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Research Article

Assessment of Heavy Metals and Polyaromatic Hydrocarbons in Ambient Air Quality of Cuttack & Bhubaneswar

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Abstract

An attempt has been made to determine the concentration of heavy metals like Cadmium, Copper, Nickel, Zinc, Lead, Manganese and Iron, as well as Polyaromatic Hydrocarbons (PAH) present in ambient air of the twin cities. The particulate matter like PM_{10} & $PM_{2.5}$ and gaseous pollutants like SO_2, NO_X, O_3 & NH_3 are also monitored on seasonal basis, where as heavy metals & PAH samples were collected once in a year. The results of heavy metals, PAH, particulate matter and gaseous pollutants are compared with the Ambient Air Quality standard prescribed by the Ministry of Environment and Forest (MoEF). Lead at all monitoring stations in the twin cities is within the limit i.e. 0.5 µg/m^3. While concentration of Nickel is observed to be more than the standard i.e. 20 ng/m^3 except at Jagatpur Industrial Estate, Cuttack and IRC Village, Nayapalli. The monitoring of benzo (a) pyrene was observed only at two places of Cuttack but the concentration are below the prescribed limit, of 1.0 ng/m^3. While other components of PAH are reflected in the result. The annual average concentration of PM_{10} at all locations of the twin cities exceeded the limit of 60 µg/m^3, while $PM_{2.5}$ at four places of Cuttack and three places of Bhubaneswar exceeded the standard i.e. 40 µg/m^3. The seasonal range and annual average of particulate matter as well as gaseous pollutants of all the locations were calculated and compared with the Ambient Air Quality standards (NAAQMS, 2005).

Keywords: *Heavy metals, Ambient Air Quality standards etc.*

Introduction

The ambient air quality is progressively deteriorating due to urbanization, industrial development, lack of awareness, poor maintenance of motor vehicles and poor road conditions. The WHO, UNEP report (1992) reveals that metropolitan cities of India are among the most air polluted cities of the world. India has 23 major cities of over 1 million people and ambient air pollution levels exceed the WHO Standards in many of them (**Gupta et al, 2002**). The main reason for deterioration of air quality in Cuttack and Bhubaneswar is the growing number of vehicles and population, road condition and traffic network (**Khare etal -2004**). Vehicular exhaust contains very fine dust particles having diameter less than 10µg/m^3 (PM_{10}) can reach the lungs and provoke the respiratory problems **(Nel A, 2005),** while the particles less than 2.5 µg/m^3 reach bronchial alveoli and have long residence time which causes asthma, lung cancer and respiratory allergies. The gaseous, pollutants like Hydrocarbons, Poly Aromatic Hydrocarbon (PAH), Benzene and Volatile Organic Compound (VOC) are carcinogenic and SO_2, NO_X, CO, NH_3 & O_3 have adverse health impact. Due to rapid urbanization in the twin cities of Odisha, an attempt has been taken to assess the existing ambient air quality status and to suggest measures for abatement of air pollution.

Plan of Study

The ambient air quality monitoring was carried out at eight selected stations each at Bhubaneswar and Cuttack. The stations were selected on the basis of major activities of the twin cities like residential and industrial. A brief description of activities around each monitoring stations are given in Table 1 and Table 2 and locations of each stations in the study area are given in Figure 1 and Figure 2.

Collection of Sample and Method of Analysis

For heavy metal analysis the dust particles are collected over EPM-2000 filter paper of Whatman make on 24 hourly basis in respirable dust sampler. The filter paper is

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subjected to digestion with nitric acid (500 ml water with 2.5ml conc. HNO_3), and evaporated till the volume reduces to 30ml. The sample was filtered and the volume was diluted with distilled water and made to 500ml. The

