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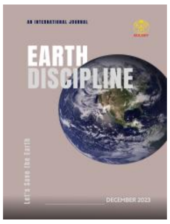

Research Article

Determining Jalna City (MS), India's air quality index: an analytical study

*[1]B. S. Dobhal, [2]R. P. Shimpi and [3]M. J. Hebade

Department of Chemistry Badrinarayan Barwale College of Arts, science & Commerce, Jalna-431203, Maharashtra

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ABSTRACT

In order to determine the current cumulative air pollution influents in the research locations was studied for the air quality index determination, an inventory of pollutants ($PM_{2.5}$, NOx,, PM_{10} and SO_2) has been prepared at the regional level and presented in this work. After samples were examined and monitoring stations were installed in both residential and commercial areas, an air quality index was calculated. The findings show that, at both monitoring sites, gaseous pollutants including NOx and SO_2 are below the allowable levels set out by the national ambient air quality standards. Study has been estimated that the AQI values for NOx and SO_2 are in the excellent range. At both monitoring stations, PM_{10} and $PM_{2.5}$ levels exceeded the recommended national ambient air quality standards, indicating that particulate matter is the major resource for air pollution in the research region. The PM_{10} AQI value was decreases into the poor and moderate ranges. The estimated $PM_{2.5}$ AQI values are in the poor and moderate categories. Because of $PM_{2.5}$, the total AQI was determined to be in the bad range. Therefore, it has been determined that the pollutants at both of these Jalna city areas are $PM_{2.5}$ and, to a lesser degree, PM_{10}. Sensitive populations, such as children and older individuals, are more likely to be exposed to long-term health impacts such as lung or heart disease, and their impact is larger than that of the general population, which is less impacted.

Introduction

One of the most important elements in our surroundings is air. Humans need 13.4 kg of air on average per day, which is 14–19 times more food than they eat in a day. Any alteration in the air's composition negatively impacts all living things, including human life, and results in air pollution. Environmental monitoring organization has noted the detrimental impacts of excessive pollution, which is growing at a startling pace. Numerous factors contribute to the devastation of the environment, including excessive population growth, urbanization, transportation, emissions, and industrialization. These include the drastically deteriorating state of human health, natural resources, and climate7–10. The environment protection agency has identified nitrogen oxides, sulphur dioxide and particulate matter as the source of air pollutants. The amount of air pollution in a given location is determined by a number of variables, including nearby and distant sources of pollution, local climatic and topographical conditions 11–14.

* Corresponding author.
E-mail address: dobhalsingbs478@gmail.com (B. S. Dobhal)

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In order to properly manage these concerns, accurate understanding of air contaminants, their concentrations, changes, and field data is required 15,16; otherwise, it would impede environment planning operations. The majority of nations and India, launched ambient air qualities initiative to monitor air qualities via the compilation of data on ambient air pollutant concentrations17. The EPA develop the air quality index to address this situation. The AQI uses a grading system based on the air quality index to offer a 1 number that indicates quality of the air in a given location by mathematically linking the concentration of different contaminants.18–21. The wintertime particulate matter concentration in Bikaner is found to be higher than the monsoon22. PM_{10} was shown to be a crucial contaminant in Vapi, a moderately polluted city23. The MPCB's compiled data for 74 AAQM sites from 2014 to 2015 revealed moderate to below-average air quality24. This report, an extension of our earlier research25–27, uses the air quality index (AQI) to examine monthly fluctuations in ambient air quality in January, February, and March 2019 on a selection of monitoring sites in Jalna city, including residential (IMA hall) and industrial (Krishidhan seeds).

Material and Method:

Area of the study

The Jalna district was located in the northern, Marathwada state of India and in the middle portion of the Maharashtra state. The Jalna district is located between latitudes 19°1¹ and 23°3¹ north and longitudes 76°4¹ and 77°4¹ east. With a total size of 7612 km^, it makes up around 2.41% of Maharashtra, an Indian state. With was heavy rainfall from the south-west monsoon from June-September. Area has a subtropical climate. In the district, there is an average of 650 to 750 mm of rainfall. Rainfall in the area during a drought might be as little as 410 to 460 mm. Following the wet season and winter lasts until February, when the lowest temperature is between 9.5 and 10.2 degrees Celsius and the highest is between 31 and 34 degrees Celsius. The summer heat lasts until June after winter. Summertime 27–28 brings highs of 43–44°C throughout the day.

