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Ambient Air Quality Index Study of Mandideep Industrial Area, Madhya Pradesh, India

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Abstract

Mandideep is fast developing industrial area near Bhopal, the capital of Madhya Pradesh. Numerous large and small scale industries in Mandideep have paved the way for a stable economy. Thus, the demand for pollution free environment has increased enormously, resulting in a severe pressure on the environmental resources. To assesses the Ambient Air Quality Index of Mandideep Industrial area of Madhya Pradesh, India. A study has been conducted during year 2017 to 2018. Total thirteen locations were selected in Mandideep Industrial area for ambient air quality monitoring of seven pollutants mainly particulate matter less than 10 µ size (PM_{10}), particulate matter less than 2.5 µ size ($PM_{2.5}$), oxides of nitrogen (NOx), sulphur dioxide (SO_2), ozone (O_3), ammonia (NH_3) and lead (Pb). The study revealed that average concentration of gaseous pollutants i.e. NOx, SO_2, O_3, NH_3 in ambient air are well within standard limits at all selected locations however particulate matter (PM_{10}, $PM_{2.5}$) levels were found exceeding the National Ambient Air Quality Standards 2009 at few monitoring locations. Air Quality Index was poor (235.10) at one location, moderate (104.41-200) at eight locations and satisfactory (89-98) at four locations around Mandideep industrial area during year 2017-18. Overall ambient Air Quality Index of Mandideep industrial area was observed to be moderate during this study span.

Key Words: Ambient Air Pollution, Industrial area, PM_{10}, $PM_{2.5}$, NOx, SO_2, Air Quality Index

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1. Introduction

India, a developing country, is one of the first ten industrial countries of the .Air pollution in India has increased rapidly because of intensive population growth, increase in the numbers of vehicles,

use of fuels with poor environmental performance, badly mentioned transportation systems, poor land use pattern, industrialization, and above all, ineffective environmental regulations [1]. Such activities have great impact on the ecology and agriculture as well as health and safety effects. Dust is small enough (small volume ranges between 0.01 - 200 Microns), that can be carried away for long distance and cause soil degradation in case it contains heavy metals and air pollution. Small suspended solids particle (small volume ranges between 0.01 - 200 Microns), remain in air for a long period of time. For this reason, these particles increase the respiratory diseases, especially asthma, and may lead to lung tissue damage. Relatively bigger particles (Nuisance dust) settle down more rapidly due to their weight where air turbulence cannot sustain their presence in suspension for a long period of time. In addition to that smaller particles seem to interact with other air pollutants, leading to severe damages [2- 5].

Air pollution is a major problem in developed and developing countries. It causes respiratory diseases and chronic illness [6-8]. Both human activities and natural environmental processes are major sources of pollution. Seasonal changes and chemical reactions contribute to the concentration of the pollutants in the air [9]. An "Air Quality Index" may be defined as a single number for reporting the air quality with respect to its effects on the human health [10]. Air Quality Index is a tool for effective communication of air quality status to people in terms, which are easy to understand. It transforms complex air quality data of various pollutants into a single number (index value), nomenclature and colour. There are six AQI categories, namely good, satisfactory, moderately polluted, poor, very poor, and severe. Each of these categories is decided based on ambient concentration values of air pollutants and their likely health impacts (known as health breakpoints). Air quality index values are divided into ranges, and each range is assigned a descriptor and a colour code. Standardized public health advisories are associated with each AQI range. There are six levels of health concern and what they mean are: Good AQI is 0-50. Air quality is considered satisfactory, and air pollution poses little or no risk. Moderate AQI is 51-100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. Unhealthy AQI is 151-200. Very Unhealthy AQI is 201-300. Hazardous AQI greater than 300 which can be very poor (301-400) and severe (401-500 & >500) [11]. All atmospheric substance that is not gases but may be suspended droplets, solid particle or mixture of the two is generally referred to as particulates.

