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## Assessment of Air Pollution Monitoring Sites in Rural and Urban Areas of Vijayawada (INDIA)

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### ABSTRACT

*Air pollution is one of the major environmental problems in India and it's creating health problems of urban residents living in Vijayawada city. The high concentration of air pollutants in developing countries and an apparent scale of its impact on the global burden of diseases to human health. This paper deals with the analysis and interpretation of ambient air pollutant concentrations for nitrogen dioxide (NO<sub>2</sub>), sulphur dioxide (SO<sub>2</sub>), particulate matter with aerodynamic diameter less than 10 μm (PM<sub>10</sub>) and total suspended particulate matter (TSPM) from five air monitoring sites during summer season (March 2010 to May 2010) in and around Vijayawada and its located in the coastal Andhra region of India. These sampling sites with different human activities such as sensitive, residential, commercial, traffic and industrial areas were indentified in this city. Especially we were conducted questionnaire survey of health conditions in industrial area surroundings of Vijayawada Thermal Power Station (VTPS) in industrial area at Ibrahimpatnam.*

**Keywords:** Urban air pollution, Health effects, Diurnal variation, Anthropogenic activities and Industrial pollution.

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### INTRODUCTION

Air pollution is causing a serious threat to public health risk in most of the urban centers in the developing countries, in this way the need for monitoring the air quality levels of Vijayawada city. The increasing of air pollution in this city is due to unplanned daily activities, high influx of population, rapid increasing automobiles and industrialization. This pollution can be altering the meteorology factors such as temperature, wind speed, wind direction and rainfall through the number of ways. In near future, these factors influences to altering the climate changes according to recent reports [9, 6, 4].

The smaller size particulate matter with aerodynamic size less than 10 micrometers is called PM<sub>10</sub> and it can be inhaled into the thoracic then move to lower regions of the respiratory tract and possess inherent potential to induce harm. The many researchers have studied in a number of cities that reported the increase of morbidity and mortality rates due to higher PM<sub>10</sub> concentrations levels [1, 2, 5, 19, 13, 16, 10, and 15]. These Particulate matter is also causing the visibility reduction in human beings, radiation balance and modifying cloud property in atmosphere [17,20,12] and number of epidemiological studies [7, 11] have

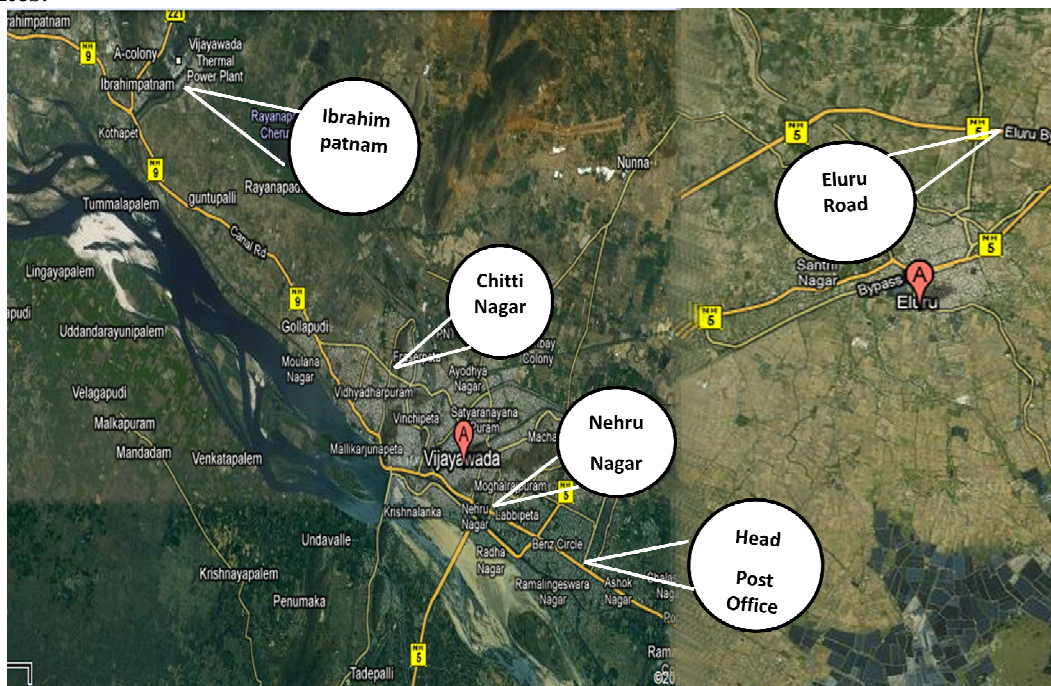
demonstrated that the atmospheric PM<sub>10</sub> in urban areas about pulmonary and cardiac disturbances [21]. The other major source of air pollution at Ibrahimpatnam is the coals based thermal power plants name is Vijayawada thermal power station, which is total generation capacity of 1.087 MW have been responsible for increased the air pollution.

