INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 1, No 3, 2010

Research Article ISSN 0976 – 4402

Ambient Air Quality Status in Choudwar Area of Cuttack District

Pradeepta K. Bhuyan[1], Pradyusa Samantray[2], Swoyam P Rout[3]

1 – Research Scholar, Department of Chemistry, Utkal University, Vani Vihar
2 – Research Scholar, Department of Chemistry, Utkal University, Vani Vihar
3 - Professor, Department of Chemistry, Utkal University, Vani Vihar,
Bhubaneswar 751004
swoyamrout@gmail.com

ABSTRACT

There are several methods to communicate the use of different environmental quality parameters. This research communication discusses 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.

Keywords : *ORAQI, Choudwar area*, *SPM, RSPM, NO_2, SO_2*

1. Introduction

Air pollution is a serious worldwide public health problem. The short-term health impacts of air pollution have been studied extensively since the London fog in the mid-20th century and the subsequent series of dramatic episodes in industrialised countries (Boyd, 1960). However, the magnitude of effect estimates varies across cities and countries (Analitis et al., 2006; Katsouyanni et al., 2001; Samet et al., 2000a), hindering interpretation and generalisation of the causal association between air pollution and health. Some investigators have attempted to explain the heterogeneity of effect estimates among regions in terms of different levels of air pollutants (Samoli et al., 2001), characteristics of pollutants (Samoli et al., 2005), specific city characteristics (Samoli et al., 2007), and potential confounders including temperature and humidity (Aga et al., 2003; Zeka et al., 2005). After decades of industrialisation, air pollution has become a major environmental issue for both developed and developing countries. Poor air quality has both acute and chronic effects on human health (Yang et al., 2004, Afroz et al., 2003).

The relationship between environment and the development is one of the most burning issues of the present times. Developmental activities e.g. industrial transportation, constructional work etc cause degradation and drastic changes in every component of environment namely, hydrosphere, lithosphere, atmosphere and biosphere through pollution. Air pollution has emerged in the past few decades as the most crucial problem to mankind.

Research Article ISSN 0976 – 4402

In recent years, a large number of studies on health impacts due to air pollution have been undertaken in developing countries (Anonymous, 1980). The public health implications of the emission of CO, O_3, toxicants and particulates are substantial (Davies, 1998, Utel Warren and Sawyer, 1998). Among air pollutants, particulate matter (PM) is a ubiquitous and its especially a major problem due to its adverse health effects, Visibility reduction and soiling of buildings (Hamilton and Mansfield, 1991, Seinfield, 1975; Williamson, 1973).

In the present paper, an attempt was made to represent the overall ambient air quality in choudwar and its adjoining areas. The environmental impact of major industries like ferro-alloys, thermal power plant and steel industry apart from other small scale industries like rolling mill and carpet manufacturing unit are studied.

2. Air Pollution Indices:

An environmental index is a tool, which is used to report the overall environmental status and trends based on a specific standard (Thom and Ott, 1996). It was developed on the lines of health index (USEPA, 1972, 1973) and measured by the degree of human suffering. Each AQI category makes it easier for the general public to understand how clean or polluted the air is. To evaluate overall air pollution due to various pollutants is complex. It consists of an ill defined mixture of several pollutants from different sources (Canter, 1997). Overall air pollution measures can be used to give meaningful assessment of air pollution to the common man. They also enable one to evaluate the alternative air pollution control policies or control equipment which, for instances, can reduce the level of certain pollutants while increasing the levels of others. AQI can represent the overall air quality status in a better way since the cumulative effect of all the pollutants and the related standard can be taken into account (Lohani, 1984). As a result we can obtain an equation, which transforms the parameter values by means of numerical manipulation into a more simple and precise form. The index of specific pollutant is derived mainly from the physical measurement of pollutants like SPM, RSPM, SO_2 and NO_2. There are several methods and equations used for determining the AQI (Inhaber, 1974). The Oak Ridge National Air Quality Index (ORNAQI) can be considered for the relative ranking of an overall air quality status at different locations of the study area.

AQI for each location in the study area has been estimated with the help of a mathematical equation developed by the Oak Ridge National Laboratory (ORNL), USA as given below.

$$AQI = [39.02 \Sigma Xi / Xs]^{0.967}$$

Where Xi = value of air quality parameters (SPM,RSPM, SO_2 and NO_2)

Xs = Standard and prescribed for Air quality parameters.

