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Study of Toxic Effects in Soil Samples at Sitakunda Ship Breaking Yard by using AAS

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Abstract

Ship breaking activities are severely polluting Sitakunda coastal area of Bangladesh. To understand the pollution by different elements (trace and heavy) in soil twenty five soil samples had been collected from different ship breaking yards. The elements concentration was analyzed by Atomic Absorption Spectrophotometer technique. The average concentration of the elements Al, Cu, Mn, Ni, Pb and Zn were found to be 16880 ppm, 224.55 ppm, 751.46 ppm, 40.03 ppm, 83.81 ppm and 283.24 ppm respectively. The mean concentrations of all metallic elements were obtained to be in the order: Al >> Mn > Zn > Cu > Pb > Ni. Most of the elements were in higher levels. The findings of this study obviously indicated the ship breaking site was moderately contaminated with heavy and trace elements. The analyses of these samples revealed high probabilities of toxic contamination in Sitakunda Ship Breaking zone.

Keywords: *Ship Breaking, Pollution, Sitakunda, Elements concentration.*

1. Introduction

Environmental pollution has become a most important alarm of developing countries like Bangladesh. Coastal soils play a significant role in the interaction of man and the sea. The main source of heavy and other elements, in the coastal soil may be comes from ship breaking activities. The distribution of heavy and other elements concentration in the soil, water and biological materials is of great importance in environmental pollution studies [1]. Bangladesh is situated at the head of the Bay of Bengal. It is one of the most populated countries of the world. Approximately 24 billion people lives in the coastal zone [2]. Using the coastal advantages, a ship breaking zone has been developed during last couple of decades. Ship breaking industries termed as heavy industries whose are grown in the coastal area of Sitakunda, Chittagong (Fig. 1). The ship breaking industry provides 80 percent of the country's steel needs, and contributes to the production of the other industries such as cement and construction materials [3]. There are about 84 ship-breaking yards in Sitakundo [4]. Bangladesh has shown largely on economic benefits of ship breaking but didn't show its impact on environment. Different types of

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disposable materials and rubbish are disposed and spilled out from scrapped ships in a way that they often get mixed with the beach soil and sea water around [5]. The ship breaking industry makes lot of hazards for the coastal and marine environment. Ship breaking emerge a large number of hazardous pollutants, including toxic waste, oil and heavy metals, into the water and seabed. Heavy metals are the pollutants of greatest concern because of their long-term toxicity for microorganisms, plants, animals and human nature [6]. Workers in this field usually work with their bare hands in a naked and dirt environment. As a result, they are living with the toxic materials as a routine task during their work. Due to daily contact of the poisonous materials like heavy metals (mercury, lead, arsenic, chromium etc.) make them seriously affected. The main object of this study is to assess the concentration of trace, heavy and toxic elements in the soil of ship-breaking yards at Sitakunda. The research work has been performed using the modern sophisticated technology to find the elemental concentration in the soil samples. Therefore, the present research work is important in the sense that it will make awareness about the impact of the contamination to the people working in that area and to the authority on the basis of the reliable findings of this investigation. So that proper attention could be given in order to working environment in the ship breaking yard.

