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Assessment of Ambient Air Quality and Air Quality Index (AQI) in Dahej Area, Gujarat, India

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A B S T R A C T

Clean air is basic requirement of living organisms. But now a day, due to the unplanned growth, development and vehicular boom, air becomes polluted. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide and that can pose a serious threat to human health. In the present study, prime air pollutants (PM_{10}, $PM_{2.5}$, SO_2 and NO_2) were estimated in seven stations of Dahej area. The projected value of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 in all the 7 stations were range from 67.39 to 98.75, 29.57 to 45.79, 17.76 to 22.29 and 28.29 to 32.42 µg/m^3, respectively. PM_{10} level in all stations and $PM_{2.5}$ level in 3 stations find little higher level than CPCB recommended limit while SO_2 and NO_2 level were found under permissible limit. AQI values in our study were calculated and it was ranged from 76.50 to 97.75, which are categorized as satisfactory level by CPCB.

Introduction

In addition to land and water, air is the prime resource for sustenance of life. For better human health and wellbeing of the humanity, clean air is one of the main basic requirements. Clean air become polluted by variety of sources, out of them household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution that change the composition of atmosphere and affect the biotic environment. The concentration of air pollutants depend not only on the quantities that are emitted from air pollution sources but also on the ability of the atmosphere to either absorb or disperse these emissions.

The unplanned growth, development and vehicular boom have deteriorated the ambient air quality. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide and that can pose a serious threat to human health if it exceeds the permissible limit (WHO, 2000; USEPA, 2008). More than two million premature deaths per year can be attributed to the effects of urban (outdoor /indoor) air pollution that is mainly caused by burning of solid fuels (WHO, 2005). More than half of the air pollution driven disease burden is borne by the population of developing countries (WHO, 2005). The

relationships between the occurrence of respiratory and cardiovascular diseases and cardiopulmonary mortality with exposure to air pollutants are well documented in the literature (Dockery *et al.,* 1994; Koken *et al.,* 2003).

Major source responsible for higher level of SPM, RSPM, SO_2, NO_x and other organic and inorganic pollutants in environment was motor vehicle emission (Sharma *et al.,* 2006; Jayaraman, 2007; Barman, *et al.,* 2010) and 60 to 70% of the pollution found in the urban environment is also due to that (Panday *et al.,* 1988; Singh *et al.,* 1995).

The public health implications due to the emission of CO, O_3, SO_2, NO_2 and particulates are very well known (Yadav *et al.,* 2012). Among air pollutants, particulate matter (PM) is a ubiquitous and it's especially a major problem due to its adverse health effect, Visibility reduction and soiling of buildings (Horaginamani and Ravichandran, 2010; Chaurasia *et al.,* 2013).

Central Pollution Control Board initiated National Ambient Air Quality Monitoring (NAAQM) programme in the year 1984 with 7 stations at Agra and Anpara. Subsequently in 1998-99 the programme was renamed as National Air Monitoring Programme (NAMP). The number of monitoring stations under NAMP has increased, steadily, to 295 by 2000-01 covering 98 cities/towns in 29 States and 3 Union Territories of the country. Under NAMP, four air pollutants viz., Sulphur Dioxide (SO_2), Oxides of Nitrogen as NO_2, Particulate Matter ($PM_{2.5}$) and Respirable Suspended Particulate Matter (RSPM/PM_{10}), have been identified for regular monitoring at all the locations.

Air pollution has emerged in the past few decades, pose a critical health problem to the mankind. So, that large number of studies in this regard have been undertaken in all over the World and also in India (Katsouyanni *et al.,* 2001; Afroz *et al.,* 2003; Yang *et al.,* 2004; Samoli *et al.,* 2005; Analitis *et al.,* 2006; Kaushik *et al.,* 2006; Barman *et al.,* 2010; Yadav *et al.,* 2012; Mukhopadhyay and Mukherjee, 2013; Rai *et al.,* 2013; Barman *et al.,* 2015). The aim of the study is to assess the ambient air quality with respect to $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_2 in Dahej area because it is a fast growing industrial area of District Bharuch, Gujarat.

Materials and Methods

Study area

Dahej (21^0 42' N and 72^0 38 'E) is a cargo port situated on the South-West coast of Gujarat, India. It is about 45 km from Bharuch.

Study sites

The study sites were chosen after proper investigation, based on basic site selection criteria and reduced interference of the local public with the devices used for the experiment. There is seven monitoring stations were chosen in around the Dahej area to measure the concentration of Sulphur dioxide, Nitrogen Dioxide, $PM_{2.5}$ and PM_{10} in surrounding environment. The monitoring stations were name as Station-1 (Project Site of Rallis India Ltd), Station-2 (Jolwa Village), Station-3 (Lakigam Village), Station-4 (Rahiyad Village), Station-5 (Jageshwar Village), Station-6 (Suva Village) and Station-7 (Ambetha Village) with station code A 1, A 2, A 3, A 4, A 5, A 6 and A 7, respectively.

