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Analysis of Ambient Air Pollution and Determination of Air Quality Status of Udaipur, Rajasthan, India

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Abstract

The present investigation is carried out to analyze the ambient air in Udaipur city and determine the air quality. This investigation represented the assessment of ambient air quality with respect to PM_{10} (RSPM), SPM, Oxides of Nitrogen (NOx) and Sulphur Dioxide (SO2) for the year 2013 at three different sites (Industrial, Residential and Urban). The AQIs were calculated using IND-AQI procedure. It has been observed that the calculated AQIs values for SOx and NOx fall under 'good' and 'good-to-moderate' categories. The calculated AQI value of SPM and RSPM for all areas are more than the prescribed standards given by Central Pollution Control Board, New Delhi, India. The overall AQI was found to fall under the category 'moderate' and 'poor' owing to RSPM and SPM, respectively. Thus it is observed that SPM is critical pollutant at these three sites in Udaipur.

Keywords: Air pollution**,** Ambient air quality, AQI, SOx, NOx, PM_{10}, SPM.

Introduction

There has been considerable increase in vehicle density in India in recent years. The increase in traffic has led to increased pollutant emissions which have resulted in the deterioration of environmental quality and human health in major cities of India. Specifically, concentrations of roadside pollutant in the cities are exceeding the Indian National Ambient Air Quality Standards. The residents of such areas and motorists, pedestrians travelling near these areas are exposed to unhealthy pollution levels[1]. Since ages, Air pollution is considered to be the most potential lethal form of pollution as it becomes unpredictable due to continuous mixing, transformation and trans-boundary transportation of air pollutants. The population growth, industrialization and increased vehicles along with improper implementation of environmental rules make the air pollution problem still more worse[2].

Increased concentration of pollutants like Particulate matter (PM), Sulfur Dioxide (SO_2) etc has resulted in a number of health problems. Every year 4 to 5 million new cases of chronic bronchitis are being reported[3]. Reports reveal that 4% to 8% premature deaths occur due to exposure of high levels of particulate matter in ambient air, globally[4]. A high level of PM10 in the ambient environment in most of the north Indian cites unknowingly results to serious health issues in humans[5].

Rapidly increasing urban population has resulted in unplanned urban development, increased consumption and higher demands for transportation, energy, other infrastructural facilities, thereby leading to problems of pollution. Exposure of humans to invisible air pollutants is unavoidable in today's perspective especially in the urban area in most of developing countries including India. There are criteria air pollutants like SO_2 (sulphur dioxide), oxides of nitrogen (NOx), particulate matter (PM), etc. which are common for the assessment of air quality in a particular area. Although, a large population lives in the medium sized cities or towns in India, data on ambient air quality, needed for health studies, is not available.

In 1976, EPA established Air quality index or AQI to assess urban air quality, primarily for the use of regional and local agencies. Air Quality Index is one of the important tools available for analysis and representation of air quality status. The sub-indices for ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and PM are included in AQI which relate ambient pollutant concentrations to index values on a scale from 0 to 500 which were sub-divided into six groups based on the health criteria[6].

Table-1
Air Quality Index scale and its categories

S. No	Category	Scale
1	Good	0-50
2	Moderate	51-100
3	Unhealthy for sensitive groups	101-150
4	Unhealthy	151-200
5	Very unhealthy	201-300
6	Hazardous	300 above

(Source: Environmental Protection Agency (EPA)

