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IMPACT OF METEOROLOGICAL FACTORS ON $PM_{2.5}$ IN CHENNAI

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ABSTRACT

Air pollution is a fast developing environmental issue of public worries in every place. It will affect the human health and local or regional weather condition. During the last decades, the special attention for the fine particles up to 2.5µm ($PM_{2.5}$) is being given. Particulate matter (2.5µm) is defined as very fine particulate pollutants which affect the human health system. In the present study, atmospheric particulate matter $PM_{2.5}$ data were collected for the period between July 2016 and March 2017 at Alandur, a fast-growing place in Chennai, Tamil Nadu. The pollution data was collected by a high volume sampler. The $PM_{2.5}$ data from the sampler was correlated with meteorological factors like temperature, wind speed and humidity to find the interrelationship between the parameters. These results will give knowledge about which meteorological factors are modifying the $PM_{2.5}$ concentrations in Alandur.

Keywords: Urban air quality, $PM_{2.5}$, Particulate matter, Meteorological factors

INTRODUCTION

The climatic particulate matter is created from most part of anthropogenic discharge sources, such as, cars, vehicles emissions, and fuel burning. These emissions are extremely harmful to human wellbeing and furthermore for nature.[1-4] As of late in Asian nations, the contamination issue has turned out to be expanding extremely because of expanded loadings of environmental particulate matter from increasing vehicular and mechanical discharges and in addition from expanding industrializations.[5-8] During storm seasons, overwhelming precipitation can wash out the climatic particulate matter and clean the air. Contemporary reviews are recommended that $PM_{2.5}$ particles in the air may influence the stormwater cycle and altogether change the biological adjust in the air.[8-10] The atmospheric particles are real air toxin in India. In numerous Indian urban communities, the level of $PM_{2.5}$ in the atmosphere is above the allowable limit given by the Central Pollution Control Board (CPCB). The study is undertaken in Alandur which lies in between the 12° 59' 50.95" N latitude, and 80° 12' 2.29" E longitude (Fig.-1). Fast urbanization, expanding industrialization and improved man-made activities had increased the particulate concentration in the atmosphere. For this study, the amount of $PM_{2.5}$ was measured at Alandur, and is then compared with meteorological parameters.

EXPERIMENTAL

Statistics and testing methods

In this review, the $PM_{2.5}$ test was used in Alandur to examine the site from July 2016 to March 2017. The particulate contamination test was gathered by a high volume sampler. The sampler has a flow limit without the paper and the flow rate of air volume sampler changes the vicinity of 0.8 and 1.4m^3/min.[11-15] The filter paper in the sampler is changed for every 12 hours while sampling according to the acknowledgment given by the Environmental Protection Agency and Central Pollution Control Board. Whatmann quartz fiber filter papers are utilized for the project in collecting the $PM_{2.5}$ particles from the study area. The meteorological information like Temperature, wind speed and humidity were gathered from the Indian Meteorological Department (IMD). The collected $PM_{2.5}$ particles are then compared with the meteorological parameters like temperature, wind speed and humidity to know the impact of each parameter on the concentration. According to IMD Chennai, the seasons of Tamil Nadu is categorized as winter (Jan–Feb), Pre-Monsoon (March-May), South-West Monsoon (June–Sept.), North-East Monsoon (Oct.–Dec.).the sampling observation was made between July 2016 to March 2017 which covers a part of South-West Monsoon, North-East Monsoon, and Winter.

Fig.-1: Location map of Alandur (Study Area)

RESULTS AND DISCUSSION

In the atmosphere, the air pollution level will get changed due to the variation in the meteorological factors like temperature, wind speed and humidity.[16-20] From the results, a strong seasonality is observed in the meteorological factors that change the atmospheric particulate matter concentration.

Impact of temperature on concentration of $PM_{2.5}$

The most peak months are December and January. In the study area the recorded temperature ranged between 22°C - 37°C during South-West Monsoon season, 18°C - 35°C during North-East Monsoon season, 17°C - 36°C during Winter season. The maximum temperature of 37°C is recorded in July 2016 and the minimum temperature of 17°C is recorded in February 2017. The maximum, minimum and average values of temperature were recorded from July 2016 to March 2017 are shown graphically in Fig.-2.