Ambient air quality monitoring

The sample was taken by help of Combo PM_{10}& $PM_{2.5}$ Instrument for PM_{10} and $PM_{2.5}$ with air flow rate of 2.3 m^3/hr and 1.0 m^3/hr respectively while Gaseous pollutant sampler

instrument was used for sampling of Sulphur dioxide and Nitrogen Dioxide with specific absorbing solution (Sodium hydroxide & Sodium arsenite for NO_2 and Potassium tetrachloromercuate for SO_2).

The analysis was carried out in month of December, 2014 to February, 2015 with a frequency of once in a week.

The apparatus was kept at a height of 5 m from the surface of the ground. Once the sampling was over, the samples were brought to the laboratory and concentration of different pollutants was determined.

The concentration of gases SO_2 and NO_2 were measured by Modified West and Gaeke method and Modified Jacob Hochheiser method respectively while the particulate pollutants $PM_{2.5}$ & PM_{10} were measured by Gravimetric Method as per prescribed in the Guidelines for Manual Sampling & Analyses, Central Pollution Control Board (CPCB, 2013; Jacob and Hochheiser, 1958; West and Gaeke, 1956).

The quality of air in the study area can be estimated from the air quality index. There are several methods and equations used for determining the AQI. However, here the below mentioned equation (Zlauddin and Siddiqui, 2006: Joshi and Semwal, 2011) has been used for computation of AQI value.

$AQI = ¼ \times (IPM_{10} / SPM_{10} + I\ PM_{2.5} / S\ PM_{2.5} + I\ SO_2 / S\ SO_2 + I\ NO_2 / S\ NO_2) \times 100$

Where,

SPM_{10}, $SPM_{2.5}$, SSO_2 and SNO_2:- represent the new ambient air quality standards as prescribed by the Central Pollution Control Board of India and IPM10, IPM2.5, ISO_2 and SNO_2 represent the actual values of pollutants obtained on sampling.

Results and Discussion

The estimated value of air pollutants (PM_{10}, $PM_{2.5}$, SO_2 and NO_2) of seven stations are presented in Table 1. The projected value of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 in all the 7 stations were range from 67.39 to 98.75, 29.57 to 45.79, 17.76 to 22.29 and 28.29 to 32.42 $\mu g/m^3$, respectively.

In the present study, value of PM_{10} were range from 67.39 to 98.75 $\mu g/m^3$, which was higher than recommended limit (60 $\mu g/m^3$) for residential area as well as industrial area by CPCB in all seven station. The standard limit prescribed by Central Pollution Board of India for $PM_{2.5}$ for residential area and industrial area was 40 $\mu g/m^3$, but study demonstrated little beat higher level in A 1, A 6 and A7 area while the concentration of SO_2 and NO_2 was still under the prescribed limits (50 $\mu g/m^3$ for SO_2 and 40 $\mu g/m^3$ for NO_2).

Table.1 Estimated Value of Air pollutants (PM_{10}, $PM_{2.5}$, SO_2 and NO_2) In seven station of Dahej area

Station Code	PM_{10} $\mu g/m^3$ (8 hr)	$PM_{2.5}$ $\mu g/m^3$ (8 hr)	SO_2 $\mu g/m^3$ (8 hr)	NO_2 $\mu g/m^3$ (8 hr)
A 1	98.75	40.45	22.29	32.42
A 2	76.28	30.48	20.84	30.88
A 3	83.82	36.67	18.73	29.17
A 4	67.39	29.57	19.80	32.33
A 5	78.56	33.64	17.89	31.04
A 6	86.70	45.79	21.59	28.79
A 7	97.44	42.5	17.76	30.18

Table.2 Air quality category based on AQI of seven station of Dahej area (CPCB)

Station Code	AQI	AQI Category
A 1	97.75	Satisfactory
A 2	82.50	Satisfactory
A 3	85.25	Satisfactory
A 4	76.50	Satisfactory
A 5	82.25	Satisfactory
A 6	93.75	Satisfactory
A 7	94.75	Satisfactory

The air quality index (AQI) may act as a valuable tool and also act as proxy of ambient air quality status. AQI values in this study were calculated by using the concentration of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 (by using standard formula mention in material and methods). The AQI value range from 76.50 to 97.75 (Table 2) in seven station of Dahej area, which are categorized as satisfactory level (50 to 100) by CPCB. This may cause minor breathing discomfort to sensitive people.

Air pollution in Dahej area was under control level. Level of PM_{10} in all stations and level of $PM_{2.5}$ in some locations found beyond the permissible limit but SO_2 and NO_2 were below the permissible limit at all the stations. Based on the AQI, the Dahej area was categorized as satisfactory, which cause minor breathing discomfort to sensitive people. So, overall air quality of Dahej area was in good condition and it should be maintained for long year, for that the periodic estimation should be carried out to check the level of air pollutants in area.

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