Variation of particulate matter PM2.5 with temperature on the year of 2021: A case study of Udaipur

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Abstract- Economy and human health affected by the global pandemic covid-19 of many countries including India. Due to unusually restricted activity, the air quality was also improved during this period i.e., during the covid-19 pandemic period. It was found that the PM2.5 and other atmospheric parameters changes drastically after this period because all the man-made activities again started. The main objective of the current study is to observe the variation of PM2.5 with temperature after covid-19 time. In this study we analyse the average mass concentration of PM2.5 during 2021 over Udaipur. It was observed that the variation of monthly average mass concentration of PM2.5 is found maximum in the month of January (87.48 µgm^{-3}) and its minimum value is found in September month of 2021. The corresponding values of temperatures were 21.21°C and 29.87°C respectively. In winter season the average value of PM2.5 were found maximum, whereas it was found minimum during the rainy season. It was found that the PM2.5 and temperature are negatively correlated with each other and its value was found to be 0.854.

Keyword; air quality, NAAQS, COVID-19, atmosphere, PM2.5.

INTRODUCTION

The air quality is most dangerous problem in the world and important to prevalent in developing countries include India which has rapidly increased industrialisation, auto mobiles and many more. The harmful emission and unhygienic air into urban atmosphere over the world due to routine activity (Yadav et al., 2022). Udaipur is most beautiful and tourist destination place in India and world although air quality of Udaipur is going very fast to hard due to unpaved road, cement, marbles and industries. The Udaipur city is under covered by the Aravli Hills range, peaceful and tourist attraction place.

Particulate matter with less diameter of 2.5µm (PM2.5) are responsible for damage human health and climate change (Yadav et al., 2014). In all five cities of Rajasthan during lock down period compared with pre lockdown period NO2(35-77%), CO (4-69%), PM10(2-61%) were found significant reduction and increased in Ozone (3-43%) and the level of particulate matter below to NAAQS with respect to pre-lockdown (Yadav et al., 2022; Vyas et al., 2023). Traffic exhaust, bio and fossil fuel, biomass burning and windblown dust are major sources of PM2.5 in India (Sahu et al., 2021).

The urban areas of world the most danger pollutant impacts on ecology and human health emerged the many air pollutants include particulate matter. The major cities of Rajasthan; Jaipur, Jodhpur, Ajmer, Kota, Alwar, Pali, Udaipur and Bhiwadi the PM2.5 indicate increasing trend in past four year (2019-2022) due to increasing industry (Vyas et al., 2024). The levels of particulate matter PM2.5 in air can adverse cardiovascular and respiratory diseases (health effect) (Wan Mahiyuddin et al., 2023).

The concentration of particulate matter i.e., PM2.5 near the road is quite high, mainly due to automobile exhaust fumes and re-suspension dust (Alshetty & SM, 2022).

A complex combination of minuscule particles and liquid droplets floating in the atmosphere is known as particulate matter (PM). Because they may enter the respiratory system deeply and lead to health issues, PM2.5, or particles with dimensions of 2.5 micrometers or less, are of special concern. There are several sources of PM2.5, including industrial operations, combustion engines, and natural sources like wildfires.

In current study we presented, the results based on the meteorological parameter temperature and with the continuous measurements of PM2.5 during January 2021 to December 2021. The main target of this study is to investigate the short-term variation of PM2.5 with temperature and also the seasonal variation of PM2.5 with temperature.

Since PM2.5 is crucial for environmental surveillance, public health, and policy formulation, so this study place a vital role for future work. Retardation and cardiovascular disorders are also linked to PM2.5, and prolonged exposure can have serious negative effects on health, including early mortality. Moreover, tracking and evaluating PM2.5 levels might support the development of efficient air quality control plans (U Pandya Joshi E, 2020).

The impact of meteorological parameter (temperature) on particulate matter PM2.5, the structures of seasonal and diurnal variation have been discussed in the present work.

