PM10 CONCENTRATION CHANGES AS A RESULT OF WIDESPRING PRECIPITATION IN AGRA

Kalpana Singh*, Dr. Randhir Singh Indolia,

Department of Physics, Dr. Bhimrao Ambedkar University, Agra (U.P), India

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Abstract - - *From 2021 to 2022, research was conducted at the Sanjay Place site to examine the impact of widespread precipitation on the decrease in PM_{1o} concentration. There was a discernible variation in the concentrations of PM_{1o} particles before and after. There was a noticeable change in the average PM_{1o} concentration and less PM_{1o} in the air during periods of precipitation compared to those without. The average PM_{10} concentration was 101.1μg/m^3 and 184.8μg/m^3 with and without precipitation. Over the July–September period, the intensity of moderate to light rain was found to have the biggest effect on the decrease in PM_{1o} concentration. The results showed that the accumulation of aerosol concentration was prevented by continuous low intensity rain episodes and that the amount and duration of precipitation have an effect on how*

***Key Words*: PM_{1o}, Atmospheric purification, Precipitation, Meteorological condition**

1.INTRODUCTION

At the expense of other elements of the natural environment, below-cloud scavenging serves as a key process that enables the removal of pollutants from the ground level zone and plays a crucial part in the maintenance of excellent air quality [1]. As a result, it is a crucial step in maintaining the equilibrium between the entrance and outflow of aerosol particles [2]. All mechanisms that cause rain, snow, fog, and ice to wash off particle matter are considered to be a part of wet below-cloud scavenging. According to [3], below-cloud scavenging appears to be more significant than in-cloud scavenging from the perspective of human well-being and the quality of the ground-level zone. This claim is supported by the observation that the particulate matter that poses an immediate threat to human health is primarily released as a result of below-cloud scavenging, with the major mechanism involved being the collision of solid particles with raindrops [4]. The wet aerosol washout process is inherently complicated because it is influenced by a variety of external phenomena, such as drop size, particle size distribution, water chemical composition, rainfall intensity, ambient temperature, as well as the chemical and physical characteristics of drops and aerosol [5]. The bulk particle number, bulk particle mass, or size-resolved particle number and mass concentration can all be used to establish the aerosol scavenging coefficient [6]. Experimental research into below-cloud purification carried out under real-world circumstances focuses on several aspects of this process. The processes are studied both on a complex scale, which includes details of the effectiveness of solid particle removal by specific types of precipitation, and on a specific scale, which can include the effectiveness of scavenging of different types of particulate particles by specific types of precipitation [7]. Transport from outside the area is the primary source of air pollution in addition to local accumulation. Clearly, there is a great deal of uncertainty around the method by which contaminants are removed by precipitation [8,9]. This paper's main goal is to analyze the variability of wet deposition, which is the process of removing coarse particles, in relation to the length, intensity, and location of precipitation [10].

2.EXPERIMENTAL

2.1. Study Area.

At the Sanjay Place site in Agra city, PM_{10} aerosol samples and rainwater samples were taken simultaneously. India's Agra is a major city. With the Thar Desert of Rajasthan enclosing two-thirds of its outer limits (SE, W, and NW), it is located in the north central area of India (27.18 N 78.02 E). Agra has 1.6 million people, according to the Census (2011). The summer months in Agra are hot and dry, with daily average temperatures ranging from 21.9 to 48 degrees Celsius, and from 4.2 to 31.7 degrees Celsius in the winter. Agra receives about 736.6 mm of rainfall each year.

2.2. Description of sampling site

The study was conducted in Sanjay place site of Agra city from October 2021 to September 2022. Map of sampling site and surroundings are shown in Fig.1. The main causes of air pollution were nearby commercial activity, industrial emissions, and emissions from vehicles. These sources have a significant impact on the site, depending on seasonal variations in wind and direction. Sanjay place is one of the most polluted areas in Agra city.

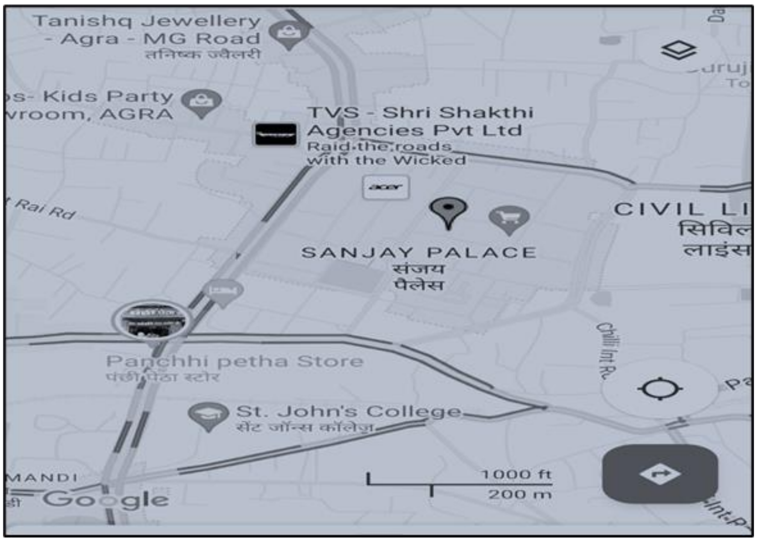

Fig.1 Map showing study area at Agra city.

