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A REVIEW

Effect of meteorological parameter on distribution of particulate matter and air quality

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SUMMARY : Air pollution byparticulate matter has concerned much interest, in resent time due to current epidemiology. Theeffect of variations inmeteorological parameters on particulate matter and air quality has been investigated thoroughly. Ambient concentrations of particulate matter of less than 10µm and their activities are being aerodynamic measured in every country. Some of the resent researches have been renewed in this paper.

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Human activities are effecting to particulate matter and other pollutants as well as air quality and atmospheric distribution patterns or climate changes. Particulate matter (PM) is a heterogeneous, complex mixture of liquid and solid particle sizes and chemicals thus, it has been difficult to conduct animal or human clinical studies using mixtures found in ambient air. The term PM is equivalent to the term atmospheric aerosol and defines a suspension of air-borne solid particles and droplets of different sizes. PM may be divided into many size fractions, measured in microns (a micron is one-millionth of a meter). ARB regulates two size classes of particles - particles up to 10 microns (PM_{10}) and particles up to 2.5 microns in size ($PM_{2.5}$). $PM_{2.5}$ particles are a subset of PM_{10}. A single particle usually contains a mixture of chemical and physical (solid, liquid) constituents. Huge quantities of coarse and fine particles can produce haze that can impair outdoor visibility, reducing visual range by as much as 60-70 per cent from natural conditions. Airborne particles and droplets also tend to remain suspended in the air for extended periods of time and can travel long distances. When they eventually settle to the surface, they can damage property, acidify lakes and streams, and harm plants and animals. ARB staff reviewed the scientific literature and recommended revisions to the PM standards based on that review. On June 20, 2002, the Board adopted staff's recommendations and the revised standards became effective on July 5, 2003.

Many research papers related to distribution of particulate matter and air quality have been reviewed in this paper. Particulate matter distribution is affected by meteorological parameter like-wind speed,temperature, humidity and pressure. A variety of emission sources and meteorological conditions contribute to ambient PM_{10} and $PM_{2.5}$. Air quality studies related to total suspended particulate matter have been done by various workers in India and in other counties.

Aneja *et al.* (2001) studied the measurement and analysis of criteria pollutants in New Delhi, India. They measured total suspended particulate from January 1997 to November 1998 in the centre of town (Income Tax Office) Delhi. They found that SO_2, NO_2 TSP and CO concentration was maximum in winter and minimum in summer.

A study in Delhi city was conducted for diurnal and seasonal variation of carbon monoxide and nitrogen dioxide. This study analysed air quality data for three years from 1997 to 1999, at two air quality control regions in Delhi city. The results showed that the highest ground level concentrations of CO and NO_2 occurred during winter (November to March) and the lowest during tropical monsoon period (July to September). This has been investigated by Nagendra and Khare (2003).

Spatial and temporal variations of PM_1, $PM_{2.5}$, PM_{10} and particle number concentration during the AUPHEP—project" was done by Gomisceka *et al.* (2004). (AUPHEP—Austrian Project on Health Effects of Particulates). For this project, they selected four sites in Austria 3 urban sites and 1 in rural for the monitoring data of PM mass fractions - PM_1, $PM_{2.5}$, PM_{10} and TSP as well as the particle number concentrations over a 1 year period. The ratios between the different fractions were concerned usually the daily and seasonal pattern. Annual means of mass concentrations for PM_1, $PM_{2.5}$ and PM_{10} were in urban sites, a little bit lower at the rural site.

Gupta *et al.*(2006) analyzed the "Satellite remote sensing data of particulate matter and made air quality assessment over different global cities". They studied 26 different locations and urban area in Delhi, Sydney, Switzerland, Hong Kong and New York were selected for measuring the $PM_{2.5}$ mass concentration, air quality and correlated it with meteorological parameters. They used Terra and Aqua satellite for measuring the ground level particulate pollutants (PM) and air quality over the earth. Their analysis evidently showed that the $PM_{2.5}$-AOT (Aerosol Optical Thickness) relationship strongly depended on aerosol concentrations, ambient relative humidity (RH), fractional cloud cover and height of the mixing layer. Highest correlation between MODIS (Moderate Resolution Imaging Spectroradiometer), Aerosol Optical Thickness and $PM_{2.5}$ mass was found under clear sky conditions with less than 40–50% RH (relative humidity) and when atmospheric MH (mixing height) ranged from 100 to 200 m.

Giri *et al.* (2008) studied the influence of meteorological conditions on PM_{10} concentrations in Kathmandu Valley, Nepal. He found particulate matter PM_{10} and correlated with daily observed meteorological parameters *viz.*, wind speed, humidity, temperature, pressure and rain fall. Pearson's co-efficient of correlation was applied to study the association between PM_{10} and meteorological variables. The atmospheric pressure, wind velocity and humidity were found to be significant factors compared to others influencing PM_{10}. Increase of rainfall and humidity had negative correlation with average PM_{10} concentration in Kathmandu valley. Kumar *et al.* (2008) studied the "carbon monoxide pollution levels at environmentally different sites." They selected four cities (Thiruannathpurum, Palode, New Delhi and Jaduguda) for investigation of NAAQS levels of carbon monoxide or diurnal and seasonal variation.

