CSCanada
Advances in Natural Science
Vol. 8, No. 1, 2015, pp. 51-58
DOI: 10.3968/6492

ISSN 1715-7862 [PRINT]
ISSN 1715-7870 [ONLINE]
www.cscanada.net
www.cscanada.org

Environmental Impacts of Ship Breaking and Recycling Industry of Sitakunda, Chittagong, Bangladesh

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Received 15 October 2014; accepted 6 January 2015
Published online 26 March 2015

Abstract

Ship dismantling of Bangladesh is a reason of concern due to its economic values and environmental hazards. This study focuses on the Ship Breaking and Recycling Industry (SBRI) of Bangladesh to assess the environmental impacts. It was done by analyzing the water quality parameters like, Turbidity, Salinity, Electric Conductivity (EC), Dissolved Oxygen (DO), pH, Total Dissolved Solids (TDS), Temperature, Ammonia-Nitrogen, Nitrate–Nitrogen, Phosphate concentrations of inside and surroundings of Ship Breaking Yard. Turbidity ranged from 7.71 to 119 FTU and 4.07 to 41.74 FTU in inside and outside the ship breaking yard, respectively. Salinity ranged from 0.95 to 14.28 ppt and 0.06 to 0.79 ppt in insde and outside, respectively. Value of EC varied from1.75 to 1280 µs/cm in inside and 0.21 to 15.7 µs/cm in outside, DO ranged from 3.77 to 7.94 mg/l in inside and 1.95 to 5.34 mg/l in outside. TDS value ranged from1,280 to 15,340 mg/l in inside and 74 to 825 mg/l in outside of ship breaking yard. Ammonia-N value ranged from 0.46 to 7.046 mg/l, Nitrate-N value ranged from 0.10 to 6.9 mg/l and Phosphate value ranged from 0.175 to 4.75 mg/l in the analyzed water sample. Magnitude of environmental alteration by establishment of ship breaking industry was assessed by quantifying Environmental impact value of Study area and the value was found as -93, where ecological parameters value was found -72, Physico-chemical parameters value was -70 and human interest value was found +49 which indicate negative alteration on environment.

Key words: Environmental Impact Value; Environmental Hazard; Economic Importance; Sustainable Development.

Talukdar, M. I., Fakhruddin, A. N. M., & Hossain M. A. (2015). Environmental Impacts of Ship Breaking and Recycling Industry of Sitakunda, Chittagong, Bangladesh. *Advances in Natural Science*, *8*(1), 51-58. Available from: http://www.cscanada.net/index.php/ans/article/view/6492
DOI: http://dx.doi.org/10.3968/6492

INTRODUCTION

Ship Breaking and Recycling Industry (SBRI) is a growing industry in the world because of its huge economic importance. Around 95% of the ships mass are valuable steel and they are completely recyclable and after sailing life they are sold for scrapping (Greenpeace, 2001). In the 20th century it was established in industrialized countries such as United Kingdom and United States. In the period of 1960s and 70s ship breaking activities migrated to semi industrialized and low income countries such as Spain, Turkey and Taiwan for the available cheap labor and re-rolled steel mill and market but currently the global center of concern of the ship breaking industry are located in South Asia, specially the Indian Sub-continent (Bangladesh, India and Pakistan). The Ship Breaking and Recycling Industry (SBRI) is a complex process and involved with many health, safety and environmental issues (OSHA, 2001). As the cost of upholding environmental and health and safety standards in developed countries has risen, ship breaking industry has increasingly shifted to poorer Asian countries (Greenpeace, 2001).

Ship breaking activities migrated to Indian-subcontinent due to the low paid available labor, suitable climatic condition and topography, a profitable local domestic and international market with shipping facilities,

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relatively less Environmental concern and implementation of laws and exchange rate, relative to the US dollar and currencies of other ship breaking countries (FIDH, 2002). Now a day's Bangladesh is the most efficient and prospective country for ship breaking industry in the world and also for the domestic production. Up to 2.2-2.5 M tons of national steel production come from the ship breaking industry. There are at least 40 active ship breaking yard and 250-350 re-rolling mills (World Bank, 2010). Around 22,000 worker are directly involved in ship breaking activities and another 200,000 are indirectly employed by ancillary work and after 2009 it increased rapidly (World Bank, 2010). Handling different types of heavy objects, poor access to progressively dismantled ship, heavy metal pollution and other chemical, lack of safety equipment is causes of these types of hazards (OSHA, 2001). At present there are at least 40 ship-breaking yards in the Sitakunda area and extend from Fauzdarhat to Kumira coast (World Bank, 2010, p.34). The Sitakunda coast is suitable for establishment of ship breaking yard for geological, topographical and economical advantages: long uniform intertidal coastline with tidal differences of 6 meters, protection of the Bay of Bengal, favorable weather condition, local market of steel and iron, low labor expenditure, little environmental awareness and moderate implementation of environmental laws (YPSA, 2005).

