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Assessment of the $PM_{2.5}$ and PM_{10} Particulate Concentration in Ambient Air of Aurangabad City, India (M.S)

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Abstract This work is a pilot study in Aurangabad, Maharashtra, to determine the seasonal concentration of fine particulate matter $PM_{2.5}$ with an aerodynamic diameter of less than 10µm between 2016 to 2018. The Seasonal concentration of $PM_{2.5}$ and PM_{10} was recorded at fifteen representative sites throughout the city. The investigation revealed that the annual average concentration of the particulate matter at the CIDCO bus stop is high, with $PM_{2.5}$ ranging from 74.64 µg/m^3 to 88.75 µg/m^3, while PM_{10} was ranging from 153.36 µg/m^3 to 535.52 µg/m^3, according to the central pollution control board standards respectively.

Keywords: *average, concentration, particulate, matter, standards, PM_{10}, $PM_{2.5}$*

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1. Introduction

The present study aims to find out the concentrations of PM_{10} & $PM_{2.5}$ in the ambient air of Aurangabad city & objective of this study is to provide authentic data regarding the concentration of PM_{10} and $PM_{2.5}$ in ambient air Aurangabad. This study shall be useful to future students, researchers, and Policymakers.

Due to the rapid increase in population, environmental quality is gradually deteriorating, and human beings are suffering from many health-associated problems. Many studies in India have focused primarily on $PM_{10,}$ and comparatively, very few have looked at $PM_{2.5}$. It has become a major environmental problem faced by the people globally in both developing and developed countries in recent times [1,2,3,4] & India is one of them. Polluted air has a high potential to have detrimental effects on human health, acute and chronic [5]. In the contemporary period, serious attempts have been made to study the suspended particulates of diameter less than 10µm considering their potency to influence property and life [6,7].

Particulate matter has been extensively investigated in recent years because of its possible health impact and the necessity to formulate control measures. Particulate matter can come from various natural and artificial sources, including acid, biological, loam, and dust particles [8,9]. $PM_{2.5}$ concentrations should not surpass an annual mean of 40 µg/cm^3 and a 24-hour mean of 60 µg/m^3 according to CPCB's NAAQS ambient air guidelines [10]. According to the CPCB, PM_{10} levels should not go above 60 µg/m^3 yearly and 100 µg/m^3 on a 24-hour basis [11], as shown in Table 1.

Table 1. The Central Pollution Control Board's $PM_{2.5}$ and PM_{10} standards are shown

Pollutants	Time Weighted Average	Standard limits as per CPCB guidelines (µg/m^3)
Particulate matter ($PM_{2.5}$)	Annual mean	40
	24 hours mean	60
Particulate matter (PM_{10})	Annual mean	60
	24 hours mean	100

2. Material and Method

Monitoring was carried out according to regulations set through the Central Pollution Control Board, India [13]. At each sampling site, the samplers were placed at the height of four feet. In three distinct seasons, namely Summer (March - June), Monsoon (July - October), and Winter (November - February), a continuous sample of respirable particles was undertaken on a 24 hours basis. For the PM_{10} sample, a Respirable Dust Sampler (RDS, Envirotech, APM 460) with a flow rate of 1.1 m^3/min was utilized. For coarse particles $PM_{2.5}$ Envirotech, APM 550 sampler was used, with a steady flow rate of 16.6 liters per minute. It has a moveable Wins-Anderson impactor used to sample PM 2.5 many times. Glass fiber paper (8×10") and Teflon filter paper with a 47-millimeter diameter were

used in the sample of PM10 and PM2.5. Before and after collecting the sample, the filters

They were stabilized in a desiccator containing silica gel for 24 hours, and the weight of collected dust was measured on a pre-calibrated electronic balance before and after sampling. The ambient air mass concentration was estimated by dividing the weight of collected dust by the amount of air sampled.

2.1. The Study Area

Aurangabad is a city in the state of Maharashtra in India. Aurangabad district lies between 19018' and 20040' North latitude and 74040' and 76040' East longitude with an area of 16,200.0 square kilometers had a city population of 1,175,116 (Aurangabad City Population Census 2011-2019 | Maharashtra n.d.) [12]. Aurangabad is known as "The city of Gates." It had 52 gates, and the solid presence of these can be felt as any person drives through the city.

