Original Research Paper

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Statistics

USE OF STATISTICAL METHODS FOR AMBIENT AIR QUALITY DATA

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ABSTRACT The purpose is to know the Ambient Air quality at different stations in Aurangabad city, which was undertaken for the study. Twenty-four hours of air sampling was carried out during the Feb.-2017 to Dec.-2019. Statistical Methods, Air Quality Index (AQI) and Time Series Analysis, Seasonal variation and coefficient of variation and cluster analysis were employed for analysis data. The parameters are Sulphur dioxide (SO2), Oxides of Nitrogen (NOX) and Reparable suspended particulate matter (RSPM or PM10) below 10-micron partials. The results indicated that the RSPM extensively contribute to air pollution at this location throughout the study period.

KEYWORDS : Air Quality Index Rating scale, Multivariate analysis method of cluster analysis, Average, Coefficient of variation, Seasonal Variation and Time Series Analysis.

1.0 INTRODUCTION:

The effect of air quality may be a reason for concern since it affects being healthy. The financial growth including rapid urbanization, increased quantity of vehicles, manufacturing, and human actions are in charge of the changes within the air quality. This has paying notice of the govt, society and tons of researchers. Pollution costs society in terms of injury to human health, buildings, flowers, lowered visibility, and increased greenhouse gases.

Air quality index (AQI) is that the key tool used for the assessment of ambient air quality. it had been introduced by the Environmental protection agency (EPA), USA to measure the amount of pollution thanks to key air pollutants. The air quality index has been used as a sign of pollution. The study was predictable to see the ambient air quality at three Pollution stations was undertaken.

The sampling was done by using the High Volume Reparable dust sampling apparatus The parameters monitored were sulfur dioxide (So2), oxides of Nitrogen (NOX) and Respirable suspended particulate matters (RSPM). The sampling was administered for twenty-four hours during a month eight to 10 days. The concentration of the pollutants was calculated in micrograms per kiloliter (µg/m3). The High Volume Reparable dust sampling apparatus is employed for monitoring of sampling of So2, NOX, and RSPM is recorded using the gravimetric method. Air is drawn into enclosed housing and thru a filter (Glass fiber filter) by means of the high-flow-rate blower at a running rate (1.13 to 1.70 m3 / min or 40 to 60 ft min) that permits suspended particles having diameters of less than100m (Aerodynamic diameter) to pass to the filter surface. The gathering concentration of suspended particulate within the ambient air (µg/m3) is computed by measuring the gathering of composed particulate and therefore the volume of air sampled. The air samples were composed to estimate sulfur dioxide and oxides of nitrogen for twenty-four hours and were analyzed by using Central Pollution control panel guidelines for analysis for these gaseous pollutants. The RSPM was sampled by the gravimetric method at a niche of 8 hours, three samples were collected in 24 hours.

Numerous researchers have measured the pollution and its major pollutants measured by Wen-Jie Zhang, Ye-Le Sun, Guo-Shun Zhuang and Dong-QunXu (2006), Rao M N, Rao HVN (1989), Hari Om Gupta and Brij Mohan Sharma (1995), Someshwara Rao N, Morel, B., Yeh, S., and Cifuentes, L. (1999), Gunaseelan K, Praksam N K and Srinivasa S.S. (1999), Ott, W. R. A. (1990), Reddy M. K. and MotatiSuneela (2000), Lu, H. (2002), Senthilnathan T and Rajan R.D. (2003), Hemavathi and Shobha Jagannath (2006), Hai-Dong, Kan And Bing-Heng Chen (2004), R.K. Srivastava and Rajasree Sarakar (2010), Schwartz, J., Dockery, D., and L.M. Neas, et al. (1994), etc..

The approved Air Quality Index (AQI) and National ambient air quality standards (NAAQS) are shown in table (I) and (II), respectively as follows.

