surpassed the recommended limits, suggesting deteriorating air quality during high-traffic periods. The observed standard deviation reflected fluctuating pollutant patterns, likely driven by changing weather conditions and varying traffic density.

Although sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) levels also exceeding safe level range, the consistently high concentrations of particulate matter (PM) and CO raise significant concern, especially during winter. These findings underscore the urgent need for improved real-time monitoring systems and increased public awareness in medium-sized urban centers across India.

During the study, the highest AQI observed in December 2025 is 306 and July 2024, is the least polluted month which AQI is 40.

VI. Conclusion

Air quality in Kharagpur during the year 2024 to 2025 was largely classified as moderate to poor, with intermittent days registering poor air quality due to elevated levels of $PM_{2.5}$, PM_{10}, and carbon monoxide (CO).

Although the pollution levels were acutely hazardous in the last of the 2025, the persistent rise in particulate matter and CO concentrations indicates mounting pressure on both environmental and public health. Vulnerable populations, particularly children and individuals with pre-existing respiratory conditions, are at heightened risk.

To address this, strategies such as increasing green cover, promoting eco-friendly fuels, and strengthening public transportation should be prioritized. Continued secondary data analysis remains a cost-effective means for monitoring trends and guiding policy.

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