Research Article ISSN 0976 – 4402

Table 1: Relative AQI and Scale

VALUE	DESCRIPTION	HEALTH EFFECTS
0-25	Clean air	None, or minimal health effects
26-50	Light air pollution	Possible respiratory or cardiac effect for most sensitive individuals
51-75	Moderate air pollution	Increasing likehood of respiratory and cardiovascular symptoms and illnesses
76-100	Heavy air pollution	Aggravation of heart or lung disease. Increased risk of death in children .(heart and lung disease); increased effects in general population
>100	Severe air pollution	Serious aggravation of heart or lung disease; increased risk of premature death. Serious risk of cardio respiratory symptoms in general population.

3. Study Area

The study area is located at Choudwar $19^0$00' 00'' North and $20^0$40'0' East in Cuttack district on National Highway 42 (NH-42) which is 15 Kms away from Cuttack City shown in in the index map of study area in Fig. 1. The central part of Choudwar area i.e. taken as core-zone constitute namely.

(i) Ferro-alloys Unit and its Captive Thermal Power Plant. (Indian Metal and Ferro-Alloys Ltd)

(ii) Ferro-chrome Unit (Utkal Manufacturing and Service Ltd.)

Table 2: Details of Ambient Air Quantity Monitoring Locations

Station Code	Location	Environmental Setting
A-1	Agrahat	4 kms from core zone towards North
A-2	Nergundi Railway station	4 kms from core zone towards Northern-East
A-3	Narapada	7 kms from core zone towards East
A-4	Kapeleswar Near IMFA	Core zone
A-5	Khuntuni (Police out-post)	10 kms from core zone towards

Research Article ISSN 0976 – 4402

		West
A-6	Ghantikhal	9 kms from core zone towards Southern-West
A-7	Near Arati Steel	9 kms from core zone towards West
A-8	Daulatabad	9 kms from core zone towards South
A-9	Kayalapada	8 kms from core zone towards Southern -West
A-10	Gurudijhatia (S.S.D. Mohavidyalaya)	10 kms from core zone towards Northern-West