1.1: Table (I): Rating scale of AQI Values:

Index values (µg/m3)	0-25	26-50	51-75	76-100	> 100
Remarks	Clean air (CA)	light air pollution (LAP)	Moderate air pollution (MAP)	Heavy air pollution (HAP)	Severe air pollution (SAP)

1.2: Table (II): National Ambient Air quality Standards (NAAQS):

Pollutants		SO2	NOX	RSPM
Time weight		24 hrs	24 hrs	24 hrs
Concentration in Ambient air quality (µg/m3)	Industrial	120	120	150
	Residential	80	80	100
	Sensitive	30	30	75
Method of measurement		High volume sampling average.		

2.0 MATERIALS AND METHODS:

The data of SO2, NOX, and RSPM is used from the website of Maharashtra Pollution Control Board for the period of **Feb.-2017 to Dec.-2019** for CADA Office, SBES College and Collector Office was undertaken for Aurangabad city. This position is in a residential area. Air Quality Index (AQI) was calculated with the concentration values by using the following formula (Rao and Rao 1989),

$$AQI = \{1/3\,[\,(So2)/SSO2 + NOX/SNOX + RSPM/SRSPM\,]\,x100\}$$

Where, SO2, NOX and RSPM symbolize the character of concentration and SSO2, SNOX and SRSPM represent the ambient air quality standard for SO2, NOX and RSPM respectively.

The cluster analysis method is a multivariate technique that divides the facts into uniform groups called as clusters equal to a certain character. That is an explanation into one cluster is like to each other and dissimilar among clusters. There are two main types of analytical clustering techniques: hierarchical and non-hierarchical. In non-hierarchical clustering, the data are separated into k partitions or groups with each partition representing a cluster. Therefore, as different from hierarchical clustering, the number of clusters must be known prior. K-means method is used, which is a non-hierarchical technique, to separate the data according to variations in levels of SO2, NOX, and RSPM in the air into uniform clusters (of months). k mean clustering is applied to data of monthly averages. Trend analysis is used to fit trends and forecast monthly levels of close to future.

3.0: STATISTICAL ANALYSIS :

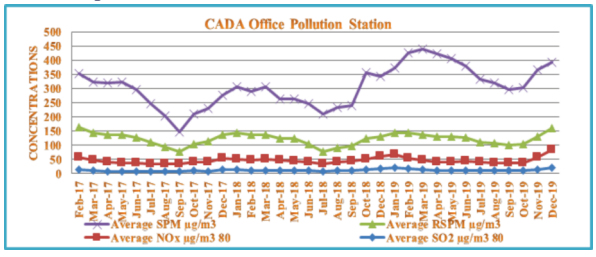
The average values of concentration of three pollutants SO2, NOX and RSPM at CADA Office, SBES College and Collector Office are following,

3.1: CADA Office Station:

3.1.1: Monthly average of all pollutants shown below:

Months	Average SO2 µg/m3 80	Average NOx µg/m3 80	Average RSPM µg/m3 100	Average SPM µg/m3	Average AQI
Feb-17	14	43	107	190	104
Mar-17	11	38	94	181	94
Apr-17	9	34	95	182	95
May-17	8	29	99	187	99
Jun-17	8	29	92	168	92
Jul-17	8	28	75	136	75
Aug-17	7	28	58	109	58
Sep-17	7	27	42	71	42
Oct-17	10	32	63	106	62
Nov-17	10	31	74	114	74
Dec-17	15	40	84	138	84
Jan-18	14	38	93	163	93
Feb-18	12	37	88	152	88
Mar-18	13	39	85	169	85
Apr-18	12	35	77	141	77
May-18	13	33	78	139	78
Jun-18	11	31	61	143	63
Jul-18	9	26	43	131	44
Aug-18	11	31	51	141	51
Sep-18	12	31	55	141	56
Oct-18	15	36	74	232	74
Dec-18	20	43	69	212	69
Jan-19	20	49	76	227	76
Feb-19	17	39	87	282	87
Mar-19	14	34	90	300	90
Apr-19	11	31	89	291	89
May-19	11	31	87	278	87
Jun-19	13	32	83	253	83
Jul-19	10	31	70	224	70
Aug-19	11	29	67	213	69
Sep-19	10	28	63	195	63
Oct-19	10	29	65	199	65
Nov-19	15	42	75	235	76
Dec-19	22	63	75	233	80

3.1.2: Graph:



It is observed that the concentrations of sulphur dioxide (SO2) and NOX were within the permissible limit under NAAQS, except sometimes the SPM and RSPM values were more sometimes were high during the entire study period. It may be due to the high traffic surrounding the Pollution station.

