Applied Ecology and Environmental Sciences, 2019, Vol. 7, No. 3, 96-100
Available online at http://pubs.sciepub.com/aees/7/3/3
Published by Science and Education Publishing
DOI:10.12691/aees-7-3-3

Water Pollution and Its Adverse Effect on Biodiversity in Ship Breaking Area of Bhatiary, Chattogram

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Received June 08, 2019; Revised August 06, 2019; Accepted August 12, 2019

Abstract Shipbreaking has obtained great importance in the micro and macro economy of poverty-stricken Bangladesh for being a profitable industry in spite of having a number of environmental and human health hazards. This study focuses on the Ship Breaking and Recycling Industry of Bangladesh to evaluate the pollution in water and measure the adverse effect on biodiversity. Here the water quality parameters like pH, Salinity, Alkalinity, Hardness, Electrical Conductivity (EC), Turbidity, Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Pb, Cr, Cd, Fe concentrations of the sea water of shipbreaking yards of Bhatiary, pond water and tube well water has analyzed. Turbidity during tide-1 was observed 2624 NTU where the standard value is 5 NTU. Similarly, BOD was measured about 11.30 mg/l which was above the permissible limit in the seawater during tide-2. Value of Pb was about 0.07018 mg/l in seawater during tide-1 which is above the permitted limit. The elevated level of different physicochemical parameters and heavy metal is a serious threat for pollution not only for the biodiversity but also for the environment. Evaluation of water pollution in water bodies by the establishment of ship breaking industry was assessed by comparing these data with WHO and BSTI standard and evaluation of the adverse effect on biodiversity was established by observing the range of the parameters measured from the water bodies.

Keywords: *water pollution, biodiversity, heavy metal, shipbreaking industry, Bhatiary*

Cite This Article: Nazmir - Nur Showva, and Adib Bin Rashid, "Water Pollution and Its Adverse Effect on Biodiversity in Ship Breaking Area of Bhatiary, Chattogram." *Applied Ecology and Environmental Sciences*, vol. 7, no. 3 (2019): 96-100. doi: 10.12691/aees-7-3-3.

1. Introduction

The seawater habitat in the coastal area of Bhatiary Union of Chattogram, Bangladesh is being polluted by ship scrapping activities. At present Bangladesh is the most efficient and prospective country not only for ship breaking industry in the world but also for the domestic steel production. It's about 2.2- 2.5 M tons of national steel production come from the ship breaking industry. In Bangladesh, there are at least 40 active ship breaking yards and 250-350 re-rolling mills [1]. There are about 22,000 workers are directly related in ship breaking activities and approximately another 200,000 are indirectly involved by ancillary work and after 2009 it increased gradually [1].

Different types of heavy objects handling, poor access to the progressively dismantled ship, pollution of heavy metal and other chemicals, lack of safety equipment are the causes of these types of hazards [2]. In Bangladesh, ships are cut up randomly on the open beaches and Environmental laws and regulations are hardly practiced. Mostly the waste disposal facilities are not safe. The coastal soil and seawater environment are being contaminated excessively by ship breaking activities mainly through the discharge of ammonia, burned oil spillage, floatable grease balls, metal rust (iron), various other disposable refuse materials and heavy metals. 95% in an average, steel are coated with 10-100 tons of paints which contain heavy metal like lead (Pb), mercury (Hg), zinc (Zn), arsenic (As), chromium (Cr) etc. PCBs, asbestos and a huge quantity of oil cause environmental pollution when the ship is broken for scrap [3].

Ship breaking activity poses a real hazard to the coastal inter-tidal zone and its ecosystem because of the unsystematic expansion of the industry. Due to the addition of ammonia, oils, and lubricants the seawater and soil may observe the elevated level of pH. Extensive human and mechanical activities are expediting the rate and amount of seashore erosion and result in a swelling level of turbidity of seawater. Decrease in the concentration of DO and substantially increase the BOD can be caused by the outrageous turbidity of water. But oil spilling may cause serious damage by reduction of light intensity, inhibiting the exchange of oxygen and carbon dioxide across the air-sea water interface and by acute toxicity. The growth and abundance of marine organisms especially plankton and fishes may seriously be affected by this contamination.

