Assessment Of Particulate Matter PM_{10} And Its Correlation By Different Metrological Parameters In Rewa City Of Central India

Dr Pramila Singh[1*] & Dr Nazir Ahmad Najar[2]

[1*,2]Research scholars, Department of Environmental biology, Awadhesh Pratap Singh University Rewa M.P.
Email : pramilasingh775@gmail.com[1] , Nazirnajar45@gmail.com[2]

***Corresponding Author:** Dr Pramila Singh
Email : pramilasingh775@gmail.com

Abstract:
It is believed that 670 million people comprising 54.5% of our population reside in regions that do not meet the Indian NAAQS for fine particulate matter. Numerous studies have revealed a consistent correlation for particulate matter concentration with health than any other air pollutant. Rewa city is rapidly growing city, which might also be adversely affected from air pollution. Therefore, this research aims at estimating PM_{10} concentrations of Rewa city. The temperature is one of the important meteorological parameter which affects the PM_{10} concentration of certain area. The study location at Sirmour Square was monitored in the month of June for seven days. The maximum 8 hrs. Temperature value is $45c^0$ on June 11 while the minimum value was decreased at 29 on June 19 as depicted in the study. With the increase in the temperature the concentration of PM_{10} also increases as predicted in this stduy.The present research work was undertaken to determine the particulate matter PM_{10} concentration in the ambient atmosphere of Rewa city and its correlation by different metrological parameters of the area.

Keywords: PM_{10}, Parameter, Air Pollution, Rewa etc.

Introduction:
All over the world air pollution has become a public health problem. In 2012, air pollution was declared as the largest environmental health risk with almost seven million deaths globally attributed to it (WHO, 2014). According to the Global Burden of Disease 2010 report it was estimated that particulate matter (PM) air pollution was responsible for about 6% of deaths on a global basis (IHME, 2013; Lim et al., 2012). India is an important country in South Asia with a rapidly growing economy and a large but young workforce. However, rapid industrialization and urbanization in the country have resulted in a significant deterioration in urban air quality (Kulshrestha et al., 2009). Data from the country's major Regulator - Central Pollution Control Board (CPCB), showed that 77% of Indian urban clusters clearly exceeded the National Ambient Air Quality Standard (NAAQS) for respirable suspended particulate matter (PM10) in 2010 (CPCB, 2012). Another key estimate from WHO points that out of 20 world's worst particulate air polluted cities around 13 are in India including the capital Delhi, which is the worst ranked city in terms of air pollution (WHO, 2014). It is quite alarming to note that the satellite measures of fine particulates created for the entire India reveal that our populations living both in urban and rural areas are exposed to hazardously high levels of particulates. Almost 670 million people comprising 54.5% of the population reside in regions that do not meet the Indian NAAQS for fine particulate matter (GreenStone et al., 2015; Dey, 2012). Numerous studies have revealed a consistent correlation for particulate matter concentration with health than any other air pollutant. Studies show a statistically significant correlation between mortality and ambient particulate matter concentration (Lee et al., 2006). The present research work was undertaken to determine the particulate matter PM_{10} concentration in the ambient atmosphere of Rewa city and its correlation by different metrological parameters of the area.

Description of selected site, Rewa city:
Rewa city:
The Rewa district lies in the central part of the state of Madhya Pradesh, covering an area of 6287.45 Sq Km. (As per Statistical Book) It lies between North latitude 24°16'30" and 25°11'15" and east longitude 81°03'15" and 82°18'45". It is located in the north-eastern comer of the State, and bounded by Satna district in the West, Sidhi district in the South & the State of Uttar Pradesh in the North & East. Rewa town is the district head quarter for administrative purposes. The district is sub divided into seven Tehsils and nine blocks. Sirmour square is the busy market location in the Rewa city where experiential work of this study was conducted.