3.1.3: Seasonal average of **AQI** and rating scale values is shown below:

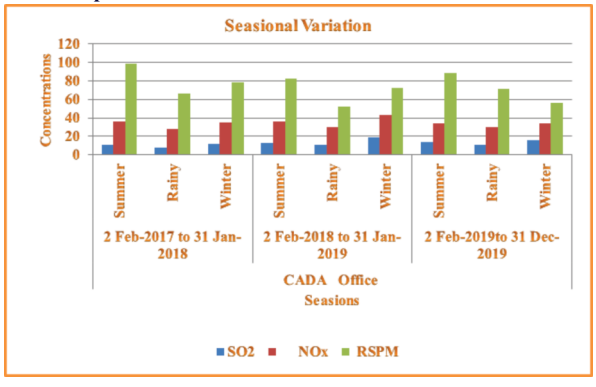
Stations	Years	Seasons	Months	Parameters (µg/m3)	Seasonal Average AQI Values	Rating scale (R.S.)
CADA Office	02 Feb-2017 to 31 Jan-2018	Summer	Feb to May	SO2	52	MAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	37	LAP
				NOX		
				RSPM		
		Winter	Oct to Jan	SO2	46	LAP
				NOX		
				RSPM		
	02 Feb-2018 to 31 Jan-2019	Summer	Feb to May	SO2	47	LAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	34	LAP
				NOX		
				RSPM		
		Winter	Oct to Jan	SO2	49	LAP
				NOX		
				RSPM		
	02 Feb-2019 to 31 Dec-2019	Summer	Feb to May	SO2	49	LAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	41	LAP
				NOX		
				RSPM		
		Winter	Oct to Dec	SO2	39	LAP
				NOX		
				RSPM		

From the above table it is observed that the light air pollution (LAP) and Moderate air pollution (MAP) air pollution is there.

3.1.4: Seasonal Variations at CADA Office pollution station are as follows:

Years	Seasons	Months	Parameters (µg/m3)	Mean	S.D.	**C.V. %**
02 Feb-2017 to 31 Jan-2018	Summer	Feb to May	SO2	10	3	**30**
			NOX	36	6	**17**
			RSPM	99	6	**6**
	Rainy	Jun to Sept.	SO2	8	0	**0**
			NOX	28	1	**4**
			RSPM	67	22	**33**
	Winter	Oct to Jan	SO2	12	3	**25**
			NOX	35	4	**11**
			RSPM	79	13	**16**
02 Feb-2018 to 31 Jan-2019	Summer	Feb to May	SO2	12	1	**8**
			NOX	36	2	**6**
			RSPM	82	5	**6**
	Rainy	Jun to Sept.	SO2	11	1	**9**
			NOX	30	3	**10**
			RSPM	52	8	**15**
	Winter	Oct to Jan	SO2	18	3	**17**
			NOX	43	6	**14**
			RSPM	73	4	**5**
02 Feb-2019 to 31 Dec-2019	Summer	Feb to Dec	SO2	14	3	**21**
			NOX	34	4	**12**
			RSPM	88	1	**1**
	Rainy	Jun to Sept.	SO2	11	1	**9**
			NOX	30	2	**7**
			RSPM	71	9	**13**
	Winter	Oct to Dec	SO2	16	6	**38**
			NOX	34	17	**50**
			RSPM	56	6	**11**

3.1.5: Graph



From the above table, At CADA office station, it is observed that in the year 02 Feb-2017 to31 Jan-2018, the variability of SO2 was more in Summer (30%) and less in the Rainy season (0%). It was more stable in

the Rainy season (0 %). As regard NOX, the variability was maximum in summer(17%) and less in Rainy(4%), In Winter season it was 11, and when RSPM is considered the variability was more in Rainy(33%) season, it is stable in summer(6%) in the year 02 Feb-2017 to31 Jan-2018.