In 1952, the “London smog episode” is the worst example of an ‘air pollution incident’ resulting the 4,000 deaths in five days. Although the components of air pollution have changed day by day with industrial emissions of toxic gases, coal remains as an important source of air pollution. In addition, vehicular traffic sources have expanded rapidly in the last five decades due to increasing man made activities and also it creates the more pollution.

## MATERIALS AND METHODS

**Geological study of Vijayawada:** Vijayawada is commercial urban centre and it’s located the central part of south India and distance about 300 km from Hyderabad, it is the capital city of Andhra Pradesh state. This city is situated at 16.52° North latitude and 80.62° East longitude and it is about 39 feet above mean sea level with a sprawling area of 61.8 square kilometers. This is the third largest city in Andhra Pradesh, India beside the Krishna River and bounded by the Indrakiladri Hills on the west and visited lacks of tourists every month. Vijayawada is an important business, educational, cultural destination and it’s having one of the largest railway junction in south India.

### Study Sites:



**Fig.1.** Five monitoring sites were selected in and around Vijayawada city.

The first site was in Chitti Nagar is a sensitive area of Vijayawada, where pollution level is almost very low, possess very dense forest, agricultural area and vegetation area. The second site is a residential area in Nehru Nagar, where moving a very high number of motor vehicles throughout the day and night and also residing more population in this area. The third site is a commercial area at Head Post Office area, which is the newly developed small scale industrial belt and about 100 industries already started for functioning and some more yet to arrive. These industries emits air pollutants through their chimneys and it can be bear a very heavy traffic including large trucks with loaded and very high number of four wheelers, three wheelers, and two wheelers throughout the day and night. The fourth site is Eluru Road, which is main

busy road and also heavy traffic area of this city. The fifth site is Industrial area at Ibrahimpatnam and it is the large-scale industry named as Vijayawada Thermal Power Station (VTPS) have been the most prominent concentration to air pollution. The main objective of this study is to monitor the ambient air quality of the proposed five sites of Vijayawada rural and urban areas.

**Sampling and analysis :** The samples were collected summer season during March 2010 to May 2010 and corresponding to each sample taken 8 hours time, at Day time (6.00 A.M - 2.00 P.M), Evening time (2.00-P.M - 10.00 P.M) and Night time (10.00 P.M - 6.00 A.M). APM-460 Respirable Dust Sampler (RDS) made by Envirotech, New Delhi, were used for measuring the concentration of the suspended particulate matter (TSPM), PM<sub>10</sub>, SO<sub>2</sub> and NO<sub>2</sub> samples in the ambient air. The samples were collected continuously for air monitoring from proposed sites and sampling equipment was alternatively positioned 1-3 meter above the ground level depending upon the site available for the RDS. The RDS sampler with cyclone and 20×25 cm glass fiber filter (GFF) for collecting the PM<sub>10</sub> and TSPM samples by centrifugal forces.

After completion of samplings and remove the GFF filter paper from RDS then the analysis of samples by using suitable techniques. The suspended particulate matter (TSPM) falling through the cyclone's conical hopper and collected in the cyclone cup and calculated the amount of non-respirable suspended particulate matter (NRSPM) or PM<sub>10</sub> per-unit volume of air passed on the basis of the difference between initial and final weight of the cyclone cup and the concentration of TSPM was calculated from total concentration of PM<sub>10</sub> and NRSPM. For collection of SO<sub>2</sub> and NO<sub>2</sub> samples by using impingers with RDS and an impingement rate was 1 Liter/minute. SO<sub>2</sub> was measured by using modified West and Geake method with the help of spectrophotometer at wavelength of 560 nm and NO<sub>2</sub> was measured by using modified Jacob-Hochheiser method with the help of spectrophotometer at wavelength of 540 nm [8].

