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Trace metal composition of airborne particulate matter in the coal mining and non–mining areas of Dhanbad Region, Jharkhand, India

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ABSTRACT

This study reports the ambient concentrations of trace metals (in PM_{10}) measured in the coal mining and non–mining areas of Dhanbad region, Jharkhand, India. Trace metal analysis 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. Mean Pb concentrations were found to be ranging from 0.024 $\mu g/m^3$ to 0.32 $\mu g/m^3$, Ni 0.002 $\mu g/m^3$ to 0.02 $\mu g/m^3$, Cu 0.06 $\mu g/m^3$ to 6.32 $\mu g/m^3$ while Mn varied from 0.14 $\mu g/m^3$ to 1.9 $\mu g/m^3$. Fe, Zn, Cd and Cr varied from 1.43 $\mu g/m^3$ to 28.48 $\mu g/m^3$, 0.16 $\mu g/m^3$ to 2.55 $\mu g/m^3$, 0.03 $\mu g/m^3$ to 0.07 $\mu g/m^3$ and 0.11 $\mu g/m^3$ to 0.42 $\mu g/m^3$ respectively. 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. The major sources of airborne trace metals identified were mainly coal mining and associated activities, emissions from automobile exhaust and industries, resuspended soil dust and earth crust, biomass burning, oil combustion, and fugitive emissions.

Keywords:
Trace metals
PM_{10}
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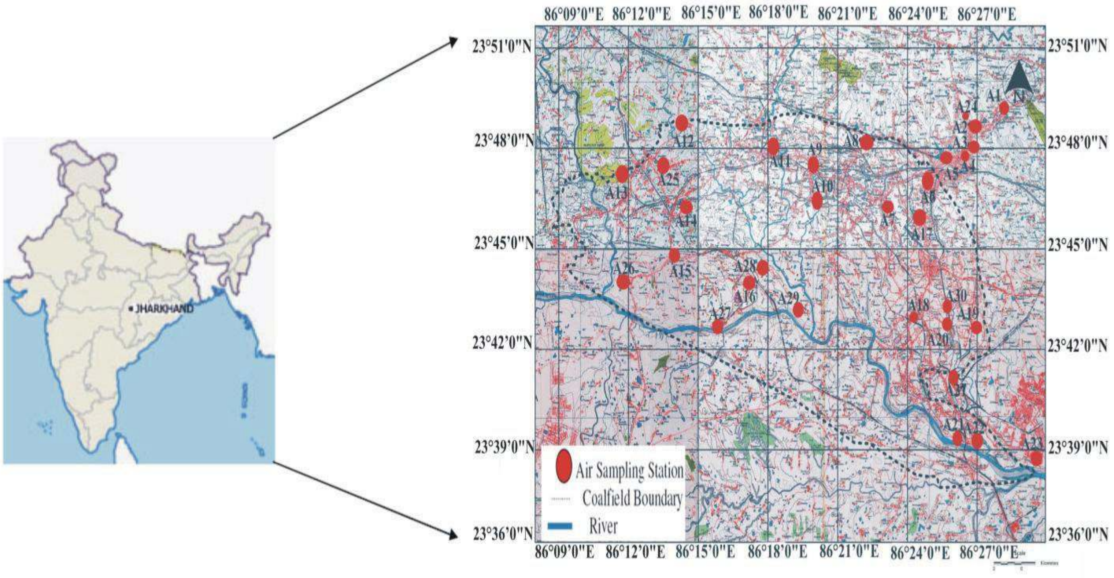
1. Introduction

Airborne particulate matter, which is composed of a broad class of chemically and physically diverse substances are variable in size, chemical composition, formation, origin and concentration, and is variable across space and time. Health effects associated with particulate matter (PM) are linked to respiratory, cardiovascular problems and premature mortality (Callen et al., 2009). The particulates may include a broad range of chemical species, ranging from metals to organic and inorganic compounds (Tsai and Cheng, 2004; Park and Kim, 2005). Among the inorganic compounds, most important ones are the trace metals, which are emitted by various natural and anthropogenic sources such as crustal materials, road dust, construction activities, motor vehicles, coal and oil combustion, incineration and other industrial activities (Watson et al., 2002; Quiterio et al., 2004; Arditsoglou and Samara 2005; Shah et al., 2006; Shah and Shaheen 2010). The airborne particulates and related trace metals have been linked with both acute and chronic adverse health effects which mostly include respiratory diseases, lung cancer, heart diseases and damage to other organs (Prieditis and Adamson, 2002; Magas et al., 2007; Wild et al., 2009). Numerous epidemiological studies have shown a correlation between elevated levels of airborne particulates and increased rate of morbidity and mortality (Pope, 2000; Shah, 2009). A number of studies conducted in the coal mining areas showed higher ambient particulate concen-trations (Ghose and Majee, 2002; Sinha and Sreekesh, 2002; Suman et al., 2007). Results from Kuopio also showed that resuspended particulate matter could contain considerable amounts of trace metals from anthropogenic sources (Hosiokangas et al., 1999). The major cause for elevated concentrations of resuspended dust in study area seems to be the turbulence and tire stress related to traffic.

