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Trace metal contamination of road side surface soils of Guwahati City, Assam, India

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Abstract: Understanding the contamination of urban soils is essential to controlling urban soil pollution as contaminated urban soil can adversely affect the health of people living in urban areas and ultimately the gross surrounding ecosystems. This paper provides an overview of studies on the quality of urban soils in Guwahati city with special reference to trace metal contamination as urbanization in Guwahati city has taken place at an unprecedented pace for the last few decades. This paper focuses on the characteristics of accumulation, spatial and temporal distribution with major sources of various potentially toxic trace metals in road side surface soil. Pollution levels in road side surface soils were discussed using the concentrations of trace metals in Guwahati city. Assesment of multicomponent environmental pollutants in urban environments is important for potential risk assessments. A comprehensive assessment of urban soil quality in addition to routine urban soil surveys is required for the control and management of urban soil pollution. Considering the sources and routes of the pollutants in the urban soils, the risk assessment frameworks for major pollutants in urban soils need to be framed in near future.

Keywords: Guwahati, Urban soil, High traffic area, Trace metals, Traffic emission, Industry.

Introduction

Trace metals have drawn considerable attention of the widespread scientific community due to their carcinogenic and severe health affecting nature .Soil contributes directly or indirectly to the normal quality of life to the residents of urban localities as soil is an important component of urban ecosystems. One of the key issues is the degradation and pollution of urban soils in many parts of the world. Urban soils are subject to continuous accumulation of contaminants from either localized or diffuse sources. Typical contaminants include persistent toxic substances (PTSs), such as trace metals(Nriag et al.,2011;Ajmone et al.,2010) and persistent organic pollutants (POPs)(Fabietti et al.,2010). Soil is responsible for biochemical transformations, cycling of various nutritious elements, water filtration including plant support. It is well established that due to anthropogenic activities urban soils differ from natural soils. Growing population and rapid urbanization is a global phenomenon. Now world's more than half population live in urban areas and it is expected that it would be raised to almost 70% by 2050 according to the United Nations report. So the study of urban environments is very much important with regard to human health and its related matter. Geographic focus of resource consumption and emissions of large amount of chemicals of various composition have been taking place in cities as the industrial and economic activities are much more concentrated in urban areas. An understanding of the properties, processes and ecosystem services of intensively disturbed urban soils has important implications for a large urban population(Vegter,2007). Thus, in the last three or four decades, the study of urban soils has emerged as an important frontier in environmental research(Wong et al.,2006;Heinrich et al.,2008).
The main sources of these pollutants are industrial discharges, traffic emissions, and wastes from municipal activities(Wang et al.,2005).

Experimental

Study Area

Guwahati is the principal city of the entire North eastern India and was chosen as the study area for the present work. Guwahati is located approximately along $26^0\ 11^/$ N latitude and $91^0\ 45^/$ E longitude. It is 54.75 m above the mean sea level, covering about 24 km in the East-West direction and about 9 km in the North-South direction. The mighty Brahmaputra flows along the Northern boundary of the city while the Southern and Eastern boundaries are made by a number of hill ranges, which are extensions of the Khasi Hills. The Jalukbari-Azara plain makes the Western boundary of the city. The master plan of the city also covers Amingaon and North Guwahati on the Northern side of the Brahmaputra. Structurally, this region is situated on the 50 m thick alluvium of the middle Brahmaputra valley. The city is situated on an outcrop of the stable rocky foundation of the Shillong Plateau and the floodplains of Brahmaputra confronting each other. Landforms within the city are therefore unique with dissected hills (originally part of the Shillong Plateau), plain areas and natural lakes (the beels), swamps and the mighty river Brahmaputra. The base map of the study area is shown in Fig 1.

Fig 1. The base map of the sampling sites

Collection of Samples

The road side surface soil samples have been collected from 14 locations (28 samples) in recent year using a plastic brush and tray during pre monsoon and post monsoon season. The 14 sampling locations were divided into Zone I (high traffic areas associated with industrial activity) and zone II (associated with high traffic activity area only).Approximately 0.5 Kg of soil sample have been collected from immediate left and right side of each location in polythene bag and immediately taken to the laboratory for preliminary physicochemical investigations (Jackson,1967;Baruah et al.,1997;Trivedi et al.,1980).