Particulate matter causes respiratory problems like asthma, reduction in visibility and cancer. It also affects lungs and tissues [12]. Oxides of nitrogen cause respiratory problem, asthma, lung irritation and pneumonia. Higher concentration of oxides of sulphur causes bronchitis. It also causes acid rain, sulphurous smog and reduced atmosphere visibility. Combination of particulate matter with sulphur oxides is more harmful than either of them separately [13]. Ozone is produced in the upper atmosphere by solar reaction. Small concentration of this gas diffuses downward and become the major concern in air pollution. It causes irritation of eyes nose and throat, headache in man. The prominent studies related to various aspects of air quality indexes are shown wide information related with air pollution [14–24].

Air bone gases and particles were never envisaged as a threat to the ecological balance until the dramatic changes in their concentrations with the advent of industrial era. Anthropogenic emissions from various industrial, domestic and automobile sources have increased manifold and eventually have led to many global problems. Particulate matter from these sources may contain hazardous pollutants that can have carcinogenic and mutagenic effects. Thus, identification of the sources is important. Very few studies have been conducted in this part of the world on

characterization of fine particulate matter ($PM_{2.5}$ or less), but their characterization and source identification is very much important as these particles can remain suspended in the air for long time and can be transported to a long distance with wind and can easily penetrate deep into our respirable tract. It should become a national effort to promote industrial area as a location for clean and green technologies to prove a point to the world. Modernization and industrialization of developing countries has led to the increased use of fossil fuels and their derivatives [25].

2. Methodology

2.1. Study Area

Mandideep is a municipality in Goharganj subdistrict of Raisen district in the Indian state of Madhya Pradesh. Mandideep is 23 km from Mandideep and is basically an Industrial township which came into existence in late 1970s. Mandideep is a Industrial area established in year 1975, is situated near Mandideep, 25 KM away from state capital of Madhya Pradesh. As of 2001 India census, Mandideep had a population of 39,898. It is situated between the latitude 22 47' and 23 33' north and the longitude 77 21' and 78 49' east and is bounded in the west by Sehore District, in the north by Vidisha District, in the east and southeast by Sagar District, and in the south by Hoshangabad and Sehore districts [26].

2.2. Monitoring Locations

Mandideep industrial area were divided in to 20 Blocks in which 13 blocks were selected for this study and other 7 blocks have open area around was no monitoring blocks. Total thirteen locations were selected for ambient air is depicted in table no 1 and figure no 1.

Table 1: Monitoring Locations around Mandideep industrial area.

S.N	Code	Monitoring Locations	Monitoring Points
1	A 1	Block 2	Near St Chavara, H. S. School, New Satlapur Mandideep
2	A2	Block 5	Near M/S Bansal Extraction & Exports Pvt, Ltd Mandideep
3	A3	Block 6	Near M/S Bhaskar Industry, Mandideep
4	A 4	Block 7	Near M/S Proctor & Gamble, Mandideep
5	A 5	Block 8	Near M/S Mahindra Steel Service Centre, Mandideep
6	A 6	Block 9	Near M/S Dawat Food Industry, Mandideep
7	A 7	Block 11	Near M/S TMTL (Eicher Tectors), Mandideep
8	A 8	Block 12	Near M/S HEG, Mandideep
9	A 9	Block 13	Near M/S Lupin ltd, Mandideep
10	A 10	Block 14	Near M/S Vardhman Yarns, Mandideep

11	A 11	Block 16	Near Lalit Gitanjali Hospital, Mandideep
12	A 12	Block 17	Near AKVN, Mandideep
13	A 13	Block 18	Near M/S Crompton & Greaves, Mandideep
Remark -Block 1,3,4,10,15,19,20 are no monitoring zones			

