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RESEARCH ARTICLE

DETERMINATION OF SPEARMANS CORRELATION COEFFICIENT OF AEROSOLS OF TROPICAL URBAN COASTAL STATION CHENNAI, INDIA

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ABSTRACT

Chennai is a(E80 14'51" and N13 03' 40"), tropical urban coastal site on the east coast (Bay of Bengal) of southeast India. For the period from April 2015 to April2016 ,correlation coefficient is determined by the method of Spearmans Rank correlation coefficient .The main objective was to study the correlation analysis of the particulate matter PM 10 and PM2.5 of various regions of Chennai. An inverse relation exist between aerosol and rainfall. Hence the aerosol analysis can be a useful in foreshadowing the rainfall, which is of considerable economic importance.

INTRODUCTION

Among all the criteria air pollutants, particulate matter (SPM and RSPM) has emerged as the most critical pollutant in almost all urban areas of the country (www.cpcb.nic.in). Atmospheric aerosols are particles of solid or liquid phase dispersed in the atmosphere (Seinfeld, 2006; Junge, 1982; Chand, 2009). Atmospheric aerosols are of natural and anthropogenic origin. On a global scale, the natural sources of aerosols are three to four times larger than the anthropogenic ones, but regionally anthropogenic emissions can be significant (Seinfeld, 2006 and Andreae, 2005). Aerosols can have significant influence on the Earth's climate, although making up only one part in a billion of the mass of the atmosphere. Atmospheric particulate matter (PM) can be classified as PM10, PM2.5 and PM1 by size with mass median aerodynamic diameter less than 10 µm, 2.5 µm and 1 µm respectively. PM plays pivotal role in the climate change, cloud dynamics, health impact, fog formation and visibility through a variety of atmospheric processes (Pillai *et al*., 2002; Pope *et al*., 2002; Das *et al*., 2009). The major source of PM10, PM2.5 and PM1 are referred as windblown dust, secondary aerosol, coal combustion, traffic exhausts and biomass burning, etc. (Tiwari *et al*. 2009). PM2.5 is a complex mixture consisting of many different components from a range of sources.

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Its composition varies depending on emissions, weather conditions, local and regional contributions, and temporal variations (see Section 2). The key aerosol species present in PM2.5 are sulphate, nitrate, minerals, ammonium, organic carbon (OC), elemental carbon (EC), metals and bio aerosols (USEPA, 2009). PM particles, once airborne, continue to undergo chemical and physical transformation by coagulation with other particles, by chemical reaction or by activation in the presence of water supersaturation to become fog and cloud droplets (Seinfeld and Pandis, 2006). Fine particles are eventually removed from the atmosphere by two mechanisms, dry deposition (deposition at the earth's surface) and wet deposition (incorporation into cloud droplets during the formation of precipitation and collisions with falling rain) (USEPA, 2009). The significant natural sources of PM2.5 particles include soil and rock debris (terrestrial dust), volcanic eruptions, sea spray, biomass burning and reactions between natural gaseous emissions. Anthropogenic sources can be divided into stationary (primarily fossil fuel combustion, industrial processes, non-industrial fugitive sources (e.g. roadway dust from paved and unpaved roads, wind erosion, construction)) and mobile or transportation-related sources (e.g. vehicles emissions) (USEPA, 2009). PM2.5 particles in the accumulation mode can remain suspended for a few days, whereas for the coarse fraction of PM this would be more minutes to hours (USEPA, 2009). As such, PM2.5 concentrations tend to be homogeneously distributed with distance from emission (Watson and Chow, 2013). Chennai is a coastal city. Chennai1 area 176 km sq, 2011 census4.34million, 2011 census 4.95million, vehicle population in 2007, 2.27• million .Weather is typically hot and and humid. There is only a small variation between the seasons due to the location and proximity to the Indian Ocean Max. Temp.: 42° C and Min Temp: 20° C• These sources include large ,medium and small-scale industries, household fuel use for cooking and heating, refuse burning, vehicular emissions, re-suspended road dust, construction activities, agricultural activity, naturally occurring dust and trans-boundary migration from other regions, etc. In Chennai the contribution of PM 10 is due to is mainly due to transport, road dust and coal. Diesel vehicles are known to be significant emitters of PM 10.

