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AMBIENT AIR QUALITY MONITORING IN A POPULAR TOURIST DESTINATION IN MAHARASHTRA, AURANGABAD

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Abstract:
Numerous health problems in both people and animals have been linked to air pollution. The investigation of how air pollution impacts health is ongoing, some dangerous diseases like cardiovascular disease, diabetes, obesity, and abnormalities of the reproductive, respiratory nervous, immune systems and Cancer are currently among the public health concerns. In the current study, we are attempting to determine the Aurangabad city's air quality, which can be useful in reducing air pollution. The results demonstrate that SBES college station is the most polluted and has the worst Air Quality Index of all the tested stations. Low air quality indices are seen at the final three stations, Waluj MIDC, C.A.D.A., and Collector Office. The AQI results for each sampling station indicate that the number of pollutants in the air in Aurangabad is steadily increasing, which is lowering the city's air quality. The air quality in those locations is poor to very poor. The results of the current study may serve to awaken people who are complacent about air pollution.

Keywords: *Pollution, Pollutants, Air Quality Index, Stations.*

1. Introduction:

Today's world still has a serious problem with air pollution. Numerous elements have an impact on air quality. The majority of experts think that socioeconomic human activities have the most effects on the environment[1]. For the majority of the year, many industrialized and emerging cities experience poor air quality. Land-based transportation, industrial pollutants, and human-caused activities are the main sources of air pollution[2]. The people's quality of life is impacted by ambient air pollution in urban areas of both developed and developing nations. Around 1.5 billion people are exposed to higher ambient air pollutant concentrations of suspended particulate matter (SPM), Sulphur dioxide ($S0_2$), and ozone, according to recent publications based on a study by Hong in 1995 (personal communication). The negative effects of ambient air pollution on health are well known in developed nations. The public is still not well informed about the negative effects of air pollution on health, especially in emerging nations where coal is heavily used for burning and the number of cars is rising. Only recently has ambient air pollution begun to receive the attention it deserves as a daily worry for everyone who lives in urban areas of emerging nations. However, due to the severity of the air pollutant concentrations observed in such areas, adverse health effects are anticipated for the local populations[3]. Total mortality was directly linked to prolonged exposure to particulate matter in all analytical analyses. More than 7000 litres of air, containing diverse amounts of inorganic, organic, and different types of gases, are directly inhaled into our lungs each day[4]. The Air Quality Index is a tool used to easily explain the ambient air quality to the general public. It simplifies the complicated information about different air contaminants into a single number known as the index value together with nomenclature and color. The Central Pollution Control Board of India's criteria were followed in order to compute the Air Quality Index (AQI) and attempt to depict the overall air quality in Aurangabad's residential and industrial areas[5].

2. Material and Methods:

Aurangabad district lying between 19^0 18' and 20^0 40' north latitude and $74^0$40' and 76^0 40' east longitude with an area of 16,200.0 square kilometres had a population of 19,71,006 with 10 towns and 1, 975 villages of which 109 were uninhabited as per the Census of 1971. Roughly triangular in shape, the southern side corresponds to the Godavari and the northern side to the northeast trending arm of the Ajanta ranges. With an extreme east to west distance of nearly 175 kilometers, this district is bounded by Jalgaon district on the north, Buldhana and Parbhani districts on the east, Bhir and Nasik district on the west and Ahmednagar districts on the south. The location and geographical information of the study area is obtained from *GEOGRAPHY (maharashtra.gov.in).*

It is best to learn about Maharashtra's rich history in Aurangabad, which is home to the gorgeous and historically significant Ajanta and Ellora Caves. The city's picturesque landscape, which is peppered with palaces, tombs, and parks, makes it a must-visit tourist destination for those who enjoy history and architecture. Also abundant in Aurangabad are handicrafts and metal goods that make wonderful mementos. UNESCO World Heritage Sites like the Ajanta and Ellora Caves are located in Aurangabad, sometimes referred to as the "City of Gates." Study area political, historical, and tourist information is gathered from *Aurangabad City Information | About Aurangabad, History, Guide and Facts - Thepackersmovers.com.*

Figure 1. Study Area, Aurangabad city of Maharashtra [6]

Data for present study is obtained from Maharashtra Pollution Control Board (mpcb.gov.in). Sampling is done at four different locations viz. Waluj MIDC (Industrial Type), C.A.D.A (Residential Type), SBES College (Residential Type) and Collector office (Residential Type). The sampling of

SOx, NOx, Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM) was recorded continuously for 24-hours on two days in each week.