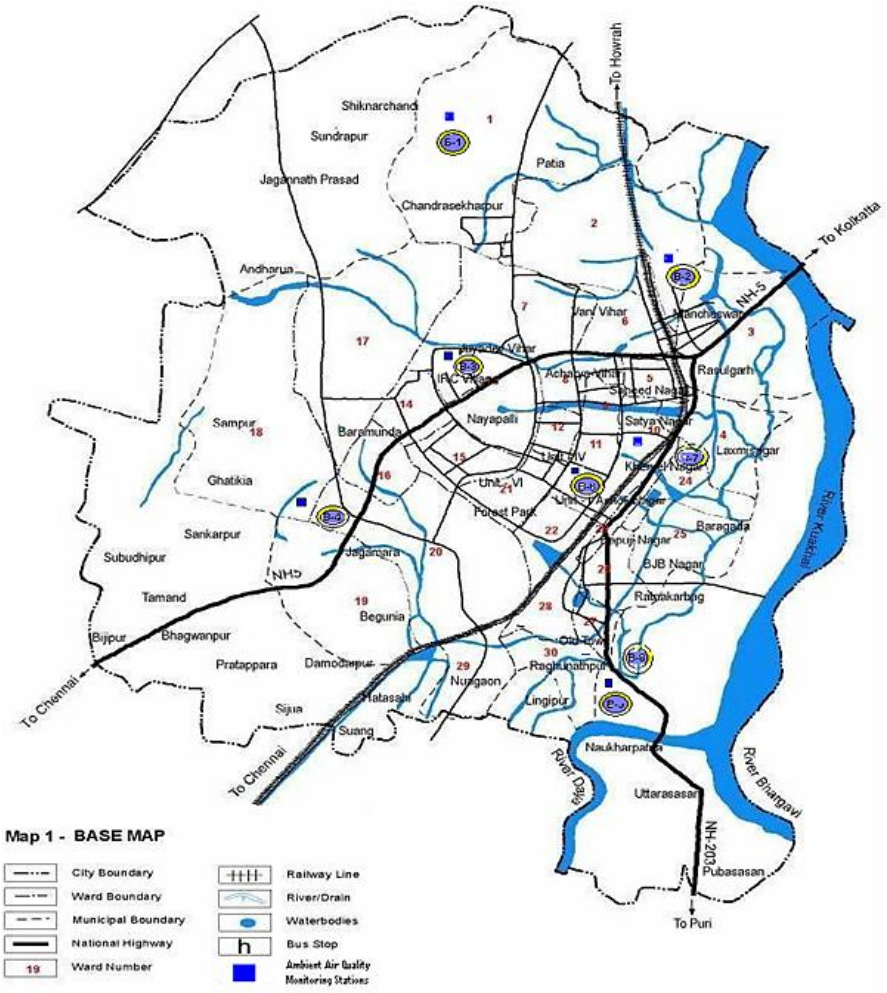

Fig. 1 Ambient Air Quality Monitoring Stations in Bhubaneswar Town

sample was then analysed in Atomic Absorption Spectrophotometer to find out different toxic heavy metals. The method of analysis are given in Table 3 (De, A.K 1994).

PAH:- For PAH analysis, the dust particles are collected over the GF/A filter paper which was extracted in Soxhlet apparatus by using toluene as the solvent. The sample was extracted for 6-7 hours., the extracted sample then passed through the filter paper containing anhydrous Na_2SO_4 to arrest moisture if present, then the sample was concentrated to 2 to 3 ml in a rotary evaporator. The concentrated sample was dissolved in n-hexane and analysed in HPLC (High Pressure Liquid Chromatography) for PAH by binary gradient method.

Particulate Matter & Gaseous Pollutants

The particulate matter PM_{10} & $PM_{2.5}$ were collected by the help of Respirable dust sampler and fine particulate sampler respectively. Both the instruments are operated simultaneously to find out the PM_{10} & $PM_{2.5}$ under same conditions. PM_{10} particulate was collected over a GF/A filter paper while $PM_{2.5}$ was collected by Teflon filter paper. The concentration of particulate matter was determined by gravimetric method. The gaseous pollutants like SO_2, NO_X, O_3, NH_3 of the ambient air are absorbed in the absorbing solution taken in the impingers fitted in the respirable dust sampler. Then the samples are analysed by colorimetric method after adding suitable reagent for colour development.

Result & Discussion

The season wise ambient air quality parameters like PM_{10}, $PM_{2.5}$, SO_2, NO_X, O_3 & NH_3 in eight monitoring stations at Bhubaneswar (B-1 to B-8) and Cuttack (C-1 to C-8) are shown in Table 4 to 9. From the tables it was observed that both in Cuttack and Bhubaneswar in all 16 stations, concentration of PM_{10}, $PM_{2.5}$ are maximum in winter and minimum in rainy season except at one place i.e. Patrapada where the PM_{10} value in summer is more than that in winter. In winter season the high concentration of dust particles in ambient air is due to temperature inversion. In Bhubaneswar the PM_{10} value in winter at all

