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Analysis Of Air Pollution In Indian Cities - A Literature Review

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ABSTRACT: Air pollution in India has increased rapidly due to population growth, increase in the numbers of vehicles, use of fuels , bad transportation systems , poor land use pattern, industrialization, and above all, ineffective environmental regulations. Sulphur Dioxide, Nitrogen Dioxide, Particulate Matter are some of the pollutants which are contributing to environmental pollution.Purpose of this paper is to review the literature relating to the analysis of ambient air quality of some Indian cities and compare the same with Indian National Ambient Air Quality Standards. Also discuss of the use of Air Quality Index (AQI), seasonal variation in concentration of air pollutants. Assessment of health impacts due to increase in the concentration of air pollutants in Indian cities.

I. INTRODUCTION

Air Pollution is one of the serious problems in the world especially in urban areas of developing countries due rapid growth of population, increase in number of vehicle and industrialization. Motor vehicle have been regarded as the primary cause of air pollution in the urban areas and account for 60 to 70% of the pollution found in the urban environment. SO_2, NO_2, SPM and RSPM are major air pollutants in India. The studies on air pollution in large cities of India showed that ambient air pollution concentrations are at such levels where serious health effects are possible. Continuous rise of population along with the lack of suitable measures for air pollution control means that there is a great potential that conditions may worsen in future in Indian cities. These all pollutants may pose harmful effect on human health such as cardiovascular and respiratory disease, Neurological impairments, increased risk of preterm birth and even mortality and morbidity. Various studies conducted in India at various locations suggests that pollution levels varies significantly in different areas with respect to its location, time, period of sampling and climatic conditions.

II. LITERATURE REVIEW

This paper reviews the Air Quality Analysis at following locations in India:

Gwalior. Gwalior is surrounded by industrial and commercial zones and rapid increase in urbanization results in increase gaseous pollutants SO_2, NO_2, SPM and RSPM. Concentration of SO_2 was monitored at 4 locations of Gwalior by using high volume air sampler (Envirotech APM 415 and 411). The average ambient air concentration of SO_2 was found below the permissible limits of NAAQS at all the sites. Comparatively somewhat higher concentration of SO_2 was observed during these months. A health survey was also carried out which showed the symptoms were developed such as sore throat, shortness of breath, skin irritation, wheezing, sneezing, chest tightness, nausea etc. An assessment for people (aged 10 to 60 years) was carried out to find health problems due to vehicular pollution between the months of November-2013 to May-2014 (winter). Average concentration of SO_2 at residential area Kampoo was found 11.800 μg/m³ which is less as compared to other sites and also the health effects are minimum because this area is not so congested and traffic is less. At commercial area Thatipur average concentration of SO_2 was found 13.300 μg/m³ which is lower that of Railway Station and Gola Ka Mandir and higher than Kampoo may be due to the fact that this area is highly congested as compared to other sites because it is the commercial area of Gwalior and also traffic is found less as compared to Railway Station and Gola Ka Mandir but higher that of Kampoo. The average concentration of SO_2 at Railway Station and Gola Ka Mandir were found to be highest i.e.14.360 and 15.020 μg/m³ respectively becausee these locations are highly congested and have heavy traffic.

The average ambient air concentration of SO_2 was found below the permissible limits of NAAQS of CPCB at all the sites. Comparatively somewhat higher concentration of SO_2 was observed during November-2013 to May-2014.

In this study, an assessment of people (aged 10 to 60 years) suffering from health problems due to vehicular pollution between the months of November-2013 to May-2014 (winter) and showing these symptoms (sneezing, sore throat, shortness of breath, wheezing, chest tightness, skin irritation,

nausea etc.) was developed. The people in Thatipur were mainly suffering from sneezing and skin irritation which may be due to the heavy emissions from Tempos. These vehicles are mainly run by diesel fuel and in most cases, are not frequently serviced. Wheezing is rare in all areas, but traders in Thatipur showed the highest complaints. Shortness of breath and skin irritation is mainly shown by the tempo drivers and other people in Thatipur. Since this is a commercial area of Gwalior. The percentage of people affected by sneezing, sore throat and shortness of breath was the highest in Railway Station and Gola ka Mandir. This may be due to the fact that Tempos, Buses, Trucks, Trains and privet cars are more common and they are not well maintained. Shortness of breath is very common in these areas. The health effects in Kampoo were found rear this may be due to the fact that this area is not so congested and the fleet of traffic is found less in this area. The people were mainly affected by skin irritation, this may be due to the fact that the spent most of their time with their vehicles which are not well maintained.

Table 1: Effects of the automobile emission on the people in the study area.

