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Study on Some air quality parameters in urban area of Vijayawada (India) in effect of human activities

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ABSTRACT

Air pollution is increasing day by day in the most of the urban areas and it is create too many health problems. This paper deals to assess the ambient air quality status in the fast growing urban areas of Vijayawada, Andhra Pradesh, India. The magnitude a problem of air pollution has increased is due to unplanned industries, increase of traffic, influxes of people from rural areas and other human activities. The air samples were collected for total suspended particulate matter (TSPM), respirable suspended particulate matter (PM_{10}), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) during different months from five proposed sites of Vijayawada during November 2009 to February 2010. The five types of sampling sites with different anthropogenic activities i.e. sensitive, residential, commercial, traffic and industrial areas were identified in this city. This analysis data obtained from Vijayawada city reveals a significant increase in the total number of hospital admissions of the patients with acute respiratory diseases in winter season.

Keywords: Air pollution, Health hazardous, Human activity, Nitrogen dioxide and Sulfur dioxide.

INTRODUCTION

Air pollution is an increasing health problem of the human beings, animals and also damage to vegetation and soil fertility. The increasing of air pollution due to industrialization, urbanization, much population, number of vehicles and improper implementation of stringent emission standards make the problems of air pollution still worse [1] is produced higher concentrations of pollutants. The increased industrialization and simultaneous growth of the metropolitan areas are strongly related with the environmental problems [2]. This air pollutants concentration depends on number of meteorological factors like wind, temperature, pressure and humidity. Air pollution into the atmosphere occurs in the form of gases or particles and it is continuous mixing transformation, trans-boundary and transportation of air pollutants and affects not only the large metropolitan areas, but also the medium-sized urban areas. In many researchers have been studied the air pollution problems in medium-sized urban areas

that are densely populated and industrialized [3-15]. The WHO\UNEP report (1992) reveals air pollution problems in metropolitan cities of world such as Bombay, Calcutta, Delhi, Dhaka and Karachi in South Asia and Bangkok, Beijing, Shanghai, Jakarta and Manila in East Asia.

Air pollution may be broadly defined as the presence of one or more contaminates like dust, smoke and must odor in the atmosphere. The pollutants entry into the atmosphere and to create the health risks in human beings, plants and animals. The adverse health effects of air pollution have been widely documented in several reports based on studies in large cities [16]. According to the estimates of WHO and World Bank from 1992 to 1995 there is an increase in premature deaths due to air pollution in Indian cities.

In India, 23 major cities and population of over 1 million people of each city and ambient air pollution levels exceed the WHO standards in many of them [17] in the past decades. The major causes of environmental degradation in mega cities have occurred 'Sequentially' rather than 'Simultaneously' and suffering intense pressure of a combination of different driving forces. The most important factor responsible for deterioration of air quality in the cities is the exponential increase in the number of motor vehicle have been doubling every year in many of countries. Motor vehicular pollution contributes to 70% of total air pollution in Delhi 52% in Mumbai and 30% in Calcutta [18-20].

The 1952 "London smog episode" was the worst example of an 'air pollution episode' resulting in estimated 4,000 deaths in five days. Although the components of air pollution have changed over the years from industrial sources includes toxic gases and coal gases. In addition, vehicular traffic sources have been expanded rapidly in the last five decades is due to increasing man made activities like emission of NO_2 and SO_2 have been rising over the past decades. Absence of proper environmental planning, unplanned industrialization, urbanization and increasing population is due to lack of proper solid waste management and greening programmed.

In 1987 United States Environmental Protection Agency (USEPA) redefined its particulate emission standards concentrating on aerosol size less than 10-micron aerodynamic diameter particles called PM_{10} (Bridgman et al.1992). Long time exposure to high level of small particles in the air also contributes to a range of chronic respiratory diseases, heart diseases, skin and eye irritation, so other types of particulate pollution either on it is combination with SO_2 leads to an enormous burden of ill health causing at least five lacks premature deaths and 4-5 million new case of chronic bronchitis each year (World Bank 1992).

Since fine particulate matter has associated heavy metals and other priority on its surface, it can pose serious threat to human health with special reference to the respiratory disorders. The association of toxic elements with PM_{10} and smaller particles can be even more harmful as these can penetrate deep into the respiratory tract. The higher concentration of PM_{10} particles is inhaled from polluted air has more possibility to reach deep in lungs and also entry of these particles into lungs is dangerous, because they can carry a complex mixture of toxic pollutants.

COEPHA (1996) estimated these effects and found that increase of PM_{10} by 10 µg m^{3-} then mortality rate percent and have been related to premature deaths, aggravated asthma, increased respiratory problems, lung or heart disease appeared to be more susceptible than others to adverse effects of $PM_{10.}$

Pollution in the cities has associated serious to moderate health problems due to high levels of total suspended particulates matter (TSPM), further 4% to 8% of premature deaths an a global scale are due to exposure to high levels of particulate matter in ambient air (WHO 2000). Ambient air levels exceeding the WHO levels in 36 major India cities and town's results in 40 thousand premature deaths, around 19 million respiratory hospital admissions and sickness requiring medical treatment and also 1.2 billion incidences of minor sickness annually [21].