An air quality index is defined as a systematic scheme that directly convert the weighed values of individual air pollution-related parameters (such as pollutant concentrations) into a single number or set of numbers (Ott, 1978). The end result is a set of rules (i.e. a set of equations) that use numerical manipulation to translate parameter values into a more simple form. If actual concentrations are reported in µg/m³or ppm (parts per million) in addition to standards, it cannot be considered an index. At the end of any system, an index will group specific concentration ranges into air quality descriptor categories[7].

2.1.2.Sub-Index calculation:

The Air Quality Index (AQI) is designed in such a way that any three parameters from SPM, RSPM, SO_2, NO_2, CO, O_3, Pb, and NH_3 are enough to calculate the AQI. Sub-indices for each selected pollutant were calculated, and the highest value from among all sub-index values was chosen as the AQI for that area. For a given pollutant concentration (*Cp*), the sub-index (*Ip*) was calculated as[5],

$$I_P = \left[\left\{ \frac{I_{HI} - I_{LO}}{B_{HI} - B_{LO}} \right\} \times (C_P - B_{LO}) \right] + I_{LO}$$

Where,

B_{HI} = Breakpoint concentration greater than or equal to given concentration

B_{LO} = Breakpoint concentration smaller than or equal to given concentration

I_{HI} = AQI value corresponding to B_{HI}

I_{LO} = AQI value corresponding to B_{LO}, subtract one from I_{LO} if I_{LO} is greater than 50

Cp = Pollutant concentration

Finally, AQI = Max (*Ip*) (where, p = 1, 2, 3 ...denotes n pollutants)

3.2.1Result and Discussion:

The sub-index values for the respective pollutant concentrations that are calibrated to Indian circumstances are shown in Table 1. along with their linear segmented connection. Table 2. lists different gaseous and particle contaminants as National Ambient Air Quality Standards (CPCB, 2009).

AQI Category	AQI	PM10	PM2.5	NO2	SO2
Good	0 - 50	0- 50	0 - 30	0 - 40	0 – 40
Satisfactory	51 - 100	51 - 100	31 - 60	41 - 80	41 – 80
Moderately polluted	101 - 200	101 - 250	61 - 90	81 - 180	81 – 380
Poor	201 - 300	251 - 350	91 - 120	181 - 280	381 – 800
Very poor	301 – 400	351 - 430	121 - 250	281 - 400	801 - 1600
Severe	401 - 500	430 +	250+	400+	1600+

Table 1.: Breakpoints for AQI Scale 0–500 (all pollutants are in units of µg/m3 and CO is expressed in units of mg/m3). *Hourly monitoring Source: Central Pollution Control Board[8].

The concentration of various gaseous and particulate pollutants recorded at various sampling locations is shown in Tables 3, 4, 5 and 6. The results of the air quality monitoring show that, based on the density of mobile and stationary air pollution sources, pollution concentration changed at different sampling locations. While gaseous pollutants stayed within acceptable limits, particulate pollutants exceeded the guidelines.

The observations show that during all of the observed locations, SO_2 levels were within the established NAAQS. Low levels of SO_2 may be the result of numerous actions performed, such as reducing the amount of sulphate in diesel, using less outdated

Sr. No.	Pollutant	Time-weighted average	Concentration in ambient air		
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	Methods of Measurement
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Greekmethod -Ultraviolet Flurorescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	

Table 2. : National Ambient Air Quality Standards (CPCB, 2009) [9]

automobiles, etc. Additionally, NO_2 levels at all of the monitored locations were within the permitted NAAQS. The removal of outdated automobiles, improved traffic management, and other actions may be the causes of the low NO_2 levels. During all of the monitoring Locations, RSPM levels surpassed the authorized NAAQS and SPM levels did so by a significant margin as well.

The data demonstrate that SO_2 levels at all of the places where they were measured were within the NAAQS. Reduced amounts of sulphate in diesel, the use of more modern vehicles, and other efforts may all contribute to low SO_2 levels. Furthermore, NO_2 concentrations were all below the permissible NAAQS at all of the tested locations. The removal of old cars, better traffic management, and other measures could be to blame for the low NO_2 levels. RSPM levels consistently exceeded the authorized NAAQS for all of the monitoring locations, and SPM levels did so as well. High vehicle movement, natural dust, dust storms, excessive vehicle traffic, and other factors may be to blame for the research area's high particulate matter levels. SPM and RSPM concentration were extremely high at Waluj MIDC, C.A.D.A., SBES College, and Collector Office. The existence of industrial areas nearby, strong vehicle traffic, high traffic densities, and natural dust are possible causes of the increased levels of particulate matter in these areas.