Complaint	Thatipur	Railway Station	Gola Ka Mandir	Kampoo	Total
Sneezing	18	29	34	6	87(21.7%)
Sore Throat	14	29	26	8	77(19.2%)
Shortness of Breath	16	23	18	5	62(15.5%)
Wheezing	4	1	4	2	11(2.7%)
Chest Tightness	13	16	21	7	57(14.2%
Skin irritation	15	14	15	10	54(13.5%)
Nausea	12	17	19	4	52(13.0%)

Cuttack. Pradeepta K. Bhuyan, Pradyusa Samantray and Swoyam P Rout (2010) discussed the use of Air Quality Index (AQI) describing air pollution in Choudwar area. AQI is computed for ten air quality sampling stations in the Choudwar area within the radius 10 kms from the core zone. This study identifies the potential sources of air pollution. The data obtained from monitoring of ambient air at ten locations within the study area are used to calculate the AQI for each season during the study period. Throughout the study period SPM was found to be minimum of 102.2 mg/m^3 at Narapada, monsoon, 2007 and maximum of 360 mg/m^3 at Kapeleswar Near IMFA, Post-monsoon, 2007 and also at Ghantikhal, Premonsoon, 2008.

Table 2: Parameters (Pollutants) in mg/m^3 Monsoon, 2007.

Location	SPM			RSPM			NO_2			SO_2		
	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon
Agrahat	169.5	120.2	178	74.4	74.4	70.2	16.2	20.4	22.4	0.8	1	1.2
Nergundi Railway station	182.5	125	180	75	75	84	24	21.4	28.4	1.2	1.2	1.4
Narapada	138.2	102.2	140	52	52	69.2	12.8	16	18.4	1.4	0.9	1.2
Kapeleswar Near IMFA	168	130.2	190	62	62	86.4	15.9	20.2	19.4	8.4	8	8.4
Khuntuni	179	118	202	53	53	75	31	31	29.6	4.5	4.2	4.1
Ghantikhal	190	125	308	25	25	125	19	23.4	28.6	4.2	4.2	4
Near Arati Steel	149	125	360	70	70	122	21.2	22.6	31.6	4	4.1	4.2
Daulatabad	148	115	200	60	60	78	20	20.2	24.2	1.4	1.2	1.6
Kayalapada	152	120	168	79	79	77	16.2	18.4	20.2	1.2	1.4	1.6
Gurudijhatia	135	125	160	30	30	82	18.2	16	22	1.2	1	1.6

The highest value of SPM is due to coke/coal dust and frequent transport of raw materials through heavy vehicles in the industrial belt located in rural area. SPM was found to be less at Kapeleswarnear IMFA on account of proper management of coke/coal dust through frequent sprinkling of water at Coal Handling plant and its peripheral area. NO_2 found to be minimum of 12.8 mg/m^3 at Narapada, Pre-monsoon, 2007 and Pre-monsoon, 2008 and maximum of 38.3 mg/m^3 at Ghantikhal. Post-monsoon, 2008 which are within limits. SO_2 found to be minimum of 0.8 μg/m^3 at Agrahat, Pre-monsoon, 2007 and maximum of 8.4 mg/m^3 at Kapeleswar Near IMFA, Post-monsoon, 2007 and Post-monsoon 2008. The SO_2 content in ambient air is slightly higher owing to combustion of high sulphur content coal/coke used in thermal power plant and ferroalloys plant and the emission of fumes. The data for three seasons revealed that concentration of pollutants except SPM, for entire monitoring stations do not exceed the permissible limits but in the locations around Arati Steel, the concentration of SPM is very high at most of the times.

Table 3: Parameters (Pollutants) in mg/m^3 Monsoon, 2008

Location	SPM			RSPM			NO_2			SO_2		
	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon	Pre Monsoon	Monsoon	Post Monsoon
Agrahat	163	124.4	173	71.2	61.2	74.4	18	22.4	24	1.8	2	2
Nergundi Railway station	181.1	135.4	182	74.6	51	82	25.4	20	28.2	2	1.6	2.2
Narapada	136.7	118	142	52.9	40	68.2	12.8	18	16.4	1.6	1.8	2
Kapeleswar Near IMFA	164.4	138.4	192	65.8	32.4	86.8	16	18.2	19.4	8	8.2	8.4
Khuntuni	170	358	133	78	117.2	63	32.4	28.1	30.3	4.1	4.2	4
Ghantikhal	360	241	328	126	115	110	28.2	27.5	38.3	4.1	4.1	4.2
Near Arati Steel	160	291	142	71	116	72	35.3	27.5	30.1	4.2	4.1	4
Daulatabad	152	122	190	62.4	48	72.2	21.2	20.4	21.2	2	1.8	2.2
Kayalapada	148	116	165	78	28.2	78	16.4	18.6	18.8	1.8	2.2	2
Gurudijhatia	140	125.2	160	32.2	24.2	82.3	18.4	17.6	16.4	2	2.2	2.2

Bangalore. Kamath and Lokeshappa (2014) investigated air pollutant concentrations at Residential, Industrial & Sensitive Areas of Bangalore. SO2, NOX and RSPM were collected over six sites in Bangalore. The sampling stations are located at Victoria Hospital, Graphite Industrial Area, Amco Apartments, Peenya Industrial Area, Yeshwantapur Residential Area and K.H.B Industrial Area.

