IJIRR

International Journal of Information Research and Review
Vol. 06, Issue, 08, pp.6429-6433, August, 2019

RESEARCH ARTICLE

RECENT STATUS OF AMBIENT AIR QUALITY INDEX OF MANDIDEEP INDUSTRIAL AREA, MADHYA PRADESH, INDIA

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ARTICLE INFO

Article History:

Received 14th May, 2019
Received in revised form
10th June, 2019
Accepted 25th July, 2019
Published online 30th August, 2019

Keywords:

Industrial area, Ambient Air Pollution, PM_{10}, $PM_{2.5}$, Air Quality Index

ABSTRACT

Industrial pollution has adversely affected environment continues to increase globally. Mandideep is fast developing industrial area near Bhopal, the capital of Madhya Pradesh. 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 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 moderate (102.82-196.48) at eleven locations and satisfactory (98.25-100) at two locations around Mandideep during this study. Overall ambient Air Quality Index of Mandideep industrial area was observed to be moderate during this study span.

INTRODUCTION

In India, population is exposed mainly to ambient air pollutants from automobile exhaust and industrial activities. Pollutants like SO_2, NOx, particulate matter etc. can affect human health. Though respiratory system usually bears the main brunt of air pollutants, many other disorders involving other organ systems even cancers are attributed to air pollution [Suresh Kumar et al., 2011]. Major man-made activities include automobiles, power generation and industrial activities in particular oil refineries, which represent the main source of air pollution. Prolonged exposure to inhalant dust can cause serious disease. Industrial activities will be more hazardous in highly populated areas [Matejicek, 2013]. 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 [Hashim, 2009; Al-Saadi, 2012; Leili et al., 2008].

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Air pollution is a major problem in developed and developing countries. It causes respiratory diseases and chronic illness [McCubbin and Delucchi, 1999; Center for International Earth Science Information Network, 2004; Zhang et al., 2000]. 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 [Cheng and Lam, 1997]. 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 [Bortnick et al., 2002]. 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) [http://cpcb.nic.in/About_AQI.pdf]. 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 [Khandbahale and Saler, 2013]. 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 [Balashanmugam at el., 2012]. 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 [Kassomenos et al., 1999; Malakos and Wong, 1999; Swamee and Tyagi, 1999; Trozzi et al., 1999; Khanna, 2000; Cogliani, 2001; Jiang et al., 2004; Longhurst, 2005; Sawamura, 2007; Mayer and Kalberlah, 2008; Elshout et al., 2008]. 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. 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 [Joel and Ruparel, 2011].

METHODOLOGY

Study Area

Mandideep is a municipality in Goharganj subdistrict of Raisen district in the Indian state of Madhya Pradesh. Mandideep is 23 km from Bhopal. 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 [https://en.wikipedia.org/wiki/Mandideep].

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: Selected Location for Monitoring

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 (Transformer Div), Mandideep

Remark -Block 1,3,4,10,15,19,20 are no monitoring zones

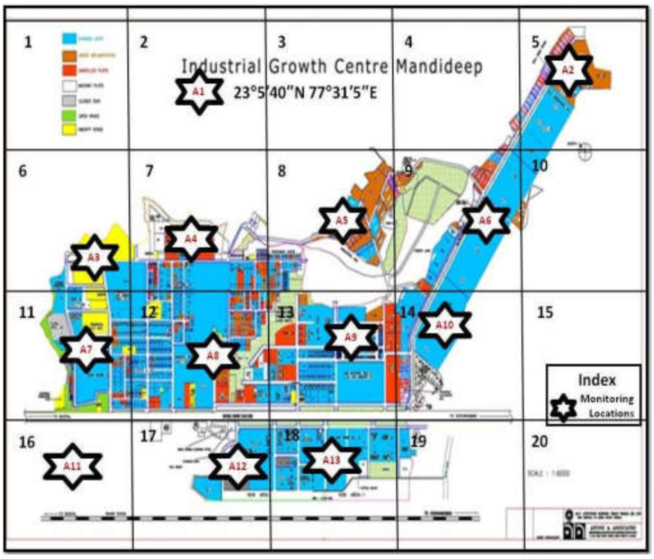

Figure 1: Monitoring Locations around Mandideep industrial area

Monitoring and Analysis: 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 [Guidelines for the Measurement of Ambient Air Pollutants Volume-I, Central Pollution Control Board].

