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AN ANALYSIS BASED STUDY OF AIR QUALITY INDEX AND PARTICULATE MATTER OVER DELHI REGION OF INDIA

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ABSTRACT

Air pollution is the most serious concern globally affecting lives of the people. Air pollution leads to various respiratory and other diseases having serious health concerns. Delhi is considered as one of the most polluted cities in India. Various sources such as vehicular pollution, industrial smokes, burning of fossil fuels, waste burning etc. during winters Delhi faces a challenge in soaring air pollution related to stubble burning from agricultural fields. Therefore, in this paper, we have collected data on PM2.5 and PM10 of the month October 2022 to February 2023 from 7 different stations in Delhi. The data was collected from the site of CPCB and analyzed. The data showed that Jahangirpuri station of Delhi had highest AQI in October 2022 i.e., 419 whereas Alipur has minimum AQI of 317 in January 2023.
Keywords **:** Air quality; particulate matter; pollution; assessment.

Introduction

Air pollution is a significant environmental issue in different parts of the world. When dangerous or excessive amounts of substances, such as gases, particles, and biological molecules, are emitted into Earth's atmosphere, air pollution occurs. Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Ozone (O_3), and Sulfur Dioxide (SO_2) are fine Particulate Matters as well as pollutants that cause air pollution. On the other hand, air pollution, as much as any other health hazard, is responsible for a large proportion of early deaths in India. Growth in population density, expansion of industry and motor vehicles, and increase in annual average temperature are the foremost influencing factors of air pollution. Additionally, the process of urbanization has a detrimental effect on air quality. Because of the harmful effects that pollution has on human health, the public is highly concerned about the future trend of air quality (Zou *et al*. 2019). Air pollution causes several diseases such as asthma, weakens lung function, increases cardiopulmonary illnesses and also escalates mortality rates. Numerous recommendations are there to shield the population from severe pollution, for example: i) public participation in outdoor activities should be reduced, ii) patients with severe diseases like heart disease, respiratory disease, pregnant women, children should stay in home more times. It is necessary to anticipate air pollution for both warning about and reducing pollution in people's daily lives.

The Air Quality Index, often known as the AQI, is a statistical measurement used to determine the quality of air in our surroundings that consolidates the concentrations of various contaminants into a single numerical form (Sarkar *et al*. 2022). It is used to investigate the long-term health effects of air pollution on a person's health as it explores the relationship between human health and air quality. The new ambient air quality standards cover six pollutants including Ozone (O_3), Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), and $PM_{2.5}$, PM_{10} (particulate matter with a diameter less than or equal to 10 µm), are used to calculate the AQI (Sarkar *et al*. 2022). The most commonly used air quality evaluation indexes are criteria air pollutants and comprehensive indices. There has been a considerable deterioration in the quality of air in several cities of India throughout the years (Singh and Chauhan, 2020).

It is very critical to monitor overall air quality within the region and provide warnings when necessary. Whenever it comes to interpreting air pollution, raw data is difficult to comprehend.

The majority of South Asian cities suffer from extremely high levels of urban air pollution, particularly in the form of small particles. The average number of deaths caused by air pollution across the south Asian country of India was over 1.66 million in 2019, up from around 1.64 million deaths in the previous year. A significant increase in the deaths due to air pollution was recorded since 1990. Region-wide, urban air pollution is estimated to cause billions of cases of respiratory illnesses every year. Urban air pollution causes five times as many deaths and illnesses as malaria and is among the largest contributors to the regional burden of disease. Deterioration of air quality is a problem that is directly experienced by a majority of the 300 million urban Indian. A local survey has indicated that the incidence of respiratory diseases in Delhi is 12 times the national average and that 30% of Delhi's population suffers from respiratory disorders due to air pollution (Kandlikar and Ramachandran 2000). For several reasons, analysis of air quality data over Delhi has been undertaken in the past. Few among these could be listed as the high pollution levels, significant vehicular traffic (number of vehicles in Delhi being about the sum of the total of vehicles put together of the other three megacities in India namely Mumbai, Chennai, and Kolkata, highest population growth amongst all megacities with mixed land use. Kandlikar and Ramachandran (2000) described the emission estimates and impact of particulate matter on the air quality of Delhi and Mumbai. In view of this, study of data of particulate matter pollution i.e. PM2.5 and PM10 along with Air Quality Index (AQI) for the period October 2022-Febrauary 2023 has been done over 7 stations in Delhi by taking data from Central Pollution Control Board (CPCB).