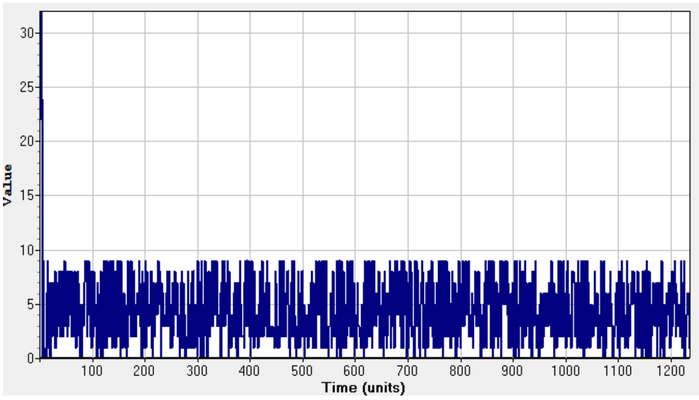
Data

For the study April 2015 to April 2016 of pm10 and pm 2.5 data was taken for the various regions (Kilpauk, T. Nagar, Anna nagar and Adyar) of Chennai. The above data is obtained from the Tamilnadu Pollution control board, Chennai.

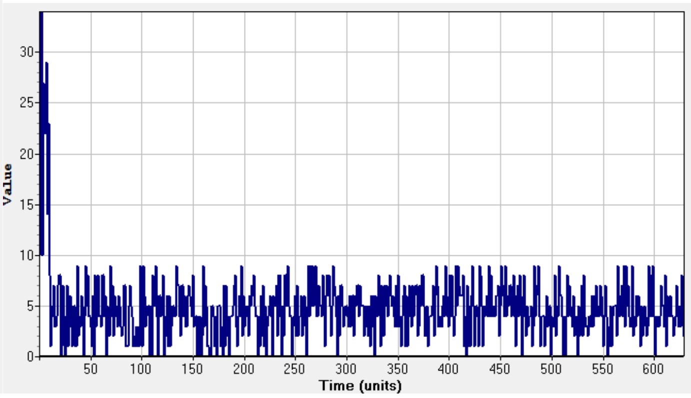
Time series Analysis Plot

The time series consists of a set sequential numeric data taken at equally spaced intervals, usually over a period of time or space.

