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RESEARCH ARTICLE

Comparative Study of Ambient Air Quality Status of Ahmedabad and Gandhinagar City in Gujarat, India

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Abstract: The present study focused on the comparative analysis of ambient air quality status of Ahmedabad city and Gandhinagar city in Gujarath, India. Both the cities have been studied on the basis of land use pattern and meteorological condition. While selecting the monitoring stations, it has been kept in mind that monitoring stations should represent the background of residential, commercial (industrial) and sensitive areas. Further, the data is interpreted in the form of general patterns, average values and trends of wind direction and the seasonal variations under the influence of varying weather conditions. After comparing it with the National Ambient Air Quality Standards (NAAQS), the Ambient Air Quality was then interpreted in results and discussion.

Keywords: Ambient Air Quality, RSPM, SPM, Sulphur dioxide, Nitrogen dioxide.

Introduction

Ahmedabad is located in Gujarat, India. It is the leading industrial and commercial city of Gujarat. Area of Ahmedabad city is 190.84 km^2. The location coordinates for Ahmedabad are N 23^0 1'- E 72^0 41'. The city is on the bank of the river Sabarmati. Annual temperature in city is ranging from 20.5 ^{0}C to 34.4 ^{0}C. Most of the rainfall occurs in the monsoon seasons from June to September. Rainfall varies from 0.9 to 265.3 mm/month. Average annual rainfall was 803 mm. The city lies in a region of North Gujarat which is a plain, dry and sandy area. The city covers an area of 47,156 acres. Except small hills of Thaltej-Jodhpur Tekra, entire surroundings of the city is a plain area. There are no woods or forests nearby. The sea is at a distance of 80.65 km at the Gulf of Cambay. Sabarmati, one of the longest rivers of Gujarat, bifurcates the city into eastern and western parts, connected by five bridges, two of which have been constructed after independence. Though the river is perennial, it gets practically less water in the summer.

Gandhinagar is the capital of Gujarat. It is located on N 23^0 22'- E 72^0 68' at a height of 81 meters (265 feet) above mean sea level. Area of Gandhinagar city is 57 km^2. According

to the 2001 India census report, Gandhinagar had a population of 195,891 inhabitants. 53% of the population is male and females 47% of the population. In Gandhinagar, 11% of the population was less than six years of age. The city is on the bank of the river Sabarmati. Annual temperature in city was ranging from 20.5 ^{0}C to 34.4 ^{0}C. Most of the rainfall occurs in the monsoon seasons from July to September. Rainfall varied from 0.9 to 265.3 mm/month. Average annual rainfall was 803 mm. The weather was hot throughout the months of March to June when the maximum temperature was ranging from 36 °C to 42 °C and the minimum in the range of 19 °C and 27 °C. From November to February, the average maximum temperature was around 29 °C, the average minimum is 14 °C and the climate was extremely dry. The southwest monsoon brought a humid climate from mid-June to mid-September. Humid climate was running from mid-June to mid-September due to the south-west wind.

Source of air pollution in Ahmedabad city

There has been a rapid growth of industries in the city especially pharmaceuticals, petroleum and petrochemical industries, steel recycling, auto parts manufacturing, beverages production and textile were the major polluting industries with respect to the air pollution. The Vatva, Naroda, Narol and Bavla Industrial area were prominent industrial zone on the outskirts of the city, with major multinational groups set up manufacturing or processing plants in and around the city. Slum areas around the monitoring stations also contributed significant amounts of unburnt carbon and particulate matter (PM) along with gaseous pollutants which were carried over in the atmosphere with fuel gas. In Ahmedabad most of the roads had been maintained and some were damaged due to heavy traffic load. Substantial dust remained in suspension due to the heavy traffic intensity causing poor visibility, respiratory problems and eye irritation in addition to general nuisance.

There had been a rapid increase in the number of vehicles in the city over the past few years. Scooters and motorcycles were the major transport source in the city. The diesel powered heavy vehicles added to the air pollution problem by emitting out black smoke. The problem was further aggravated when some vehicles used adulterated petrol mixed with kerosene oil. The emission from such vehicles was very high in suspended particulate matter such as carbon and soot particles resulted in smoke.

Source of air pollution in Gandhinagar city

There had been a rapid growth of population lead to increase automobile transportation in city contributed air pollution. The sector-29 and sector-30 industrial area is prominent industrial zones on the outskirts of the city, with major multinational groups having set up manufacturing or processing plants in and around the city. Slum areas around the monitoring stations also contributed significant amount of unburnt carbon and particulate matter along with gaseous pollutants which were carried over atmosphere with fuel gas. In Gandhinagar most of the roads were well maintained. Substantial dust remained in suspension due to traffic intensity.

Location of sampling stations in Ahmedabad city

Ahmedabad city has been studied on the basis of land use pattern and micro meteorological conditions. Thus, six stations were set up as the ambient air quality monitoring stations established at Ahmedabad city as per siting criteria IS: 5182 part XIV.

