J. Environ. Sci. & Natural Resources, **8(1): 65-68, 2015** ISSN 1999-7361

Physicochemical Properties and Heavy Metal Concentration in Soil of Industrial Area, Zirani, Savar, Dhaka

M. S. Rahaman*, F. Nessa, M. M. Hoque, M. Rehnuma and M. S. Islam[1]

Department of Environmental Science and Resource Management
Mawlana Bhashani Science and Technology University, Tangail
[1]Chittagong Polytechnic Institute, Chittagong-4209
*Corresponding author: sadeqer08015@yahoo.com

Abstract

Zirani of Savar is an important industrial area of the country which provides wide range of potentiality for economic development. The purpose of the study was to observe the nutrient status and heavy metals concentration of the soil in Zirani, Savar, Dhaka. Nine soil samples were collected and analyzed through different methods for analyzing pH, OC, N, K, P, S and the heavy metals including Zn, Cd, Cu, and Pb, were investigated using Atomic Absorption Spectroscopy (AAS) technique. The analyzed result revealed the soil surrounding the dumping site was slightly acidic which is not harmful for agricultural production. The highest value of OC was recorded 2.14% at point 3 and the lowest value was 1.92% which was found in point 2 that is greater than the reference value. Except total N concentration, the amount of available P, K, and S were greater than their recommended level. In addition the result showed that the concentration of Cu and Pb were much higher than their recommended level and the maximum value of Cu was 0.09 ppm and 0.762 ppm was the maximum concentration of Pb. and the concentration of Zn and Cd were within tolerable limit. Zn at point 3 showed higher concentration which was 3.05 ppm. The maximum value of Cd was 0.09 ppm that was found at station 1 under point 3.

Key words: Heavy metal, Industrial area, Nutrients, Soil pollution

Introduction

Environmental and health related problems have become a major global concern in the recent years (Smical *et al*., 2008). The significance of environmental factors to the health and well-being of human populations is increasingly apparent (Rosenstock 2003; WHO, 2010). Environment pollution is a worldwide problem and its potential to influence the health of human populations is great (Fereidoun *et al.,* 2007; 2005). Pollution reaches its most serious proportions in the densely settled urban-industrial centers of the more developed countries (Kromm, 1973). Soil plays a very important role for environment as it produces food for human beings and animals. Good soil and a congenial climate for productivity are valuable assets for any nation. But, due to human activities, soil is the receptor of many pollutants including pesticides, fertilizers, particulate matters etc. Heavy metal contamination in soil is a major concern because of their toxicity and threat to human life and the environment (Begum *et al*., 2009). Contamination of soils by heavy metals is the most serious environmental problem and has significant implications for human health process (Dang *et al.,* 2002; Obiajunwa *et al.,* 2002). Sources such as atmospheric deposition, waste disposal, fertilizer application and wastewater in agricultural land constitute the major anthropogenic inputs (Krishna and Govil, 2007). Some physicochemical properties of soils such as pH and OC are important parameters that control the accumulation and the availability of heavy metals in the soil environment (Wolnik *et al*., 1983). At high concentrations these metals exhibit chronic toxicity or carcinogenicity as well as fatality (Olayinka *et al*., 2011). Sustainable ecosystem management, ecological restoration, promoting ecological and public health system etc. can be possible through identifying the problems and quantitative analysis of toxic metals in our ecosystems. Savar, one of the largest industrial belts near Dhaka in Bangladesh, has more than 100 local and foreign industries. These generate a large amount of effluents everyday which are being directly discharged into the surrounding land, agricultural fields, irrigation channels and surface water that finally enter into the river (Sultana *et al*., 2003).So a large number of areas in Saver upazila are now being threatened by the environmental pollution. The major objective of the present study was to find out the present situation of heavy metals residues status in surface soil samples in the textile, battery, pharmaceutical, dyeing and printing industrial areas of Zirani, Savar, Bangladesh. Heavy metal analysis of this investigation may provide valuable information to solve the pollution problem.

Materials and Method

The study was carried out through experimental method. The sample was analyzed through experiment with the independent variable which collected as sample from the Savar (near DEPZ area) industrial zone, Zirani, Savar, Dhaka and was compared with the standard level of soil quality parameters which is the control variable that already exists. It takes six months (July to December 2013) to carry out the experiment, under the department of Environmental Science and Resource Management, MBSTU.