With these objectives, we aimed at characterizing ambient respirable particles (aerodynamic diameter ≤10 µm) with respect to eight trace metals (Fe, Mn, Pb, Ni, Zn Cd, Cu, and Cr) at thirty one locations of mining and non–mining areas of Dhanbad region. According to study conducted by Central Pollution Control Board (CPCB) in consultation with the Ministry of Environment and Forests, Government of India, Dhanbad is regarded as critically polluted area and it ranks 13th among 88 industrial areas, which scores 78.60 out of scale of 100 (Kamyotra, 2009). Pollution assessment in this area is important since air quality has a major influence on mine workers and inhabitants living around the area. The major pollution source in the study area is due to several noxious gases and particulate emissions from opencast mines, coal based industries, and diesel based vehicular movement in haul roads, releasing large amounts of pollutants into the air, coal washeries and increasing vehicular population (heavy and light duty). Apart from this, with the introduction of new mining technology, which provided new machineries and techniques in the coal mining sectors also enhances the problem of pollution (Singh and Sharma, 1992). Monitoring of ambient air quality is the first step to check the status of pollution in any area of interest.



A1– Steel Gate	A2–ISM(Main Gate)	A3– Bus Stand	A4–Court More
A5–Railway stn.	A6–Bank More	A7–Kusunda	A8–E.Bassuria
A9–Tetulmari	A10–Sijua	A11–Katras	A12–Muraidih
A13–Baghmara	A14– Kharkharee	A15–Mohuda	A16–Murulidih
A17– Bastacola	A18–Jamadoba	A19–Tisra	A20–Barari
A21– Sudamdih	A22– Chasnala	A23–BIT–Sindri	A24– ISM(MB)
A25– Madhuband	A26– Lohapatti	A27– Bhatdih	A28– Singra
A29– Jarma	A30– Lodna	A31– Patherdih	

Figure 1. *Location of the study area along with sampling stations in Dhanbad, Jharkhand,India.*

Overall, this study delineates a systematic investigation of trace metals in and around coal mining sector of Dhanbad region, their variation and source apportionment of metallic species at various locations of mining and non mining areas.

2. Study Area

Dhanbad lies between 23°37'3" N and 24°4' N latitude and between 86°6'30" E and 86°50' E longitude (Figure 1). It has an average elevation of 222 m. Its geographical length, extending from North to South, is 43 miles and width 47 miles, stretching across East to West. It shares its boundaries with West–Bengal in the Eastern and Southern part, Dumka and Giridih in the North, Bokaro in the west and it is the administrative headquarter of district and Dhanbad Municipal Corporation (DMC). Dhanbad comes under Chota–Nagpur plateau. It is mainly known as "the Coal Capital of India" or "Coal City" and is the third largest city in Jharkhand state. Tata Steel, BCCL, ECL and IISCO are some of the companies having coal mines in the district. These companies have developed townships for their employees. Besides, there are number of rural areas where the ethnic people are residing. It comes under Grand Chord rail line in between Delhi to Kolkata. In terms of Road Link it is on Grand Trunk road (NH–2) which is now converted into Four Lane Golden Quadrilateral.

3. Methodology

3.1. Ambient measurements

Ambient air monitoring was done at 31 locations (consisting of coal mining and non mining areas) from December 2008 to January 2009 for PM_{10}. Samples were collected on EPM 2000 filter papers using a Respirable dust sampler 460 NL (1.1–1.3 m^3/min) (Envirotech, India). Twenty four hour average sampling was done twice a week for four weeks in a season. Twenty seven samples were taken per location. The sampling locations have been selected according to the criteria of IS 5182 Part–XIV. Relevant features of air quality stations are shown in Table 1. The basic mechanism of this respirable dust sampler is based on centrifugal forces (cyclone separator). Ambient air carrying the suspended particles enters the system through an inlet pipe. As the air passes through the cyclone the coarse, non respirable fractions are separated from the air stream by the action of centrifugal forces. These separated particles pass through a conical hopper of the cyclone and get collected in the sampling bottle at the bottom (tare). The PM_{10} fraction passes through the cyclone and is carried by the air steam to be deposited on the filter paper placed between the top cover and filter adaptor assembly. The PM_{10} fraction is retained here in the filter paper and the carrier air is exhausted from the system through the blower. The PM_{10} were retained on the EPM 2000 Glass fiber filter.

