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Assessment of Heavy Metal (Pb, Zn, Cr and Cu) Content in Roadside Dust of Dhaka Metropolitan City, Bangladesh

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Abstract

This study was focused on metal contamination of the road side dusty soil along with environmental impacts in the Dhaka City of Bangladesh. The energy based dispersive X-ray fluorescence (EDXRF) methods was applied to investigate the target metal (Pb, Cr, Zn and Cu) concentration form samples. Most of the metal content was observed to be higher compare to the background values. A significant positive correlation was found among the pairs of element Pb/Zn, Pb/Cr, Pb/Cu, Zn/Cr and Cr/Cu, respectively. Results showed that anthropogenic input and upward trends of industrial growth identified as a main cause of environmental contamination. Long term exposure of public health to metals may expedite health risk of the city dwellers.

Keyword: Road dust, Heavy metals, contamination and EDXRF.

Introduction

Air pollution is an emerging issues in the developed and developing countries. Rapid urbanization and industrialization is directly involved with anthropogenic emission into the atmosphere. It plays a vital role in the atmospheric chemistry and soil contamination due to dry or wet deposition. Most of the pollutant tends to aggregate in upper part of soil. Urban soil contamination and its chronological contamination rate act as environmental indicator. Its drastically compositional change is a reflection of anthropogenic or natural environmental change. Population growth and unplanned urbanization has been negatively impacted on environmental ambient quality degradation through improper way to resource utilization and its management facility. Its effect and future consequences is a great threat for public health issues.

The categorical aspects of pollutants (inorganic and organic) come from different source of industrial activities and vehicle-based emission. The contaminant is varied from one source to another source and region to region in a city. It depends on population growth and its economical demands along with positional value. Inorganic pollutants and its compounds come from vehicle pollution and industrial emission. Trace elemental concentration in street dust which is significantly deposited due to anthropogenic stress and ignorance. Metal accumulation rate from atmospheric deposition in road side dust depends on sedimentation, interception and impaction[1]. A number of authors have been done research on trace element concentration in street dust at the mega city based in the developed countries[1-7]. In addition, chromium based contamination comes different industrial dust and emission. On the other, lead-based pollution and its isotopic analytical results has been directly indicated to vehicle pollution. Air pollutants and its deposition rate expedite to future development threats to achieve sustainability. Heavy metal and its bioaccumulation in human body lead to carcinogenic diseases and hamper to cognitive developments.

Now a day, air pollution is concerning public health issues in Bangladesh. Population density and unplanned urbanization negatively implies to environmental management system in Dhaka City. Total number of vehicles (gasoline based) and industries is increased many folds than previous time[8]. Heavy metals (including Zn, Pd and Cu) enrichment in urban soil increases due to atmospheric pollution, building material damage, automobile, industrial discharge and vehicle exhausts[1, 2, 9]. Waste generation and its improper management are an important environmental concern which is attributed to environmental degradation and metal pollution. The aim of the study is to investigate the heavy metal (Cu, Pd, Zn and Cr) concentration along roadside soils. It is leading to indentify the spatial variation and its future trends concerning environmental hazard and human health.

Material and Methods

The study was performed at Dhaka city in Bangladesh. It is situated at the heartiest point of Bangladesh whereas it's defined by 23° 43' 23" N latitude and 90° 24' 31" E longitude. This city is densely populated and increased vehicle problem. Sampling site selection and its cause is a reflection previous environmental degradation due to air, water and soil pollution. It

is ensured that scientific investigation will be guided and showed the present situation along with unplanned urbanization and transportation system. Previous study has been emphasized on pollution control to get sustainable environmental and human health. Street dust samples were collected randomly from ten point [*Amin Bazar* i., *Motijheel* ii., *Shabagh* iii., *Tongi* iv., *Hazaribagh* v., *Ashulia* vi., *Farmgate* vii., *Shyamoli* viii., *Savar Bazar* ix., *Malibagh* x.] and of the Dhaka city (figure 1). The dust samples were collected using spatula and preserved in contamination free polyethylene-beg. In the mean time, it was intensively labeled using permanent marker pen in purpose of experimental analysis. It was sieved through mesh (1.0mm) to remove external big size materials, debris, stone and others. The finer particles were put into Petri-dish.