Despite the increasing evidence of negative impact of air quality on human health [22-24] not much data on ambient air quality a prerequisite for health studies is available for most of the medium size cities or towns in India. Although a large population lives in these cities or towns not much higher the air quality of Vijayawada, which has increased rapid industrial and vehicular growth during last few decades. In the present study to assess the prevailing concentration of the NO_2, SO_2, PM_{10} and TSPM in

the fast growing urban centers of various cities in relation to different anthropogenic activities. Furthermore the epidemiological data of Vijayawada city was evaluated in relation to the health risks of these criteria pollutants.

MATERIALS AND METHODS

Site Specifications: Vijayawada is one of the commercial centers in the Andhra Pradesh state of south India situated at 16.52^0 North latitude 80.62^0 East longitude and 39 feet above mean sea level with a sprawling area of 61.8 square kilometers with its 25 lacks of population is a rapidly growing city. The air quality parameters that had been analyzed five proposed sites with namely Chitti Nagar, Siddhartha Nagar, Head post office, Benz circle and Auto Nagar which have observed considerable growth in commercial and industrial sectors during last few years were selected for ambient air quality monitoring sites (Fig.1). The five sampling sites were selected in and around Vijayawada city on the basis of differential anthropogenic activities, which include residential (R), sensitive (S), commercial (C), traffic (T) and industrial (I). The site specific characteristics and associated back ground activities are presented in Table 1.

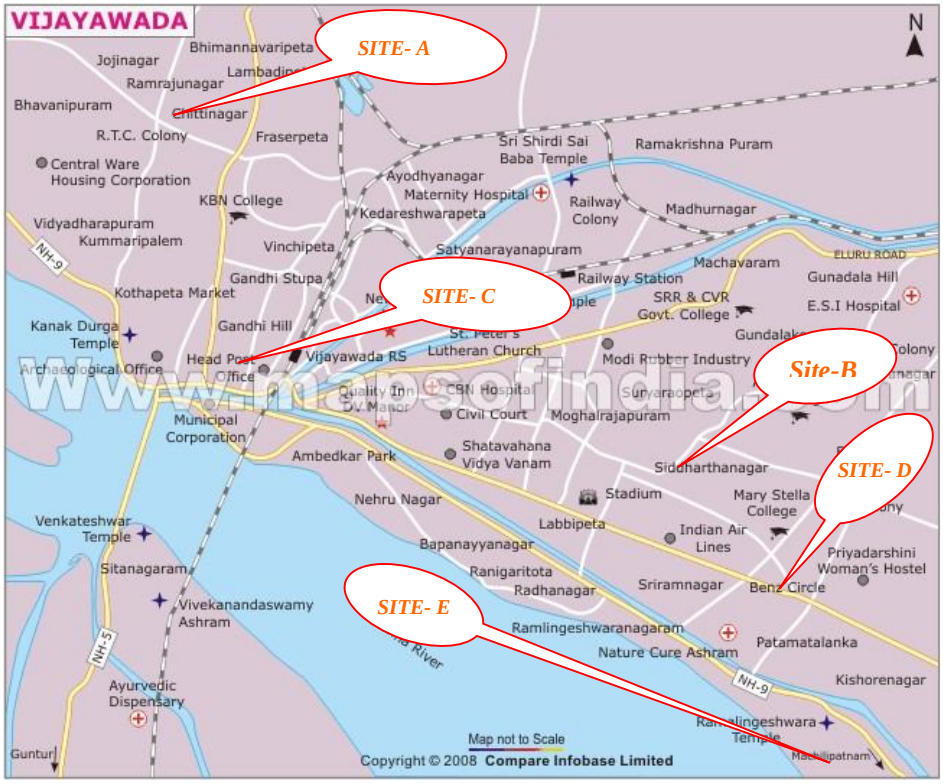


Fig.1 Location of different proposed sites in and around Vijayawada city.

Table 1. Characteristic features of sampling locations with background activities.

S. No	Nature of area	Locations	General Features
1	**S**	Chitti Nagar	Poor roads, less populated area, milk factory, no traffic with lots of greenery (trees) and agriculture land.

2	**R**	Siddhartha Nagar	Less traffic with lots of greenery (trees), well maintained roads, thickly populated area, low motor vehicles, un polluted area and peace full area.
3	**C**	Head Post Office	Commercial activity with heavy traffic density, proximity to national highway, use of diesel generators and well populated area.
4	**T**	Benz Circle	Heavy traffic with no greenery (trees), well maintained roads, proximity to Bus terminus, thickly populated area with high motor vehicles and proximity to National highway.
5	**I**	Auto Nagar	Proximity to automobile industry, Industrial area with well maintained roads, heavy traffic density and transport area.

S-Sensitive; R-Residential; C-Commercial; T-Traffic and I-Industrial.