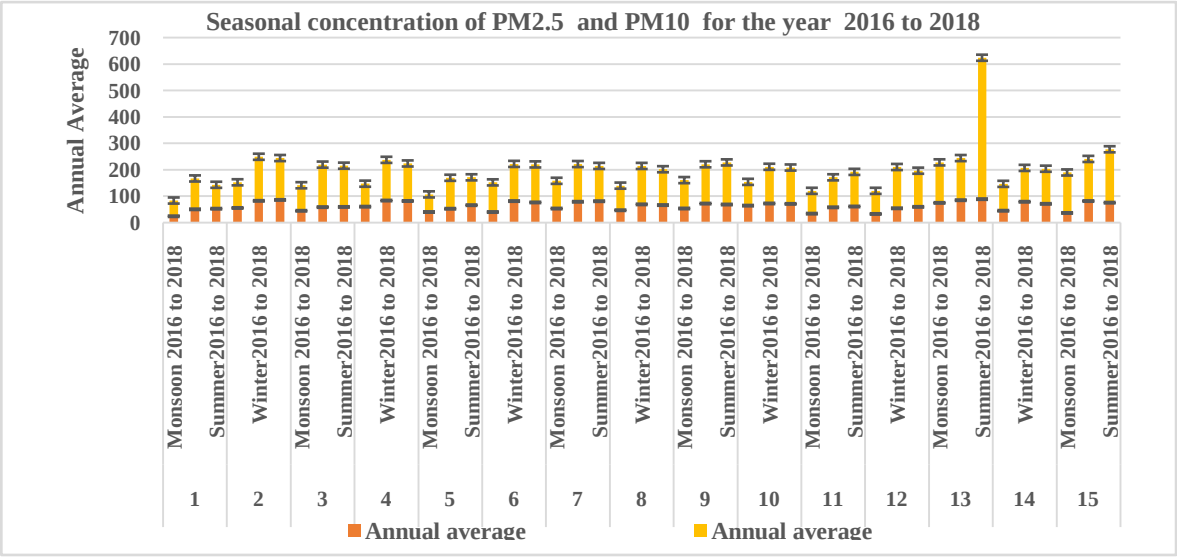
2.2. Description of sampling Sites

The present investigation deals with the study of seasonal variations of $PM_{2.5}$ and PM_{10} from 2016 to 2018 from fifteen sites of Aurangabad city, Maharashtra (India). The detailed sampling sites description is shown in Table 2.

All the 15 sites mentioned above were selected considering the activities at the site and the volume of the population visiting the sites daily. Also, the sites were selected so that all the geographical expanse of the city would be covered to a significant extent.

Table 2. Shows sampling sites description

Site No	Name of the sampling sites	Description of sampling sites
1	Dr. BAM University	The sampling site was selected as a silent zone having Sparse human activity and greenery in this zone.
2	MIT College Road	• Severe human activity • High movement of heavy transport vehicles.
3	Maulana Azad College Road	• It is an educational institution with intense human activity • small shops as well as food courts.
4	Kranti Chowk	• This site is a central traffic island • heavy and prolonged traffic jams as well as human activities.
5	Aurangpura	• Aurangpura is a major commercial hub • It is a crowded place with shops and schools and colleges.
6	Amarpreet Chowk	• This site was exposed to heavy traffic loads with frequent traffic jams.
7	Diwali Chowk	• Traffic center connecting important areas and town, High movement of heavy transport vehicles
8	Shahanurmia Darga Road	• A private vehicles Bus Stop is located here • The Local Vegetable market is situated in this area • The Popular Holy Shrine of Shahnoor Miyan is in this locality
9	Chikalthana	• Sampling site near the airport; a crowded place with shops and civil hospitals.
10	T.V.Center	• Site exposed to vehicular emissions, dust from constructions, commercial complexes, and Intense human activity.
11	Jatwada Road	• This site with small shops and light traffic.
12	Roshan Gate	• Site exposure to vehicular emission • Roshan Gate has a high density of population. • There is a mosque, a market & several commercial buildings in very close vicinity
13	Cidco Bus Stand	• High movement of heavy transport vehicles.
14	Railway Station	• This site near the railway station has heavy transportation • There are frequent traffic jams crowded with an open restaurant.
15	Central Bus Stand	• The site is a Public utility station having Intense human activity • High movement of heavy transport vehicles.



