

# Urban Air Quality of Million Populated Cities of India

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## Abstract

Like many countries central pollution control board (CPCB) conducted evaluation of air pollution in many cities against National Ambient Air Quality Standards (NAAQS) on the basis of which we can understand the quality of India as there exceedances' gives the idea of level of pollution. Online monitoring station gives the opportunity to understand the level of air pollution in particular area daily or yearly basis. That facilitate to calculate health risk assessment in that areas. The potential for adverse health effects is substantial. According to a detailed analysis of most of the criteria pollutants in Delhi, except for SO<sub>2</sub>, all criteria pollutants exceeded the National Ambient Air Quality Standards (NAAQS) applicable in USA (V. P. Aneja et al. 2001). As we know that carbon dioxide (SO<sub>2</sub>), oxide of nitrogen (NO<sub>x</sub>), particulate matter (PM<sub>10</sub>), mainly affects the human health so study is being focus on the diseases caused by these pollutants.

**Keywords:** Urban Air Quality, Mortality, Multi Pollutant Index

## I. INTRODUCTION

### A. General

Rapid urbanization and increasing population has resulted in drastic increase in air pollutants emissions due to anthropogenic activities like transportation, industrial activity, and energy production, all concentrated in heavily populated areas. The impacts of air pollution are severe on environments, particularly in cities of about 10 million or more populations also named as megacities (Gurjar and Lelieveld, 2005), especially in Asia subcontinents where some countries (e.g., China and India) combine strong industrial growth, high no of population and also density, and extreme vehicular use. The environmental impacts are particularly severe in metro cities and million populated cities where combination of intense industrial activity, large populations, and increased motor vehicle usage.

As we know that there is a very close relationship between human health and pollution level in that area. It is found from various studies and epidemiological data that health affected directly from ambient air quality of local and nearby location. From the very previous days' air pollution from automobiles, and the burning of coal in factories and in homes has also been a problem. But in the 19th century, episodes of smog (a combination of smoke and fog) in famous cities like London and New York resulted in many deaths drawn a special attention of everybody. Air pollution continued to be a severe problem up through the mid of the 20th century. In late October of 1948, 20 people were suffering from asphyxiated and more than 7,000 became seriously ill as the result of air pollution over Donora, Pennsylvania (Pennsylvania Department of Environmental Protection, 2005). From recent studies of Global Burden of Disease (GBD), it is estimated that in urban environment approximately 1.4% of total mortality, 2% of all cardiopulmonary diseases (Ezzati et al., 2002; WHO, 2002; Cohen et al. 2004).

### B. Objective of Present Study

Due to high level of air pollutants, metropolitan cities have got lot of attention. In present study central idea is to cover most of the metropolitan cities with respect to their air quality and health risk associated due to main pollutants like SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>. To simplify the study and for better understanding cities are grouped into several zone. Present study has considered 37 million populated cities of India divided into zones as given in Table 1.

Table – 1  
Million plus Populated Cities of India (Source: Census 2011)

| North zone | East zone | South zone cities | West zone | Central zone |
|------------|-----------|-------------------|-----------|--------------|
| Ludhiana   | Patna     | Hyderabad         | Ahmedabad | Raipur       |

|            |            |                    |          |           |
|------------|------------|--------------------|----------|-----------|
| Amritsar   | Ranchi     | Vishakhapatnam     | Surat    | Durg      |
| Faridabad  | Jamshedpur | Bangalore          | Vadodara | Indore    |
| Delhi      | Dhanbad    | Kochi              | Rajkot   | Bhopal    |
| Ghaziabad  | Kolkata    | Chennai            | Jodhpur  | Jabalpur  |
| Chandigarh | Asansol    | Madurai            | Jaipur   | Gwalior   |
|            |            | Thiruvananthapuram | Kota     | Allahabad |
|            |            |                    | Mumbai   | Luck now  |
|            |            |                    |          | Varanasi  |
|            |            |                    |          | Kanpur    |

### C. Significance of Present Study

For Indian context studies are available for ambient air quality of various cities (Sharma et al. 1967; Bhanakar et al. 2005; Gupta and Kumar, 2006) and health impacts of various carcinogenic pollutants (e.g.: Gurjar et al. 1996; Gurjar and Mohan, 2002). But air quality with respect to most common pollutants (SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>) has not been done for Indian context. Various studies done earlier have been focus on one or small number of cities like for Delhi city a depth study have been done from 1991-2009 in which variation of air quality and health effects both have been considered (Nagpure et al. 2014). But this study made an attempt to quantify the air quality of million populates cities and their potential of harm toward the human health. Present study offers a comparative view at a glance of million plus populated cities discussed here to understand the burden of air pollutants and health effects chances. Thus analysis of urban air quality as well as health impact assessment is main focus of this present study.