Sampling and Analytical Procedure:

Measurement of PM_{10} and TSPM: APM-460 respirable dust sampler (Envirotech, Delhi) were used for measuring the concentration of TSPM, $PM_{10,}$ NO_2 and SO_2 in the ambient air. The sampling was collected during winter season and each sample taken 8 hours time the sampling was collected 8 hours at Daytime (6.00A.M-2.00P.M), Evening time (2.00P.M-10.00P.M) and Night time (10.00-6.00A.M). The sampling equipment was placed on above the ground level, this instrument was connect with inlet pipe was placed 1-3 meter above the ground level depending upon the site available for the Respirable Dust Sampler (RDS). RDS has been provided with a cyclone is designed to provide separations of PM_{10} particles. Atmospheric air was drawn for 24h through the cyclone and we are using 20×25cm glass fiber filter (GFF) sheet at a flow rate of 0.8 to 1.2 m^3 min^{-1} and finally the average flow rate was calculated. As the air with suspended particulate enters the cyclone, coarse non-respirable dust is separated from the air stream by centrifugal forces.

The suspended particulate matter falls through the cyclone's conical hopper and gets collected in the cyclonic-cup. The fine dust comprising the respirable fraction of TSPM passes through the cyclone and gets collected on GFF. The amount of non-respirable suspended particulate matter (NRSPM) and respirable particulate per unit volume of air passed was calculated on the basis of the difference between initial and final weight of the cyclone cup and that of the filter paper and the **t**otal volume of the air draw during sampling. Mass concentration of TSPM was calculated by adding the concentration of PM_{10} and NRSPM. For sample analyzed by the gravimetric method and mass concentration of TSPM was calculated by adding the concentration of PM_{10} and NRSPM.

$$TSPM\ (\mu g\ m^{3\,-1}) = PM_{10}\ (\mu g\ m^{3\,-1}) + NRSPM\ (\mu g\ m^{3\,-1}).$$

Measurement of SO_2 (Sulfur dioxides): The modified West & Geake method was adopted for collecting and analysis of SO_2 concentration in atmosphere. A known quantity of air was passed through the impinger containing a volume of absorbing solution and it was used for SO_2 in the impinger was potassium tetra chloromercurate (0.04M) in distilled water. Atmospheric air was drawn at measured and controlled rate of 480 minutes through a solution of potassium tetra chloromercurate in an orifice tipped bubbler continuously during the entire sampling period. SO_2 in the air sample was absorbed in the absorbing reagent and forms stable Di-chloro sulphito mercurate complex is formed. After the completion of sampling period, the sample solution was treated with sulphamicacid, formaldehyde, parosanilin and

methyl sulphonic acid. The absorbance of the resulting solution was measured with the help of spectrophotometer at wave length of 560 nm and SO_2 was expressed as microgram per cubic meter (µg $m^{3\ -1}$).

Measurement of NO_2 (Nitrogen dioxide): NO_2 concentration was determined by Saltzman's method as modified by Jacob and Hochheiser [25]. 25ml of absorbing solution used for NO_2 contained 0.4% sodium hydroxide and 0.1% sodium arsenite in distilled water. Atmospheric air was draw at a measured and controlled rate of 480 minutes in an orifice tipped bubbler. The air existing in this bubbler was passed through an acidic permanganate solution and through an orifice tipped bubbler, containing sodium hydroxide and arsenite solution, the air sample was drawn in atmospheric NO_2 converted into sodium nitrite. After completion of the sampling, the sample solution was treated with hydrogen peroxide, sulphanilamide and NEDA (N-1-napthyl ethylene diamine dihydrochloride) and to form an intensely colored azodye complex**.** The absorbance of the resulting solution was measured with the help on spectrophotometer at wave length of 540nm [26] and NO_2 air sampled expressed as microgram per cubic meter .

RESULTS AND DISCUSSION

Five proposed sites with collected for 180 samples during the study period, the study of air quality in winter season (From November to February) in and around Vijayawada.