Location of Case Study: Udaipur

The Udaipur, is situated in the Indian state of Rajasthan, having latitude and longitude 24.5854° N and 73.7125° E, respectively (Fig. 1). It is a tourist spot surrounded by Aravali Hills. Lots of industrial work is going in city like mining, melting, refining etc. In this regard PM2.5, PM10, black carbon emitted during the process. Apart of it, Udaipur is also a part of dream Smart City Project of Central Government of India, so lots of construction is also going in the city. The city presents an intriguing subject for research on the relationship between temperature fluctuations and PM2.5 levels due to its distinct geography and climate. This city is well-known for its rich cultural heritage and scenic lakes, so it is also known as lake city. The city has scorching summers, a monsoon season, and moderate winters due to its semi-arid environment.

Fig. 1: Location of Udaipur (Rajasthan)

2. METHODS AND MATERIALS

In the present study the daily data of air pollutants, particulate matter (PM2.5) and temperature was collected from CPCB (Central Pollution Control Board, Delhi) for Udaipur city January 2021 to December 2021.

The daily data obtained from CPCB is arranged in monthly average and seasonally average, where season divide as winter (November to February), summer (March to June) and monsoon (July to October). For better understanding the result standard deviation is also calculated from the data. To evaluate the association between temperature and PM2.5 levels, the correlation coefficients is computed.

Results and Discussion;

Monthly Variation of PM2.5 level;

The monthly average concentration of PM2.5 is represented in Fig.2(a). In the months April, May, Jun, July, August, September and October, the monthly mean value of PM2.5 is found to be under NAAQS (60µgm^{-3}), but in the months January, February, March, November and December it crosses the value of NAAQS and it was found to be 87.48 µgm^{-3}, 67.38 µgm^{-3}, 59.96 µgm^{-3}, 85.33 µgm^{-3}, and 78.29 µgm^{-3} respectively, also the temperature in the corresponding months were found to be 21.21°C, 25.19°C, 31.06°C, 23.75°C and 19.87°C, which is shown in Fig.2(b). The minimum concentration of PM2.5 in found to be in the September (30.93µgm^{-3}), whereas the maximum average was found in the months of January (87.48 µgm^{-3}).