The objective of this study was to determine physicochemical parameters of surface and groundwater

from the study area and evaluation the range of pollution in water bodies with its effect on biodiversity. The aim is to access the water pollution associated with the Shipbreaking industry.

2. Materials and Methods

2.1. Study Area

The water samples of the seashore, pond, and tube well water approximately 0.5 and 1km away neared the Shipbreaking yard were collected from Bhatiary Union in Chattogram district located at the southeastern part of Bangladesh. The study area lies between the latitudes 22º25´41´´N and longitudes 91º45´01´´ E. Map of the study location is presented in Figure 1 with red spot. Figure 2 indicates the Google map of the sample collection area.

2.2. Sample Collection and Preservation

Seawater, pond water, and tube well water were collected from Bhatiary. Seawater was collected from Bhatiary seashore during a tide (tide-1) and ebb (tide-2). Pond and tube well water sample were collected from two different sources which were near about 0.5 km and 1 km. away from the seashore respectively. Samples were collected in Summer 2018. Samples were bought to the laboratory as early as possible after collection. For avoiding further contamination and changes in the parameter, samples were carried in airtight sample bottle in an insulated box with ice to maintain the desired temperature around 4 to 6°C.

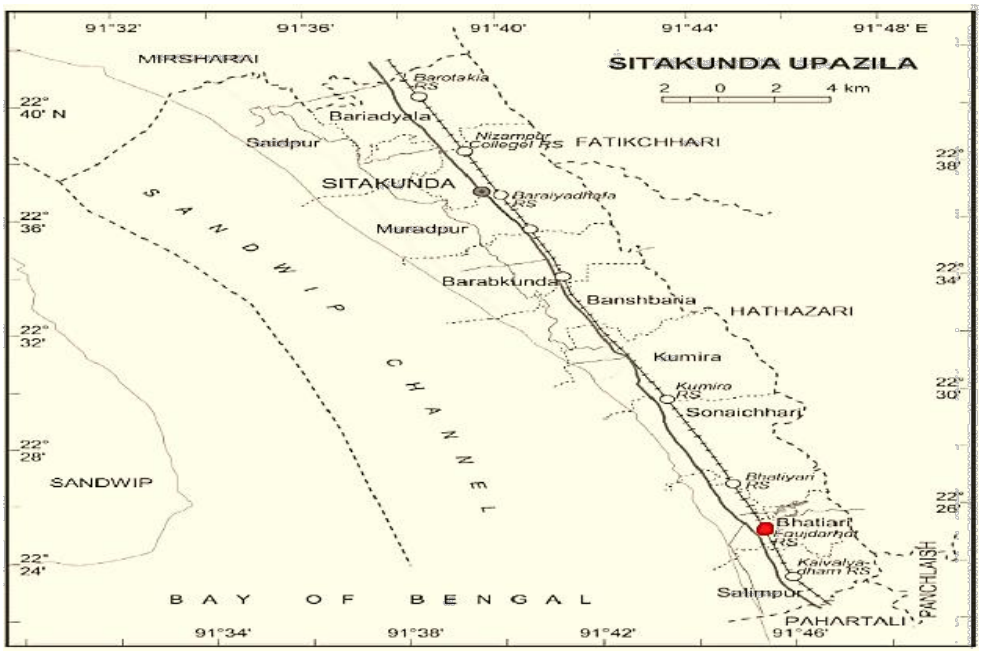

Figure 1. Map of the study location

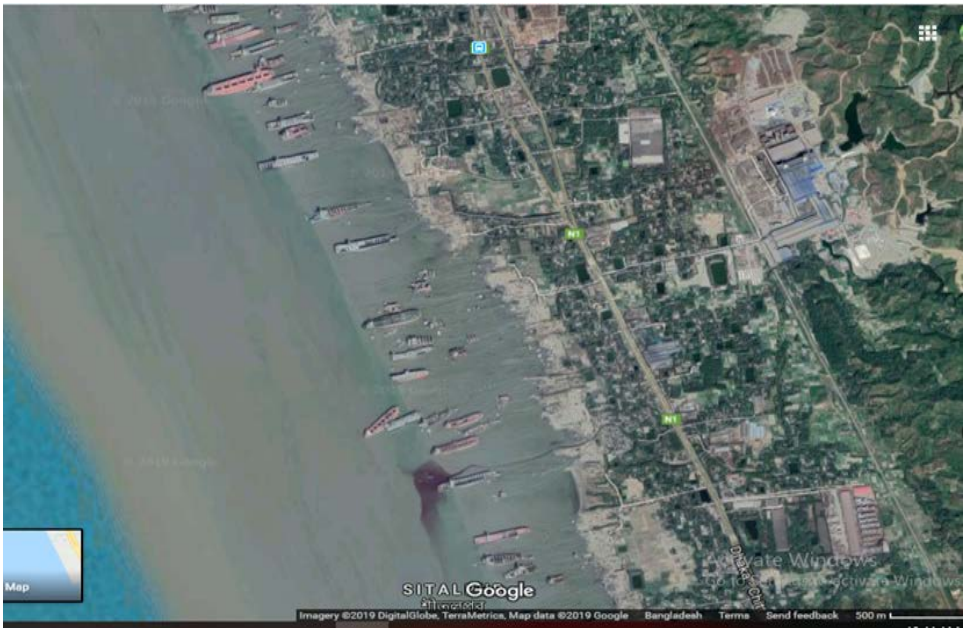

Figure 2. Satellite image of the sample collection area

2.3. Physicochemical Parameter Analysis of Water Samples