Sampling. Faceplate was removed by loosening the wing nut. Filter paper was placed on the centre (on the support screen) with the rough side of the filter facing upwards. Reading of the elapsed time meter was recorded. The specified length of sampling used was 24 hours. After the required time of sampling, the flowmeter reading was recorded, filter was collected from the sampler, and kept in a container or envelope (IS5182 Part XXIII, 2006BIS).

Filter inspection. Filter paper was inspected for pin holes using a light table. Loose particles were removed with a soft brush.

3.2. Mass concentration

In addition to the determination of elemental concentrations, airborne fraction masses of PM_{10} samples were measured using a Mettler AE163 microbalance. The filter papers were weighed under controlled conditions of humidity and temperature before and after collection of particulate matter. Weights for the blank filters were also recorded. Prior to weighing, all filter paper (EPM 2000) were left to equilibrate their humidity (around 50%) and

***Table 1.** Relevant features of the air quality station*

Location Code	Remarks
A1, A2, A3, A4, A5, A6, A11 and A15	Vehicular movement and other commercial activities. Road traffic and commercial activities
A7, A8, A9, A10, A12, A13, A14, A16, A17, A18, A19, A20, A21, A25, A26, A30 and A31	Mining activities, coal handling plant, railway siding, other ancillary activities, vehicular movement, transport on paved road and unpaved road, haul road, industrial activity and. exposed dump/exposed pit surface, domestic coal burning and residential activities etc.
A22, A23, A24, A27, A28 and A29	Vehicular movement and residential activity and domestic coal burning etc.

temperature conditions (20±1 °C) for at least 24 hours. The collected particle mass was calculated by subtracting pre–weight from post–weight of the filter.

3.3. Sample analysis

Acid digestion, required for the metals determination by Atomic absorption spectrophotometer (AAS, –GBC, Avanta, Australia) was carried out according to a standard procedure. Acid digestion was performed in Teflon bombs by following these steps: (1) samples of dry filters were dissolved in nitric acid and perchloric acid (20:2), (2) digestates were evaporated till white fumes arose and reduced to 2–3 mL, (3) the content was filtered through a Whatman Filter 42 and the final volume was adjusted to 50 mL by double distilled water.

A series of blanks were prepared using the same digestion method. Metals and reagents used for standard solutions were of AR grade. The reagents used were HNO_3 71% (specific gravity 1.41, Pb and Fe 0.00002%, Mn 0.00004% while Cu 0.00001%) and $HClO_4$ 40% (specific gravity 1.13). The filtrates were analyzed for trace metals using AAS (Katz, 1977). The trace metal amounts in the samples were calculated by subtracting the blank value for the respective metal. The detection limit of various trace metals for the AAS are Fe (0.005 ppm), Pb (0.01 ppm), Ni (0.009 ppm), Zn (0.005 ppm), Cu (0.001 ppm), Cd (0.004 ppm), Mn (0.0015 ppm) and Cr (0.003 ppm).

The concentration of individual elements in the solution was determined by comparing the absorbance of the standard metal solution. Samples were directly introduced into the frame of continuous aspiration through polyethylene tubing and the concentration of the object element (µg/mL) was obtained from the calibration plot. The concentration of an element in the atmosphere is obtained from the following relation (Sinha and Banerjee, 1997):

$$C\left(\frac{\mu g}{m^3}\right)=\frac{Concentration\ of\ the\ element\ in\ digested\ sample\left(\frac{\mu g}{mL}\right)}{Volume\ of\ air\ sample\ (m^3)}\times\frac{Total\ volume\ of\ the\ sample\ (mL)}{Percent\ of\ filter\ area\ used\ for\ analysis} \quad (1)$$

3.4. Data analysis techniques

Obtained data were processed for statistical analysis including univariate and multivariate methods. Basic statistical parameters such as mean, median, range and standard deviation are computed along with correlation analysis, while multivariate statistics in terms of principal component analysis (PCA) (Pandit et al., 2011) and calculation of Enrichment Factors (EFA) (Sinha and Banerjee 1997; Haritash and Kaushik, 2007; Senlin et al., 2007) were also performed using the SPSS version 16.0 statistical software.