Jalna is well-known in the industry for its steel and seed sectors. Jalna's industrial growth is mostly driven by engineering, plastics, and agriculture. Currently, the Maharashtra Industrial Development Corporation (MIDC) oversees six industrial sectors in Jalna. These areas include co-ops producing sugar factories, fertilisers, pesticides, steel rerolling, plastics, tiles, and cement pipes. The primary sources of air pollution of Jalna city are industries, the rising number of cars on the road, high traffic density, heavy vehicle movement, the existence of an industrial sector nearby, natural dust, building and mining activities, dust storms, etc.30, 31.

Analysis of particulate pollutant samples (NRSPM and RSPM):

From January to March 2019, samples of NOx, SO_2, NRSPM (PM_{10}) and RSPM ($PM_{2.5}$) were taken intervals a week from residential and commercial locations. The equipment was utilised for a 24-hour period to collect samples using a high volume air sampler (model RDS APM 465NL) with gaseous sampling attachment APM 411TE (manufactured by Enviro-tech India Pvt. Ltd.). Samples of particulate matter, such as RSPM and NRSPM, were collected over a period of nine hours by controlling airflow at 1.2–1.3 m^3/min. The air inside the sampler was sent through a cyclone separator and filter in two stages. The cyclone separator collects larger particles, or non-respirable particulate matter (NRSPM) (particle size > 10µm), in a first-stage dust collector that has been previously weighed. The remaining particles, or respirable particulate matter (RSPM) (size < 10µm), are collected over a glass microfiber filter that has been previously dried and weighed (Whatmann GF/A, 204x252mm). Using the standard procedure CPCB 201132, the concentrations of NRSPM and RSPM were measured gravimetrically.

Gaseous pollutants (NOx and SO_2):

By absorbing SO_2 from a known volume of air in an absorbent solution of potassium tetrachloromercurate (TCM), ambient air samples for SO_2 were obtained. It was decided to react the stable dichlorosulphitomercurate complex with methyl sulphonic acid and para rosaniline. Using a spectrophotometer, the absorbance of the coloured solution was measured at 531 nm. The concentration of sulphate ions in the absorbent was determined by the use of the modified West and Gaeke Method (IS 5182 part 2:2001); CPCB 200133. By bubbling a known amount of air through a solution of sodium hydroxide and sodium arsenite, ambient nitrogen dioxide was collected. By reacting nitrile ion with phosphoric acid, sulphanilamide, and N-(1-naphthyl)-ethylenediamine dihydrochloride (NEDA) and measuring the absorbance of the strongly coloured azo-dye at 541 nm34,35, the nitrile ion concentration created during sampling was discovered calorimetrically.

Analysis of air quality index (AQI):

Air quality grade was represented by a single value that represents the difference between the actual measured concentration of criterion pollutants and the standard allowed concentration 36, 37.

An important current method for assessing and depicting the uniform air quality state is the AQI.

The formula used to calculate the air quality index was

$$AQI = (\frac{100}{n})\sum_{k=1}^{n}(\frac{APC_k}{SPC_k})$$

Where, AQI is air quality index
N is number of criteria pollutants
APC is Actual pollutant concentration
SPC is Standard pollutant concentration (CPCB 2011)

Table-1) Indian national ambient air quality standard

Sr.No.	Pollutant	Time weighted Average	Air Quality Standard concentration in Ambient air	
			Industrial, residential, rural and other area	Ecologically sensitive area (notified by central Govt.)
1	SO_2 µgm/m^3	Annual 24 hours	50 80	20 80
2	NO_2 µgm/m^3	Annual 24 hours	40 80	30 80
3	PM_{10} µgm/m^3	Annual 24 hours	60 100	60 100
4	$PM_{2.5}$ µgm/m^3	Annual 24 hours	40 60	40 60

Observation and results:

Table 3 provides the breakpoint concentration of different contaminants, whereas Table 2 shows the locations of sampling sites. The AQI is the maximum value of each pollutant's subindex, which is calculated using these breakpoint concentrations. Table -4. provides average (µgm/m^3) concentrations of NOx, PM_{10} SO_2 and $PM_{2.5}$ for industrial and residential locations. Graphs 1, 2, 3, and 4 illustrate the variations in NOx, PM_{10} SO_2 and $PM_{2.5}$ (µgm/m^3) for residential and industrial locations, respectively. The average, lowest, and maximum AQI values for both sampling sites was shown by Table 5.