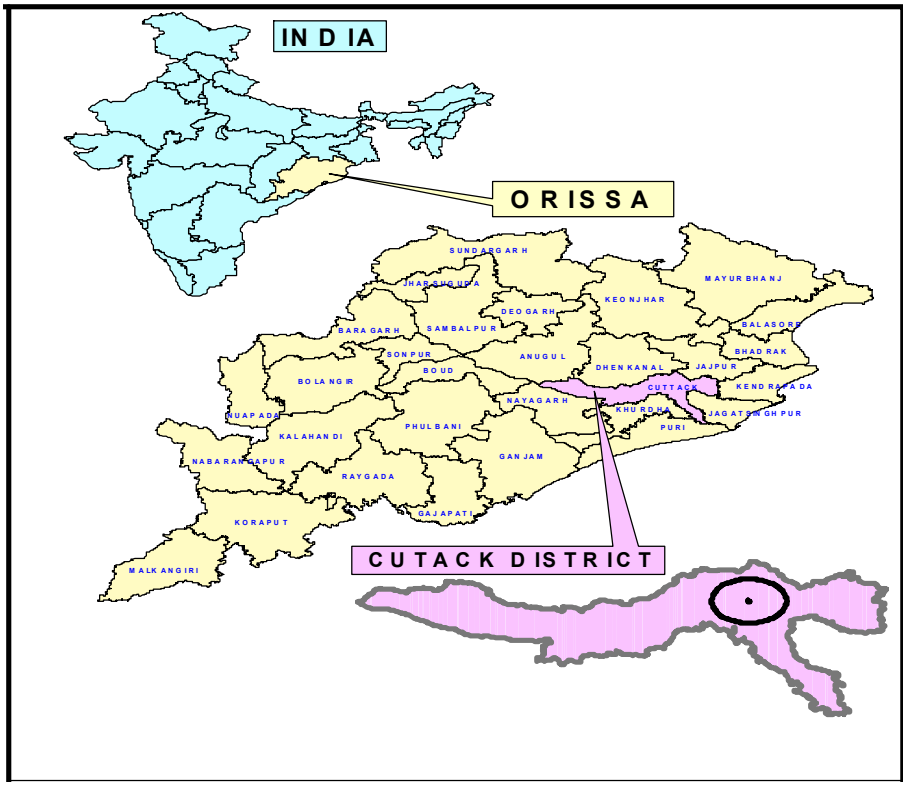

Figure 1: Index Map of study area

Research Article ISSN 0976 – 4402

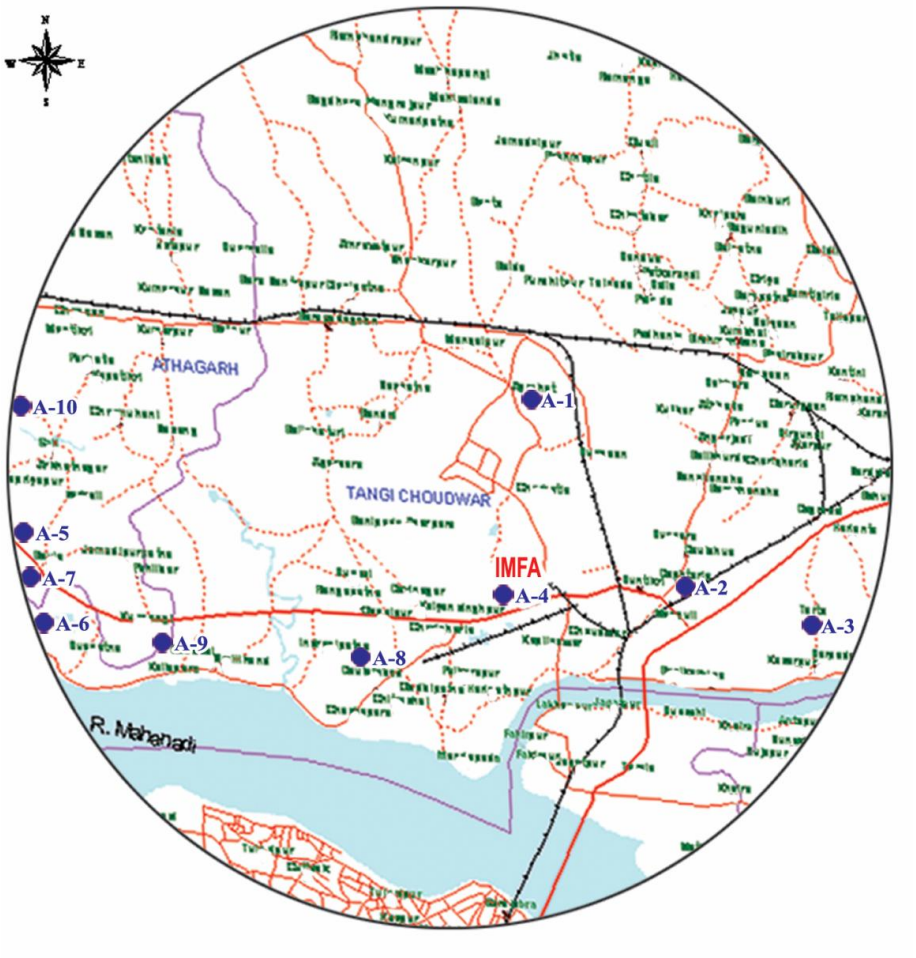

Figure 2: Map of study area

The Air Force Defence Unit (Aviation Research Centre, Government of India) is situated just adjacent to the core zone towards North. The study area consists of one major industry. Arati Steel at Ghantikhal towards the west on the bank of river Mahanadi. A few small industrial units like rolling mill, coke production unit are also situated nearby.

Within the study area, ten different monitoring stations were established. Out of these, four stations (A-4, A-5, A-6 and A-7) are located in industrial belt and other six stations are located in the rural areas. The whole study area covers ten monitoring stations and having two lakhs population. The main sources of air pollution in the study area are industries like ferro-alloys unit, steel unit and thermal power plant and their transport through heavy vehicles. The locations of sampling stations are given in the Table. 2 and shown in Figure. 2.

3.1 Methodology

Suspended Particulate Matter was collected using a Respirable Dust Sampler (Model APM 451 Environtech India) at ten sampling stations (A-1,A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-9 and A-10, given in Table. 2) during the study period March, 2007 to

Research Article ISSN 0976 – 4402

February, 2009 in three different seasons viz pre-monsoon. monsoon and post-monsoon 2007 and 2008. The APM 451 is a high volume sampler with a cyclone attachment which fractionate the dust into respirable and non-respirable fractions. The respirable fraction (RSPM or PM_{10}) of the suspended particulate matter was collected on a pre-weighed Whatman glass microfibre filter paper (GF/A 20.3×25.4 cm). SPM larger than 10 mm (RSPM) was collected in a separate sampling bottle. The RSPM collected over the GF flter paper and the RSPM collected in the sampling bottles were weighed using an electronic top loading weighing balance. For the collection of gaseous pollutants the RDS sampler having impingers (bubbler trains) in series with sodium tetrachloromercurate as absorbing solution for SO_2 and sodium hydroxide solution for NO_2 was used. The impinger samples were put in ice boxes immediately after sampling and transferred to a refrigerator prior to analysis. The samples were analysed spectrophotometrically using West and Gaeke method and Jacob and Hocheiser modified method for analysis of SO_2 and NO_2 (APHA, 1977).