Material and methods:
The present Research work was under taken in Rewa city in the north- eastern part of Madhya Pradesh state in India (24.53^0 N, 81.30 E).Rewa has a humid subtropical climate, with cold, misty winter, a hot summer and a humid monsoon season. The average temperature being around 30^0C (86^0F).Ambient air quality monitoring and Meteorological parameters were undertaken in the study area for particulate matter (PM_{10}). Particulate sampling was done by using Respirable Dust

Sampler (Envirotech-make Model APM 550) for Fine Particulate Sampler. Envirotech, (APM550) is a combo type which runs constant flow rate of 16.6L/min. It has a portable Wins –Anderson impactor for the sampling PM_{10}.On the basis of anthropogenic activities and relative traffic load, air quality monitoring has been carried in the Rewa city. The sampler was installed at a height of 4 feet at the sampling site Sirour choura in Rewa city. Before starting the combo Air sampler (APM 550) we have to set the filter papers at their own places. For automatically flow controlled units, record the designated flow rate on the data sheet. Record the reading of the elapsed time meter. The specified length of sampling is commonly 8 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, record the flow meter reading, take out the filter media from the sampler, and put in a container or envelope.

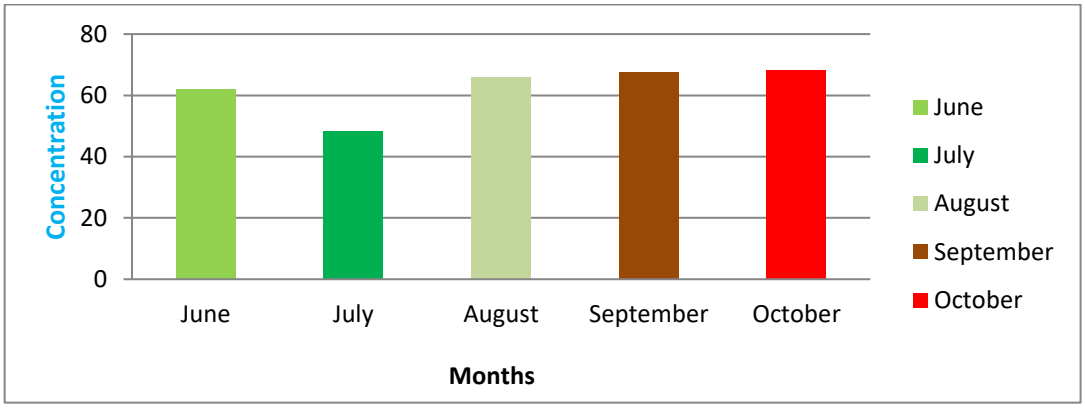
Results:

1. Concentration of PM_{10} in ambient atmosphere of Rewa, (M.P.)

The 8 hour PM_{10} concentration data was collected during five months period from June 3, 2022 upto Oct 2022 at Sirmour Choura site. The data collected during these months is recorded which show the date of sampling, Concentration, Wind Speed, Humidity, and Temperature. The mean value of 8 hour PM_{10} concentrations at different months at different locations was 61.93 µg/m^3, 48.42µg/m^3, 65.95 µg/m3, 67.51 µg/m^3, 68.05 µg/m^3 shown in below table .The Pearson co-efficient Correlation analysis were conducted between PM_{10} value and Meteorological variable. The maximum 8 hours value was equal to 102.7 µg/m^3 on Oct 16 2022 It tops the average standard limit i.e. (60-100) While the minimum value was 20.2 µg/m^3 on July 16 2022.The high concentration of PM_{10} was found in the month of Oct. and lower in the month of July.

Table 1. The distribution of particulate matter PM_{10} Concentration at different locations and months are present in this table below

S/NO	Month	Average Conc. µg/m^3
1	June	61.93
2	July	48.42
3	August	65.95
4	September	67.51
5	October	68.05