Table-2) Sampling stations of the study

Sr. No.	Station Name	Location		
		Latitude	Longitude	Elevation
1	Residential site: IMA Hall	19^0 84’86.87”N	75^0 88’92.84”E	503m
2	Industrial site: Krishidhan Seeds Pvt Ltd	19^0 85’04.63”N	75^0 85’32.35”E	524m

Table- 3) Points for AQI Scale 0-500 (Units: µgm/m^3 unless mentioned otherwise)

AQI Category (Range)	**$PM_{2.5}$ 24-hr**	**NOx 24-hr**	**PM_{10} 24-hr**	**SO_2 24-hr**
Good (0-50)	0-30	0-40	0-50	0-40
Satisfactory (51-100)	31-60	41-80	51-100	41-80
Moderately polluted (101-200)	61-90	81-180	101-250	81-380
Poor (201-300)	91-120	181-280	251-350	381-800
Very poor (301-400)	121-250	281-400	351-430	801-1600
Severe >401	250+	400+	430+	1600+

Table-4) Average concentration of NOx, PM_{10} SO_2 and $PM_{2.5}$ (µgm/m^3) at residential and industrial sites.

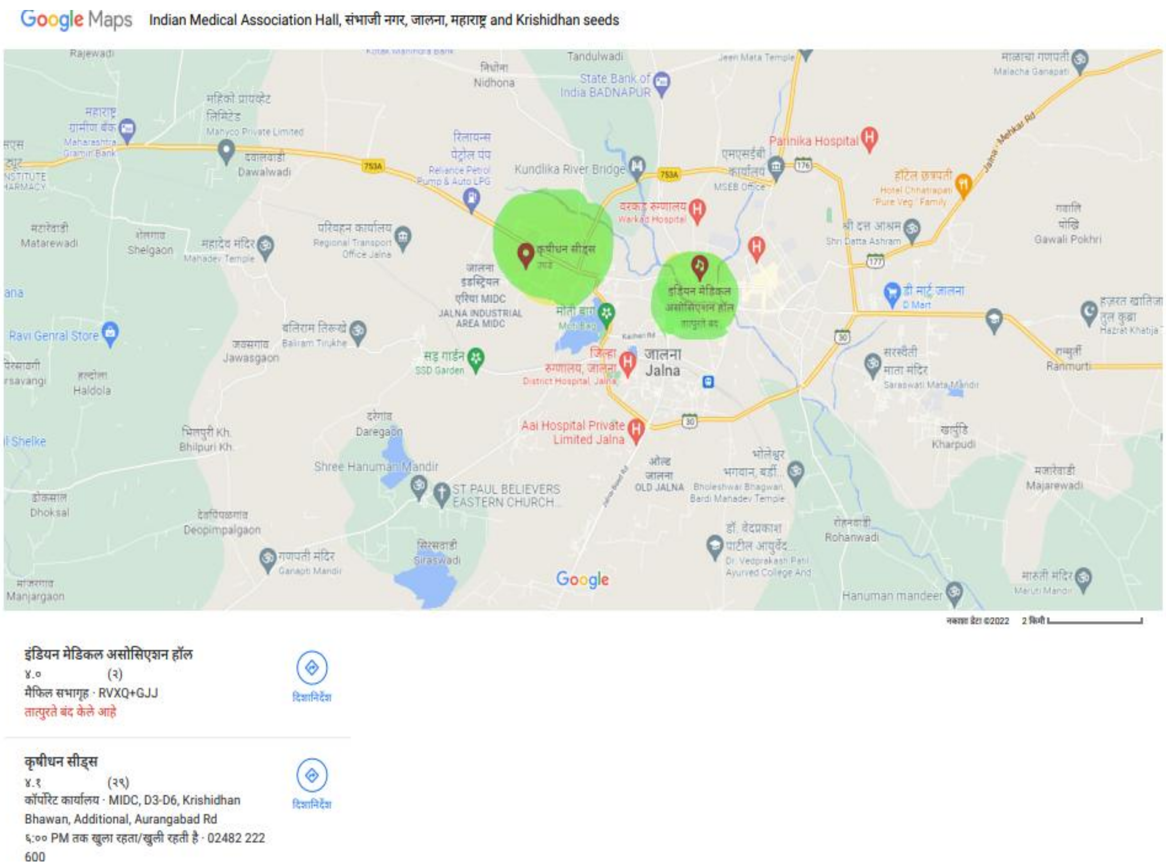
Date	**Month**	**Pollutants (24 hour average)**							
		$PM_{2.5}$ (µg/m^3)		**PM_{10} (µg/m^3)**		**SO_2 (µg/m^3)**		**NO_X (µg/m^3)**	
		Industrial	**Residential**	**Industrial**	**Residential**	**Industrial**	**Residential**	**Industrial**	**Residential**
01/01/2019	January	103	112	226	219	10.96	11.26	44.46	50.51
01/02/2019		96	118	209	228	10.90	9.96	48.41	43.91
01/08/2019		99	107	235	237	9.60	9.51	41.34	39.88