4. Findings of Pollutant

Seasonal average value of ambient air quality parameters at different locations and their respective air quality index are given below i.e from Table.3 to Table.8. Graphical representation of pollutants (SPM, NO_2 and SO_2) and respective AQI are also given corresponding to different tables (Table.3 to 8) in Figure.3 to 8 respectively.

Table 3: Parameters (Pollutants) in µg/m^3 Pre-Monsoon, 2007

Locations	SPM	RSPM	NO_2	SO_2	ORAQI
A1	169.5	74.4	16.2	0.8	55.3
A2	182.5	75.0	24	1.2	62.2
A3	138.2	52.0	12.8	1.4	45.5
A4	168	62.0	15.9	8.4	57.9
A5	179	53.0	31	4.5	65.5
A6	190	25.0	19	4.2	63.4
A7	149	70.0	21.2	4	53.0
A8	148	60.0	20	1.4	51.2
A9	152	79.0	16.2	1.2	50.6
A10	135	30.0	18.2	1.2	46.8

Research Article ISSN 0976 – 4402

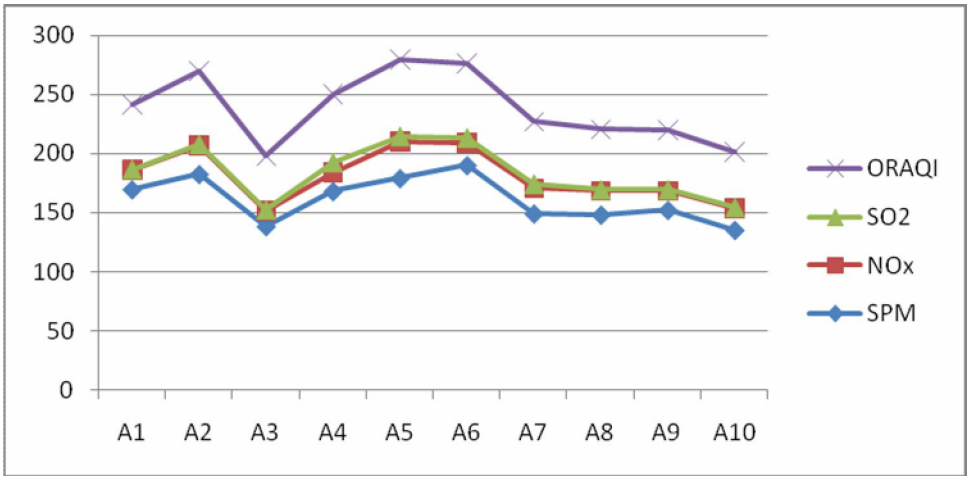

Figure 3: Graphical representation of pollutants

Table 4: Parameters (Pollutants) in µg/m^3 Monsoon, 2007

Locations	SPM	RSPM	NO_2	SO_2	ORAQI
A1	120.2	74.4	20.4	1	43.5
A2	125	75.0	21.4	1.2	45.4
A3	102.2	52.0	16	0.9	36.7
A4	130.2	62.0	20.2	8	49.1
A5	118	53.0	31	4.2	48.6
A6	125	25.0	23.4	4.2	47.4
A7	125	70.0	22.6	4.1	47.0
A8	115	60.0	20.2	1.2	42.1
A9	120	79.0	18.4	1.4	42.8
A10	125	30.0	16	1	43.0

