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CONCENTRATION OF MAJOR AIR POLLUTANTS IN WARORA CITY OF CHANDRAPUR DISTRICT

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ABSTRACT:
Warora is developing city of Chandrapur district with increasing population. From last 15 years, the developing rate of Warora city has been increased rapidly due to the establishment of coal based powerplants like GMR and Wardha Power along with other industries and corporate companies. With increasing development, the air quality of Warora is also deteriorating. The present study is a sincere effort to measure the levels of major criteria air pollutants viz; PM_{10}, $PM_{2.5}$, SO_2, and NO_x of Warora city.
Considering MSRTC Bus Stand as a centre of the city, ambient air samples were collected and analysed over a period of one year from 10 locations. Two locations were selected near the centre and eight locations were selected towards the eight directions within radius of 5 Km from the centre. Samples were collected by following National Ambient Air Quality Monitoring Standards (NAAQMS) using Respirable Dust Sampler (RDS) machines. Except during Monsoon months, the concentration of PM_{10} and $PM_{2.5}$ were found exceeding the limits. The concentration of SO_2, and NO_x were found within the NAAQM limits throughout the year. The overall air quality of Warora city is found unsatisfactory in terms of particulate air pollution.

Keywords: - RDS, NAAQM, PM_{10}, $PM_{2.5}$, SO_2, and NO_x.

INTRODUCTION :

Warora city of Chandrapur district is well known for the 'Anandwan' project of the famous social worker and activist Padma Vibhushan Late Shri Baba Amte. It lies on the geographical coordinates of 20° 14' 0" N, 79° 0' 0" E. Rapid development of the Warora city took place due to industrialisation. The Sai Wardha Power Plant having four units of capacity 135 MW each had started its commercial generation from 2010-11, and GMR Power Plant with two units of capacity 300 MW each had started its commercial generation from 2013. This two powerplants plays significant role in the development of Warora city. The coal based thermal powerplants are the major source of air pollutants and comes under red category of industrial categorisation as per the direction of CPCB and Ministry of Environment, Forest and Climate Change (MoEFCC). That is why, the air quality of Warora city should be monitored regularly. PM10, PM2.5, SO2, and NOx are the main pollutants emitted from industries and vehicles. Common health hazards causing from these pollutants are as follows;

Particulate Matter (PM10, PM2.5):

The higher level of PM is always associated with increased rate of mortality and hospitalisation because of respiratory diseases (Dockery et al., 1994). PM10 and PM2.5 are responsible for premature mortality, asthma, pneumonia, cancer, decrease in lung function, chronic respiratory diseases, emergency hospital visits etc. (Pope, 1989; Schwartz, 1996; Wichmann et al., 2000). PM2.5 is more dangerous because it has higher proportion of toxic metals and acid and can easily be penetrated deep inside the respiratory tract.

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Oxides of Nitrogen (NOx):

Combustion process and vehicular emissions are the major source of NOx. The matter of concern is that the 70-90% of NOx can get absorbed in respiratory tract on inhalation. This percent may increase when inhaled during physical exercises (Miler et al., 1982). It causes reduction in lung function, increased airway responsiveness to broncho-constrictions, changes in lung volume and characteristics etc. (WHO, 2000). Even a little concentration of NOx (0.1 ppm) on continuous exposure for one to three years may cause bronchitis, emphysema and adverse effect on lung performance (WHO, 2000). Exposure to higher concentration decreases immunity and makes prone to respiratory diseases.

Sulphur dioxide (SO2):

Combustion of fossil fuels like coal and oil are the major source of Sulphur dioxide. It is soluble in aqueous media and hence absorbed in mucous membrane of the nose and upper respiratory tract causing respiratory diseases. It causes eye irritation, coughing, sneezing, mucus secretion, asthma, and chronic bronchitis etc. Exposure to SO2 during exercise is more dangerous to health. Both SO2 and NOx contribute to produce secondary air pollutants like acid rain. NO2 with hydrocarbon produces Ozone (secondary air pollutant) in presence of sunlight.

Most of the people are unaware or know very less about pollution terminologies, permissible limits of pollutants and their possible health hazards etc. and hence, the exceeded concentration of pollutants are often neglected by the society. In addition, industries do not always follow the emission regulations. According to the CPCB and MPCB guidelines, industries should regularly monitor their emissions through third party. But third parties are easily managed by industries and always produce manipulated results in favour of the industries. The present study is a sincere effort to find out the actual concentration of four criteria air pollutants viz; PM10, PM2.5, SO2, and NOx of the Warora city.