2.3. Sample collection

PM_{10} samples were collected by low volume sampler. Three sets of samples were collected before rain, during rain and after rain each at site. The rainfall data was collected by using rain gauge instrument through bottle and funnel method. The amount of rain was measured for calculation of rain intensity. The site is free from any obstacles. The PM_{10} instrument shown in fig.2 and Rain gauge instrument shown in fig.3.

Fig.2. PM_{10} Low Volume sampler

Fig.3. Rain gauge

3. RESULT AND DISCUSSION

3.1. Statistical description

Table.1 provides a summary of the statistical information that was examined during the 2021–2022year experiment, including information on the chosen air pollution (PM_{10}), meteorological variables, and precipitation. Rainfall intensity (light, moderate, heavy) plays a crucial role in the removal of PM_{10} from the troposphere.

Table 1. PM_{10} and meteorological parameters characterization

Precipitation samples	Descriptive statistics	PM_{10}	T (°C)	RH (%)	WS	WD
11 samples	avg	135	26.3	70.2	2.19	169.3
	min	51	11	30.5	1.04	94
	max	281.3	36	82	3.52	267
	med	144.6	26	74	2.58	141

Note: T- temperature, RH- relative humidity, WS- wind speed, WD- wind direction, Avg.- average, Med.-median, Min-minimum, Max-maximum, precipitation samples.

During large-scale rain events in the cold and warm seasons, the average air temperature was around 19.8°C and 31.8°C respectively. The warm season is characterized by higher relative humidity and lower wind speed than cold season.

3.2. PM_{10} concentration with and without precipitation

In the case of rainfalls, PM_{10} concentrations were lower than during the non-precipitation period, and between 101.1 and 184.8, there was a discernible difference in average PM_{10} concentration. The pattern of hourly PM_{10} concentration variation of precipitation and non-precipitation was quite similar to each other. Quantitatively, the reduction effect of precipitation scavenging in the warm period was higher than in the cold period. The hourly PM_{10} concentration in the cold period increased due to a relatively more substantial direct effect of vehicle emissions despite the rainfall. The meteorological parameters also effect the concentration of PM_{10} during warm and cold periods.

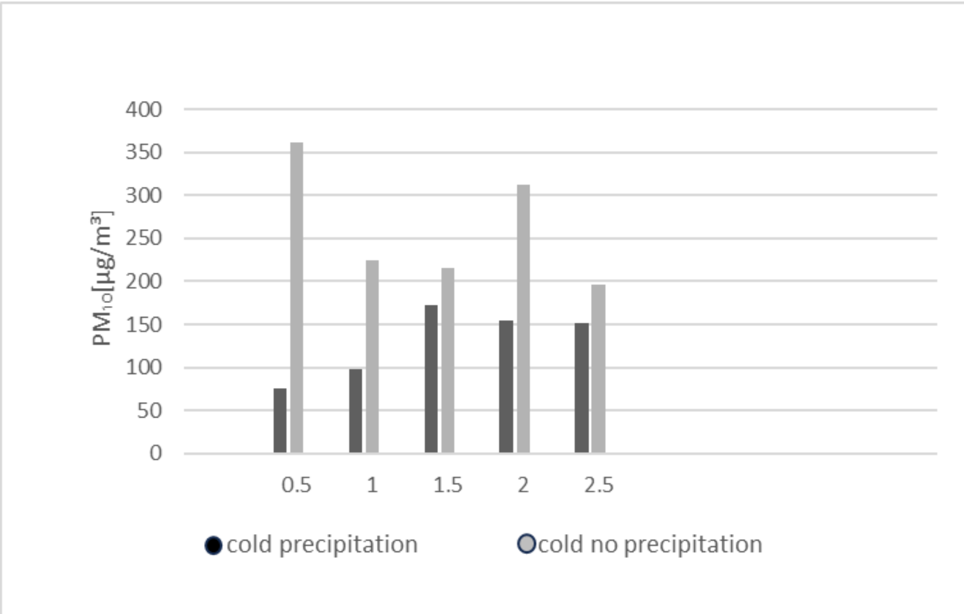

Fig. 4 PM_{10} hourly variations of precipitation and non-precipitation in the cold period.