Metal concentration of samples was identified using energy based dispersive X-ray fluorescence (EDXRF) methods which is adopted by a number of authors[10,11]. It is non-destructive and more efficient technique to investigate trace element concentration from road dust and/or soil. It was equipped with Rh (Rhodium) anode which was coupled with filter and Si (Li) (liquid-nitrogen-cooled) detector. It was operated with 900 w along with maintained 45 KV and sample were placed 45° geometry among the x-ray tube in purpose of beam and irradiation (kept distance in between sample and irradiation tube). Then Sample was counted 1000 counts per second to get better spectrum at the targeted energy region (for target metal) and maintained detector resolution 155eV. Irradiate samples were measured in the atmosphere (air) and He (helium) gas was frequently applied to wash out the button. Measured data was stored for the future analysis with the help of coupled computer. Quality control was an important part to compare with measured element concentration and also justification. The quality control was performed using standard reference materials (IAEA soil 7) for the authenticity judgment. It was maintained to standards error within 5% using calibrated strategy and accuracy technique. Statistical analysis was performed using different statistical package tools (e.g. SPSS 11.5, MS excel 7 and sigma plot version 7) for the descriptive statistical analysis, correlation co-efficient matrix and concentration variability test.

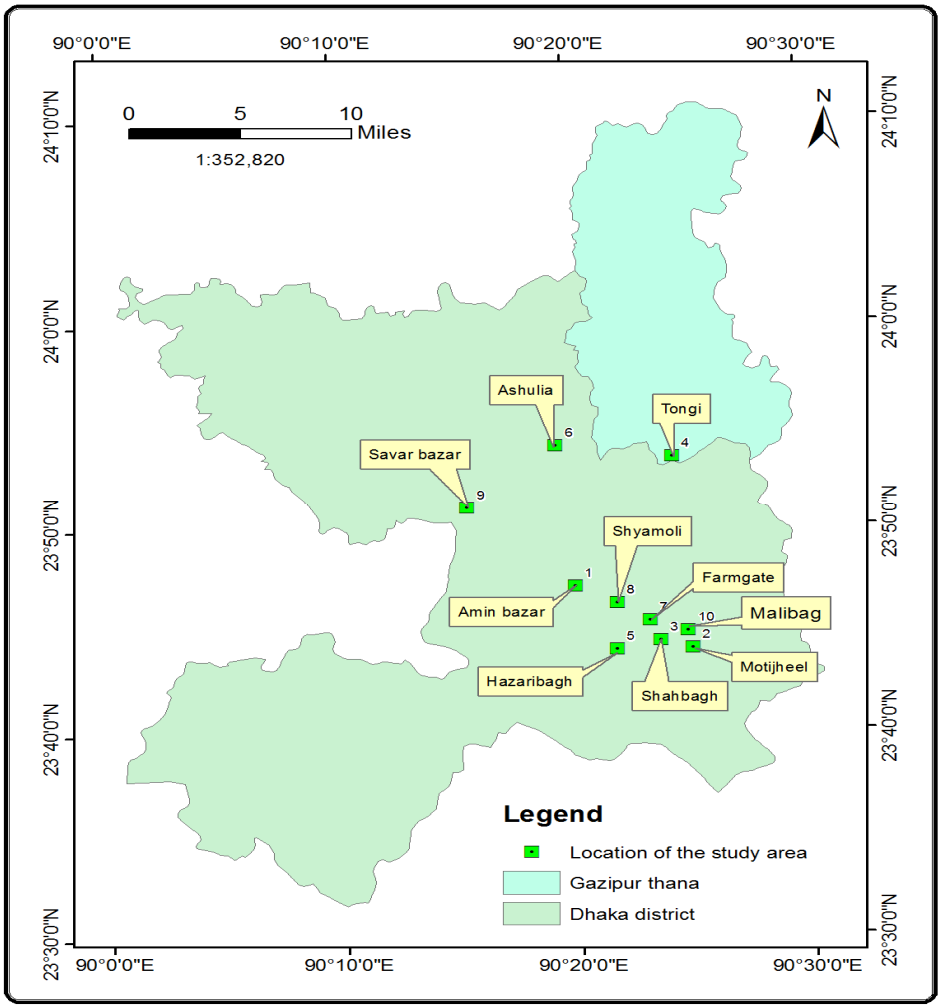

Figure-1
Shows location of the study area

Results and Discussion

The highest content of Pb, Zn, Cr and Cu was found in *Hazaribagh* and the lowest concentration of Pb, Zn, Cr and Cu was observed in *Savar Bazar* area in the greater Dhaka City (figure 2). In addition, the minimum concentration of Pb, Zn, Cr and Cu was found to be 30.02 ppm, 49.91 ppm, 61.24 ppm and 12.21 ppm, respectively (table 1). Consecutively, the maximum concentration of Pb, Zn, Cr and Cu was identified 198.16 ppm, 283.21 ppm, 303.89 ppm and 179.80 ppm, respectively (table 1). However, the average concentration of Pb, Zn, Cr and Cu was observed 67.60 ppm, 144.20 ppm, 124.70 ppm and 98.90 ppm respectively (table 1).

A significant positive correlation was observed among the pair of elements Pb-Zn (r=0.69; p=0.01), Pb-Cr (r=0.73; p=0.01), Pb-Cu (r=0.35; p=0.01), Zn-Cr (r=0.53; p=0.01) and Cr-Cu (r=0.20; p=0.01) respectively. In contrast, a significant negative correlation was observed between Zn and Cu.

The regression analysis revealed the inter element relations depending upon pollution source and coexisting behavior, whereas it implies to dependent and independent variables. The positive significant correlation was found to be between Zn and Pb (r=0.50; p=0.01) concentrations. Whereas, another significant positive correlation was observed between Cr and Pb (r=0.53; p=0.01) concentrations (figure 3). It may be significantly attributed to Pb abundance in the study area.

Table-1
Descriptive statistics of heavy metal concentration (ppm) in the study area

Parameter	Min	Max	Mean	Median	CV	Skewness	Kurtosis
Pb	30.02	198.16	67.60	55.00	72.30	2.50	6.88
Zn	49.91	283.21	144.20	149.50	47.67	0.51	0.71
Cr	61.24	303.89	124.70	88.50	63.24	1.56	1.97
Cu	12.21	179.80	98.90	95.50	47.51	-0.09	0.54

Note: CV (coefficient of variation)