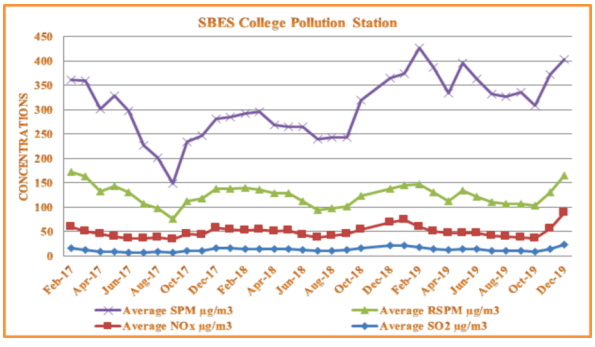
In the year 02 Feb-2018 to31 Jan-2019, the variability of SO2 was more in winter (17%) and less in the summer season (8%). It was more stable in the summer season (0 %). As regard Nox, the variability was maximum in Winter(14%) and less in Summer(6%) , In Rainy season it was 10, and when RSPM is considered the variability was more in Rainy(15%) season, it is stable in Winter(5%) in the year 02 Feb-2017 to 31 Jan-2019 and from 02 Feb-2019 to 31 Dec-2019 stable in summer.

3.2: SBES College Station:

3.2.1: Monthly average of pollutants is given below:

MONTHS	Average SO2 µg/m3	Average NOx µg/m3	Average RSPM µg/m3	Average SPM µg/m3	Average AQI
	80	80			
Feb-17	16	45	111	190	108
Mar-17	12	39	112	198	108
Apr-17	10	35	88	169	88
May-17	9	31	104	186	102
Jun-17	8	29	94	167	94
Jul-17	8	29	70	120	70
Aug-17	8	29	60	103	60
Sep-17	7	26	42	72	42
Oct-17	12	34	67	122	68
Nov-17	10	32	75	129	75
Dec-17	16	41	82	144	82
Jan-18	15	40	83	146	83
Feb-18	14	39	87	153	87
Mar-18	14	40	83	160	83
Apr-18	14	38	78	140	78
May-18	15	38	77	136	77
Jun-18	12	32	68	153	68
Jul-18	10	27	57	146	57
Aug-18	10	31	56	146	57
Sep-18	13	33	57	142	57
Oct-18	17	38	68	197	68
Dec-18	22	47	70	227	70
Jan-19	22	52	71	229	71
Feb-19	18	42	87	280	87
Mar-19	15	35	81	256	81
Apr-19	13	34	66	221	66
May-19	14	33	88	261	88
Jun-19	14	33	75	241	75
Jul-19	11	31	69	222	69
Aug-19	11	29	67	219	67
Sep-19	11	27	69	229	73
Oct-19	8	28	67	206	67
Nov-19	15	40	76	240	76
Dec-19	23	65	77	238	82

3.2.2: Graph



It is observed that the concentrations of sulphur dioxide (SO2) and NOX were within the permissible limit under NAAQS, except sometimes the SPM and RSPM values were more sometime were high during the entire study period. It may be due to high traffic at surrounding at Pollution station.