**Questionnaire survey:** The present study, we have conducted the questionnaire survey from 100 houses located in and around Vijayawada Thermal Power Station at Ibrahimpatnam. This survey includes daily activity of different age group people health conditions changed day by day. We have observed my investigation of these people; they suffered much kind of diseases like allergies, skin problems, sinus, cold, flu, nausea or dizziness, eyes or nose irritation headache and mental fatigue.

## RESULTS AND DISCUSSION

We were collected total of 180 samples from proposed sites during summer season (March 2010 to May 2010) in rural and urban areas of Vijayawada. The resulted concentration of various air pollutants are presented in table1.

**Table:1:** Ambient air concentration of pollutants( $\mu\text{g}/\text{m}^3$ ) and monitoring sites in rural and urban area of Vijayawada

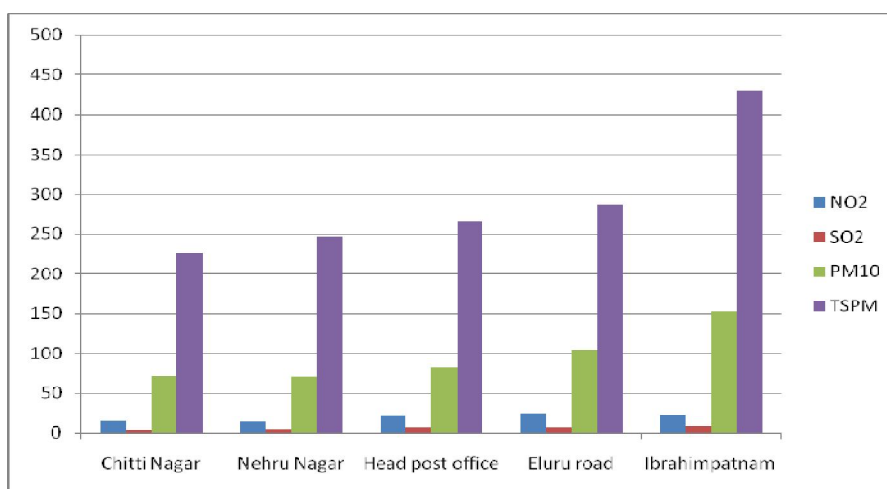
	March 2010				April 2010				May 2010			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
<b>Location1 : Chitti Nagar</b>												
NO <sub>2</sub>	10.59	4.08	13.01	2.23	16.44	18.08	17.14	0.84	7.74	22.11	20.06	2.19
SO <sub>2</sub>	4.08	5.32	4.80	0.64	4.98	6.01	5.65	0.58	5.01	6.14	5.67	0.59
PM <sub>10</sub>	65.48	76.14	71.60	5.50	79.14	95.01	84.91	8.77	79.01	90.55	86.01	6.16
TSPM	210.58	240.48	225.62	14.95	210.64	280.18	250.39	35.81	205.48	80.67	239.01	38.24
<b>Location 2: Nehru Nagar</b>												
NO <sub>2</sub>	12.48	17.07	14.86	2.30	15.01	20.17	17.75	2.59	18.03	25.11	21.07	3.64
SO <sub>2</sub>	3.02	5.06	4.02	1.02	5.01	6.88	5.97	0.93	5.89	6.24	6.09	0.18
PM <sub>10</sub>	68.75	73.21	70.82	2.24	80.03	95.08	89.04	7.95	85.72	98.01	91.95	6.14
TSPM	220.13	280.16	246.41	30.70	220.01	310.13	266.79	45.15	235.18	300.15	265.15	32.77
<b>Location 3: Head Post office</b>												
NO <sub>2</sub>	17.44	24.38	21.68	3.71	17.59	26.12	22.63	4.47	22.09	27.15	23.82	2.88
SO <sub>2</sub>	5.05	8.70	6.58	1.89	6.00	7.17	6.53	0.59	6.12	7.94	7.31	1.03
PM <sub>10</sub>	76.50	92.28	81.90	8.98	97.52	108.23	101.28	6.02	99.12	112.41	107.55	7.33
TSPM	231.02	318.72	264.96	47.08	259.23	386.51	312.52	66.11	250.36	380.36	309.17	65.87

