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Investigation of particulate matter in Perungudi, Chennai, Tamil Nadu (India) during the winter period

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ABSTRACT

Air pollution studies have found that the coarse and fine particulate matter are mainly responsible for various respiratory health effects for humans. This study focuses on the distribution and changes in the concentrations of PM_{10} and its precursors (SO_2, NO_2 and CO) in Perungudi, Chennai. Perungudi is chosen as the study area, as it is located on both commercial and residential site. The acquired data is used to estimate the various concentration levels of particulate pollution during the winter season of January and February 2022, using Pearson correlation and linear regression models .This statistical study helps in identify the significant relationship between the various pollutants SO_2, NO_2 and CO with PM_{10}. Pearson correlation and linear regression models were applied to evaluate the dependence of PM_{10} concentration on its precursors based on daily values. The correlation results indicated positive low and moderate values. The regression R^2 values show the variation of 20% to 25%. This study is an effective step toward a better understanding of PM_{10} changes in Perungudi under the changing influence of precursors.

Keywords: Particulate matter, Precursors, Perungudi, Chennai, Winter period, Pearson correlation, Regression

INTRODUCTION

The atmosphere is a blanket of air that surrounds the Earth. This is a mixture of gases that contains a huge number of solid and liquid particles (Lal, 2004). It is a source of essential gases, temperature, rain, air and protects from UV rays and meteors (Sharma, 2002). Air can be defined as combination of gaseous matter that forms the stratosphere or the invisible gaseous substances surrounding the Earth. Further, the local meteorological conditions can also influence the level of PM_{10} which include land surface temperature, precipitation and wind pressure (Zhang et al., 2015; Li et al., 2019; Faisal et al., 2022).

According to World Health Organization (WHO), one in eight total global deaths occurs as a result of exposure to air pollution. Over 3.5 million people die each year from outdoor air pollution. Low and middle-income countries, especially the Western Pacific and South-East Asian countries, account for about 88% of those premature deaths (WHO, 2012). Particulate matter which is often called as PM is a very fine proxy indicator for air pollution, strong evidence has been observed for the negative health impacts due to the exposure of this pollutant, whose components include sulphates, nitrates, ammonia, sodium chloride, black carbon, and water. The WHO has set thresholds on limits of key air pollutant to aid in the policies related to decision making process. 3,00,000 deaths would be saved worldwide annually with a PM concentration of around 35 $\mu g/m^3$.

These particulates in outdoor air pollution were recently designated as Group I carcinogen by the International Agency for Research on Cancer (Hamra et al., 2014). Many epidemiological studies have shown that particulates, especially inhalable particulates, are harmful to human health. In urban areas around the world, it is observed that on certain days, the atmospheric particulate matter is exposed to unhealthy concentrations. Therefore, using the Pearson's linear correlation coefficient, it was possible to analyze the interrelations between the occurrence of air pollution. The dust particle is mainly divided into different categories namely Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (PM_{10} or RSPM), $PM_{2.5}$, PM_1 and ultrafine particles (Kushwaha et al., 2016). The classification and size of particles is given in Table 1.

Although the air quality at a specific site, depend on many factors, some common characteristics of changes could be determined using statistical methods. Therefore, in literature, the correlation coefficient is often used as a statistical tool to analyze the nature of changes in air pollution (Coyne and Bingham, 1977; Sonkin and Nikolaev, 1993; Karaca, 2012; Keresztes and Rapo, 2017)

Table 1. Classification and size of pollutant particles

Fraction	Size range
SPM	0.01-100µm in diameter
RSPM or PM_{10}	<=10µm diameter and diameter ranges from 2.5-10 µm is called coarse fraction.
Fine particles or $PM_{2.5}$	<=2.5 µm in diameter
PM_1	<=1 µm in diameter
Ultrafine particles (UFP)	<=0.1 µm in diameter