Study area

The study area located at the Dhamsona Union under Savar Upazila of Dhaka District which was within latitude 23º50` 39 N and longitude 90º15` 4 E. The selected sites situated from the effluent discharging point (back side) of the DEPZ to the

Bangshi River in which effluents are finally mixed. Physiographical the study area belongs to Madhupur Tracts, which is a Pleistocene elevated landscape distinct from the surrounding Fluvio-deltaic plains by Ganges, Brahmaputra and Meghna River. It is about 35 km from Dhaka City and 25 km from Hazrat Shahjalal International Airport in the NW direction and represents a limited extend of landscape yet having distinct morphological features.

Data collection

The research was based on both primary and secondary data. Primary data were collected through field observation and on laboratory work, and secondary data were collected from governmental organization, personal records, journals and papers (published and unpublished), articles, and from electronic and web based information.

Collection of soil samples

Nine soil samples representing 0-15 cm (SRDI, 2005) from the surface was collected at approximate distance of 30, 40 and50 meters from the waste dumping site. The samples were then carried to the laboratory of Environmental Science department, BAU, Mymensingh and BINA Mymensingh.

Preparation of samples for analysis

From the collected samples, the gravels, pebbles, plant roots, leaves, etc. were picked up and removed. The collected soil samples were dried in air for 7 days by spreading on a clean piece of paper, and then the samples were mixed well and ground to pass through a 2 mm mesh stainless steel sieve. The soil samples were kept in a clean polythene bag and then transported to the Central laboratory of BAU, Mymensingh for the analysis of soil pH, EC, organic matter, available phosphorus, available sulfur, total nitrogen and heavy metals (Cu, Cd, Fe, Pb and Zn).

Analysis of the sample

In order to determine e.g., pH, OC, nutrient such as N, K, P, S and Heavy metal concentration of supplied soil samples the following methods were used. Soil pH was determined by glass electrode pH meter. The organic carbon of the each soil sample was determined by Walkley and Blacks wet oxidation method. Total nitrogen in the soil was determined by Semi-micro Kjeldahl method by digesting soil sample with concentrated H_2SO_4 and catalyst mixture (K_2SO_4: $CuSO_4.5H_2O$: Se=10:1:0.1) (Bammer and Malvey, 1982). Available phosphorus was determined by Olsens method using $SnCl_2$ as reducting agent. Exchangeable potassium in soil was determined by the extraction with ammonium acetate (CH_3COONH_4; pH=7.0) by using flame photometer (Black, 1965) at the wave length of 766.5 to 769.5 nm. Available sulphur was determined by Turbid metric method with the help of a spectrophotometer. $CaCl_2$ solution (0.15%) was used for the extraction of soil (Page *et al.*, 1982). The amount of sulphur in the extract was estimated turbid metrically by spectrophotometer at 420 nm wavelength (Jackson, 1973).

Analysis of heavy metal of supplied soil samples

To determine the total Cd and Pb content of soil 4 M HNO_3 was used as extracting solution. Two grams of soil was digested with 12.5 ml extracting solution at 80oC for 24 hours. Then it was made of 50 ml and filtered. Copper (Cu) and Lead (Pb) content of soil extracts were determined directly by Atomic Absorption Spectrophotometer (AAS) following the procedure of McLaren *et al.* (1984). The wavelengths of Pb and Cd were 217 nm and 228 nm respectively. Zn and Cu were determined by soil extraction method using NOV AA-300 Atomic Absorption Spectrophotometer (AAS). They were measured by Atomic Absorption Spectrophotometer on undiluted soil extracts. All the ends of data collection, data were compiled, tabulated and analyzed by Microsoft Office -2007.

Results and Discussion

This chapter presents the results of analysis soil quality parameters. The chemical parameters of soil in and around the Zirani municipal area obtained from the analyses are described in the Table 1.

pH

All of the station of the sampling points are indicates the lower pH value considering the standard value of 7 except station 2 under the point of 3 which indicates the acidic condition of the soil. In the three points from nine stations the highest value of pH is 7.19 in the 2nd station of 3rd point which is slightly basic and the lowest value of pH 5.33 at the 3rd station of 1st point which is slightly acidic. The average value of pH at P2 is 5.92 and overall of different points is 6.02. This indicates slightly acidic condition of soil. The acidic agents of soil may come from the nearby industries which make the soil that condition.

OC (Organic carbon)

The lowest value 1.11% is found in station 1 under point 2 and the highest value 2.13% is found in the station 2 under point 3. The total average is 1.56.

Available K (Potassium)

The highest value 303.44 ppm of available k is found in station 2 under point 3 and the lowest 181.63ppm value is found in station 1 under point 2. It represents the higher value than standard level. The average concentration of potassium lies between 190-300 ppm which indicates the larger amount for crops production. It is over nutritious soil especially rich in potassium.

