REGIONAL AMBIENT AIR QUALITY IN WESTERN PART OF INDIA – TWENTY FIVE YEARS SCENARIO

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ABSTRACT

A large of almost 500 sq. km. region in South West of India, the industrial zone is intersected with two highways. The region experienced significant cumulative pollution load (CPL) of SPM, SO_2 & NOx i.e. 532µg/m^3 during 1986-1990 and 251.66µg/m^3 during 1999-2002. The CPL in area decrease during 1999-2002, maximum at Nayagaon-Khor i.e. 75% and minimum at Nagda i.e. 11% than 1986-1990 except Pithampur where 37% increase in CPL. This may be due strong regulatory actions which is resulted in improvement of the ambient air quality.

A perusal for the total cumulative pollution load picture exhibit that the total load in the RZ (1.5km against wind direction) is 100µg/m^3 which increased by 3.6, 2.8 & 1.7 times at HZ(1-1.2 km), MAZ (2-2.5 km) & LAZ (4.5-5 km) in upwind direction respectively during 1999-2002.

In new industrial areas like Pithampur ambient air environment quality demonstrates a rising trend especially in gaseous pollutants i.e. SO_2 & NOx,17.40 & 15.19 µg/m^3 (during 1986-1990) to 23.66 & 34.49 µg/m^3 (during 1999-2002).

The ground level ozone was never estimated for the region which ranged to13- 34µg/m^3 with area average of 17.58µg/m^3.

In the cement producing zone with prevalence of SPM the average cumulative pollution load was 1100 & 832 µg/m^3 at Nimbaheda and Nayagoan-Khor respectively during 1986-1990 got reduced by 31% & 27% during1999-2002.

Statistically during last 16-17 years the gaseous pollutant concentration increased by two times in the region while particulate increased by 1.5 times.

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INTRODUCTION

In India too problems of air pollution are rapidly increasing on account of industrialization, urbanization, and rapid expansion of transport sector and escalating consumption of energy. With growing emphasis on economic development and industrial expansion, air pollutants pose serious consequences for crop plants and human life. The problem of air pollution may be ubiquitous, affecting large areas of a country or localized around industrial sources. Thus, regardless of the relative importance of individual pollutants alone, the mixed load must be of concern to the living system.

A significant deterioration of ambient air quality occurs due to an increase in atmospheric concentration caused locally and regionally as well as due to high air pollutant emissions from different kinds of point or non point sources. After emission air pollutants dilute, disperse and travel long distances with air masses, passing through the larger areas. These different pollutants once released into air can not be stopped/ curtailed and ultimately travel to longer distances where they settle and affect.

Though the global air pollution and atmospheric load of air pollutants occupy a crucial role in environment management policy at world level, the regional air pollution problems cannot be ignored because they often pose both local episodic conditions and induced chronic injury to plant and human life as well as edaphic ecosystem. Such regional programmes have been launched and executed in Europe as well as in USA (Fowler & Cape, 1982).

The paper refers to a comprehensive long-term study of about 18 years of air quality in the selected sites upto 5-7 km area with wide microclimatic conditions and various types of crops. The sites are around Dewas, Nagda, Pithampur, Nayagaon-Khor and Nimbaheda (Raj.) industrial areas. Air pollutants in combination may induce antagonistic or synergistic impacts on plants depending upon the specific pollutants and their concentrations, exposure duration and environmental condition. Plants/crops play a large part of the interaction with the ambient air quality as they form large part of composition in nature and are also sensitive (Dubey, 1990 & 1997).

This study was aimed at the fact that inspite of the best control efforts and regulation, the impact of industrial and autovehicular pollution has affects the host zones as well as periurban regions. This study is an attempt to identify the extent of the distribution of SPM, SO_2, NOx and ground level ozone in the study areas.

METHODOLOGY

An extensive sampling programme was designed for a period of two decades (1986-1990 & 1999-2002) including all the seasons of these years..