(1) Naroda Lake (A1) : Naroda was approximately three miles from Ahmedabad town (8 km), near the intersection of National Highway No. 8 and National Highway 59. The Naroda is GIDC's industrial park which hosted National and multinational industries. Most major township projects were coming up along Ahmedabad-Vadodara expressway with Naroda being a nodal center for development. One of the ambient air quality monitoring station is situated in this area. 2) Narol Naroda Cross Road (A2): It is situated near the Vatva GIDC industrial area and is surrounded by residential as well as small scale chemical industries. 3) Panjarapol Char Rasta (A3): It is situated nearby Gujarat University and is located in the nucleus of various institutes of National importance such as PRL, ATIRA, ISRO, IIM *etc*. The campus having building for various departments, offices, hostels, residences. 4) Jagnath Mahadev Chowk (A4): This is the area having high population density because of hospitals, market, and residential area within the old city. 5) Shahibaug Under Bridge (A5): It is basically a residential area with current development of various constructions sites. 6) Ekta Circle, Behrampura (A6): It is situated in the old city of Ahmedabad. Since it is in the old city area, it showed the heavy traffic density and traffic jam in the peak hours. Residential area, different hospitals and air port is located near this hospital.

Location of sampling stations in Gandhinagar city

Sampling stations were set up at the following locations:

1) Nr. Shoping Centre, Sector-8
2) Nr. Inquiry Office, Sector-30

1) Nr. Shoping Centre, Sector-8 (A7): All Government vehicles in large number were parked near the site. The residential area surrounds the monitoring point. 2) Nr. Inquiry Office, Sector-30 (A8): This is a Government offices area, which is surrounded by residential area. This location of monitoring is closed to industrial area. A heavy volume of all kinds of vehicles were plying on this road. There is a big ground nearby. On this ground, various festive activities and exhibitions are continuously going on which add to fluctuations in pollution levels.

Methodology

SPM in the ambient atmosphere in the size range of 0.1 to 100 microns were collected in a hoper attached with Respirable Dust Sampler (RDS) and glass fiber filter paper had been used for estimation of PM10. Oxides of nitrogen (NO_2) was determined by bubbling the ambient air sample through a solution of sodium arsenite and sodium hydroxide, sulphur dioxide was determined by bubbling the air samples through solution of sodium tetrachloromercurate (TMC) absorbing solution. Both gaseous protocols were determined spectrophotometrically. All the protocols such as the Respirable Suspended Particulate Matter (RSPM), Suspended Particulate Matter (SPM), NO_2 and SO_2 *etc*. were analyzed as per prescribed methods of Central Pollution Control Board (CPCB) and NAAQS guidelines[1-5].

Ambient Air Quality Monitoring had been carried out with the help of RDS. The instrument was operated at an average flow rate of 1.1-1.2 m^3/min. As per IS: 5182 Part IV and Part-XXIII, 2006 for sampling/collection of SPM, PM10 levels respectively. In case of NOx IS 5182 Part IV and SO_2 IS 5182 Part VI had been followed for concentration measurement from April 2012 to February 2013. The analysis of all samples at all stations was carried out from April 2012 to February 2013 (Table 2). The data is presented in the form of annual average concentration of these protocols.

Table 1. National Air Quality Standards (Year 2009 and 1994)

Parameter	Weighted Avg.	Conc. of Ambient Air (μm/m^3)			Year
		Industrial	Residential and other	Ecologically Sensitive	
RSPM	Annual Avg.*	60	-	60	2009
	24 h**	100	-	100	
NO_2	Annual Avg.	40	-	30	
	24 h	80	-	80	
SO_2	Annual Avg.	50	-	20	
	24 h	80	-	80	
SPM	Annual Avg.	360	140	70	1994
	24 h	500	200	100	
RSPM	Annual Avg.	120	60	50	
	24 h	150	100	75	
NO_2	Annual Avg.	80	60	15	
	24 h	120	80	30	
SO_2	Annual Avg.	80	60	15	
	24 h	120	80	30	

**Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. **24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a yr. 2% of the time; they may exceed the limits but not on two consecutive days of monitoring*

Table 2. Status of Ambient Air Quality Status of different stations in Ahmedabad city, under NAMP project (Annual average of year April, 2012-February 2013)

Name of sampling station	Parameters			
	RSPM μm/m^3	SPM, μg/m^3	NO_2, μg/m^3	SO_2, μg/m^3
Naroda Lake, Ahmedabad (A1)	135	362	25	14
Narol Naroda Cross Road, Ahmedabad (A2)	84	214	21	13
Panjarapol Char Rasta, Ahmedabad (A3)	74	185	20	12
Jagnath Mahadev Chowk, Ahmedabad (A4)	86	224	20	13
Shahibaug Under Bridge, Ahmedabad (A5)	90	206	21	13
Ekta Circle, Behrampura, Ahmedabad (A6)	80	211	20	12
Nr. Inquiry Office, Sector-30, Gandhinagar (A7)	86	224	21	9
Nr. Shoping Centre, Sector-8 Gandhinagar (A8)	68	178	17	8

Results and Discussion

The seasonal influence of varying weather conditions on the RSPM, SPM, NO_2 and SO_2 concentration was well pronounced with their annual cycles showing maximum and

minimum values[6-8]. Due to daily six to eight hours load shedding at Ahmedabad, the sampling was carried out on the average 16-18 h/day. The results were then calculated for 24 h.