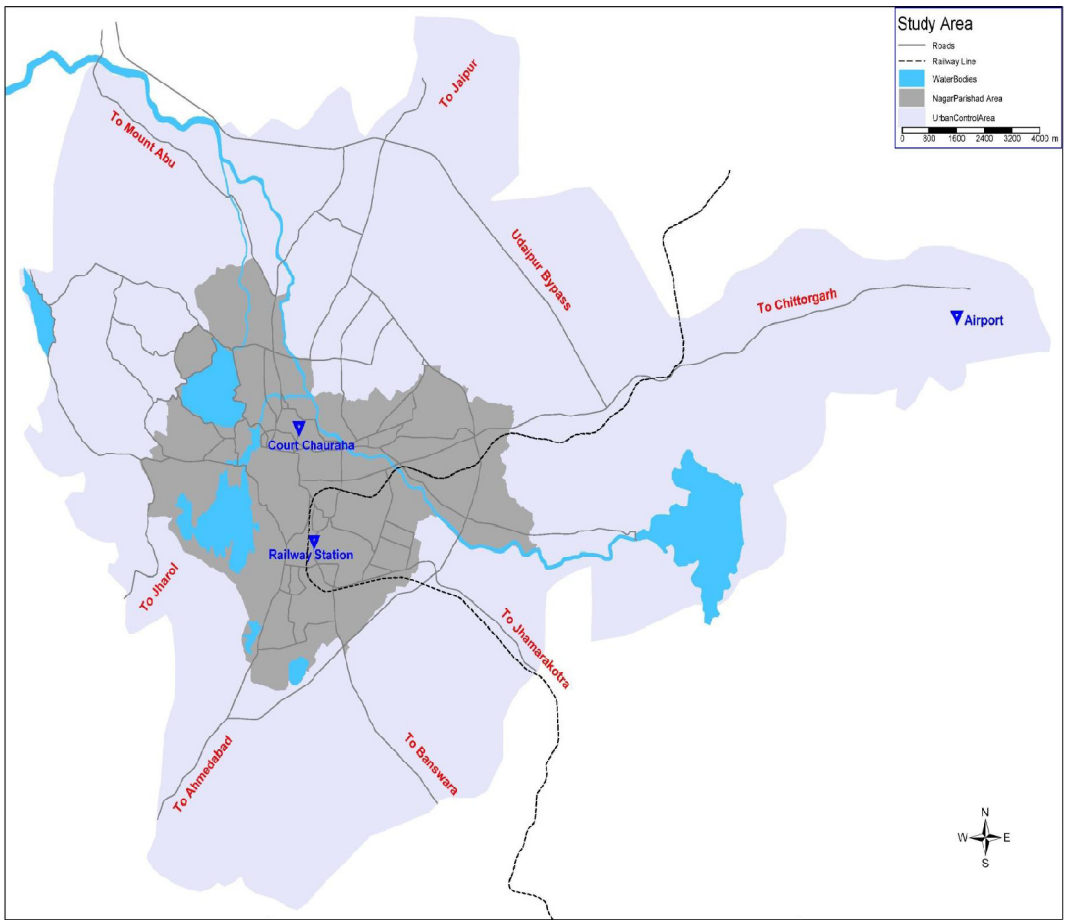

Figure-1
Map of study area

Material and Methods

Udaipur city of Rajasthan is situated at 24.5800° N, 73.6800° E and around 598 m above mean sea level with an area of 37Km^2 and population of about 4, 51,735 according to 2011 census.

Monitoring was carried out at three air quality monitoring sites residential, Urban, Industrial. Sampling was carried out at three different locations using High Volume Samplers and Respirable Dust Samplers. The frequency of the sampling was twice a week and 104 samples in a year wre collected. The collected samples were analyzed for various parameters (SOx, NOx) using standard methods prescribed by Central Pollution Control Board. Particulate matter that is SPM and RSPM were estimated by gravimetric method.

Air Quality Index (AQI): The following mathematical equation is for the calculation of sub-indices developed while considering health criteria as shown in Table1.

$$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}}(C - C_{low}) + I_{low}$$

Where I is AQI for pollutant, C is the actual ambient concentration of pollutant, C_{high} the upper end breakpoint concentration that is greater than or equal to C, C_{low} is the lower end breakpoint concentration that is less than or equal to C, I_{low} the sub index or AQI value corresponding to C_{low}, I_{high} the sub index or AQI value corresponding to C_{high}.

Results and Discussion

Monthly average concentration value of criteria pollutants like SPM, PM10, SOx, NOx, have been plotted in graphs (figure 2) for the year 2013 for Industrial, Urban and Residential sites of Udaipur. The table 2 represents monthly variation of Sox, NOx, PM10, SPM at monitoring sites.

The ambient air concentration of particulate matter both SPM and RSPM were observed to be greater than the prescribed standard at all the three sites. SPM ranged from 295ug/m3 in the month of August to 448ug/m3 in the month of December in residential area. In urban area SPM ranged from 342ug/m3 in the month of august to 450ug/m3 in the month of December. In industrial area SPM level was much higher. It ranged from 335ug/m3 in August to 592ug/m3 in November.