Sampling Location	Sampling Code	GPS Value	Zone
Chandmari	R1	N 26°11′00.9″ and E 091°46′26.9″	II
Ganeshguri	R 2	N 26°08′57.1″ and E 091°47′08.5″	II
Khanapara	R3	N 26°07′14.1″ and E 091°49′18.5″	I
Jorabat	R4	N 26°05′56.7″ and E 091°52′35.4″	I
Noonmati	R5	N 26°10′55.3″ and E 091°48′10.5″	I
Paltan Bazar	R6	N 26°10′43.3″ and E 091°45′02.8′	II
Adabari	R7	N 26°09′29.9″ and E 091°40′52.5″	II
Kachari	R8	N 26°11′21.3″ and E 091°44′46.6″	II
Beltola Chariali	R9	N 26°06′43.8″ and E 091°47′52.6″	II
Jalukbari	R10	N 226°09′26.5″ and E 091°40′25.0″	I
Byrnihat	R11	N 26°02′42.2″ and E 091°52′04.9″	I
Narengi	R12	N 26°10′42.7″and E 091°49′43.9″	I
Amingaon	R13	N 226°11′45.0″ and E 091°40′13.0″	I
Satgaon	R14	N 26°10′2.0″and E 091°49′50.0″	I

Analysis of samples

All pH measurements were done using a digital pH meter (Model LT-120, ELICO, India). The instrument was calibrated for each set of measurements with standard buffer solutions. Conductance was measured using a digital conductivity meter (Model: ACM-340913-R, India), calibrated with 0.01 M KCl solution (of conductivity 1287 μS/cm at 298 K). The concentrations of Al,Cu,Ni, Cd, Mn and Zn were analysed by using Atomic Absorption Spectrometer (Perkin Elmer AAnalyst 200) with Flow Injection Analyze Mercury Hydride Generation System as per the standard procedures (APHA,1998).

Results and Discussion

The present research assessed the levels of six trace metals namely aluminium, cadmium, nickel, copper, manganese and zinc in the high traffic activity and industrialized area of greater Guwahati. The results of concentration of six trace metals with pH and conductivity determined in 14 soil samples collected during pre and post monsoon season of the 2012-13 session in the greater Guwahati are discussed here. The mean concentration of pH, conductivity and trace metals with simple statistics is shown in Table 1.The statistical analysis of the concentration of trace metals of zone I and zone II is shown in Table 2 and Table 3.

The pH was found in the range of 5.79(R2) to 6.29(R14) with mean value of 6.04 showing the acidic nature of the soil samples. It is already reported that the Assam's soil is acidic in nature. The electrical conductivity was found in the range of 0.91µScm^{-1} to 2.28 µScm^{-1} indicating the presence of various ions in the soil samples. The general existence of different trace metals ranged between 1.28 mg/kg to 1900.17 mg/kg for zone I and 1.27 mg/kg to 2159.52 mg/kg for zone II. The lower mean concentration existence was found for Cd (7.55 mg/kg)(table 2) and 17.17 mg/kg (table 3) for both the zone I and II. Mn was found to have the highest mean concentration with the amount of 659.23 mg/kg (table 2) and 1213.18 mg/kg (table 3) for zone I and zone II amongst the studied trace metals. Both in the zone I and zone II the minimum concentration among all the trace metals was found for Cd [1.27 mg/kg (table 1),R7] and maximum concentration among all the trace metals was found for Cu [2159.52 mg/kg(table 1),R6].The mean concentration of Mn of zone I(659.23 mg/kg) (table 2) was less than the concentration of zone II (1213.18 mg/kg) (table 3).The mean concentration of Zn (342.32 mg/kg) (table 3) of zone II was larger than the concentration of of zone I(214.75 mg/kg) (table 2). The mean concentration of Al (135.54 mg/kg) (table 3) of zone II was larger than the concentration of of zone I(68.64 mg/kg) (table 2). Aluminium is found commonly with oxygen, silicon, and fluorine in combined state. The chemical compounds of aluminium are commonly found in soil, minerals (sapphires, rubies, turquoise), igneous rocks and clays. Aluminum is found in consumer products like antacids, astringents, ,food additives, buffered aspirin, antiperspirants, cosmetics. Aluminum is also used to make beverage cans, pots and pans, airplanes, siding and roofing, and foil. Explosives and fireworks also contain aluminium powder. Aluminum compounds are found in many important industrial applications such as alums in water-treatment and alumina in abrasives and furnace linings.

