An Assessment of Ship Breaking Yard and Lead Generation on the Coastal Zone of Chittagong, Bangladesh

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ABSTRACT

Ship breaking Industry is one of the most economically important and growing industries in the coastal regions of Bangladesh. Bangladesh is the 3rd leading Ship breaking industry in the world. However, ship breaking yards generate solid, gaseous and liquid toxic substances. Among them lead (Pb), which is one of the heavy metal pollutants, has harmful effects over both environment and human health. Lead (Pb) generation is increasing since the numbers of dismantled ships are rising. The objective of this paper is to assess the ship breaking yard in Sitakunda, discussing its present situation and probable future in terms of the number of dismantled ships, and also assessing lead (Pb) concentrations in the ship breaking areas. The study has been carried out using the secondary data obtained from a good number of scholarly journals. It is found that Ship breaking is expected to grow exponentially and with this growth, lead (Pb) generation is also expected to increase

Keywords: ship breaking, lead (Pb) generation, growth of ship breaking, Chittagong.

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1 INTRODUCTION

Ship breaking industry is one of the most economically important and growing industries in the coastal regions of Bangladesh that have a lot of environmental drawbacks. Coastal environment is highly dynamic and ecologically diverse accompanying critical terrestrial and aquatic habitats such as, mangrove forests, seasonally and permanently inundated wetlands and tidal flats. People utilize significant amount of environmental goods and services from this coastal system [1],[17]. These enriched ecosystems are extremely at risk due to environmental impacts and human intrusion [1]. Ship breaking is one of the examples of human intrusion which has been causing much environmental degradation. Adaptations to artificial conditions make organisms' life susceptible while organisms are naturally adaptable to natural changes such as tide and storms. Considering the benefits of the ecosystem and services, and for sustainable ecosystem management, coastal ecosystem needs to be harness in a systematic and coordinated way [1].

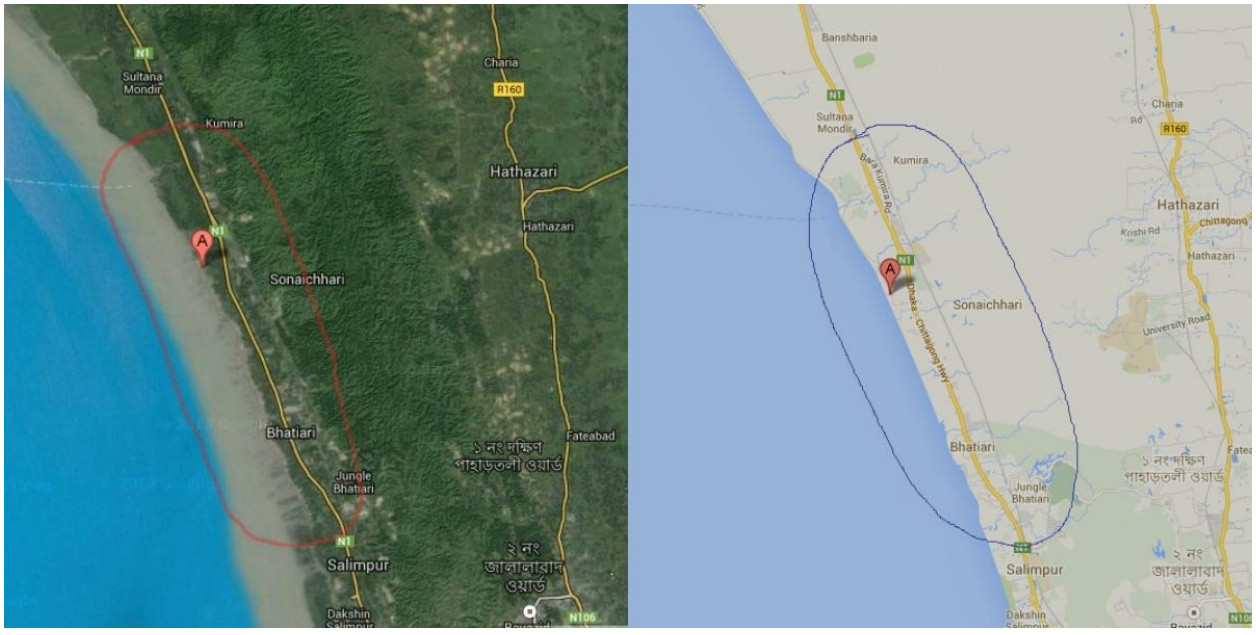
Ship breaking is a process of dismantling out-of-service ships in order to recycle the scrap metals and Bangladesh is the leader in breaking down of large ships [2]. At present, Bangladesh holds the third position among all the ship breaking countries. It breaks mainly large toxic ships like tankers, cargo ships, and container ships [10]. This industry is beneficial and green from a life-cycle assessment point of view since every part of the scrap metals and items are being recycled [18]. But, the problem arises because of the pollution on the marine ecosystem and beach exploitation. Most of the ships brought back to Bangladesh are the toxic, outdated ships age around 20-30 years[18] Generally, a ship consists of approximately 95% steel and 5% hazardous materials [10]. These 5% harmful wastes include oil sludge, toxic paints, halons in foam and firefighting equipment (ozone depleting substances), fuel residues, heavy metals (arsenic, cadmium, chromium, lead, mercury), organotins or biocides, persistent organic pollutants (dioxins, PVCs, PAHs), and radioactive substances [10]. Lead (Pb) is one of the pollutants, which may exhibit extreme toxicity even at low levels under certain conditions [4]. Lead is harmful for environment since lead cannot be naturally broken, but it can convert into other forms. It can remain same in the soil for 2000 years [15],[20]. The report aims to assess the ship breaking yard in Sitakunda, discussing its present situation and probable future in terms of the number of dismantled ships, and also assessing lead (Pb) concentration in the ship breaking area.

