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Ambient Air Quality Monitoring Near Busy Road Junctions In Coimbatore City

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ABSTRACT

One of the greatest impact of the industrial revolution on people's lives has been the manufacture of automobiles. Air pollution is a serious public health problem in most of the metropolitan areas around the world. Rapidly growing vehicle fleets with poor quality emission and poor maintenance are significant contributors to air pollution in cities. The rapid growth of motor vehicles in Indian cities is causing serious health, environmental and socio-economic impacts. Vehicular pollution is the major contributor of urban air pollution in most of the cities in India and estimated to account for approximately 70% of CO, 50% of HC, 30% of SPM and 10% of SO_2 of the total pollution load of which two third is contributed by two wheelers alone. This research work focuses on the urban air quality monitoring in Coimbatore city. Since the Coimbatore city is experiencing an exponential industrial and population growth, it has a high potential for air pollution. In addition, the prevailing meteorological conditions in this city are not favourable for the dispersion of the pollutants. In order to monitor the ambient air quality near busy road junctions in Coimbatore city, 6 busy road junctions were selected. In all these stations, ambient air quality monitoring was conducted on two selective days for each month, during January 2011 to December 2012. The concentration of PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO, O_3 and NH_3 were measured during the monitoring at all the stations. The Air Quality Index (AQI) was arrived at all the stations. The concentrations of PM_{10}, $PM_{2.5}$, O_3 and NH_3 at AAQMS 6 were found to be the highest among all the stations investigated. The concentration of $PM_{10,}$ $PM_{2\cdot5}$, $O_{3,}$ $NH_{3,}$ pertains to all the AAQM stations were varied from 98.5 µg/m^3 to 152.5 µg/m^3, 16 µg/m^3 to 49.8 µg/m^3, 6.2 µg/m^3 to 32.5 µg/m^3,5.4 µg/m^3 to 29.8 µg/m^3 respectively. The concentration of SO_2, NO_X and CO pertaint to all the AAQM stations were varied from 5.3 µg/m^3 to 35.0 µg/m^3,7.3 µg/m^3 to 41.0 µg/m^3,500 µg/m^3 to 779 µg/m^3 respectively.

1.INTRODUCTION

The greatest impact of the industrial revolution on people's life is the manufacture of automobiles. Motorization has brought unprecedented mobility and an extremely convenient form of transport for men and goods while creating new opportunities for employment. One of the important sources of air pollution is the vehicular exhaust emission. Study of emissions from automobiles, their transport and transformation at the urban scale are complex tasks. Air pollution is a serious public health problem in most metropolitan areas around the world. Vehicles with poor quality emission and poor maintenance are significant contributors to air pollution in cities. Air Pollutants are fine particles and gaseous contaminants that are let into the atmosphere from various sources. These air pollutants cause physiological responses in organisms and a wide range of health effects in humans. Among the various sources contributing to air pollution, the automobiles have emerged as the largest source for urban air pollution. Because of versatility, flexibility and low initial costs, there has been a boom in the manufacturing and usage of different types of vehicles. This has resulted in deterioration of air quality (Longhurst et al 2000).Most of the cities suffer from serious outdoor air pollution due to improper maintenance of vehicles (Ravindra 2003). The increased demand of vehicles has increased the emission of air pollutants into the atmosphere (Tecer 2008). Such activities cannot be stopped as they are directly related to the development of the society. This type of development and urbanization brings with them the unwanted air pollutants, namely Suspended Particulate Matter measured as PM_{10} and $PM_{2.5}$, Sulphur dioxide (SO_2), Oxides of Nitrogen (NO_X), etc.

1.1AIR POLLUTANTS AND THEIR IMPACT

Most of the cities in Northern India are affected due to the presence of unusually high concentration of PM_{10} in the ambient air posing a serious risk to human health (Tandon 2008). The increased air pollutant concentrations in urban area are responsible for the malfunctioning of the pulmonary system, cardiovascular disease, neuro-behavioural effects.