The comparison of mean concentration of the trace metals of zone I and zone II is shown in Fig 2.From the Fig 1,it is revealed that the concentration of the trace metals of high traffic area is much more than the industrial area associated with high traffic area except that for cadmium. Corrosion processes of galvanized-metal structures and the abrasion of all Cd-bearing alloys and tire rubbers are among the main sources of Cd emissions(Chalesworth et al.,2011;Ozaki et al.,2004).Products of oil combustion include Mn. Zn comes from vehicle exhausts(Thomas et al.,2002); Zn is often added to motor oil(Mackey et al.,1997). Carbrakes are one of the major sources of Cu release(Napier et al.,2008).Road side soil contain potentially toxic pollutants originating from a range of anthropogenic sources common to urban land uses and soil inputs from surrounding areas. The relatively high total content of Zn in all fractions is assumed to be due to such sources in traffic pollution, such as tire rubber of motor vehicles and/or lubricating oils, to which Zn compounds are added for the quality improvement. What is more, diesels are also doped with Zn or $ZnSO_4$ (Katternan et al.,2007;Chalesworth et al.,2011). The most contaminated soils obtained for the zone I and zone II is R3 and R6 . Both the locations witnessed high traffic activities round the clock. Besides high traffic activity, the site R3 also witnessed the presence of various industry like coke processing unit, flour mills and many more vehicles repairing garages. The concentration of Ni was found in considerable amounts for few sites otherwise the sites R4,R5,R6,R7,R10 and R13 witnessed BDL values. Nickels comes to the soil samples due to its application by humans in the manufacturing of steel and other metal products. foodstuffs naturally contain small amounts of Ni metal but chocolate and fats are known to contain severely high quantities.

Statistical Analysis

Statistical analysis of the present investigated data indicates off normal distribution of the studied parameters. This is evident from the difference between mean and median values, and positive skewness of the studied parameters. Positive value of kurtosis show sharp distribution around the study area. Positive value of skewness gives a distribution with a significant long right tail and negative value of skewness gives a distribution with a significant long left tail. Negative value of kurtosis show a flat distribution around the study area. The correlation between various paramers is shown in Table 4. Positive correlation is found for conductance with Cu trace metal. Al also showed positive correlation with Mn, Ni and Cd. Cu showed positive correlation with Zn and Mn metals, while Zn, Mn and Cd showed positive correlation with Mn, cd and Ni metals.

Conclusions

Many pollutants can remain in urban soils for a long time, which may act as a source of further pollution in urban environments, and pose a potential threat to human health and ecological systems. Food chain contamination by heavy metals has become a burning issue in recent years because of their potential accumulation in biosystems through contaminated water, soil and air. Traffic appears to be responsible for the high levels of Zn, Cu, Al,Ni and Cd. The increase of road transportation and of industrial activities has led to notable build up of heavy metals amounts in the environmental media. Anthropogenic activities are responsible for the increased amount of trace metals in the study area. It is important to understand types and distribution behavior of trace metals in soil and how their concentration in soil varies significantly with traffic and industrial activity. Considering risk factors, routine urban soil survey and a comprehensive assessment of soil quality is needed for the control and management of urban pollution.

Reference

[1]. Ajmone-Marsan F, Biasioli M., Trace elements in soils of urban areas, Water Air Soil Pollut 2010;213:121–43.

[2]. APHA (American Public Health Association), Standard Methods for Examination of Water and Waste Water (1998), APHA, Public Health Association, American Water Works Association and Water Pollution and Control Fed., 20th Edition,

[3]. Baruah T.C., and Barthakur, H.P.,(1997) A textbook of soil chemical Analysis, Vikash publishing, New Delhi.