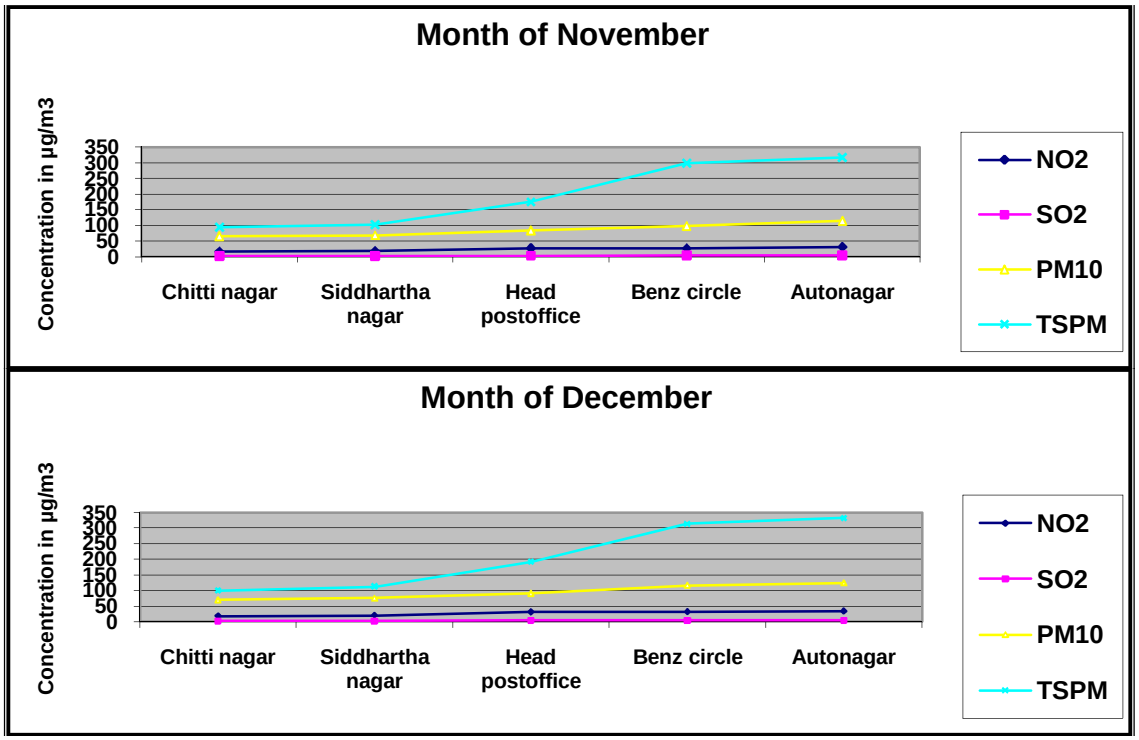
Site-specific variations: The average concentration of various criteria pollutants is shown in Table 2. The ambient air concentration of TSPM was observed stipulated standard values at almost all the sites. It ranged from 85.2 µg $m^{3\ -1}$ to 113.1 µg $m^{3\ -1}$ in sensitive area at Chitti Nagar and 93.8 µg $m^{3\ -1}$ to 125.8 µg $m^{3\ -1}$ in residential area at Siddhartha Nagar, Commercial area also had TSPM is ranged from 120.3 µg $m^{3\ -1}$ to 235.8 µg $m^{3\ -1}$ at Head post office, Traffic area also had TSPM ranged from 262.3 µg $m^{3\ -1}$ to 363.3 µg $m^{3\ -1}$at Benz circle and 235.8 µg $m^{3\ -1}$ to 382.7 µg $m^{3\ -1}$ industrial area at Auto Nagar. Further it was observed that concentration of PM_{10} ranged from 61.0 µg $m^{3\ -1}$ to 75.1 µg $m^{3\ -1}$in sensitive area at Chitti Nagar and 61.9 µg $m^{3\ -1}$ to 82.1µg $m^{3\ -1}$ in residential area at Siddhartha Nagar. Commercial area also had PM_{10} ranged from 69.6 µg $m^{3\ -}$ to 105.3 µg $m^{3\ -1}$ at Head post office, the PM_{10} ranged from 79.1 µg $m^{3\ -1}$ to 138.5 µg $m^{3\ -1}$ in traffic area at Benz circle and 98.2 µg $m^{3\ -1}$ to 148.4 µg $m^{3\ -1}$ in industrial area at Auto Nagar.

The WHO reports (1998, 1999) also show that most of the cities in India, the TSPM levels above 300 µg $m^{3\ -1}$ and PM_{10} annual average ranged from 50 to 100 µg $m^{3\ -1}$ in the year of 1995-1996. The highest concentration of PM_{10} exceeding (250 µg $m^{3\ -1}$) was observed in Kolkata and New Delhi. Comparison of our result with WHO reports reveals higher levels of particulate matter in the present study, the probable reason for the high levels of atmospheric TSPM and PM_{10} could be industrial and agriculture activities.

Gaseous pollutants (SO_2 and NO_2) were found below the permissible limits at all the proposed sites. The SO_2 concentration in the ambient air in cities of developed countries has mostly decreased in the last two or three decades due to follow the strict emission control. The mean levels of SO_2 observed in different sites with varied from 3.2 µg $m^{3\ -1}$(Head Post office) to 6.5 µg $m^{3\ -1}$(Auto Nagar). The residential, commercial and industrial areas in all the sites exhibited lower concentration of gas pollutants. The mean concentration range of NO_2 in different sites, it ranged from 12.8 µg $m^{3\ -1}$ (Chitti Nagar) to 44.4 µg $m^{3\ -1}$ (Auto Nagar). The high concentration of NO_2 pollutant due to increasing the number vehicles day by day in proposed sites in and around Vijayawada city.