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 were studied during this study. 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).

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

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 $PM_{2.5}$ or PM_{10}. The India-AQI is then taken as the maximum AQI_i of the constituent pollutants, denoted as dominating pollutant. The India-AQI is divided into five categories: good, satisfactory, moderate, poor, very poor and severe depending on whether the AQI falls between 0–50, 51–100, 101–200, 201–300, 301–400 or 401–500, respectively [Guidelines for the Measurement of Ambient Air Pollutants Volume-I, Central Pollution Control Board].

RESULTS AND 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 quality 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 industrial area

S.N	Sampling Locations	NOx	SO_2	PM_{10}	$PM_{2.5}$	O_3	NH_3	Pb
		(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)
1	A1	5.5	0	109	58	3.97	0	0
2	A2	6.11	23.45	98	53	5.43	1.77	0.158
3	A3	5.75	0	100	48	2.59	2.15	0.176
4	A4	6.3	2.97	138	75	6.78	8.12	0.071
5	A5	16.46	0	107	37	5.39	9.37	0.087
6	A6	16.53	0	156	70	5.23	10.2	0.173
7	A7	18.16	0	104	35	2.16	0.43	0.047
8	A8	54.59	55.54	189	70	2.33	2.36	0.229
9	A9	30.76	15.37	136	54	13.57	1.77	0.19
10	A10	61.82	0	125	41	6.94	28.54	0.187
11	A11	6.58	2.26	146	89	3.6	15.52	0.123
12	A12	22.15	12.03	179	81	26.4	19.18	0.157
13	A13	3.98	49.61	124	66	23.05	3.12	0.063

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.

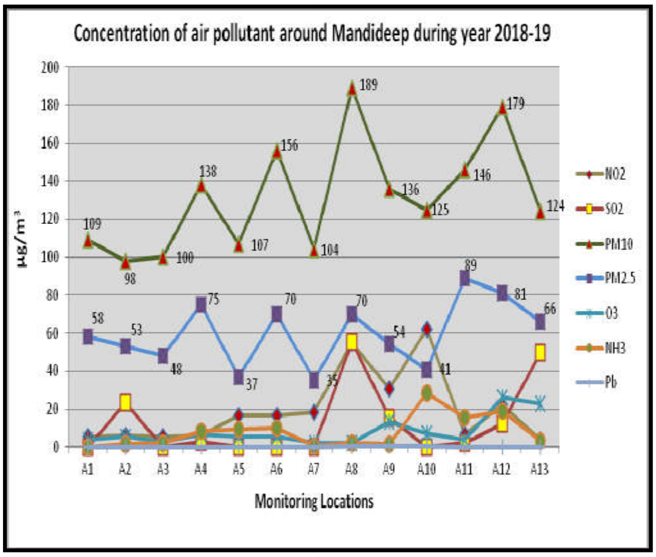

Figure 2. Concentration of air pollutants around Mandideep industrial area during year 2018-19

Table 3. Sub Index and Air Quality Index of air pollutants in Mandideep industrial area

S. N	Sampling Locations	NOx	SO_2	PM_{10}	$PM_{2.5}$	O_3	NH_3	Pb
		(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)
1	A1	6.88	0	106.28	96.6	3.97	0	0
2	A2	7.64	29.31	98	88.16	5.43	0.44	15.8
3	A3	7.19	0	100	79.71	2.59	0.54	17.6
4	A4	7.88	3.71	125.42	148.74	6.78	2.03	7.1
5	A5	20.58	0	104.96	61.13	5.39	2.34	8.7
6	A6	20.66	0	137.3	131.69	5.23	2.55	17.3
7	A7	22.7	0	102.98	57.76	2.16	0.11	4.7
8	A8	67.99	69.18	159.08	131.69	2.33	0.59	22.9
9	A9	38.45	19.21	124.1	89.85	13.57	0.44	19
10	A10	77.03	0	116.84	67.89	6.94	7.14	18.7
11	A11	8.23	2.83	130.7	196.48	3.6	3.88	12.3
12	A12	27.69	15.04	152.48	169.2	26.4	4.8	15.7
13	A13	4.98	61.76	116.18	118.05	23.05	0.78	6.3