4. Results and Discussion

4.1. PM_{10} concentrations

The statistical distribution parameters for PM_{10} and trace metals (Cd, Cr, Cu, Fe, Mn, Pb, Ni and Zn) for coal mining and non–mining areas are given in Table 2. The particulate matter concentrations varied from 170–339 µg/m^3 for coal mining area while 59–176 µg/m^3 for non–mining area. PM_{10} concentration were higher at location A7 (Kusunda), A10 (Sijua), A17 (Bastacola) and A30 (Patherdih). These locations are very close to opencast mines though they are receiving higher emissions (Figures 1 and 2). It is supported by various studies (Ravichandran et al., 1998; Kumar and Ratan, 2003; Sinha and Sreekesh, 2002; Reddy and Ruj, 2003; Huertas et al., 2012) that in coal mining areas SPM and PM_{10} are exceeding the standards (Table 3). Mean annual PM_{10} at various locations of mining and non–mining areas were 258 ± 64 and 134 ± 29 µg/m^3, respectively (Table 2), giving an overall mean of 193 ± 79 µg/m^3 for Dhanbad region. These values are ~3 times higher than the annual PM_{10} (60 µg/m^3) National Ambient Air Quality Standard (NAAQS, 2009) prescribed by the Central Pollution Control Board (CPCB) of India and around 9–10 times higher than the annual PM_{10} air quality guideline (AQG) (20 µg/m^3) set by the World Health Organization (WHO, 2006). Apart from coal mining activities, diesel vehicle exhaust is also responsible for emitting particulate matter (PM_{10}) in large amounts (Onursal and Gautam, 1997).

4.2. Elemental concentrations

Average concentrations for different trace metals at various locations (coal mining and non–mining areas) are shown in Figure 3 for the study area**.** The highest mean concentration (Table 2) was found for Fe at 8.5 µg/m^3, followed by Cu (1.43 µg/m^3), Zn (0.60 µg/m^3), Mn (0.39 µg/m^3), Cr (0.28 µg/m^3), Cd (0.050 µg/m^3), Pb (0.24 µg/m^3) and Ni (0.0096 µg/m^3). On the average, the decreasing elemental concentration trend was: Fe>Cu>Zn>Mn>Cr>Cd>Pb>Ni. The correlation study revealed very strong correlations between Pb–Ni, Fe–Mn, and Fe–Zn with correlation coefficients of 0.638, 0.739 and 0.614, respectively for coal mining area while 0.817, 0.677 and 0.539 for Pb–Ni, Fe–Mn and Zn–Cd respectively for non–mining area.

4.3. Source apportionment

To understand the origin of trace metals in the Dhanbad region, for the current study, source apportionment has been performed by applying principal factor analysis (Varimax rotated analysis) and Enrichment Factors were calculated. Principle component analysis best explains the quantitative information of these metals and their corresponding sources (Watson et al., 2002; Tsai and Cheng, 2004; Park and Kim, 2005; Shah, 2009).

Table 2. *Statistical distribution of PM_{10} and trace metals levels ($\mu g/m^3$) in particulate matter of study area*

Pollutants	Range	Arithmetic Mean	Geometric Mean	Median	SD
		Coal mining area			
PM_{10}	170-339	258	250	287	64
Pb	0.040-0.318	0.15	0.128	0.128	0.082
Ni	0.0001-0.02	0.01	0.004	0.004	0.006
Cu	0.06-6.32	1.44	0.911	0.834	1.550
Mn	0.079-1.75	0.47	0.316	0.309	0.499
Fe	1.0-28.0	8.90	5.87	4.435	8.115
Zn	0.17-2.26	0.68	0.521	0.473	0.576
Cd	0.04-0.074	0.06	0.058	0.068	0.014
Cr	0.125-0.430	0.32	0.307	0.32	0.094
		Non-mining area			
PM_{10}	59-176	134	130	133	29
Pb	0.003-0.75	0.269	0.093	0.090	0.281
Ni	0.0002-0.03	0.010	0.006	0.006	0.008
Cu	0.081-2.37	1.426	1.117	1.411	0.789
Mn	0.073-0.44	0.240	0.217	0.239	0.101
Fe	1.074-19.57	8.044	6.042	5.789	5.358
Zn	0.185-2.40	0.532	0.380	0.275	0.585
Cd	0.025-0.06	0.042	0.040	0.041	0.011
Cr	0.125-0.42	0.235	0.226	0.226	0.078