3.2.3: Seasonal average of AQI and rating scale values are shown below :

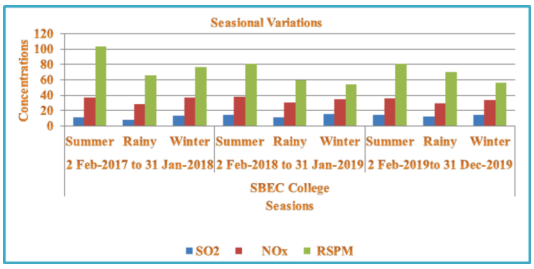
Stations	Years	Seasons	Months	Parameters (µg/m3)	Seasonal Average AQI Values	Rating scale (R.S.)
SBES College	02 Feb-2017 to 31 Jan-2018	Summer	Feb to May	SO2	55	MAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	37	LAP
				NOX		
				RSPM		
		Winter	Oct to Jan	SO2	46	LAP
				NOX		
				RSPM		
	02 Feb-2018 to 31 Jan-2019	Summer	Feb to May	SO2	49	LAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	37	LAP
				NOX		
				RSPM		
		Winter	Oct to Jan	SO2	39	LAP
				NOX		
				RSPM		
	02 Feb-2019 to 31 Dec-2019	Summer	Feb to May	SO2	48	LAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	39	LAP
				NOX		
				RSPM		
		Winter	Oct to Dec	SO2	41	LAP
				NOX		
				RSPM		

From the above table it is observed that Moderate air pollution (MAP) and light air pollution (LAP) air pollution.

3.2.4: Seasonal Variations at SBES College pollution station are as follows:

Years	Seasons	Months	Parameters (µg/m3)	Mean	SD	C.V. %
02 Feb-2017 to 31 Jan-2018	Summer	Feb to May	SO2	11	3	**27**
			NOX	37	6	**16**
			RSPM	14	11	**79**
	Rainy	Jun to Sept.	SO2	8	0	**0**
			NOX	28	1	**4**
			RSPM	66	22	**33**
	Winter	Oct to Jan	SO2	13	3	**23**
			NOX	37	4	**11**
			RSPM	77	7	**9**
02 Feb-2018 to 31 Jan-2019	Summer	Feb to May	So2	14	1	**7**
			NOX	38	1	**3**
			RSPM	81	5	**6**
	Rainy	Jun to Sept.	SO2	11	1	**9**
			NOX	31	3	**10**
			RSPM	59	6	**10**
	Winter	Oct to Jan	SO2	15	10	**67**
			NOX	35	22	**63**
			RSPM	54	32	**59**
02 Feb-2019 to 31 Dec-2019	Summer	Feb to Dec	SO2	15	2	**13**
			NOX	36	4	**11**
			RSPM	80	10	**13**
	Rainy	Jun to Sept	SO2	12	1	**8**
			NOX	30	3	**10**
			RSPM	70	4	**6**
	Winter	Oct to Dec	SO2	15	8	**53**
			NOX	34	19	**56**
			RSPM	56	5	**9**

3.2.5: Graph



At SBES College station, it is observed that in the year 02 Feb-2017 to31 Jan-2018, the variability of SO2 was more in Summer (27%) and less in the Rainy season (0%). It was more stable in the Rainy season (0 %). As regard NOX, the variability was maximum in summer(16%) and less in Rainy(4%), In Winter season it was 11, and when RSPM is considered the variability was more in Rainy(33%) season, it is stable in summer(6%) in the year 02 Feb-2017 to31 Jan-2018.

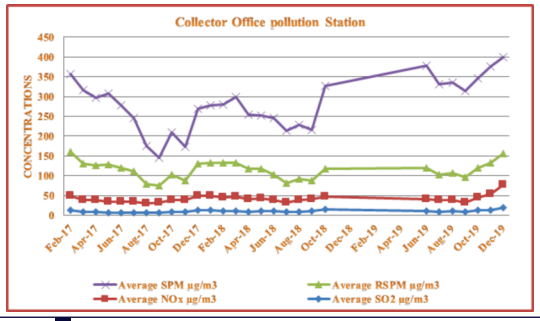
In the year 02 Feb-2018 to31 Jan-2019, the variability of SO2 was more in Winter (67%) and less in the Summer season (7%). It was more stable in the summer season (7 %). As regard NOX, the variability was maximum in Winter(63%) and less in Summer(3%) , In Rainy season it was 10, and when RSPM is considered the variability was more in winter(59%) season, it is stable in summer(6%) in the year 02 Feb-2018 to 31 Jan-2019 and from 2Feb-2019 to 31 Dec-2019 it is stable in rainy season.

