AIR QUALITY INDEX AND ITS VARIATIONS IN HARIDWAR

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ABSTRACT

Air quality monitoring was carried out with Air Quality Index (AQI) method by using ambient air monitoring data. Three pollutants namely SO_2, NO_x and SPM were analyzed. The study was conducted at four different sites namely Shivalik Nagar, SIDCUL, Roshnabad and Jhamalpur village of Haridwar District between December 2006 to February 2007. It was observed that the concentration of suspended particulate matter (SPM) in Shivalik Nagar and SIDCUL was higher than the values prescribed by Central Pollution Control Board (CPCB). Air monitoring studies revealed that SPM varying from 379.21 μgm^{-3} to 402.13 μgm^{-3} and 514.10 μgm^{-3} to 544.22 μgm^{-3} at Shivalik Nagar and SIDCUL, respectively.

INTRODUCTION

Over the years there has been a tremendous increase in human population, road transportation, vehicular traffic and industries in Haridwar region, has lead to increases the concentration of gaseous and particulate pollutant (Chauhan and Joshi, 2007). Air pollution is a problem faced by both developing and developed countries alike. Air pollution has emerged in the past few decades as most crucical problem of mankind (Joshi *et al.,* 2006). Entry of pollutants into the atmosphere occurs in the form of gases and particulates (Kaushik *et al.,* 2005). Air pollution is one of the major environmental problems in many cities as a consequence of industrial and urban growth. Major pollutants emitted by vehicles include carbon monoxide, hydrocarbons,

oxides of nitrogen, sulphur dioxide, suspended particulate matter (SPM) and lead (Parida and Gupta, 1992). The industrial revolution brought the comforts to the mankind in abundance but at the same time this brought with it miseries and discomforts to mankind as well (Agrwal, 1993). The pollutants can cause harm even when present in the air in very small concentrations (Gupta *et al.*, 1997). Air Quality Index (AQI) was introduced by the Environmental Protection Agency (EPA) in USA to measure the levels of pollution due to major air pollutants (Senthilnathan and Rajan, 2003). It is one of the important tools available for analyzing and representing air quality status uniformly (Swamee and Tyagi, 1999). The main objective of the study is to monitor the ambient air quality of Haridwar.

MATERIALS AND METHODS

Study area

Haridwar is one of the most important holy cities of India, located in newly carved state of Uttaranchal. Haridwar is extended from latitude 29° 58' in the north to longitude 78°13' in the east and has subtropical climate. It is about 60 kms in length from east to west and about 80 kms in width from north to south. District Haridwar lies in the foot hills of Shivalik ranges. Total area of district Haridwar is 2,360 sq km^2 with a population of 14, 44,213 (according to 2001 census). It receives millions of tourists every month. There exist a highest temperature recorded was 40.9 ^{0}C -15.5^{0}C during summer season whereas lowest temperature of 16.6^{0}C - 4.0^{0}C during winter.

Study Sites

The sampling of ambient air was done during 2005-2006 in the city of Haridwar to assess air quality standards. Four sampling sites were selected for the study, one site in the Shivalik Nagar area (referred to as site-1), which is surrounded by two industrial area namely, Industrial Area, Bahadarabad and SIDCUL in the west and north, respectively. Second site was selected in the Jhamalpur village which 4km far from Shivalik Nagar, third site was selected in SIDCUL (State Industrial Development Corporation of Uttaranchal Limited) which has about 240 new units of different industries have been established here (referred to as site-3), fourth site was selected in Roshnabad which is 4 km far from SIDCUL.

Concentration of air pollutants viz. NO_x, SO_2, SPM and RSPM was measured with the help of RDS APM 460 by sucking air into appropriate reagent for 24 hours at every 30 days and after air monitoring it procured into lab and analysis for the concentration level. The concentration of NO_x was measured with standard method of Modified Jacobs- Hochheiser method (1958), SO_2 was measured by Modified West and Geake method (1956). The apparatus was kept at a height of 2 m from the surface of the ground. AQI (air quality index) is then calculated with the concentration values using the following equation (Rao & Rao, 1998).

$$AQI = 1/3\ [(SO_2)/Sso_2 + (NO_x)/S_{NOX} + SPM/S_{SPM}] \times 100$$

Where (SO_2), (NO_x) and (SPM) represent the individual concentration and Sso_2, S_{NOX}, S_{SPM} represents the ambient air quality standards for SO_2, NO_x and Suspended Particulate Matter (SPM), respectively.

RESULTS AND DISCUSSION

The different categories of sampling sites are given in Table 1. The mean concentration of different pollutants during the sampling months of December 2006, January 2007 and February 2007 were given accordingly (Table 2).

It was observed that the average concentration of SO_2 were found to be varying from 8.90 μgm^{-3} to 12.40 μgm^{-3}**,** 9.80 μgm^{-3} to 14.80 μgm^{-3} , 1.62 μgm^{-3} to 1.82 μgm^{-3} and 1.34 μgm^{-3} to 1.62 μgm^{-3} at the site 1, site 2, site 3 and site 4, respectively. The average concentration of NO_x were found to be varying from 13.42 μgm^{-3} to 19.44 μgm^{-3}**,** 14.24 μgm^{-3} to 22.40 $\mu gm^{-3,}$ 2.13 μgm^{-3} to 2.23 μgm^{-3} and 2.09 μgm^{-3} to 2.21 μgm^{-3}, at the site 1, site 2, site 3 and site 4, respectively, while the average concentration of suspended particulate matter (SPM) were found to be varying from 379.21 μgm^{-3} to 402.13 μgm^{-3}**,** 514.10 μgm^{-3} to 544.22 $\mu gm^{-3,}$ 92.26 μgm^{-3} to 107.20 μgm^{-3} and 91.15 μgm^{-3} to 109.24 μgm^{-3}, at the site 1, site 2, site 3 and site 4, respectively.