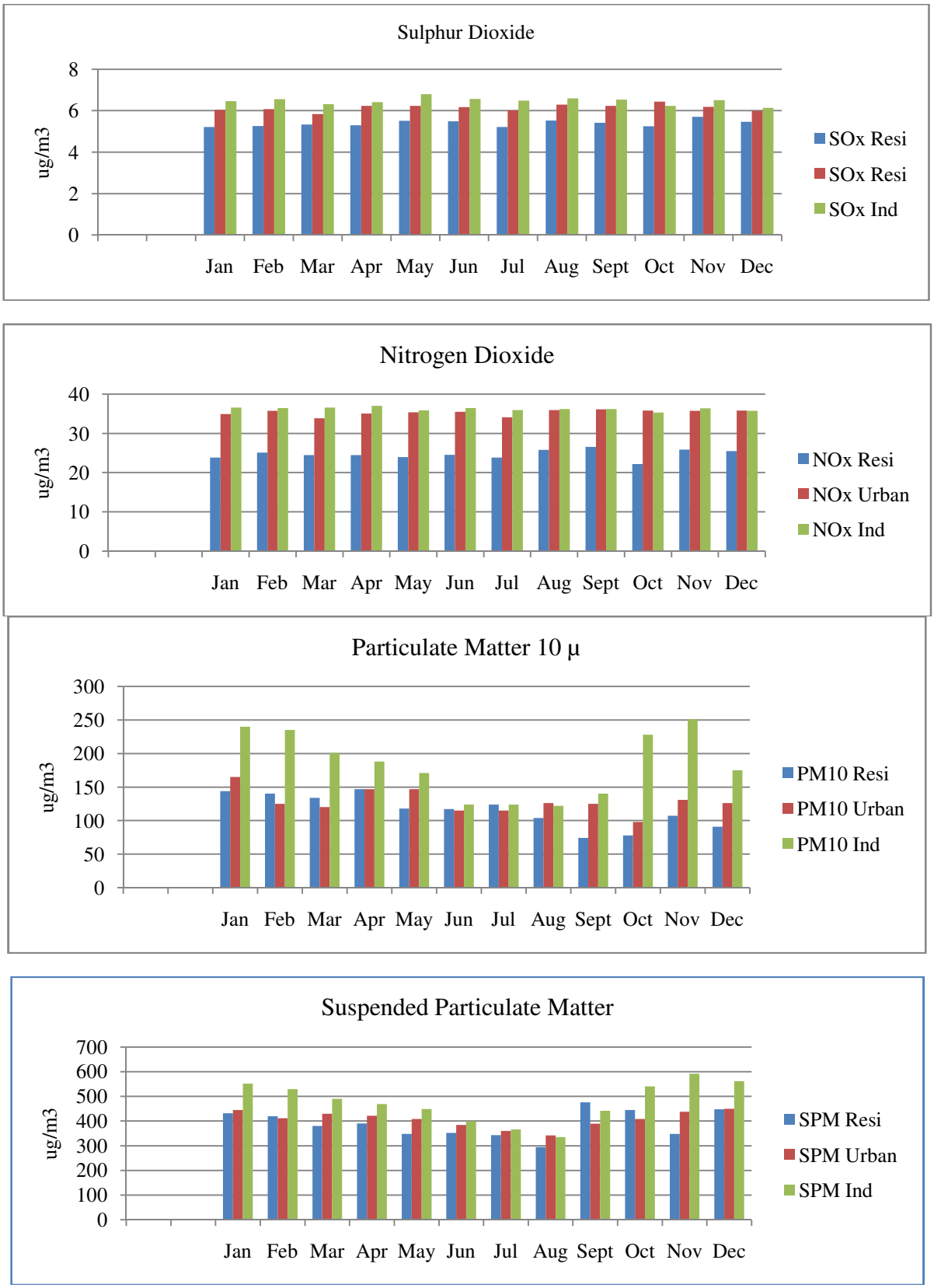

Figure-2
Monthly variations of SOx, NOx, PM10, SPM at three selected sites in Udaipur

Table-2
Ambient air pollution data from Jan 2013 to Dec 2013

Months	SOx			NOx			PM10			SPM		
	Resi	Urban	Ind	Resi	Urban	Ind	Resi	Urban	Ind	Resi	Urban	Ind
Jan	5.21	6.04	6.46	23.82	34.96	36.56	144	165	240	432	445	552
Feb	5.26	6.08	6.56	25.10	35.74	36.46	140	125	235	420	412	530
Mar	5.33	5.84	6.32	24.50	33.82	36.58	134	120	201	380	430	490
Apr	5.30	6.23	6.42	24.49	35.07	37.04	147	147	188	390	422	469
May	5.51	6.24	6.80	23.98	35.37	35.89	118	147	171	348	408	449
Jun	5.49	6.18	6.57	24.56	35.47	36.44	117	115	124	352	384	399
Jul	5.21	6.02	6.49	23.86	34.10	35.96	124	115	124	343	360	366
Aug	5.53	6.29	6.59	25.81	35.93	36.21	104	126	122	295	342	335
Sept	5.42	6.23	6.53	26.58	36.15	36.22	74	125	140	476	389	442
Oct	5.25	6.44	6.23	22.19	35.82	35.32	78	98	228	445	409	541
Nov	5.70	6.19	6.51	25.88	35.73	36.36	107	131	251	348	438	592
Dec	5.47	5.99	6.14	25.46	35.79	35.76	91	126	175	448	450	562