Particulate air pollution was one of the pollutants demonstrated to have serious short-term health effects, even at low ambient levels, when absorbed into human lungs. The issue of urban air quality is receiving increasing attention, as a growing share of the world's population is now living in urban centres, and demanding a cleaner urban environment (Gurjar 2008). According to the United Nations report (UN 2003) the global urban population continues to grow faster than the total population of the world. Population and economic growth have often been a serious concern for the environmental deterioration on the surrounding areas (Reddy 2001).India has experienced substantial increase in Vehicle Miles Traveled (VMT) in recent years. The increased traffic has resulted in increased pollutant emissions and the

deterioration of air quality and human health in several major cities in India.

1.2 NEED FOR THE STUDY

The total number of vehicles registered in Coimbatore city as in 2010 exceeded 1 million. Over the period of five years ending in 2006, 23 metros posted a compound annual growth rate of 8.3% in the number of total vehicle registrations. Significantly, among the second-tier cities, Coimbatore with 12.9% growth rate stood first in Tamilnadu state, India, followed by Madurai city (10.9%) (Ministry of Shipping, 2009). Coimbatore holds a share of 0.84% and 7.46% of the total registered motor vehicles in India and Tamilnadu, respectively. Slower growth in goods vehicle category hints an economic shift from commodity-producing sector (agriculture and industry) towards service sector. High growth in personalized motor vehicles reflects rising per capita income of middle class market competition in automobile sector due to globalization coupled with convenient financing options. This proliferation in the personalized mode of transport has evidently increased traffic congestion and air pollution. Because of the prevailing weather condition, topography and growth pattern, this city has a high potential for air pollution.

1.3 OBJECTIVES OF THE STUDY

The objective of this study is to conduct Ambient air quality monitoring to assess the AAQ parameters such as PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, O_3 and NH_3 near all the 6 busy road junctions in Coimbatore city during the period from January 2011 to December 2012.

2.METERIALS AND METHODS

2.1 Description of the Study Area

The Coimbatore city lies between 10° 10′ and 11° 30′ of the northern latitude and 76° 40′ and 77° 30′ of eastern longitude. The mean value is 11.01° N and 76.96° E. It is in the extreme west of Tamil Nadu and near Kerala state. The elevation of Coimbatore city is + 432.50. It is surrounded by mountains on the west and on the north. The location map of the study area is shown in Figure.1.

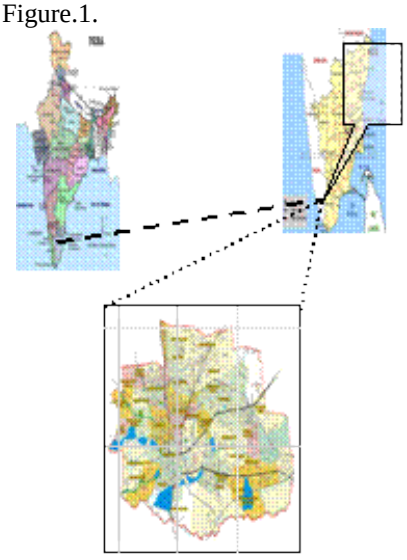

Figure.1 Location map of the study area

2.2 Ambient Air Quality Monitoring Stations

The Ambient Air Quality Monitoring Stations were chosen on the basis of maximum vehicular usage. In order to assess the impact of automobile emissions on the ambient air quality in Coimbatore City, the following Ambient Air Quality Monitoring Stations (AAQMS) were selected:

AAQMS 1: Near Gandipuram bus terminal junction
AAQMS 2: Near Railway station junction
AAQMS 3: Near Ukkadam bus terminal junction
AAQMS 4: Near Hope College Junction – Peelamedu
AAQMS 5: Near Lawley road junction
AAQMS 6: Near Mettupalayam road bus terminal junction

All the 6 Monitoring stations are indicated in Figure 2**.** They are totally urbanized with continuous traffic inflow and highly populated, and represent Coimbatore's traffic intensity.

