Kalpa Publications in Civil Engineering
Volume 1, 2017, Pages 124–131
ICRISET2017. International Conference on Research and Innovations in Science, Engineering &Technology. Selected papers in Civil Engineering

Ambient Air Quality Assessment using Air Quality Index of Delhi

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Abstract

Urban air pollution is rapidly increasing in Indian cities. It affects the health and mental status of urban dwellers. In the present study, air pollutants data were collected for a year 2016 at 4 locations in Delhi from Central Pollution Control Board. The present study incorporates the analysis of the ambient air in Delhi city using Air Quality Index (AQI). An AQI is proposed for the city of Delhi, India for easy data interpretation and understanding of air quality. The air pollutants analyzed are Sulfur dioxide (SO_2), Nitrogen dioxide (NO_2) and Particulate matter ($PM_{2.5}$). The locations selected are Dwarka, R.K Puram, Panjabi Baugh, and Anand Vihar. The AQI were calculated using IND-AQI procedure. It has been observed that AQI's values of all four locations falls under very poor category. The overall AQI was found under very poor and sever categories. It was found that AQI values were very high during winter season and low during monsoon season. The AQI of $PM_{2.5}$ was found exceeding the limits for all the months in each location. Thus, it is observed that $PM_{2.5}$ is critical pollutant at these four locations in Delhi.

Keywords: Air Pollution, Air Quality Index, Particulate Matter ($PM_{2.5}$), SO_2, NO_2

Introduction

Clear air is essential for the healthy life and sustainability of humans. The presence of dangerous substances in the form of particulate matters and gases in the air leads to the degradation of air quality. Anthropogenic emission such as particulate matter and various gaseous emissions are being pumped into the atmosphere.

Urban air quality is degrading at a faster rate due to combustion of fossil fuel that is used in generation of power, transportation, industrial needs and other activities. Air pollution causes a damaging effect on the physiology as well as the psychology of urban dwellers. Number of studies carried out on Indian cities showered that ambient air pollution concentrations are very high risking the life of people continuous deterioration of ambient air in cities due to urban activities along with lack of

C.D. Modhera, G.J. Joshi, D. Soni, I.N. Patel, A.K. Verma, L.B. Zala, S.D. Dhiman, D.R. Bhatt, J.M. Rathod, B.C. Goradiya, M.S. Holia and D.K. Patel (eds.), ICRISET2017 (Kalpa Publications in Civil Engineering, vol. 1), pp. 124–131

mitigation measures will worsen the problem in future. The pollutants responsible for adversely affecting the air quality are SPM, RSPM, SO_2, CO, and NO_2. These pollutants exposure on a prolong time period can cause cardiovascular and respiratory disease. Delhi is among the most polluted cities of India and the world and provides a good choice for study. The air quality reports published by central pollution control board has showed the presence of various pollutants exceeding the limits over a years, the report published by world health organization indicated the rise in deaths due to air pollution in Delhi. Number of steps taken the part under the observation of Supreme Court of India including switching over a CNG introduction of batter standard of fuel, intermittent closer of power plant located in Delhi closing of air polluting industries; odd-ever plan for playing private cars on road. In spite of all these, the level of air pollution is increasing due to rapid population growth and expanding industrial activities in and around the Delhi. The city has highest registered motor vehicle in India more than other cities such as Mumbai, Kolkata and Chennai.

Air quality monitoring in Delhi carried out at various localities. The monitoring is carried out by various organizations such as central pollution control board, Delhi pollution control committee (DPCC) and system of air quality and whether forecasting and research (SAFAR) of Indian institute of tropical meteorology (IITM), Pune the monitoring data provides a large volume of data that do not provide a clear picture to policy maker or to a common man regarding the status of air quality in terms of how good or bad the air is? The raw data can be presented in statistical forms but become confusing for the common people. As a result, people tend to lose interest and cannot understand the state of air quality. To overcome this problem the concept of air quality index (AQI) has been developed.

In the past, some studies were carried out for air quality assessment of Delhi. The present study includes the daily averaged concentration data of air pollutants for the year 2016 based on AQI values. This IND-AQI has six categories.

Category	**Range**
Good	0-50
Satisfactory	51-100
Moderately Polluted	101 - 200
Poor	201 - 300
Very poor	301 - 400
Severe	401 - 500

Table 1: Various Categories of IND-AQI (National Air Quality Index, CPCB, Oct. 2014)

Air Quality Index

AQI is a tool developed by the United States environmental protection agency (USEPA) to characterize the air quality. An AQI transforms weighted values of individual air pollution related parameters into a single number on set of numbers.