Intensive study is needed to observe different kinds of pollutants since data varies depending upon seasonal variance, number of dismantled ships and timing. The study reports history of ship breaking, dismantling procedure, sources of pollutants, and number of dismantled ships to find out the industry's growth besides assessing lead (Pb) concentration in the ship breaking yard. This report is based on a good number of secondary data sources (internet and publications).

2 STUDY AREA: BACKGROUND TO THE SITAKUNDA SHIP BREAKING YARD

This industry is situated in the Fauzdarhat beach, Sitakunda (Bhatiary to Barwalia) (Fig-2.1) covering 16 km area near the coastline of the Bay of Bengal, approximately 20-km south-west of Chittagong [7]. The geographical location of the ship scrapping zone is between latitude $22^{o}252$ and $22^{o}282$ N, and longitude $91^{o}422$ and $91^{o}452$ E [3]. This area was used to be a mangrove forest, but since the starting of this industry form 1969 it had been exploited and still being exploited [7].

Figure 2.1: Area of Ship Breaking Industry, Bangladesh [11]



3 HISTORY & PRESENT STATUS OF SHIP BREAKING YARD

Ship breaking industry started in Bangladesh during 1960s. The first commercial scrapped ship was ‘AL Abbas’ in 1974, which was damaged by bombing in liberation war, 1971. Later, this industry flourished in 1980s [12].There were about 84 ship breaking yards in Sitakunda [2], but YPSA had reported that more than 100 industries were involved in this business [1]. According to Bangladesh Ship Breakers Association there were about 179 proprietors in this industry (2011). Surprisingly, this industry is not yet recognized as a true industry with its individual and judicious protocols , but many macro and micro organizations have grown up based on this ship breaking [1],[12]. There were about 40 active scrap yards in Chittagong and estimated number of workers were 22000 [18]. The extensions of this industry are supply chain, shops, and re-rolling mills which have also involved over 5,00,000 people in this industry [18]. Consequently, Bangladesh government earns 7000 million taka each year from this industry. Apart from this economic importance, this industry also provides 90% of the iron materials since Bangladesh does not have any ore source for iron [2]. This implies that for iron, Bangladesh depends on this industry and saves a huge amount of revenue.

This rising ship breaking industry was almost shut down in 2010 because of High Court declaration. In 2009, UN had planted trees which had been cut down illegally for making new ship breaking yards [21]. Bangladesh Environmental Lawyer Association (BELA) filed a petition against ship breaking yard; High Court directed Department of Environment (DoE) to monitor the environmental clearance of the ship breaking yards. None of 36 ship breaking yards had not environmental clearance which almost made the industry to shut down [9]. The clearance order included that the ships need to be decontaminated at source before import and the companies need to install proper facilities to handle the broken metals and hazardous materials [5]. However, the court cancelled the banning and ship breaking resumed its pace [8], [21]. Even after that, the mangrove forest was still being exploited since thousands of trees were being chopped down to start new ship breaking yards at the end of 2012 [6]. From the Landsat imagery it has been observed that coastal area had grown from 308.7% from 367 ha in 1989 to 1,133 ha in 2010 (Fig 3.1) [1].