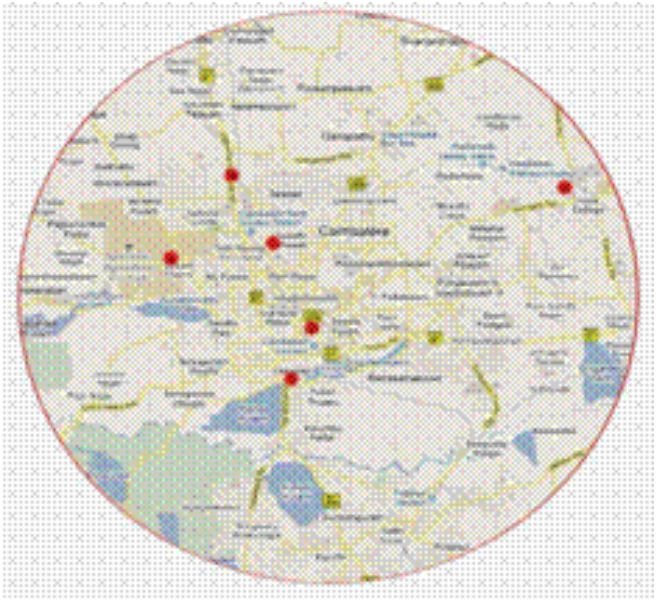

Figure.2 Location of Ambient Air Quality Monitoring Stations

2.2.1 Description of AAQMS 1

It is a junction of 4 major roads. Sakthi road on North, Nanjappa road on the South, Bharathi road on the east and cross cut road on the west. In addition to that, Town bus terminal, State Express Transport Corporation terminal and Omni bus terminal are nearby. More number of vehicles cross this junction. Hence, this location is chosen for the AAQMS1. The monitoring equipment was kept in the first floor (terrace) of municipal shopping complex.

2.2.2 Description of AAQMS 2

It is a junction of 2 major roads and a railway junction. Singanalloor road on South (This road is diverged to West for connecting Ukkadam) and Gandhipuram road on North. The railway junction connects various cities of Tamilnadu and other states. This is one of the major road in the south side of the Coimbatore so more number of vehicles cross this junction. Hence, this location is chosen for the AAQMS2. The monitoring equipment was kept in the first floor (terrace) of a commercial complex.

2.2.3 Description of AAQMS 3

It is a junction of 3 major roads. Pollachi / Palakad road on south, Perur road on West and Railway station road on North. In addition to that, Town bus terminal is nearby. This is one of the major road in south side of the Coimbatore which connects Industrial clusters and many Institutions so more number of vehicles cross this junction. Hence, this location is chosen for the AAQMS3. The monitoring equipment was kept in the first floor (terrace) of a hotel building.

2.2.4 Description of AAQMS 4

It is a junction of 2 major roads. Avinashi road on East and Gandhipuram road on West. This is one of the major road in East side of the Coimbatore which connects many Institutions and Airport so more number of vehicles cross this junction. Hence this location is chosen for the AAQMS4. The monitoring equipment was kept in the first floor (terrace) of a commercial building.

2.2.5 Description of AAQMS 5

It is a junction of 4 major roads. Thadagam road on North, Gandhi park road on South, Cowley brown road on East and Maruthamalai road on West. This is one of the major junction in West side of the Coimbatore which connects many Institutions and Maruthamali temples so more number of vehicles cross the junction. Hence,this location is chosen for the AAQMS5. The monitoring equipment was kept in the first floor (terrace) of a commercial building.

2.2.6 Description of AAQMS 6

It is a junction of 2 major roads. Gandhipuram road on South and Ooty road on North. This is one of the major road on North side of Coimbatore which connects many small scale industries and tourist places so more number of vehicles cross this road. Hence, this location is chosen for the AAQMS6. The monitoring equipment was kept in the first floor (terrace) of a commercial complex.

3.AMBIENT AIR QUALITY MONITORING

In all the ambient air quality monitoring stations, the monitoring was conducted on two selective the days for every month using Ambient Fine Dust and Respiarable Dust Samplers. The period of monitoring is from 7 A.M to 7 P.M (12 hours monitoring). For CO, the period of sampling is 8 hours. In all these ambient air quality monitoring stations, PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, O_3 and NH_3 were monitored. The air quality monitoring at all the stations were conducted for a period from January 2011 to December 2012.