Area and site

The industrial area selected for the study are Dewas, Pithampur, Nagda, Nayagaon-Khor in Madhya Pradesh and Nimbaheda in Rajsthan of Indian subcontinent (table 1).

S. No.	Name of Site	Location	Longitude, Latitude and Geology	Distance from Ujjain (km)
1.	Dewas	SW M.P.	$22^0$20' to $12^0$44'N $75^0$21' to $35^0$45'E	40
2.	Pithampur	SW M.P.	$22^0$36' to $22^0$44'N $75^0$25' to $75^0$45'E	80
3.	Nagda	SW M.P.	$32^0$27' N $75^0$25'10"E	65
4.	Nayagaon- Khor	Border of M.P. and Rajsthan	$24^0$07'10"N to $75^0$58'10"E	150
5.	Nimbaheda	Rajsthan	$24^0$07'10"N $75^0$58'10"E	225

Table -1. Details of the sites, locations and climatic conditions

In above study areas wind direction and deflection ranges largely get confined between West-North-East. Since it is well-established fact that maximum load of pollutants occur in vicinity of the source i.e.0.5 to 1.5 km area. This criterion was effectively applied in the selection of sites. At different direction upto 6 km sites were marked in up and prevailing wind direction. Depending on the wind directions and deflections during the three seasons sampling fields have selected around the industrial area. After visual survey sampling fields were marked in upwind direction at about 1-1.5 km as reference zone (RZ) and in the prevailing wind direction at 1-1.5 km as host zone (HZ), 2-2.5 km as moderately affected zone (MAZ) and 4.5-5 km as least affected zone (LAZ) respectively.

Ambient Air Quality Monitoring

Sampling schedule was prepared on monthly basis. The protocol observed for SPM was 24 hrs. average/day with two days per week and for gaseous analysis one day/week with 4 observations per day with 2 hrs. intervals as TGM reads concentration instantaneously.

Ambient Air Quality Monitoring

Ambient air quality monitoring was done with various equipments adopting APHA protocol –

(a). Suspended Particulate Matter (SPM) - High Volume Sampler (Kimoto-120, Japan),

(b). Oxides of Sulphur (SO_2,West and Gaeke,1956) - Toxic Gas Monitor- 555 (CEA, USA)

(c). Oxides of Nitrogen (NOx, Griess and Saltzman,1954) - Toxic Gas Monitor- 555 (CEA, USA)

(d). Ozone (O_3) (Byers and Saltzman, 1958) - Portable gas sampler (Netel NPM-PS-1, India) and analysis UV-VIS Spectrophotometer, Toshniwal, TSUV-75, India.

The bimonthly analysis was executed for SPM taking 8 hrs average. Gaseous analysis was done on bimonthly basis with four times a day during crop growth i.e. at least four-times/ month. The results were computed and average data of three years are presented during 1986-1990 and 1999-2002.

RESULTS & DISCUSSION

The data shows that level of air pollutants is far below the ambient air quality standards but not absent altogether. On the basis of types of pollutant present in study area, it can be divided into two categories i.e. predominately with gaseous pollutants or particulate pollutants where SPM is too high due to cement production and mining activities.

Suspended particulate matter (SPM) at Nimbaheda industrial area between 800-1200 $\mu g/m^3$ & 760-860 $\mu g/m^3$ at Nayagaon-Khor during 1986-1990 (table 2). As evident the SPM load at above area is due to cement production of about 7300 tons per day. Reduction in SPM load around cement industrial complex during 1999-2002 was definitely due to control equipments their operations when compared to 1986-1990.