Air Quality Index

The Air Quality Index (AQI) is an index for reporting daily air quality. It tells us how clean or polluted the air is, and what associated health effects might be a concern for us. The AQI focuses on health effects we may experience within a few hours or days after breathing polluted air. The AQI varies from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concerns. An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA (Environment Protection Authority), has set to protect public health in India. AQI values below 100 are generally thought of as satisfactory.

Materials and Methods

The area selected for the study covers 7 stations of the Delhi region. These stations includes Alipur, ITO Delhi, Jahangir Puri, Anand Vihar, Bawana, Ashok Vihar, and Okhla Phase-2. We thoroughly analyzed these stations on the basis of air quality data collected from CPCB.Pollutants PM10, PM 2.5 and AQI were considered for the study for which various Air Quality Standards have been prescribed. The above-mentioned pollutants were considered as most hazardous and have adverse effects on human health. For this study, the raw values were fetched from the Central Pollution Board daily monitoring site. This is an authenticated government air quality data repository.

Result and Discussion

For various pollutants, CPCB prescribed air quality index assessment (Table 1). According to CPCB, the level of pollutants has been prescribed into 5 categories i.e., Good, satisfactory, Moderate, Poor and Very Poor. However, for example, the air quality index to considered as Good, the breakpoint for PM10 is 50 and for PM 2.5 it is 30 (Bhalla *et al*. 2021).

Table 1 : AQI Assessment

AQI	Remark	Possible Health Effects
0-50	Good	Minimal impact
51-100	Satisfactory	Minor breathing discomfort to sensitive people
101-200	Moderate	Breathing discomfort to the people with lungs, asthma, and heart diseases
201-300	Poor	Breathing discomfort to most people on prolonged exposure
301-400	Very Poor	Respiratory illness on prolonged exposure
401-500	Severe	Affects healthy people and seriously impacts those with existing diseases

The values for PM10, PM2.5from October 2022 to February 2023 were collected with 7 different stations in Delhi by taking average, minimum and maximum of the pollutant concentration. The values for PM 2.5 and PM10 is summarized in Table 2.

Table 2 : Different values of PM 2.5 and PM 10 for 7 stations in Delhi

Station		PM 2.5			PM 10			AQI
	Month	Average	Min	Max	Average	Min	Max	
Alipur-Delhi DPCC	Oct-22	402	323	467	356	218	463	402
	Nov-22	401	260	482	359	140	494	401
	Dec-22	378	237	496	273	109	459	378
	Jan-23	137	40	362	86	34	194	137
	Feb-23	246	78	356	177	107	273	246
ITO Delhi	Oct-22	360	279	400	221	154	276	360
	Nov-22	343	249	406	226	137	333	343
	Dec-22	339	198	451	163	91	294	339
	Jan-23	296	209	357	157	111	212	296
	Feb-23	220	84	330	175	119	282	220
Jahangir Puri, Delhi-DPCC	Oct-22	419	321	500	408	262	500	419
	Nov-22	414	237	500	401	167	500	414
	Dec-22	394	312	500	347	168	500	394
	Jan-23	238	63	500	199	83	460	238
	Feb-23	265	87	426	274	139	500	274
Anand Vihar, Delhi (DPCC)	Oct-22	392	316	459	415	304	500	415
	Nov-22	404	305	491	407	206	500	407
	Dec-22	399	290	500	338	165	500	399
	Jan-23	220	63	405	217	70	457	220
	Feb-23	259	92	483	247	152	487	259
Bawana, Delhi	Oct-22	413	318	500	390	217	500	413
	Nov-22	392	280	493	359	171	491	392
	Dec-22	380	220	500	342	126	500	380
	Jan-23	170	58	353	121	50	265	169
	Feb-23	245	85	380	219	138	417	245
Ashok Vihar	Oct-22	400	338	466	374	248	465	400
	Nov-22	389	257	469	363	155	464	389
	Dec-22	384	277	500	300	135	500	387
	Jan-23	188	73	374	134	58	259	186
	Feb-23	200	70	308	203	133	354	208
Okhla Phase-2	Oct-22	372	253	427	351	196	436	372
	Nov-22	355	290	411	293	174	456	355
	Dec-22	399	277	500	332	157	495	400
	Jan-23	189	57	378	138	58	282	185
	Feb-23	209	67	382	222	126	451	219

