RESEARCH PAPER:

Comparative evaluation of gaseous and particulate pollutant load in some parts of western Madhya Pradesh

KRISHNA HARYANI AND SUSHIL MANDERIA

Asian Journal of Environmental Science, **(June, 2011) Vol. 6 No. 1 : 32-36**

See end of the article for authors' affiliations

Correspondence to :
KRISHNA HARYANI
Department of Botany, P.M.B. Gujarati Science College, INODRE (M.P.) INDIA
krishnaharyani@gmail.com

SUMMARY

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 and NOx *i.e.* 532mg/m^3 during 1986-1990 and 251.66mg/m^3 during 2006-2010. The CPL in area decrease during 2006-2010, 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 100mg/m^3 which increased by 3.6, 2.8 and 1.7 times at HZ(1-1.2 km), MAZ (2-2.5 km) and LAZ (4.5-5 km) in upwind direction, respectively during 2006-2010. Statistically during last 20-25 years the gaseous pollutant concentration increased by two times in the region while particulate increased by 1.5 times.

Haryani, Krishna and Manderia, Sushil (2011). Comparative evaluation of gaseous and particulate pollutant load in some parts of western Madhya Pradesh. *Asian J. Environ. Sci.*, **6**(1): 32-36.

Key words : Cumulative pollution load, Host zone, Moderately affected zone, Least affected zone

Received: *December, 2010*
Revised: *January, 2011*
Accepted : ***February, 2011***

In India problems of air pollution are rapidly increasing on account of industrialization urbanization, and rapid expansion of transport sector and escalating consumption of energy. 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 (Varshney *et al.,* 1997; Agrawal *et al.*, 1985). The National Crop Loss Assessment network (NCLAN) project was a pioneering effort to assess large-scale effects of air pollutants on crop loss in USA (Adams *et al.,* 1998 and Jager *et al.,* 1994)). Such regional programmes have been launched and executed in Europe as well as in USA (Fowler and Cape, 1982).

This paper refers to a comprehensive long-term study of about 25 years of air quality in the selected sites upto 5-7 km area with wide microclimatic conditions and various types of crops (Dubey, 1990 and 1997).

MATERIALS AND METHODS

An extensive sampling programme was designed for a period of two decades (1986-90 and 2006-10) including all the seasons of these years.

Area and site:

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

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 criteria was effectively applied in the

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

selection of sites. At different direction upto 6 km sites were marked in up and down wind. 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. The various equipments adopting APHA protocol –

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

– Oxides of sulphur- Toxic Gas Monitor- 555 (CEA, USA) (SO_2,West and Gaeke,1956)

– Oxides of nitrogen - Toxic Gas Monitor- 555 (CEA, USA) (NOx, Griess and Saltzman,1954)

– Ozone (O_3) - Portable gas sampler (Netel NPM-PS-1, India) (Byers and Saltzman, 1958) 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 2006-2010.

RESULTS AND DISCUSSION

The data showed that level of air pollutants was 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 mg/m^3 and 760-860 mg/m^3 at Nayagaon-Khor during 1986-1990 (Table 2). As evident the SPM load at above area was due to cement production of about 7300 tons per day. Reduction in SPM load around cement industrial complex during 2006-2010 was definitely due to control equipments their operations when compared to 1986-1990.

The decreasing trend of particulate matter load was observed at all sites. The maximum decrease is at

Table 2: Suspended particulate matter (μg/m^3) at different study areas during two decades

Year		Dewas	Pithampur	Nagda	Nayagaon-Khor	Nimbaheda	Area av.
RZ	1986-90	126.80	125.00	129.55	243.45	342.15	193.39
	2006-10	78.13	49.26	46.15	78.62	112.62	72.96
HZ	1986-90	407.60	257.50	440.45	832.75	1148.70	61.40
	2006-10	315.29	229.00	194.14	234.37	428.10	280.18
MAZ	1986-90	346.30	240.00	358.90	724.90	775.35	489.09
	2006-10	290.54	141.61	135.00	175.34	327.80	214.06
LAZ	1986-90	311.30	142.50	187.05	269.95	476.55	277.47
	2006-10	156.26	94.80	109.65	113.90	213.45	137.61
Area av.	1986-90	298.00	191.25	278.99	517.76	685.69	349.33
	2006-10	210.06	128.67	121.24	150.56	270.49	176.20