Above results shows that concentration of gaseous pollutants (SO_2 and NOx) remained under the NAAQS limit stipulated by Central Pollution Control Board (CPCB), however, particulate matter (SPM) was higher than the NAAQS. Using Table 2 the Air Quality Index (AQI) values for different pollutants were calculated (Table 3) (Senthilnathan *et al*, 2000). The status of air quality at different sampling sites can easily be identified using the AQI values. The high value of AQI observed at site 1 show that this site is highly polluted and this is termed under the categories "Heavy Air Pollution". This site is bear high number of scooters, three vehicles, loaded trucks, cars, motor cycles close to industrial area and poor road conditions. The site 2, site 3 and site 4 are under the categories of LAP, CA and CA, respectively. The average rating

scale of AQI values varying from 76.32 to 79.21, 41.43 to 46.61, 16.92 to 19.45 and 16.79 to 19.65 at site 1, site 2, site 3 and site 4, respectively during study period.

The natural sources of particulate matter in the atmosphere are the erosion of soil by wind, salt particles from oceans, forest fires, volcanic residues, plant pollen and seeds. Manmade sources are households grates, automobile exhaust, thermal power stations, iron and steel plants, foundaries, cement factories, petrochemical refineries, paper mills, agricultural operations and so on (Gurtu *et al.,* 2001). Motor vehicles generate a range of particulate matter through the dust produced from brakes, clutch plates, tyres and indirectly through the re-suspension of particulates on road surfaces through vehicles – generate turbulence (Watkins, 1991). In a study conducted by Kirchstetter *et al.*, (1999) in Northern California, it is found that heavy diesel vehicles emitted 24 times more fine particles than light day gasoline vehicles. Joshi *et al.,* (2006) found that the concentration of gaseous pollutants viz. SO_x and NO_x was under the permissible limits as per CPCB while the concentration of particulate (SPM and RSPM) was higher the permissible limits as per CPCB in Haridwar city.

Table 1 Categories of different sampling sites at Haridwar

Site No.	Name of site	Category
1	Shivalik Nagar	Residential/ Traffic intersection
2	Jhamalpur Village	Rural area/ Agricultural Land
3	SIDCUL	Industrial/ Traffic intersection
4	Roshnabad Village	Rural area/ Agricultural Land

Table 2 The concentration of various pollutants at the sampling sites for the sampling period December 2006-Feb 2007.

Month	Pollutant	Site 1	Site 2	Site 3	Site 4
December 2006	SO_2	12.20	1.72	17.47	1.62
	NO_x	19.40	2.62	24.40	2.60
	SPM	413.91	110.26	513.94	111.63
January 2007	SO_2	11.32	1.39	13.43	1.58
	NO_x	16.41	2.14	18.64	2.08
	SPM	380.41	105.14	510.38	109.32
February 2007	SO_2	11.84	1.79	14.78	1.67
	NO_x	19.12	2.19	21.43	2.23
	SPM	390.47	112.30	522.29	98.88

Table 3 Rating scale of (AQI) values for three mention months using the average concentration values of the pollutants SO_2, NO_x and SPM.

Month	Site 1	Site 2	Site 3	Site 4
December 2006	82.15	20.19	46.52	21.20
January 2007	74.96	18.99	42.91	19.75
February 2007	77.98	20.36	44.88	18.11

Table 4 Rating scale of AQI values

Index value	Remarks
0-25	Clean air (CA)
26-50	Light air pollution (LAP)
51-75	Moderate air pollution (MAP)
76-100	Heavy air pollution (HAP)
>100	Severe air pollution (SAP)

Table 5 Rating scale for AQI values at different sampling sites

Month	Site 1	Site 2	Site 3	Site 4
December 2006	HAP	CA	LAP	CA
January 2007	MAP	CA	LAP	CA
February 2007	HAP	CA	LAP	CA

REFERENCES

Chauhan, A. and Joshi, P.C. 2007. Analysis of ambient air status in Haridwar city using air quality index. Brainstorming workshop on urban air pollution in India. organized by I.I.T. Roorkee, India. ***(For workshop or seminar or conference citation)***

Joshi, P.C., Swami, A. and Gangwar, K.K. 2006. Air quality monitoring at two selected traffic junctions in the city of Haridwar. *Him. J. Env. Zool.* 20(2), 219-221. ***(For Research paper citation)***

Kaushik, C.P., Ravindra, K., Yadav, K., Mehta, S. and Haritash, A.K. 2006. Assesment of ambient air quality in urban centres of Haryana (India) in relation to different anthropogenic activities and health risk. *Evniron. Monit. Assess.* 122, 27-40. ***(For Research paper citation)***

Kirchstetter, T.W., Harly, R.A., Kreisberg, N.M., Stolzenburg, M.R. and Hering, S.V. 1999. On road measurement of the fine particles and nitrogen oxide emissions from light and heavy duty motor vehicles. *Atmospheric Environment* 33, 2955-2968. ***(For Research paper citation)***

Rao, M.N. and Rao, H.N.V. 1998. Air pollution. Tata McGraw Hill Publishing Company Limited, New Delhi. ***(For Book Citation)***

Swamee, P.K. and Tyagi, A. 1999. Formation of air pollution index. *J. of Air and Waste Manag. Assoc.* 49, 88-91. ***(For Research paper citation)***

West, P.W. and Gaeke, G.C. 1956. Fixation of sulphur dioxide as sulfitomercurate III and subsequent colorimetric determination. *Annal. Chem.*, 28, 1816. ***(For Research paper citation)***