Table-3
AQI ratings and category for various pollutants

S.No	Pollutants	AQI rating Residential	AQI Category	AQI rating Urban	AQI Category	AQI rating Industrial	AQI Category
1	SOx	13	Good	15	Good	16	Good
2	NOx	62	Moderate	89	Moderate	91	Moderate
3	PM10	158	Unhealthy	165	Unhealthy	192	Unhealthy
4	SPM	293	Poor	302	Very poor	316	Very poor
5	Average of all	131	Unhealthy for sensitive groups	142	Unhealthy for sensitive group	153	Unhealthy

Similarly PM10 level in residential areas was also observed to be much above the prescribed limits. It ranged from 74ug/m3 in September to 147ug/m3 in the month of April. In urban area due to high traffic load PM10 concentration ranged between 98ug/m3 in the month October to 165ug/m3 in the month January. In industrial area PM10 concentration was between 122ug/m3 in August to 251ug/m3 in November.

The maximum concentration of pollutant occurred during winter months and a general trend of minimum values occurred during Monsoon season. Since frequent rains washes down the air borne particulates, period from July to September is much cleaner as compared to other months of the year. However, as the winter months have comparatively calm weather conditions, facilitating more stability to atmosphere and thus, slow dispersion of pollutants resulting in higher concentrations of pollutants in the ambient air.

In case of gaseous pollutants (SOx, NOx) the concentration observed were much below than the prescribed limit. Sulphur Dioxide concentration in residential area ranged from 5.21ug/m3 to 5.70ug/m3. In urban area it ranged from 5.84ug/m3 to 6.44ug/m3 and in industrial area it ranged from 6.14ug/m3 to 6.80ug/m3.

Nitrogen Dioxide concentration in residential area was observed between 22.19ug/m3 to 26.58ug/m3. In urban area it ranged from 33.82ug/m3 to 36.15ug/m3 while in Industrial area it was observed to be 35ug/m3 to 37ug/m3.

Result of AQI: The index is designed in such a way that a minimum of three pollutants, SPM, SO_2 and NO_2 are sufficient to calculate the index. The method involved formation and aggregation of sub-indices for each pollutant.

Data obtained from monitoring of ambient air at three different sites is used to calculate the sub- indices for critical parameters. The calculated AQI values for 24 hourly average SOx and NOx concentrations are categorized as “good” and “good to moderate” at all the three sites. But in case of PM10 and SPM AQI rating falls under “Unhealthy to Very poor” category during most of the time of the year. The average AQI was 131, 142, and 153 for residential, urban, industrial areas respectively.