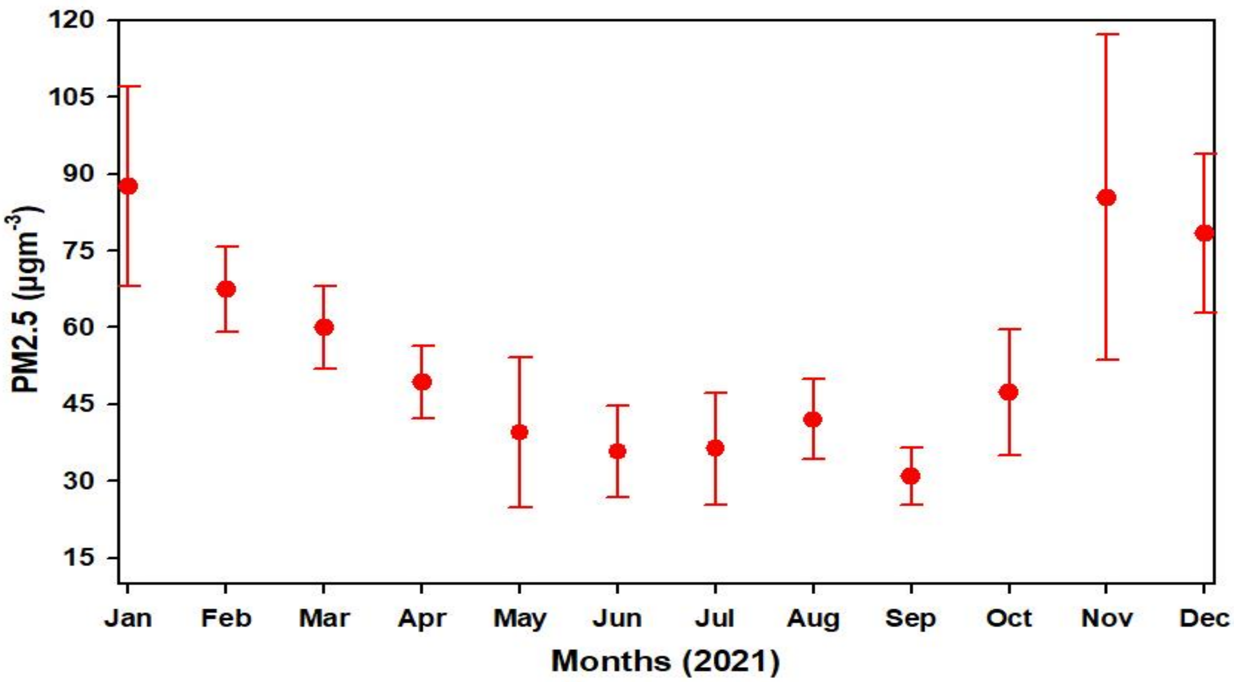

Fig.2(a): The monthly average of PM2.5

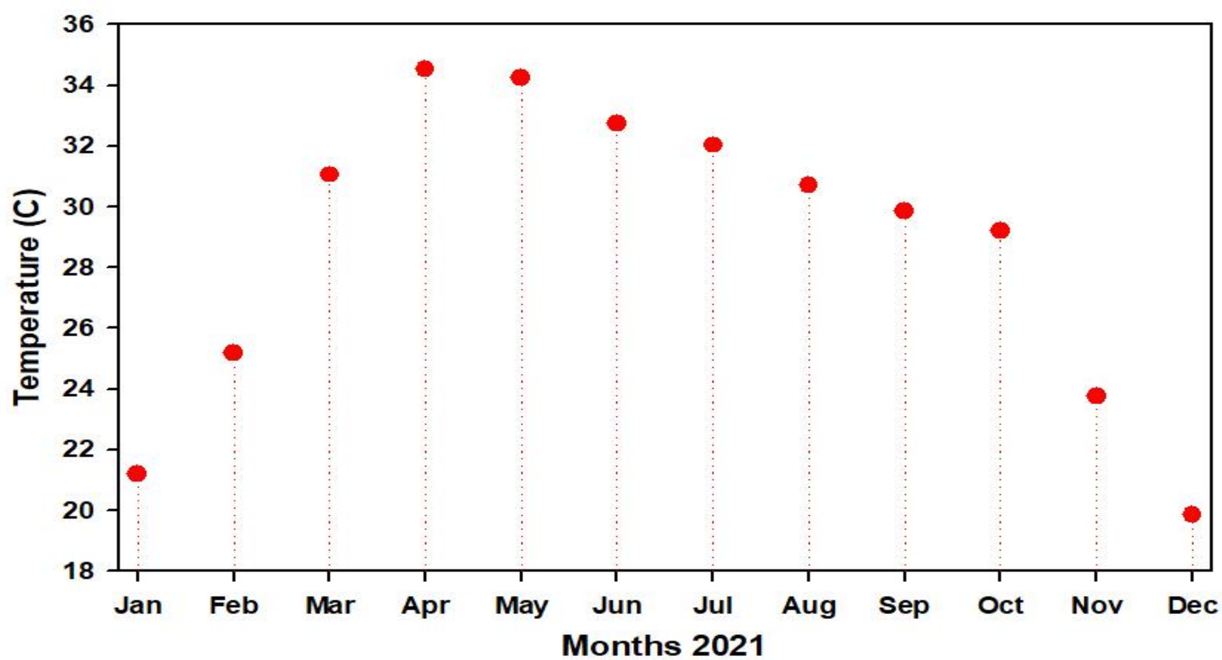

Fig.2(b): The monthly average of Temperature

Seasonal Variation of PM2.5 Level;

Fig.3(a) shows the seasonal (winter, summer and monsoon) average concentration of PM2.5. It was found that its value in summer, winter and monsoon season were 46.11 μgm^{-3}, 79.62 μgm^{-3}, and 39.11 μgm^{-3} respectively and also the temperature in that seasons were 33.14°C, 22.5°C, 30.45°C respectively [Fig.3(b)].