The turbidity was measured using turbiditimeter (HACH 2100a), electrical conductivity and salinity were measured using an electrical conductivity probe (HACH HQ 40d), dissolved oxygen (DO) was measured using DO probe (HACH HQ 40d), pH was measured using pH probe (HACH HQ 40d),alkalinity was measured using digital titrator (HACH),hardness was measured using hardness indicator (Marven 2).

2.4. Heavy Metal Analysis of Water Samples

Heavy metals (Pb, Cr, Cd, Fe) were measured using Atomic Absorption Spectrophotometry (AAS) model (PerkinElmer, PinAAcle 900T).

3. Results and Discussion

Physicochemical parameters and heavy metals of water samples were collected from different sources of shipbreaking yards of Bhatiary union and compared with BSTI and WHO standard values. Standards of water quality are presented in Table 1.

Table 1. BSTI [4,8] and WHO [5,8] standards of water quality

Parameters	BSTI	WHO
pH	6.4-7.4	6.0-8.5
Salinity(PPT)	35	35
Alkalinity (mg/L) (both the calcium concentration and the alkalinity)	40	40
Hardness (mg/L)	Max.500	Max.500
Electrical Conductivity (EC) (µs/cm)	3000	3000
Turbidity(NTU)	Below 5	Not more than 5
Biological Oxygen Demand(BOD), (mg/L)	6.0	5.0
Dissolved Oxygen (DO), (mg/L)	Max. 6	Max. (4- 6)
Pb(mg/L)	0.05	0.05
Cr(mg/L)	0.05	0.05
Cd(mg/L)	0.005	0.005
Fe(mg/L)	0.03-1.0	0.1-1.0

*BSTI = Bangladesh Standards and Testing Institute *WHO = World Health Organization.

3.1. Effect of Physicochemical Parameters on Biodiversity

Physicochemical parameters of collected water samples from different sources of ship breaking yards of Bhatiary are presented in Table 2.

The Standard limit of pH is established by DOE Bangladesh is 6.5-8.5 [6]. pH is almost similar in different sampling site and varies slightly.

