Assessment of Water Quality in Surface Water of Shipbreaking Sites at Kumira Ghat, Sitakunda, Bangladesh

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ABSTRACT

The Bay of Bengal ecosystem is blessed with vast resources. A major part of the people living nearby coastal areas depends on marine resources for their livelihood. These resources are facing risks due to pollution caused by shipbreaking activities. The present study was conducted to investigate the water quality adjacent to shipbreaking sites of Kumira Ghat, Sitakunda, Chittagong, Bangladesh and was carried out by field measurements of DO, pH, TDS, EC, temperature; BOD and heavy metals (Cd, Pb, Hg, Cu and Fe) in the laboratory while heavy metals followed by Atomic Absorption Spectrometry (AAS) methods of 5 water samples. The values of DO, pH, TDS, EC, BOD and temperature ranged from 7.16 to 7.43 mg/l, 8.02 to 8.04, >10000 mg/l, 5752 to 6745 µS/cm, 1.4 to 2.76 mg/l, 26.87 to 27.6 ºC, respectively. The values of Temperature, pH and BOD were within the standard limit but TDS and EC values were exceeding the standard level given by WHO for surface water. According to the study, the water was contaminated with Cd (0.003 to 0.007 mg/l), Pb (0.01 mg/l), Hg (<0.001), Cu (<0.1 mg/l) and Fe (25.2 to 53.6 mg/l). The amount of Fe crossed the standard level for surface water (0.1-1.0 mg/l) given by WHO. Finally, it was found that water was alkaline based on pH range. The ionization capacity of the water was very high because of high TDS and EC values. Positive correlations were found among pH and Temperature, BOD and Temperature, BOD and pH, Fe and EC and negative correlations were found among EC and Temperature, EC and BOD, Fe and Temperature and Fe and BOD.

Keywords: water quality, shipbreaking, physicochemical parameter, heavy metal, sitakunda area

ABSTRAK

Ekosistem Teluk Benggala diberkati dengan sumber daya yang melimpah. Sebagian besar masyarakat yang tinggal di sekitar wilayah pesisir bergantung pada sumber daya laut untuk mata pencaharian mereka. Sumber daya ini menghadapi risiko akibat pencemaran yang disebabkan oleh aktivitas kerusakan kapal. Penelitian ini dilakukan untuk menyelidiki kualitas air yang berdekatan dengan lokasi pemecah kapal di Kumira Ghat, Sitakunda, Chittagong, Bangladesh dan dilakukan dengan pengukuran lapangan DO, pH, TDS, EC, suhu; BOD dan logam berat (Cd, Pb, Hg, Cu dan Fe) di laboratorium sedangkan logam berat dilanjutkan dengan metode Spektrometri Serapan Atom (SSA) sebanyak 5 sampel air. Nilai DO, pH, TDS, EC, BOD dan suhu berkisar antara 7,16 hingga 7,43 mg / l, 8,02 hingga 8,04, >10000 mg/l, 5752 hingga 6745 µS / cm, 1,4 hingga 2,76 mg / l, 26,87 hingga 27,6 ºC, masing-masing. Nilai Temperatur, pH dan BOD berada dalam batas standar tetapi nilai TDS dan EC melebihi standar yang diberikan WHO untuk air permukaan. Menurut penelitian, air terkontaminasi dengan Cd (0,003 sampai 0,007 mg / l), Pb (0,01 mg / l), Hg (<0,001), Cu (<0,1 mg / l) dan Fe (25,2 sampai 53,6 mg / l). Jumlah Fe melebihi standar air permukaan (0,1-1,0 mg / l) yang diberikan oleh WHO. Akhirnya,
ditemukan bahwa air bersifat basa berdasarkan kisaran pH. Kapasitas ionisasi air sangat tinggi karena nilai TDS dan EC yang tinggi. Korelasi positif ditemukan antara pH dan Temperatur, BOD dan Temperatur, BOD dan pH, Fe dan EC dan korelasi negatif ditemukan antara EC dan Temperatur, EC dan BOD, Fe dan Temperatur dan Fe dan BOD.