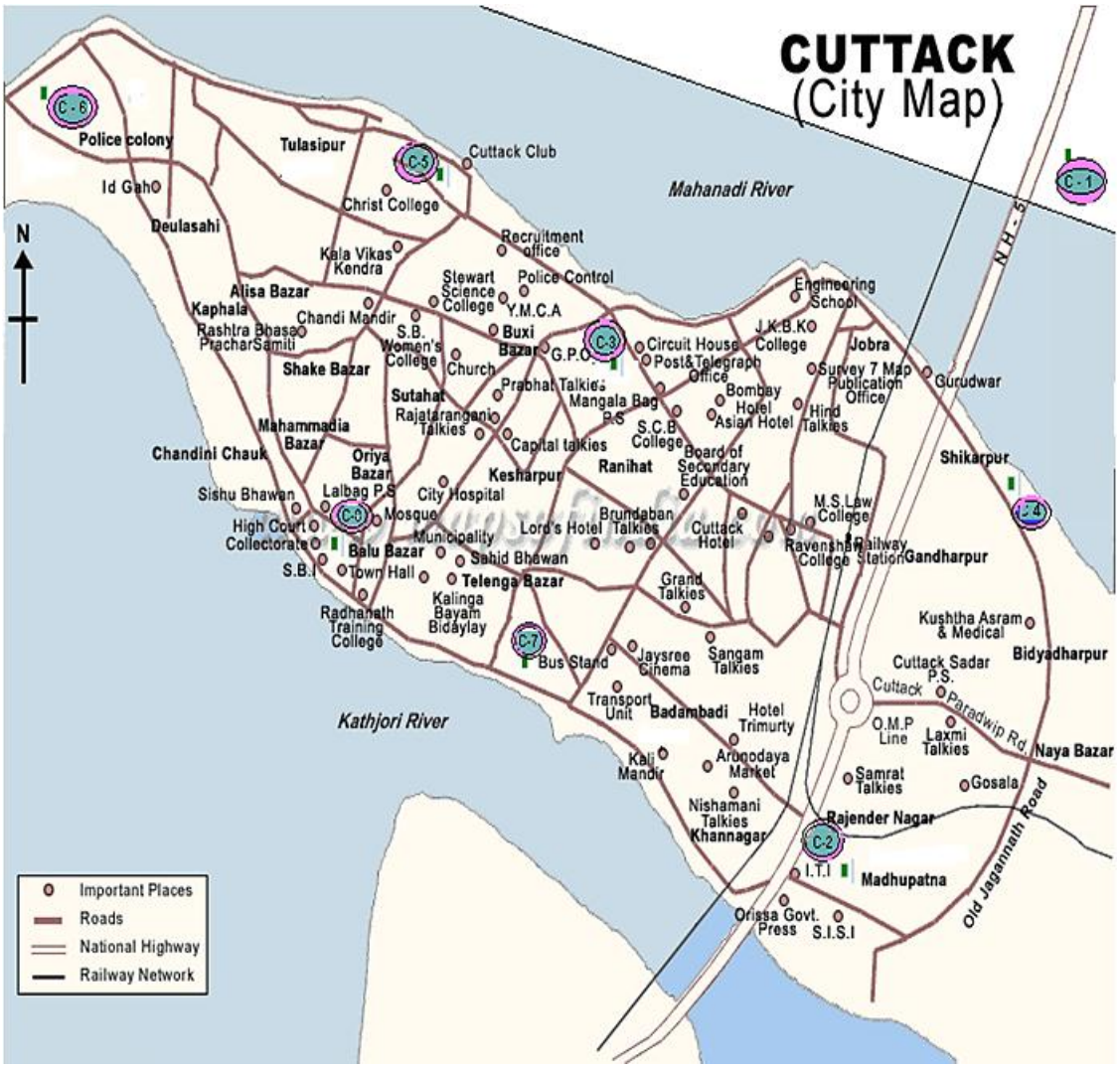

Fig. 2 Ambient Air Quality Monitoring Stations in Cuttack City

Table 1 Brief description of the sampling locations at Bhubaneswar

Sl.No.	Name of the location	Area type	Code	Surrounding activities
1	Chandaka Ind. Estate	Industrial	B-1	Industrial, residential & Vehicular
2	Mancheswar Ind. Estate	Industrial	B-2	Industrial, residential & Vehicular
3	IRC Village, Nayapalli	Residential	B-3	Vehicular, residential & NH-5 passing near by
4	Kalinga Vihar	Residential	B-4	Vehicular, residential & NH-5 passing near by
5	Patrapada	Residential	B-5	Vehicular, residential & NH-5 passing near by
6	Unit-1 Area	Residential & Commercial	B-6	Vehicular, commercial & residential
7	Unit-3 Area	Residential	B-7	Vehicular & residential
8	Samantarapur Area	Residential & Commercial	B-8	Vehicular & commercial