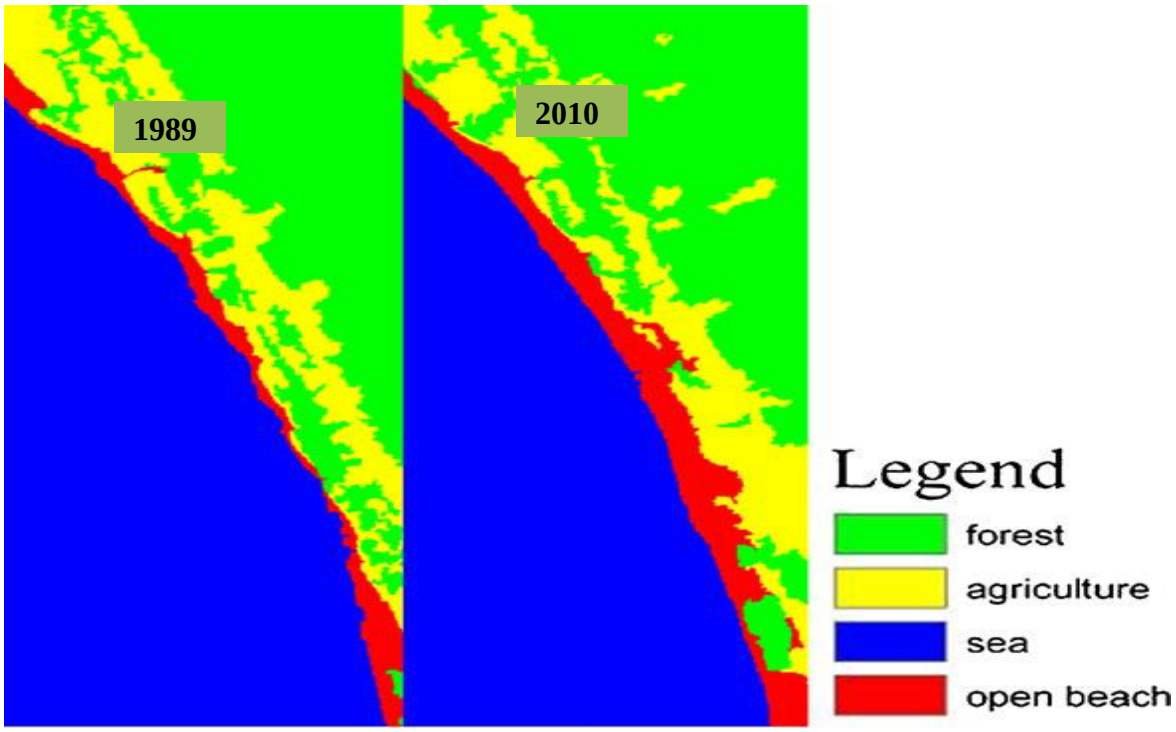


Figure 3.1: Land use map of Sitakunda ship breaking area in 1989 and 2010 Landsat TM imagery [1]

This figure indicates forest area has been decreased and open beach area has been increased. For ship breaking and agriculture purpose the shore line is being exploited.

Ship breaking did not start in a day and it was thought that ship breaking was a mechanized process [21]; during and after World War II, industrialized nations like United States (US), Japan, and the United Kingdom (UK) used to scrap ships [10]. In reality, during 1960s and 1970s USA and UK wanted to get rid of this ship breaking industry due to the new environmental protection standards and labor safety rules [2],[23]. Then the industry started to shift in Asian region because of these countries cheap labor cost, steel market, deprived labor rights, and poor environmental regulations [12]. Like other developing countries, Bangladesh grabbed at this lucrative market and now is a part of the Asian regions that lead this market.

The geographic position, the temperate climate, high tide, favorable beach conditions, and cheap and easy route made Chittagong a suitable place for the ship breaking [10]0,8[8]. Bangladesh was the top ship recycling nation from 2004 to 2009. Bangladesh held second position in 2012, scrapping around 270 ships. In 2013, Bangladesh became the third largest ship breaking nation in the world after dismantling 210 ships [21].