The average mass concentration of PM2.5 crosses NAAQS in winter season and temperature is minimum in this season, whereas in monsoon season the air pollutant PM2.5 was found to be minimum (39.11 μgm^{-3}).

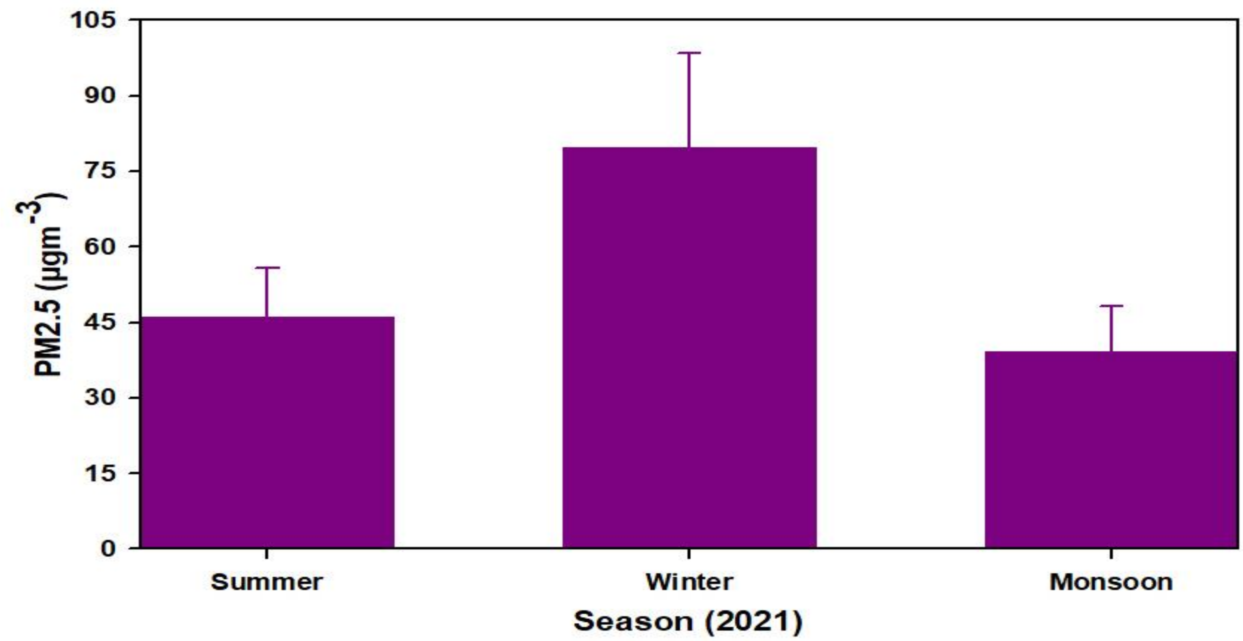

Fig.3(a): The seasonally average of PM2.5

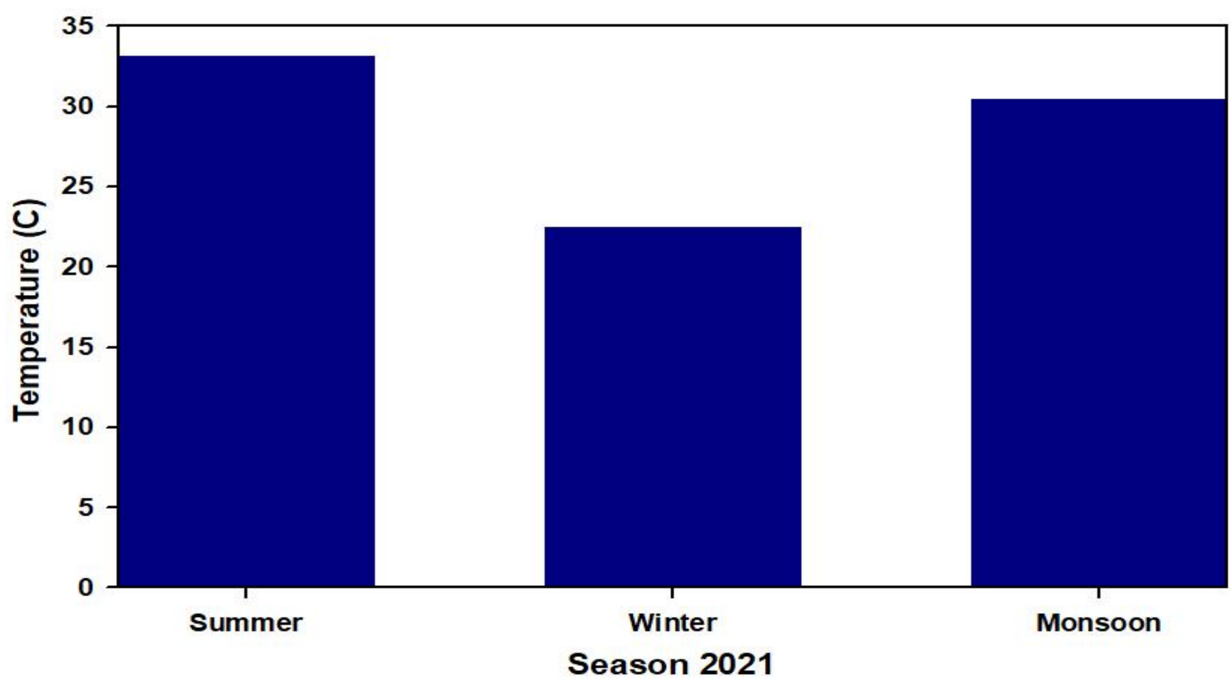

Fig. 3(b): The seasonally average of PM2.5

Relation between PM2.5 level and temperature;

An investigation of the association between temperature and PM2.5 level was done for year 2021 using correlation analysis. The finding showed a negative connection between PM2.5 and temperature and its value is 0.854, which meant that lower PM2.5 concentration were typically linked to higher temperatures, the same result was obtained by Kassomenos et al. (2014).

Potential Sources and Influencing Factors

Several possible sources and variables impacting Udaipur's PM2.5 levels were found by the study. These sources are traffic emissions, industrial activities, meteorological conditions etc. It is notices that High traffic volumes, particularly in the winter, greatly increased PM2.5 concentrations. The variations in PM2.5 concentrations were also influenced by emissions from nearby industries and building projects. The dispersion and concentration of PM2.5 were significantly influenced by temperature, wind speed, and humidity. Wintertime lows caused air inversion, which trapped pollutants near to the ground.

Summary

The winter months in Udaipur had the greatest levels of PM2.5, while the monsoon season saw the lowest levels. There was a negative relationship found between temperature and PM2.5 concentrations, with higher temperatures often resulting in lower PM2.5 levels. The fluctuation in PM2.5 levels was shown to be significantly influenced by industrial activity, traffic emissions, and weather.

On the basis of above work, it can be concluded that the measurement of specific air quality in Udaipur is essential. To better understand temporal fluctuations and sources, thorough and ongoing monitoring of PM2.5 and other pollutants is conducted. Putting policies in place to lessen emissions from traffic, such encouraging public transit and enforcing emission limits on cars. Industrial Regulation: Imposing more stringent emission requirements on businesses and building projects. Educating the public about the harmful effects of PM2.5 on health and promoting local participation in programs aimed at reducing pollution (Alzayani & Alsabbagh, 2022).

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