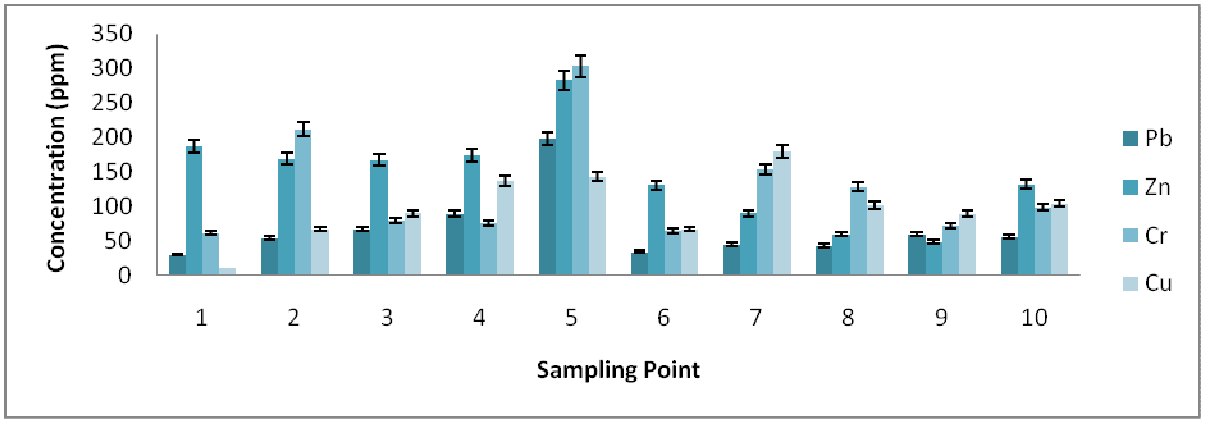

Figure-2
Metal concentration in different sampling point

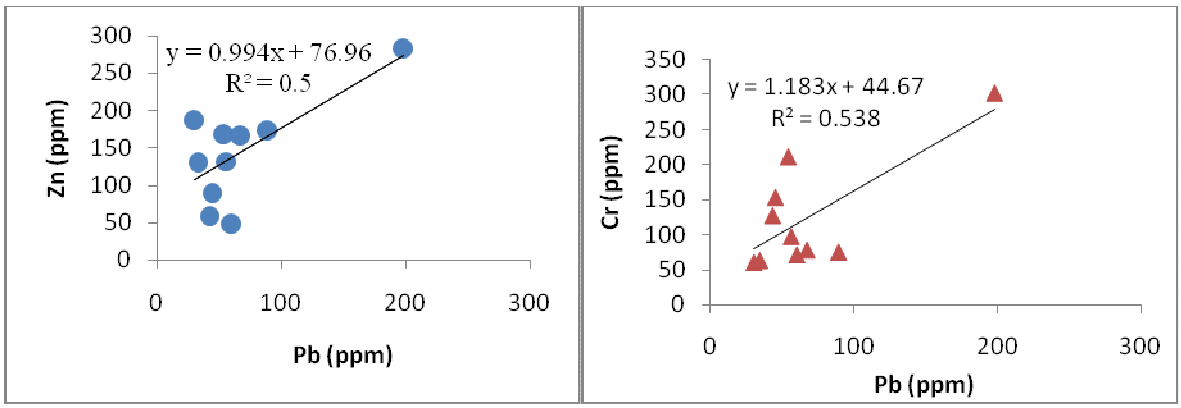

Figure-3
Shows the correlation in relation to Pb concentration availability in the study area

Metal concentration and its abundance may act as a mirror of existing pollution scenario in a specific area. Nevertheless, metal concentration varies in relation to source and exposure time. Rapid urbanization and industrialization are attributed to environmental degradation in entire aspects. A number of sources directly plays a significant role for the worsen air quality releasing huge amount of inorganic and organic air pollutants into the atmosphere by industrial emission, waste dumping site, vehicle pollution, agricultural anthropogenic input and etc. For example, Pd is frequently used in different industries such as dyes and paints, pesticides, explosive, battery[12] and fertilizer industries[13]. Its bio-product and/or wastage materials significantly affected to the environment when it mix up with soil and sediments. This study showed that lead concentrations were found to be highest in the industrial and densely vehicle traffic area in the Dhaka city. Its accumulation and abundance in roadside soil dust was derived from leaded gasoline[14-16] and brake wear[17]. Chamon et al.[18] reported that Pd concentration has been found 136 mg kg^{-1} in contaminated soil at the Tejgaon industrial area in Dhaka city. Ahmed and Ishiga[8] reported that the average (136 and 105ppm) and maximum (203 and 304ppm) concentration of Cr and Cu respectively in the Dhaka city. Total number of vehicles and other gasoline using automobile has been increased at several folds in the Dhaka city[8]. Consecutively, similar finding have been associated for Zn accumulation in roadside soil dust in the study area. The highest Zn content has been derived from different Zn containing vulcanized vehicle tires and as a corrosion bi-product from automobile equipments[1, 2]. It has been identified as a main source Zn contamination in the surface environment[9]. Environmental stress and its negative consequences are an emerging issues for the urban environmental and public health. Anthropogenic input and upward trends of industrial growth identified as a main cause of environmental degradation.