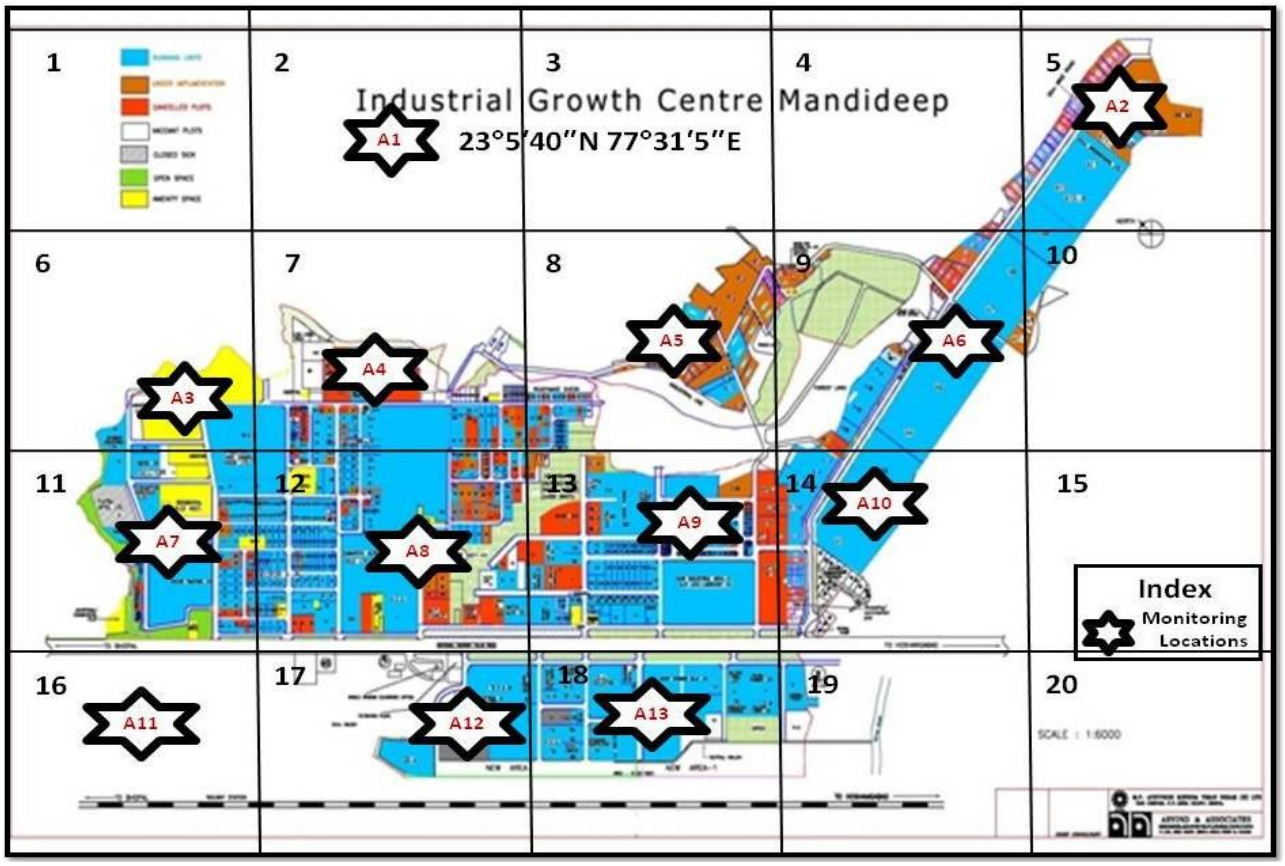

Figure 1: Monitoring Locations around Mandideep industrial area

2.3. Monitoring

Ambient air was drawn through a size-selective inlet of the dust sampler Envirotech APM-460 BL and APM 540 equipments. 24 hour air monitoring has been conducted in eight hrs basis in selected eighteen locations for parameters namely Particulate Matter less than 10 µ size (PM_{10}), Particulate Matter less than 2.5 µ size ($PM_{2.5}$), Sulphur dioxides (SO_2), oxides of nitrogen (NOx) were monitored on four hourly basis. Ozone (O_3) and ammonia were monitored on one hourly basis for during the entire monitoring duration. The collected samples were analyzed for various parameters using standard methods prescribed by Central Pollution Control Board, India [27]. Particulate Matter (PM_{10} and $PM_{2.5}$) in ambient air were analyzed by gravimetric method. Oxides of nitrogen, sulphur dioxide in ambient air were analyzed by Jacob & Hochheiser method and

West & Geake method respectively. Ozone, ammonia, heavy metal lead in ambient air was analyzed by chemical method, indophenols blue method and atomic absorption spectroscopy respectively.