In an average 95% steel are coated with 10-100 tons of paints which contain lead, mercury, zinc, arsenic, chromium etc. PCBs, asbestos and a huge quantity of oil cause environmental pollution when the ship is broken for scrap (Islam and Hossain, 2006). In Bangladesh ships are often cut up by manual way on the open beaches and Environmental law and regulations are not practiced here. Most of the time there is no safe waste disposal facilities. The objectives of this study include were to determine physico-chemical parameters of surface and ground water from the study area and their impacts on health and environment. Aim was also to identify the hazards associated with Ship breaking industry and finally to measure the magnitude of impact on the environment.

1. METHODS

1.1 Selection of Study Area

The water samples of the Ship breaking yard and other necessary data are collected from Sitakunda Upazila in Chittagong district located at the south eastern part of Bangladesh where most of the Ship breaking and Ship re-rolling Industries are located. The study area is lies between the latitudes 22º37´99´´N and longitudes 91º33´05´´. Map of the sampling sites is presented in Figure 1. The samples are collected from the study area in December 2011.

Figure 1
The Study Location Sitakunda, Chittagong, Bangladesh

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1.2 Water Sample Collection and Preservation

The water used in the experiment was collected from adjacent river, ponds and tube well of Fouzdarthat, Kumira and Vatiary area of Shitakunda, Chittagong, Bangladesh and bought to the laboratory as early as possible in the experimental analysis. For the avoidance of further contamination and changes in parameter samples were carried in airtight sample bottle in insulated box with ice to maintain the temperature around 4 to 6 ^oC.

1.3 Physico-Chemical Parameter Analysis of Water Samples

The turbidity, total dissolved solid and salinity was measured using (Hanna Instrument Model-H19143, Portugal), electric conductivity was measured using portable Multi parameter Meter sension^{TM}156 (HACH), dissolved solid was measured by DO meter(Hanna Instrument Model-H19143, Portugal) and the hydrogen ion concentration (pH)was measured using pH meter (Jenway, pH meter, Model-3305, Germany).

1.4 Ammonia-N and Phosphate Analysis

Ammonia-N was determined using Nesslerization method as described in Standard methods for the examination of water and wastewater (APHA, 1975). The Nitrate -N was determined using Cd reduction method described in Standard methods for the examination of water and wastewater (APHA, 1998). Phosphate was measured using the Ascorbic acid method according to the Standard methods for the water and wastewater Examination (APHA, 1998).

1.5 Environmental Impact Value Analysis

The study was conducted by a series of steps; visiting the ship breaking yard, total environment, occupational and cultural condition were observed, water sample were collected from on shore and offshore area and analyzed. Onsite assessment and interviews with relevant personnel including worker, yard manger, other stakeholders and local people were taken, important environmental parameters associated with establishment of ship breaking industry were identified and at last quantifying Environmental Impact Value based on the Environmental Evaluation System (ESS). In this method, reference level were the background environmental conditions and positive and negative changes in Environmental parameters are resulting from Ship breaking industry was evaluated and assessed by the following equation as described by LGED (1994):

$$EIV=\sum V_i W_i \quad . \qquad (1)$$

Where, Vi = Relative change in the value of environmental quality of parameter i with respect to the existing situation. It represents the magnitude of alteration of the environmental parameters.

Wi = Relative importance or weight of parameter i. It represents relative weight or importance of the respective parameters.

n = Total number of environmental parameter related to the project.

The changes of environmental parameter are measured with to back ground condition. Here No changes have 0 values. The negative adverse changes have been given -1, -2, -3, -4, - 5 to represent very low, low, moderate, high and severe negative impact respectively. Similarly very low, low, moderate, high and very high positive impacts are represented by +1, +2, +3, +4, +5, respectively. All environmental parameter that are influenced by the SBRI are not having equal value the importance of parameter varies from country to country depends on the Human life standard, loss of natural resources and environmental concerns. In Bangladesh, flood, employment, agriculture, fisheries etc. are more important than other parameter. Relative importance value is evaluated which indicates the magnitude of environmental changes and corresponding importance of environmental parameter. They are placed on the chart and then multiplied them to obtain positive and negative impact of the parameter finally all these impact were summed up to obtain the total EIV value.