Material and Methods

Study area

Delhi is geographically located in north India at 28°21’17” and 28°53’00’’ N 77°45’30” and 77°21’30’’ E long, spreading across and area of 1483 km². It is administrated by central and state government. As per the census 2011, Delhi is inhabited by approximately 16.3 million people making it the second most populous city in India.

Delhi experiences dry climate and extreme summer and winter. Delhi is four well-designed seasons. Winter (December to February), summer (March to June), Monsoon (July to September) and post monsoon (October to November), Delhi has taken various steps control the air pollution level during last decade however more efforts are required to improve the ambient air quality of Delhi.

Air Quality Data

CPCB along with DPCC and SAFAR monitors. The level of pollutants in various areas of Delhi under the national Ambient air quality-monitoring program (NAAQMP) the daily average concentration data of NO_2, SO_2 and $PM_{2.5}$ were collected from the CPCB for different monitoring stations located in Figure 1 shows location of the monitoring stations.

Figure 1: Delhi Air Quality Monitoring Stations (Source: CPCB)

AQI Development

The sub-index values of various pollutants values calculated based on the maximum operation system of USEPA for each month of year 2016. The maximum value of sub-indices for each pollutant taken to represent overall AQI. The mathematical use for calculating the sub-indices is as follows:-:

$$I_p = \left(\frac{(I_{HI} - I_{LO}}{B_{PHI} - B_{PLO}} \times (C_P - B_{PLO}) \right) + I_{LO} \quad (1)$$

Where, I_P is the Sub-index of pollutants, C_P is the Pollutants concentration, B_{PHI} is the Break point concentration greater or equal to given concentration, B_{PLO} is the Break point concentration smaller equal to given concentration, I_{HI} is the sub-index or AQI value corresponding to $B_{PHI,}$ I_{LO} is the sub index or AQI value corresponding to B_{PLO}. The table 2 shows the Linear segmented relationship for sub-index values and the corresponding pollutant concentrations that calibrated to Indian conditions.

AQI Category Range	$PM_{2.5}$ (24hrs)	SO_2 (24hrs)	NO_2 (24hrs)
Good (0-50)	0-30	0-40	0-40
Satisfactory (51–100)	31-60	41-80	41-80
Moderately Polluted (101–200)	61-90	81-380	81-180
Poor (201-300)	91-120	381-800	181-280
Very Poor (301-400)	121-250	801-1600	281-400
Severe (401-500)	>250	>1600	>400

Table 2: Breakpoints of various pollutants (National Air Quality Index, CPCB, Oct. 2014) (Units: μg/m^3)

Results and Discussion

The air quality trends compared on yearly basis for all the monitoring stations:

AQI analysis of different air quality monitoring stations

In the analysis, it was observed that AQI values very widely among various stations.

A. Dwarka Monitoring Station

The study shows that maximum and minimum concentration of $PM_{2.5}$, SO_2 and NO_2 are 1033.76 μg/m^3 and 40.28 μg/m^3, 122.64 μg/m^3 and 1.46 μg/m^3, 108 μg/m^3 and 4.22 μg/m^3. The AQI values for all months except August falls under very poor category. The $PM_{2.5}$ is critical pollutant at this location.

B. R.K. Puram Monitoring Station

The study shows that maximum and minimum concentration of $PM_{2.5}$, SO_2 and NO_2 are 713.11 μg/m^3 and 18.55 μg/m^3, 317.75 μg/m^3 and 4.15 μg/m^3, 150.17 μg/m^3 and 21.72 μg/m^3. The AQI values falls under very poor, Moderate, Satisfactory and Severe categories. The AQI values of July and August falls under satisfactory category. The $PM_{2.5}$ is critical pollutant at this location.

C. Punjabi Baugh Monitoring Station

The study shows that maximum and minimum concentration of $PM_{2.5}$, SO_2 and NO_2 are 783.14 μg/m^3 and 11.31 μg/m^3, 130.41 μg/m^3 and 0.42 μg/m^3, 196.74 μg/m^3 and 21.72 μg/m^3. The AQI values falls under poor, very poor, Moderate, Satisfactory and Severe categories. The AQI values from June to September falls under satisfactory category. The $PM_{2.5}$ is critical pollutant at this location.

D. Anand Vihar Monitoring Station

The study shows that maximum and minimum concentration of $PM_{2.5}$, SO_2 and NO_2 are 848.55 μg/m^3 and 20.84 μg/m^3, 607.9 μg/m^3 and 4.76 μg/m^3, 192.13 μg/m^3 and 0.24 μg/m^3. The AQI values falls under poor, very poor, Moderate, Satisfactory and Severe categories. The AQI values July and August falls under satisfactory category. The $PM_{2.5}$ is critical pollutant at this location.