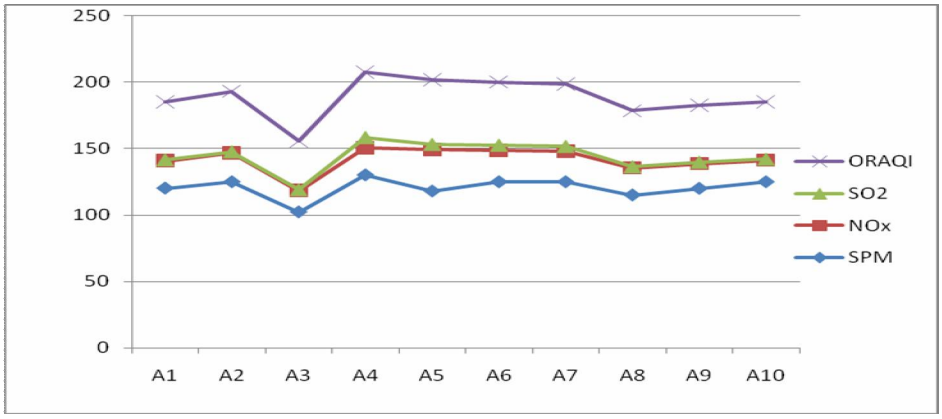

Figure 4: Graphical representation of pollutants

Research Article ISSN 0976 – 4402

Table 5: Parameters (Pollutants) in μg/m^3 Post – Monsoon, 2007

Locations	SPM	RSPM	NO_2	SO_2	ORAQI
A1	178	70.2	22.4	1.2	60.3
A2	180.2	84.0	28.4	1.4	63.5
A3	140	69.2	18.4	1.2	48.3
A4	190	86.4	19.4	8.4	65.3
A5	202	75.0	29.6	4.1	71.0
A6	308	125.0	28.6	4	99.2
A7	360	122.0	31.6	4.2	114.4
A8	200	78.0	24.2	1.6	67.2
A9	168	77.0	20.2	1.6	56.9
A10	160	82.0	22	1.6	55.4

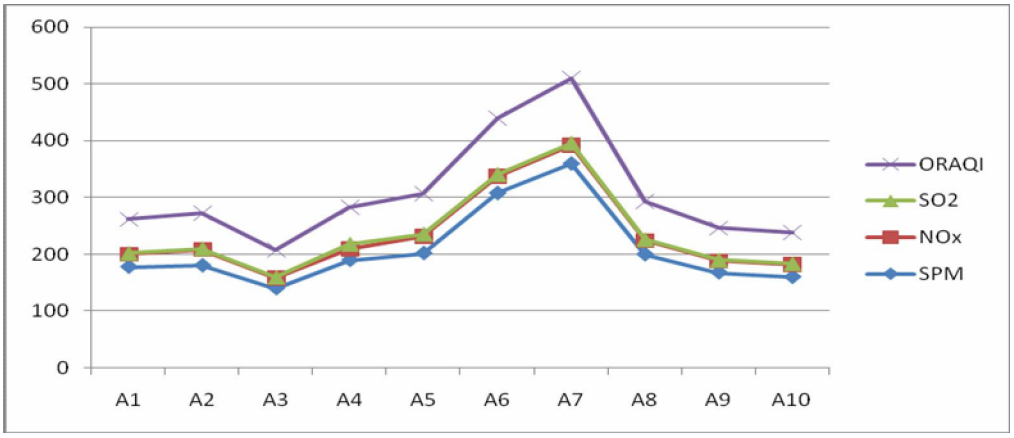

Figure 5: Graphical representation of pollutants

Table 6: Parameters (Pollutants) in μg/m^3 Pre – Monsoon, 2008

Locations	SPM	RSPM	NO_2	SO_2	ORAQI
A1	163	71.2	18	1.8	54.7
A2	181.1	74.6	25.4	2	62.7
A3	136.7	52.9	12.8	1.6	45.2
A4	164.4	65.8	16	8	56.8
A5	170	78.0	32.4	4.1	63.4
A6	360	126.0	28.2	4.1	112.5
A7	160	71.0	35.3	4.2	61.9
A8	152	62.4	21.2	2	53.0
A9	148	78.0	16.4	1.8	49.9
A10	140	32.2	18.4	2	48.6

Research Article ISSN 0976 – 4402

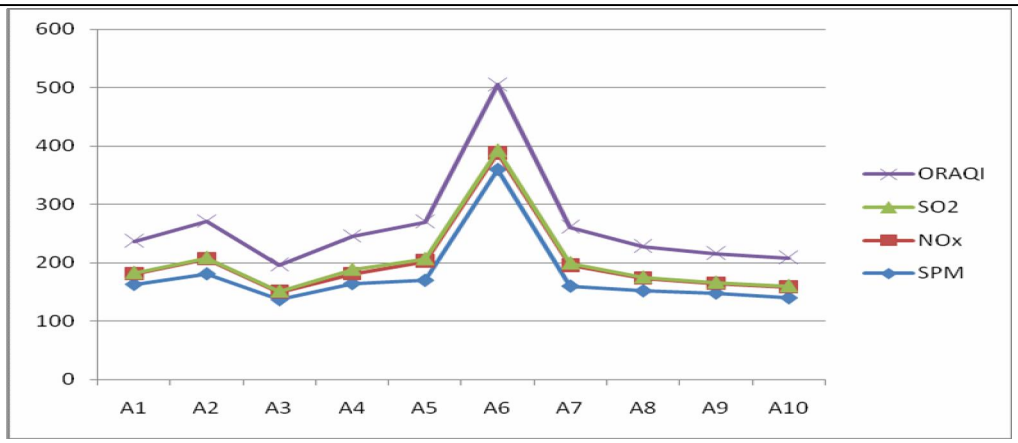

Figure 6: Graphical representation of pollutants

Table 7: Parameters (Pollutants) in µg/m^3 Monsoon, 2008

Locations	SPM	RSPM	NO_2	SO_2	ORAQI
A1	124.4	61.2	22.4	2	45.9
A2	135.4	51.0	20	1.6	47.8
A3	118	40.0	18	1.8	42.3
A4	138.4	32.4	18.2	8.2	50.6
A5	358	117.2	28.1	4.2	112.5
A6	241	115.0	27.5	4.1	80.7
A7	291	116.0	27.5	4.1	94.2
A8	122	48.0	20.4	1.8	44.4
A9	116	28.2	18.6	2.2	42.1
A10	125.2	24.2	17.6	2.2	44.3