4. Analysis of Air Quality data for the year 2011 and 2012

4.1.1 PM_{10}

For the year 2011, it was observed that, for PM_{10} the minimum value of 98.5 µg/m^3 was recorded at AAQMS3.The maximum value of PM_{10} of152.5 µg/m^3 was recorded at AAQMS 6. Please see Table -1.

For the year 2012, it was observed that, for $PM_{10,}$ the minimum value of 100.2 µg/m^3 was recorded at AAQMS 3. The maximum value of PM_{10} of 154.6 µg/m^3 was recorded at AAQMS 6. Please see Table -2.

3.1.2 $PM_{2.5}$

For the year 2011, it was observed that, for $PM_{2.5,}$ the minimum value of 16.0 µg/m^3 was recorded at AAQMS 3. The maximum value of $PM_{2.5}$ of 49.8 µg/m^3 has been recorded at AAQMS 6. Please see Table -1.

For the year 2012, it was observed that, for $PM_{2.5}$ the minimum value of 18.7 µg/m^3 was recorded at AAQMS 2. The maximum value of $PM_{2.5}$ of 51.2 µg/m^3 was recorded at AAQMS 4. Please see Table -2.

3.1.3 SO_2

For the year 2011, it was observed that, for SO_2,the minimum value of 5.3 µg/m^3 was recorded at AAQMS 2. The maximum value of SO_2 of 33.5 µg/m^{3}was recorded at AAQMS 1. Please see Table -1.

For the year 2012, it was observed that, for SO_2 the minimum value of 7.5 µg/m^{3}was recorded at AAQMS 2. The maximum value of SO_2 of35 µg/m^3 was recorded at AAQMS 1. Please see Table -2.

3.1.4 CO

For the year 2011, it was observed that, for CO the minimum value has been recorded at AAQMS 5. The maximum value of CO of 779 µg/m^3 was recorded at AAQMS 1. Please see Table -1.

For the year 2012, it was observed that, for CO,the minimum value has been recorded at AAQMS 5 and the minimum value was 501 µg/m^3. The maximum value of CO has been recorded at AAQMS 1 and the maximum value was 782 µg/m^3.

3.1.5 O_3

For the year 2011, it was observed that, for O_3 the minimum value of6.2 µg/m^3 was recorded at AAQMS 5.The maximum value of O_3 of 32.5 µg/m^3 was recorded at AAQMS 6. Please see Table -1.

For the year 2012, it was observed that, for $O_{3,}$ the minimum value of 8.1 µg/m^3 was recorded at AAQMS 2.The maximum value of O_3 of 34.5 µg/m^3 was recorded at AAQMS 6. Please see Table -2.

3.1.6 NH_3

For the year 2011, it was observed that, for $NH_{3,}$ the minimum value of 5.4 µg/m^3 of recorded at AAQMS 2.The maximum value of NH_3 of 27.5 µg/m^{3}was recorded at AAQMS 6. Please see Table -1.

For the year 2012, it was observed that, for $NH_{3,}$ the minimum value of 7.5 µg/m^3 was recorded at AAQMS 2. The maximum value of NH_3 of 29.8 µg/m^3 was recorded at AAQMS 6. Please see Table -2.

3.1.7 NO_X

For the year 2011, it was observed that, for $NO_{X,}$ the minimum value of 7.3 µg/m^{3}was recorded at AAQMS 4. The maximum value of NO_X 39.7 µg/m^3 was recorded at AAQMS 1. Please see Table -1.

For the year 2012, it was observed that, for $NO_{X,}$ the minimum value of 9.7 µg/m^3 was recorded at AAQMS 4. The

maximum value of NO_X of 41.0 µg/m^3 recorded at AAQMS 1. Please see Table -2.