Central Pollution Control Board, India set guidelines for Indian national ambient air quality standards of 12 pollutants (CPCB, 2009). Out of which 7 pollutants NO_2, SO_2, $PM_{2.5}$, PM_{10}, O_3, Pb and NH_3 have short term standards. To inform people about the quality of air quickly so that people can take appropriate measures to protect themselves, India-AQI was released in 2014. The details of India-AQI are available elsewhere (CPCB, 2014), and only briefly summarized here. India-AQI considers concentrations of PM_{10}, $PM_{2.5}$, NO_2, O_3, SO_2, NH_3 and Pb. The concentration of each pollutant is converted to a number on a scale of 0–500. The sub AQI (AQIi) for each pollutant (i) is calculated using Eq. (1).

$$AQI = I_{HL}\text{-}I_{LO} / B_{HO}\text{-}B_{LO} * (C_i - BR_{LO}) + I_{LO} \quad \text{Eq. (1)}$$

Where, Ci is the concentration of pollutant 'i'; BR_{HI} and BR_{LO} are breakpoint concentrations greater and smaller to Ci and I_{HI} and I_{LO} are corresponding AQI ranges.

The overall AQI, India-AQI, can be estimated only if the concentrations of minimum three pollutants are available, with at least one of them being either PM2.5 or PM10. The India-AQI is then taken as the maximum AQI_i of the constituent pollutants, denoted as dominating pollutant.

3. Results & Discussion

The cumulative effect of concentration of individual pollutants in ambient air is often expressed through a single value in the form of Air Quality Index (AQI). Air pollution index was calculated for seven parameters at all monitoring location around Mandideep industrial area. The observed concentration of seven air pollutants is depicted in table 2 and showing in figure 2.

Table 2: Concentration of air pollutants around Mandideep, Industral Area

S.N	Sampling Locations	NOx ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	O_3 ($\mu g/m^3$)	NH_3 ($\mu g/m^3$)	Pb ($\mu g/m^3$)
1	A1	7.56	0	127	62	0	0	0.122
2	A2	16.31	8.33	160	73	6.3	11.99	0.064
3	A3	28.54	0	98	41	29.04	5.43	0.155
4	A4	23.46	3.58	122	84	2.32	2.19	0.343
5	A5	13.23	0	89	47	4.13	0.62	0.093
6	A6	21.04	2.51	95	52	5.02	62.86	0.058
7	A7	22.38	0	92	54	3.13	9.03	0.044
8	A8	12.12	21.68	137	101	1.94	16.16	0.265
9	A9	13.63	4.82	121	56	2.42	108	0.201
10	A10	16.01	17.02	129	68	8.75	38.9	0.084
11	A11	13.25	5.71	151	90	3.83	4.37	0.116
12	A12	19.17	6.7	162	86	29.65	23.15	0.016
13	A13	20.09	0	125	60	7.01	14.21	0.012