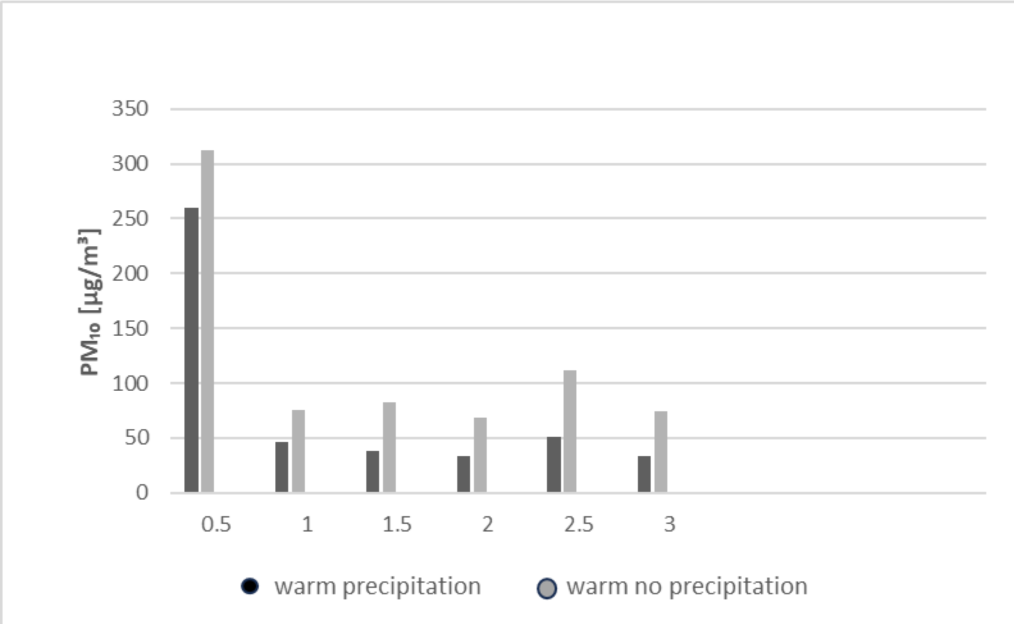

Fig. 5 PM_{10} hourly variations of precipitation and non-precipitation in the warm period.

At the Sanjay place site, A comparison was made between the hourly PM_{10} concentration during periods of rainfall and no precipitation to ascertain the purifying impact of precipitation.

4.CONCLUSION

After 6 hours of continuous rain with low to moderate intensity, the warm season had the greatest PM_{10} concentration reduction. The most frequent duration of rainfall was an hour, and low intensity precipitation predominated. The PM_{10} concentration measured in the cold and warm periods showed a substantial difference as a result of the differing emission sources and weather conditions. In places with poor air quality, the immediate purification effect brought on by the occurrence of moist deposition is reduced to a minimum. Scavenging efficiency greatly depends on the structure of the precipitation.

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REFERENCES

[1] Goncalves FL, et al., "Modelling and measurements of below cloud scavenging processes in the highly industrialised region of Cubatao-Brazil". Atmos Environ. (2000).

[2] Chate DM. Rao P, et al., "Scavenging of aerosols and their chemical species by rain". Atmos Environ. (2003).

[3] Bae SY et al., "Development and evaluation of an expression for polydisperse particle scavenging coefficient for the below-cloud scavenging as a function of rain intensity using the moment method". Aerosol Sci. (2006).

[4] Kim J-E et al., "Factors influencing atmospheric wet deposition of trace elements in rural korea". Amos Res. (2012).

[5] Zhao H, et al., "solution of wet removal of aerosols by precipitation". Atmos Environ. (2006).

[6] Andronache C, et al., "A Scavenging of ultrafine particles rainfall at a boreal site: observation and model estimations". Atmos Chem Phys. (2006).

[7] Kreidenweis SM, et al., "Modification of aerosol mass and size distribution due to aqueous-phase SO2 oxidation in clouds: Comparison of several models". J Geophys Res. (2003).

[8] L. Zhang, et al., "Numerical studies of aerosol scavenging by low-level, warm stratiform clouds and precipitation," Atmospheric Environment, vol. (2004).

[9] K. F. Li, et al., "Analysis on precipitation scavenging on PM10 and PM2.5 in central and south of Beijing-Tianjin-hebei region," Journal of Arid Land Resources and Environment, (2019).

[10] Zhang X, et al., "Aerosol characteristics including fumigation effect under weak precipitation over the southeastern coast of China". J Atmos. Phy. (2012).