## II. PRELIMINARIES

AQI is a number notation used by the government agencies to characterize the quality of air in local environment. As AQI increases, chances of health effects is likely to increases on large scale. AQI values varies by pollutants and also with local (i.e. country to country). For AQI representation there is a range assigned for showing the impacts of that range on human health with color code. These type of representation of AQI might also encourage the number of person to take some responsibility toward towering of AQI values. (Srinivas et al. 2013).

Urban air quality mainly represented by two index:

- AQI (air quality index)
- MPI (multi pollutant index)

### A. AQI

- The AQI (Air Quality Index) is a scale in numerical values for representing the ambient air pollution recorded at monitoring sites on a particular time (e.g., daily). AQI generally gives the instantaneous understanding of air quality of local. The two main objectives of to study AQI are (a) to inform and warn to the people about the risk of exposure to daily pollution levels and (b) to implement required regulatory measures for immediate local impact to ascertain better level of air quality (Stieb et al., 2005).
- The higher value of AQI, represents the higher level of air pollution and health risk.

### B. MPI

- MPI is a rating scale gives numeric value on basis of combined air pollution.
- A study have been done by Gurjar et al. (2008) showed urban air quality of megacities of Asia ranking on basis of MPI Index. Formula is given by Eq. (2.1)

$$MPI = (1/2N) [\sum\{(ACI - GCI)/GCI\} + \sum\{(AEI - GEI)/GEI\}] \dots\dots\dots (2.1)$$

- Here ACI is atmospheric concentration of a pollutant
- And GCI is guideline concentration of a pollutant
- N is number of observation that is sample size for different years.

AQI is representation of air quality in number scale of local environment which offer to better understanding of our surrounding on daily basis. AQI values are prescribed on the basis of topographical as well as metrological condition so it varies from country to country.

Table – 2  
AQI (Air Quality Index) Value & Descriptor

| SN | AQI VALUE | LEVEL OF HEALTH CONCERN      |
|----|-----------|------------------------------|
| 1  | 0-50      | Good                         |
| 2  | 51-100    | Moderate                     |
| 3  | 101-150   | Unhealthy for sensitive area |
| 4  | 151-200   | Unhealthy                    |
| 5  | 201-300   | Very unhealthy               |
| 6  | 301-500   | Hazardous                    |

(Source: David et al. 2006)

### III. METHODOLOGY

Urban air quality is an indicator of level of pollution in concern area or locals. Air quality indicates how much level of any pollutants fluctuates with respects to the prescribed value. For representing air quality on basis of short term exposure (i.e. 24 hours) there are various studies given the values of Air Quality Index (AQI). AQI is direct representation of quality of air of surrounding on hourly basis.

Calculation of AQI involves following steps:

- 1) Average of concentration of all the monitoring station given in that city gives actual concentration of that city.
- 2) Convert that average daily concentration of pollutants in desire units like SO<sub>2</sub>& NO<sub>2</sub> in ppm and PM<sub>2.5</sub> in µg/m<sup>3</sup> with use of following relation:

$$Y (\mu\text{g}/\text{m}^3) = x(\text{ppm}) * \text{MW} * 10^3 * 273 * P(\text{atm}) / 22.41 * T(\text{K})$$

$$X (\text{ppm}) = y(\mu\text{g}/\text{m}^3) * 22.41 * 10^{-3} * T(\text{K}) / \text{MW} * P * 273$$

- 3) Then with use Table 3 simple interpolation gives the values of AQI.

For present study we consider 37 million populated cities so only correlate the level of pollutants that fluctuates with prescribed limits given by NAAQS with the human health risk.

Table – 3  
Breakpoints for AQI

| This Breakpoint          |                       |                       | Equal this AQI | And this category             |
|--------------------------|-----------------------|-----------------------|----------------|-------------------------------|
| PM10(µg/m <sup>3</sup> ) | SO <sub>2</sub> (ppm) | NO <sub>2</sub> (ppm) | AQI            | CATEGORIES                    |
| 0-54                     | 0-0.034               | ( <sup>2</sup> )      | 0-50           | Good                          |
| 55-154                   | 0.035-0.144           | ( <sup>2</sup> )      | 51-100         | Moderate                      |
| 155-254                  | 0.145-0.224           | ( <sup>2</sup> )      | 101-150        | Unhealthy for sensitive group |
| 255-354                  | 0.225-0.304           | ( <sup>2</sup> )      | 151-200        | Unhealthy                     |
| 355-424                  | 0.305-0.604           | .65-1.24              | 201-300        | Very Unhealthy                |
| 425-504                  | 0.605-0.804           | 1.25-1.64             | 301-400        | Hazardous                     |
| 505-604                  | 0.805-1.004           | 1.65-2.04             | 401-500        | Hazardous                     |

(Source: USEPA 2014)