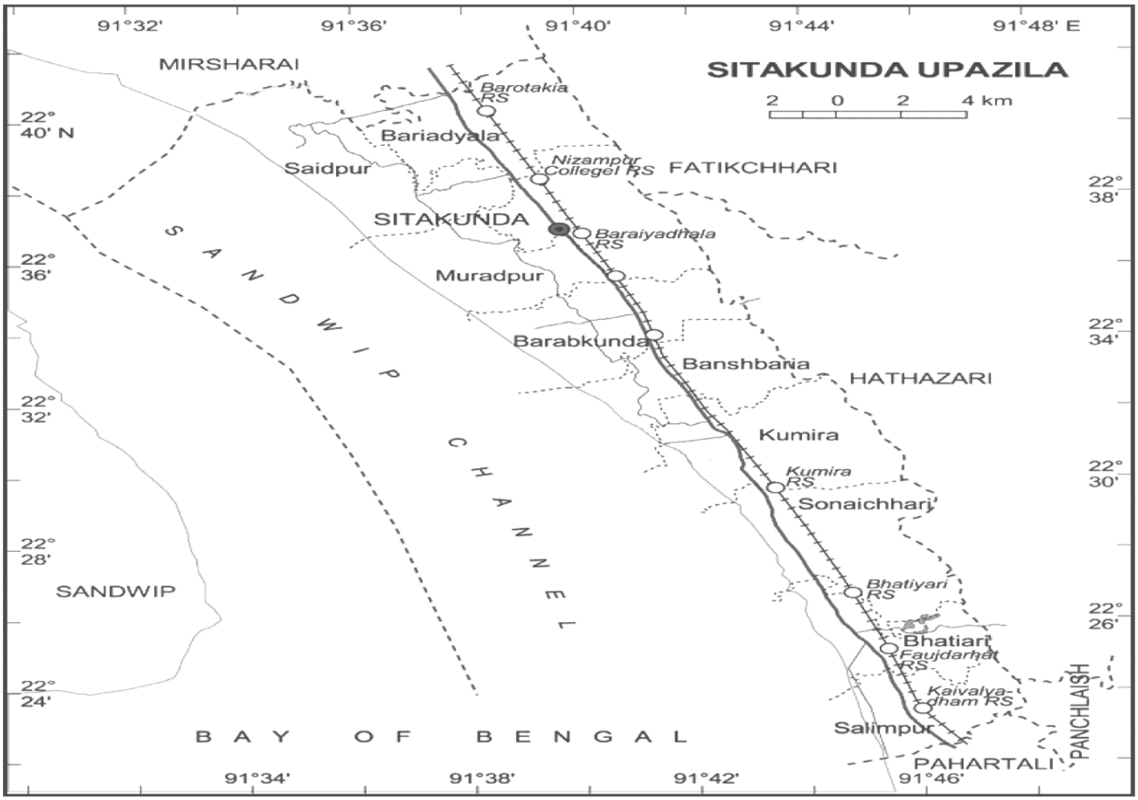

Fig. 1: Coastal zone of Chittagong, Bangladesh.

2. Materials and Method

25 soil samples were collected from five different ship breaking yards situated at Bhatiary of Sitakunda. The geographical location of the ship scrapping zone is between latitude 22^{o} 250′ and 22º 280′ N, and longitude 91º420′ and 91º450′ E shown in Fig. 2.

Fig. 2: The map showing sampling locations at Sitakunda, Chittagong, Bangladesh.

Samples were collected in cleaned polyethylene bag and marked separately by giving the identification (ID) number carefully. To avoid contamination, hand gloves were used to collect the samples. The name and addresses of the ship yards with soils identity are listed in Table 1. After collecting the soil samples, stored in a polyethylene bags and kept at low temperature until brought to the laboratory. In the laboratory, soil sample were spread on trays and air-dried at ambient conditions. After that, soil was ground by mortar andpestle, passed through a 1 mm mesh sieve and oven-dried at 50ºC for 48 h. 0.5 g of soil was placed in a100 mL Pyrex digestion flux with 10 mL HNO_3 and heated the solution at 70ºC for 0.5 h. Then 5 mL $HClO_4$ was added to solution and again boiling to 80º C for 2 h. 25 mL of water was added down the condenser before filtration of the mixture through using a Whatman No. 42 filter.The filtered residue was rinsed twice with 5 mL of water and solution was made up to 100 mL. Concentrations of Al, Cu, Mn, Ni, Pb and Zn in the digested samples were determined using Atomic Absorption Spectrophotometer technique.

3. Results and Discussion

The heavy and trace elements concentration in soil samples collected from ship breaking site in sitakunda were determined. The measured concentrations of six different elements are given in table 2.

Table-1: Samples identity of different Ship breaking yards.