3.1.Concentration of pollutant at various stations in Aurangabad:

Table 3.: Concentration of Pollutant at Station Waluj MIDC (Industrial Area) January to April 2022.

Month/Pollutant	SOx µg/m³	NOx µg/m³	RSPM µg/m³
January-2022	18.36	7	100.5
February-2022	20.27	9	114.47
March-2022	28.29	9	82.86
April-2022	22.73	9	88.2

Table 4.: Concentration of Pollutant at Station C.A.D.A (Residential Type) January to April 2022.

Month/Pollutant	SOx µg/m³	NOx µg/m³	RSPM µg/m³	SPM µg/m³
January-2022	26.17	62.83	97	304.33
February-2022	27	60.8	113	311.8
March-2022	25	57.1	116.6	324.9
April-2022	14	29.88	111.75	307.25

Table 5. : Concentration of Pollutant at Station SBES (Residential Type) January to April 2022.

Month/Pollutant	SOx µg/m³	NOx µg/m³	RSPM µg/m³	SPM µg/m³
January-2022	26	62.5	110.5	309.17
February-2022	27.8	61.6	122.2	332
March-2022	25.56	57.78	121.78	337.33
April-2022	15	30.88	114.25	302

Table 6.: Concentration of Pollutant at Station Collector Office (Residential Type) January to April 2022

Month/Pollutant	SOx µg/m³	NOx µg/m³	RSPM µg/m³	SPM µg/m³
January-2022	25.71	61.57	90.57	287
February-2022	27.17	61	110.17	310.67
March-2022	25.5	59.12	115.5	319.62
April-2022	12.7	28.7	108	304.5

3.2 Sub indices of pollutants and AQI at various Stations in Aurangabad:

Table 7.: Sub indices of pollutants and AQI, at Waluj MIDC (Industrial Area) January to April 2022

Months/Pollutant	SOx	NOx	RSPM	AQI
January-2022	23	9	235	235
February-2022	25	11	282	282
March-2022	35	11	176	176
April-2022	28	11	194	194

Table 8.: Sub indices of pollutants and AQI, at C.A.D.A (Residential Type) January to April2022

Month/Pollutant	SOx	NOx	RSPM	SPM	AQI
January-2022	33	79	223	254	254
February-2022	34	76	277	262	277
March-2022	31	71	289	271	289
April-2022	18	37	273	257	257

Table 9.: Sub indices of pollutants and AQI, at SBES (Residential Type) January to April 2022

Month/Pollutant	SOx	NOx	RSPM	SPM	AQI
January-2022	33	78	268	259	268
February-2022	35	77	302	282	302
March-2022	32	72	301	287	301
April-2022	19	39	281	252	281

Table 10.: Sub indices of pollutants and AQI, at Collector Office (Residential Type) January to April 2022.

Month/Pollutant	SOx	NOx	RSPM	SPM	AQI
January-2022	32	77	202	237	237
February-2022	34	76	267	261	267
March-2022	32	74	285	270	285
April-2022	16	36	260	255	260

3.3 Graphical representation of Sub indices of pollutants and AQI at various Stations in Aurangabad:

Figure 2.: Sub indices of pollutants and AQI, at Waluj MIDC (Industrial Area) January to April 2022.