MATERIALS AND METHODS :

Considering MSRTC Bus Stand as a centre of the city, ambient air samples were collected and analysed from 10 locations over a period of one year (October 2021 to September 2022). Two locations were selected near the centre and eight locations were selected towards the eight directions within radius of 5 Km from the centre. The Respirable Dust Sampler (RDS) machines were kept at each location for sampling purpose. The sites selected at centre of the city were MSRTC Bus Stand and Vinayak Mandir at Shrikrushna Nagar and for convenience they were designated as C1 and C2 respectively. The sites selected around the centre were Radhakrushna Mandir at Vivekanand Colony towards North, Krushi Utpan Bajar Samiti at Voltas Nagar toward North West, Shri Gajanan Maharaj Temple at Tagor Nagar toward East, Ashirwad Mangal Karyalay at Buddha Vihar area toward South West, Gayatri Coaching Class at Azad ward toward South, Radhamilan Hall at Padmalaya Nagar toward South East, Maa Saraswati Enterprises toward East and Shiv Temple at MIDC Colony toward North East direction from the centre and for convenience these sites are designated as S1, S2, S3, S4, S5, S6, S7, and S8 respectively. At each location, 8 hrs of sampling is done twice a week for four parameters viz; PM_{10}, $PM_{2.5}$, SO_2 and NO_x.

To understand the pattern of average wind direction in Warora city, we accessed the website weatherspark.com. In the month of March, wind blows from north to south. From April to September, wind blows from west to east. And from mid-October to February, it blows from east to west.

The present study followed NAAQMS guidelines to sample and analyse above mentioned

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parameters. For PM_{10}, ambient air is sampled by RDS machine, in which, ambient air is drawn through glass fibre filter paper of dimension 8 X 10 inch, through size-selective inlet at the average flow rate of 1.1 to 1.2 m3/min. The weight of particulate matter (PM10) is determined for sampled volume of air by using Analytical balance and desiccator. Concentration of pollutant is calculated in $\mu g/m^3$.

Particulate matter of size 2.5 micrometre is also determined gravimetrically by following NAAQMS guidelines using RDS machines. The ambient air is drawn at the average flow rate of 16 to 17 LPM. By using Analytical balance and desiccator, the concentration of PM2.5 in sampled volume of air is calculated in $\mu g/m^3$ from the difference in Initial and Final weights of PM2.5 circular filter paper i.e., 47mm Polytetrafluoroethylene (PTEE) filter papers.

Following NAAQMS guidelines, SO2 and NOx is determined spectrophotometrically by modified West & Gaeke method and modified Jacobs & Hochheiser method respectively. For both the parameter, the ambient air is passed through the 30ml of respective absorbing media in the impinger at the flow rate of 1 lpm for 4 hrs. All the parameters are calculated in µg/m3.

RESULT AND DISCUSSION :

In the Warora city, the months of October and November were found more polluted and the concentration of pollutants were found least in the months of July and August.

The concentration of PM_{10} in the months of October to January were found exceeding the prescribed limits at all the locations. At all the sites, from October to June, the concentration of $PM_{2.5}$ was found exceeding the limit. Specially, from October to January, its concentration was found 2 to 2.2 times higher than the prescribed limit.

Site wise, the central locations, i.e., MSRTC Bus Stand and Vinayak Mandir were found more polluted than peripheral locations in terms of particulate pollution.

The concentration of SO_2 and NO_x were found within the limits at all the locations.

The table no.1 shows the limits prescribed by NAAQS for PM_{10}, $PM_{2.5}$, SO_2 and NO_x and table no.2 shows the concentration of these pollutants actually found in the Warora city from October 2021 to September 2022.

CONCLUSION :

Higher concentration of $PM_{2.5}$ at all the locations both in terms of monthly average and annual average throughout the year except monsoon months are the matter of concern. Although, the annual average concentration of PM_{10} is within the limit, but the monthly average indicates that it often exceeds the limits prescribed for 24 hrs monitoring. Preventive measures should be taken immediately to control the particulate pollution in Warora city.

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IS 5182 Part 2, Method of Measurement of Air Pollution: Sulphur dioxide

IS 5182 Part 6, Methods for Measurement of Air Pollution: Oxides of nitrogen

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IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique.

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler.