<b>Location 4: Eluru Road</b>												
NO <sub>2</sub>	17.44	27.0	22.55	4.81	9.57	17.96	12.68	4.59	16.56	19.46	18.25	1.51
SO <sub>2</sub>	5.05	8.70	6.58	1.89	5.37	7.28	6.24	0.96	4.26	6.81	5.14	1.44
PM <sub>10</sub>	76.50	92.28	81.90	0.98	72.73	122.14	104.16	27.31	76.83	121.59	106.28	225.51
TSPM	231.02	318.72	264.96	47.08	231.58	395.23	314.98	81.87	241.62	386.39	317.09	72.58
<b>Location 5: Ibrahim Patnam</b>												
NO <sub>2</sub>	19.39	26.42	23.36	3.60	16.56	19.46	18.25	1.51	23.12	29.59	25.84	3.35
SO <sub>2</sub>	6.78	9.12	7.74	1.22	4.26	6.81	5.14	1.44	7.08	9.28	7.91	1.19
PM <sub>10</sub>	135.19	169.16	151.60	17.01	76.83	121.59	106.28	25.51	134.44	161.72	148.27	13.64
TSPM	375.20	486.45	429.69	55.65	241.62	386.39	317.09	72.58	315.46	403.81	366.62	45.80

**Specific variations of different pollutant concentrations:** In proposed sites, the various air pollutant concentrations are medium level in summer season due to high temperature, high wind erosion and low humidity. In this paper, we report the concentration of NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub> and TSPM ranges are observed from five proposed sites in rural and urban areas of Vijayawada. The concentration of NO<sub>2</sub> is ranged from 10.59 µg/m<sup>3</sup> to 22.11 µg/m<sup>3</sup> in sensitive area, 12.48 µg/m<sup>3</sup> to 25.11 µg/m<sup>3</sup> in residential area, 17.44 µg/m<sup>3</sup> to 27.15 µg/m<sup>3</sup> in commercial area, 9.57 µg/m<sup>3</sup> to 27.10 µg/m<sup>3</sup> in traffic area and 19.39 µg/m<sup>3</sup> to 29.59 µg/m<sup>3</sup> in industrial area and simultaneously the concentration of SO<sub>2</sub> is ranged from 4.08 µg/m<sup>3</sup> to 6.14 µg/m<sup>3</sup> in sensitive area, 3.02 µg/m<sup>3</sup> to 6.88 µg/m<sup>3</sup> in residential area, 5.05 µg/m<sup>3</sup> to 8.70 µg/m<sup>3</sup> in commercial area, 4.26 µg/m<sup>3</sup> to 7.72 µg/m<sup>3</sup> in traffic area and 6.12 µg/m<sup>3</sup> to 9.28 µg/m<sup>3</sup> in industrial area. The concentration of PM<sub>10</sub> is ranged from 65.48 µg/m<sup>3</sup> to 95.01 µg/m<sup>3</sup> in sensitive area, 68.75 µg/m<sup>3</sup> to 98.01 µg/m<sup>3</sup> in residential area, 76.50 µg/m<sup>3</sup> to 112.41 µg/m<sup>3</sup> in commercial area, 72.73 µg/m<sup>3</sup> to 122.14 µg/m<sup>3</sup> in traffic area and 129.36 µg/m<sup>3</sup> to 169.16 µg/m<sup>3</sup> in industrial area. Further it was observed that concentration of TSPM is ranged from 205.48 µg/m<sup>3</sup> to 280.67 µg/m<sup>3</sup> in sensitive area, 220.01 µg/m<sup>3</sup> to 310.13 µg/m<sup>3</sup> in residential area, 231.02 µg/m<sup>3</sup> to 386.51 µg/m<sup>3</sup> in commercial area, 231.58 µg/m<sup>3</sup> to 395.23 µg/m<sup>3</sup> in traffic area and 305.11 µg/m<sup>3</sup> to 486.45 µg/m<sup>3</sup> in industrial area.

**Monthly variation in concentration of pollutants:** Monthly comparison of NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub> and TSPM average concentration levels in summer season are shown in fig.2. Significantly highest concentration of NO<sub>2</sub> was observed in May 2010 and SO<sub>2</sub> concentration levels also highest in the same month compare to other months in summer period [18, 14]. PM<sub>10</sub> concentration levels are observed highest in March 2010 as well as TSPM is also higher in the same month than compare to other months in study period.