01/09/2019		91	98	220	225	10.97	10.91	46.10	38.49
01/15/2019		97	113	243	234	9.95	12.20	46.18	42.88
01/16/2019		91	100	226	230	9.60	10.28	44.94	47.20
01/22/2019		95	104	219	220	9.54	10.59	44.09	40.13
01/23/2019		105	111	245	231	10.56	9.66	44.02	36.18
01/29/2019		98	100	235	236	9.17	10.50	35.59	49.73
01/30/2019		95	104	241	240	11.55	9.99	41.11	47.06
02/05/2019	February	92	105	229	225	10.78	11.09	49.14	44.48
02/06/2019		100	110	231	242	10.18	11.44	40.68	41.17
02/12/2019		94	99	237	246	11.20	9.80	48.37	43.62
02/13/2019		98	106	223	244	9.86	10.13	45.57	43.05
02/19/2019		94	99	230	221	11.73	10.80	50.36	37.90
02/20/2019		100	104	234	236	12.05	9.70	41.75	49.95
02/26/2019		93	107	236	227	10.49	9.61	38.36	46.50
02/27/2019		96	97	230	250	9.41	10.91	44.01	39.57
03/05/2019	March	99	98	236	233	10.11	8.60	39.47	46.52
03/06/2019		93	102	241	224	10.46	10.09	43.65	35.19
03/12/2019		94	105	236	254	11.03	10.81	52.23	40.36
03/13/2019		93	104	226	242	10.33	10.19	44.37	40.99
03/19/2019		92	100	236	242	9.69	10.03	39.48	33.24
03/20/2019		89	103	249	249	9.80	9.47	34.82	34.40
03/26/2019		92	103	247	233	10.96	9.61	38.79	39.35
03/27/2019		95	97	250	241	9.91	10.49	37.35	35.67

Table- 5) Shows pollutant sub index of all sampling stations

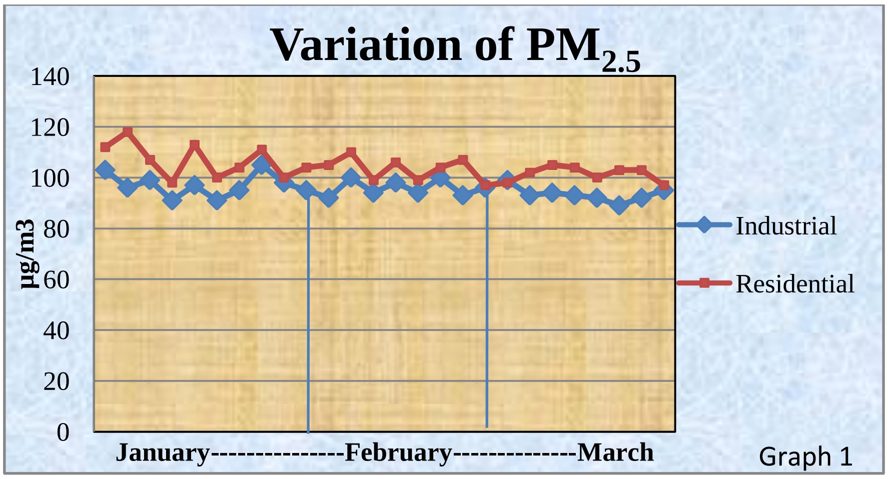
Station Name : Residential site: IMA Hall					
Sub Index	Pollutants				AQI
	$PM_{2.5}$	PM_{10}	SO_2	NOx	
Maximum	118	254	11.44	50.51	254
Minimum	97	219	8.60	33.24	219
Average	104	235	10.29	41.84	235
Station Name : Industrial site: Krishidhan Seeds Pvt. Ltd.					
Sub Index	Pollutants				AQI
	$PM_{2.5}$	PM_{10}	SO_2	NOx	