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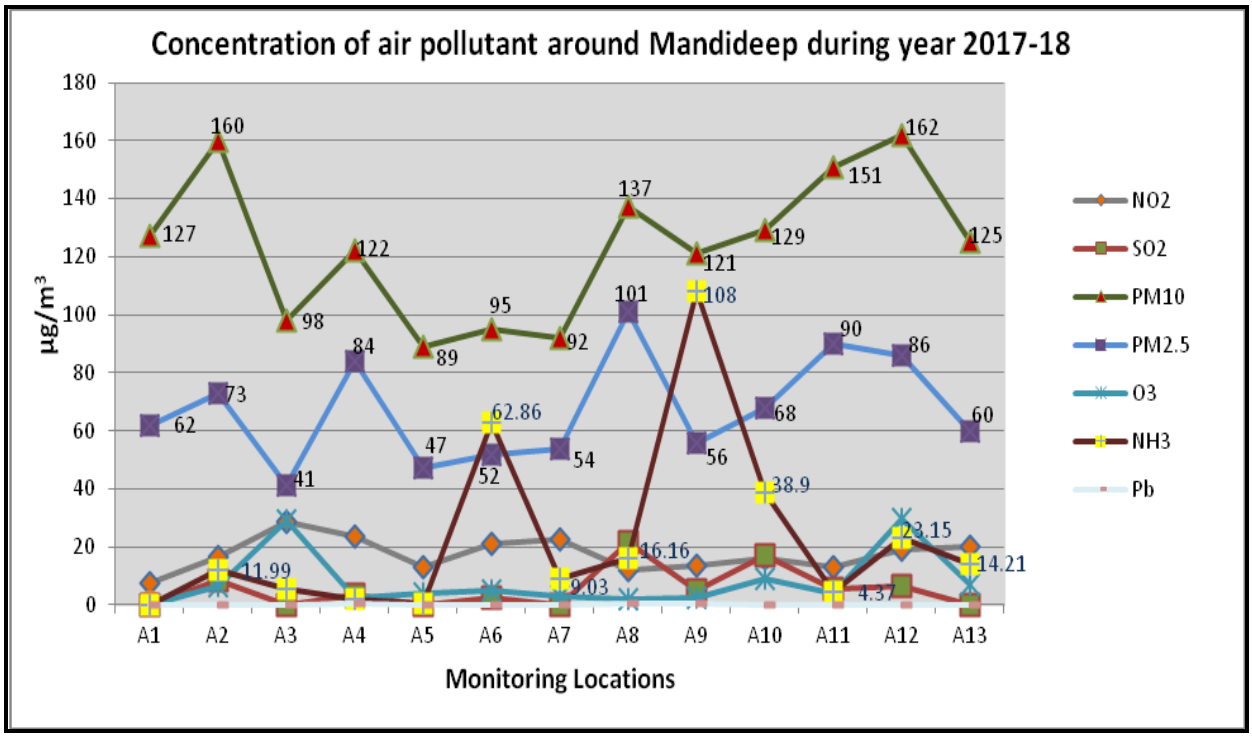

Figure 2: Concentration of air pollutant around Mandideep industrial area during year 2017-18

AQ sub-index and health breakpoints are evolved for seven pollutants (PM_{10}, $PM_{2.5}$, NO_2, SO_2, O_3, NH_3, and Pb) for which short-term (upto 24-hours) National Ambient Air Quality Standards are prescribed by Central Pollution Control Board of India. Sub Index and Air Quality Index of seven air pollutant studied are depicted in table 3.

Table 3: Sub Index and Air Quality Index of air pollutant in Mandideep industrial area

S.N	Sampling Locations	NOx ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	O_3 ($\mu g/m^3$)	NH_3 ($\mu g/m^3$)	Pb ($\mu g/m^3$)
1	A1	9.45	0	118.16	104.41	0	0	12.2
2	A2	20.39	10.41	139.94	141.92	6.3	3	6.4
3	A3	35.68	0	98	67.89	29.04	1.36	15.5
4	A4	29.33	4.48	114.86	179.43	2.32	0.55	34.3
5	A5	16.54	0	89	78.02	4.13	0.16	9.3
6	A6	26.3	3.14	95	86.47	5.02	15.72	5.8
7	A7	27.98	0	92	89.85	3.13	2.26	4.4
8	A8	15.15	27.1	124.76	235.1	1.94	4.04	26.5
9	A9	17.04	6.03	114.2	93.23	2.42	27	20.1
10	A10	20.01	21.28	119.48	124.87	8.75	9.73	8.4

11	A11	16.56	7.14	134	199.89	3.83	1.09	11.6
12	A12	23.96	8.38	141.26	186.25	29.65	5.79	1.6
13	A13	25.11	0	116.84	99.98	7.01	3.55	1.2

The Air Quality Index were found poor (235.10) at one monitoring location i.e. A8, satisfactory (89-98) at four monitoring locations i.e. A5 (89.00), A7 (92.00), A6 (95.00) and moderate (100-200) at eight monitoring location i.e. A1 (118.16), A2 (141.92), A4 (179.43) ,A9 (114.20), A10 (124.87) , A11 (199.89), A12 (186.25), A13 (116.84) during year 2017-18. Range and distribution of air quality at around Mandideep industrial area is depicted in table 4.