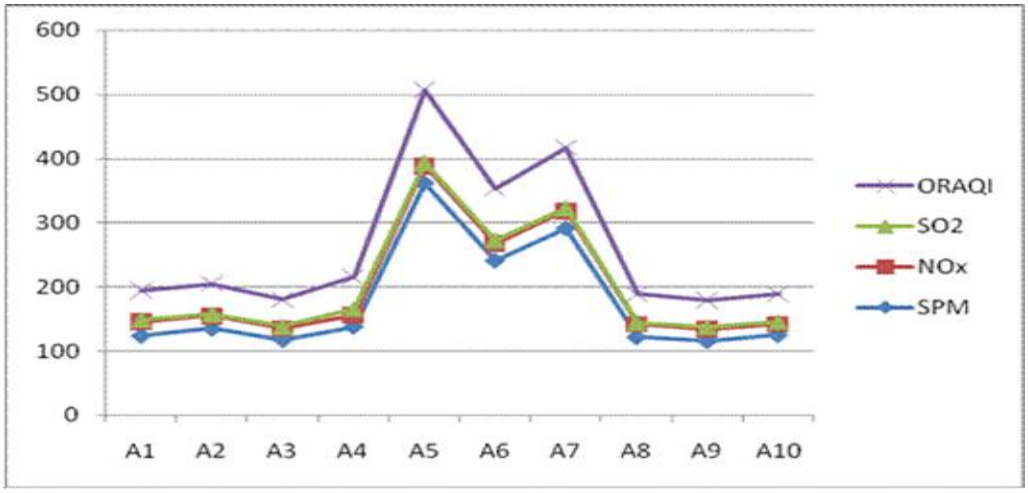

Figure 7: Graphical representation of pollutants

Research Article ISSN 0976 – 4402

Table 8: Parameters (Pollutants) in μg/m^3 Post- Monsoon, 2008

Locations	SPM	RSPM	NO_2	SO_2	ORAQI
A1	173	74.4	24	2	59.9
A2	182.4	82.0	28.2	2.2	64.3
A3	142.2	68.2	16.4	2	48.4
A4	192	86.8	19.4	8.4	65.9
A5	133	63.0	30.3	4	52.4
A6	328	110	38.3	4.2	108.6
A7	142	72	30.1	4	54.8
A8	190	72.2	21.2	2.2	63.5
A9	165	78.0	18.8	2	55.6
A10	160	82.3	16.4	2.2	53.3

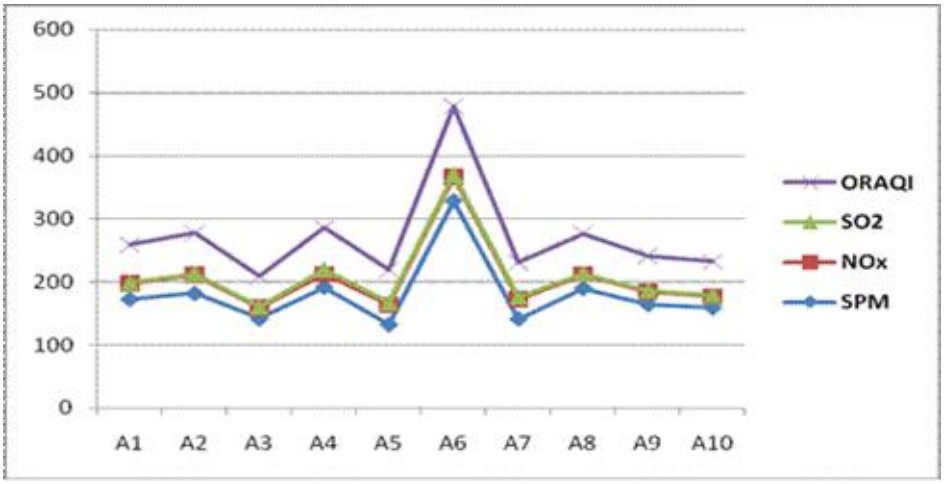

Figure 8: Graphical representation of pollutants

4.1 Results and Discussion

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, which is a single value of combination of all pollutants viz. SPM. NO_2 and SO_2.