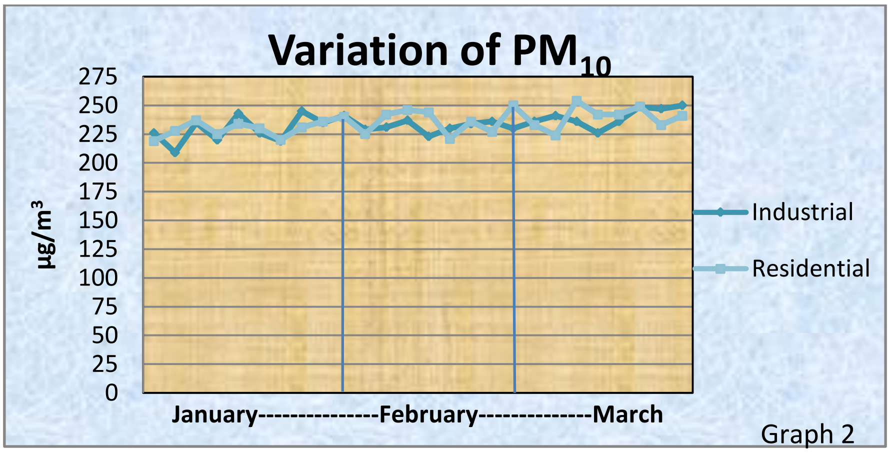
Maximum	105	250	12.05	52.23	250
Minimum	89	209	9.17	34.82	209
Average	96	233	10.42	43.23	233