4 SHIP BREAKING AND POLLUTANTS

4.1 Processes involved in Ship Dismantling

Man power is the main work force for the operations in ship breaking. In a ship dismantling process, the required tools are a large winch, some blowtorches and a bulldozer [21]. Generally, beaching method is followed for ship dismantling since large tidal difference exposes intertidal zone for longer period of time and beaching method is easy and inexpensive [7]. The timeline for a Very Large Crude Carrier (VLCC) demolition is 5-6 months [7].

A long procedure takes place for the dismantling of a ship. Firstly, the ship is brought in to the international water away from Chittagong without the help of cargo. Then, checking procedure is followed for government's clearance and next formalities. Later, the ship is inspected and gas is made free to enter into the territorial water for dismantling. During low tide, beaching method starts on the ashore water and the ship is winched to cut into pieces. After this primary cutting, secondary cutting starts where big steel parts are cutting into small parts and in the mean time the extractable materials are moved away [12][23]. After all the procedures, the scrap metals and materials are ready for selling. This fig-4.1 shows the flow process that involves in a ship breaking [16].

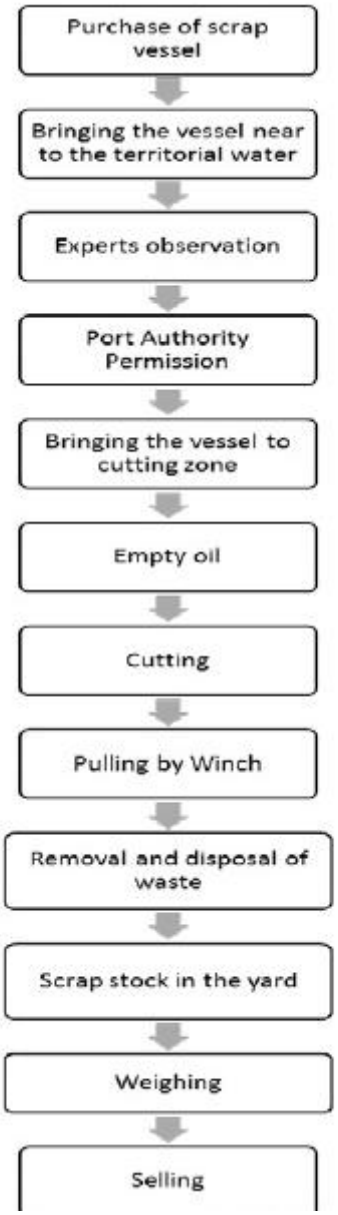


Figure 4.1: Flow Process in a Ship Breaking Yard [16]

4.2 Sources of pollutants in ship breaking yard

Ship breaking yard generated solid, liquid and gaseous pollutants which come from different sources. But, paints, coatings, anodes and electrical equipments are the main source of heavy metals [12].

Table 4.1: Sources of pollutants in ship breaking yard

Pollutants	Materials containing pollutant
Asbestos	Hanger lines, mastic under insulation, cloth over insulation, cable lagging and insulation on pipes and hull, adhesive
Polychlorinated biphenyls	Rubber products such as hoses, plastic foam insulation, cables, silver paint and habitability paint
Lead and Lead Compounds	Lead and chromate paint, hammering, metal cutting and other activities, Connectors, couplings, bearings, batteries, paint coatings, cable insulation, lead ballast, generators, and motor components
Excess noise	With grinding, hammering, metal cutting and other activities
Fire	Ignited insulation, matting, lagging, an residual fuel; and from lubricants and other flammable liquids
Others	Heavy metal in ship transducers, ballast and paint coatings; mercury in florescent light tubes, thermometers, electrical switches, light fittings and fire detectors

Data Extracted from [1], [12]

5 ASSESSMENT OF FUTURE PROJECTION OF SHIP BREAKING & LEAD

5.1 Future projection of ship breaking industry

The data has been collected and put in a graph to find the probable number in future. This graph displays data collection from 1981 to 2013 and shows that on average there is an increase in number of dismantled ships each year. The growth rate is exponential, so average numbers of dismantled ships in 5 years of logarithmic values have been taken. From the graph, the R^2 value indicates 94% data can be explained through this graph and there is a strong co relationship between the average number of dismantled ships and year. The trend line has been extended till 2020. The trend line indicates that the probable number of dismantled ships will be 257 in 2020. Since the ship breaking industry was in a halt in 2009, so the value became lower. Otherwise, the expected number of ship dismantling number would have been much higher than 257. At

present, the average numbers of dismantled ships are about 193, but Bangladesh had scrapped 270 ships in 2012 and 210 ships in 2013. The recent years' data implies that the projection should be higher than 257 in 2020.