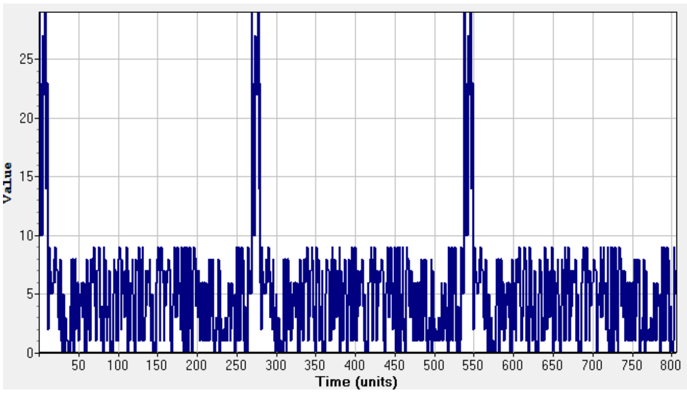
Time Series Plot for the Aerosols



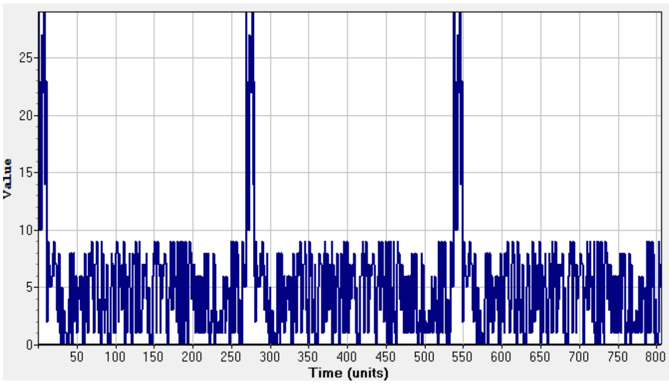
PM 2.5



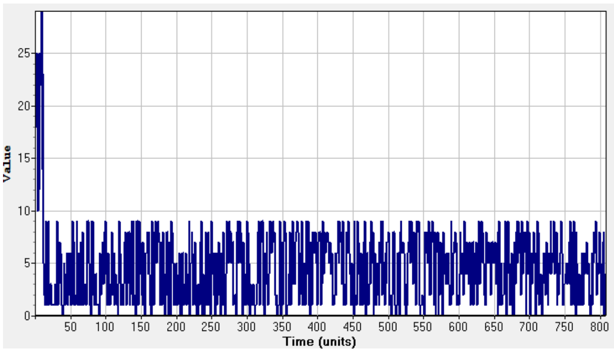
PM10 ADYAR



PM10 ANNA NAGAR



PM10 T.NAGAR



PM 10 KILPAUK

Table 1.

	RH	Temperature	wind speed	ozone	precipitation
pm 2.5	.1043	.0382	.0492	.0834	-
pm10(adyar)	0.0336	0.0297	0.0142	-	-
pm10 (kilpauk)	0.0320	0.0434	-	-	0.0358
pm10 (anna nagar)	0.1055	0.0447	0.0972	0.0987	-

The first step in time series analysis is to draw time series plot which provides a preliminary understanding of time behaviour of the series (Andreae *et al*., 2002 and Marzuki Ismail, 2011). Time series analysis is a useful tool for better understanding of cause and effect relationship of environmental pollution. The main aim of time series analysis is to describe movement history of a particular variable in time. Many authors have tried do detect changing behaviour of air pollution through time using different techniques (Pope, 2002 and Hies, 2003).

Spearman's rank correlation method

Methodology: The spearman rank correlation coefficient is a nonparametric test which determines the measure of strength between any two variables. Spearman's coefficient is not a measure of the linear relationship between two variables, It assesses how well an arbitrary monotonic function can describe a relationship between two variables, without making any assumptions about the frequency distribution of the variables. This method (Press *et al*. 1992) (Das, 2009 and Press, 1992), of finding the correlation between two variabilities is more robust than the usual method (i.e., by linear correlation).

The spearman method first determines the rank order of the sample values of each of the two variables X and Y separately. Then, it transforms the original N ordered pairs of scores to N ordered pairs of ranks. The ranks of the X scores comprise all integers from 1 to N, and similarly for the Y scores. This procedure makes it possible to derive a simple computational formula based on a sum of squared differences between ranks

$$\rho = \frac{1 - 6\Sigma D^2}{N - (N^2 - 1)}$$

Where $D=R_x - R_y$, the difference between ranks corresponding to X and Y.

The spearmen's correlation coefficient for the PM 2.5 and PM 10 for various regions of Chennai is given in the following Table 1

RESULT AND DISCUSSION

The PM 10 of T. Nagar shows insignificant results whereas the other region like Adyar shows positive correlation for relative humidity and wind speed. The PM10 of Kilpauk shows positive correlation with relative humidity temperature and precipitation.PM2.5 shows positive correlation with relative humidity, temperature, wind speed and ozone. There exists a relation between the aerosol and the meterological parameters and further analysis is required to study there relation. Before the forecast study Spearman's rank correlation method can be used to study the relation between the aerosols and meterological parameters.

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