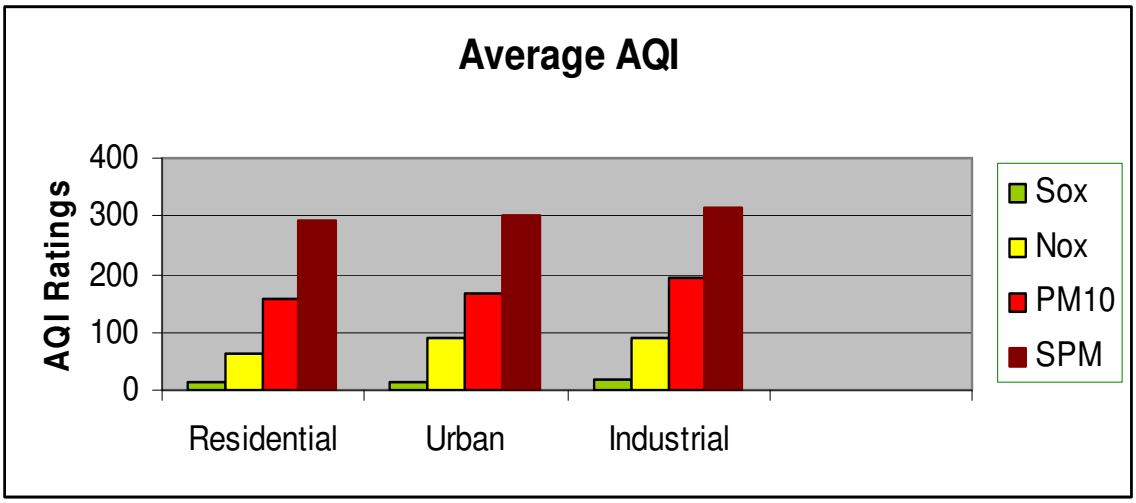

Figure-3
Average AQI Ratings

Conclusion

The overall AQI can give a clear view about ambient air and the critical pollutant The AQIs were calculated to assess the ambient air quality at three different sites namely the industrial, commercial and residential during the year 2013. The AQI study reveals that SPM and RSPM were mainly responsible for most of the times in all sites in Udaipur. The majority of AQI values of SPM and RSPM fall under the category of Unhealthy to poor. The major reasons for unhealthy Particulate matter concentration are rapid increase in human population, growth of vehicular population, frequently occurring dust storms, and unorganized infrastructural development. It was reported that the high concentration of RSPM in all commercial sites was due to plying of diesel vehicles. The dust produced through clutch plates, breaks, tyres also increase the range of Particulate matter in urban air[8]. The concentration of gaseous pollutants viz SOx and NOx was under the permissible limits as per CPCB while the concentration of particulate pollutants (SPM and PM10) was higher the permissible limits as per CPCB in most of the Indian cities [9, 10].

Reference

1. Muruganandam B., Nagendra S.M., Air quality in Chennai city. Proceeding of the Brainstorm Workshop on Urban Air Pollution in India, held at IIT Roorkee, 35-39 **(2007)**

2. Kaushik C.P., Ravindra K. and Yadav K., Assessment of Ambient Air Quality in Urban Centres of Haryana (India) in Relation to Different Anthropogenic Activities and Health Risk, *Environ. Monit. Assess.*, **122(1-3),** 27-40 **(2006)**

3. WHO, Guidelines for Air Quality, World Health Organization, Genewa, (http://www.who.int/peh/) **(2000)**

4. WHO/UNEP Report, Urban Air Pollution in Mega-cities of the World, World Health Organisation and United Nations Environment Programme, Blackwell Publishers, UK **(1992)**

5. Tandon A., Yadav S. and Attri A.K., City-wide Sweeping a Source for Respirable Particulate Matter in the Atmosphere, *Atmos. Environ.*, **42**, 1064-1069 **(2008)**

6. USEPA United States Environmental Protection agency. http://www.epa.gov. **(2010)**

7. Prakash Mamta and Bassin J.K., Analysis Of Ambient Air Quality Using Air Quality Index – A Case Study, *Int. J. Adv.. Engg. Tech.*, **I(II)** 106-114 **(2010)**

8. Sandhu P.S., Patel U. and Gupta A.B., Exposure to Airborne Particles and their Physical Characterization in Ambient Environment of Jaipur City, *Nat .Environ. Poll. Tech.,* **3(4),** 509-514 **(2004)**

9. Joshi P.C., Swami A. and Gangwar K.K., Air Quality Monitoring at Two Selected Traffic Junctions in the City of Haridwar, *Him. J. Env. Zool.,* **20(2)**, 219-221 **(2006)**

10. Chauhan A. and Joshi P.C., Effect of Ambient Air Pollutants on Wheat and Mustard Crops Growing in the Vicinity of Urban and Industrial Areas, *New York Sci. J.,* **3(2)**, 52-60 **(2010)**

11. Chauhan A. and Pawar M., Assessment of Ambient Air Quality Status in Urbanization, Industrialization and Commercial Centers Of Uttarakhand (India), *New York Sci. J.,* **3(7)**, 85-94 **(2010)**

12. Jehangir A., Ahmad Dar N., Yousuf A.R. and Hamid Sofi A., Air Quality at Sonamarg - A Tourist Hill Station in Kashmir Valley, India, *J. Expt. Sci.,* **2(6)**, 18-22 **(2011)**

13. Reddy M.K., Rao K.G.R. and Rao I.R., Air Quality Status of Visakhapatnam (India)-Indices Basis, *Environ. Monit. Assess.,* **93**, 1-12 **(2004)**

14. Senthilnathan T., Status of Respirable Dust Particle (RDP) Concentration-A case study in Chennai City, *J. Environ. Biol.,* **20(2),** 425-428 **(2005)**

15. Sharma M., Maheswari M. and Pandey R., Development of Air Quality Index for Data Interpretation and Public Information, Department of Civil Engineering, IIT Kanpur, Report submitted to CPCB, Delhi **(2001)**

16. Srinivas J. and Purushotham A.V., Determination of Air Quality Index Status in Industrial areas of Visakhapatnam, India, *Res. J. Engg. Sci.*, **2(6),** 13-24, June **(2013)**

17. Central Pollution Control Board, http://www.cpcb.nic.in/standard2.htm **(2006)**