Salinity diverse from one place to another place due to the dimension of shipbreaking activities. The lowest value of salinity was measured in the pond water which is 1km away from the beach was 0.12 PPT and the highest value was measured about 1.25 PPT in the seawater during tide-2. All the samples were within the permissible limit.

Alkalinity was measured in pond water from 0.5 km from the beach indicates the highest range of alkalinity about 290 (mg/l) which is beyond the standard level. Though Alkalinity itself has little public health significance, although highly alkaline waters are unpalatable and can cause gastrointestinal discomfort.

The values of the hardness of all the samples are within permitted limit. The Electrical conductivity of ship breaking yard area in tide-1 and tide-2 were examined and the resultant values were 2237 µs/cm and 2474 µs/cm respectively. Tube wells which were located from 0.5 and 1 km from seashore showed EC in sampled water were 395 µs/cm and 778 µs/cm. A water sample collected from pond showed EC 1000.89 µs/cm and 287 µs/cm. The Standard limit of EC for drinking purpose is 1,200 µs/cm and measured values were within this limit [6].

Turbidity is a characteristic of water which is caused by the suspended particles or the colloidal matter in water which obstructs light transmission through the water which may be caused by inorganic or organic matter or a combination of the two [7]. The Turbidity of the water varies from sample to sample. The values of Turbidity were 2624NTU and 2160 NTU in sea water, tide-1 and tide-2 respectively. The Turbidity of the water samples collected from tube well water located from 0.5 and 1km away from ship breaking yard respectively is 3.92NTU and 2.26 NTU. On the other hand, the Turbidity of the water sample collected from pond water located from ship breaking yards is 8.35NTU and 12.30 NTU. According to BSTI the standard value of turbidity for drinking water is below 5 NTU and WHO standardized the value not more than 5 NTU for drinking water and should ideally be below 1 NTU [7,8]. All of the collected water samples crossed the permitted limit of Turbidity. This uncontrolled level of turbidity can play a deadly effect on recreation and tourism notably decreasing the aesthetic quality of water sources. It can significantly increase the cost of water treatment for drinking and food processing. Turbidity is harmful for fish and other aquatic life which reduces the food supplies, degrades the spawning beds, and affects the gill function. Fine particles can have a detrimental impact on freshwater fish. Turbidity acts directly on fish, kills them or reduces their growth rate, resistance to disease. It prevents the successful development of fish eggs and larvae. Turbidity changes the natural movements and migrations of aquatic life. It also decreases the amount of food availability which affects the efficiency of methods for fish catching.

The highest level of BOD showed during tide-2, 11.30(mg/l) and pond water which was 1km away from the beach. The value of BOD of these two mentioned samples are beyond the standard limit. Therefore, a low level of BOD indicates good quality of water and high level of BOD indicates the contaminated water. When sewage with high level of BOD is discharged into water bodies, it accelerates bacterial growth in the water source and reduces the oxygen levels in the water source. The level of oxygen may decline which is lethal for most fish and many aquatic life.

Table 2. Physiochemical Parameters of Collected Water Samples from Different Sources

Collected sample	pH	Salinity (PPT)	Alkalinity (mg/l)	Hardness (mg/l)	EC (µs/cm)	Turbidity (NTU)	BOD (mg/l)	DO (mg/l)
Sea Water (Tide-1)	7.13	1.10	130	231	2237	2624	0.66	7.62
Sea Water (Tide-2)	7.01	1.25	199	330	2474	2160	11.30	4.90
Tube well water(After ½ km of the beach)	7.40	0.17	148	109	395	3.92	1.49	5.97
Tube well water (After 1 km of the beach)	6.91	0.36	270	444	778	2.26	1.61	7.63
Pond water(After ½ km of the beach)	7.25	0.47	290	348	1000.89	8.35	1.62	3.94
Pond water(After 1km of the beach)	7.34	0.12	119	79	287	12.30	9.84	3.89

The standard limit of DO in brackish water for Bangladesh is 4.5-8 mg/L and the water sample indicated the values of DO in tide-1 and tide-2 are 7.62 mg/l and 4.90mg/l respectively[6]. DO from tube well water sample indicated the results 5.97 mg/l and 7.63 mg/l. Sample from pond water showed DO 3.94 mg/l and 3.89 mg/l. The maximum value for DO standardized by WHO and BSTI is 4-6 mg/l and 6mg/l respectively. So most of the values are within the permissible limit.