[4]. Charlesworth S, De Miguel E, Ordóñez A. A review of the distribution of particulate trace elements in urban terrestrial environments and its application to considerations of risk. Environ Geochem Health 2011; 33:103–23.

[5]. Fabietti G, Biasioli M, Barberis R, Ajmone-Marsan F. (2010) Soil contamination by organic andinorganic pollutants at the regional scale: the case of Piedmont, Italy. J Soils Sediments;10:290–300.

[6]. Heinrich Almut B, Morel Jean-Louis (2008) SUITMA—Soils in urban, industrial, traffic, mining and military areas, 206-207. In *Journal Of Soils And Sediments* 8 (4).

[7]. Jackson,M.L, 1967.Soil Chemical Analysis. Prentice-Hall(India),New Delhi.

[8]. Katterman M.E, Birchard S, Seraphin S., Riley M.R. Cellular evaluation of the toxicity of combustion derived particulate matter: influence of particle grinding and washington cellular response. Chemosphere 2007;66:567–73.

[9]. Mackey, J.R., Watt, S.T., Cardy, C.A., Smith, S.I., Meunier, C.A., 1991. Analysis of Additive Metals in Lubricating Oils. In: Nadkarni, R.A. (Ed.), Modem Instrumental Methods of Elemental Analysis of Petroleum Products and Lubricants. ASTM STP 1109. American Society for Testing and Materials,Philadelphia, pp. 52–61.

[10]. NriaguJozef, Pacyna M. Jerome O., Quantitative assessment of worldwide contamination of air, water and soils by trace metals, *Nature*333, 134 - 139 (1988).of risk. Environ Geochem Health 2011;33:103–23.

[11]. Napier, F., D'Arcy, B., Jefferies, C., 2008. A review of vehicle related metals and polycyclic aromatic hydrocarbons in the UK environment. Desalination 226,143–150.

[12]. Ozaki H, Watanabe I, Kuno K. Investigation of heavy metal sources in relation to automobiles. Water Air Soil Pollut 2004;157:209–23.

[13]. Thomas, S., Morawska, L., 2002. Size-selected particles in an urban atmosphere of trace elements in urban terrestrial environments and its application to considerations.

[14]. Trivedy, R. K., and Goel, P. K., (1986). Chemical and biological methods for water pollution studies, Environment publication, Karad, India.

[15]. Vegter(2007), Urban Soils - An Emerging Problem? Journal of soils and sediments. 7(2) p 63.

[16]. Wong, D., Qian, L., Xiong, H., Liu, J., Neckameyer, W.S., Oldham, S., Xia, K., Wang, J., Bodmer, R., Zhang, Z. (2006). Antioxidants protect PINK1-dependent dopaminergic neurons in Drosophila. Proc. Natl. Acad. Sci. U.S.A. 103(36): 13520--13525

[17]. Wang, C.F., Chang, C.Y., Tsai, S.F., Chiang, H.-L., (2005). Characteristics of road dust from different sampling sites in Northern Taiwan. J. Air Waste Manage. Assoc.55, 1236e1244.

Table 1. The mean concentration of six studied trace metals with simple statistical analysis.