Baxla *et al.* (2009) studied the analysis of diurnal and seasonal variation of submicron outdoor aerosol mass and size distribution in a northern India city and its correlation to black carbon. They measured size distribution and mass concentration of the atmospheric submicron aerosol by diurnal and seasonal behaviour in Kanpur city using scanning mobility particle sizer (SMPS). Rana *et al.* (2009) studied the diurnal and seasonal variation of spectral properties of aerosols over Dehradun, India. They worked on diurnal variation of aerosol optical depth and its spectral properties over non-cloudy days in summer and winter seasons. During high relative humidity and stable conditions, the AOD was found to be relatively low as compared to unstable meteorological conditions. Arkouli *et al.* (2009) conducted studies on the "distribution and temporal behaviour of particulate matter over the urban area of Buenos Aires". They measured $PM_{2.5}$ and PM_{10} concentrations and their variation relationships with relevant variables that characterize of the air pollution potential of the urban site during one year from 2006 to 2007. Jacob and Winner (2009) studied the effect of climate change on air quality. Air quality depends upon weather and it is sensitive for climate changes. In this paper, Jacob and Winner worked out estimates of climate effect through correlations of air quality with meteorological variables used by Chemical Transport Models (CTMs).

Zha *et al.* (2010) analysed in Nanjing, China city and worked on monitoring of urban air pollution from MODIS aerosol data: effect of meteorological parameters. In this paper, they have analysed the influence of four meteorological parameters (air pressure, air temperature, relative humidity, and wind velocity) on estimating particulate matter (PM) from MODIS (Moderate resolution Imaging Spectroradiometer) AOT (aerosol optical thickness) data. After that the data collection they correlated PM data with AOT data and they found that in winter season, minimum correlation co-efficient but stronger correlation in summer and autumn. Bathmanabhan and Madanayak (2010) worked on Chennai city on "analysis and interpretation of particulate matter – PM_{10}, $PM_{2.5}$ and PM_1 emissions from the heterogeneous traffic near an urban roadway". They analysed and interpreted diurnal, weekly and seasonal cycles of 1hr. average particulate matter (PM_{10}, $PM_{2.5}$ and PM_1) concentrations, measured near an urban roadway in Chennai city. Analysis showed highest PM concentrations during post monsoon season as compared to winter and summer seasons. Bhaskar *et al.* (2010) studied "atmospheric particulate pollutants and their relationship with meteorology in Ahmedabad". They observed the suspended particulate matter and their concentration and air quality by the help of Gujarat Pollution Control Board and its collected with respirable dust samplers (RDS). After correlation with meteorological data, they found that the atmospheric environment of Ahmedabad was moderately polluted to unhealthy range. Beig (2010) monitored the air pollution during Commonwealth games and found that dust particles played a bigger role than vehicular emission for decreasing the quality of air. In the same year they noted the different scientific evolution of air quality standard and the Air Quality Index for India.

Bahauddin and Uddin (2010) studied status of particulate matter and its impact on roadside population of Dhaka city, Bangladesh. This paper investigated the level of particulate matter and to determine adverse impact of this on health of roadside population of Dhaka city. It was a desk research which has involved the collection of previous research reports, newspapers and journal content and also collection and synthesis of existing project reports regarding to air pollution of Bangladesh. In the year 2002-07, the maximum concentration of $PM_{2.5}$ and PM_{10} in Dhaka city and average of particulate matter levels were 2 times higher than the Bangladeshi standard and the residential areas.

Cattani *et al.* (2010) investigated evaluation of the temporal variation of air quality in Rome, Italy from 1999 to 2008. They studied to assess the temporal variation of air quality in Rome, focusing on airborne concentration of selected pollutants (PM_{10} and $PM_{2.5}$ mass concentration and particle number concentration, PNC, carbon monoxide, CO, nitrogen oxides, NO and NO_2). They used it for health effects assessment in epidemiological analyses. Time series analysis using Seasonal Kendall test was applied. A statistically significant decreasing trend was found for primary gaseous pollutants and total particle number concentrations. They found urban background PM_{10} and NO_2 concentrations seemed to be practically unchanged since 1999 as no statistically significant trends were found. All the pollutants showed higher slope of the estimated trend line at traffic oriented sites compared with those observed at the urban background. Thus, a reduction of the intra-city concentration variability throughout the years occurred.

Visibility degradation during foggy period due to anthropogenic urban aerosol at Delhi, India was measured by Tiwari *et al.* (2011). They studied particulate matter concentration, meteorological parameters and atmospheric visibility in Delhi city during winter season. The Windows software SPSS (version 17.0) was used to fit a linear regression model. The model explained the variation in visibility due to depression temperature and aerosols load. They found that fog occurred more frequently over urban areas than rural areas. It may occur due to increased air pollution emanating from variety of sources in the urban areas. Northern regions of India experience severe foggy conditions during the winter period.