Table 2 Brief description of the sampling locations at Cuttack

Sl.No.	Name of the location	Area type	Code	Surrounding activities
1	Jagatapur Ind. Estate	Industrial	C-1	Industrial , vehicular, residential & NH-5 passing near by
2	Khapuria Ind. Estate	Industrial	C-2	Industrial , vehicular, residential & NH-5 passing near by
3	Mangalabag Area	Residential & Commercial	C-3	Vehicular, commercial & residential
4	Mahanadi Vihar	Residential	C-4	Vehicular & residential
5	Barabati Stadium	Residential	C-5	Vehicular & residential
6	CDA Colony	Residential	C-6	Vehicular & residential
7	Badambadi Area	Residential & Commercial	C-7	Vehicular, commercial residential & NH-5 passing near by
8	Choudhury Bazar	Residential & Commercial	C-8	Vehicular, commercial & residential

Table 3 Methods of Measurement for Different Parameters

Sl.No.	Parameters	Methods of Measurement
1.	SO_2 µg/m^3	Improved West & Gaeke method.
2.	NO_X µg/m^3	Modified Jacob & Hochheiser method.
3.	SPM µg/m^3	Gravimetric.
4.	PM_{10} µg/m^3	Gravimetric.
5.	$PM_{2.5}$ µg/m^3	Gravimetric.
6.	O_3 µg/m^3	Chemical method.
7.	NH_3 µg/m^3	Indophenol Blue method.
8.	Heavy metals in µg/m^3 except –as ng/m^3	Sampling with EPM-2000 filter paper, Acid digestion followed by
9.	PAH(ng/m^3)	Solvent extraction followed by HPLC

Table 4 Concentration of pollutants in (µg/m3) at Bhubaneswar during Winter 2009

Sl.No.	Location code	Particulate Matter			Gaseous Pollutants			
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	O_3	NH_3
1.	B-1	384.0	224.0	40.0	BDL	19.2	1.4	0.03
2.	B-2	370.0	264.0	48.0	BDL	13.6	1.1	0.01
3.	B-3	412.0	207.0	56.0	BDL	9.9	0.4	0.009
4.	B-4	378.0	255.0	68.0	BDL	14.2	0.7	0.01
5.	B-5	280.0	142.0	32.0	BDL	14.3	4.48	0.02
6.	B-6	432.0	216.0	44.0	BDL	28.1	0.9	0.01
7.	B-7	333.0	185.0	73.0	BDL	9.3	1.9	0.007
8.	B-8	364.0	219.0	64.0	BDL	23.2	1.08	0.009

Table 5 Concentration of pollutants in (µg/m3) at Bhubaneswar during Summer 2010

Sl.No.	Location code	Particulate Matter			Gaseous Pollutants			
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	O_3	NH_3
1	B-1	264.0	64.0	16.0	BDL	15.1	0.79	0.01
2	B-2	183.0	90.0	23.0	BDL	9.0	0.9	0.005
3	B-3	240.0	136.0	38.0	BDL	10.4	0.5	0.013
4	B-4	268.0	151.0	42.0	BDL	22.8	6.18	0.026
5	B-5	361.0	171.0	23.0	BDL	9.3	1.0	0.01
6	B-6	240.0	148.0	42.0	BDL	10.5	0.32	0.007
7	B-7	258.0	133.0	38.0	BDL	19.1	0.3	0.016
8	B-8	245.0	152.0	60.0	BDL	9.3	0.09	0.003

Table 6 Concentration of pollutants in(µg/m3) at Bhubaneswar during post Monsoon 2010

Sl. No.	Location code	Particulate Matter			Gaseous Pollutants			
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	O_3	NH_3
1	B-1	206	48	10	BDL	10.6	0.016	0.016
2	B-2	130	72	20	BDL	16.4	0.004	0.004
3	B-3	198	86	26	BDL	11	0.006	0.006
4	B-4	200	90	20	BDL	15.6	0.011	0.011
5	B-5	156	48	12	BDL	9.8	0.008	0.008
6	B-6	230	74	18	BDL	12.4	ND	ND
7	B-7	202	58	20	BDL	15	0.008	0.008
8	B-8	206	62	24	BDL	11	ND	ND

places are more than the standard value i.e. 100 µg/m^3. During rainy season the values are within the standards. In summer the PM_{10} value are exceeded at 6 locations i.e. at B_3 to B_8. In case of $PM_{2.5,}$ it exceeded the standard value of 60 µg/m^3 at B-4, B-7 & B-8. However $PM_{2.5}$ in summer and rainy season are well within the limits. In Cuttack the PM_{10} in winter and summer at all locations exceeded the limits. $PM_{2.5}$ in five places i.e. C-1, C-2, C-3, C-5 & C-8 exceed the limit in winter. In summer and rainy season the values of $PM_{2.5}$ are within the limits. Gaseous pollutants SO_2 at all locations of Bhubaneswar and Cuttack are less than the minimum detection limit i.e 4.0µg/m^3 and NO_X are in the range varying from 9.3 to 28.1 µg/m^3 in Bhubaneswar and in Cuttack the range is between 9.4 to 40.8 µg/m^3, O_3 is in the range between 0.3 to 6.18 and NH_3 is in the range of ND-0.03 ng/m^3 in Bhubaneswar. In Cuttack, O_3 is in the range between 0.24 to 3.07 and NH_3 from ND-0.080 µg/m^3 .The detailed