Year		Sites					
		Dewas	**Pithampur**	**Nagda**	**Nayagaon -Khor**	**Nimbaheda**	**Area Average**
RZ	1986-1990	126.80	125.00	129.55	243.45	342.15	193.39
	1999-2002	085.83	59.67	56.83	84.50	125.83	82.53
HZ	1986-1990	407.60	257.50	440.45	832.75	1148.70	61.40
	1999-2002	335.16	249.00	204.34	254.67	458.50	300.33
MAZ	1986-1990	346.30	240.00	358.90	724.90	775.35	489.09
	1999-2002	305.00	161.84	155.00	186.84	347.50	231.23
LAZ	1986-1990	311.30	142.50	187.05	269.95	476.55	277.47
	1999-2002	170.16	104.50	119.34	123.34	227.83	149.03
Area	1986-1990	298.00	191.25	278.99	517.76	685.69	349.33
Av.	1999-2002	224.04	143.75	133.88	162.33	289.92	190.78

Table 2. Suspended particulate matter ($\mu g/m^3$) at different study areas during two decades

The data indicate that there is a decreasing trend of particulate matter load at all sites. The maximum decrease is at Nayagaon-Khor i.e. 68.60% and at Nimbaheda 57.81% with reference to 1986-90 data. This may be due to air pollution control systems like ESP's, Bag filters, Dust separators etc. Earlier there is no efficient control devices were installed by industries during establishment of cement plant and people were not so aware about environmental quality around. Also, at times particulate concentration exceeded the standard limits laid by Central Pollution Control Board (CPCB) or Ministry of

Environment & Forestry (MoEF) i.e. 500µg/m^3 SPM for industries. Now the scenario has changed and particulate concentration is well below the limits laid by authorities.

Sulphur di oxide (SO_2) concentration in the ambient air of different sites in various industrial areas attained a maximum level of 65-71 µg/m^3. The result shows that there is a decreasing trend of SO_2 at all study sites during 1999-2002. The maximum decrease is at Nimbaheda & Nagda i.e. 52 & 51% respectively with reference to 1986-1990 loads. This may be due to modification of coal quality and technology inputs.

Year		Sites					
		Dewas	**Pithampur**	**Nagda**	**Nayagaon -Khor**	**Nimbaheda**	**Area Average**
RZ	1986-1990	4.43	12.50	6.55	3.21	3.57	9.21
	1999-2002	4.00	5.00	3.50	0.75	3.50	7.80
HZ	1986-1990	71.15	31.00	65.10	15.60	16.70	43.16
	1999-2002	44.50	36.17	37.50	5.17	5.84	34.37
MAZ	1986-1990	54.25	26.50	53.55	8.82	11.99	33.46
	1999-2002	29.50	24.67	22.67	7.00	3.33	27.10
LAZ	1986-1990	36.75	20.00	34.58	4.85	5.98	22.68
	1999-2002	18.28	10.17	14.34	5.84	5.59	15.34
Area Av.	1986-1990	41.65	22.50	39.94	8.12	9.56	27.13
	1999-2002	24.07	19.00	19.50	4.69	4.56	21.15

Table 3. Sulphur dioxide concentration (µg/m^3) at different study areas during two decades

Oxides of nitrogen (NOx) concentration in the ambient air at selected sites attained the maximum levels of 58 & 68 µg/m^3 at Dewas and Nagda respectively during the year 1986-1990, after ten years the NOx concentration is decreased at Dewas and Nagda by 7 & 23% respectively while at other three areas NOx concentration increased.

Year		Sites					
		Dewas	**Pithampur**	**Nagda**	**Nayagaon -Khor**	**Nimbaheda**	**Area Average**
RZ	1986-1990	13.33	14.20	15.37	10.22	11.90	13.00
	1999-2002	11.00	11.34	8.67	17.84	18.83	13.53
HZ	1986-1990	58.80	16.60	68.06	28.93	35.40	41.55
	1999-2002	58.50	45.34	55.00	30.34	45.50	46.93
MAZ	1986-1990	45.50	15.35	48.34	26.23	26.44	32.37
	1999-2002	41.16	36.67	39.50	38.50	40.83	39.33
LAZ	1986-1990	29.43	15.10	31.71	18.99	17.68	22.58
	1999-2002	25.16	21.50	22.00	20.67	31.17	24.10
Area Av.	1986-1990	36.74	15.31	40.87	21.09	22.85	27.37
	1999-2002	33.96	28.71	31.29	26.83	34.08	30.97

Table 4. Oxides of Nitrogen (µg/m^3) at different study areas during two decades

The maximum increase in NOx concentration is at Pithampur 87%, at Nimbaheda 49% and at Nayagaon-Khor 27%. In all of these places highways cross the industrial zones. At Pithampur it may be due to high industrial activities and increased traffic density.