Table 4: Range and distribution of air quality around Mandideep industrial area

Index	**Category**	2017-18	
		No of Locations	**Name of Locations**
401-500	SEVERE	0	-
301-400	VERY-POOR	0	-
201-300	POOR	1	A8
101-200	MODERATE	8	A1,A2,A4,A9,A10,A11,A12,A13
51-100	SATISFACTORY	4	A3,A5,A6,A7
0-50	GOOD	0	-

The overall relative AQI with background study of sources of pollution at selected monitoring locations in Mandideep industrial area during study period depicted in Table 5.

Table 5: Air quality index with pollution sources at monitored locations around Mandideep industrial area

Code	**Sampling Point**	**AQI during year 2017-18**	**Pollution Sources**
A1	St Chavara, H. S. School, New Satlapur Mandideep	118.16	School Activities, Road side ,Vehicle, Public activities, Anthropogenic activity, residential and salient area
A2	M/S Bansal Extraction & Exports Pat, Ltd Mandideep	141.92	Near admin building, edible oil extraction unit, soya meal production unit, Transport, Vehicle and public activity
A 3	M/S Bhaskar Industry, Mandideep	98.00	Near Textile Industry, Near mandir, production unit , Transport, Vehicle and public activity

A 4	M/S Proctor & Gamble, Mandideep	179.43	Near Industry unit II, Production Unit, Transport, Vehicle and public activity
A5	M/S Mahindra Steel Service Centre, Mandideep	89.00	Near Nayapura, Hill area, Transport, Vehicle and public activity
A 6	M/S Dawat Food Industry, Mandideep	95.00	Left side MPED, right side Vardhman industry, in front road near kanpura gao Transport, Vehicle and public activity
A7	M/S TAFE Motors and Tractors Limited (Eicher Trectors), Mandideep	92.00	Near fabrication yard, right side makson industry , left side road, mechanical engineering workshop, steel related work, Transport, Vehicle and public activity
A 8	M/S HEG, Mandideep	235.10	Near Highway NH12, HEG thermal power station, in front of Indira Nagara, Traffic Area, Transport, Vehicle and public activity
A9	M/S Lupin ltd, Mandideep	114.20	Near Highway NH12, Pharmaceutical Unit, Transport, Vehicle and public activities.
A10	M/S Vardhman Yarns, Mandideep	124.87	Near Highway NH12, Near Dawat Industry, Transport, Vehicle and public activities
A11	M/S Lalit Gitanjali Hospital, Mandideep	199.89	Indira Nagar residential area, Grocery Shops, Public activities
A12	M/S AKVN, Mandideep	186.25	Highway NH12, Insulators and electrical unit, SMV unit Transport, Vehicle and public activities
A13	M/S Crompton & Greves, Mandideep	116.84	Infront of Anant spinning mill, left side railway track, right and back side Sourabh metals Transport, Vehicle and public activities

The significant correlation of Air Quality Index of thirteen teen monitoring locations in Mandideep industrial area during year 2017 to 18 is shown in figure no 3.