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Table no. 1: **National Ambient Air Quality Standards**

Pollutants	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
SO_2 (µg/m³)	Annual	50	20
	24 hours	80	80
NO_x (µg/m³)	Annual	40	30
	24 hours	80	80
PM_{10} (µg/m³)	Annual	60	60
	24 hours	100	100
$PM_{2.5}$ (µg/m³)	Annual	40	40
	24 hours	60	60

Table no. 2: **Monthly average and Annual average Concentration of criteria air pollutants analysed in Warora city**

Sr. No.	Site	Parameter	Monthly Average Concentration (µg/m³)												Annual Average
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
1	C1	PM_{10}	147	128	142	117	84	92	86	79	34	16	21	33	**82**
		$PM_{2.5}$	167	144	171	153	125	138	131	120	70	64	72	77	**119**
		SO_2	45	38	41	29	36	51	28	22	12	09	11	16	**28**
		NO_x	52	40	37	36	42	64	44	35	34	50	37	28	**42**
2	C2	PM_{10}	144	119	134	125	80	94	83	76	31	14	19	30	**79**
		$PM_{2.5}$	160	137	158	140	118	125	121	113	64	52	59	63	**109**
		SO_2	31	24	44	30	18	17	25	31	26	14	11	18	**24**
		NO_x	43	39	28	36	44	29	33	47	38	42	30	29	**37**
3	S1	PM_{10}	122	130	108	112	65	73	67	62	29	13	17	28	**69**
		$PM_{2.5}$	148	152	136	130	96	113	102	94	56	40	38	47	**96**
		SO_2	22	40	31	37	25	36	32	35	22	11	09	12	**26**
		NO_x	34	45	28	21	38	42	19	25	33	23	29	25	**30**
4	S2	PM_{10}	130	114	121	106	69	81	69	63	27	11	18	24	**69**
		$PM_{2.5}$	151	146	129	144	99	126	101	86	53	38	43	55	**98**
		SO_2	33	40	51	29	32	24	21	30	20	15	10	10	**26**
		NO_x	30	46	38	37	43	51	64	43	31	70	38	29	**43**
5	S3	PM_{10}	138	126	118	130	73	96	70	75	28	15	18	25	**76**
		$PM_{2.5}$	142	128	134	151	89	97	88	91	57	29	39	47	**91**
		SO_2	41	32	27	31	26	17	25	30	14	18	13	11	**24**
		NO_x	44	48	41	28	36	54	51	27	32	41	37	33	**39**
6	S4	PM_{10}	120	105	113	117	68	87	72	70	30	13	18	27	**70**
		$PM_{2.5}$	146	88	101	148	94	106	97	89	54	23	31	39	**85**
		SO_2	29	36	34	31	43	32	24	26	18	12	11	13	**26**
		NO_x	26	52	38	44	47	40	29	35	29	40	38	27	**37**
7	S5	PM_{10}	145	123	128	134	70	83	77	66	25	10	14	23	**75**
		$PM_{2.5}$	132	140	133	127	101	115	92	97	52	21	33	42	**90**
		SO_2	47	31	38	26	17	23	15	21	17	10	10	14	**22**
		NO_x	42	45	31	37	25	29	21	35	28	30	33	25	**32**
8	S6	PM_{10}	108	97	103	102	72	85	74	65	27	13	17	24	**66**
		$PM_{2.5}$	130	117	142	133	97	104	96	90	41	28	22	31	**86**
		SO_2	26	33	25	27	19	22	30	19	12	14	12	10	**21**
		NO_x	29	40	43	32	28	31	37	29	18	27	28	22	**30**

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9	S7	PM_{10}	126	115	94	99	78	87	71	68	29	14	20	29	**69**
		$PM_{2.5}$	155	137	129	148	120	113	88	92	50	22	31	49	**95**
		SO_2	32	24	40	24	21	35	27	17	14	10	13	11	**22**
		NO_x	26	40	34	41	55	34	39	47	29	36	39	43	**39**
10	S8	PM_{10}	139	128	90	110	80	73	74	69	31	16	20	32	**72**
		$PM_{2.5}$	143	151	128	136	119	102	109	82	48	20	27	38	**92**
		SO_2	43	30	34	28	21	25	15	22	14	11	14	12	**22**
		NO_x	46	48	37	45	51	57	32	35	31	26	24	27	**38**

Figure 1: **Graphical representation of site wise monthly variation in PM_{10} (µg/m³) in Warora city**