Month of March



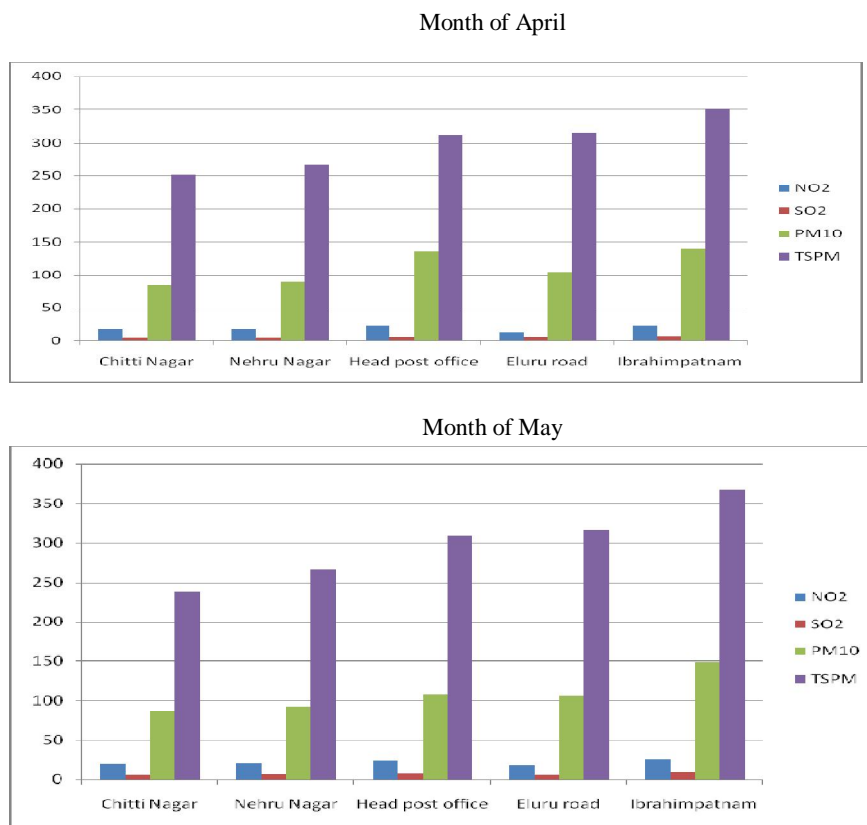
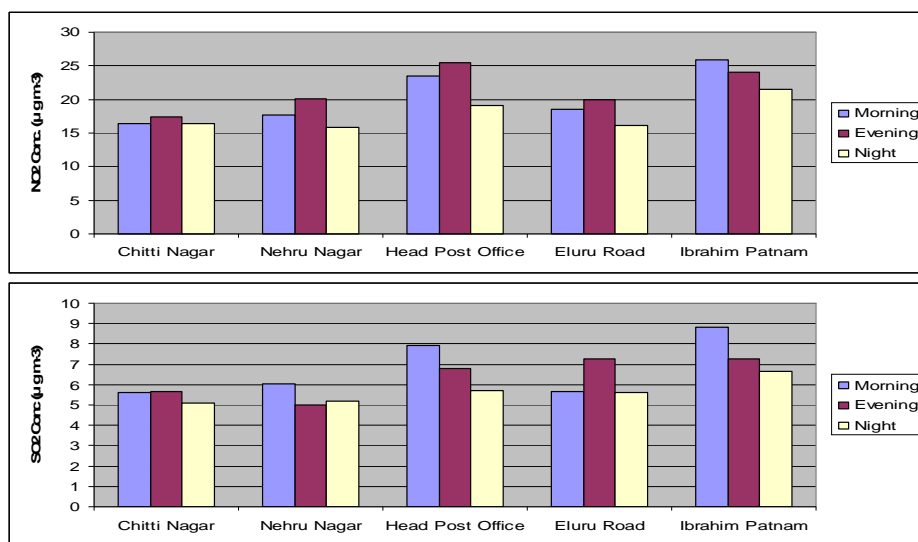


Fig. 2. Monthly average concentration of air pollutants proposed sites in and around Vijayawada.