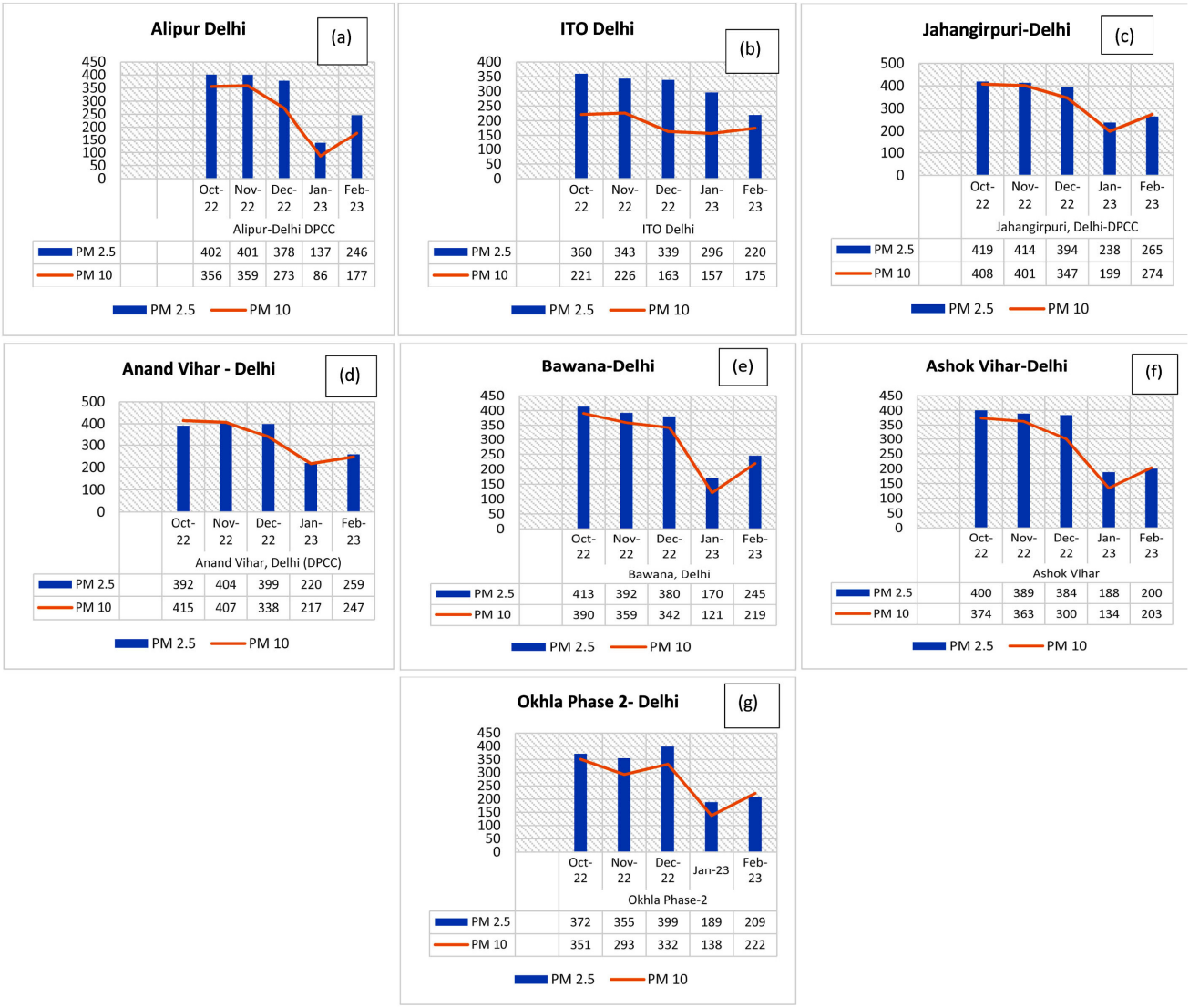

Fig. 1 : PM 2.5 and PM10 values in the months of October 2022 to February 2023 in (a) Alipur (b) ITO (c) Jahangirpuri (d) Anand Vihar (e) Bawana (f) Ashok Vihar (g) Okhla Phase 2

Delhi has a high variation between summer and winter temperatures due to semi-arid climate conditions. Moreover, its proximity to Himalayas dips temperatures when col waves blow from Himalayas. Winter is the most important season of Delhi which is dominated by cold, dry air and ground-based inversions thus increasing the pollutant concentrations (Anfossi *et al.* 1990). The stations studied above has been chosen ascontinuous monitoring stations of CPCB and the busiest traffic intersections.