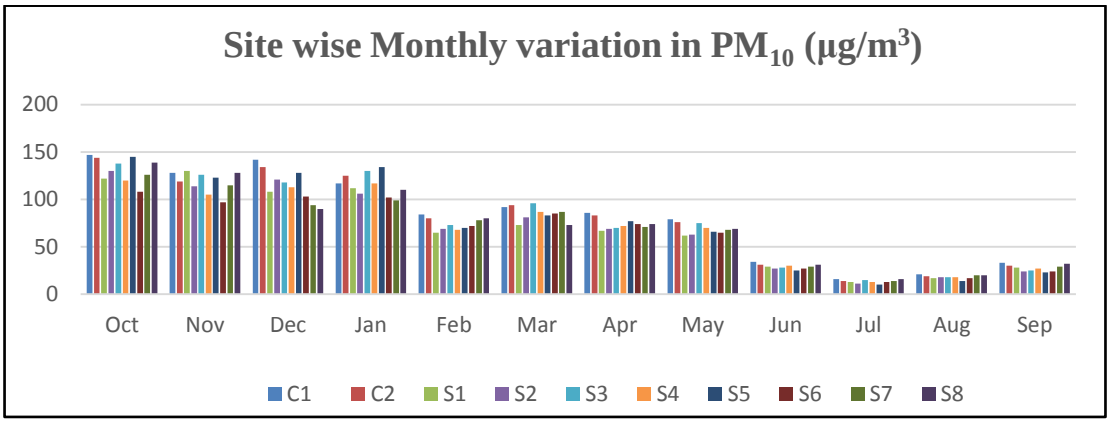

Figure 2: **Graphical representation of site wise monthly variation in $PM_{2.5}$ (µg/m³) in Warora city**

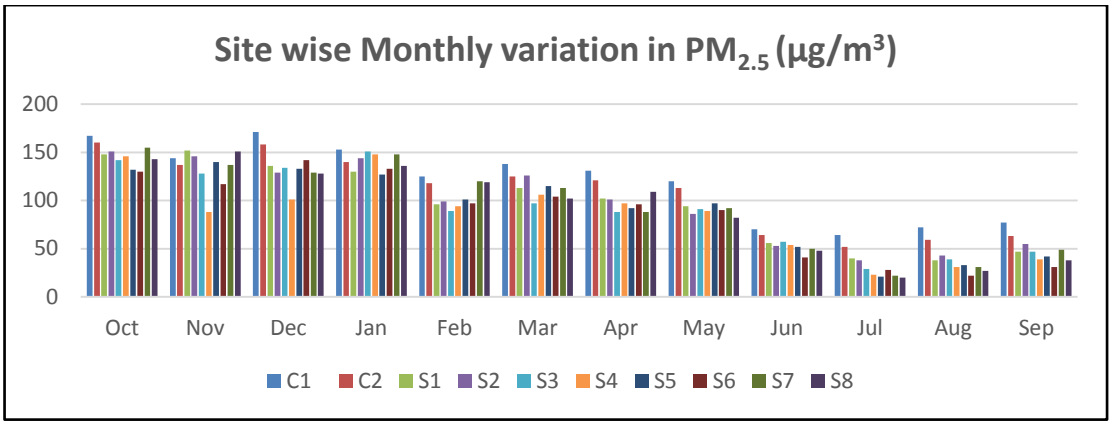

Figure 3: **Graphical representation of site wise monthly variation in SO_2 (µg/m³) in Warora city**

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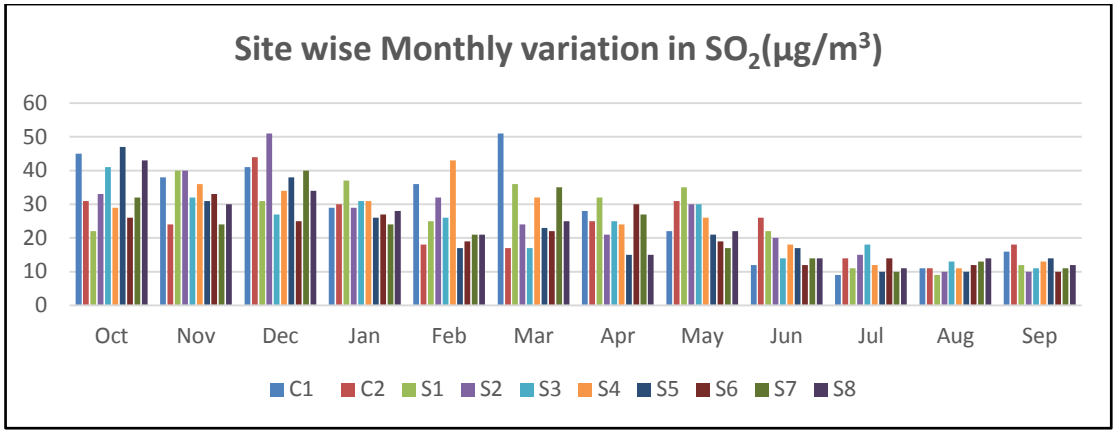