Mkoma and Mjemah (2011) investigated influence of meteorology on ambient air quality in Morogoro, Tanzania. They measured the influence of meteorological parameters (precipitation, temperature, relative humidity and wind speed) on air quality in rural Morogono city during wet and dry seasons of 2005 and 2006 period and their relationship with PM_{10}. They found the result that higher concentrations of PM_{10} obtained during the 2005 dry season and the lowest during the 2006 wet season. It was interpreted that reasons for the higher levels of the particulate matter in the dry season were due to temperature inversions and absence of rain wash down. The observed particulate matter levels were also affected by the variations in sources strengths and in meteorological conditions.

Mishra *et al.* (2011) studied modeling the effect of wind speed and win direction on RSPM concentrations in ambient air: A case study at urban areas in central India. They used statistical approach to study the impact of wind speed and direction on ambient RSPM concentration at three different urban sampling locations in Nagpur. They compared the results with benchmark persistence model. Elampari Chithambarathanu (2011) studied the diurnal and seasonal variations in surface ozone levels at tropical semi- urban site, Nagercoil, India and relationships with meteorological conditions. They measured surface ozone at the southernmost tropical semi-urban site Nagercoil, India and used Gas Sensitive Semiconductor (GSS) sensor. They found that the ozone concentration was minimum in morning time and maximum in afternoon. Temperature showed a good positive correlation and relative humidity showed a negative correlation with ozone as well as they found that seasonal concentration was highest average in summer and lowest in north east monsoon. Sanchez *et al.* (2011) studied "black carbon in $PM_{2.5}$, data from two urban sites in Guadalajara, Mexico during 2008". They measured BC and $PM_{2.5}$ concentrations using a two–wavelength Aethalometer and a Partisol sampler. The BC study period was divided into three seasons: two dry seasons (DS1 and DS2) and one rainy season (RS). They found that BC concentration was less than 10 per cent of the fine particles.

Majumder *et al.* (2012) published their findings on "assessment of occupational and ambient air quality of traffic police personnel of the Kathmandu valley, Nepal; in view of atmospheric particulate matter concentrations (PM_{10})". In this study they conducted analysis during the period of February 2008 to January 2009 and the purpose was to understand how the pollution trends are associated with the high density road traffic intersections considering the levels of particulate matter concentrations (PM_{10}), representing the occupational and ambient air quality of the traffic police personnel of the Kathmandu valley, Nepal.

Dubey *et al.* (2012) studied "trace metal composition of airborne particulate matter in the coal mining and non–mining areas of Dhanbad Region, Jharkhand, India". They reported the ambient concentrations of trace metals (in PM_{10}) measured in the coal mining and non–mining areas of Dhanbad region, Jharkhand, India. The analysis of trace metal was carried out using EPM 2000 filter paper followed by acid digestion, extraction and analysis through Atomic Absorption Spectrophotometer (AAS). The mean concentrations of trace metals were found in the order of Fe>Cu>Zn>Mn>Cr>Cd>Pb> Ni. Univariate (correlation study) and multivariate statistical analysis were adopted including; factor analysis and enrichment factor analysis to identify the sources and their contributions to particulate matter.

Khillare and Sarkar (2012) studied on "airborne inhalable metals in residential areas of Delhi, India: distribution, source apportionment and health risks". They studied inhalable fraction of ambient particles (PM_{10}) and collected at three residential sites in Delhi, India during 2008–2009 which were characterized with respect to 8 major and trace metals (Fe, Mn, Cd, Cu, Ni, Pb, Zn and Cr). Weekday/weekend effects on PM_{10} and associated metals were investigated. They used significant seasonal variations (ANOVA) in species concentrations which were observed with PM_{10} and crustal metals peaking in summer while anthropogenic metals peaked in winter. Spatial distributions of metals were influenced mainly by proximity to traffic and industrial areas.

Edgerton *et al.* (2013) investigated particulate air pollution in Mexico city: a collaborative research project. They measured PM_{10}, $PM_{2.5}$, precursor gas and upper-air meteorologically Mexico city, Mexico, from February to March to understand concentration sand chemical compositions of the city's particulate matter (PM). They used a method for this study PM_{10} and $PM_{2.5}$ mass measurements, PM_{10} and $PM_{2.5}$ chemical measurements, ion chromatography, elemental analyses, hourly nephelometer and aethalometer for visibility measurements. They found that about 50 per cent of the PM_{10} consisted of $PM_{2.5}$, with higher percentages during the morning hours and after sunset, when the mixed layers were shallow.

Zhao *et al.* (2013) investigated "characteristics of visibility and particulate matter (PM) in an urban area of Northeast China". They studied visibility data from 2010 to 2012 obtained at Shenyang in Northeast China and the relations between visibility, PM mass concentration and meteorological variables were statistically analyzed. These results demonstrate that the monthly–averaged visibility over Shenyang was higher in March and September with low visibility over Shenyang occurred in January.

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