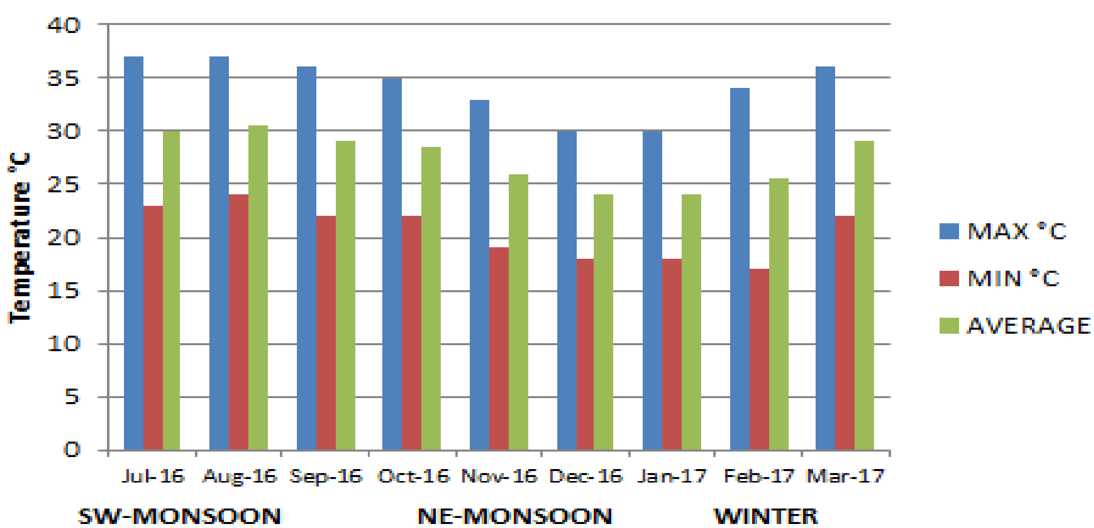

Fig.-2: Seasonal fluctuation of temperature

The fluctuation of temperature in the seasons and the impact on the concentration of $PM_{2.5}$ is shown in the Fig.-3.

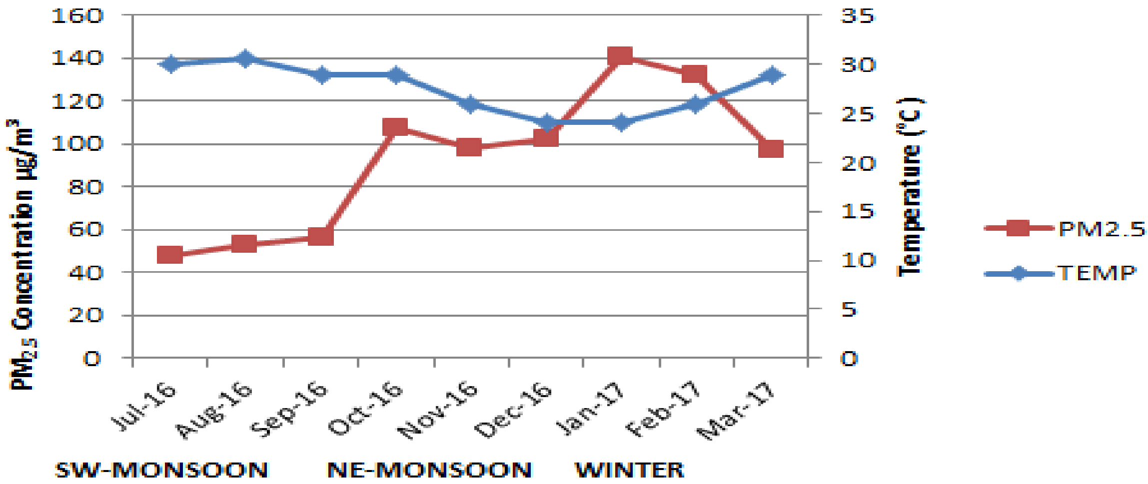

Fig.-3: Interrelationship among temperature and $PM_{2.5}$

The result of regression analysis found that $PM_{2.5}$ has the negatively correlated with temperature during North-East Monsoon season ($r^2 = -0.896$) and positively correlated during South-West Monsoon season ($r^2 = 0.348$) and winter season ($r^2 = -0.846$). This sampling location accomplished a little lower temperature in Post-Monsoon and spring season. The statistics of regression analysis are reported in the Table-1.