The comparison and explanation of AQI, SPM SO_2 and NO_2 values at different location within one season in the study period are given the Table 3 to 8 and their respective graphical representations.

SPM : Throughout the study period SPM was found to be minimum of 102.2 μg/m^3 at A-3. monsoon, 2007 and maximum of 360 μg/m^3 at A4, Post-monsoon, 2007 and also at A-6, Pre-monsoon, 2008. The highest value of SPM is due to coke/coal dust, frequent transport of raw materials through heavy vehicles in the industrial belt (Arati Steel) located in rural area. SPM was found to be less at A-4 (core-zone) on account of proper

Research Article ISSN 0976 – 4402

management of coke/coal dust through frequent sprinkling of water at Coal Handling plant and its peripheral area.

NO_2 : NO_2 found to be minimum of 12.8 µg/m^3 at A-3, Pre-monsoon, 2007 and Pre-monsoon, 2008 and maximum of 38.3 µg/m^3 at A-6. Post-monsoon, 2008. However these findings are much less than the standard values.

SO_2 : SO_2 found to be minimum of 0.8 µg/m^3 at A-1, Pre-monsoon, 2007 and maxmium of 8.4 µg/m^3 at A-4, Post-monsoon, 2007 and Post-monsoon 2008. The SO_2 content in ambient air is slightly higher owing to combustion of high sulfur content coal/coke used in thermal power plant and ferro-alloys plant and the emission of fumes due to smelting of chrome-ore at furnace of ferro-alloys unit, at the core-zone. However, the findings are found to be much less than standard values.

The data for three seasons revealed that concentration of pollutants except SPM, for entire monitoring stations do not exceed the permissible limits specified by Central Pollution Control Board (CPCB) but in the locations around Arati Steel, the concentration of SPM is very high at most of the times.

4.2 Result of AQI

At A-1, A-3, A-9 and A-10, the average of AQIs are below 50. Therefore in these locations, light air pollution is observed due to high traffic density along (N.H.42) National Highway. A-1 A1, A-2, A-4 and A8, the average value of AQIs are just above 50. It is due to high transport activities and emission of gaseous pollutants. At A-5, A-6 and A-7 the average AQIs are much higher i.e. 51 to 75 attributed to high SPM value on account of emission of gaseous pollutants and frequent transport of raw materials.

Table 9: The average values of AQI are at different location are given below.

Location	Average AQI
A1	53.3
A2	57.7
A3	44.4
A4	57.6
A5	69.0
A6	68.7
A7	70.9
A8	53.6
A9	49.7
A10	48.6

Research Article ISSN 0976 – 4402

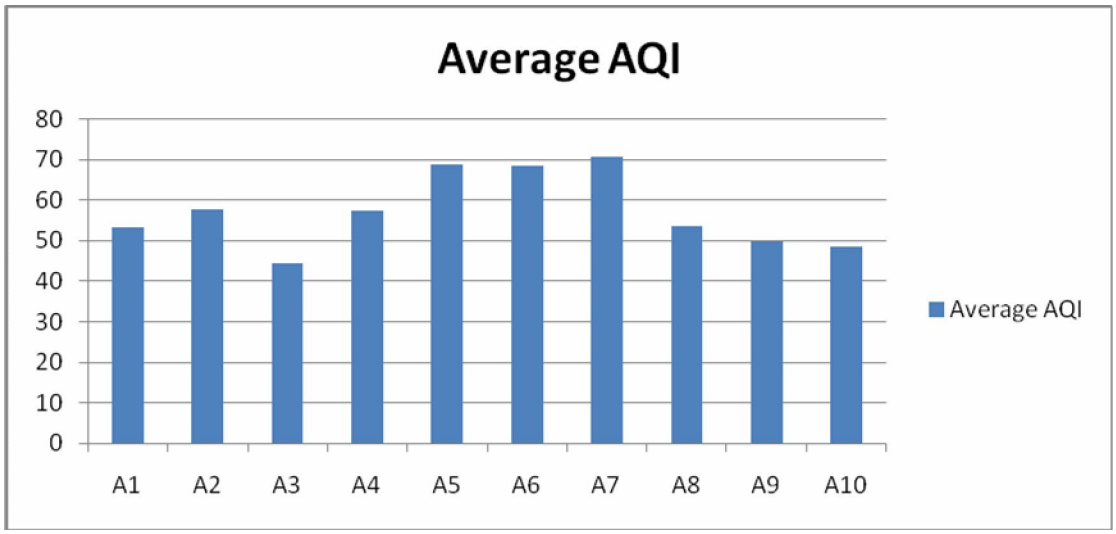

Figure 9: Average AQI of various pollutants

The highest AQI which is 114.4 μg/m^3 at A-7 in Post-monsoon 2007, 113.0 μg/m^3 at A-6 in Pre-monsoon, 2008, 112.5 μg/m^3 at A5 in Monsoon.2008 are observed. However, the average value AQIs in these locations (A-5, A-6 and A-7) are within the range of 51 to 75 μg/m^3. Therefore, moderate pollution is observed in these locations on account of emission of gaseous pollutants from steel industry and its transport activities.