**Day variation in concentration of pollutants:** The day (24 hours) variation of NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub> and TSPM concentration levels are represented as triple peak structure in fig.3. The first peak is indicated that the morning hours, the second peak is shown the evening hours and third peak is for night hours. After analyzing that the highest concentration of NO<sub>2</sub> was recorded in morning hours and also highest SO<sub>2</sub> concentration levels are recorded same time. PM<sub>10</sub> concentration levels are observed highest in evening time as well as TSPM is also higher in the same time.



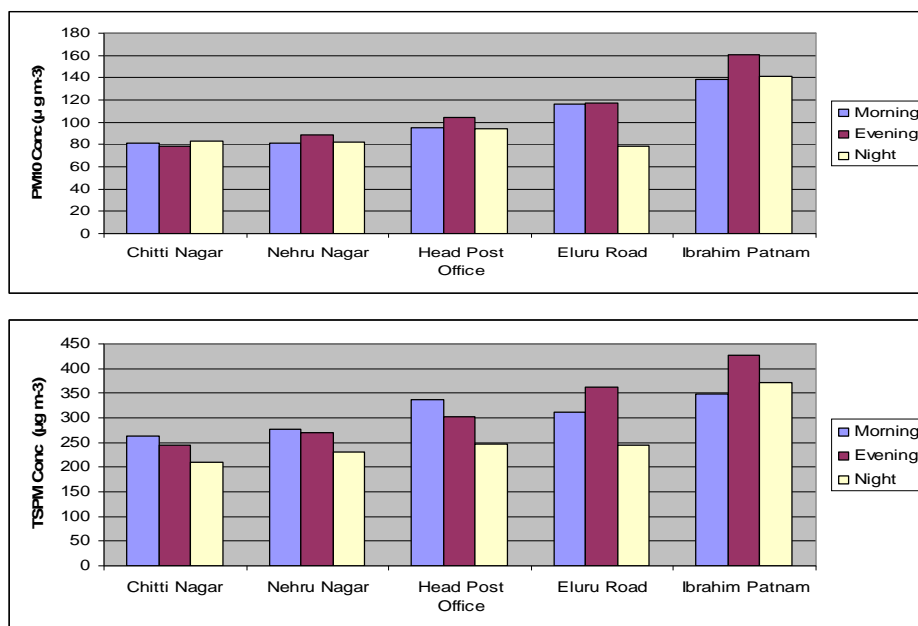


Fig. 3: Day average concentration of NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub> and TSPM at proposed sites.

**Questionnaire survey on health effects:** The questionnaire survey was conducted from 100 houses about their health effects near by Vijayawada Thermal Power Station in industrial area at Ibrahimpatnam (table 2).

Table 2. Questionnaire survey analysis of human diseases\*

S.No.	Name of Disease	Distance up to 0.5 Km	Distance up to 1 Km	Distance up to 1.5 Km
1.	Respiratory Problems	75	65	60
2.	Cardiovascular	60	52	45
3.	Headaches	80	60	55
4.	Eyes and nose irritation	70	60	50
5.	Cold and flu	50	45	40
6.	Allergies	48	25	18
7.	Skin problems	60	50	40
8.	Sinus problems	30	25	16
9.	Mental fatigue	30	20	15
10.	Nausea and dizziness	20	15	14

\*(People suffered with diseases in percentage)

The air pollution is create a variety of health effects in human body [3] and immediate health disorder including such as irritation of the eyes, nose and throat, headaches, cold, dizziness and fatigue, the health

effects may be apparent years and it includes respiratory diseases, heart diseases, cardiovascular diseases and cancer. According to this survey, the higher percentage of people is suffered with headache compare to other diseases in short distance from industrial area.

### APPLICATIONS

This study is useful to make the People awareness to control of pollution and motivation.

### CONCLUSIONS

In conclusion, the samples of NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub> and TSPM concentration values are observed in varied at different sites in rural and urban areas of Vijayawada and we have conducted questionnaire survey on human health from 100 houses up to distance 0.5 Km to 1.5 Km around the Vijayawada Thermal Power Station at Ibrahimpatnam. In this area is assuming the concentration of NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub> and TSPM values are observed higher compare to other proposed sites. The questionnaire survey also reveals a significant of high percentage of people suffered with headache and respiratory diseases compare to other diseases in industrial areas than other sites. This study was indicated to need the awareness programmes and control by pollution and motivate the people by respective authorities.

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