Impact of wind speed on concentration of $PM_{2.5}$

Wind speed was recorded and it ranged between 3 to 28 km/h during South-West Monsoon season, 4 to 25 km/h during North-East Monsoon season and 2 to 22 km/h during the winter season. And the maximum range of wind speed was recorded during Monsoon season and the minimum range was recorded during the spring season. And the monthly maximum, minimum and average ranges of wind speed recorded for the sampling site from July 2016 to March 2017 are shown in the Fig.-4.

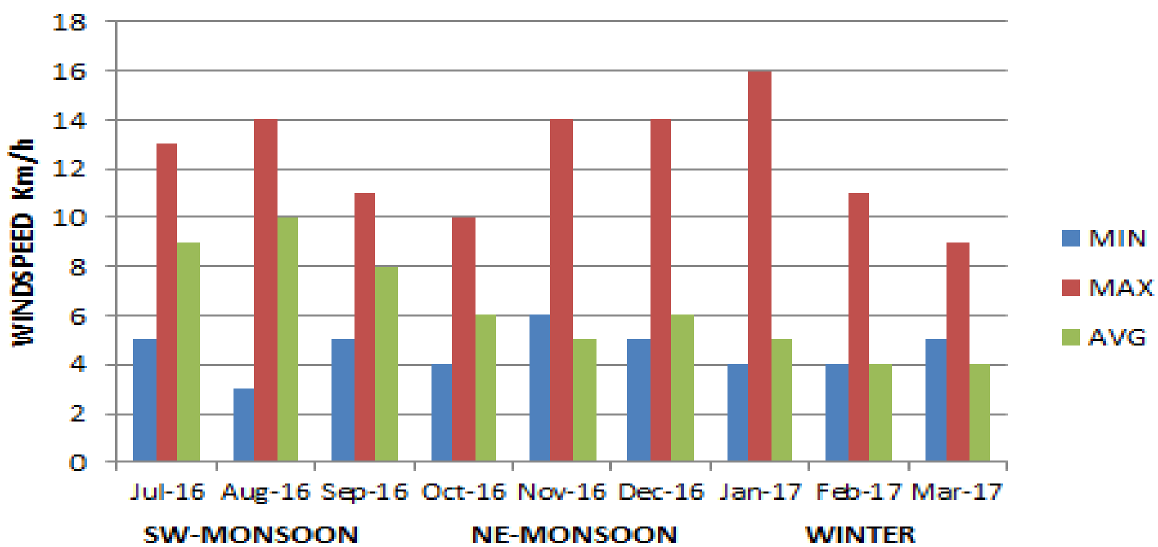

Fig.-4: Seasonal Fluctuation of Wind speed

The fluctuation of wind speed in the seasons and the impact on the concentration of $PM_{2.5}$ is shown in the Fig.-5. The statistics showed that $PM_{2.5}$ had a negative correlation with wind speed during South-West Monsoon season ($r^2 = -0.321$) and it had a positive correlation during North-East Monsoon season ($r^2 =$

0.714) and winter season ($r^2 = 0.847$). It may be due to the direction of the wind and the floating or unsettled particulate matter in the atmosphere. The statistics of regression analysis are reported in the Table-2.

