Abstract

The research work of the thesis investigated two aspects of the aerosol concentration in Kharagpur Town, India. As a first part, the spatial and seasonal variability of atmospheric particulate matter (PM_{10}, $PM_{2.5}$, and PM_1) on the day time outdoor exposure is examined. The one-year study conducted during the period from September 2014 to August 2015 consisted of 34 locations, which is uniquely extensive, grouped into four zones namely traffic, commercial, residential and sensitive. The monitoring was carried out with GRIMM Aerosol Spectrometer 1.108 during each Saturday from 8 AM to 2 PM such that at each location the instrument operated for 10 minutes.

The meteorological parameters for the study period were obtained from the Indian Meteorological Department (IMD). The measured PM concentrations and collocated meteorological parameters are used to construct the General Additive Models (GAMs) which help to examine the effect of each meteorological variable on PM concentration for each zone. In agreement with previous studies, the most significant meteorological parameters influencing PM concentrations are temperature, relative humidity and wind speed for all zones.

The highest annual mean concentrations from this study are PM_{10} = 649 μg m^{-3}; $PM_{2.5}$ = 194 μg m^{-3} and PM_1 = 140 μg m^{-3} from locations classified as commercial and traffic zones. The corresponding lowest concentrations of 95 μg m^{-3}, 71 μg m^{-3} and 58 μg m^{-3} occurred at Gopali Ashram of the sensitive zone. Across the zones, the variability of PM_{10} concentrations is increased by 2 times from sensitive zone or residential zone to traffic or commercial zone. Unlike PM_{10}, the variability experienced across the zones for PM_1 particulates is comparatively low, pointing out the dominant role of anthropogenic activities in determining the PM_{10} concentration changes. With respect to three seasons studied, the monsoon season has the lowest concentration of particulates and summer season has the higher concentration but close to monsoon. The winter concentrations are higher by almost 4 times for the PM_1 concentration and by nearly 2.5 times for the PM_{10} concentrations. The proportionate increase in the concentration from monsoon to winter is higher for residential and sensitive zones as opposed to commercial and traffic zones. Examination of PM_1/PM_{10} and $PM_{2.5}/PM_{10}$ ratios pointed out that the ratios are lower for traffic (PM_1/PM_{10} = 0.26; $PM_{2.5}/PM_{10}$ = 0.40) and commercial zones (PM_1/PM_{10} = 0.27; $PM_{2.5}/PM_{10}$ = 0.38) in comparison to residential (PM_1/PM_{10} = 0.41; $PM_{2.5}/PM_{10}$ = 0.52) and sensitive zones (PM_1/PM_{10} = 0.43; $PM_{2.5}/PM_{10}$ = 0.58). Seasons also played a strong role such that the PM_1/PM_{10} ratios are lowest in monsoon (about 0.2) and

highest in winter (about 0.4). Zone-wise GAM modeling with explanatory variables temperature, relative humidity and wind speed provided the best possible adjusted R^2 values. In general, the model performance diminished from PM_1 to PM_{10} particulates. It emerged from this study that seasons have a very strong role to play in determining the PM_1 concentrations and anthropogenic activities are the dictating factors for determining the changes in PM_{10} concentrations.

The second part of the study examined the spatial and seasonal variation of ambient dustfall and chemical characterization of its insoluble fraction for 1 year (July 2014 to June 2015) for four sampling sites in Kharagpur Town. With respect to three seasons studied, the maximum dustfall deposition is found during summer (March to June) and in the range of 2.01 ± 0.36 to 15.74 ± 3.83 tonne km^{-2} $month^{-1}$, and minimum deposition is during monsoon season (July to October) in the range of 0.42 ± 0.72 to 7.38 ± 5.8 tonne km^{-2} $month^{-1}$. Selected metals like Sc, V, Cr, Co, Ni, Zn, Y, Zr, Ce, Hf, and Pb were analyzed using the high-resolution inductively coupled mass spectrometer (HR-ICP-MS) technique and the contamination level of heavy metals was assessed using the geoaccumulation index (I_{geo}) and enrichment factor (EF). To estimate the sources for the metallic contaminants, principal component analysis (PCA) was conducted. The US EPA health risk assessment model was applied to determine the hazard index and hazard quotient values.

The results show the significant level of enrichment for Pb (EF = 41.79) and Cr (EF = 4.39). The I_{geo} values point out moderate contamination by Pb (I_{geo} = 2.01) and Cr (I_{geo} = 1.6) in Kharagpur Town. This study suggests that in the context of noncancer risk of heavy metals as determined by the hazard index (HI) and hazard quotient (HQ) values, ingestion is the main source of exposure to dust in adults and children followed by dermal contact. The carcinogenic risk estimated for adults and children shows values lower than the acceptable range based on the USEPA model applied.

Keywords: *Spatial and seasonal variability, GAM, PM_{10}, $PM_{2.5}$, PM_1, Meteorological parameters Heavy metal, Dustfall, Geoaccumulation index (I_{geo}), Enrichment factor (EF), Principal component analysis, Health risk, Hazard index*