2 NO<sub>2</sub> has no short-term NAAQS and can generate an AQI only above a value of 200.

Table – 4  
National Ambient Air Quality Standards (NAAQS)

| SN  | Pollutants                              | Time               | Concentration in Ambient Air                 |                                                           |
|-----|-----------------------------------------|--------------------|----------------------------------------------|-----------------------------------------------------------|
|     |                                         |                    | Industrial, Residential Rural and other area | Ecological sensitive area(notified by central government) |
| (1) | (2)                                     | (3)                | (4)                                          | (5)                                                       |
| 1   | Suphur Dioxide                          | Annual<br>24 hours | 50<br>80                                     | 20<br>80                                                  |
| 2   | Nitrogen dioxide                        | Annual<br>24 hours | 40<br>80                                     | 30<br>80                                                  |
| 3   | Particulate matter<br>PM <sub>10</sub>  | Annual<br>24 hours | 60<br>100                                    | 60<br>100                                                 |
| 4   | Particulate matter<br>PM <sub>2.5</sub> | Annual<br>24 hours | 40<br>60                                     | 40<br>60                                                  |
| 5   | Ozone                                   | Annual<br>1 hour   | 100<br>180                                   | 100<br>180                                                |
| 6   | Lead (Pb)                               | Annual<br>24 hours | 0.50<br>1.0                                  | 0.50<br>1.0                                               |
| 7   | Carbon Monoxide<br>(CO)                 | 8 hours<br>1 hours | 0.2<br>0.4                                   | 0.2<br>0.4                                                |
| 8   | Ammonia (NH <sub>3</sub> )              | Annual<br>24 hours | 100<br>400                                   | 100<br>400                                                |

### IV. RESULT

#### A. Urban Air Quality

Urban air quality trend in terms of main air pollutants of concern cities (i.e. million populated cities of India) have shown (2008-2012) in fig no. 4.1-4.10. To make air quality of cities easy to understand cities are shown in zones.

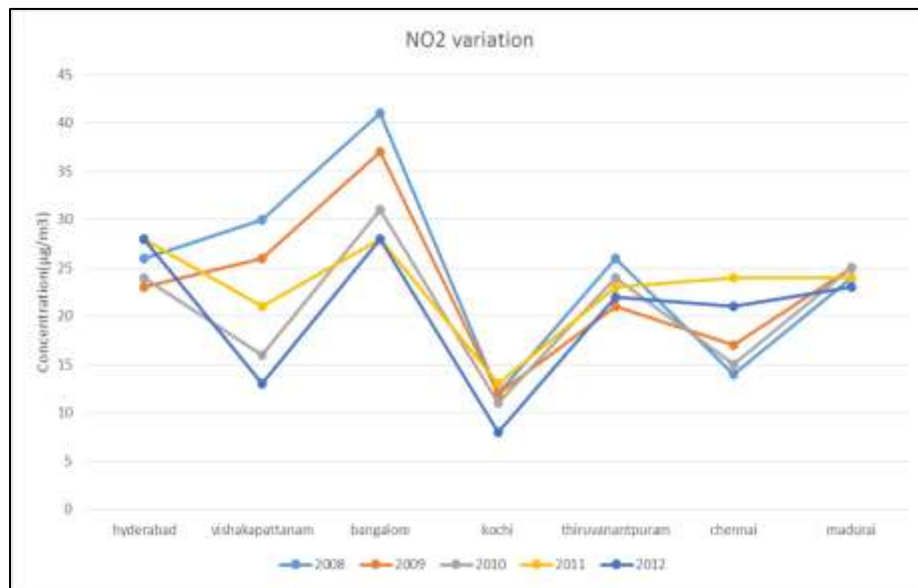
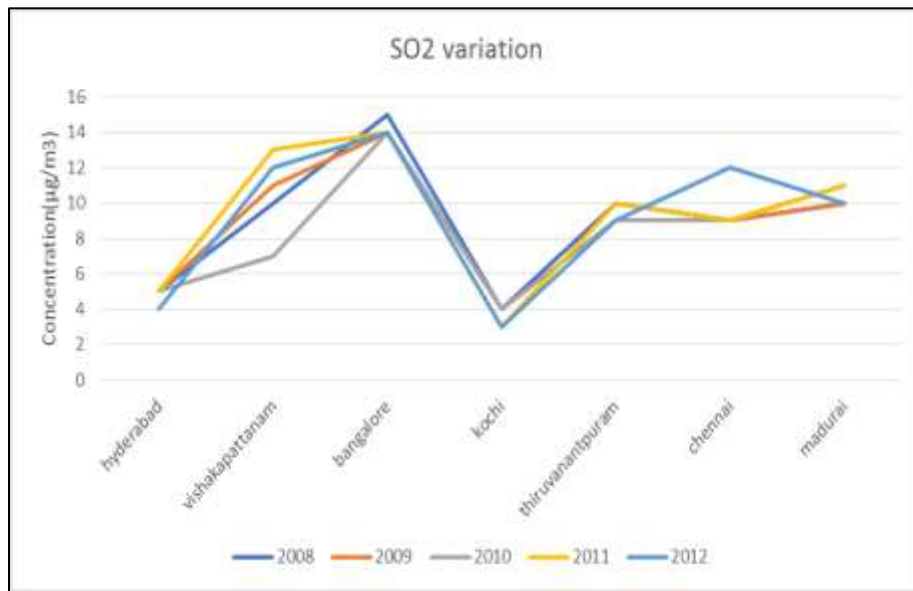
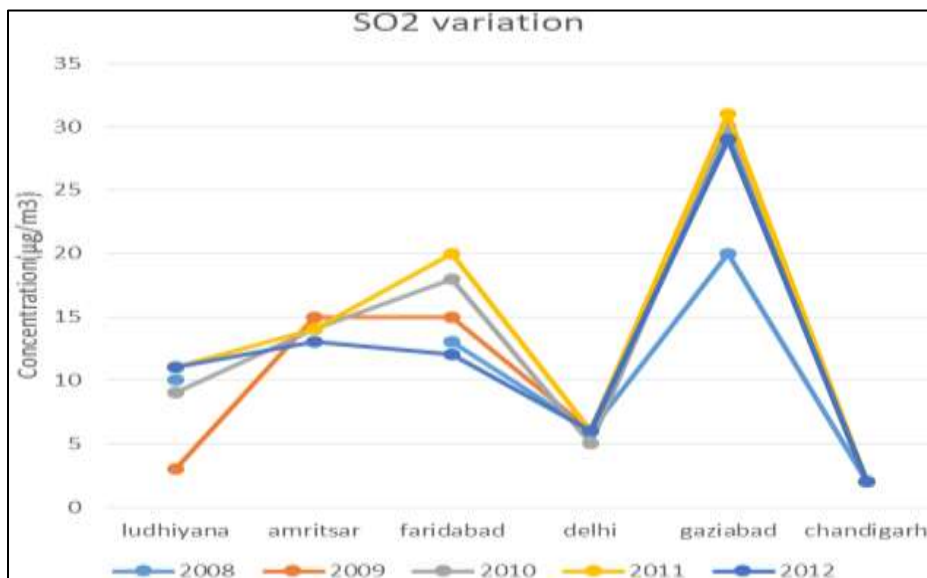