Table 1. Present status of the soil properties in and around the sampling area

Sampling Stations		pH	OC%	K (ppm)	S (ppm)	P (ppm)	Zn* (ppm)	Cd* (ppm)	Cu* (ppm)	Pb* (ppm)
P_1	S_1	5.64	1.22	209.88	450.00	20.76	2.03	0.13	0.08	0.76
	S_2	5.71	1.13	201.41	431.23	18.51	2.10	0.11	0.08	0.62
	S_3	5.33	1.33	199.62	459.01	19.31	1.91	0.13	0.08	0.75
	Average	**5.56**	**1.23**	**203.64**	**446.75**	**19.53**	**2.01**	**0.12**	**0.08**	**0.71**
P_2	S_1	5.88	1.11	181.63	396.29	14.66	1.99	0.20	0.08	0.59
	S_2	5.77	1.22	198.34	401.19	15.67	2.01	0.20	0.07	0.58
	S_3	6.12	2.01	203.43	435.55	16.23	2.10	0.24	0.07	0.65
	Average	**5.92**	**1.45**	**194.47**	**411.01**	**15.52**	**2.03**	**0.21**	**0.07**	**0.60**
P_3	S_1	6.22	1.81	294.65	605.55	16.49	3.05	0.10	0.09	0.74
	S_2	7.19	2.13	303.44	553.67	15.69	2.99	0.18	0.07	0.71
	S_3	6.35	2.03	299.31	622.68	17.97	3.03	0.17	0.07	0.67
	Average	**6.59**	**1.99**	**299.13**	**593.97**	**16.72**	**3.03**	**0.15**	**0.07**	**0.71**
**Standard		6.5-7		0.08-0.12	8-10	7	2.20	0.20	0.20	0.20

**Heavy metal, **WHO, 2002*

Available S (Sulphur)

The highest value 622.68 ppm of available S is found in station 3 under point 3 and the lowest 396.29 ppm value is found in station 1 under point 2. The available sulphur concentration is much higher than the acceptable limit of sulphur. Sulphur is used to crops production as macro nutrients of plant but excessive amount of sulphur in soil may cause of detrimental effects of crops production. The lowest limit of the value is much higher than the acceptable limit and the highest value is intolerable for plants.

Available P (Phosphorus)

The highest value 20.76 ppm of available P is found in station 1 under point 1 and the lowest 14.66 ppm value is found in station 1 under point 2. The average (15-20 ppm) phosphorus concentration is much higher than the acceptable limit of phosphorus. Phosphorus is used to crops production as macro nutrients of plant but excessive amount of phosphorus in soil may cause of detrimental effects of crops production. The lowest limit of the value is much higher than the acceptable limit and the highest value is intolerable for plants.

Zn (Zinc)

The highest value 3.05 ppm of available Zn is found in station 1 under point 3 and the lowest 1.91 ppm value is found in station 3 under point 1. Zinc plays role in the environment especially in soil as a micronutrient or is used as a trace element. But the concentration of zinc is detrimental for the plants or organisms if it is available in higher amount. The concentration of all stations of P_1 and P_2 is in the tolerable limit but the three stations of third point exceed the standard or recommended limit.

Cd (Cadmium)

The highest value 0.24 ppm of available Cd is found in station 3 under point 2 and the lowest 0.10 ppm value is found in station 1 under point 3. The average value of three points is 0.16ppm.

Cu (Copper)

The highest value .089ppm of available Cu is found in station 1 under point 3 and the lowest .065ppm value is found in station 3 under point 3. Copper is a micro-nutrient. The average value of P3 is .07 which is in the imit.

Pb (Lead)

The highest value 0.76 ppm of available Pb is found in station 1 under point 1 and the lowest 0.56 ppm value is found in station 2 under point 2. But the standard value of lead for soil is 0.2 ppm and all the values of lead in all sampling points are greater than the standard value. There were a number of battery industries here so the concentration of Pb may be present here for this reason.

Conclusions

The contamination of soil by heavy metals from industrial sources had become a serious environmental issue. The country is committed to increase its economic growth through industrialization but the environmental aspects and impacts is same important. From present research it has been stated that the soil quality was not satisfactory during study period. So appropriate measure and proper maintenance is must to reduce heavy metals concentration in soil.

References

Begum, A.; Ramaiah, M.; Irfanulla, K. and Veena, K. 2009. Analysis of heavy metal concentrations in soil and litchens from various localities of Hosur Road, Bangalore, India. CODEN ECJHAO, *E-J. Chem*., 6(1): 13-22.