5. Conclusion

Air pollution measured in the form of Air Quality Index can be used to provide a meaningful assessment of air pollution in the common man's perception. It is concluded from the observations at different monitoring stations are within permissible limits excepting SPM in the entire study area as specified by Central Pollution Control Board (CPCB). However SPM was found to be higher in most of the locations in pre-monsoon and post-monsoon seasons in both the urban and the rural areas.

The area nearer to the vicinity of the industries are moderately air polluted as per the AQI values i.e. 51 to 75. Air pollution in the core-zone was found little higher than 50 due to eco-friendly control measures such as green plantation and sprinkling of water despite the continuous production of ferro-alloys and generation of thermal power round the year. In the region around the steel industry, air pollution is anticipated to cross the barrier from moderate pollution to heavy pollution in the near future. In order to control the pollution load, green plantation is to be made in the entire area and along the boundary of NH-42. In the rural and the urban areas which are far away from industrial site, light air pollution has been observed.

Research Article ISSN 0976 – 4402

6. References

1. CEQ, (1976). A Recommended Air Pollution Index, report prepared by the Federal Interagency Task Force on Air Quality Indicators, Council on Environmental Quality, Environmental Agency, and Department of Commerce.
2. Anonymous (1980). A study of air pollution in Bangalore, Regional Occupational Health Centre, Annual Report.
3. Smith, F.B (1990). Atmospheric structure. Unpublished note presented at Air Pollution Modelling for EIA, International Center for Theoretical, Trieste June.
4. EPA, (1994) Measuring Air Quality. The pollutant standards Index, U.S. Environmental Agency. Office of Air Quality planning and standards (MD-10). Research Triangle park, NC, 27711, EPA 451/K-94-001.
5. EPA (1999C), The Air Quality Index, US. Environmental Protection Agency. Office of Air Quality planning and standards, Research Triangle park, NC-27711.
6. EPA (2001), Health and Ecological Effect. www.epa.gov/air/urban air/pm/index.
7. EPA (2001), Office of Air Quality Planning and Standards, www.epa .gov/air/oaqps.
8. CPCB (2001), National Air Quality standard, www. cpcb.gov/air/index.
9. Afroz R, Hassan MN, Ibrahim NA. Review of air pollution and health impacts in Malaysia. Environ Res 2003;92:71–7.
10. Yang CY, Chang CC, ChuangHY, Tsai SS,Wu TN, Ho CK. Relationship between air pollution and daily mortality in a subtropical city: Taipei Taiwan. Environ Int 2004; 30: pp 519–23.
11. Boyd, J.T., 1960. Climate, Air Pollution, and mortality. Br. J. Prev. Soc. Med. 14, pp 123–135.
12. Analitis, A., Katsouyanni, K., Dimakopoulou, K., Samoli, E., Nikoloulopoulos, A.K., Petasakis, Y., et al., 2006. Short-term effects of ambient particles on cardiovascular and respiratory mortality. Epidemiology 17, pp 230–233.
13. Katsouyanni, K., Touloumi, G., Samoli, E., Gryparis, A., Le, T.A., Monopolis, Y., et al., 2001. Confounding and effect modification in the short-term effects of ambient particles on total mortality: results from 29 European cities within the APHEA2 project. Epidemiology 12, pp 521–531.

Research Article ISSN 0976 – 4402

14. Samet, J.M., Dominici, F., Curriero, F.C., Coursac, I., Zeger, S.L., 2000a. Fine particulate air pollution and mortality in 20 US cities, 1987–1994. N. Engl. J. Med. 343, pp 1742–1749.

15. Samoli, E., Schwartz, J., Wojtyniak, B., Touloumi, G., Spix, C., Balducci, F., et al., 2001. Investigating regional differences in short-term effects of air pollution on daily mortality in the APHEA project: a sensitivity analysis for controlling long- term trends and seasonality. Environ. Health Perspect. 109, pp 349–353.

16. Samoli, E., Analitis, A., Touloumi, G., Schwartz, J., Anderson, H.R., Sunyer, J., et al., 2005. Estimating the exposure-response relationships between particulate matter and mortality within the APHEA multicity project. Environ. Health Perspect. 113, pp 88–95.