Fig. 4.1: SO<sub>2</sub>, NO<sub>2</sub> Level in Southern Indian Cities



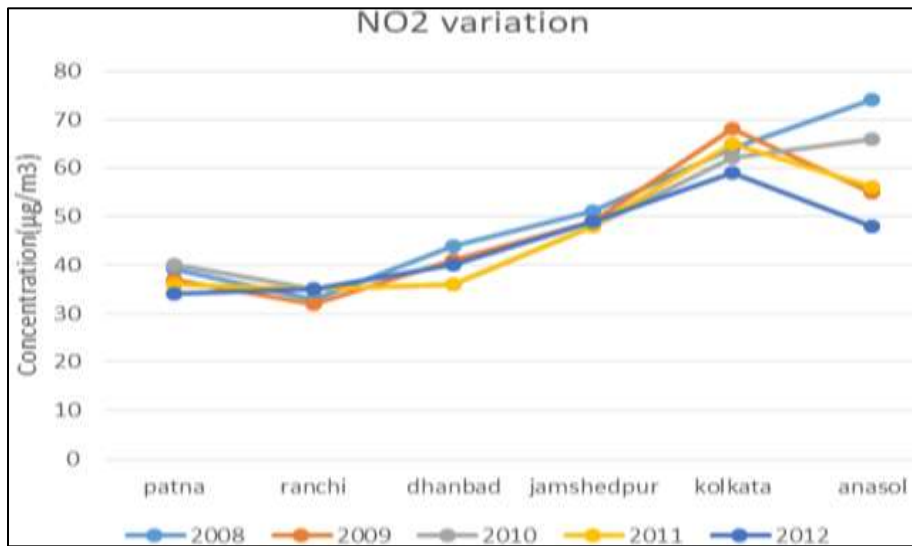


Fig. 4.2: SO<sub>2</sub>, NO<sub>2</sub> Level in Northern Indian Cities

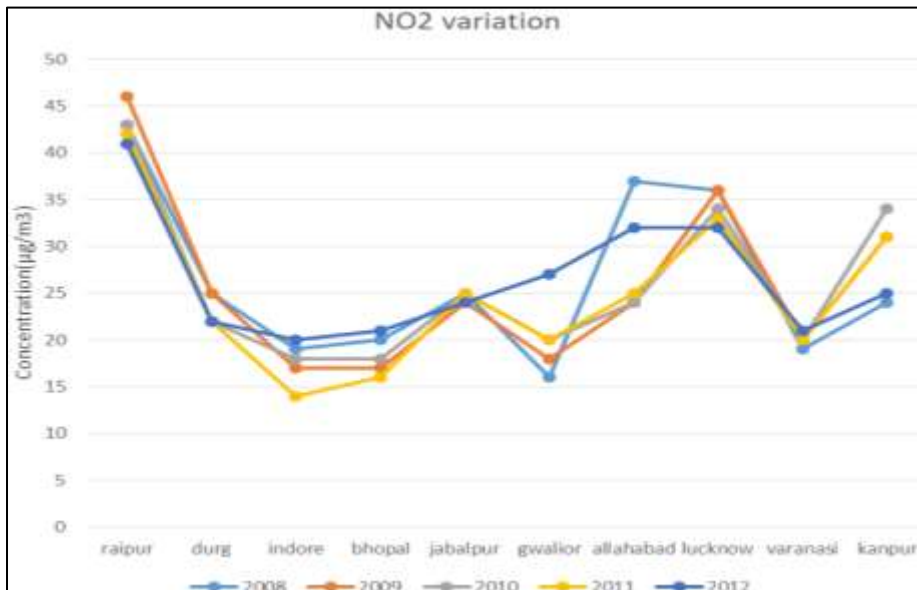
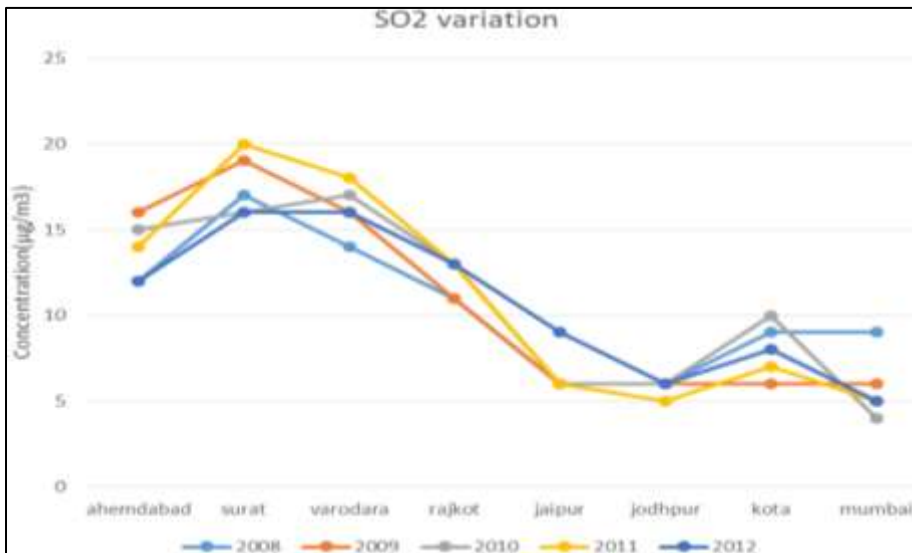