Air Quality Status of Ahmedabad City

(All the interpretation of April 2012 - February 2013, is based on monthly data collected for all parameters such as SO_2, NO_2, RSPM and SPM of ambient air)

During monsoon (June 2012 to August 2012), on an average, the minimum concentration level of pollutants were found. The factors responsible may be increased vertical dispersion, washout by monsoon rains and suppressed wind erosion. During winter (November 2012 to February 2013) there was a maximum concentration range of all parameters. The minimum and maximum average concentration of SPM was recorded from 185 µg/m^3 to 362 µg/m^3. However, maximum concentrations were recorded in the month of January. During winter season mixing height was very less with respect to the other seasons. Pollutants were disperse at the very near to the ground level. Remarkable concentration levels of Pollutants were observed on October month due to festival activities[9]. Minimum concentration levels of particulates as well as gases pollutants were found during summer season (April 2012 to June 2012). Lesser concentration levels of pollutants were recorded due to maximum mixing height, high temperature, high wind erosion and moderate stability. As compared with NAAQS, 2009, it is observed that on annual average basis SO_2 and NO_2 concentration levels were found well below the prescribed limits; RSPM levels were slightly increasing order at sampling station A3 (Figure 1), whereas SPM showed increasing trend at sampling station A3 as well as sampling station A4 on annual average basis. The minimum and maximum average concentration of RSPM was recorded from 74 µg/m^3 to 135 µg/m^3. Monitoring station which were established nearby city area were found maximum NOx concentration levels and monitoring station establish those were established nearby industrial area were found maximum SO_2 concentration levels due to industrial influence.

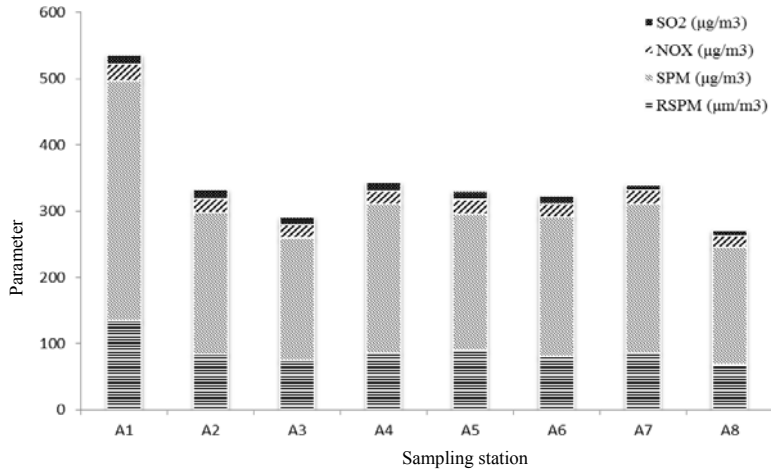

Figure 1. Air quality status of Ahmedabad and Gandhinagar city (April 2012 - February 2013)

Air quality status of Gandhinagar city

During monsoon, on an average, the concentration was at the minimum levels. The factors responsible may be increased vertical dispersion, washout by monsoon rains and suppressed wind erosion, while the factors like higher rainfall and washout, lead to decrease of pollutants.

The minimum particulates and gases concentration were found on winter season due to minimum mixing height. The minimum and maximum average values of SPM were ranging from 178 $\mu g/m^3$ – 224 $\mu g/m^3$. The maximum average concentration of RSPM was recorded to 86 $\mu g/m^3$, which is under the permissible limit as per NAAQS, 2009. However maximum concentrations were observed in the month of January. During summer (April to June 2012), on an average, the concentration levels of gaseous & SPM pollutants were at the minimum due to high temperature, mixing height, high wind erosion, moderator stability, almost dry atmosphere and less humidity.

As compared with NAAQS, it was observed that SO_2 and NO_2 concentration were found to be very low from the prescribed limits. Annual average concentration levels of RSPM and SPM were also found to be slightly increasing order.

Conclusion

It has been concluded from the present study of Ahmedabad city that the SO_2 and NO_2 concentrations were well below the National Ambient Air Quality Standards, while RSPM concentration had shown very slight increase at sampling station A3 and the SPM concentrations had shown the increasing trend at sampling station A3 and A4.

The present study of Gandhinagar city showed that the SO_2 and NO_2 concentrations were well below the National Standards, while the SPM concentrations in residential area were found to be slightly more than the NAAQS, 2009. On the other hand SPM concentration in industrial area of Gandhinagar was found to be within limits as compared to NAAQS, 1994. The authors have already assessed and published the ambient air quality status of Gandhinagar city.

It can be concluded from present and previous study of ambient air quality status of Ahmedabad and Gandhinagar city respectively that there has been a rapid growth of population leads to increase automobile transportation in both the cities, contributing various air pollution problems. There has been also a rapid growth of industries in cities especially in Ahmedabad city, contributing to air pollution. Due to various environmental problems, new methods should be innovated; to pose a high risk to the health of citizens and appropriate measures need to be taken, in terms of planning future urban growth.

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