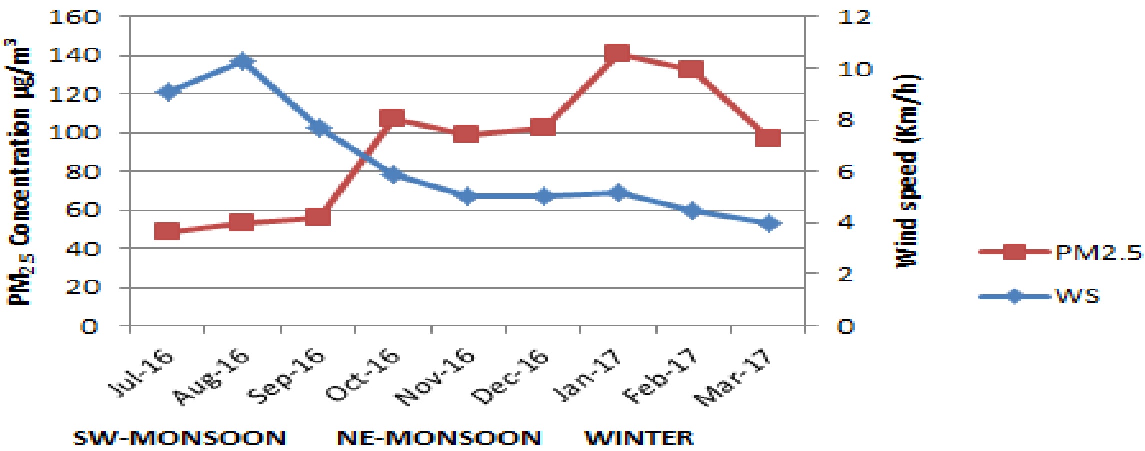

Fig.-5: Interrelationship among Wind speed and $PM_{2.5}$

Table-1: Interrelationship and regression equation among Temperature and $PM_{2.5}$

Seasons	Temp Range (°c)	r^2	$PM_{2.5}$ Equation
SW-Monsoon	22 - 37	0.348	$PM_{2.5} = 1.680T + 56.125$
NE-Monsoon	18 - 35	-0.896	$PM_{2.5} = -0.128T + 110.18$
Winter	17 - 36	-0.846	$PM_{2.5} = -2.655T + 246.094$

Impact of humidity on concentration of $PM_{2.5}$

The relative humidity was recorded and it ranged from 47% to 83% during South-West Monsoon season, 56% to 87% during North-East Monsoon season and 45% to 84% during the winter season. And the maximum range of relative humidity was recorded during the spring season and the minimum range was recorded during Post-Monsoon season. And the monthly maximum, minimum and average ranges of humidity recorded for the sampling site from July 2016 to March 2017 is shown in the Fig.-6.

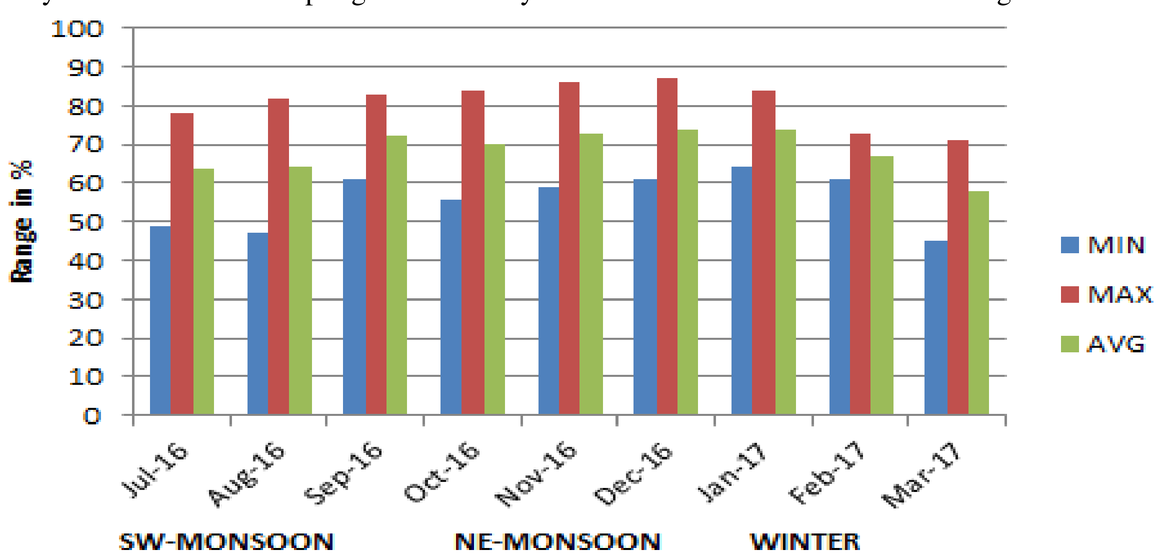

Fig.-6: Seasonal Fluctuation of Humidity

The fluctuation of humidity in the seasons and the impact on the concentration of $PM_{2.5}$ is shown in the Fig.-7. The statistics shown that $PM_{2.5}$ had weak positive correlation with humidity during South-West

Monsoon season ($r^2 = 0.597$) and it had a weak negative correlation during North-East Monsoon season ($r^2 = -0.448$) and winter season ($r^2 = -0.553$). It may be due to the increase in the rate of humidity and absorption of particulate matter in the atmosphere. The statistics of regression analysis are reported in the Table-3.