Basic statistics with concentration of air pollutants for different proposed sites of Vijayawada during the study period

	Nov'2009				Dec'2009				Jan'2010				Feb'2010			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
Location1: Chitti Nagar																
NO_2	12.80	19.80	1.16	3.50	14.00	22.80	17.93	4.47	13.50	20.10	16.56	3.32	13.00	20.80	16.76	3.90
SO_2	1.20	3.00	2.00	0.91	1.50	3.50	2.43	1.00	1.00	2.70	1.73	0.87	1.10	2.80	1.93	0.85
PM_{10}	61.00	73.50	65.56	6.89	64.50	76.80	69.86	6.29	63.80	72.30	67.63	4.31	62.00	75.10	67.16	6.97
TSPM	85.20	102.80	94.10	8.80	87.90	113.10	99.93	12.63	80.00	98.00	89.36	9.02	82.30	110.30	95.93	14.01
Location2: Siddhartha Nagar																
NO_2	13.10	25.30	18.13	6.37	14.40	28.20	20.03	7.24	12.20	22.20	17.40	5.01	13.90	24.80	18.30	5.74
SO_2	1.00	2.70	1.76	0.86	1.80	3.00	2.26	0.64	1.10	2.90	1.76	0.98	1.60	2.50	1.93	0.49
PM_{10}	61.90	78.50	68.50	8.80	70.10	82.10	75.33	6.14	67.20	79.20	72.16	6.26	69.10	80.80	73.60	6.3
TSPM	95.00	115.10	102.76	10.80	96.80	125.80	112.60	14.67	92.90	115.00	100.96	12.19	93.80	120.80	106.03	13.67
Location3: Head post office																
NO_2	26.0	31.60	27.86	3.23	27.30	43.80	33.46	9.00	25.80	30.90	28.16	2.56	26.30	35.00	29.86	4.55
SO_2	2.00	4.10	2.86	1.09	2.80	4.50	3.50	0.88	1.90	3.50	2.76	0.80	2.10	4.00	3.00	0.95
PM_{10}	71.80	95.10	84.10	11.70	78.50	105.30	91.30	13.44	69.60	98.90	85.26	14.75	75.00	101.80	88.26	13.40
TSPM	125.10	220.10	175.10	47.69	150.30	235.80	192.10	42.78	120.30	200.80	161.20	40.26	130.20	230.20	178.56	50.07
Location4: Benz Circle																
NO_2	19.80	30.80	26.80	6.08	22.00	8.90	31.56	8.66	18.80	35.80	28.43	8.72	20.20	38.10	29.93	9.05
SO_2	2.50	5.00	3.36	1.41	2.80	5.50	3.80	1.47	1.50	4.90	3.06	1.71	1.90	5.20	3.33	1.6
PM_{10}	79.10	128.10	97.46	26.70	95.40	138.50	111.70	23.38	80.80	130.70	93.93	26.90	75.00	99.80	89.33	12.84
TSPM	265.60	350.10	298.76	45.08	278.80	368.60	314.33	47.74	262.30	360.80	297.90	54.63	270.40	363.30	306.50	49.78
Location5: Auto Nagar																
NO_2	22.80	35.30	30.30	6.61	25.20	44.40	35.53	9.84	20.30	38.60	29.90	9.18	20.90	37.90	30.43	8.68
SO_2	2.40	6.20	3.90	2.02	2.80	6.50	4.30	1.94	2.00	5.80	3.56	1.98	2.50	6.00	4.00	1.80
PM_{10}	95.30	142.10	114.33	24.59	105.10	148.40	124.53	21.98	99.80	140.20	116.93	20.88	98.20	145.30	119.56	23.85
TSPM	240.10	360.80	317.06	66.86	248.60	382.70	332.33	73.01	235.80	365.30	319.30	2.43	240.00	368.10	322.93	71.91