2. Effect of PM_{10} by Temperature, Humidity, and wind speed at Sirmour Square.

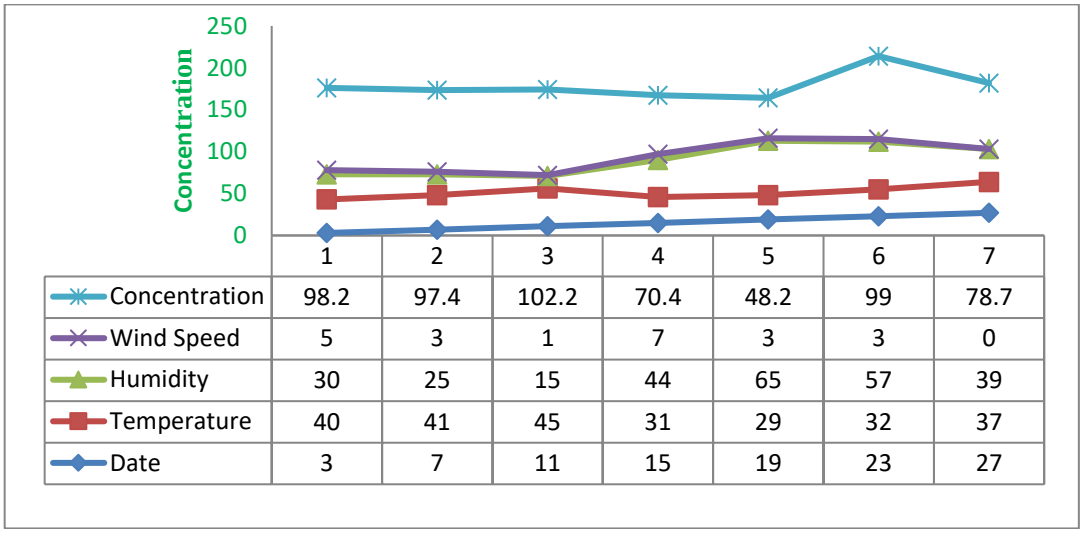
The temperature is one of the important meteorological parameter which affects the PM_{10} concentration of certain area. The study location at Sirmour Square was monitored in the month of June for seven days. The maximum 8 hrs. temperature value is $45c^0$ on June 11 while the minimum value was decreased at 29 on June 19 as shown in the below mentioned table 2.With the increase in the temperature the concentration of PM_{10} also increases showing the value of 102.2 µg/m^3.

Similarly, the humidity effects the concentration of PM_{10}. At Sirmour Square, the maximum 8 hrs. Humidity value is 63% on june19 while the minimum value was decreased at 15% on June 11 in the month of June. The concentration of PM_{10} shows the value of 48.2 µg/m^3 at the mentioned site on June 19 because the humidity was high on that day that will affect temperature obviously to get higher that will affect the wind speed in the area which causes abundant moisture in the air which ultimately results low concentration of PM_{10} in the area on that day.

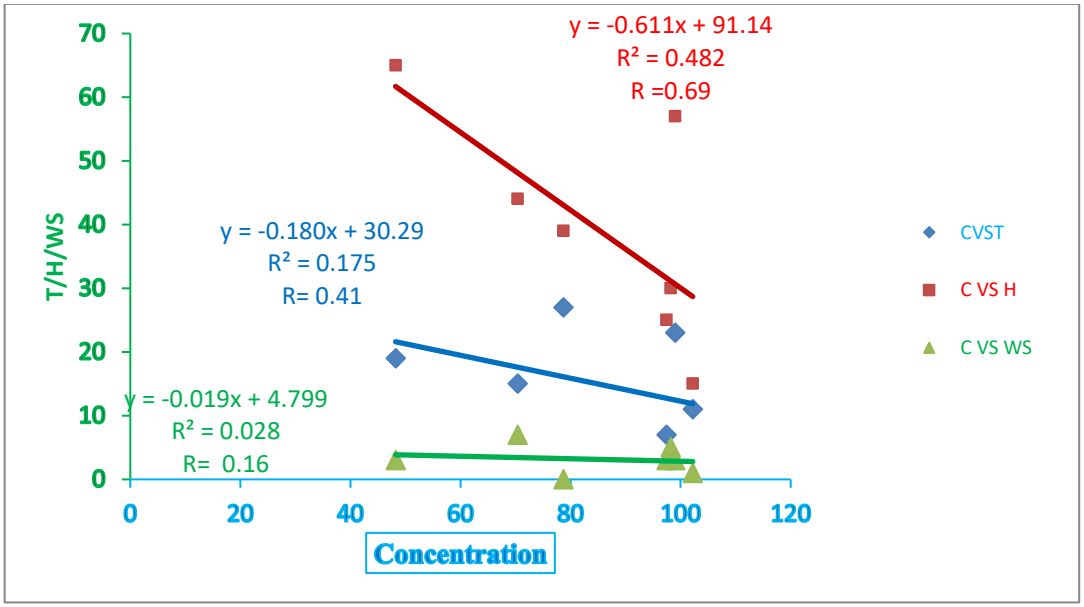
The wind speed is also one of the important meteorological parameter which affects the PM_{10} concentration. With increases in wind speed generally leading to decreases in PM_{10} concentrations, and decreases in wind speed generally leading to increases in PM_{10}. At the low wind speed the rate of dispersion of particulate matter in the atmosphere is very low which result in increase of the concentration of PM_{10}.But when wind speed increases the dispersion of particulate matter occurs more effectively. At sirmour the maximum 8hrs. Wind speed value is7km/h on June 15 while the minimum value was decreased at 0km/h on June 27as shown in the below mentioned table1. With the increase in the wind speed the concentration of the PM_{10} also decreased showing the value of 78.7 µg/m^3