The overall AQI of all this stations exceeds the satisfactory level value, which indicates the poor air quality.

Analysis of AQI trend for different seasons:

It was found that for all the stations the AQI values were high during winter season and low during monsoon season on account of low wind speed resulting into low dispersion air pollutants.

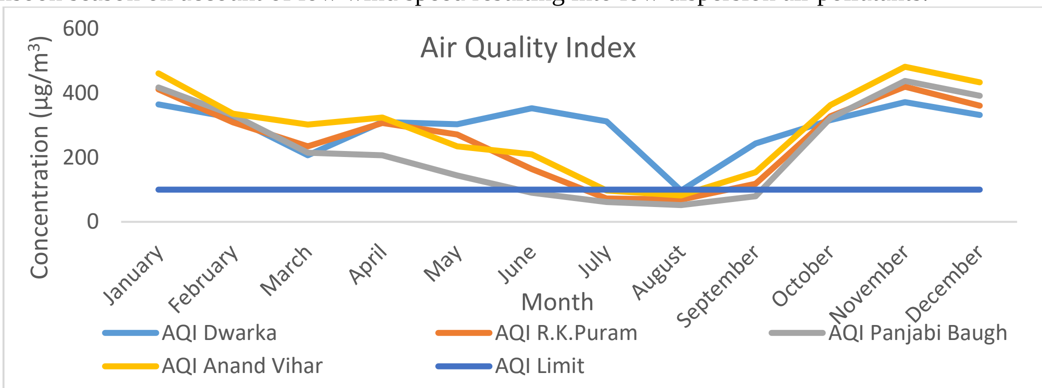

Figure 2: Variation of AQI at various locations

Month	AQI			
	Dwarka	R.K Puram	Panjabi Baugh	Anand Vihar
January	365	412	418	461
February	323	309	332	336
March	207	235	215	302
April	310	307	207	324
May	303	271	144	235
June	353	164	90	210
July	312	73	62	97
August	97	69	52	82
September	244	118	79	154
October	316	328	322	363
November	372	420	438	482
December	332	361	392	434

Table 3: Monthly Air Quality Index Value of monitoring stations of Delhi (2016)