The Air Quality Index were found satisfactory at two monitoring locations i.e. A2 (98.00), A3 (100.00) and moderate (100-200) at eleven monitoring location i.e. A1 (106.28), A4(148.74), A5(104.96), A6(137.30), A7(102.98), A8(159.08), A9(124.10), A10(116.84), A11(196.48), A12(169.20), A13(118.05) during year 2018-19. 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	2018-19	
		Number of Locations	**Name of Locations**
401-500	SEVERE	0	-
301-400	VERY-POOR	0	-
201-300	POOR	0	-
101-200	MODERATE	11	A1,A4,A5,A6,A7,A8,A9, A10,A11,A12,A13
51-100	SATISFACTORY	2	A2,A3
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 2018-19	Pollution Sources
A1	St Chavara, H. S. School, New Satlapur Mandideep	106.28	School activities, Road side ,Vehicle, Public activities, Anthropogenic activity, residential and salient area
A2	M/S Bansal Extraction & Exports Pat, Ltd Mandideep	98.00	Near admin building, edible oil extraction unit, soya meal production unit, Transport, Vehicle and public activity
A 3	M/S Bhaskar Industry, Mandideep	100.00	Near Textile Industry, Near mandir, production unit , Transport, Vehicle and public activity
A 4	M/S Proctor & Gamble, Mandideep	148.74	Near Industry unit II, Production Unit, Transport, Vehicle and public activity
A5	M/S Mahindra Steel Service Centre, Mandideep	104.96	Near Nayapura, Hill area, Transport, Vehicle and public activity
A 6	M/S Dawat Food Industry, Mandideep	137.30	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	102.98	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	159.08	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	124.10	Near Highway NH12, Pharmaceutical Unit, Transport, Vehicle and public activities.
A10	M/S Vardhman Yarns, Mandideep	116.84	Near Highway NH12, Near Dawat Industry, Transport, Vehicle and public activities
A11	M/S Lalit Gitanjali Hospital, Mandideep	196.48	Indira Nagar residential area, Grocery Shops, Public activities
A12	M/S AKVN, Mandideep	169.20	Highway NH12, Insulators and electrical unit, SMV unit Transport, Vehicle and public activities
A13	M/S Crompton & Greves (Transformer Div), Mandideep	118.05	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 2018 to 19 is shown in figure no 3.

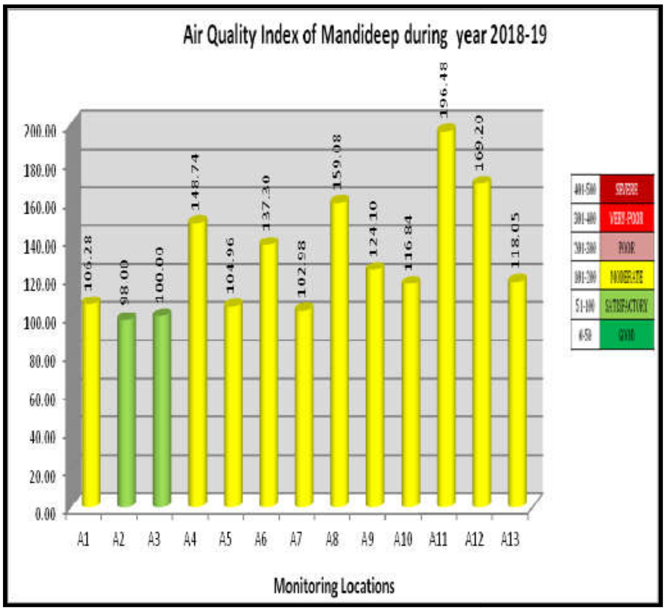

Figure 3. Air Quality Index of Mandideep industrial area during year 2018 -19

Conclusion

Air Quality Index was moderate (102.82-196.48) at eleven locations and satisfactory (98.25-100) at two locations around Mandideep. Overall ambient Air Quality Index of Mandideep was observed to be moderate during year 2018-19. 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.