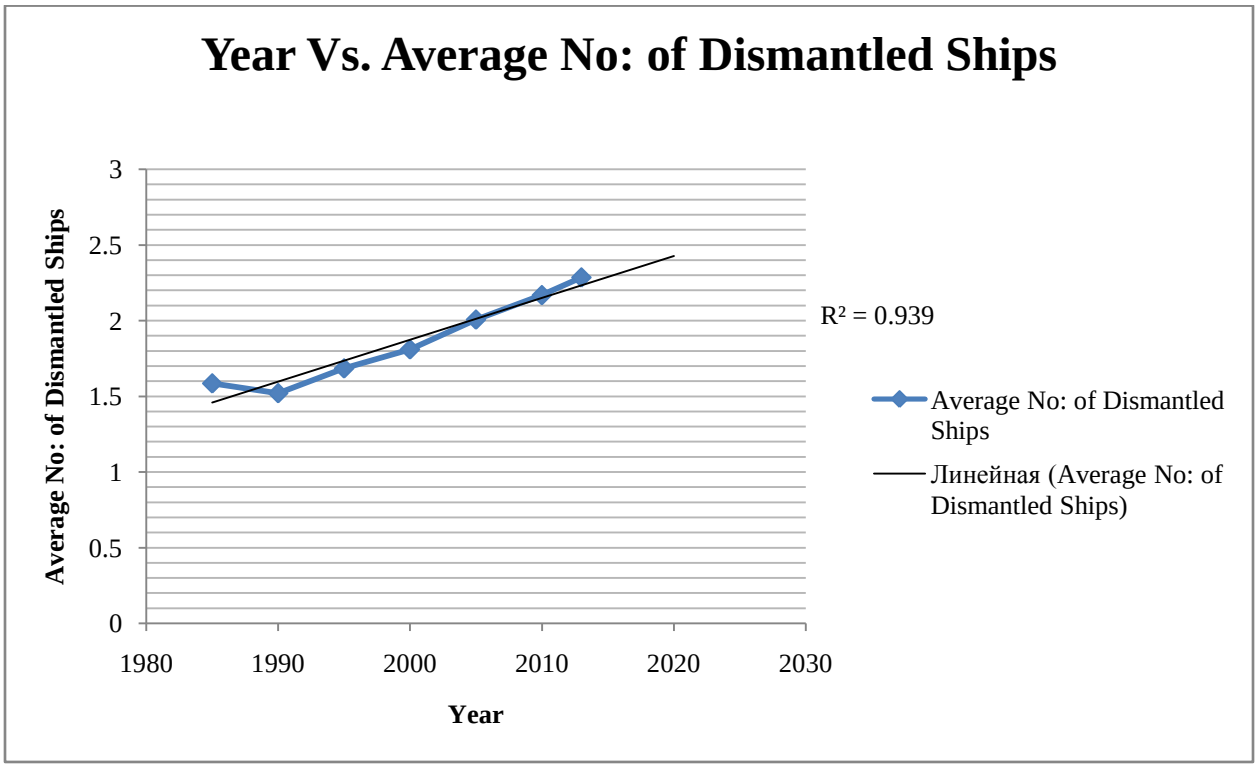


Figure 5.1: Year Vs. Average No: of Dismantled Ships

Source: Data Extracted from [21] [22]

The graph-5.2 is about the percentage of ship breaking of Bangladesh in the whole world from 1985 to 2010. This graph shows a zigzag pattern of ship breaking growth. From 2005 to 2008, a sharp rise was observed as Bangladesh broke 53% and 50% of total ships in the world respectively [13]. Bangladesh leaded the industry well until 2008, but in 2009 and 2010 the number of ship breaking reduced drastically. In these years, Bangladesh had dismantled only 15% and 9% of the total percentage of the ships respectively. The reasons behind the drop in this industry were public awareness through media coverage, high court orders, global economic recessions and rise in transportation cost [1] [13].