Sampling Code	pH	Cond (µScm-1)	Al (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Cd (mg/kg)	Ni (mg/kg)	MEAN	STDEV
R1	6.02	1.19	276.29	154.23	102.64	46.82	4.99	16.22	100.20	93.90
R2	5.79	0.91	77.06	68.46	224.83	2102.18	3.07	18.39	415.66	757.63
R3	5.89	0.92	161.14	382.78	346.16	1900.17	8.00	53.92	475.36	651.94
R4	5.93	2.28	61.17	1217.17	119.96	914.12	3.46	BDL	463.17	502.52
R5	6.12	1.25	84.68	47.80	221.87	436.51	BDL	BDL	197.71	152.36
R6	5.91	1.36	109.59	2159.52	614.15	1423.96	3.16	BDL	862.07	820.31
R7	5.97	1.03	92.37	90.79	538.74	929.52	1.27	BDL	330.54	353.48
R8	5.97	1.61	133.93	43.69	98.85	1168.70	BDL	99.36	308.90	430.87
R9	6.07	1.18	124.01	112.27	474.72	1607.89	73.37	243.85	439.35	539.34
R10	6.29	1.10	35.57	607.79	176.44	306.01	11.19	BDL	227.40	217.72
R11	6.22	2.10	42.06	122.37	329.66	1021.27	BDL	18.18	306.71	373.73
R12	6.12	1.22	60.65	274.19	274.56	35.28	BDL	2.72	129.48	119.72
R13	6.25	1.26	64.48	545.28	56.79	1.28	BDL	BDL	166.95	219.78
R14	6.52	0.42	39.36	144.25	192.58	BDL	BDL	53.46	107.41	63.55
MIN	5.79	0.91	35.57	43.69	56.79	1.28	1.27	2.72	100.20	63.55
MAX	6.52	2.28	276.29	2159.52	614.15	2102.18	73.37	243.85	862.07	820.31
MEAN	6.04	1.34	97.31	426.47	269.42	914.90	13.56	63.26	323.64	378.35
MEDIAN	6.02	1.22	80.87	149.24	223.35	929.52	4.22	35.92	307.80	363.61
SKEW	0.19	1.43	1.84	2.32	0.80	0.18	2.74	2.07	1.38	0.44
KURT	-0.87	1.35	4.19	5.55	-0.31	-1.16	7.59	4.56	2.73	-0.98
STDEV	0.19	0.47	63.76	593.33	172.39	716.32	24.37	79.30	203.59	249.26

Table 2. The simple statistical analysis of the trace metal concentration in zone I

Sampling Code	Al(mg/kg)	Cu(mg/kg)	Zn(mg/kg)	Mn(mg/kg)	Cd(mg/kg)	Ni(mg/kg)	MEAN	STDEV
R3	161.14	382.78	346.16	1900.17	8.00	53.92	475.36	651.94
R4	61.17	1217.17	119.96	914.12	3.46	BDL	463.17	502.52
R5	84.68	47.80	221.87	436.51	BDL	BDL	197.71	152.36
R10	35.57	607.79	176.44	306.01	11.19	BDL	227.40	217.72
R11	42.06	122.37	329.66	1021.27	BDL	18.18	306.71	373.73
R12	60.65	274.19	274.56	35.28	BDL	2.72	129.48	119.72
R13	64.48	545.28	56.79	1.28	BDL	BDL	166.95	219.78
R14	39.36	144.25	192.58	BDL	BDL	53.46	107.41	63.55
MIN	35.57	47.80	56.79	1.28	3.46	2.72	107.41	63.55
MAX	161.14	1217.17	346.16	1900.17	11.19	53.92	475.36	651.94
MEAN	68.64	417.70	214.75	659.23	7.55	32.07	259.27	287.67

MEDIAN	60.91	328.48	207.22	436.51	8.00	35.82	212.56	218.75
SKEW	2.02	1.46	-0.16	1.06	-0.51	-0.30	0.77	0.89
KURT	4.54	2.35	-0.82	0.79	0.39	-4.28	-0.98	-0.29
STDEV	40.7208	380.264	99.9981	674.853	3.8846	25.75	143.306	204.417

Table 3. The simple statistical analysis of the trace metal concentration in zone II

Sampling Code	Al(mg/kg)	Cu(mg/kg)	Zn(mg/kg)	Mn(mg/kg)	Cd(mg/kg)	Ni(mg/kg)	MEAN	STDEV
R1	276.29	154.23	102.64	46.82	4.99	16.22	100.20	93.90
R2	77.06	68.46	224.83	2102.18	3.07	18.39	415.66	757.63
R6	109.59	2159.52	614.15	1423.96	3.16	BDL	862.07	820.31
R7	92.37	90.79	538.74	929.52	1.27	BDL	330.54	353.48
R8	133.93	43.69	98.85	1168.70	BDL	99.36	308.90	430.87
R9	124.01	112.27	474.72	1607.89	73.37	243.85	439.35	539.34
MIN	77.06	43.69	98.85	46.82	1.27	16.22	100.20	93.90
MAX	276.29	2159.52	614.15	2102.18	73.37	243.85	862.07	820.31
MEAN	135.54	438.16	342.32	1213.18	17.17	94.45	409.45	499.25
MEDIAN	116.80	101.53	349.77	1296.33	3.16	58.87	373.10	485.10
SKEW	2.00	2.44	0.00	-0.74	2.23	1.32	1.15	-0.30
KURT	4.39	5.96	-2.57	1.16	4.96	1.05	2.63	-0.56
STDEV	71.98	844.14	228.27	697.62	31.44	106.85	252.10	268.95