3.2. Effect of Heavy Metals on Biodiversity

Ships are not properly cleaned before beaching. Most of the time an eyewash test is carried out to certify that a ship is free from hazardous chemical and fumes. Ship breaking activities is a danger to both the ocean environment along with the public health. In many parts of ships such as in paints, coatings, anodes and electrical equipment heavy metals are found. These pollutants are taken apart without any protective measures in place and reused. Regarding this problem, presence of heavy metal was measured in the collected water sample. The result has shown in the Table 3.

Table 3. Measured Heavy Metals of Collected Water Samples from Different Sources

Sample	Pb (mg/l)	Cr (mg/l)	Cd (mg/l)	Fe (mg/l)
Sea Water (Tide-1)	0.07018	0.031950	0.004910	0.857
Sea Water (Tide-2)	0.06123	0.032220	0.002640	0.176
Tube well water (After ½ km of the beach)	0.00161	0.000340	0.022950	1.670
Tube well water (After 1 km of the beach)	0.00689	0.000153	0.001850	0.136
Pond water (After ½ km of the beach)	0.0198	0.000654	0.001751	0.220

Pb is present in high concentration in the sample of tide-1 water about 0.070180(mg/L) but the presence of Pb in other sources in a permissible range. Though Lead is considered one of the most hazardous and cumulative environmental pollutants that affect all biological systems through exposure to air, water, and food sources [9]. Lead is a poisonous element which affects the different body systems and is dangerous to young children. Lead in the body is spread to the main organs like brain, liver, kidney, and bones. Lead takes time to accumulate and stored in the teeth and bones. The amount of lead accumulation in human body is usually measured the level of lead in blood. Lead in bone is released into blood during pregnancy which becomes a source of dispense the threat of lead to the developing fetus. Actually there is no safe level of lead exposure is found yet.

The value of Cr in different samples are 0.031950 (mg/l), 0.032220 (mg/l), 0.000340(mg/l), 0.000153(mg/l), 0.000654 (mg/l), 0.000073(mg/l) in different collected samples. The permitted limit for WHO and BSTI is 0.05(mg/l).Here all of the samples are within the standard rate.

Presence of Cd in different samples ranged from 0.001751 (mg/l) to 0.022950 (mg/l). On the other hand, the presence of Fe ranges from 0.176(mg/l) to 1.670(mg/l) in different samples which are within in standard limit.

4. Conclusion

Except Turbidity and BOD from tide-2 sample, tested physicochemical parameters like pH, Salinity, EC, DO of water samples of ship breaking yard area and the other sources were within the acceptable limit. Again sample water from all of the sources showed the acceptable range of heavy metal except the water collected from the ship breaking yard during Tide-1 which showed the elevated range of presence of Pb.

In Bangladesh, shipbreaking industry cannot be stopped considering the positive role of ship breaking in the national economy. Contrary to shipbreaking industry playing a detrimental role in biodiversity and environment which should not be overlooked.

To mitigate the negative consequences of the Shipbreaking and Recycling Industry, sustainable approaches should take in our Chattogram coastal area. Steps of some measures are recommended here as follows:

- A well-regulated master plan should be designed before starting a ship breaking yard.
- Government and NGO should implement efficient national and international policies for environmental safety; if needs they should work in collaboration.
- The marine environment should be kept undisturbed to maintain a healthy environment and biodiversity.
- Ship breaking activities should be carried out in a regulated and hygienic way.

Acknowledgements

The authors would like to thank to the Environmental Engineering Lab of Department of Civil Engineering, Bangladesh Military Academy, Bhatiary, Chattogram for their cordial support.

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