Table 7 Concentration of pollutants in (µg/m3) at Cuttack during Winter 2009

Sl. No.	Location code	Particulate Matter			Gaseous Pollutants			
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	O_3	NH_3
1	C-1	532	228	76	25.8	11.5	2.4	0.028
2	C-2	286	215	68	6.8	23.9	2.7	0.038
3	C-3	356	281	77	BDL	23.6	3.07	0.08
4	C-4	418	300	49	BDL	20.1	2.9	0.03
5	C-5	290	208	76	BDL	12.2	2.2	0.01
6	C-6	336	276	52	BDL	18.6	1.6	0.01
7	C-7	328	275	44	BDL	33	2.2	0.008
8	C-8	333	240	65	BDL	26.8	1.15	0.017

Table 8 Concentration of pollutants in (µg/m3) at Cuttack during Summer 2010

Sl. No.	Location code	Particulate Matter			Gaseous Pollutants			
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	O_3	NH_3
1	C-1	455	185	47	18.8	24.7	2.27	0.017
2	C-2	175	87	38	6.4	40.2	1.8	0.03
3	C-3	244	188	25	BDL	10.3	0.37	0.004
4	C-4	300	200	35	BDL	14.4	1.4	0.018
5	C-5	211	128	27	BDL	30.7	1.89	0.019
6	C-6	260	158	24	BDL	12.8	1	ND
7	C-7	238	156	34	BDL	13.1	0.66	0.02
8	C-8	312	208	41	BDL	20.2	1.02	0.015

Table 9 Concentration of pollutants in (µg/m3) at Cuttack during post Monsoon 2010

Sl.No.	Location code	Particulate Matter			Gaseous Pollutants			
		SPM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	O_3	NH_3
1	C-1	306	98	36	16.4	18.6	1.6	0.008
2	C-2	106	59	22	5.8	22.4	1.2	ND
3	C-3	154	82	15	BDL	9.4	0.24	ND
4	C-4	230	148	20	BDL	12.2	1	0.01
5	C-5	158	106	18	BDL	24	1.2	0.01
6	C-6	183	88	14	BDL	11	0.5	0.011
7	C-7	209	147	24	BDL	22.8	0.8	0.006
8	C-8	200	104	20	BDL	10.4	0.6	ND

Table10 Seasonal Range, Annual Average value (Avg.) and Standard Deviation (S.D) of Air Pollutants in (microgram/m^3) at Bhubaneswar during 2009 and 2010

Sl.No.	Location code	SPM Range (Avg)(S.D.)	PM_{10} Range (Avg)(S.D.)	$PM_{2.5}$ (Avg)(S.D.)	SO_2 Range (Avg)	NO_X Range (Avg)	O_3 Range (Avg)	NH_3 Range (Avg)
1	B-1	206-384	48-224	Oct-40	BDL-BDL	10.6-19.2	0.66-1.4	0.006-0.03
		-284.7	-112	-22	-2	-15	-0.95	-0.015
		-90.78	-97.32	-15.87		-4.3		
2	B-2	130-370	72-264	20-48	BDL-BDL	10.4-13.6	0.84-1.1	0.004-0.01
		-227.7	-142	-30.3	-2	-11	-0.95	-0.006
		-126.08	-106.03	-15.37		-3.73		
3	B-3	198-412	86-207	26-56	BDL-BDL	9.9-11.0	0.4-0.54	0.006-0.013
		-283.3	-143	-40	-2	-10.4	-0.48	-0.009
		-113.39	-60.8	-15.09		-0.55		
4	B-4	200-378	90-256	20-68	BDL-BDL	14.2-22.8	0.7-6.18	0.01-0.026
		-282	-165.7	-43.3	-2	-17.5	-3.9	-0.016
		-89.82	-83.42	-24.02		-4.61		
5	B-5	156-361	48-142	Dec-32	BDL-BDL	9.3-14.3	0.8-4.5	0.008-0.2
		-265.7	-87	-22.3	-2	-11.1	-2.1	-0.012
		-103.24	-64.29	-10.01		-2.75		
6	B-6	230-432	74-216	18-44	BDL-BDL	10.5-28.1	0.32-0.9	ND-0.01
		-300.7	-148	-34.7	-2	-17	-0.67	-0.009
		-113.84	-71.02	-14.46		-9.65		
7	B-7	212-333	58-185	20-73	BDL-BDL	9.3-19.1	0.3-1.9	0.007-0.016
		-267.7	-125.3	-43.7	-2	-14.5	(0.93	-0.01
		-65.72	-63.84	-26.95		-4.92		
8	B-8	206-364	62-219	24-64	BDL-BDL	9.3-23.2	0.06-1.08	ND-0.009
		-271.7	-144.3	-49.3	-2	-14.9	-0.41	-0.006
		-82.3	-78.78	-22.03		-7.58		