Meteorological parameters like Temperature, Relative humidity, Wind speed, Wind direction & Rain fall data were also recorded during the sampling period. Monthly and seasonal variation of these pollutants have been analysed and noted. It has been observed that the concentrations of the pollutants are high in summer in comparison to the Pre-monsoon and post-monsoon seasons. In the present study, it was noticed that the RSPM levels at all selected sites exceeds the prescribed limits. Apart from this the SO_2 and NO_2 levels in industrial areas remain under prescribed limits. In this study, air quality data of different Areas of Bangalore were collected and also to assessed the air quality and finally following conclusions have been drawn. At all areas SO_2 and NO_2 concentration in the ambient air was found to be within the permissible limit except at Victoria Hospital for NO_2. RSPM concentration exceeding 4.5 times than acceptable limit was observed in the ambient air at Yeshwanthpur during 2014 (RSPM - 274μg/m^3). Air quality at Victoria is very sensitiv is found to be much deteriorated in terms of NO2, SPM and RSPM concentrations.

Further based on the average AQI of different Areas studied, it was concluded that sensitive area viz., Victoria Hospital has unhealthy air quality followed by Yeshwanthpura Residential Area unhealthy for sensitive group. Moderate air quality condition was detected at industrial area namely near Graphite India Ltd., and at AMCO Residential Area. AQI established for the month of April for Victoria Hospital (187.88) indicated the hazardous level of health concern. Even the Yewshwanthpura Area exhibited very unhealthy level of health concern (191.50). Thus the AQI values warn that there is an urgent need to take steps to mitigate the deterioration of air quality.

Ahmedabad and Gandhinagar. Chintan Y. Pathak, Hiren C. Mandalia D. Roy and R. B. Jadeja (2014) studied the comparative analysis of ambient air quality of Ahmedabad and Gandhinagar in Gujarat. Both thecities have been studied on the basis of land use pattern and meteorological condition.

Ahmedabad - During monsoon (June 2012 to August 2012), the minimum concentration of pollutants were found due to increased vertical dispersion, washout by monsoon rains and suppressed wind erosion. During winter (November 2012 to February 2013) there was a maximum concentration range of all parameters. The minimum and maximum average concentration of SPM was recorded from 185 $\mu g/m^3$ to 362 $\mu g/m^3$.Maximum concentrations were recorded during January. During winter season mixing height was very less with respect to the other seasons. High concentration of Pollutants were observed on October due to festival. Minimum concentration of particulates and gases pollutants were found during summer season (April 2012 to June 2012). Lesser concentration levels of pollutants were recorded due to maximum mixing height, high temperature, high wind erosion and moderate stability. As compared with NAAQS, annual average SO_2 and NO_2 concentrations were found well below the prescribed limits. RSPM levels were slightly increasing order at station Panjarapol Char Rasta while SPM showed increasing trend. The minimum and maximum average concentration of RSPM was recorded from 74 $\mu g/m^3$ to 135 $\mu g/m^3$. Monitoring station nearby city area were found maximum NO_2 concentration levels and monitoring station nearby industrial area were found maximum SO_2 concentration levels due to industrial influence.

Table 4: Ambient Air Quality Status.

Name of sampling station	RSPM, $\mu g/m^3$	SPM,$\mu g/m^3$	NO_2,$\mu g/m^3$	SO_2,$\mu g/m^3$
Ahmedabad				
Naroda Lake	135	362	25	14
Narol Naroda Cross Road	84	214	21	13
Panjarapol Char Rasta	74	185	20	12
Jagnath Mahadev Chowk	86	224	20	13
Shahibaug Under Bridge	90	206	21	13
Ekta Circle, Behrampura	80	211	20	12
Gandhinagar				
Inquiry Office, Sector-30	86	224	21	9
Shoping Centre, Sector-8	68	178	17	8

Gandhinagar - During monsoon, average concentration was at the minimum levels. The factors responsible same as Ahmedabad. The minimum particulates and gases concentration were found on winter season due to minimum mixing height. The minimum and maximum average values of SPM were ranging from 178 $\mu g/m^3$ – 224 $\mu g/m^3$. The maximum average concentration of RSPM was recorded to 86 $\mu g/m^3$, which is under the permissible limit. However maximum concentrations were observed in January. During summer (April to June 2012), the concentration of gaseous & SPM pollutants were at the minimum due to high temperature, mixing height, high wind erosion, moderator stability, almost dry atmosphere and less humidity.As compared with NAAQS, SO_2 and NO_2 concentration were found to be very low from the prescribed limits. Annual average concentration levels of RSPM and SPM were also found to be slightly increasing order.