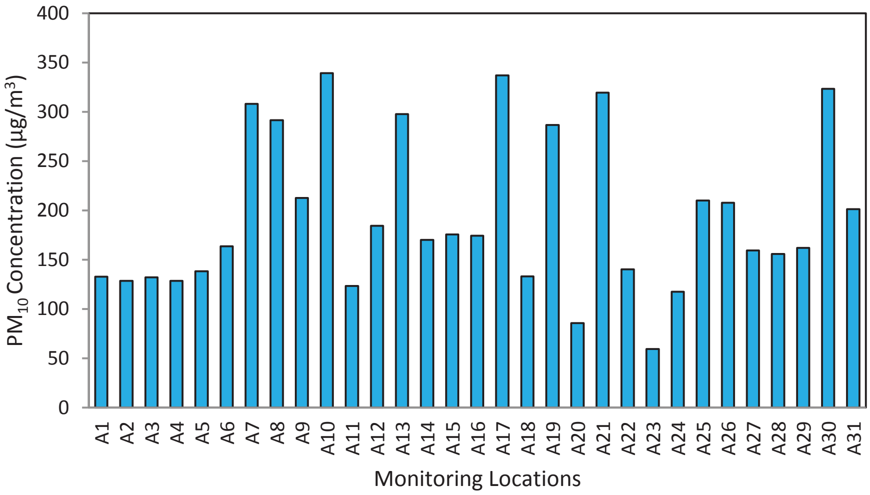


Figure 2. *Annual average PM_{10} concentration at various locations of the study area.*

Table 3. *Results of PM_{10} concentrations in different urban cities*

Locations	PM_{10} ($\mu g/m^3$)	Reference
Colombo, Sri Lanka	50	Seneviratne et al. (2011)
Hongkong	105	He and Lu (2012)
Panzhihua, China	137	Yong-hua et al. (2010)
Zagreb, Croatia	36	Cackovic et al. (2008)
Oxford, USA	16	Wojas and Almquist (2007)
Nepal	61-120	Giri et al. (2007)
Kanpur, India	226	Gupta (2007)
Padampur OCP Chandrapur District, Maharashtra, India	103-226	Trivedi et al. (2007)
Erzurum, Turkey	31	Bayraktar et al. (2006)
Mumbai, India	61	Kumar and Joseph (2006)
Amsterdam, Finland	36	Vallius (2005)
Ibvalley, Orissa, India	46-291	Chaulya (2003)
Qalabotjha, South Africa	90	Engelbretch etal. (1999)