Ship breaking yard	Sample ID
Rising Ship Breaking Yard	S-1, S-2, S-3, S-4, S-5
Pakhiza -1 Ship Breaking Yard	S-6, S-7, S-8, S-9, S-10
Ziri Subader Ship Breaking Yard	S-11, S-12, S-13, S-14, S-15
7B Ship Breaking Yard	S-16, S-17, S-18, S-19, S-20
Pakhiza -2 Ship Breaking Yard	S-21, S-22, S-23, S-24, S-25

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Table-2: Concentration of elements in different study areas.

Yard	Sample ID	Al (ppm)	Cu (ppm)	Mn (ppm)	Ni (ppm)	Pb (ppm)	Zn (ppm)
Yard 1	S1	20640.30	191.14	934.94	34.52	57.52	313.90
	S2	15976.80	118.02	685.20	35.04	76.24	414.38
	S3	16064.66	123.02	775.30	26.92	205.80	316.56
	S4	16837.82	523.08	865.06	89.22	132.36	321.48
	S5	14170.44	162.90	652.10	27.28	112.56	291.48
Yard 2	S6	7099.64	347.78	233.38	13.16	41.50	177.60
	S7	6175.36	170.58	290.94	15.46	76.24	255.22
	S8	9232.82	102.54	252.72	14.22	43.24	229.88
	S9	17864.00	67.36	635.10	27.46	69.64	212.76
	S10	6252.68	99.46	301.74	10.34	89.44	203.96
Yard 3	S11	19262.70	503.18	1144.84	61.70	129.22	333.64
	S12	15941.66	205.98	851.92	37.70	83.68	311.08
	S13	11000.52	374.98	1185.12	114.46	133.18	359.88
	S14	13650.32	60.96	433.84	23.40	24.26	197.22
	S15	16686.70	253.32	954.72	57.82	143.08	355.42
Yard 4	S16	23877.00	144.98	971.18	49.16	42.34	302.64
	S17	19796.88	342.88	1143.04	39.82	82.02	338.06
	S18	23912.14	117.80	1017.04	44.22	51.50	320.14
	S19	20879.28	326.24	1014.70	43.16	109.26	339.08
	S20	19895.28	80.06	695.80	35.76	28.38	281.76
Yard 5	S21	25772.37	99.61	817.51	38.00	72.12	256.65
	S22	20081.54	250.12	866.68	50.40	74.60	268.80
	S23	20633.28	257.90	697.96	38.92	63.86	214.36
	S24	20766.82	433.62	690.24	36.64	54.80	221.38
	S25	19645.76	256.30	675.66	35.92	98.52	243.80

Comparison of Concentration:

The average concentration of heavy and trace element ranges were: Al: 9324.90 -21672.11 ppm; Cu: 157.54 -279.68 ppm; Mn: 342.78 -968.35 ppm; Ni: 16.13 -59.12 ppm; Pb: 62.20 -115.66 ppm; and Zn: 215.88 –331.56 ppm; and the order of heavy metals concentration in the soil samples were Al >> Mn > Zn > Cu > Pb > Ni. The average values of the concentrations of Al in each yard are shown in Fig. 3. These values are far more than the reference level or world average 7130 ppm [7]. The average values of the concentrations of Cu in every experimental site are shown in Fig. 4. These values were greater than the standard value 34 ppm [8]. The average values of the concentrations of Mn and Ni in all yard were increased in similar fashion which shown in Fig. 5

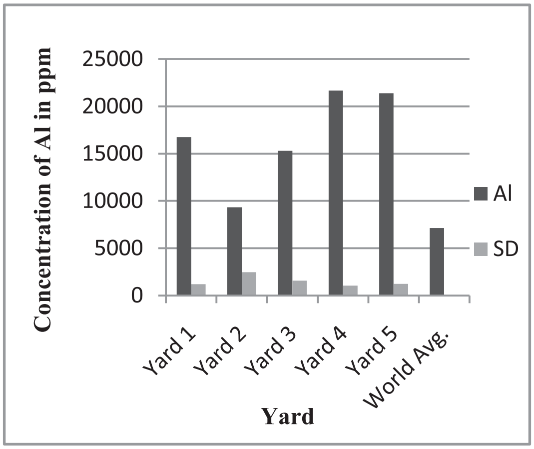

Fig. 3: Concentrations of Al in different study areas.