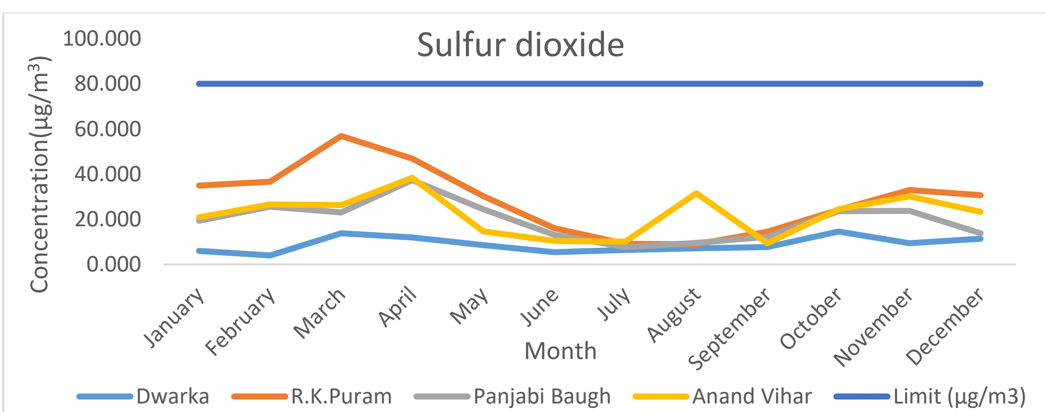

Figure 3: Monthly variation of Sulfur dioxide at various locations

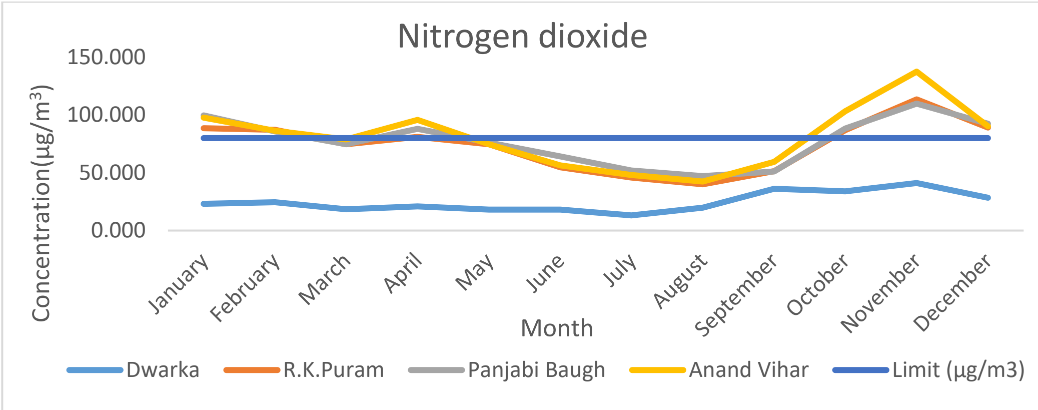

Figure 4: Monthly variation of Nitrogen dioxide at various locations

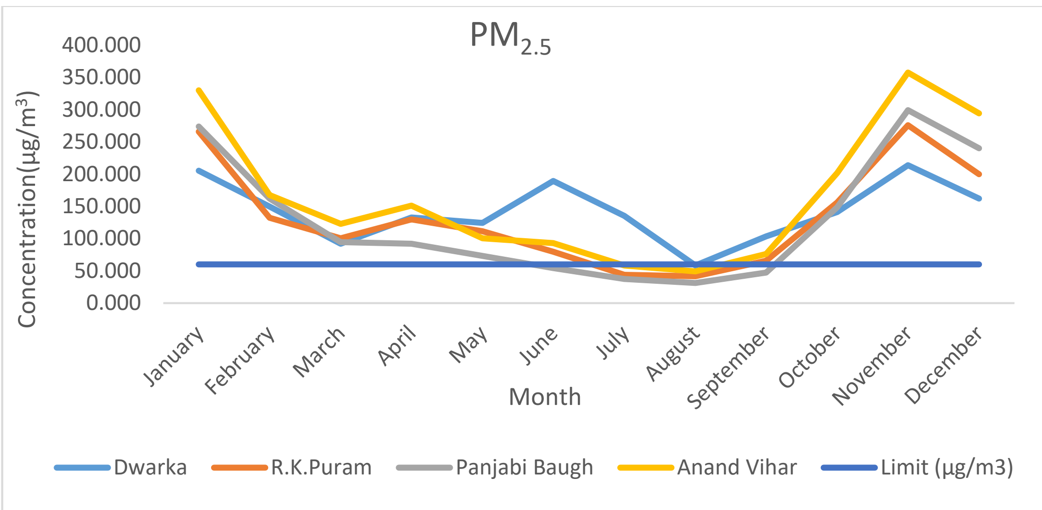

Figure 5: Monthly variation of Particulate Matter ($PM_{2.5}$) at various locations