Table 1 Maximum, Minimum Concentrations of air pollutants during 2011

Sites	Maximum Concentrations in µg/m^3 for 2011							Minimum concentrations in µg/m^3 for 2011						
	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	O_3	NH_3	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	O_3	NH_3
1	142.5	48.5	33.5	39.7	779	31.5	18.5	101.3	32.2	8.5	11.2	650	7.8	5.6
2	119.8	28.4	21.4	38.5	750	29.6	17.4	100.1	17.6	5.3	8.9	600	6.4	5.4
3	143.4	48.5	27.4	31.5	750	32.4	20.4	98.5	30.8	8.3	9.2	600	7.3	6.3
4	136.5	49.3	9.6	20.3	750	23.4	16.4	101.6	30.8	6.2	7.3	600	6.8	6.3
5	119.3	24.7	26.5	28.8	583	19.5	20.7	100.5	16.0	5.4	9.3	500	6.2	6.2
6	152.5	49.8	28.5	33.7	779	32.5	27.5	107.8	36.9	8.5	7.5	600	8.6	8.5

Table 2 Maximum, Minimum Concentrations of air pollutants during 2012

Sites	Maximum Concentration in µg/m^3 for 2012							Minimum Concentrations in µg/m^3 for 2012						
	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	O_3	NH_3	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO	O_3	NH_3
1	144.2	49.8	34.5	41.0	782	32.6	21.0	102.3	34.2	10.5	13.6	652	9.8	8.7
2	125.4	29.5	22.4	39.4	754	31.0	19.4	102.5	18.7	7.5	11.5	602	8.1	7.5
3	145.2	49.2	29.4	32.4	752	34.2	22.4	100.2	32.2	10.5	11.5	602	9.3	8.3
4	138.5	51.2	21.6	22.4	753	25.6	18.9	103.2	32.5	8.2	9.7	602	8.9	8.9
5	121.5	26.8	28.7	30.1	584	21.0	21.5	102.5	18.1	7.4	11.5	501	8.3	8
6	154.6	51.0	29.9	34.6	781	34.5	29.8	109.5	38.5	10.4	9.8	603	10.5	10.8

The variations of the pollutants with respect to months during the year 2011 is depicted in Figure-3 and in Figure-4. The air quality index with respect to the months during the year 2011 is depicted in Figure-5. The AQI for AAQMS -6 for the year 2011 is listed under Light Air Pollution for all the monitoring days except two days. For that two days, AQI comes under Moderate Air pollution.The variations of the pollutants with respect to months during the year 2012 is depicted in Figure6 and in Figure-7. The air quality index with respect to the months during the year 2012 is depicted in Figure-8. The AQI for AAQMS 6 for the year 2012 comes under Light Air Pollution for all the monitoring days except six days. For that six days, AQI comes under Moderate Air Pollution.