Figure 4: **Graphical representation of site wise monthly variation in NO_x (µg/m³) in Warora city**

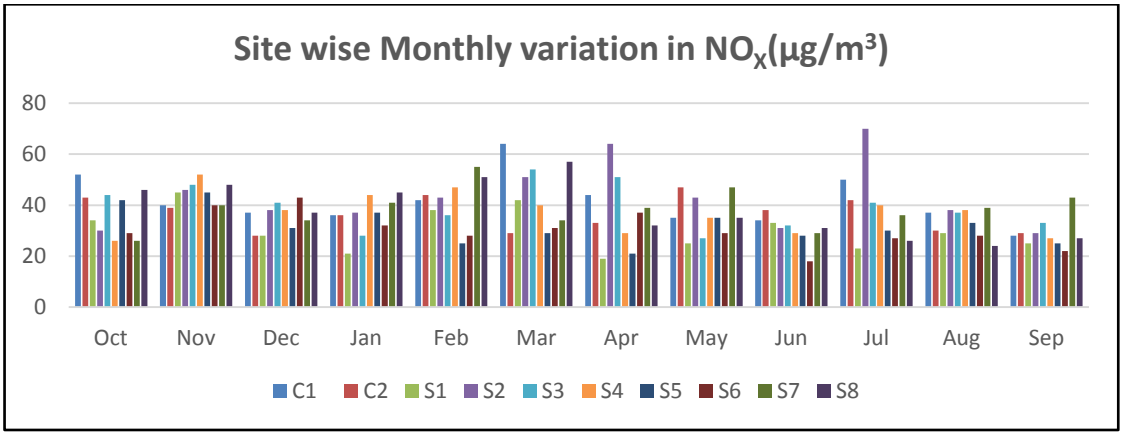
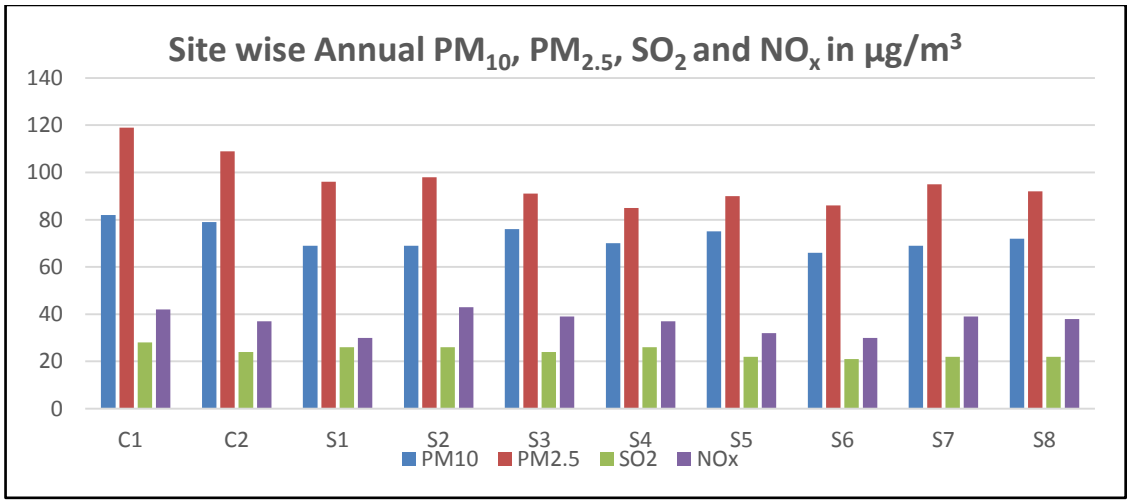


Figure 4: **Graphical representation of site wise annual average concentration of PM_{10}, $PM_{2.5}$, SO_2 and NO_x in µg/m³ in Warora city**



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