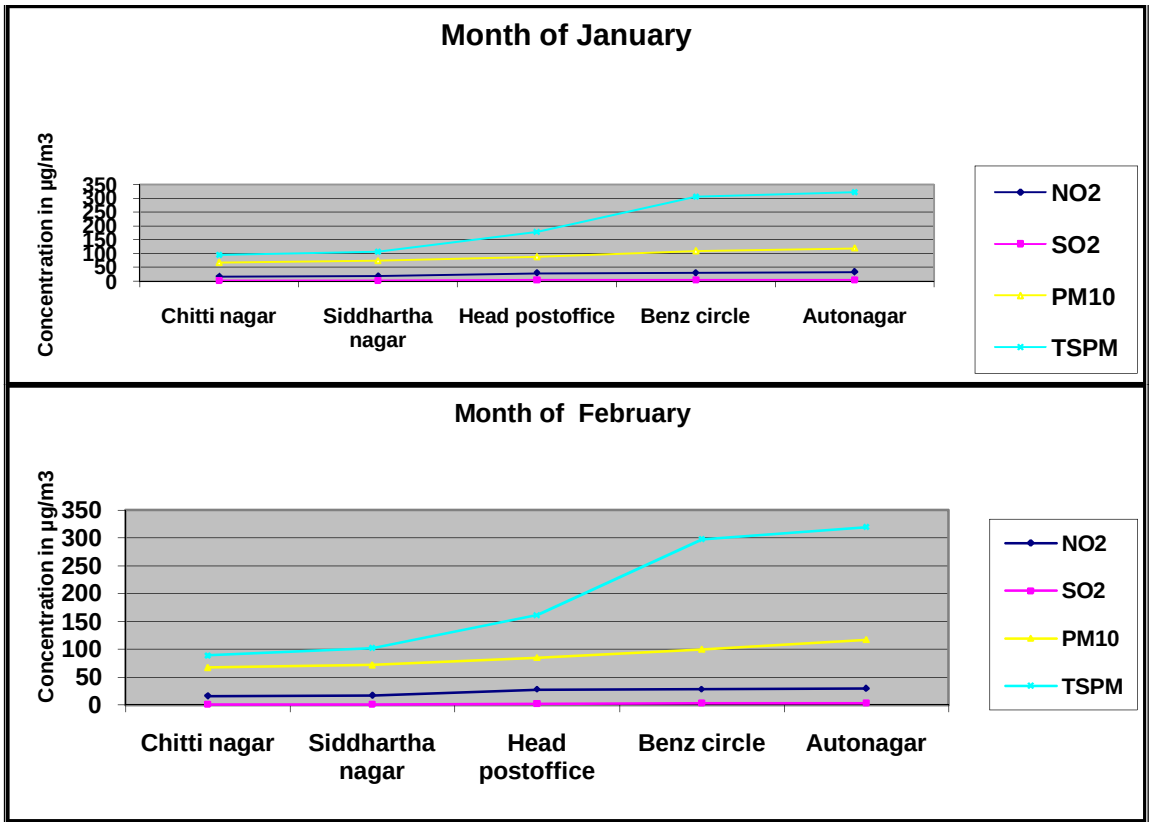


Fig.2 Monthly average concentration of different pollutants (µg/m^3) in proposed sites of Vijayawada during the study period.

Monthly variations: Monthly comparison of NO_2, SO_2, PM_{10} and TSPM average concentration levels value in winter season, than observed from November 2009 to February 2010 (Fig.2). Significantly highest levels of NO_2 were observed in December 2009 in comparison to other months at sampling period. The high NO_2 concentration combined with the intensive UV radiation in subtropical India conditions, results in photochemical smog with high O_3 concentration, which can adversely effect of Human health [27,28] observed this phenomenon in New Delhi and Vishakhapatnam. The highest concentration levels of SO_2 were observed in December 2009 in comparison of other months. Significantly highest levels of PM_{10} were observed in December and source of such particulates are vehicular and industrial emissions. An increased concentration of TSPM a month of December.

Day Variation: The mean diurnal day variation of NO_2, SO_2, PM_{10} and TSPM concentration is (Fig.3) characterized by a triple peak structure. The first peak which is the dominant is observed during the morning hours, the second peak during evening hours and third peak during night hours. Examining the period of air sampling, the highest value of NO_2 recorded in the study at the Auto Nagar during evening (39.5 µg $m^{3\,-1}$) and SO_2 recorded in the study at the Auto Nagar during evening time (6.1 µg $m^{3\,-1}$), the highest concentration of PM_{10} values in Auto Nagar during night time (144.0 µg $m^{3\,-1}$) and TSPM highest concentration recorded in the study at the Auto Nagar during night time (369.2 µg $m^{3\,-1}$).