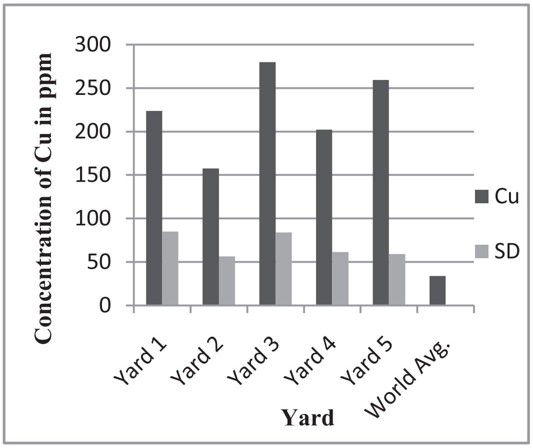

Fig. 4: Concentrations of Cu in different study areas.

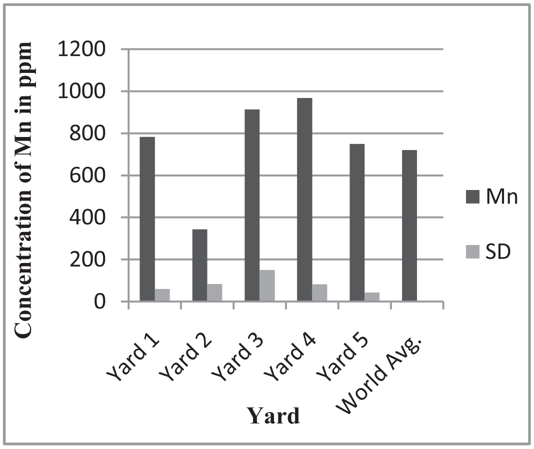

Fig. 5: Concentrations of Mn in different study areas.

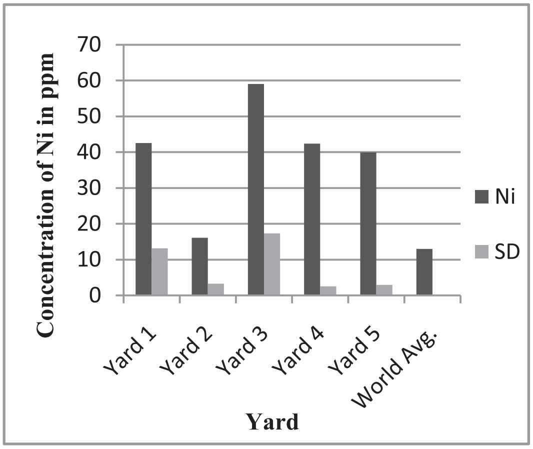

Fig. 6: Concentrations of Ni in different study areas.

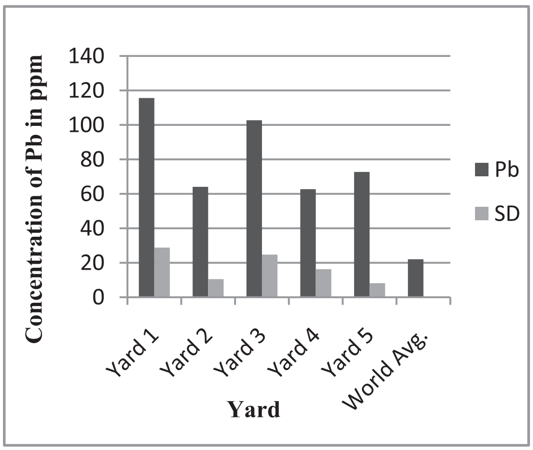

Fig. 7: Concentrations of Pb in different study areas.