Table 11 Seasonal Range, Annual Average value (Avg.) and Standard Deviation (S.D) of Air Pollutants in (microgram/m^3) at Cuttack during 2009 and 2010

Sl.No.	Location code	SPM Range (Avg)(S.D.)	PM_{10} Range (Avg)(S.D.)	$PM_{2.5}$ (Avg)(S.D.)	SO_2Range (Avg)	NO_X Range (Avg)	O_3 Range (Avg)	NH_3 Range (Avg)
1	C-1	431	170.3	53	20.3	14.9	2.1	0.018
		(306-532)	(98-228)	(36-76)	(11.4-25.8	(11.5-24.7)	(1.6-2.4)	(0.08-0.028)
		-114.89	-66.22	-20.66		-6.6		
2	C-2	189	120.3	42.6	6.2	28.8	1.9	0.034
		(106-286)	(159-215)	(22-68)	(5.8-6.4)	(22.4-40.8)	(1.2-2.7)	(ND-0.038)
		-90.81	-83.17	-23.35		-9.87		
3	C-3	251.3	183.7	39	2	14.4	1.22	0.048
		(154-356)	(82-281)	(15-77)	(BDL-BDL)	(9.4-23.6)	(0.24-3.07)	(ND-0.08)
		-101.19	-99.57	-33.28		-7.95		
4	C-4	316	216	34.6	2	15.6	1.77	0.019
		(230-418)	(148-300)	(20-49)	(BDL-BDL)	(12.2-20.1)	(1.0-2.9)	(0.01-0.03)
		-95.01	-77.25	-14.5		-4.05		
5	C-5	219.7	147.3	40.3	2	22.3	1.77	0.013
		(158-290)	(106-208)	(18-76)	(BDL-BDL)	(12.2-39.7)	(1.2-2.2)	(0.010-0.019)
		-66.42	-53.67	-31.21		-9.36		
6	C-6	259.7	174	30	2	14.1	1.03	0.01
		(183-336)	(88-276)	-14.52	(BDL-BDL)	(11.0-18.6)	(0.5-1.6)	(ND-0.016)
		-76.5	-95.01	-19.69		-3.97		
7	C-7	255	192.7	34	2	26.3	1.22	0.011
		(209-318)	(147-275)	(24-44)	(BDL-BDL)	(22.8-33.0)	(0.8-2.2)	(0.006-0.020)
		-62.05	-71.44	-10		-9.95		
8	C-8	281.7	184	42	2	19.1	0.92	0.016
		(200-333)	(104-240)	(20-65)	(BDL-BDL)	(10.4-26.8)	(0.6-1.15)	(ND-0.017)
		-71.5	-71.1	-22.51		-8.25		

Table: 12 National Ambient Air Quality Standards (A/A/Q/S) Gazette Notification No. SO 384(E) Air (PCP) dt. 11.04.94, EPA-GSR 176(E) 02.04.96, S.O. 955 (E) Air (PCP) 14.10.98

Pollutants	Time Weighted Average	Industrial	Resident,Rural and Other area	Sensitive Area
SO_2	Annual*	80 mg/m^3	60 mg/m^3	15 mg/m^3
	24 hours**	120 mg/m^3	80 mg/m^3	30 mg/m^3
NO_x	Annual*	80 mg/m^3	60 mg/m^3	15 mg/m^3
	24 hours**	120mg/m^3	80 mg/m^3	30 mg/m^3
SPM	Annual*	360 mg/m^3	140 mg/m^3	70 mg/m^3
	24 hours**	500 mg/m^3	200 mg/m^3	100 mg/m^3
RPM	Annual*	120 mg/m^3	60 mg/m^3	50 mg/m^3
	24 hours**	150 mg/m^3	100 mg/m^3	75 mg/m^3
Lead (Pb)	Annual*	1.0 mg/m^3	0.75 mg/m^3	0.50 mg/m^3
	24 hours**	1.5 mg/m^3	1.00 mg/m^3	0.75 mg/m^3
NH_3	Annual*	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3
	24 hours**	0.4 mg/m^3	0.4 mg/m^3	0.4 mg/m^3
CO	Annual*	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3
	24 hours**	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3

* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hours at uniform interval.