2. RESULTS AND DISCUSSION

2.1 Assessment of the Impact of Aquatic Environment

Physico-chemical parameters of water samples collected from inside and outside of ship breaking yards are presented in Tables 1 and 2, respectively. The Turbidity of the water sample inside the ship breaking yard varied frequently. The value of Turbidity ranged from 7.71 to 119 FTU, which is within the limit (150 FTU). The Turbidity of water sample collected from outside of the ship breaking yard ranged from 4.07 FTU to 41.74 FTU, which was also within the permissible limit as described by DOE (1997).

Table 1
Physiochemical Parameters of Water Sample Collected From Different Ship Breaking Yard Area

Sample ID	Parameters					
	Turbidity (FTU)	Salinity (PPT)	EC (µs/cm)	DO (mg/l)	pH	TDS (mg/l)
V-1	33.89	8.05	1,100	7.76	7.7	11,000
V-2	76	9.03	1,125	6.60	7.98	12,490
V-3	35.72	8.10	1,110	6.60	7.85	11,360
V-4	119	7.2	1,132	6.47	7.90	13,230

To be continued

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Continued

Sample ID	Parameters					
	Turbidity (FTU)	Salinity (PPT)	EC (µs/cm)	DO (mg/l)	pH	TDS (mg/l)
V-5	11.06	8.9	1,080	7.05	8.11	12090
V-6	10.83	8.33	1,216	7.30	7.30	14620
V-7	93	7.96	1,260	6.68	8.24	11400
V-8	14.41	7.65	1,100	7.94	8.16	12700
V-9	44.55	8.05	1,135	7.30	8.28	11210
V-10	91	8.11	1,124	7.30	8.17	10340
F-1	17.63	0.95	1.75	5.46	8.10	1480
F-2	70	0.99	1.80	4.94	8.25	1280
F-3	7.71	14.28	1,280	4.88	7.92	14400
F-4	9.29	13.56	1,200	4.30	7.94	11980
F-5	67	13.60	1,278	3.77	8.09	15340

*Note.**V-Vatiary, F-Fouzdarhat.

Table 2
Physiochemical Parameters of Water Samples Collected From the Surrounding Environment of Ship Breaking Yard

Sample ID	Parameters					
	Turbidity (FTU)	Salinity (PPT)	EC (µs/cm)	DO (mg/l)	pH	TDS (mg/l)
B.C.T-1	15.80	0.41	0.84	1.95	7.74	349
B.C.T-2	4.07	0.40	0.80	2.91	7.36	396
B.C.T-3	5.09	0.67	1.51	2.89	7.75	790
B.C.T-4	5.34	0.68	1.56	2.60	7.90	656
B.C.P-1	24.04	0.06	0.21	5.34	7.65	117
B.C.P-2	19.40	0.09	0.19	5.15	8.15	74
V.T-1	33.34	0.39	0.87	3.12	7.27	825
V.T-2	41.74	0.79	1.70	2.80	7.29	809
V.T-3	8.76	0.35	15.73	3.96	7.46	447
V.T-4	8.21	0.49	1.00	3.10	7.44	558
V.T-5	6.38	0.53	1.96	7.28	7.57	595
V.T-6	15.77	0.54	1.92	4.22	7.48	370
V.T-7	12.31	0.45	0.93	4.06	7.43	499

*Note.**B.C.T-Base Camp tube well, B.C.P- Base Camp Pond, V.T- Vatiary Tube well.

Salinity also varies from place to place due to the dimension of ship breaking activities. The EPA standard for brackish water is $0.5\text{-}29\times10^{-12}$ and the salinity range was within the limit. The Electrical conductivity of ship breaking yard area (on site) was examined and the value varied from 1.75 µs/cm to 1,280 µs/cm. In all sampling point of Vatiary area EC was too high and crossed the limit. Value of EC which are found in previous result in Fauzdarhat area was 1,600 µs/cm (Islam and Hossain, 1986) and 2,230 µs/cm was in Vatiary region (Pasha et al, 2012), a great deviation were found in this study from previous studies. The Standard limit of EC for drinking purpose is 1,200 µs/cm (DOE, Bangladesh, 1997) and measured values were within this limit.

The standard limit of DO in brackish water for Bangladesh is 4.5-8 mg/L (DOE Bangladesh,1997) and within the yard area the water sample indicates the highest value of 7.98 mg/l at V-8 sampling site and stands within the permissible limit. The level of DO is low in Fauzdarhat area than the Vatiary because the Fauzdarhat is more polluted than the Vatiary region. Value of DO which are found from the secondary data was 4.10 (Islam and Hossain, 1986) in Fauzdarhat which are similar to the present study.