Ground level ozone (O_3) is produced photochemically and its transport is light intensity and temperature dependent. During 1986-1990 its monitoring was not done hence no baseline data are available for comparison. Individually the range of O_3 at different sites do not provide any specific picture, the value ranges between 7-31 $\mu g/m^3$ at various area at different sites.

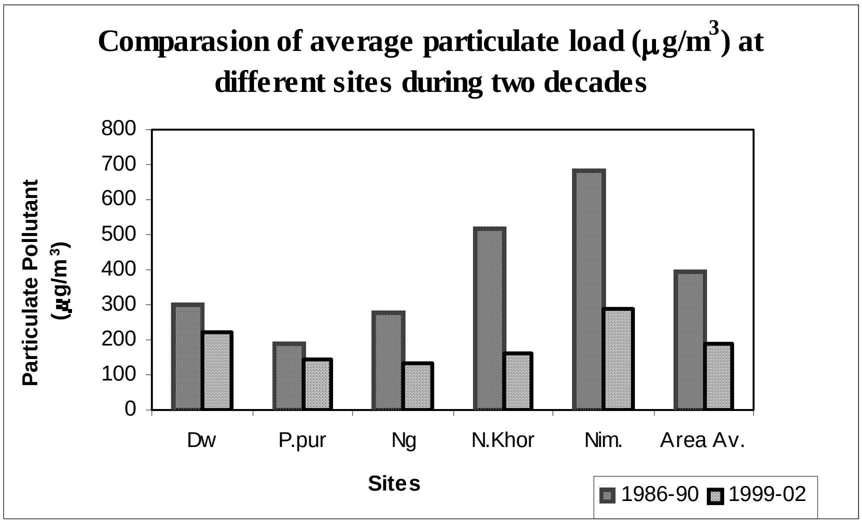
Distance	**Sites**					
	Dewas	**Pithampur**	**Nagda**	**Nayagaon-Khor**	**Nimbaheda**	**Area Average**
RZ	7.17	9.33	9.83	9.33	7.67	8.66
HZ	18.83	18.17	31.00	18.34	27.34	22.73
MAZ	19.17	19.33	26.67	22.17	25.34	22.53
LAZ	12.00	11.83	18.50	17.00	22.84	16.43
Area Av.	14.29	14.66	21.50	16.71	20.79	17.59

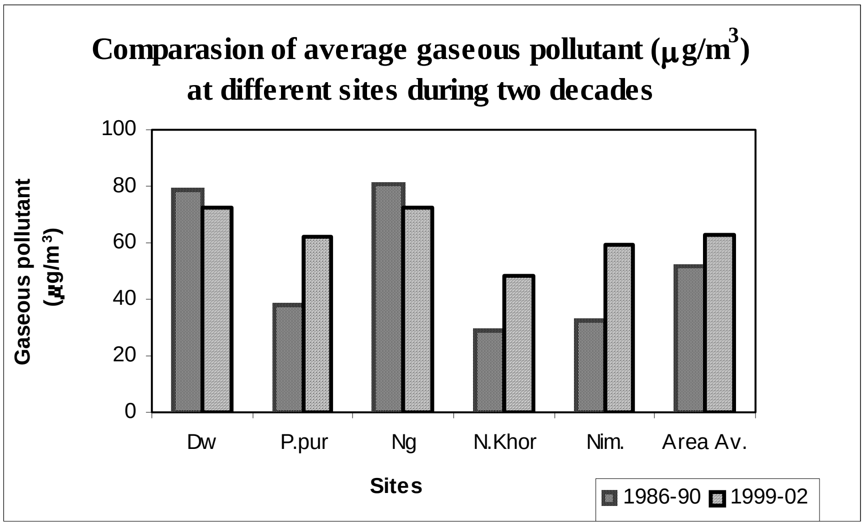
Table 5. Ground level ozone ($\mu g/m^3$) at different study areas during 1999-2002