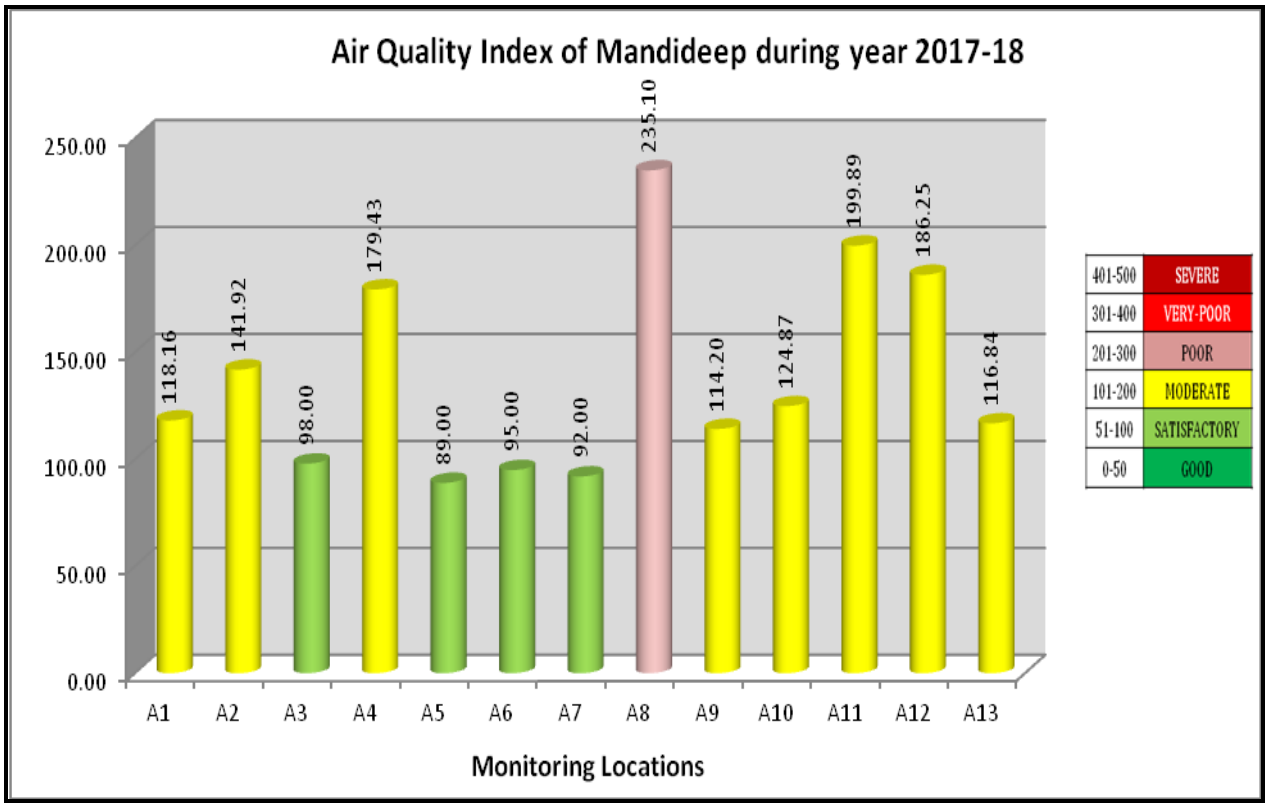

Figure 3: Air Quality Index of Mandideep industrial area during year 2017 -18

4. Conclusion

Air Quality Index was poor (235.10) at one location, moderate (104.41-200) at eight locations and satisfactory (89-98) at four locations around Mandideep industrial area. Overall ambient Air Quality Index of Mandideep was observed to be moderate during year 2017-18. It may cause serious aggravation of heart or lung disease, it is indication of increased risk of cardio respiratory symptoms in general population in Mandideep industrial area of Madhya Pradesh, India.