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 and Forestry (MoEF) *i.e.* 500mg/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 mg/m^3. The result shows that there is a decreasing trend of SO_2 at all study sites during 2006-2010 (Table 3). The maximum decrease is at Nimbaheda and Nagda *i.e.* 52 and 51%, respectively with reference to 1986-1990 loads. This may be due to modification of coal quality and technology inputs.

Oxides of nitrogen (NOx) concentration in the ambient air at selected sites attained the maximum levels of 58-68 mg/m^3 at Dewas and Nagda, respectively during the year 1986-1990, after twenty five years the NOx concentration is decreased at Dewas and Nagda by 7 and 23%, respectively while at other three areas NOx concentration increased (Table 4).

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 mg/m^3 at various area at different sites (Table 5).

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

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

Year		Sites					
		Dewas	Pithampur	Nagda	Nayagaon-Khor	Nimbaheda	Area av.
RZ	1986-90	4.43	12.50	6.55	3.21	3.57	9.21
	2006-10	3.60	4.85	3.15	1.87	3.80	3.45
HZ	1986-90	71.15	31.00	65.10	15.60	16.70	43.16
	2006-10	40.20	32.47	35.93	4.95	5.14	23.74
MAZ	1986-90	54.25	26.50	53.55	8.82	11.99	33.46
	2006-10	26.10	22.37	20.97	6.81	3.02	15.85
LAZ	1986-90	36.75	20.00	34.58	4.85	5.98	22.68
	2006-10	16.18	9.77	13.04	4.15	5.12	9.65
Area av.	1986-90	41.65	22.50	39.94	8.12	9.56	27.13
	2006-10	21.52	17.37	18.27	4.45	4.27	13.17

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

Year		Sites					
		Dewas	Pithampur	Nagda	Nayagaon-Khor	Nimbaheda	Area av.
RZ	1986-90	13.33	14.20	15.37	10.22	11.90	13.00
	2006-10	12.00	10.54	8.07	16.24	17.43	12.86
HZ	1986-90	58.80	16.60	68.06	28.93	35.40	41.55
	2006-10	56.20	43.84	52.65	29.14	43.20	45.01
MAZ	1986-90	45.50	15.35	48.34	26.23	26.44	32.37
	2006-10	39.26	34.87	37.30	36.20	38.13	37.15
LAZ	1986-90	29.43	15.10	31.71	18.99	17.68	22.58
	2006-10	23.96	20.06	20.92	19.47	30.27	22.94
Area av.	1986-90	36.74	15.31	40.87	21.09	22.85	27.37
	2006-10	32.86	27.33	29.74	25.26	32.26	29.49

Table 5: Ground level ozone ($\mu g/m^3$) at different study areas during 2006-10

Distance	Sites					
	Dewas	Pithampur	Nagda	Nayagaon-Khor	Nimbaheda	Area av.
RZ	10.75	11.20	11.37	10.03	9.85	10.64
HZ	27.63	28.65	42.00	26.14	35.16	31.92
MAZ	26.17	26.12	32.57	30.70	30.83	29.28
LAZ	15.79	16.43	21.90	21.00	28.55	20.73
Area av.	20.09	20.60	26.96	21.97	26.10	23.14

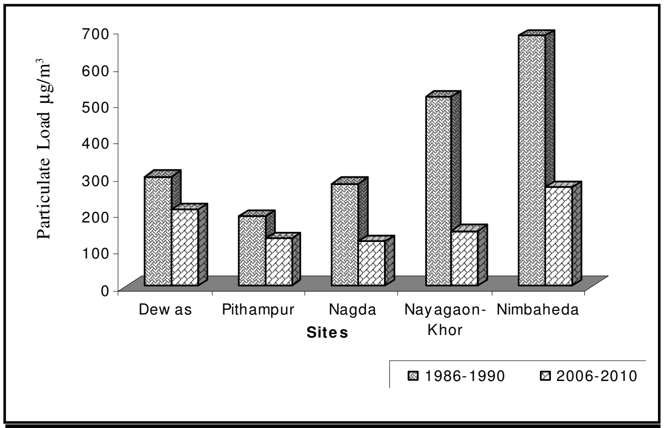

Fig. 1: Comparasion of average SPM load ($\mu g/m^3$)