Fig. 4.3: SO<sub>2</sub>, NO<sub>2</sub> Level in Western Indian Cities

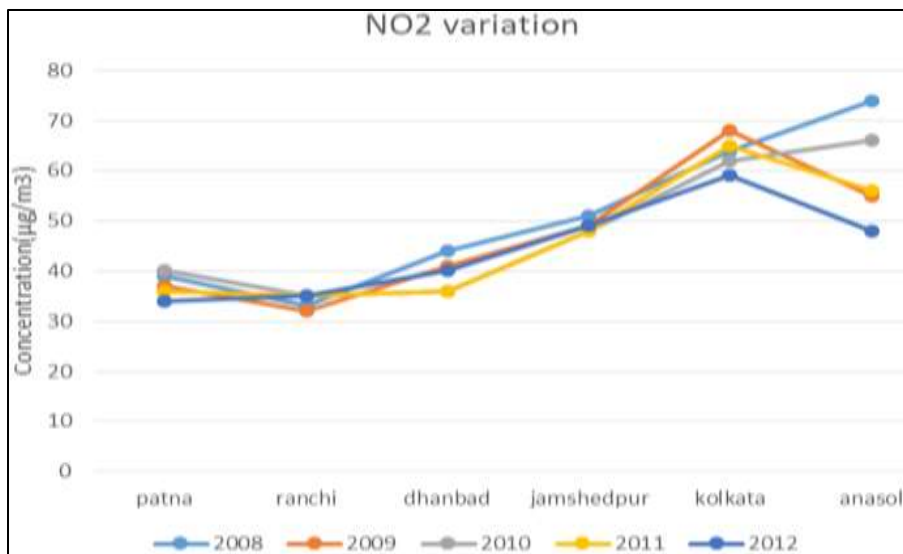
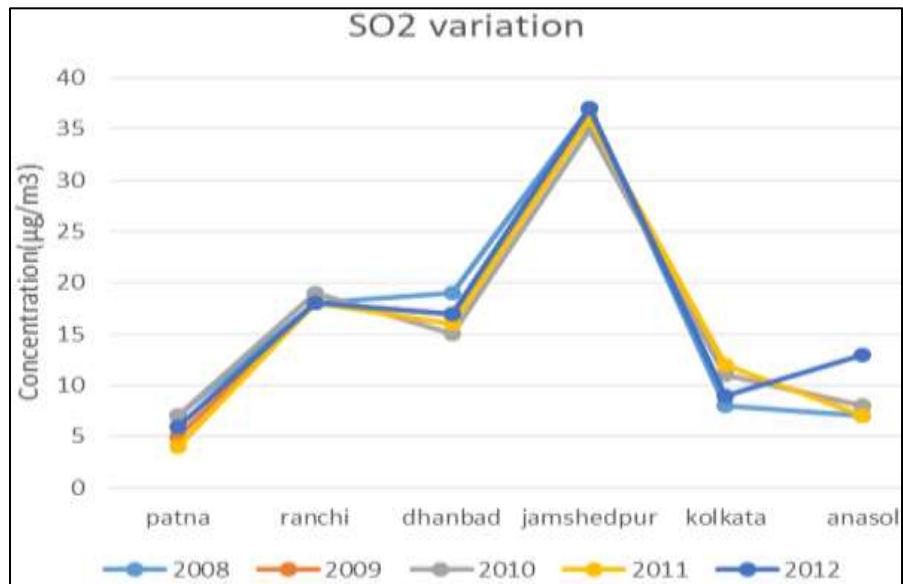
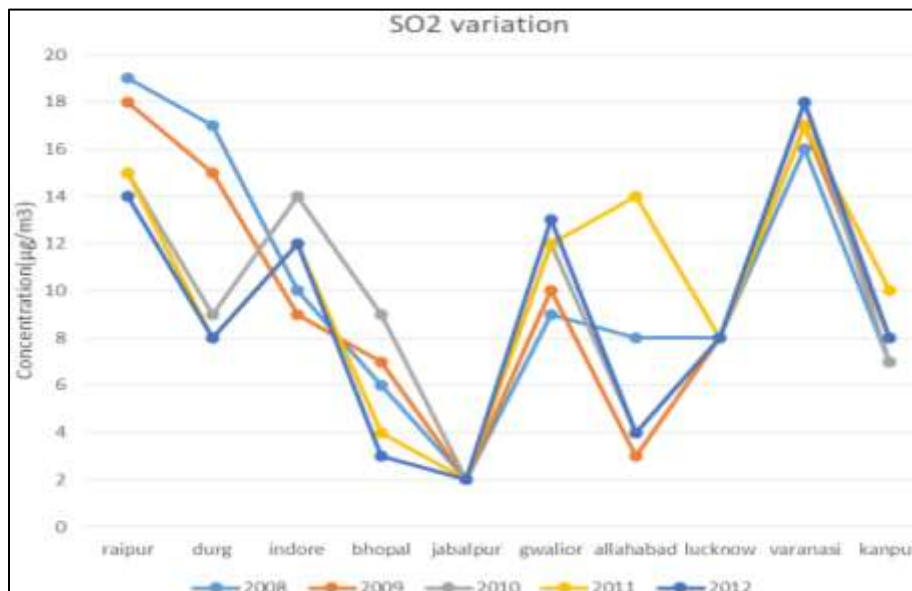