The tennary and dying industries generate highest amount of Cr in this study area. Major portion of Cr is used to tanning hide and coloring products. A limited amount of Cr come from soil dust (geogenic) and deposited in the earth surface after a certain period of time. However, gradually it has been increased due to over population, vehicle density and industrial growth. The average Cu concentration was found to be alike in different sampling sites in the Dhaka city. Though the wastes and effluents coming from major industrial units, it may attribute to Cu contamination in road side dusty soil sediments through mixing dry and wet deposition.

Environmental contamination negatively impacted on environmental matrix and human health which was observed through different exposure pathways' due to long term pollution trends. The children, aged peoples and pregnant women have been identified as a most vulnerable group who are living near to the busy roads[10]. The investigated metals were considered as carcinogen which may occur human health hazards. Heavy metal abundance in soil may directly or indirectly be attributed to food chain contamination.

Conclusion

Heavy metal pollution and its negative consequences impacted on environmental and human health. In this study, heavy metal enrichment in road dust directly emphasized to industrial growth and upward trends of vehicle density in the street. Metal concentration in dusty soil matrix may vary from place to place depending on pollutant types and accumulation and/or depositional factor. Specific metal abundance may indicate to source and degree of contamination with respect to environmental stress. The correlation and regression study among the metals was revealed the better understanding on contamination level, source and possible threats to the environment. The co-existing metals were indicated to similar source of contamination along with future trends. Long term exposure may influence to nuisance environmental condition associated with health risk.