Acknowledgements

We all authors acknowledge the help received from authorities of monitoring institutions and industries. We all authors also acknowledge to the Chairman and Member Secretary, Madhya Pradesh Pollution Control Board, for encouragement of study work and kind permission to publish this paper.

REFERENCES

Al-Saadi GM. 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.

Balashanmugam P, Ramanathan AR and Nehru VK. 2012. Ambient air quality monitoring in Puducherry. Int J of Eng Res and Appli. 2.

Bortnick SM, Coutant BW and Eberly SI. 2002. Using Continuous $PM_{2.5}$ monitoring data to report an air quality index. J. Air Waste Manage. Assoc. 52, 104-112.

Cheng S and Lam KC. 1997, Climatic impact on air pollution concentrations in hong kong. department of geography, occasional paper, The Chinese university of Hong Kong, Hong Kong.

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.

Cogliani E. 2001. Air pollution forecast in cities by an air pollution index highly correlated with the meteorological variables. Atmos Environ. 35: 2871-2877.

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.

Guidelines for the measurement of ambient air pollutants Volume-I, Central Pollution Control Board.

Hashim BM. 2009. Measurement and study concentrations some air pollutants in Baghdad City. M.Sc. Thesis, College of Science Al-Mustansiriyah Univ. in Atmospheric Sciences, 95.

http://cpcb.nic.in/About_AQI.pdf

https://en.wikipedia.org/wiki/Mandideep

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.

Joel M and Ruparel PN. Urban corridor noise pollution: a case study of Surat city, India International Conference on Environment and Industrial Innovation IPCBEE. 2011. 12.

Kassomenos P, Skouloudis AN, Lykoudis S and Flocas HA. 1999. Air quality indicators for uniform indexing of atmospheric pollution over large metropolitan areas. Atmos Environ. 33: 1861-1879.

Khandbahale DS and Saler RS, 2013, Ambient Air Quality Monitoring in Nashik city (Maharashtra, India) Bionano Frontier. 6, 2.

Khanna N. 2000. Measuring environmental quality: an index of pollution. Eco. Econ. 35: 191-202.

Kumar S, Nair P, Shenoy KT, Mularidharan V, Vijayalakshmi NR, Nikhil S, Simon A, Varghese N, and Ramaswamy V. 2011. Study of morbidity pattern of a population exposed to industrial air pollution at Trivandrum and Pune, India. Bio info Env Poll. 1: 1-4.

Leili M, Naddafi K, Nabizadeh R and Yunesian M. 2008. The Study of TSP and PM_{10} concentration and their heavy metals content in Central area of Tehran, Iran. Air Qua Atoms Heal.1: 159-166.

Longhurst J. 2005. Creating an Air Quality Index in Pittsburg. Environ. Monit. Assess. 106: 27-42.

Malakos M and Wong KFV. 1999, Proposed pollutant index to incorporate synergistic effects. Int J Environ Poll. 12: 2-10.

Matejicek L. 2013. Spatial Modeling of Air Pollution in Urban Areas with GIS: A case study on integrated database development. Adv Geosci. 4: 63-68.

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.

McCubbin DR. and Delucchi MA. 1999. The health cost of motor vehicle related air pollution. J Trans Eco Pol. 33: 253 -286.

Sahu K and Kota SH. 2017. Significance of $PM_{2.5}$ air quality at the Indian capital. Aero Air Qua Res. 17:588–597.

Sawamura P and Uehara ST. 2007. Air quality assessment using a multiinstrument approach and air quality indexing in an urban area. Atmos Res. 85: 98-111.

Swamee PK and Tyagi A. 1999. Formation of an Air Pollution Index. J Air Waste Manage Assoc. 49:88-91.

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.

Zhang JT, Pouyat R and Zhang JT. 2000. 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: 42-45.

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