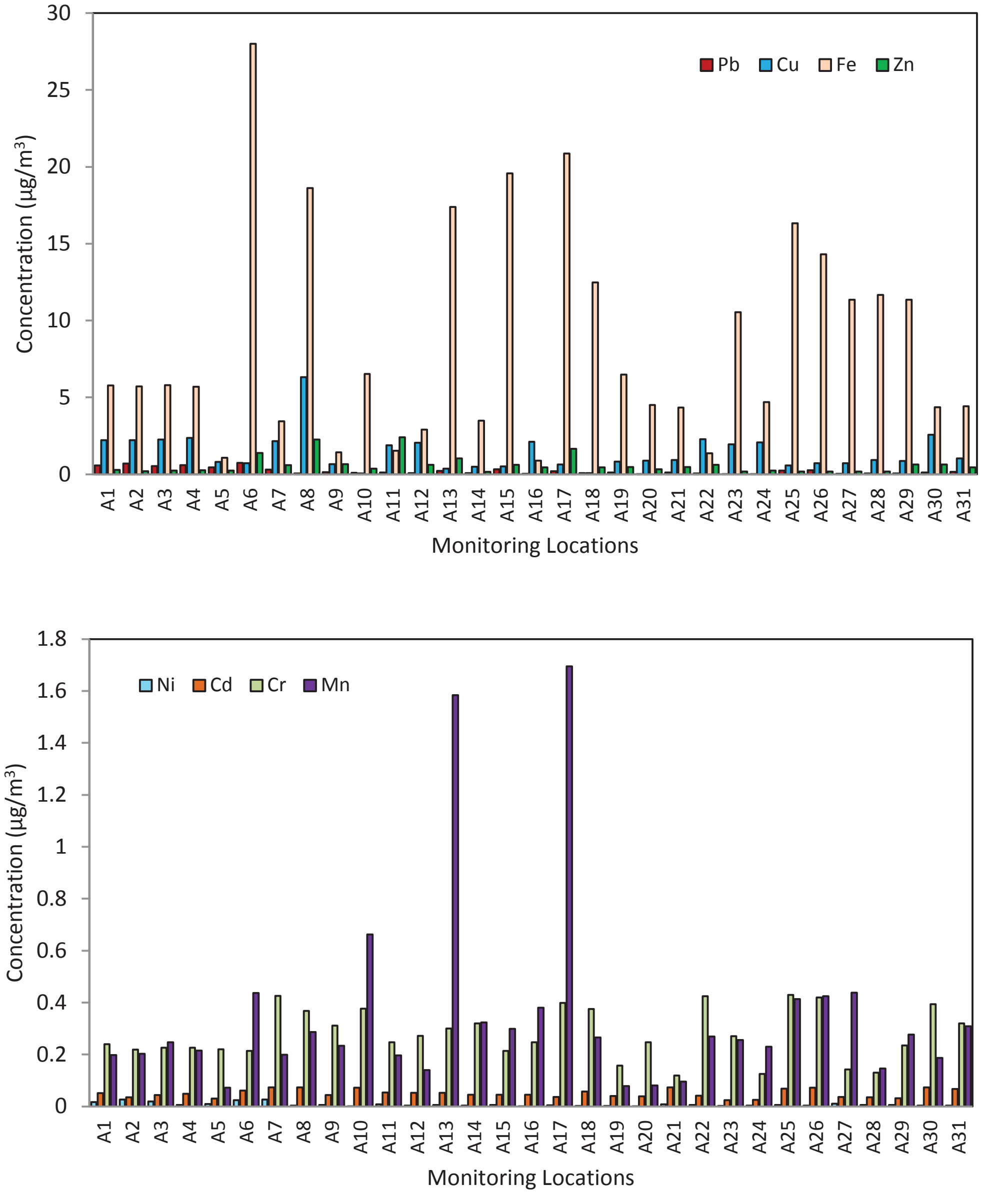


Figure 3. *Annual average concentration of trace metals (µg/m^3) at various locations of study area.*

Factor analysis. The principal application of factor analysis is to reduce the number of variables. Therefore, factor analysis can be applied as a data reduction method. PCA was performed by the Varimax Rotated Factor Matrix method, based on the orthogonal rotation criterion that maximizes the variance of the squared metals in the column of a factor matrix. This method focuses on cleaning up the factors. It produces factors that have high correlations with one smaller set of variables and little or no correlation with another set of variables (Stevens, 1996). Table 4 presents the Principal Component (PC) loadings for the metal data of the study period with corresponding eigenvalues and variances. The data for PM$_{10}$ were interpreted on the basis of three common factors. Three PCs with eigenvalues greater than 1.0 were extracted with 74.60% and 71.341% cumulative variance for coal mining and non–mining areas respectively. The PC 1 with 31.64% and 28.62% (for coal mining and non–mining areas, respectively) total variance shows highest loadings for Mn and Fe. This revealed close association of Fe and Mn, in PM$_{10}$, mainly contributed by earth crust /wind–blown soil (Ragosta et al., 2002; Quiterio et al., 2004; Shah et al., 2006; Chakraborty and Gupta, 2009;). The second factor (PC 2) contributed 22.49% and 24.89% for both mining and non–mining areas as high loadings of Pb, Cd and Cr. These trace metals are well known to be associated with the industrial and automobile emissions (Ahumada et al., 2007; Cetin et al., 2007; Querol et al., 2007). Cd and Cr have significant contributions from crude–oil combustion and metallurgical units housed in the industrial areas and vehicular emissions. One of the most important sources of cadmium, chromium and lead in the urban environment is road traffic as suggested by various researchers (Ayras and Kashulina, 2000). Other contributors include waste incinerators, coal–fired power plants, geogenic dust, and construction debris (Chandler, 1996). High loadings of Pb and Ni is due to emissions from vehicular exhaust (Ramadan et al., 2000; Weckwerth, 2001; Ragosta et al., 2002; Kim et al., 2002; Hafner et al., 2004; Shah et al., 2006). After analysis of results it can be concluded that in the study area, source contribution is mainly due to earth crust and second is shown by vehicular emissions while third due to road dust through unpaved roads and coal mining and the last due to industrial activities.

Table: 4. *Principal component loadings of the trace metals for the study area*

Factors	Components		
	PC1	PC2	PC3
PM_{10}	0.458^a/0.725^b	0.339^a/0.230^b	0.301^a/0.011^b
Pb	0.305^a/0.091^b	0.809^a/0.928^b	-0.397^a/0.063^b
Ni	-0.082^a/0.181^b	0.790^a/0.918^b	0.018^a/0.012^b
Cu	-0.066^a/-0.721^b	0.039^a/0.464^b	0.953^a/-0.008^b
Mn	0.922^a/0.705^b	-0.041^a/0.146^b	-0.241^a/0.139^b
Fe	0.909^a/0.870^b	0.099^a/0.141^b	0.124^a/0.080^b
Zn	0.632^a/0.187^b	-0.086^a/0.056^b	0.722^a/0.718^b
Cd	-0.285^a/0.353^b	0.670^a/0.331^b	0.383^a/0.769^b
Cr	0.346^a/-0.273^b	0.600^a/-0.204^b	0.039^a/0.735^b
Eigen Value	2.848^a/2.576^b	2.024^a/2.168^b	1.842^a/1.676^b
%Variance	31.64%^{a}/28.625%^{b}	22.49%^{a}/24.094%^{b}	20.46%^{a} /18.622%^{b}
%Cumulative Variance	31.64%^{a}/28.625%^{b}	54.13%^{a}/52.719%^{b}	74.60%^{a}/71.341%^{b}