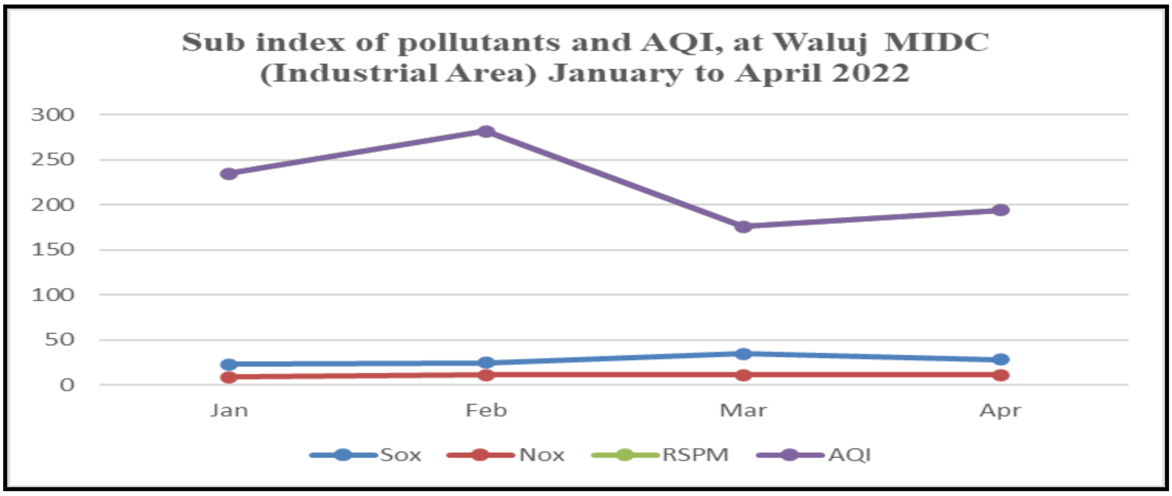


Figure 3.: Sub indices of pollutants and AQI, at C.A.D.A (Residential Type) January to April 2022

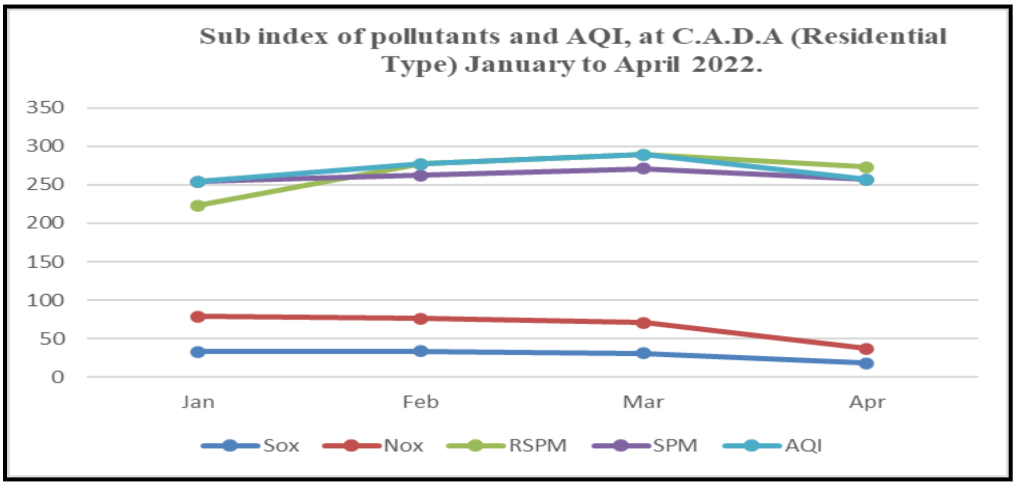


Figure 4.: Sub indices of pollutants and AQI, at SBES (Residential Type) January to April 2022.

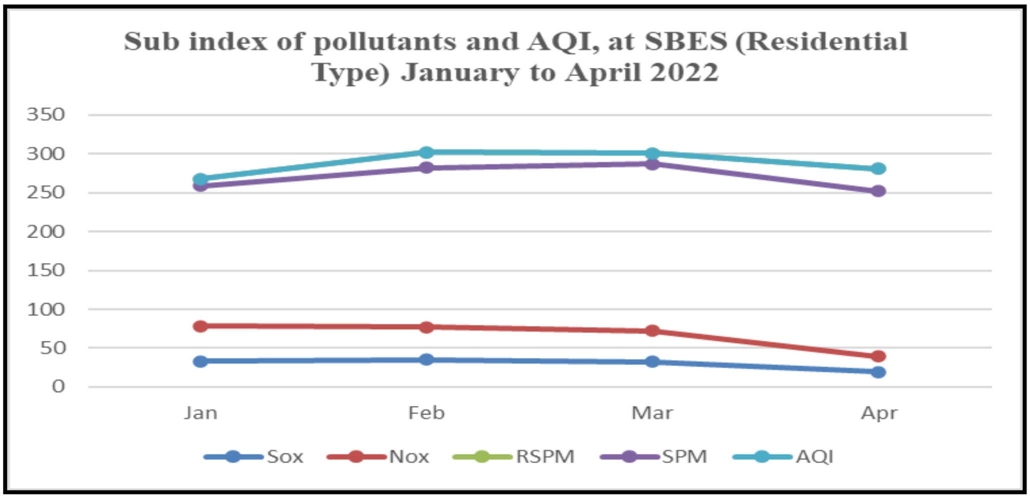
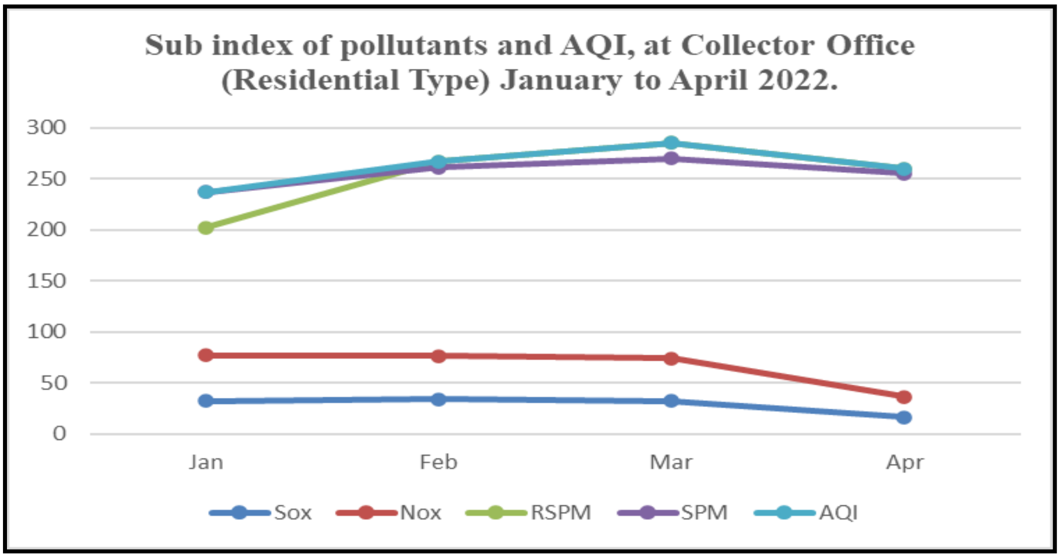