Bhopal. SadhanaChaurasia, PragyaDwivedi, Ravindra Singh and Anand Dev Gupta (2013) analysed ambient air quality of industrial, commercial and residential area of Bhopal (M.P.). The outcome of the study has been presented in the form of AQI. The study was carried out in February and March, 2012. Sampling time was 24 hrs. at three different locations with respect to SO_2, NOx, PM_{10} and $PM_{2.5}$. PM_{10} and $PM_{2.5}$ was always found beyond the permissible limit at all the sampling site. The relative AQI was found in severe air pollution range. Maximum value of $PM_{2.5}$ and PM_{10} was found 80.90 $\mu g/m^3$ and 160.53 $\mu g/m^3$ respectively at Hamidia road on March and minimum value was observed 62.90 $\mu g/m^3$ and 108.20 $\mu g/m^3$ respectively at Govind Pura on February. All values of $PM_{2.5}$ and PM_{10} at all selected stations were obtained beyond the permissible limit i.e. 60 $\mu g/m^3$ and 100 $\mu g/m^3$respectively on both studied months. SO_2 and NOx values were found within limit (80 $\mu g/m^3$) at all selected stations in study period.

Air pollution index was also calculated for all the parameters of both months and value of $PM_{2.5}$ was found in red zone at all stations which indicate unhealthy air quality for health concern. Similarly API of PM_{10} was found in yellow zone at all stations accept Hamidia road on March. Yellow zone indicate level of health concern moderate and API of Hamidia road was found orange zone which indicate unhealthy air quality for sensitive group. API of SO_2 and NOx was found in green zone indicating clean air quality and this zone is not harmful. Overall relative AQI indicates that severe air pollution in Bhopal city during study period.

Shillong. R. E. Lamare and S. S. Chaturvedi (2014) studied concentration of RSPM, NRSPM and TSPM Shillong, Meghalaya. Sampling was done in April, 2010. The concentration of RSPM, NRSPM and TSPM at Dhankheti Junction varies from 81.24 μg/m^3 to 261.43 μg/m^3; 73.17 μg/m^3 to 265.54 μg/m^3 and 212.49 μg/m^3 to 467.94 μg/m^3, respectively. Overall RSPM and TSPM concentrations were found to exceed the permissible limit. Based on the results obtained, the concentrations of particulate matter in the ambient air at Dhankheti Junction was mainly by vehicles. However, their concentrations at NEHU campus were found comparatively lower and are within the limit.

Respirable Suspended Particulate matter (RSPM)

The concentration of RSPM at Dhankheti Junction varies from 81.24 μg/m^3 to 261.43 μg/m^3. Based on NAAQS, the permissible limit for RSPM for 24 hours is 100 μg/m^3. The results revealed that 73.33% out of the total sampling period RSPM exceeded the permissible limit at Dhankheti Junction due to increase number vehicles. However, RSPM concentration at NEHU campus ranged from 13.34 μg/m^3 to 95.02 μg/m^3 and all are within the limit.

Non-Respirable Suspended Particulate matter (NRSPM)

At Dhankheti, the 24 hour concentration of NRSPM varies from 73.17 μg/m^3 to 265.54 μg/m^{3}and at NEHU campus varies from 6.16 μg/m3 to 162.02 μg/m^3. The re-suspension of coarse and fine soil dust from unpaved portion of the road and its dispersal by the action of wind leads to the rise of NRSPM concentration in the air.

Total Suspended Particulate Matter (TSPM)

The permissible limit for TSPM for 24 hours sampling at industrial, residential-rural and sensitive area was 500 μg/m3, 200μg/m3 and 100μg/m3, respectively. The TSPM concentration at Dhankheti and NEHU campus was observed between 212.49 μg/m^3 to 467.94 μg/m^3 and 67.51 μg/m^3 to 226.24 μg/m^3, respectively. Based on the prescribed standard limit, TSPM concentrations at Dhankheti exceed the given limit for 24 hour sampling period and at NEHU campus for little duration it crossed the limit due to elevated concentration of NRSPM in the ambient

III. CONCLUSION

There is great need to control the air pollution as it is impacting the environment and human health seriously. The concentration of air pollutants like have to be controlled to save the environment. To control air pollution, proper rules and regulations should be implemented by the government, awareness among the people, control the growth of population, number of vehicles, industries and energy consumption. We need to take pollution issue seriously because ignorance is certainly not the proper way to go. The stakes are really high and world needs to wake up and start acting right now because environmental issues are constantly growing in number and size.

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