3.3: Collector Office Station:

3.3.1: Monthly average of all pollutants are shown below,

Months	Average SO2 µg/m3 80	Average NOx µg/m3 80	Average RSPM µg/m3 100	Average SPM µg/m3 200	Average AQI
Feb-17	12	38	110	197	106
Mar-17	8	29	93	187	92
Apr-17	8	30	89	171	89
May-17	7	27	95	180	94
Jun-17	7	27	85	159	85
Jul-17	7	27	77	136	77
Aug-17	6	24	48	98	48
Sep-17	7	26	42	71	42
Oct-17	9	30	63	107	62
Nov-17	9	30	51	84	59
Dec-17	13	37	80	140	80
Jan-18	13	36	83	146	83
Feb-18	11	35	86	149	86
Mar-18	11	36	85	167	85
Apr-18	9	32	76	138	76
May-18	11	31	77	134	77
Jun-18	11	28	64	144	64
Jul-18	9	24	48	134	48
Aug-18	10	29	53	137	53
Sep-18	10	30	47	130	46
Oct-18	14	33	70	209	70
Jun-19	11	30	79	259	79
Jul-19	10	30	64	227	64
Aug-19	10	29	69	229	69
Sep-19	9	24	64	218	64
Oct-19	12	33	74	228	74
Nov-19	14	40	79	243	79
Dec-19	20	57	79	245	80

3.3.2: Graph



It is observed that the concentrations of sulphur dioxide (SO2) and NOX were within the permissible limit under NAAQS, except sometimes the SPM and RSPM values were more sometime were high during the entire study period.

3.3.3: Seasonal average of AQI and rating scale values are shown below :

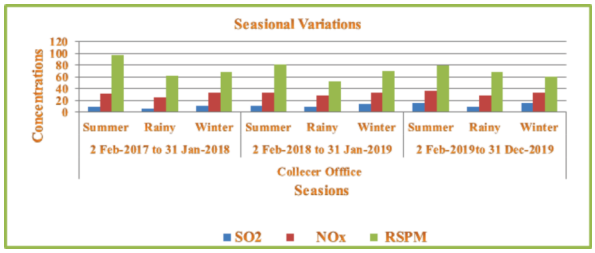
Stations	Years	Seasons	Months	Parameters (µg/m3)	Seasonal Avg. AQI Values	Rating scale (R.S.)
Collector Office	02 Feb-2017 to 31 Jan-2018	Summer	Feb to May	SO2	49	LAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	35	LAP
				NOX		
				RSPM		
		Winter	Oct to Jan	SO2	41	LAP
				NOX		
				RSPM		
	02 Feb-2018 to 30 Jan.-2019	Summer	Feb to May	SO2	45	LAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	33	LAP
				NOX		
				RSPM		
		Winter	Oct to Jan	SO2	43	LAP
				NOX		
				RSPM		
	02 Feb-2019 to 31 Dec-2019	Summer	Feb to May	SO2	48	LAP
				NOX		
				RSPM		
		Rainy	Jun to Sept.	SO2	39	LAP
				NOX		
				RSPM		
		Winter	Oct to Dec	SO2	40	LAP
				NOX		
				RSPM		

From the above table light air pollution is there in all seasons.