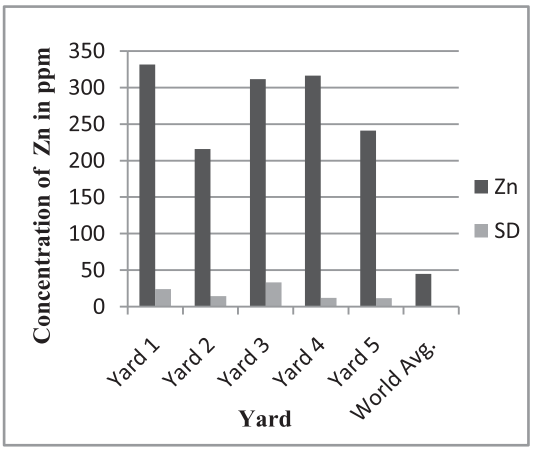

Fig. 8: Concentrations of Zn in different study areas.

and Fig. 6 respectively. These values were more than higher from the reference level 720 ppm for Mn [8] and 13 ppm for Ni [8] but in yard 2, Mn concentration was below reference level whereas Ni concentration was close to reference level. On the other hand, the concentrations of Pb and Zi in all yards are shown in figure 7 and figure 8. The average values of each site were very much higher than the world standard value 22 ppm for Pb [8] and 45 ppm for Zi [8]. These heavy metals originated from the part of old ships scrapped without the correct protective equipment. These parts are often go through further treatment resized, burnt, dumped etc. on the beaches and these are causing heavy pollution of the area. The high concentrations of heavy metals such as Pb, Zn and Cu reflect heavy metals typically found in paints. This high concentration of heavy metals is also harmful for adjacent marine ecosystem especially plankton and fishes is being affected seriously. These heavy metallic substances through intake of affected fish, causes human health hazards. Long contact to heavy metals like Cu, Pb, Ni and Zn can result in lethal health problems in human [9]. After being stored in various organs of the human body these heavy metals can results in annoying side effects [10]. Lead toxicity may results in decrease of hemoglobin production, malfunctioning of kidney, reproductive system, joint and cardiovascular and nervous system [11]. Higher concentration of Zn can cause impairment of growth and reproduction [12]. Microbial enzymes might be affected by heavy metals due to the potential inhibition to both enzymatic reactions and complex metabolic processes [13]. Ship breaking activities that carry huge amount of Al containing materials, therefore the study area was contaminated with Al. The higher concentration of Pb in soil of ships breaking site was probably due to the activities of dismantling of large ship along the coast that carry huge amount of Pb bearing materials. Present study shows that all the sampling sites are moderately to heavily pollute for Al, Mn, Zn, Cu, Pb and Ni. Therefore, these pollutants, when discharged, are polluting the nearby soil thus deeply rendering us a polluted environment.

Correlations

Pearson's correlation coefficient matrix among the selected heavy metals is shown in table 3. Significant correlations between thecontaminants of Zn and Mn (r = 0.81), Zn and Ni (r = 0.75), Zn and Pb (r = 0.64), Pb and Cu (r = 0.52), Pb and Ni (r = 0.58), Ni and Al (r = 0.52), Ni and Cu (r = 0.88), Ni and Mn (r = 0.89), Mn and Al (r = 0.77), and Mn and Cu (r = 0.66), are significantly correlated with each other, These correlations may reflected that these heavy metals had similar pollution level and similar pollution sources from ship breaking activities.

4. Conclusions

This extended degree of heavy metal concentration in soil is the direct consequence of ship breaking activities in these study areas. The widely varied degree of correlations among different elements indicates the diversified ship breaking activities in these yards. It could be said that, the ship breaking activities involve serious hazards for the worker and the ecosystem. So these activities should be continued by ensuring minimum harm to the environment andthe people involved there. As a part of long term development goal the authority can

Table-3: Correlations coefficient (r) among the concentrations of heavy metals in soil sample

	Al	Cu	Mn	Ni	Pb	Zn
Zn	0.409338	0.386272	0.809873	0.745039	0.639956	1
Pb	-0.07235	0.521538	0.320085	0.582162	1	
Ni	0.518793	0.877104	0.891122	1		
Mn	0.774528	0.665704	1			
Cu	0.483061	1				
Al	1					

confined ship breaking activities to a separate zone like a dockyard. It would be helpful to enforce the laws in this regard and to protect our environment before it is too late.

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