[a] *Coal mining area*
[b] *Non-mining area*

Enrichment factor analysis. The concept of enrichment factor was initially introduced by Rahn (1971) to determine whether a particular metal is found in greater abundance in air or expected to be crustal in origin. Enrichment factors are used to calculate the concentration of the metals in an air sample with that of a selected reference element that is entirely crustal in origin and the corresponding ratio in the average composition of the earth's crust and to gage the extent of anthropogenic influence (Al–Momani et al., 2005; Cocker and Na, 2009). Usually, Na, K, Al, Mg, Ca, Mn and Fe are used as the reference metals. Annual mean of percent composition of metals detected in PM_{10} samples were correlated and Fe shown the best correlated with all other element hence, selected as the reference element (Nazir et al., 2011). The enrichment factor is calculated through the equation:

$$EF(x)=\frac{(X/F)_{Sample}}{(X/F)_{Crust}} \tag{2}$$

where EF(x) is the ratio of element to reference material, $(X/Fe)_{Sample}$ and $(X/Fe)_{Crust}$ refer to the mean concentrations of the target element and Fe in atmospheric particulate matter and in continental crust, respectively. The EFs are calculated on the basis of earth crust mean abundance of the metals given in CRC handbook (Lide, 2008). The enrichment factors for coal mining and non–mining areas were calculated and shown in Figures 4a and 4b, respectively.

4.4. Correlation analysis

Correlation matrix were developed and shown in Tables 5 and 6 for coal mining and non–mining areas respectively, clearly indicates that how the data points are correlated with each other. Particulate matter PM_{10} are significantly correlated with each other at the level of 0.01 (Pb and Ni, Fe and Mn and Zn and Cd showing r=0.817, 0.677and 0.539, respectively. While for coal mining area they are correlated in this manner like Pb and Ni 0.638; Fe and Mn 0.739; and for Zn and Fe 0.614.

Table 5. *Annual correlation matrix for coal mining area*

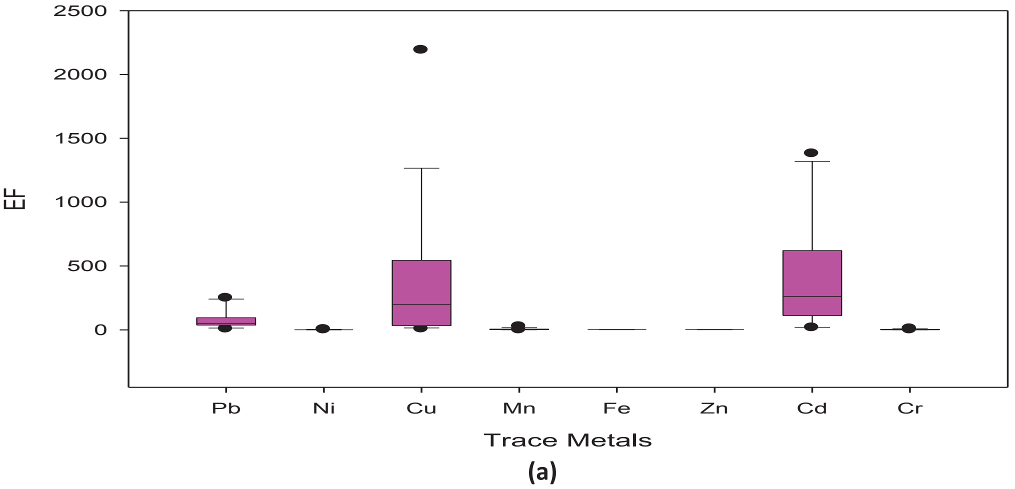
	SPM	PM_{10}	Pb	Ni	Cu	Mn	Fe	Zn	Cd	Cr
SPM	1	0.677^a	-0.031	0.243	0.086	0.168	0.203	0.263	0.023	-0.048
PM_{10}		1	0.218	0.279	0.090	0.345	0.365	0.439	0.268	0.054
Pb			**1**	**0.638**^{a}	-0.323	0.306	0.348	-0.128	0.254	0.500
Ni				**1**	0.092	-0.093	-0.101	0.015	0.258	0.238
Cu					1	-0.296	0.081	0.633^a	0.326	0.116
Mn						**1**	**0.739**^{a}	**0.411**	**-0.339**	**0.273**
Fe							**1**	**0.614**^{b}	**-0.065**	**0.409**
Zn								**1**	**-0.066**	**0.142**
Cd									**1**	**0.337**
Cr										**1**