Kata Kunci: kualitas air, kerusakan kapal, parameter fisika-kimia, logam berat, sitakunda

INTRODUCTION

During ship breaking activity different types of heavy metal entering into the surface water and fishes through water flow. Heavy metal also accumulated by human body through food chain. As a result heavy metal can affect the physiological state of human body. Ship breaking is the process of breakdown an obsolete vessel’s structure for scrapping which includes a wide range of activities, from removing all equipments cutting down the ship’s infrastructure (OSHA, 2001). Since 1984, Bangladesh has developed one of the largest ship breaking industries in the world (Kutub et al, 2017). For fulfilling its national demands for steel and iron Bangladesh relies on ship scrapping (Hossain et al, 2008).

Ship breaking is a challenging process, due to the structural complication of ships and the many environmental, safety, and health injuries involved (OSHA, 2001). About 50,000 people have involved directly and all over 200,000 people relies on scrapping activities including the indirect employment created by re-fabrication, recycling and distribution (Hossain et al, 2008). At present there are 24 ship breaking yards in Sitakunda region and the area is enlarged from over 14 km along Fauzdarhat to Kumira coast (YPSA, 2005). Each year 60-65 ships are either being damaged or used for the dismantling process (SHED, 2002).

The main pollutants from ship breaking were heavy metals, petroleum hydrocarbons and other contaminants. Among all these pollutants, petroleum hydrocarbons and heavy metals were the most important because of their toxicity and persistence (Hasan et al, 2013). There are some fundamental heavy metals, such as Fe, Zn, and Cu required for both aquatic organisms and the human body. But they have prolonged exposure to the excess level of these metals could be toxic. On the hostile, there are some nonessential toxic metals such as As, Cd and Pb with no known potential benefits for a human being (Wei et al, 2014). The area is severely fallen down with loss of its physical, chemical and biological characteristics. The removal processes required, generate debris and wastes that itself represent harmful to the environment and consequently to human health (Muhibullah, 2013).

The shipping industry has a probably negative impact on the marine environment and some economic disadvantages. But there is no appropriate integrated system for the recycling or reusing of ship- related materials. At the time of ship recycling process different type of heavy metal discharge into marine water body like Cd, Pb, Hg, Ni, Fe, Co, Zn, etc and also Asbestos. These heavy metals deprave marine water bodies and also marine habitats (Chang et al, 2010). As Sitakunda area has the largest number of ship breaking yards in Bangladesh, water pollution problem is getting very alarming here. So, the study aimed to investigate the water quality parameters and heavy metal concentration in surface water adjacent to ship breaking yard at Kumira ghat, Sitakunda, Chittagong, Bangladesh.

MATERIALS AND METHOD

Location of The Study Area
The water samples of the Ship breaking yard was collected from Kumira Ghat, Sitakunda Upazila in Chittagong district located at the south eastern part of Bangladesh where most of

the Ship breaking and Ship recycling Industries are located. The study area (Fig. 1) is 10 km away from the Chittagong city located between the latitudes 22.48078ºN and longitudes 91.70726ºE. Location of the sampling points were Point-1 (Latitudes: 22.30266ºN and Longitudes: 91.41238ºE), Point-2 (Latitudes: 22.302041ºN and Longitudes: 91.41276ºE), Point-3 (Latitudes: 22.301088ºN and Longitudes: 91.413520ºE), Point-4 (Latitudes: 22.30239ºN and Longitudes: 91.413923ºE) and Point-5 (Latitudes: 22.295284ºN and Longitudes: 91.414484ºE). Total distance of the study area is approximately 750 m.

Water Sampling
To analyze water quality a 1000 ml of water was collected by plastic bottles with double stoppers from each sampling station. Before sampling, the bottles were cleaned and washed with a detergent solution and treated with 5% HNO₃ overnight. The bottles were finally rinsed with deionized water and dried. After sampling, the bottles were screwed carefully and marked with the respective identification number. Temperature, DO, pH, EC and TDS were measured at the collection spots for all water samples. BOD was measured at the laboratory of Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University and heavy metals were analyzed at Institute of National Analytical Research and Service (INARS), BCSIR Laboratories, Dhaka.

Sample Analysis
The Dissolved Oxygen (DO) value of the water samples were measured by using a digital DO meter (Lutron, DO-5509), BOD measured by Winkler’s Iodometric Method, EC values were determined by using digital EC meter (HM Digital), TDS value measured by using TDS meter (HM Digital) and Temperature by using digital thermometer.