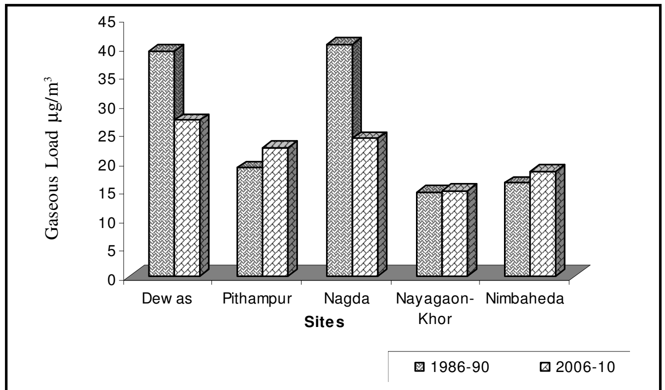

Fig. 2: Comparasion of average gaseous pollutant load ($\mu g/m^3$)

of gaseous pollution load is quite satisfactory and the results of all areas does not exceeds the standard limits *i.e.* 120 mg/m^3 SO_2 and 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.

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 mg/m^3 SPM : 240 mg/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 ratio limits. Now the situation has changed, this ratio is ranges between 3 to 6 during 2006-10 at Nayagaon-Khor and Nimbaheda. While at other areas where particulate load not very high the ratio is same as standard limit ratio (Fig 1 and 2).

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.

Acknowlegement:

Authors extend thanks to ICAR, Ministry of Agriculture and Government of India for sponsoring the project and also Head, IEMPS, Vikram University, Ujjain for providing necessary research facility.

Authors' affiliations:

SUSHIL MANDERIA, School of Studies in Microiology, Vikram University, UJJAIN (M.P.) INDIA

REFERENCES

Adams, R.M., Glyee, D.J. and McCarl, B.A. (Ed.), W.W. Heck, O.C. Taylor and D.T. Tingey (1988). The NCLAN economic assessment-approach, findings and implications, In: Assessment of Crop Loss From Air Pollutants, Elsevier, London, pp. 473.

Agrawal, M., Nandi, P.K. and Rao, D.N. (1985). *Indian, J. Environ. Health*, **27**(4): 318.

APHA, (1997). In (ed. K Morris): Methods of air sampling and analysis, 2nd edition, American Public Health Association, Washington, D.C.

Byers, D.H. and Saltzman, B.E. (1958). *J. Am. Ind. Hyg. Assoc*., **19**: 251.

Dubey, P.S. (1990). Study and assessment of plant response against air pollution in industrial environment. Final technical report of all India coordinated program on air pollution and plants, Ministry of Environment, Forest and Wild Life, Govt. of India, New Delhi.

Dubey, P.S. (1997). In: Effect of air pollution on Indian crop plants. ODA report, JNU, New Delhi, India, pp. 83 – 147.

Fowler, D. and Cape, J.N. (1982). Air pollutants in Agriculture and Horticulture. In: Effects of gaseous air pollution in agriculture and horticulture. Unsworth, M.H. and Ormrod, D.P., Butterworth Scientific, London.

Fuhrer, **J.,** Skarby, L. and Ashmore, M.R. (1997). *Environ. Pollut.,* **97**: 91.

Jager, H.J., Unsworth, M. , Temmerman, L. de and Mathy, P. (1994). Air Pollution Report 46, CEc, Brussels.

Philip West, W. and Gaeke, G.C. (1956). *Anal. Chem.,* **28**(12):1816-1819.

Varshney, C.K., Agrawal, M., Ahmad, K.J., Dubey, P.S. and Raza, S.H. (1997). Jawaharlal Nehru University, New Delhi, India.