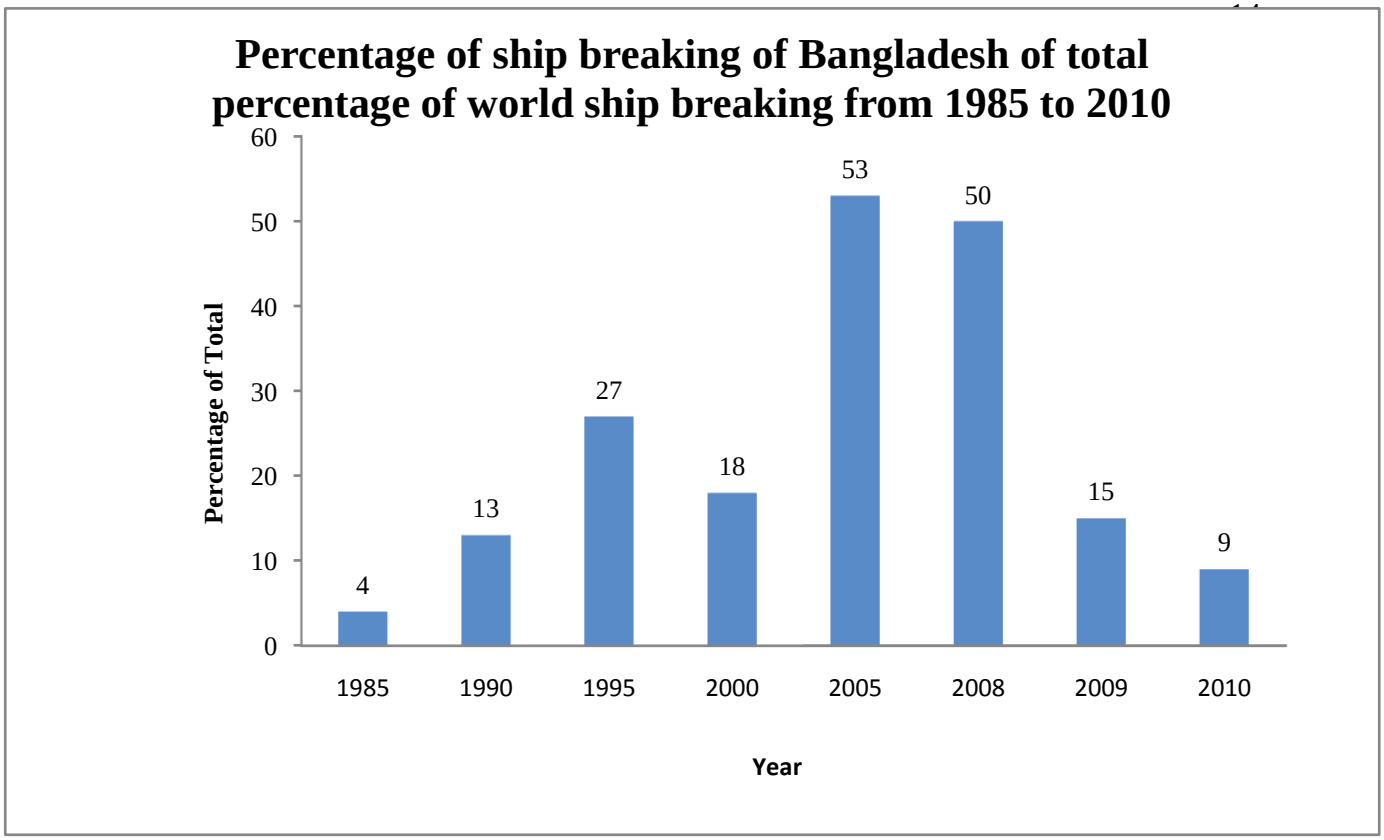


Figure 5.2: Percentage of total world ship breaking in Bangladesh from 1985 to 2010 [13]

5.2 Assessing Lead in Sitakunda Ship Breaking Yards

The sea is a dynamic ecosystem since ship dismantling occurs in beach area, thus tidal zone, sub-tidal zone, deep sea gradually becomes host to the different kind of wastes. These wastes contain heavy metals, petroleum hydrocarbons, and bacterial contaminants [17]. Heavy metals and petroleum hydrocarbons' toxicity and tenacity make them the most serious pollutants among all [17]. Heavy metals can be accumulated by the marine invertebrates, associate with particulates, adsorp by the sediments. These all could be suspended or create soluble complex to lead bioaccumulation [17]. Generally, a ship, mass of 5000 ton to 40000 ton, is coated with 10 to 100 ton of paint containing heavy metal [13]. All the heavy metals concentration is above the background level in soil sample. Except Iron (Fe), metals like Copper (Cu), Lead (Pb) and Zinc (Zn)'s concentration are high in soil sample [12]. These heavy metals include lead (Pb), which may exhibit extreme toxicity even at low levels under certain conditions. The Fig-5.3 explains that in different level of concentration exposure the kind of biological effects [4].