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6. References

[1] Chattopadhyay S., Gupta S. and Saha R. N. (2010), Spatial and Temporal Variation of Urban Air Quality: A GIS Approach. Journal of Environmental Protection, 1: 264-277.
[2] World Health Organization (WHO) (1996) Revised WHO Air Quality Guidelines for Europe.
[3] Hashim, B.M. (2009) Measurement and Study Concentrations Some Air Pollutants in Baghdad City. M.Sc. Thesis, College of Science Al-Mustansiriyah Univ. in Atmospheric Sciences, 95 p.
[4] Al-Saadi, G.M. (2012) Assessment of Air and Water Pollution Due to Operation South of Baghdad Power Plant. M.Sc. Thesis, Building and Construction Engineering Department, University of Technology, 147 p.
[5] Leili, M., Naddafi, K., Nabizadeh, R. and Yunesian, M. (2008) The Study of TSP and PM10 Concentration and Their Heavy Metals Content in Central Area of Tehran, Iran. *Air Quality Atoms Health*, 1, 159-166. http://dx.doi.org/10.1007/s11869-008-0021-z
[6]McCubbin, D.R. and Delucchi, M.A. (1999) The health cost of motor vehicle related air pollution. Journal of Transport Economics and Policy. 33 (3) : 253 -286.
[7] CIESIN (Center for International Earth Science Information Network), Columbia Universit and Centro International de Agriculture Tropical, CIAT) (2004) Gridded Population of the World (GPW), Version 3.
[8] Zhang Jin Tun, R. Pouyat and J.T. (2000) Zhang. Effects of urbanization on the concentrations of heavy metals in deciduous forest floor in a case study of New York City. Scientia Silvae Sinicae. 36 (4) : 42-45.
[9] S. Cheng, and K.C. Lam. (1997) Climatic Impact on air pollution concentrations in Hong Kong. Department of Geography, Occasional paper, The Chinese University of Hong Kong, Hong Kong.
[10] Bortnick, S. M., Coutant, B. W. and Eberly. S. I. (2002). Using Continuous PM2.5 Monitoring Data to Report an Air Quality Index. J. Air Waste Manage. Assoc. 52: 104-112.
[11] http://cpcb.nic.in/About_AQI.pdf
[12] D S Khandbahale and R S Saler. (2013) Ambient Air Quality Monitoring in Nashik city (Maharashtra, India) Bionano Frontier. 6: 2.
[13] P. Balashanmugam, A. R. Ramanathan and V. Nehru Kumar (2012). Ambient Air Quality Monitoring in Puducherry. Int J of Eng Res and Appli. 2.
[14] Kassomenos, P., Skouloudis, A. N., Lykoudis, S. and Flocas, H. A. (1999). Air-Quality Indicators" for Uniform Indexing of Atmospheric Pollution Over Large Metropolitan Areas. Atmos. Environ. 33: 1861-1879.
[15] Malakos, M. and Wong, K-F. V. (1999). Proposed Pollutant Index to Incorporate Synergistic Effects. Int. J. Environ. Poll. 12: 2-10.
[16] Swamee, P. K. and Tyagi, A. (1999). Formation of an Air Pollution Index. J. Air Waste Manage. Assoc. 49: 88-91.
[17] Trozzi, C., Vaccaro, R. and Crocetti, S. (1999). Air Quality Index and its Use in Italy's Management Plans. Sci. Total Environ. 235: 387-389.
[18] Khanna, N. (2000). Measuring Environmental Quality: an Index of Pollution. Ecol. Econ. 35: 191-202.

[19] Cogliani, E. (2001). Air Pollution Forecast in Cities by an Air Pollution Index Highly Correlated with the Meteorological Variables. Atmos. Environ. 35: 2871-2877.
[20] Jiang, D., Zhang, Y., Hu, X., Zeng, Y., Tan, J. and Shao, D. (2004). Progress in Developing an ANN Model for Air Pollution Index Forecast. Atmos. Environ. 38: 7055-7064.
[21] Longhurst, J. (2005). Creating an Air Quality Index in Pittsburg. Environ. Monit. Assess. 106: 27-42.
[22] Sawamura, P. and Uehara, S. T. (2007). Air Quality Assessment Using a MultiInstrument Approach and Air Quality Indexing in an Urban Area. Atmos. Res. 85: 98-111.
[23] Mayer, H. and Kalberlah, F. (2008). Two Impact Related Air Quality Indices as Tools to Assess the Daily and Long-Term Air Pollution. Int. J. Environ. Poll. 32: 232-243.
[24] Elshout, S. van den, Leger, K. and Nussio, F. (2008). Comparing Urban Air Quality in Europe in Real Time A Review of the Existing Air Quality Indices and the Proposal of a Common Alternative. Environ. Int. 34: 720-726.
[25] Joel Macwan and Pratik N. Ruparel. Urban Corridor Noise Pollution: A case study of Surat city, India International Conference on Environment and Industrial Innovation IPCBEE. 2011, vol.12, Singapore.
[26] https://en.wikipedia.org/wiki/Mandideep
[27] Guidelines for the Measurement of Ambient Air Pollutants Volume-I, Central Pollution Control Board .