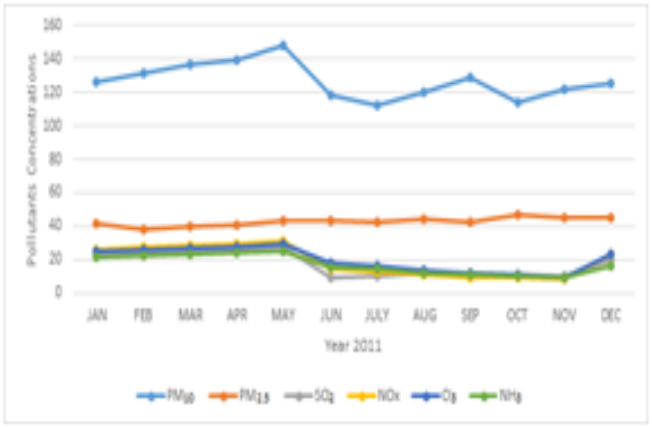

Figure 3 Pollutants Concentrations at AAQMS 6 for the year 2

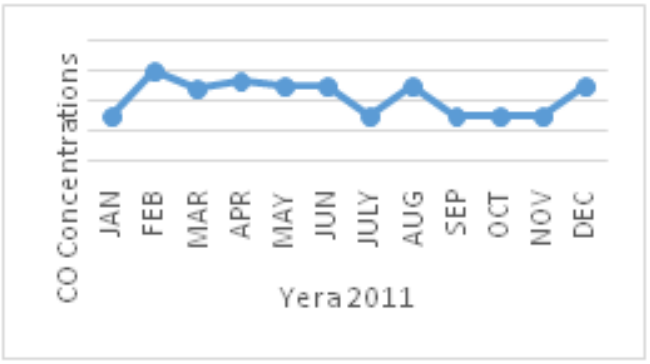

Figure 4 CO Concentrations at AAQMS 6 for the year 2011

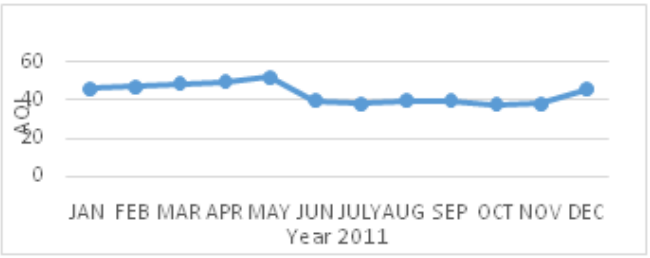

Figure 5:AQI at AAQMS 6 for the year 2011

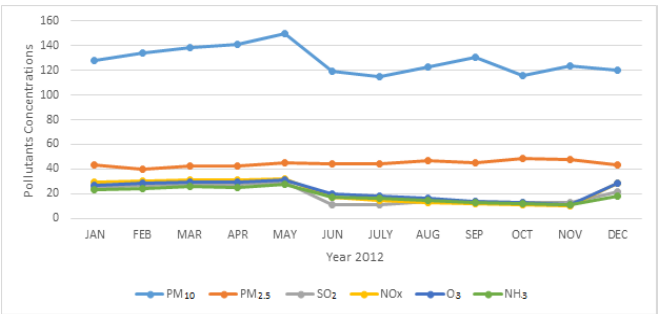

Figure 6 Pollutants Concentrations at AAQMS 6 for the year 2012

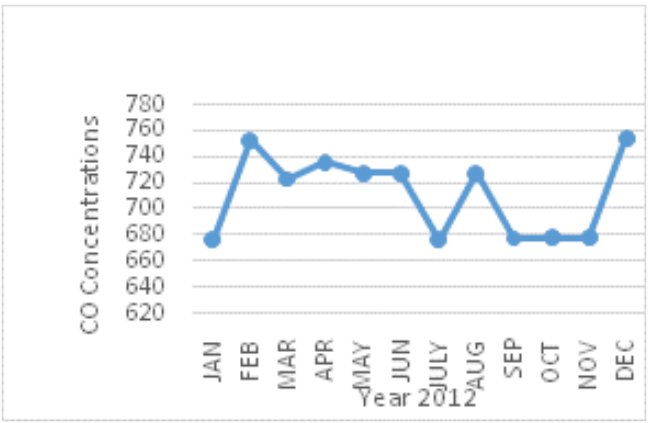

Figure 7 Concentrations at AAQMS 6 for the year 2012

Figure 8 AQI at AAQMS 6 for the year 2012

Conclusions

It is Concluded that the concentrations of PM_{10}, $PM_{2.5}$, O_3 and NH_3 at AAQMS 6 were found to be the highest among all the stations investigated. The concentration of PM_{10} at all stations varied from 98.5 µg/m^3 to 152.5 µg/m^3. The concentration of $PM_{2.5}$ at all stations varied from 16 µg/m^3 to 49.8 µg/m^3. The concentrations of O_3 at all stations varied from 6.2 µg/m^3 to 32.5 µg/m^3. The concentrations of NH_3 at all stations varied from 5.4 µg/m^3 to 29.8 µg/m^3.

The concentration of SO_2, NO_X and CO were highest at AAQMS 1. The concentration of SO_2 at all stations varied from 5.3 µg/m^3 to 35.0 µg/m^3. The concentration of NO_X at all stations varied from 7.3 µg/m^3 to 41.0 µg/m^3. The concentrations of CO at all stations varied from 500 µg/m^3 to 779 µg/m^3.

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