Figure 5.: Sub indices of pollutants and AQI, at Collector Office (Residential Type) January to April 2022.

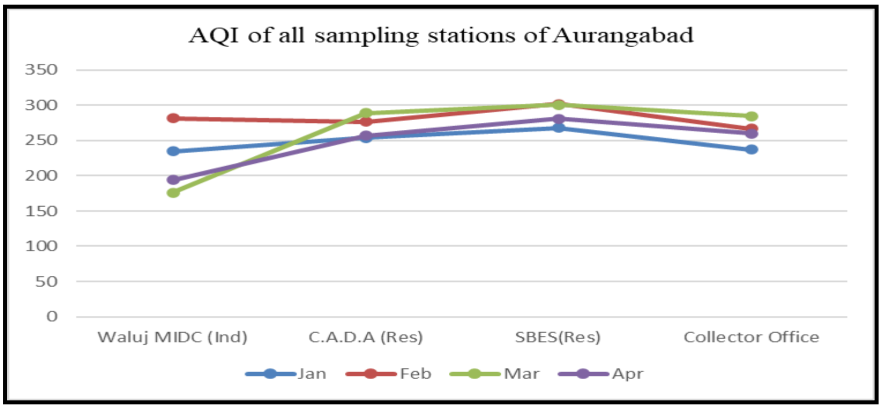


3.4 Comparative study of AQI of all sampling stations:

Table 11.: Comparative Air Quality Indices of all stations of Aurangabad

Month/Pollutant	Waluj MIDC (Ind)	C.A.D.A (Res)	SBES(Res)	Collector Office
January-2022	235	254	268	237
February-2022	282	277	302	267
March-2022	176	289	301	285
April-2022	194	257	281	260

Figure 6.: Comparative study of AQI of all sampling stations at Aurangabad



4. Conclusion:

The concentration of particle matter (RSPM & SPM) in the air is steadily rising, which is the main source of air pollution in Aurangabad city. The increasing number of automobiles in the study area is the main cause of air pollution. Particulate particles can cause chronic bronchitis and other respiratory conditions when inhaled in high amounts. The size of the particulate matter affects the impact to a different extent. While fine particles are deposited in the deeper sections of the lungs, coarse particles have a negative impact on the lung system. The findings show that among all the monitored stations, SBES college station has the worst Air Quality Index and is the most contaminated station. The remaining three stations, Waluj MIDC, C.A.D.A., and Collector Office, have low air quality indices. All sample stations' AQI values show a steady rise in the amount of pollutants in the air in Aurangabad, which is degrading air quality. The places in question have poor to very bad air quality.

5. Suggestions to control air pollution:

Public involvement and awareness are required for improving the air quality. Maintaining the vehicles properly i.e., getting PUC checks, replacing car air filters on time, maintaining proper tire pressure, follow lane discipline and speed limits, turn off engines at traffic signals when it is red will help reducing air pollution. As the study area shows poor to very poor air quality index people have to minimize travel, promote mass transportation or public transportation instead of individual transportation in order to improve air quality.

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