References

1. Li X. D., Poon C. and Liu P. S., Heavy metal contamination of urban soils and street dusts in Hong Kong, *Applied Geochemistry*, **16**, 1361–1368 **(2001)**

2. Li X. D., Lee S., Wong S., Shi W. and Thornton I., The study of metal contamination in urban soils of Hong Kong using a GIS-based approach, *Environmental Pollution*, **129**, 113–124**(2004)**

3. Chen T. B., Wong J. W. C., Zhou H. Y. and Wong M. H., Assessment of trace metal distribution and contamination in surface soils of Hong Kong, *Environmental Pollution,* **96 (1)**, 61–68 **(1997)**.

4. De Miguel E., Llamas J. F., Chaco´n E., Berg T., Larssen S., Røyset O. and Vadset M., Origin and patterns of distribution of trace elements in street dust: unleaded petrol and urban lead, *Atmospheric Environment*, **31 (17)**, 2733–2740 **(1997)**

5. Wang W. H., Wong M. H., Leharne S. and Fisher B., Fractionation and biotoxicity of heavy metals in urban dusts collected from Hong Kong and London, *Environmental Geochemistry and Health*, **20**, 185–198**(1998)**

6. Imperato M., Adamo P., Naimo D., Arienzo M., Stanzione D. ans Violante P., Spatial distribution of heavy metals in urban soils of Naples city (Italy), *Environmental Pollution*, **124**, 247–256 **(2003)**

7. Sezgin N., Ozcan H.K., Demir G., Nemlioglu S. and Bayat C., Determination of heavy metal concentrations in street dusts in Istanbul E-5 highway, *Environment International*, **29**, 979–985 **(2003)**

8. Ahmed F. and Ishiga H., Trace metal concentrations in street dusts of Dhaka city, Bangladesh, *Atmospheric Environment,* **40,** 3835–3844 **(2006)**

9. Adriano D. C., Trace Elements in Terrestrial Environments: Biogeochemistry, Bioavailability, and Risks of Metals, second ed. Springer, New York, 867 **(2001)**

10. Atiemo M. S., Ofosu G. F., Kuranchie-Mensah H., Tutu A. O., Palm N. D. M. L. and Blankson S. A., Contamination Assessment of Heavy Metals in Road Dust from elected Roads in Accra, Ghana, *Research Journal of Environmental and Earth Sciences*, **3(5)**, 473-480 **(2011)**

11. Yeung Z. L. L., Kwok R. C. W. and Yu K.N., Determination of multi-element profiles of street dust using energy dispersive X-ray fluorescence (EDXRF), *Appl. Radiat. Isotopes*, **58,** 339-346 **(2003)**

12. Khuda Z. R. M. M., Environmental degradation, challenges of the 21st century. Environmental Survey and Research Unit, Dhaka, 247 **(2001)**

13. Oprea C. D. and Pincovschi E., The assessment of pollution in the area of Turnu Magurele affected by fertilizers plant, *Romanian Reports in Physics,* **55(2)***,* 111-115 **(2003)**

14. Rahman G., Majumder M. K. and Rana B., State of air pollution in Bangladesh. Bangladesh state of environment report 1999. Forum of Environmental Journalists of Bangladesh (FEJB), Dhaka, 71–84 **(1999)**

15. Hossen M., Bangladesh environment facing the 21st century, second ed. Society for Environment and Human Development (SEHD), Dhaka, 207–216 **(2002)**

16. Karim M. M., Islam M. and Hoque M. S., Current status, comprehensive management tool, and state-of-art solution for air quality in Bangladesh. Bangladesh environment 2000 (an outcome of ICBEN-2000). Bangladesh Poribesh Andolon (BAPA), Dhaka, 1–28 **(2000)**

17. Smichowski P., Gómez D. R., Frazzoli C. and Caroli S., Traffic-related elements in airborne particulate matter, *Appl. Spectros. Rev.*, **43**, 23-49 **(2008)**

18. Chamon A.S., Mondal M.N. and Ullah S.M., Effects of different organic amendments on growth and elemental composition of tomato grown on polluted soil, *Journal of the Asiatic Society of Bangladesh,* **32 (1)***,* 127-139 **(2006)**