Figure 1. Map of the study area (Sitakunda, Chittagong, Bangladesh)

To analyze heavy metals at first 100 mL water sample was taken in a beaker by using a calibrated pipette. Then 4-5 mL concentrated HNO₃ was added in it and the beaker was put on the hot-plate for digestion. After proper digestion, the sample was taken in a 100 mL volumetric flask and it was filled with distilled water up to the mark. Then it was filtered with
a filter paper (Whatman Qualitative 1) and preserved in a container. Pb, Cd concentrations of
water samples were analyzed by using Zeeman Atomic Absorption Spectrometer (Model:
Varian, AA 240Z and Method: APHA 3111.B), Hg concentration determined by using Cold
Vapor Hydride Generation Atomic Absorption Spectrometer (Model: Varian, AA 220FS and
Method: APHA 3112.B), Cu concentrations measured by using Flame Atomic Absorption
Spectrometer (Model: Varian, AA 240FS and Method: APHA 2340.C) and Fe concentrations of
water samples were analyzed by using Flame Atomic Absorption Spectrometer (Model:

RESULTS AND DISCUSSION

Physicochemical Parameters

**DO**
Dissolved oxygen (DO) refers to oxygen gas that is dissolved in water. Atmospheric air and
photosynthetic planktons are the origins of DO in water (Kane et al, 2015). In present study the
average value of DO was 7.28 mg/l (Fig. 2). The highest value 7.43 mg/l was found at point-5
and the lowest value 7.17 mg/l was found at point-4. DO values of all sampling points were
higher than the standard value (4-6 mg/l) given by WHO, 1993 because of the presence of a
large amount of metallic wastes and decreasing decomposition activities by a microorganism.

**BOD**
Biological oxygen demand (BOD) is a chemical process for the ascertaining of DO required by
aerobic organisms in a water body to break disintegrate organic material present in a given
water sample at a certain temperature over an earmarked period time (Sawyer, 2003). In
present study the average value of BOD was 1.90 mg/l (Fig.3). The highest value was 2.77
mg/l found at point-1 and lowest value was 1.4 mg/l found at point-4 and 5. All BOD values
were within the average water quality standard (5 mg/l) given by WHO, 1993 (WHO, 1993)
for surface water due to increasing inorganic wastes and metallic wastes day by day in the
ship breaking area.

**pH**
pH is the negative logarithm of the hydrogen ion concentration of a solution and it is thus a
measure of whether the liquid is acid or alkaline. The pH scale ranged from 0 (very acidic) to
14 (very alkaline). In the present study the average value of pH was 8.03 (Fig.4). The highest
value was 8.04 found at point-1 and lowest value was 8.02 found at point-5. In the study pH
values were within the WHO (1993) standard value (6 - 8.5). In this study pH increased due to
photosynthetic activity is reduced. Due to shipbreaking activities photosynthetic activities was
reduced and had a serious impact on aquatic organism lifecycle (Patil et al, 2012).

**EC**
Electrical Conductivity is the amount of electric current and total sum of dissolved ions in
water body Hud et al, 2005). In present study average value of EC was 6391.20 μS/cm (Fig. 5).
The highest value was 6745 μS/cm found at point-4 and lowest value was 5752 μS/cm found
at point-1. All the values were higher than the permissible limit for surface water (3000
μS/cm) given by WHO (1993). EC positively correlated with transparency, salinity, TDS; negatively correlated with air temperature, DO, BOD and water temperature (Talukder et al.,
2016). When EC increased in water in a shipbreaking yard , the water was very hard and cause
different health hazard.