Table-2: Interrelationship and regression equation among Wind speed and $PM_{2.5}$

Seasons	Wind Speed Range km/h	r^2	$PM_{2.5}$ Equation
SW-Monsoon	3 – 28	-0.321	$PM_{2.5} = 0.579W + 39.221$
NE-Monsoon	4 – 25	0.714	$PM_{2.5} = 19.023W + 423.027$
Winter	2 – 22	0.847	$PM_{2.5} = 4.321W + 101.543$

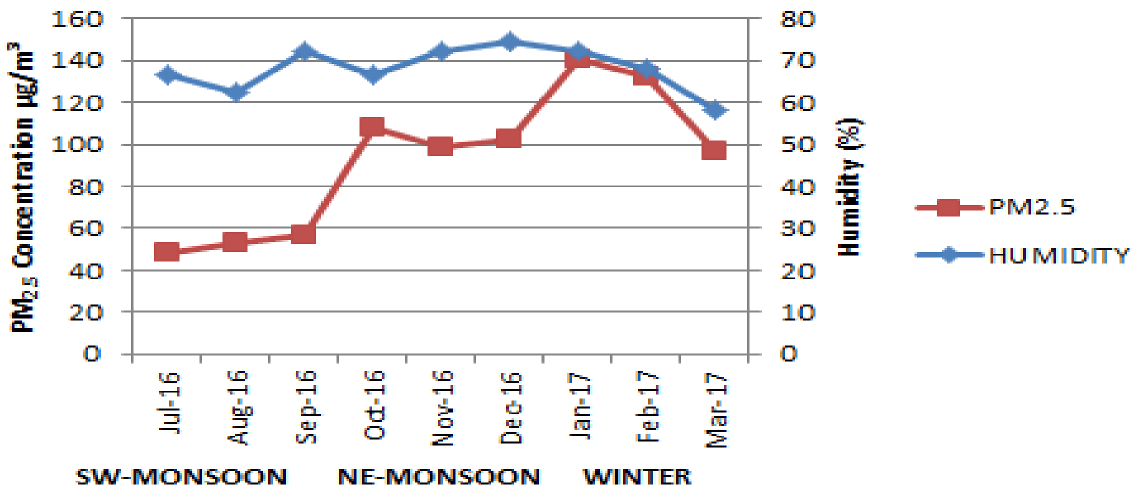

Fig.-7**:** Interrelationship among Humidity and $PM_{2.5}$

Table-3: Interrelationship and regression equation among Humidity and $PM_{2.5}$

Seasons	Humidity range (%)	r^2	$PM_{2.5}$ Equation
SW-Monsoon	47 – 83	0.597	$PM_{2.5} = 9.122H + 264.72$
NE-Monsoon	56 – 87	-0.448	$PM_{2.5} = 13.254H + 623.56$
Winter	45 – 84	-0.553	$PM_{2.5} = 2.674H + 49.817$

CONCLUSION

The impact of temperature, wind speed and humidity on the concentration $PM_{2.5}$ were evaluated from the month of July 2016 to March 2017 in Alandur using regression analysis and the terms are given below. $PM_{2.5}$ is positively correlated with temperature in South-West Monsoon season, and it had a negative correlation during North-East and winter seasons, because of the impact of decreasing temperature in the atmosphere on the concentration of $PM_{2.5}$. And $PM_{2.5}$ had the positive correlation with wind speed during North-East Monsoon season and winter season. And it had the negative weak correlation during South-West Monsoon season. $PM_{2.5}$ had the positive correlation with humidity during South-West Monsoon season and negatively weak correlation during North-East Monsoon and winter seasons.

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