The results of gaseous load shows that it is increasing at three sites while at Nagda and at Dewas it is decreasing. The maximum increase in gaseous load is at Pithampur i.e. 67% with reference to 1986-90 result. The scenario of gaseous pollution load is quite satisfactory and the results of all areas does not exceeds the standard limits i.e. 120$\mu g/m^3$ SO_2 & NOx individually for industrial areas.

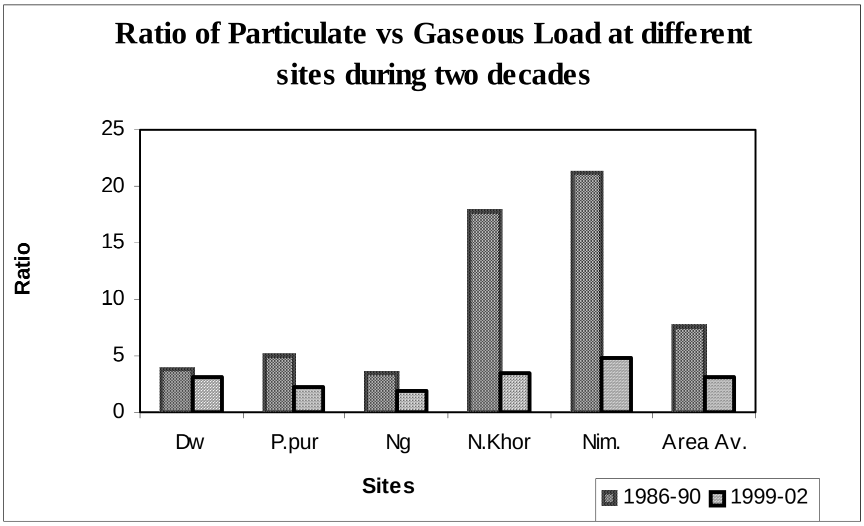
Individually all the pollutants existing in the air are quite below the limit prescribed by the MoEF or CPCB, New Delhi. More interestingly the SO_2 and NOx were quite below the standard limit prescribed for industrial areas but our observation is that these individual pollutants including the ozone, jointly are quite enough to be considered as effective for certain damage to the ecosystem component including crop. But there is no standard limits prescribed by authorities for ground level ozone and cumulative air pollution load.

The represented graph indicate the picture of particulate and gaseous load during 1986-1990 & 1999-2002. The area average of particulate and gaseous concentration shows that during ten years particulate load is decreased while gaseous load is increased. Nimabaheda air appears to be seriously loaded with SPM At all selected study areas particulate concentration is decreased in ten years data but gaseous concentration is increased. Pithampur air appears to be acutely weighed down with gaseous pollutant.





Particulate vs gaseous pollutant load gives an index for air quality scenario of that area. According to standard limits particulate is more than gaseous pollutant and ratio is approximately 2:1 (500 $\mu g/m^3$ SPM : 240 $\mu g/m^3$ SO_2 + NOx). The same trend is observed at study areas i.e. particulate concentration is more than gaseous concentration. In cement producing areas the particulate load is higher and ratio lies between 18 to 22 during 1986-90 at Nayagaon-Khor and Nimbaheda, which is too high than standard limits ratio. Now the situation has changed, this ratio is ranges between 3 to 6 during 1999-02 at Nayagaon-Khor and Nimbaheda. While at other areas where particulate load not very high the ratio is same as standard limit ratio.



There is deterioration of ambient air quality over all the years at these sites and practically in the overall regional sectors around industries and highways. It is apparent that ambient air quality has improved in some regions specially with reference to cement production but it has deteriorated in fastly developing industrial zones. We have submitted this data here much because even this cumulative load induced latent crop loss (Dubey, 2002)

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