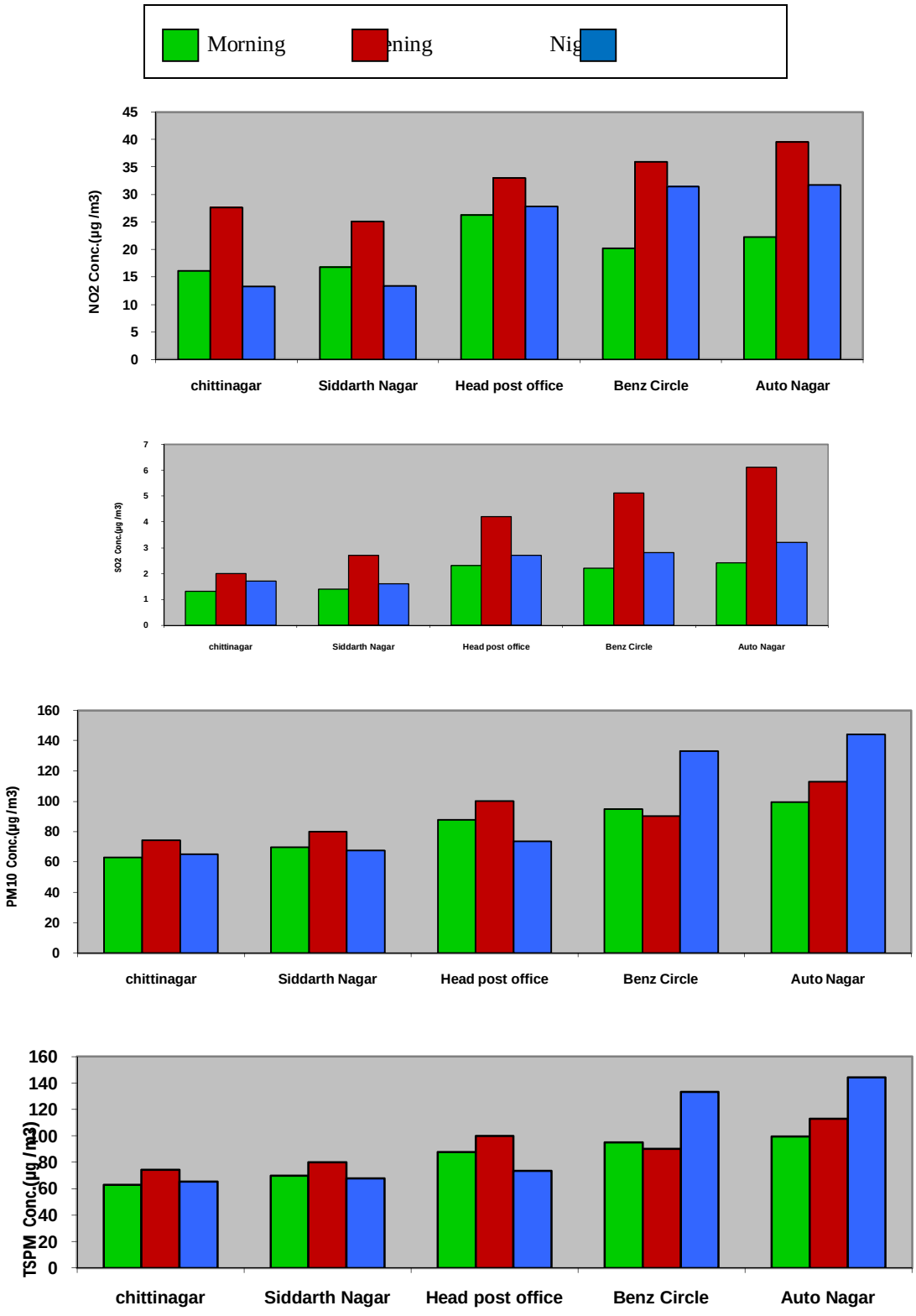


Fig 3. Day variation of average concentration NO_2, SO_2, PM_{10} and TSPM at proposed sites.

Health risk study of Vijayawada City: Various air pollutants are known to cause cardiac and respiratory diseases like asthma, bronchitis, emphysema, cardiovascular diseases or chronic lung diseases, children and elderly are more susceptible. The air pollution studies have been conducted in the developed countries with epidemiological data on the health effects of air pollutants are not abundant for most of the developing countries, where a major proportion of the population lives in environmentally poor conditions.

In the present study the data related to visit of patients for acute respiratory diseases was obtained from district civil hospital of Vijayawada city for the year 2008 and 2009 (Table 3). A comparison of the data shows significant fall (< 20%) in the total number of patients who visited during 2009 and it was also noticed that a large number of patients visited hospital during the winter season in comparison to other season is due to during winter, cold weather conditions with high levels of pollutants may aggravate the problem of sensitive population and hence results in increased hospital visits in the winter months.

Table 3: Patients with respiratory diseases admitted in Civil Hospital at Vijayawada city.

		Patient Conculantancy			Patient admitted		
Months /Year		**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
January	2008	137	110	247	12	7	19
	2009	115	90	205	17	14	31
February	2008	145	120	265	8	3	11
	2009	120	92	212	10	7	17
March	2008	109	65	174	13	8	21
	2009	125	40	165	8	6	14
April	2008	95	20	115	5	9	8
	2009	105	32	137	7	8	15
May	2008	20	15	35	5	2	7
	2009	38	22	60	6	4	10
June	2008	108	80	188	5	6	11
	2009	75	24	99	3	2	5
July	2008	130	79	209	10	8	18
	2009	70	28	98	4	2	6
August	2008	140	101	241	4	2	6
	2009	90	32	122	6	5	11
September	2008	112	98	210	12	8	20
	2009	085	42	127	9	4	13
October	2008	160	65	225	16	8	24
	2009	210	88	298	20	10	30
November	2008	175	91	266	18	12	30
	2009	215	88	303	28	18	46
December	2008	260	105	365	34	15	49
	2009	290	125	415	40	16	56

APPLICATION

These studies are applicable to suggest the Air -Pollution nature in more Populated Cities. Also useful to say which pollutants are more effective in studied areas and for suffering with different deceases by the Public. Also it is useful to bring awareness in the Public about surrounding Environment where they are living.

CONCLUSIONS

The air pollution is increasing day by day in the study area, depending on the direction and flow rate and local tidal air. The PM_{10} and TSPM are the air pollutants in proposed sites, which pose heavy risk either alone or in combination with other pollutant report is the study of five sites in and around Vijayawada. The present study as increase higher ambient concentration of air pollutants in industrial area at Auto Nagar, it also reveals as significant increase the total number of patients admitted for respiratory problems in winter season.