Black, C. A. (ed.) 1965; Method of Soil Analysis, Part 2, Chemical and Microbiological Prope rties, American Society of Agronomy, Inc, Publisher, Madison, Wisconsin USA,

Bremner, J. M. and Mulvaney, C. S. 1982. Total nitrogen. In ñMethods of Soil Analysis (Part 2)ò, 2nd ed., ed. by A. L. Page, R. H. Miller and D. R. Keeny, American Society of Agronomy, Inc. and Soil Science Society of America, Inc., Madison, Wisconsin, pp. 595-622.

Dang, Z.; Liu, C.; Haigh, M. J. 2002. Mobility of Heavy Metals Associated with the Natural Weathering of Coal Mine Soils. *Environ Pollut.,* 118**:** 419-426.

De, A. K. 2003. Environmental Chemistry, Fifth edition, New Age International Publishers, pp.89-116.

Fereidoun, H.; Nourddin, M. S.; Rreza, N. A.; Mohsen, A.; Ahmad, R. and Pouria, H. 2007. The Effect of Long-Term Exposure to Particulate Pollution on the Lung Function of Teheranian and Zanjanian Students. *Pakistan Journal of Physiology,* 3(2): 1-5.

Jackson M. L. 1958. Soil Chemical Analysis. Constable and Co. Ltd. London.

Krishna, A. K. and Govil, P. K. 2007. Soil Contamination due to Heavy Metals from an Industrial Area of Surat, Gujarat, Western India. *Environ Moni Assess,* 124: 263-275.

Obiajunwa, E. I.; Pelemo, D. A.; Owalabi, S. A.; Fasai, M. K. Fatokun, F. O. 2002. Characterization of Heavy Metal Pollutants of Soils and Sediments around a Crude- Oil Production Terminal using EDXRF. *Nucl. Instr. Methods Phys. B.,* 194: 61ï 64.

Olayinka, K. O.; Oyeyiola, A. O.; Odujebe, F. O. and Oboh, B. 2011. Uptake of potentially toxic metal by vegetable plants grown on contaminated soil their potential bioavailability using sequential extraction. *Journal of Soil Science and Environmental Management*, 2 (8): 220-227.

Page A. L., R.H. Miller, and D. R. Kenny. 1982. Methods of Soil Analysis, Part II. Second edition, American Society of Agronomy, Inc. Madison, Wisconsis, USA. p. 1203.

Rosenstock, L. 2003. The Environment as a Cornerstone of Public Health. *Environmental Health Perspectives*, 111(7): A376-A377.

Smical, A. I.; Hotea, V. Oros, V. Juhasz, J. and Pop, E. 2008. Studies on transfer and bioaccumulation of heavy metals from soil into latuice, *Environmental Engineering and Management Journal*, **7**(5): 609-615.

SRDI (Soil Resource Development Institute). 2001. Land and Soil Resources Utilizations Guide (in Bengali). Upazila Nirdeshika Series-Singra Upazila, Soil Resources Development Institute, Dhaka, pp. 22-55.

SRDI (Soil Resource Development Institute). 2005. Land and Soil Resources Utilization Guide Upazila Nirdeshika series. Soil Resources Development Institute, Dhaka. pp. 45-63.

Sultana, M. S.; Kabir, S. E.; Kabir, M.; Mia, C. M.; Begum, N.; Chowdhury, D. and Rahman, M. S. 2003. Assessment of Effluent Quality of Dhaka Export Processing Zone with special Emphasis to that of the Textile and Dyeing Industries; *Jahangirnag. Univer. J. of Scien.*, 25:137-143.

USEPA (United States Environmental Protection Agency). 2007. Supplemental guidance for developing soil screening levels for superfund sites. Office of Solid Waste and Emergency Response, Washington, D.C.CX/FAC 02/16.

WHO (World Health Organization). 2002. Codex Alimentarius-General standards for contaminants and toxins in Soil. Schedule 1 Maximum and Guideline levels for contaminants and toxins in food, Joint FAO/WHO Food Standards Programme, Codex Committee, Rotterdam. pp. 1-12.

Wolnik, K. A.; Fricke, F. L.; Capar, S. G.; Braude, G. L., Meyer, M. W.; Satzger, R. D. Bonnin, E. 1983. Elementsin major raw agricultural crops in the United States. Cd and Pb in lettuce, peanuts, potatoes, soyabeans, sweetcorn and wheat, *J. Agric. Food Chem.,* 31: 1240-1244.