** 24 hours/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

Table 13 National Ambient Air Quality Standards (A/A/Q/S) Gazette Notification No. SO 384(E) Air (PCP) dt. 11.04.94, EPA-GSR 176(E) 02.04.96, S.O. 955 (E) Air (PCP) 18.11.2009

Sl. No	Parameters	Time weighted Average	Industrial, Residentia and Rural areal	Sensitive area
1	SO_2 (µg/m^3)	Annual*	50	20
		24 hours**	80	80
2	NO_X (µg/m^3)	Annual*	40	30
		24 hours**	80	80
3	PM_{10} (µg/m^3)	Annual*	60	60
		24 hours**	100	100
4	$PM_{2.5}$ (µg/m^3)	Annual*	40	40
		24 hours**	60	60
5	O_3 (µg/m^3)	8 hours**	100	100
		1 hours**	180	180
6	NH_3 (µg/m^3)	Annual*	100	100
		24 hours**	400	400
7	Lead (µg/m^3)	Annual*	0.5	0.5
		24 hours**	1	1
8	CO (mg/m^3)	8 hours*	2	2
		1 hours**	4	4
9	Benzo (a) Pyrene, ng/m^3	Annual*	1	1
10	Benzene µg/m^3	Annual*	5	5
11	Nickel (Ni) (ng/m^3)	Annual*	20	20

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hours at uniform interval.
** 24 hours/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

Table 14 Heavy Metal Content in Ambient Air of Cuttack City

Sl.No.	Location	Cd (µg/m^3)	Cu (µg/m^3)	Ni (ng/m^3)	Zn (µg/m^3)	Pb (µg/m^3)	Mn (µg/m^3)	Fe (µg/m^3)
1	C-1	ND	0.016	0.013	0.192	0.006	0.168	1.46
2	C-2	0.0006	0.018	0.047	0.23	0.11	0.48	3.63
3	C-3	0.006	0.073	0.145	0.058	0.077	0.16	0.76
4	C-4	0.006	0.016	0.043	0.23	0.021	0.107	2.27
5	C-5	0.003	0.009	0.033	0.18	0.028	0.063	1.29
6	C-6	0.006	0.011	0.43	0.238	0.029	0.12	0.66
7	C-7	0.003	0.03	0.068	0.186	0.024	0.166	0.39
8	C-8	0.004	0.035	0.068	0.213	0.046	0.208	2.29

Table 15 Heavy Metal Content in Ambient Air of Bhubaneswar City

Sl.No.	Location	Cd (µg/m^3)	Cu (µg/m^3)	Ni (ng/m^3)	Zn (µg/m^3)	Pb (µg/m^3)	Mn (µg/m^3)	Fe (µg/m^3)
1	B-1	0.005	0.022	0.038	0.21	0.045	0.551	4.08
2	B-2	0.006	0.024	0.031	0.192	0.038	0.152	1.85
3	B-3	0.002	0.009	0.018	0.155	0.026	0.115	1.6
4	B-4	0.002	0.222	0.028	0.271	0.016	0.155	3.19
5	B-5	0.003	0.024	0.906	0.20	0.047	0.202	1.83
6	B-6	0.001	0.009	0.027	0.102	0.045	0.095	0.66
7	B-7	0.004	0.017	0.053	0.142	ND	0.128	1.02
8	B-8	0.001	0.004	0.028	0.09	0.12	0.085	0.72

Table 16 PAH in Ambient Air of Cuttack City

Sl.No.	Location	PAH Components	Result (ng/m^3)
1	C-1	(i)Chrysene	0.11
2	C-2	(i)Benzo(k) fluoranthene	0.33
		(ii)Di Benzo(a,h) anthracene	0.47
3	C-3	No data found	-
4	C-4	(i)Anthracene	0.51
		(ii) Chrysene	0.38
		(iii)Benzo(a)pyrene	0.34
		(iv) Di Benzo(a,h) anthracene	0.09
5	C-5	(i)Anthracene	2.06
		(ii) Benzo(a) anthracene	0.28
		(iii)Benzo(b) fluoranthene	0.08
		(iv)Benzo(a) pyrene	0.96
6	C-6	(i)Acenaphthene	0.92
7	C-7	(i)Naphthalene	3.21
		(ii)Acenaphthylene	1.46
		(iii)Acenaphthene	ND
		(iv)phenanthrene	0.37
		(v)Benzo(k) fluoranthene	49
		(vi) Di Benzo(a,h) anthracene	42.4
8	C-8	(i) Fluoranthene	0.1
		(ii) Benzo(b) fluoranthene	0.08