The Standard limit of pH is established by DOE Bangladesh is 6.5-8.5. pH is almost similar in different sampling site and varies slightly. The results range between 7.30 to 8.2. Present study showed that tube

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well water is affected by alkalinity, 2 tubes well water samples showed pH 8.10 and 8.25. In Vatiary, previous study noticed pH 8.4 (Pasha et al., 2012). The result of pH ranged from 7.27 to 8.15 outside areas of ship yard.

Both onsite and offsite sample a higher amount of TDS were found due to the presence of different physical pollutants. Standard level of TDS for Bangladesh is 2,100 mg/l and 1,000 mg/l Brackish and inland surface water respectively (DOE, Bangladesh, 1997). In the current study the TDS values ranged from 11,000 to 15,340 mg/l. In 1986 Islam and Hossain observed the water of Fauzdarhat area and found the value of TDS which was 199. Comparing with present study it is clear that the TDS increased with the time. The Value of TDS ranged between 74 mg/L to 825 mg/L in outside area of ship breaking yard.

The surface and groundwater quality are easily determined by the value of Nitrogen and Phosphate concentration found in the water sample of surrounding area of ship breaking yard. Nitrate N and phosphate concentrations of the collected samples are presented in Table 3. In 10 sampling site, the NH_3-N concentration varied from 0.46 to 7.046 mg/ l. The standard level of Ammonia (Nitrogen) for drinking purpose is 0.5 mg/l (DOE, Bangladesh, 1997). Eight out of ten of these water samples crossed the permitted limit. Highest value found 7.046 mg/l which is vulnerable for human health. The Nitrate-N is another important parameter for drinking purposes. The standard level of Nitrate (Nitrogen) for drinking purpose is 10 mg/l (DOE, Bangladesh, 1997). The NO_3-N concentration varied from 0.1 to 6.9 mg/ l. Nitrate-N concentration stands below the permissible limit. The PO_4 concentration was found highest in the pond water sample of Base camp area which was 4.25 mg/l and concentration of phosphate ranged between 0.175 to 4.25 mg/l. The standard level of phosphate for drinking purpose is 6 mg/l (DOE, Bangladesh, 1997). All of the ten samples were found within the standard value.

Table 3
Analysis of Ammonia-Nitrogen, Nitrate-Nitrogen and Phosphate Content of Water Samples Collected From the Surrounding Environment of Ship Breaking Yard

Sample ID	Parameters		
	NH_3-Nmg/L	NO_3-N\mg/L	PO_4mg/L
B.C.T-1	2.37	1.4	3.95
B.C.T-2	1.82	0.8	4.0
B.C.T-3	7.046	1.1	3.90
B.C.T-4	4.64	1.8	4.10
B.C.T-5	4.31	6.9	0.175
B.C.P-1	0.413	0.41	4.25
B.C.P-2	0.46	3.7	0.362
V.T-5	4.19	0.5	4.10
V.T-6	4.5	0.1	4.12
V.T-7	4.19	0.5	4.10

*Note.**B.C.T-Base Camp tube well, B.C.P- Base Camp Pond, V.T-Vatiary Tube well.

2.2 Assessment of Environmental Impact Value

Environmental Impact Value of Ship Breaking Yards of Sitakunda, Chittagong, Bangladesh is presented in Table 4. The beneficial and adverse changes in environmental parameters resulting from the establishment of ship breaking industry are expressed in qualitative terms plotted in a scale of +5 to -5 to quantifying the environmental alteration. From the checklist analysis as shown in Table 5, it was found that Fisheries and Forests have the very high Negative impact which was quantify as -5, Eutrophication having no positive or negative impact on environment quantified as 0. In the physico- chemical parameters water pollution has very high negative impact and flooding has very low negative impact. Employment opportunity which is a human interest related parameter has a high positive degree of impact with the value of +5.