3.3.4: Seasonal Variations at Collector Office pollution station are as follows:

Years	Seasons	Months	Parameters (µg/m3)	Mean	SD	C.V. %
02 Feb-2017 to 31 Jan-2018	Summer	Feb to May	SO2	9	2	22
			NOX	31	5	16
			RSPM	96	9	9
	Rainy	Jun to Sept.	SO2	7	0	0
			NOX	26	1	4
			RSPM	63	21	33
	Winter	Oct to Jan	SO2	11	2	18
			NOX	33	4	12
			RSPM	69	15	22
02 Feb-2018 to 31 Jan.-2019	Summer	Feb to May	SO2	11	1	9
			NOX	33	2	6
			RSPM	81	6	7
	Rainy	Jun to Sept.	SO2	10	1	10
			NOX	28	3	11
			RSPM	53	8	15
	Winter	Oct to Jan	SO2	14	7	50
			NOX	33	17	52
			RSPM	70	35	50
02 Feb-2019 to 31 Dec-2019	Summer	Feb to May	SO2	15	2	13
			NOX	36	4	11
			RSPM	80	10	13
	Rainy	Jun to Sept.	SO2	10	1	10
			NOX	28	3	11
			RSPM	69	7	10
	Winter	Oct to Dec	SO2	15	4	27
			NOX	33	12	36
			RSPM	60	3	5

3.3.5: Graph:



At Collector Office station, it is observed that in the year 02 Feb-2017 to31 Jan-2018, variability of SO2 was more in Summer (22%) and less in Rainy season (0%). It was more stable in Rainy season (0 %). As regard NOX, the variability was maximum in summer(16%) and less in Rainy(4%) , In Winter season it was 12, and when RSPM is considered the variability was more in Rainy(33%) season, it is stable in summer(9%) in the year 02 Feb-2017 to31 Jan-2018 and from 2Feb-2019 to 31 Dec-2019 it is stable in winter season.

4.0 : Trend Analysis:

Time series analysis was performed to fit the trend line to seasonal SO2 values. The best fitted equation for SO2 in winter season is given below which is selected on the basis of coefficient of determination R^2 is,

Y(summer) = -0.004x6 + 0.137x5 – 1.793x4+10.95x3 – 31.65x2 + 38.25x – 5.777 with $R^2 = 0.583$

Y(Rainy) = -0.012x6 + 0.397x5 – 4.833x4+28.43x3 – 82.48x2 + 107.1x – 36.44 with $R^2 = 0.583$

Y(winter) = 0.001x6 + 0.014x5 + 0.012x4+0.332x3 +0.434x2 -7.803x + 21.22 with $R^2 = 0.584$

4.1.1: Trend Analysis for all pollution Stations for SO2 from feb-2017 to Dec-2019:

Feb-2017 to Dec-2019	CADA Office		So2 Summer	SO2 Rainy	SO2 Winter
		1	10	12	14
		2	8	11	11
		3	3	3	6
	SBES College	4	11	14	15
		5	8	11	12
		6	13	15	15
	Collector Office	7	9	11	15
		8	7	10	10
		9	11	14	15

4.1.2: Graph:

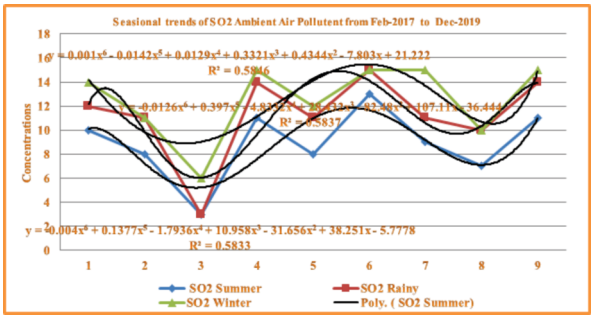


Fig. : Actual and estimated SO2 for summer, rainy and winter season.