REFERENCES

[1] K.Ravindra, A.K. Mittal, R. Van Grieken, .*Environ.Health*, **2001,**16**,**169-189.
[2] D.B.Botkin , E.A. Keller, Environmental science: Earth as living planet (1st ed)*) New* York: Wiley, **1950.**
[3] E.Bridgman ,Global Air Pollution problems for the 1190'S CBS publishers and Distributors (P) LTD. New Delhi: 261 ,**1992.**
[4] I.C.Ziomas, C.S. Zerefos, A.F. Bais, A.G. Proyou, G.T. Amanatidies, A.G. Kelessis, *Environment Technology Letters*,**1989,** 10**,**1071-1082.
[5] E. Grosjean, R.A. Rasmussen, D. Grosjean, *Atmospheric Environment*, **1998,** 32**,** 3371-3379,**.**
[6] S.Kartal, U. Ozer, . *Journal of the Air & Waste Management Association*,**1998** ,48,853-859..
[7] R.L.R.Salcedo, M.C.M. Alvim, Ferraz, C.A. Alvez, F.G. Martins, *Atmospheric Environment*, **1999,**33, 2361-2372.
[8] A.G.Kelessis, *Fresenius Environmental Bulletin*, **2001**,10**,**624-628.
[9] N.Papamanolis, *Fresenius. Environmental Bulletin*,**2001,** 10,749-754.
[10] A.G.Traintafyllou, A. Patra, I. Zuburtikoudis, A. Pavlidis, F.Vosniakos, N. Zoumakis, *Freseniu Environmental Bulletin*, **2001,**10,615-619.
[11] F.Ferreira, H. Tente, P. Torres, P., *Water, Air and Soil Pollution* **2002,**2, 103-114**.**.
[12] A.N.Karandinos-Regia, C. Saitanis, *Chemosphere*, **2005,** 59, 1125-1136.
[13] A.N.Karandinos-Reiga, C. Saitanis, G. Arapis, *International Journal of Environment and Pollution*,**2006,** 27(4), 300-312.
[14] F.Costa bile, F.Wang , W. Hong , F. Liu , I. Allegrini**,** *JSME International Journal series B***,** **2006,** 49, 27-34**,.**
[15] D.Papanastasiou, D. Melas, *International Journal of Environment and Pollution*,**2009,** 36 (1/2/3).127-138.
[16] K.Katsouyanni, G. Touloumi, C. Spix, Short-term effects of ambient sulphur Dioxide and particulate matter on mortality in 12 European cities: results from times series data from the APHEA project: BMJ. **1997,** 314.1658-1663.
[17] H.K.Gupta, V.B. Gupta, C.V.C. Rao, D.G. Gajghate, M.Z. Hasan, Bul. *Environ Contam. Toxico* ,**2002,** l68**,** 347-354.
[18] C.P.C.B., .Parivesh, "Polycyclic aeromatic hydrocarbons (PAHs) in air and their effects on human health" November (2003) Central pollution control Board, Ministry of Delhi-32, Page 20.**2003.**
[19] S.B.Gokhale, R.S. Patil, *Environ Monit Assess***. 2004,** 95, 311-324,**.**
[20] K.Ravindra, E. Wauters, S.K.Taygi, S. Mor, R.V. Grieken, C.Brandon, , K. Homman , The cost of inaction valuing the economy-wide cost of Enviromental degradation in India.World Bank, Washington DC.**1995.**
[21] D.W.Dockery, C.A. Pope, J.D. Xu X.,Spengler, J.H.Ware, M.E. Fay, B. Ferris, F. Speize, , *New Eng.J.Med.* **1993,** *329, 1753-1759,*
[22] A.Pope, M. Than, M. Namboodiri, *Am J Respir Crit Care Med*.**1995,**151, 669-674.

[23] *Environ Monit. Asses*,**2005,** 115:405-17, 2006.
[24] N.Kunzli, R. Kaiser, S.Medina, M. Studnicka, O. Chanel, P. Filliger, M. Herry, F. Horak, Jr, V.Puybonnieux - Texier, P.Quenel, J. Schneider, R. Seethaler, Vergnaud , H. Sommer, Public-health impact of outdoor and traffic-related air pollution: a European Assessment' the Lancet.**2000,**356, 795-801.
[25] V.P.Kudesia, Air pollution Pragati, Prakasm, Meerut, India.**1992.**
[26] J.Lodge, . *Atmospheric Environment,* **1989,**19,715-726.

[27] A.Singh, S.M. Sarin, P. Shanmugan, N. Sharma, A.K. Attri, V.K. Jain, *Atmospheric Environment,* **1997**,31:20, 3421-3427.
[28] M.K.Reddy, K.G. Ramarao, I. Rammohanrao, *Environ. Monit. Asses*. **2004** ,95, 1 -12,.