Table 4
Environmental Impact Value of Ship Breaking Yards of Sitakunda, Chittagong, Bangladesh

Environmental parameters	Relative importance value	Degree of impact	Relative impact		EIV
			(+)	(-)	
1. Ecological paramter					
Fisheries	5	-5		-25	-72
Forest	3	-5		-15	
Tree plantation	2	-4		-8	
Wildlife	3	-4		-12	
Wetlands	4	-3		-12	
Eutrophication	1	0		0	

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Environmental parameters	Relative importance value	Degree of impact	Relative impact		EIV
			(+)	(-)	
2. Physico-chemical parameter					
Erosion & siltation	2	-2		-4	-70
Water logging	5	-2		-10	
Flooding	6	-1		-6	
Flood control & drainage	6	0		0	
Soil fertility	5	-4		-20	
Ground water table	3	-3		-9	
Water pollution	3	-5		-15	
Dust/ noise pollution	2	-3		-6	
Obstruction of waste-water flow	3	0		0	
3. Human interested related parameter					
Health & nutrition	6	-3		-18	+49
Loss of agricultural land	8	-1		-8	
Employment opportunity	8	+4	+32		
Commercial & service facilities	6	+4	+24	0	
Navigation	3	0	+25		
Industrial facilities	5	+5		0	
Irrigation facilities	2	0		-2	
Land ownership	2	-1		-4	
Landscape	2	-2			
Total environmental impact value			+49	-142	-93

Table 5
Checklist of Environmental Parameter of Shipbreaking Yard Establishment Scheme

Environmental parameter	Impact on environment										
	Positive impact					Negative impact					No impact
	Very low	Low	Moderate	High	Very high	Very low	Low	Moderate	High	Very high	
1. Ecological											
Fisheries										√	
Forest										√	
Tree plantation									√		
Wildlife									√		
Wetlands								√			
Eutrophication											√
2. Physico-chemical parameter											
Erosion & siltation							√				
Water Logging							√				
Flooding						√					
Flood Control & Drainage											√

To be continued

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Continued

Environmental parameter	Impact on environment										
	Positive impact					Negative impact					No impact
	Very low	Low	Moderate	High	Very high	Very low	Low	Moderate	High	Very high	
Soil fertility									√		
Ground water table								√			
Water pollution										√	
Dust/ noise pollution								√			
Obstruction of waste-water flow											√
3. Human interest related parameter											
Health & nutrition								√			
Loss of agricultural land						√					
Employment opportunity				√							
Commercial & service facilities				√							
Navigation											√
Industrial facilities					√						
Irrigation facilities											√
Land ownership						√					
Landscape							√				

Environmental Impact Assessment is necessary to make a decision on the establishment of a Ship breaking industry. Based on Environmental Evaluation System (EES) in this study Environmental Impact Value (EIV) is calculated (LGED, 1994), which describes the positive and negative effects on environment. EIV is an essential small scale but very effective evaluation process for the assessment of environmental alteration. The parameters related to SBRI were given different values based on prevailing environmental concerns in Bangladesh. The values representing importance or weight of the parameters can be used to compute the relative impacts of the parameters which are then summed up to obtain the total EIV of the industry.

The total EIV is found -93 which indicates mostly the negative impact on environment. Total EIV of ecological parameter was -72 which points out about degradation of ecosystem in respect to forest, tree plantation, wild life, wetland etc. which have individual negative impact by establishing this industry. Total EIV of Physico- chemical parameter was -70. Erosion siltation has -4, soil pollution has -20, water pollution has -15 EIV value itself. Only the Human interest parameter has little positive impact which is important for the economical growth. Total EIV of Human interest parameter was +49 with individual value of Commercial and service facilities +24, employment opportunity +32, Industrial facilities +25. This positive impact point out about the chance of founding this industry with consideration of economic perspective. In 2012 Pasha et al. evaluated the Environmental alteration due to establishing SRS Ship breaking industry in Sitakunda coastline By EIV method, where the total EIV was found -53 considering Physical, Ecological, Human interest and Quality of life parameters. Ecological value showed a great disturbance with a negative result of -30 but Human interest parameters showed positive impact with the value +5.

CONCLUSION AND REMARKS

- Except TDS, tested physicochemical parameters, like Turbidity, Salinity, pH and DO of water samples of ship breaking yard (onsite) area were within the acceptable limit. But the water sample collected from surrounding of the ship breaking yard area (offsite) showed low Turbidity, EC and DO level.
- Except one tube well water samples, the Ammonia concentrations were found acceptable optimum limit. But Nitrate and Phosphate are found below the Standard.
- The total Environmental Impact Value revealed a negative result -93 which clearly indicates the environmental degradation by establishing Ship breaking and recycling industry.

In Bangladesh the rapid development of ship breaking and recycling industries has a significant impact on both human and environment but it is economically important too. To mitigate the adverse effect of SBRI in a sustainable format some measures are recommended here as follows:

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- A well-recognized layout plan should be designed before starting a ship breaking yard.
- Government and other stakeholders should implement a set of national and international policies for environmental safety.
- Effective Environmental Management Plan (EMP) should be set up for maximum pollution abatement.

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