Fig. 4.4: SO<sub>2</sub>, NO<sub>2</sub> Level in Eastern Indian Cities



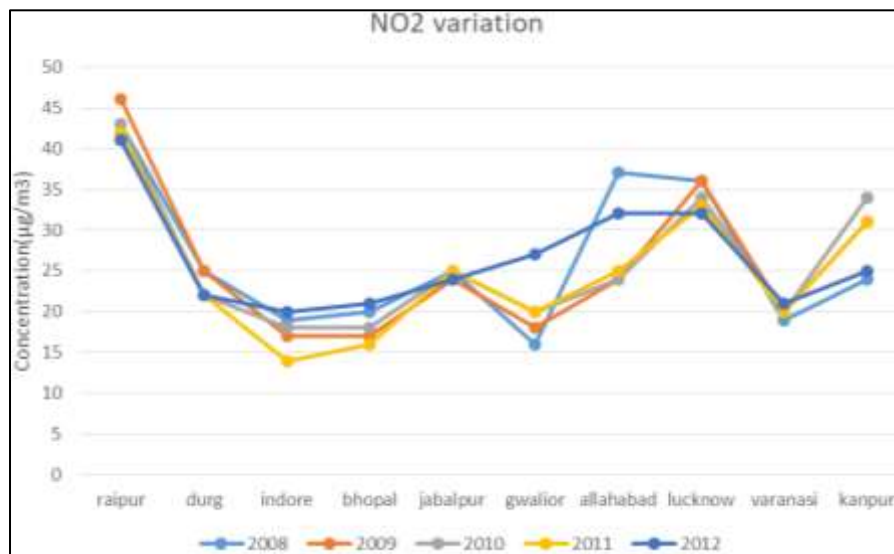


Fig. 4.5: SO<sub>2</sub>, NO<sub>2</sub> Level in Central Indian Cities

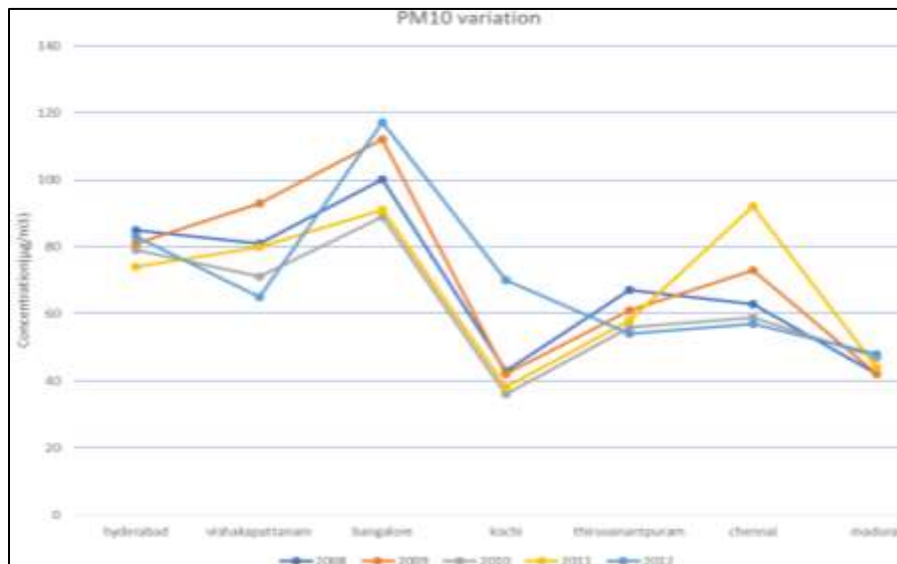


Fig. 4.6: PM<sub>10</sub> Level in Southern Indian Cities

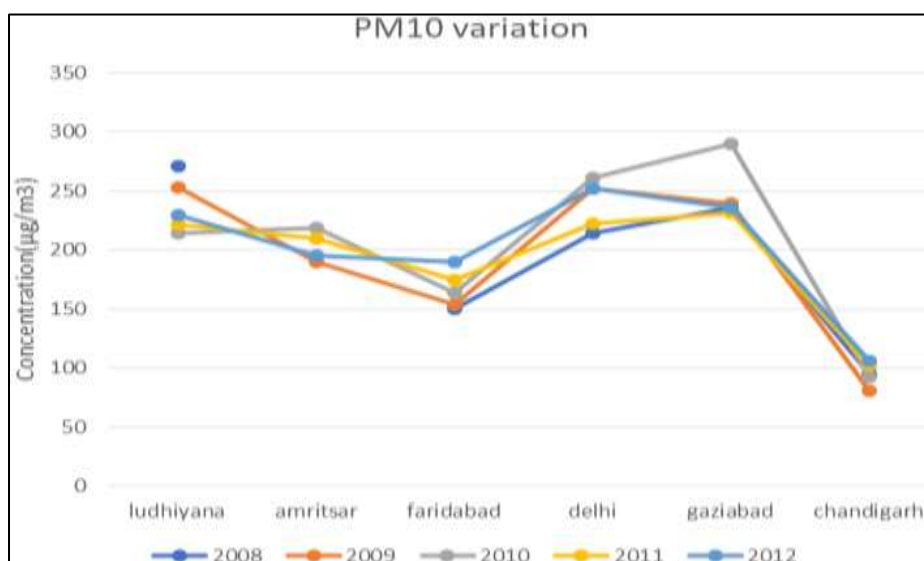


Fig. 4.7 PM<sub>10</sub> Level in Northern Indian Cities

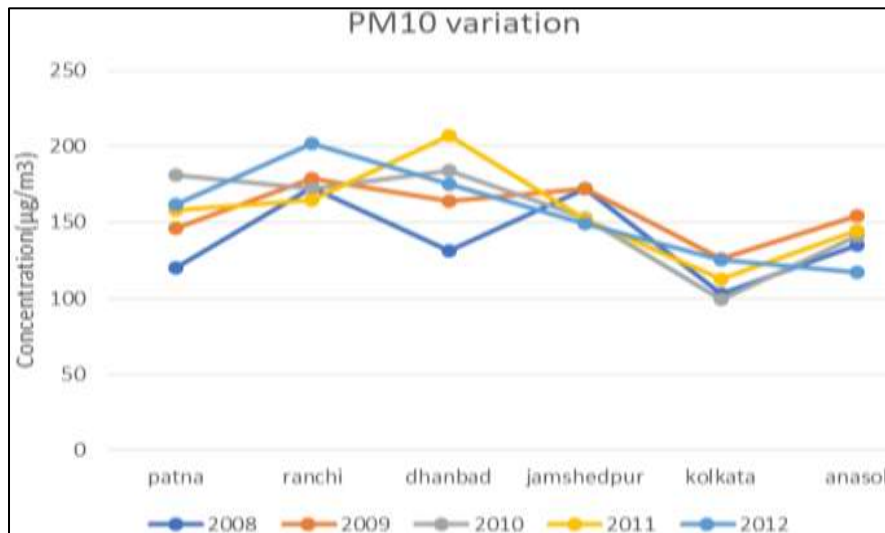


Fig. 4.8 PM<sub>10</sub> Level in Eastern Indian Cities

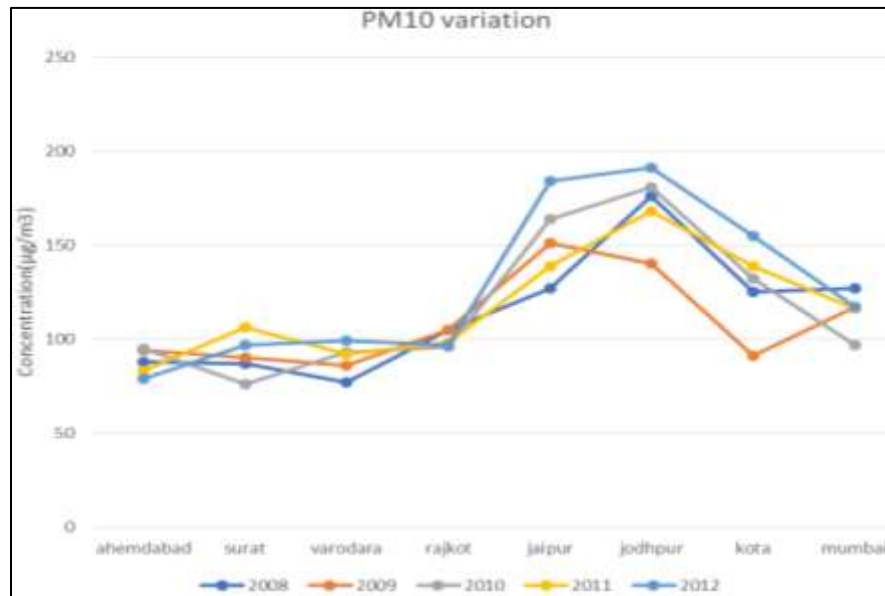


Fig. 4.9: PM<sub>10</sub> Level in Western Indian Cities

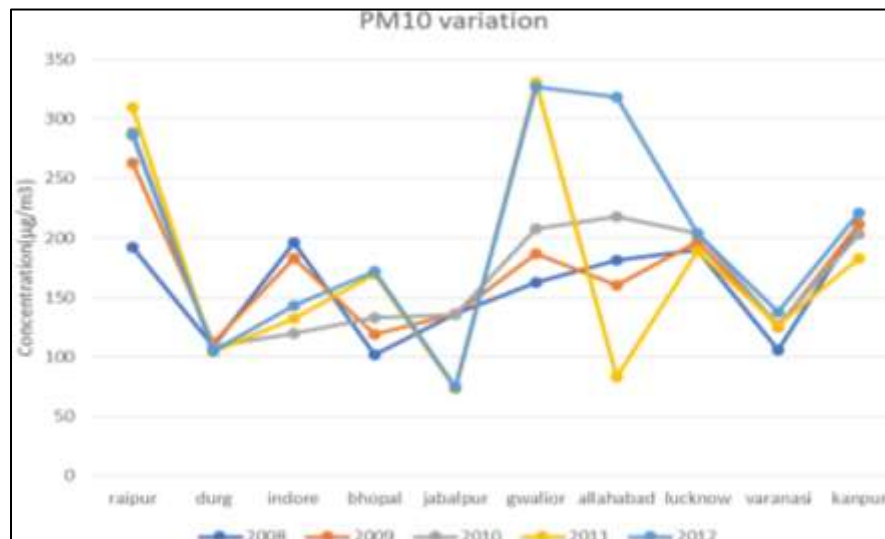


Fig. 4.10: PM<sub>10</sub> Level in Central Indian Cities

## V. CONCLUSIONS

The following conclusion are drawn based on this study:

- 1) Urban ambient air quality status in the selected cities are very inferior in terms of PM10 concentration which is about 18-245 times higher than the annual average NAAQS. The average annual concentration found maximum for Gwalior, Delhi, Ghaziabad, Raipur and Kanpur in terms of PM10 for concern years (2008-2012).
- 2) Ambient concentration of SO<sub>2</sub> and NO<sub>2</sub> were found within the limits of NAAQS prescribed by CPCB, but for some cities NO<sub>2</sub> concentration exceed in their annual average concentration.
- 3) NO<sub>2</sub> concentration found maximum for Kolkata which is nearly 60% higher than the NAAQS limit prescribed by CPCB.
- 4) In terms of percentage increase in concentration of PM10 from 2008-2012 Gwalior is on top where nearly 200% (163 to 327 µg/m<sup>3</sup>) concentration increase during these years. The main reason of such high concentration of PM10 is high constructional activities and monitoring site present at constructional site.

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