Table 17 PAH in Ambient Air of Bhubaneswar City

Sl. No.	Location	PAH Components	Result (ng/m^3)
1.	B-1	(i)Naphthalene	1.41
		(ii)Anthracene	0.19
		(iii)Benzo(k) fluoranthene	3.93
2.	B-2	(i)Chrysene	1.81
		(ii)Benzo(k) fluoranthene	2.01
3.	B-3	No data found	-
4.	B-4	No data found	-
5.	B-5	(i)Naphthalene	ND
		(ii)Pyrene	32.3
		(ii)Benzo(k) fluoranthene	0.8
		(vi) Di Benzo(a,h) anthracene	21.0
6.	B-6	-	-
7.	B-7	(i) phenanthrene	52.4
		(ii) Benzo(a) anthracene	0.23

season wise data are presented in Table-10 to11. The concentration of lead at all locations of twin cities within the limits i.e. 0.5 µg/m^3 whereas nickel at all locations exceeded the standard i.e 20 ng/m^3 except at Jagatpur Industrial Estate, Cuttack and IRC Village, Bhubaneswar in Table-14 and 15. From PAH components benzo (a) pyrene was observed at two locations of Cuttack in the twin city and it ranges from 0.34 to 0.96 µg/m^3. In the ambient air of Bhubaneswar, heavy metals like Cd is in the range 0.001-0.006, Cu- 0.004 – 0.22, Ni-0.018 – 0.91 ng/m^3, Zn-0.09 -0.27, Pb-ND-0.047, Mn-0.085 to 0.551 Iron 0.66 to 4.08 ng/m^3,. However in Cuttack-heavy metals are as follows: Cd-ND-0.006, Cu-0.009 – 0.073, Ni-0.013-0.125 ng/m^3, Zn-0.058-0.24, Pb-0.006-0.11, Mn-0.063-0.48, Iron -0.39 to 3.63 ng/m^3. From the result of heavy metals in Cuttack and Bhubaneswar it was observed that the concentration of heavy metals in the ambient air are low in both cities except iron.

From the PAH analysis it was observed that no PAH components are found in Bhubaneswar at three place i.e. B-3, B-4, and B-6 and one place at Cuttack i.e C-3. In Cuttack the maximum components occurs at Badambadi area having six components like Napthalene, Acenapthalene, Acenapthene, Phenanthrene, Benzo (k) Flourene (49.0 ng/m^3 & Dibenzo (a,h) anthracene (42.4 ng/m^3) similarly in Bhubaneswar maximum components occur at Patrapada area i.e. four components like Pyrene (32.3 ng/m^3), Benzo (k) Flouranthene & Di benzo (a,h) anthracene (21.0 µg/m^3) while in Unit-3 area phenanthrene occur maximum i.e. 52.4 ng/m^3.

Conclusion

Experimental observation of ambient air quality of Cuttack and Bhubaneswar shows that the particulate matter like PM_{10} & $PM_{2.5}$ in both the cities are exceeded the 24 hourly average value almost in all locations. Air Pollution with respect to dust particle is severe during winter due to non-dispersion of pollutants. The heavy metals like Cd, Ni, Cu, Zn, Lead, Manganese and Iron are found in the atmosphere mostly comes from vehicular emissions. It was observed that ambient air quality for nickel at all locations are more than the prescribed standard i.e 20 ng/m^3 in both the cities except at two locations. Similarly observations for PAH was found in most of the monitoring points. Presence of Benzo (a) pyrene is observed at two places of Cuttack i.e. at Mahanadi Vihar and Barabati stadium but both the values are below the prescribed limit. While in some places high values of PAH components are observed like Benzo (k) fluranthene, 49 ng/m^3 & Dibenzo (a.h) anthracene, 42.4 ng/m^3 were found in Badambadi area. In

Bhubaneswar pyrene is observed 32.3 ng/m^3 and Dibenzo (a.h) anthracene, 21.0 ng/m^3 in Patrapada area, while Unit-3 area exhibit maximum 52.4ng/m^3 of phenanthrene. The PAH components mainly comes from the vehicular exhaust. It is time that necessary steps have to be taken to improve the ambient air quality. The first steps towards improvement of air quality is to reduce the number of vehicles both petrol and diesel driven in both the towns, regular tuning of vehicles, use of catalytic converter, regular check-up of pollution level of the vehicles as well as adulteration of fuel, improving road condition and traffic control systems. Steps have to be taken to adopt CNG system in the engine and make it mandatory for all vehicles in Cuttack and Bhubaneswar. This will certainly improve the air quality in future.

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