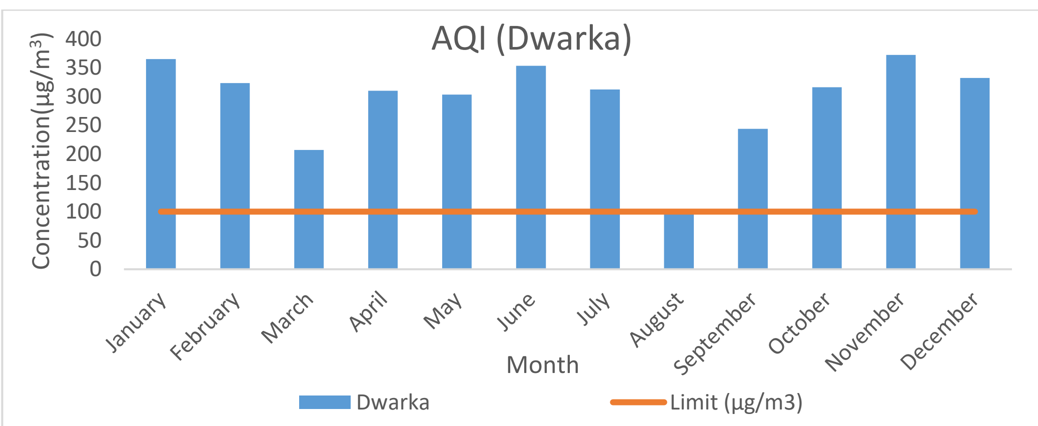

Figure 6: Variation of AQI at Dwarka

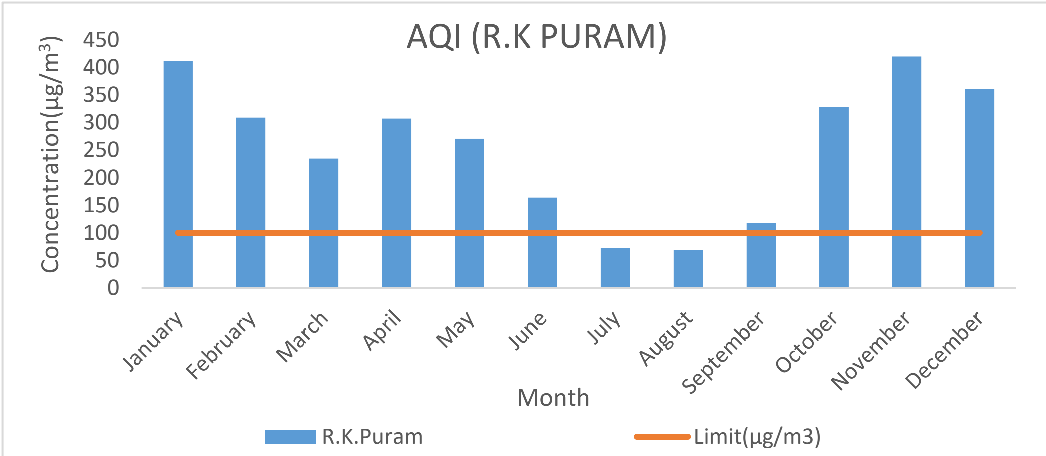

Figure 7: Variation of AQI at R.K Puram

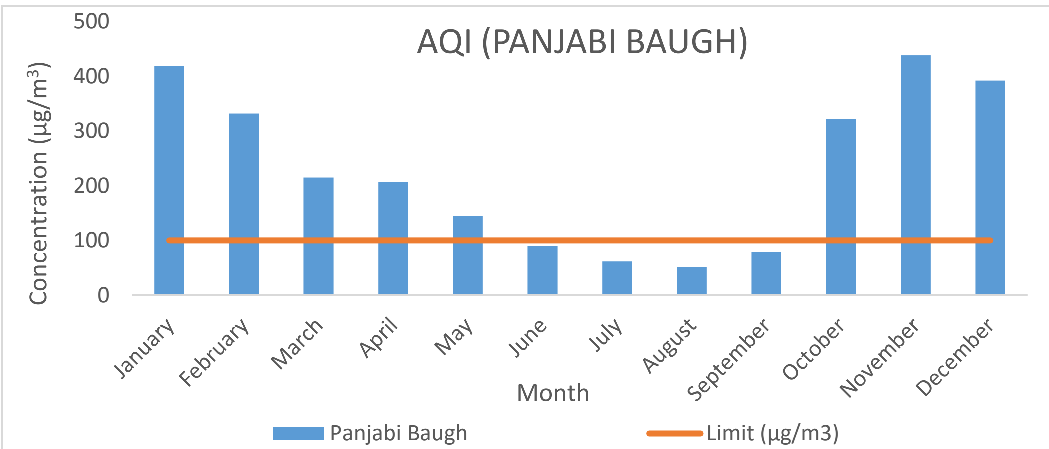

Figure 8: Variation of AQI at Panjabi Baugh

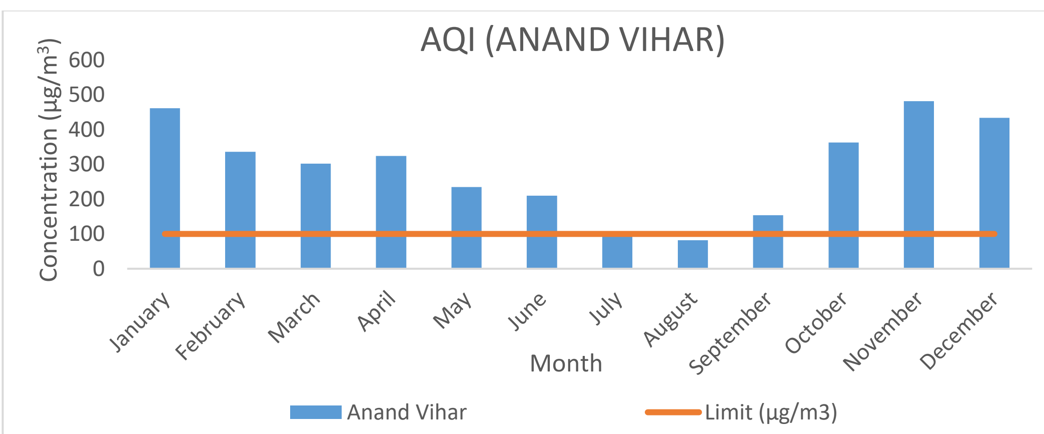

Figure 9: Variation of AQI at Anand Vihar

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