Table 4. The Pearson's correlation table pH, conductance and trace metals

	pH	Cond.	Al	Cu	Zn	Mn	Cd	Ni
pH	1	-0.25069	-0.44278	-0.2222	-0.28419	-0.70844	0.318748	-0.00976
Cond.		1	-0.09487	0.29312	-0.11745	-0.10582	-0.08933	-0.02468
Al			1	-0.08919	-0.01575	0.031744	0.028468	0.075276
Cu				1	0.320465	0.074897	-0.27529	-0.24964
Zn					1	0.471688	0.25344	0.531037
Mn						1	0.214532	0.372511
Cd							1	0.994034
Ni								1

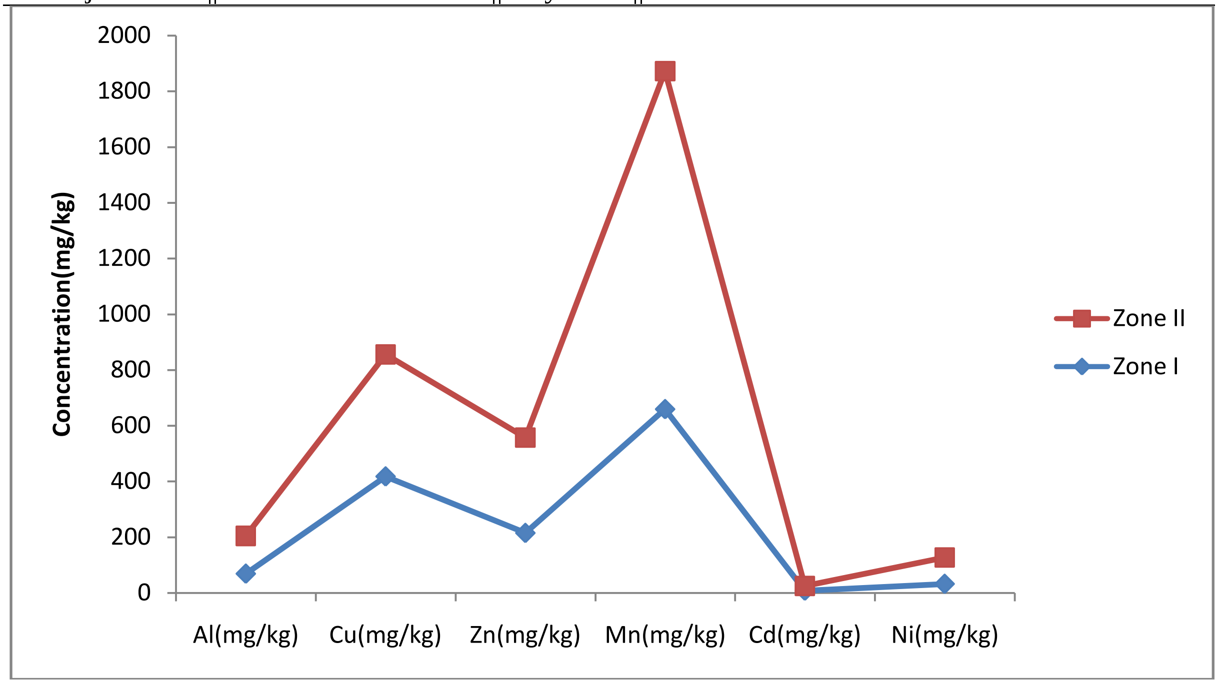

Fig 2. The comparison of mean concentration of the trace metals of zone I and zone II