4.2.1: Trend Analysis for all pollutions Stations for NOX from feb-2017 to Dec-2019:

Time series analysis was performed to fit the trend line to seasonal NOX values. The best fitted equation for NOX in summer season is given below which is selected on the basis of coefficient of determination R^2 is,

Y(summer) = -0.013x6 + 0.398x5 – 4.656x4+26.39x3 – 74.87x2 + 98.19x – 9.444 with **$R^2 = 0.980$**

Y(Rainy) = -0.008x6 + 0.263x5 – 3.172x4+18.82x3 – 57.01x2 + 81.91x – 12.88 with $R^2 = 0.664$

Y(winter) = -0.016x6 + 0.508x5 -6.287x4+38.64x3 -122.4x2 +183.4x – 58.77 with $R^2 = 0.859$

Feb-2017 to Dec-2019	CADA Office		NOX Summer	NOX Rainy	NOX Winter
		1	36	28	35
		2	36	30	43
		3	34	30	34
	SBES College	4	37	28	37
		5	38	31	35
		6	36	30	34
	Collector Office	7	31	26	33
		8	33	28	33
		9	36	28	33

4.2.2: Graph:

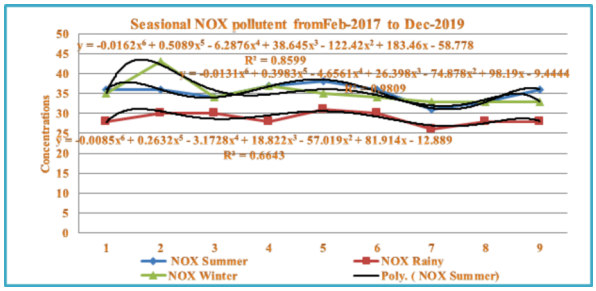


Fig. : Actual and estimated NOX for summer, rainy and winter season.

4.3.1: Trend Analysis for all pollutions Stations for RSPM from Feb-2017 to Dec-2019:

Time series analysis was performed to fit the trend line to seasonal RSPM levels in air. The best fitted equation for RSPM in rainy season is given below which is selected on the basis of coefficient of determination R2 is,

Y(summer) = 0.043x6 -1.117x5+10.49x4-43.10x3 + 74.63x2 -54.80x +11.5 with $R^2 = 0.536$

Y(Rainy) = -0.061x6 -1.841x5 +21.68x4-126.7x3 +380.5x2 -540.5x +333.6 with **$R^2 = 0.879$**

Y(winter) = -0.006x6 + 0.142x5 – 0.973x4+1.560x3 +8.202x2 -35.61x +106.3 with $R^2 = 0.502$

Feb-2017 to Dec-2019	CADA Office		RSPM Summer	RSPM Rainy	RSPM Winter
		1	99	67	79
		2	82	52	73
		3	88	71	56
	SBES College	4	14	66	77
		5	81	59	54
		6	80	70	56
	Collector Office	7	96	63	69
		8	81	53	70
		9	80	69	60

4.3.2: Graph:

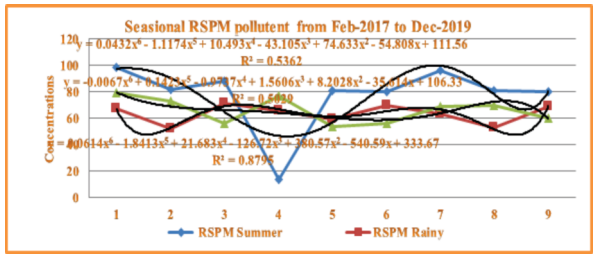


Fig. : Actual and estimated RSPM for summer, rainy and winter season.

5.0: Cluster analysis:

Cluster analysis is performed on monthly data of major pollutant levels of SO2, NOx, and RSPM as a character for clustering during the period Feb. 2017 to Dec. 2019. The 3 clusters are obtained using the K-means method of non-hierarchical clustering. SPSS software is used to obtain clusters. The clusters obtained are listed in the following table.

Table: Clusters of monthly Average of SO2, NOX, and RSPM

Clusters	Months
1	February , March, April ,May
2	June, July, August, September
3	October, November, December, January

6.0: CONCLUSION:

It minimizes that RSPM broadly gives towards air pollution at above three different station locations all throughout the study period, it is residential Area. When RSPM restriction is considered, there is air pollution. For reducing this, regular travel management, development of plants and class-wise allocation of vehicles split up on other routes to minimize air pollution.

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