According to the values obtained it was observed that PM2.5 and PM10 has maximum value in the month of October and November respectively and lowest in the month of January in the Alipur station of Delhi (Figure 1a). The reasoncould be the seasonal phenomenon as during winters, atmospheric pollutants get trapped nearer to the earth's surface. Whereas another reason can be the stubble burning in the nearby states of Delhi. However, a similar pattern is observed in the stations ITO, Jahangirpuri, Bawana, Ashok Vihar and Okhla Phase 2 (Figure 1b, c,e, f, g). Contrarily, in case of Anand Vihar PM2.5 is high in November and PM10 is high in October, and both have low values in January.

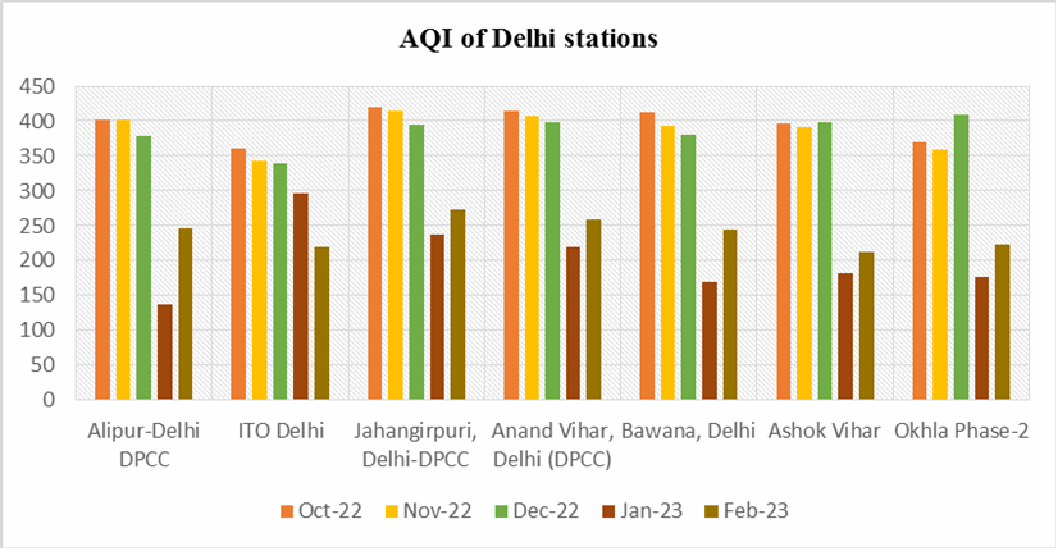

Fig. 2 : Air Quality index from October 2022 to February 2023 of Alipur, ITO, Jahangirpuri, Bawana, Ashok Vihar and Okhla Phase 2.

According to the Indian National Ambient Air Quality Standard, specific pollutants have adverse health effects. The overall Air quality Index (AQI) is determined on the basis of AQI formula (Reporting and Rule, 1999) as mentioned below:

$$I_p = \left[\frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})}\right](C_p - BP_{Lo}) + I_{Lo}$$

Where

I_p = AQI for pollutant 'p'

Cp = actual ambient concentration of the pollutant 'p'

BP_{Hi} = the breakpoint that is greater than or equal to C_p

BP_{Lo} = breakpoint less than or equal to C_p

I_{Hi} = the sub index value corresponding to BP_{Hi}

I_{Lo} = the sub index value corresponding to BP_{Lo}

The graphical presentation of overall AQI (Figure 2) of the studied Delhi stations showed that the AQI in the month of October exceeds the value of 400 in Alipur, ITO, Jahangirpuri, Anand Vihar and Bawana stations showing that AQI is very poor or Severe thus can be responsible for fatal health effects. However, in the month of January, the AQI drops down in nearly all the stations except ITO which is the busiest traffic area year around. The same trends in the month of February also. The major contribution towards poor AQI is from PM2.5 and PM10 due to large number of vehicles plying on the roads of Delhi and particulate matter travelling from neighboring states while stubble burning during the winters.

Conclusion

It is important to study the air pollution problem of Delhi as the AQI of Delhi is very poor most of the time. The main reason behind is the PM 2.5 and PM10. Hence it becomes obligatory for the government to take necessary preventive measures. This study clearly indicates how severe is the particulate matter and what consequences has to be faced by the citizens of Delhi. The level at which particulate matter is present in the atmosphere surely leads to the severe health effects on the people of Delhi. It is the need of the hour to predict values and take mitigation measures to burn them down to tolerable limits. Furthermore, this study has more scope by implementing certain statistical models to develop seasonal modelling of the air pollution in other parts of the countries also.

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