**Temperature**
Water temperature plays a significant role in affecting physical, chemical, and biological
processes in water bodies. Increasing water temperature solubility rate of gases in water
decreased the respiration rate of aquatic organisms as a result consumption of oxygen increases the rate of decomposition (Chapman and WHO, 1996). In the present study average value of temperature was 27.1 °C (Fig. 6). The highest value was 27.6°C found at point-1 and lowest value was 26.8°C found at point-5. All temperature values of the present study (DoE, 2001) were within the DoE (2001) standard value (30.5 °C).
TDS
TDS is the very significant chemical parameter of water. TDS mainly indicate the presence of various kinds of minerals like ammonia, nitrite, nitrate, phosphate, alkalis, some acids, sulfates and metallic ions etc. which are comprised both colloidal and dissolved solids in water (Rahman et al, 2012). The enhanced TDS could indicate the presence of salts due to wastes (Irshad et al, 2011). The TDS value of the samples collected from all points were higher than the machine’s (HM digital) detection limit, i.e. 10,000 mg/l which exceeds the standard value (500 mg/l) given by EPA (EPA, 2001) and WHO (WHO, 1993). In ship breaking areas various refuse and disposable materials are discharged and spilled from scraped ships and often get mixed with the water and higher TDS value shows deterioration of the physiochemical properties of seawater within the ship breaking area (Hossain et al., 2006).

Heavy Metals
Different heavy metals discharge during shipbreaking activities. In the present study, the order of concentration of heavy metals was found Fe>Cd>Pb>Cu>Hg in the water. The observed Cu values in all water samples were less than the water quality standard 1 mg/l (WHO) for surface water. According to the study, Fe concentration ranged from 25.2 to 53.6 mg/l and highest value was found at point-4 and lowest value was found at point-1 (Table 1). Cd concentration ranged from 0.003 to 0.007 mg/l (Table 1). The highest value of Cd was found at point-3 and lowest value was found at point-1, point-2, point-4 and point-5. Pb concentration at all sampling points were 0.001 mg/l (Table 1). Cu concentration at all
sampling points was < 0.1 mg/l and Hg concentration was <0.001 mg/l at all sampling points (Table 1).

Table 1. Heavy metal concentrations of water samples in ship breaking site, Kumira Ghat, Sitakunda.

<table>
<thead>
<tr>
<th>Sampling Points</th>
<th>SI No.</th>
<th>Heavy Metal Concentrations (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pb</td>
</tr>
<tr>
<td>Point-1</td>
<td>0.01</td>
<td>0.003</td>
</tr>
<tr>
<td>Point-2</td>
<td>0.01</td>
<td>0.003</td>
</tr>
<tr>
<td>Point-3</td>
<td>0.01</td>
<td>0.007</td>
</tr>
<tr>
<td>Point-4</td>
<td>0.01</td>
<td>0.003</td>
</tr>
<tr>
<td>Point-5</td>
<td>0.01</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Permissible limit for surface water (WHO, 1993; EPA, 2001)

<table>
<thead>
<tr>
<th></th>
<th>Pb</th>
<th>Cd</th>
<th>Fe</th>
<th>Hg</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.05</td>
<td>0.005</td>
<td>0.1-1</td>
<td>0.002</td>
<td>1</td>
</tr>
</tbody>
</table>

**Correlation**

Pearson’s correlation analysis was done among the water quality parameters. Positive correlations were found among pH and Temperature; BOD and Temperature; BOD and pH; and Fe and EC. Also negative correlations were found among EC and Temperature; EC and BOD; Fe and Temperature; and Fe and BOD (Table 3).

Table 3. Correlations among water quality parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Temperature</th>
<th>DO</th>
<th>pH</th>
<th>BOD</th>
<th>EC</th>
<th>Fe</th>
</tr>
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<tbody>
<tr>
<td>Temperature</td>
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<td></td>
</tr>
<tr>
<td>DO</td>
<td>-.411</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>pH</td>
<td>.896*</td>
<td>-.652</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOD</td>
<td>.981**</td>
<td>-.308</td>
<td>.881*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td>-.911*</td>
<td>.176</td>
<td>-.689</td>
<td>-.932*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>-.974**</td>
<td>.221</td>
<td>-.839</td>
<td>-.977**</td>
<td>.893*</td>
<td>1</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

**CONCLUSION**

The surface water quality of ship breaking area in Kumira Ghat, Sitakunda, Bangladesh is not satisfactory compared to the typical coastal areas where there is no ship breaking yards. The EC and TDS were much higher than the standard level indicating high pollution of water. The concentration of Fe exceeded the standard level. Finally, it could be said that, if the ship breaking industry is to spread in the country it could damage the water quality of the coastal area of Bangladesh. So it is needed to ensure the minimization of pollution through effective measures against environmental and health hazards inherent in the process of ship breaking. Future research work could be done to find out the effects of ship breaking yards on air, health and marine animals.
REFERENCES