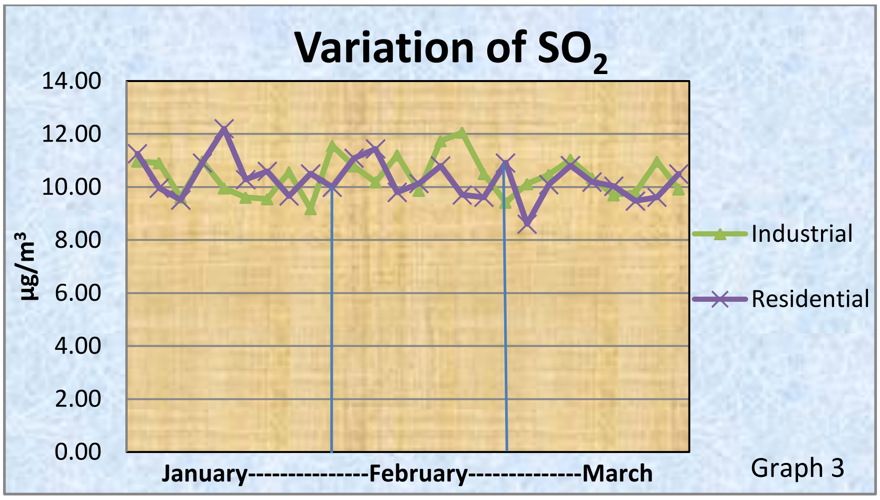


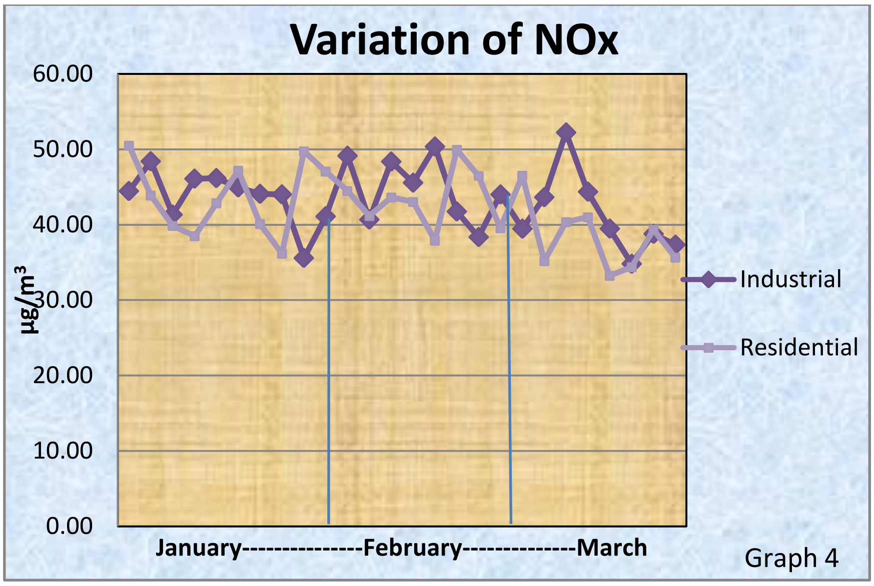
The findings show that throughout the research period, SO_2 levels at both monitoring sites were within the recommended NAAQS. Low levels of SO_2 might be the result of a number of actions, including fewer outdated cars and a drop in diesel's sulphur content. In every observed site, NO_2 levels were likewise within the allowed NAAQS. The elimination of outdated cars, improved traffic management, and other actions might be the cause of the low NO_2 levels. The primary air pollutants released by burning fossil fuels, vehicles, and industry are sulphur dioxide and nitrogen oxides [38, 39]. Meteorological factors and the emission characteristics of the main sources influence the seasonal concentration pattern of air pollutants [13]. Similar findings were found by researchers [40–42].

At the two monitoring locations, PM_{10} and $PM_{2.5}$ levels, respectively, above the recommended NAAQS. The research area's high particulate matter, including excessive traffic, nearby industrial areas, natural dust storms, and high traffic density. Automobiles and industry are the main sources of particulate matter in ambient air [7,40,41]. In comparison to the general population, which is less impacted, members of sensitive groups, such as youngsters and older individuals, may have health impacts such heart or lung illness on prolonged exposure and at increased risk [43]. According to data from the US Environmental Protection Agency, coarse particles ($PM_{10-2.5}$) may irritate a person's nose, throat and eyes. A lower level of particulate matter can be attained by expanding the green belt development in the area, improving traffic management, cutting back on the use of appliances that produce particulate matter, avoiding burning, quitting smoking indoors, choosing to walk rather than drive, using solar energy, routinely maintaining vehicles, and other measures.


Variation of PM2.5
140
120
100
80
60
40
20
0
µg/m3
Industrial
Residential
January---------------February--------------March
Graph 1


Variation of PM10
275
250
225
200
175
150
125
100
75
50
25
0
µg/m³
Industrial
Residential
January--------------February-------------March
Graph 2


Variation of SO2
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
µg/m³
Industrial
Residential
January--------------February-------------March
Graph 3



Conclusions:

The primary cause of Jalna City's air pollution issue is the rising amounts of particulate matter (PM_{10} and $PM_{2.5}$) in the atmosphere. The expanding number of building projects, cars, combustion activities, agricultural activities and factories are the main causes of pollution of air was study region. Deforestation and mining are also significant factors. When breathed in significant numbers, particulate matter may cause respiratory and cardiovascular symptoms including asthma episodes and bronchitis as well as cardiac arrhythmias and heart attacks. The size of the particulate matter also affects the degree of effect. While small particles are deposited in the deeper regions of the lungs, coarse particles have a negative impact on the respiratory system. The findings show that the residential site, IMA Hall, has a lower air quality index and is generally more contaminated than the industrial site in krishidhan Seeds. The air quality index of both sample sites shows that the quantity of pollutants in the air in Jalna city is steadily rising and declining. Both of these stations have moderately to severely degraded quality of air.

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