[a] *Correlation is significant at the 0.01 level*
[b] *Correlation is significant at the 0.05 level*

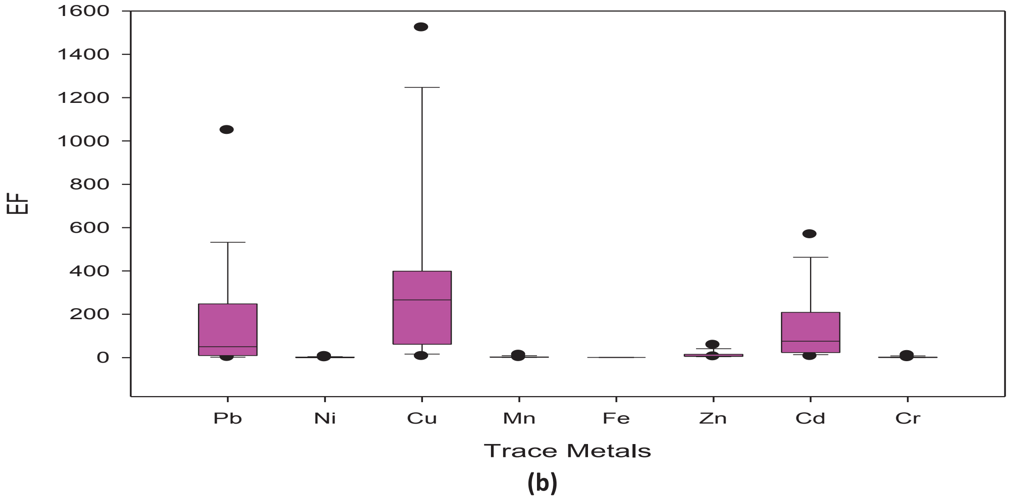
Table 6. *Annual correlation matrix for non-mining area*

	SPM	PM_{10}	Pb	Ni	Cu	Mn	Fe	Zn	Cd	Cr
SPM	1	0.913^a	0.406	0.395	-0.280	0.484	0.3880	0.152	0.444	-0.054
PM_{10}		1	0.264	0.312	-0.406	0.433	0.437	0.154	0.341	-0.192
Pb			**1**	**0.817**^{a}	0.254	0.086	0.255	0.018	0.431	-0.111
Ni				**1**	0.236	0.274	0.271	0.114	0.314	-0.179
Cu					1	-0.187	-0.536	-0.049	-0.168	0.059
Mn						**1**	**0.677**^{a}	**0.186**	**0.289**	**-0.022**
Fe							**1**	**0.180**	**0.397**	**-0.169**
Zn								**1**	**0.539**^{a}	**0.154**
Cd									**1**	**0.334**
Cr										**1**

[a] *Correlation is significant at the 0.01 level*
[b] *Correlation is significant at the 0.05 level*



(a)



(b)

Figure 4. *Box plot showing quartile distribution of crustal enrichment factors for trace metals in PM_{10} with Fe as reference element in coal mining* ***(a)*** *and non-mining areas* ***(b)****.*

5. Concluding remarks

The study area covers a substantial portion of Dhanbad region (an industrial area). The characterization of trace metal sources in the study area is quite challenging due to a large number of industrial and urban sources. Trace metals (Fe, Mn, Cu, Zn, Cd, Cr, Pb and Ni) associated with PM_{10} were characterized at thirty one locations of mining and non–mining areas of Dhanbd, India to identify and quantify their major sources. Factor Analysis–Principal Component Analysis, identified dominance of crustal source, 31.64% and 28.62% for mining and non–mining areas, respectively. It was supported by correlation study, where, r=0.677 and 0.739 ($p<0.01$) for mining and non–mining areas respectively. Local sources such as construction activities, mining, road dust resuspension etc. most likely contributed to this factor. Various developed countries have successfully used measures such as large–scale water flushing and chemical suppression to prevent resuspension of road dust (Amato et al., 2010). Vehicular sources contributed 22.49% and 24.89% (r=0.638 and 0.817) for mining and non–mining areas to ambient metals and included tailpipe/abrasion emissions along with resuspended dust. The industrial activities contributed 20.46% and 18.62% and (r=0.614 and 0.539) for coal mining and non–mining areas. Enrichment factor analysis portrayed anthropogenic emissions of trace metals, Pb, Cd and Cr in coal mining area while Cu in addition to Pb and Cd in non–mining area. The findings of this study may provide a comprehensive database for framing an appropriate strategy for necessary mitigative/preventive measures.

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