Table 2: Shows the Meteorological parameters and Concentration of PM $_{10}$ in the month of June at Sirmour choura

S/no	Date	Temperature	Humidity	Wind speed	PM_{10} Conc.
01	03	40^0C	30%	5km/h	98.2 µg/m3
02	07	41^0C	25%	3km/h	97.4 µg/m3
03	11	45^0C	15%	1km/h	102.2 µg/m3
04	15	31^0C	44%	7km/h	70.4 µg/m3
05	19	29^0C	63%	3km/h	48.2 µg/m3
06	23	32^0C	57%	3km/h	99 µg/m3
07	27	37^0C	39%	0km/h	78.7 µg/m3



In the month of June the average concentration of PM_{10} for seven days at Sirmour square was observed 84.87 µg/m3.The Pearson coefficient correlation between PM_{10} value and meteorological variables which are Temperature, Humidity, Wind speed having Pearson value are, R=0.41,R=0.69,R=0.16 respectively were also calculated.



Shows the parsons correlation of PM_{10} and Meteorological parameters.

Discussion

It is observed that the mean value of 8 hour PM_{10} concentrations at different months at different locations was 61.93 µg/m^3, 48.42µg/m^3, 65.95 µg/m3, 67.51 µg/m^3, 68.05 µg/m^3 measured at four sites in Monsoon, post monsoon respectively**.** It is observed that the average concentration of PM_{10} show distinct seasonal variations in monsoon value in the study area than the post monsoon value. This drop down in the concentration of PM_{10} in monsoon may be due to the monsoonal washout effect of particles. Similar kind of findings is also reported by Gupta et al. (2008). At Sirmour Square it is observed to have a very high average concentration of PM_{10} (79.3 µg/m3) during post monsoon season. This site is situated in densely

populated region of the town. So, the accumulation of such a high level of RSPM may be endured at this site due to the emission from the surrounding traffic of the city, resuspension of dusts from the paved and unpaved road etc along with the prevailing meteorological condition. Similarly at site second, Bus stand it is observed to have a very high average concentration of PM_{10} (66.2 μg/m3) during monsoon season. This site is situated in also densely populated region of the town. So, the accumulation of such a high level of RSPM may be endured at this site due to the emission from the surrounding traffic of the city, resuspension of dusts from the paved and unpaved road etc along with the prevailing meteorological condition. At site third Hospital Square, it is observed to have a moderate average concentration of PM_{10} (59.9 μg/m3) from the above mentioned two sites in the Rewa city during post monsoon season. This site is also situated in densely populated region of the town but it shows less value of average concentration of PM_{10} because there was less accumulation of such a high level of RSPM. Similarly at fourth site University campus it was observed to have a very less average concentration of PM_{10} (46.1 μg/m3) during five month period. This site is situated towards the peripherals of the town and there is less movement of the traffic from the other mentioned sites and the atmosphere is clean and a number of green plants are present which contributes the lesser average value of PM_{10} pollutant of the region. This observation is also been corroborated with the work of Ali and Athar (2008) and Girl et al. (2006). Both of them found that high concentration of PM_{10} in some selected places of Pakistan and Kathmandu which is attributed due to traffic volume, length of days and meteorological condition.

Conclusion

Urban air pollution is a severe environmental problem, which requires immediate attention on the part of researchers. The detailed background information on urban air quality status is very much essential for local control agencies to implement the air quality management programme. Rewa city has a high potential for air pollution due to its exponential population and industrial growth. The hostile topography and climate necessitates continuous monitoring of air pollutants and implementation of control strategies. However, this requires a systematic, cost effective and efficient air quality monitoring and modelling procedure for Rewa city.

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