Graph 1. Shows Seasonal Concentrations of PM2.5 & PM10 for 2016 to 2018

3. Result

Graph 1 shows an annual mean seasonal concentration of $PM_{2.5}$ and PM_{10} from fifteen different sites of Aurangabad city over two years. During the study period, particulate concentration was low because of wet deposition in the monsoon. The above condition is due to the scavenging of particles or dissolved gaseous contaminants from the air, which causes aerosols to fall to the ground (Tian et al., 2021). Site 1 had the lowest concentrations of both particulate compared to the other sites. $PM_{2.5}$ levels vary from 23.88 µg/m^3 to 52.53 µg/m^3, while PM_{10} levels range from 59.63 µg/m^3 to 116.87 µg/m^3. Perhaps because of the abundant flora on campus, the restricted quantity of heavy vehicles in the vicinity, and also it is covered mountainous terrain.

For site 13, there was an average seasonal variation, with a higher concentration occurring during the summer season. $PM_{2.5}$ range from 74.64 µg/m^3 to 88.75 µg/m^3, while PM_{10} range from 153.36 µg/m^3 to 535.52 µg/m^3 respectively. Due to the frequent heavy traffic, buses are the city's main bus station.

4. Discussion

Meteorological observations, i.e., temperature, relative humidity(RH), wind speed (WS), and wind direction (WD), were all recorded during the assessment period. The average minimum temperature was 22°C and maximum 32°C, respectively. The relative humidity (RH) ranged between 30 and 55 percent, with a westerly wind direction, wind speed of 5 to 12 kilometers per hour. We identified a substantial association between the annual average of particle matter and meteorological observations for the study region.

Table 3. Shows for the study region a significant correlation in the winter season

Winter Season					
	$PM_{2.5}$	***PM_{10}***	***Temp***	***RH***	***WS***
$PM_{2.5}$	1				
PM_{10}	0.419297	1			
Temp	0.018853	0.225561	1		
RH	0.300047	0.451177	0.405442	1	
WS	-0.0094	0.22071	0.99554	0.426699	1

Table 4. Shows for the study region a significant correlation in the monsoon season

Monsoon Season					
	$PM_{2.5}$	***PM_{10}***	***Temp***	***RH***	***WS***
$PM_{2.5}$	1				
PM_{10}	0.425839	1			
Temp	0.087001	-0.36721	1		
RH	-0.05686	-0.07822	0	1	
WS	-0.70551	-0.23345	-0.42263	0.358155	1

Table 5. Shows for the study region a significant correlation in the summer season

Summer Season					
	$PM_{2.5}$	***PM_{10}***	***Temp***	***RH***	***WS***
$PM_{2.5}$	1				
PM_{10}	0.552732	1			
Temp	-0.28774	-0.19378	1		
RH	-0.34079	-0.19081	0.328318	1	
WS	-0.02664	0.082812	0.202073	-0.31592	1

Season-wise correlation for the study region, as shown in Table 3, is a positive correlation between $PM_{2.5}$ and PM_{10} in temperature (r =0.41). Wind speed and temperature have a very strong positive correlation (r = 0.99) throughout the winter season. There is a negative correlation between all the factors with particulate matter in the monsoon season, as shown in Table 4. There is a positive correlation between temperature (r= 0.55) in summer, as shown in Table 5.

5. Conclusion and Recommendation

The PM_{10} and $PM_{2.5}$ values had a high annual average compared to the central pollution control board standards. The meteorological parameters affect particulate matter in different seasons [14]. Strong seasonal modulation occurred, and the lower monsoon average decreased the annual average. Traffic was the main source of particulate matter [15]. Due to rising particulate matter concentrations and road dust resuspension, increased vehicular numbers, the development of unstructured infrastructure, poor road conditions, less greenery, and population growth. High concentrations of respirable suspended particulate matter ($PM_{2.5}$) due to the utilization of diesel vehicles, even residue produced through utilizing continued brakes, gears, and so on builds the particulate matter.

The following recommendations are given based on the study's findings:

i. According to the study, particulate dispersion in airborne dust can be decreased by limiting the likelihood of raw sand emission during transportation, setting speed limits on loaded trucks, and so on.

ii. Unpaved roads primarily inhibit particulate resuspension, reducing ambient particulate concentrations.

iii. Encourage compressed natural gas (CNG) automobiles instead of diesel and gasoline vehicles.

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