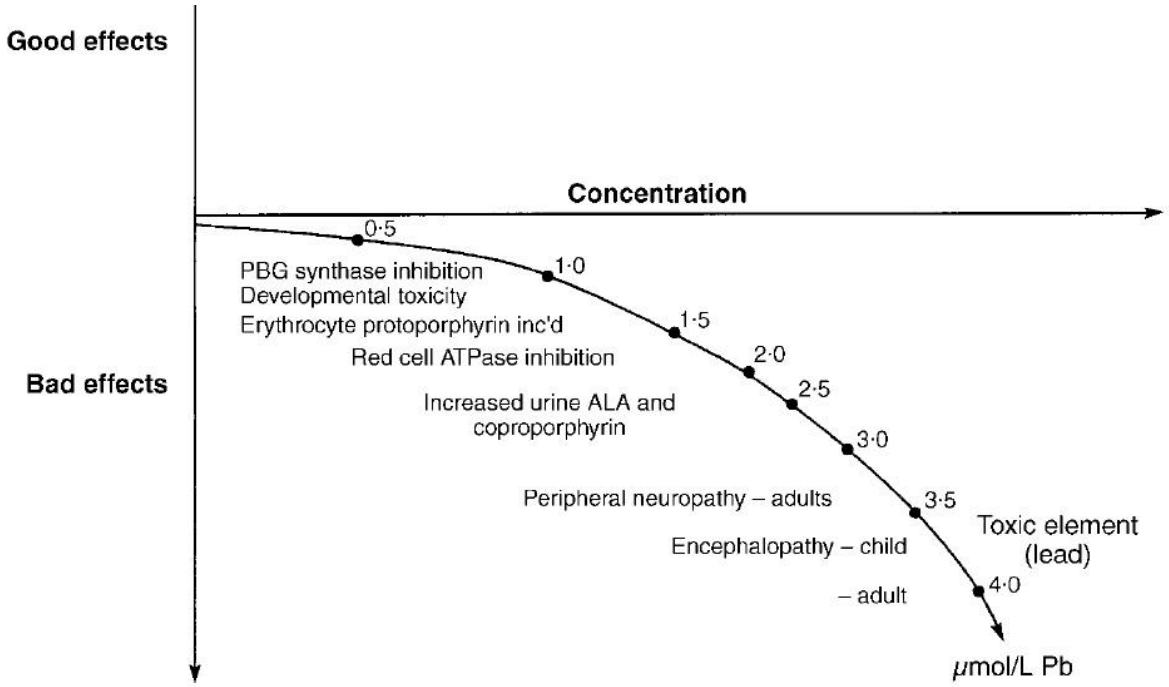


Figure 5.3: Biological Effects over Different Level of Concentration Exposure (modified) [4]

Based on the research of different scholarly journals, in different years the lead concentration data is collected. These journals have used different methods and units to find out the lead concentration, thus the standard value of lead varied upon the experiment. Overall, it is found that the lead concentration is always higher than the recommended value. In 1996, average lead (Pb) concentration in Karnafully river mouth sediment was 23.18 µg.g-1, where the back ground value was 19 µg.g-[1] or mg/kg [14][1]. In 2000, ship breaking area lead (Pb) concentration ranged from 4,232 mg/kg to 5,733 mg/kg, where the background value of Lead (Pb) was 144mg/kg on dry weigh basis [7]. In 2008, lead (Pb) concentration was 41.57 µg.g-1 [19]. Soil samples from thirty Ship-breaking yards were collected and analyzed during the period 2011-2012 and lead (Pb) concentration was found 0-137.05 mg/kg, where the standard value for sandy soil was 22 mg/kg [2]. Another study showed that the lead concentration for sediment was 55.93±18.70 mg/Kg, where the recommended value for soil is 40 mg/Kg, and for water was 0.134-0.904 mg/l [3].

[1] 1 µg.g-1= 1mg/kg

Table 5.1: Summary of the Observed Concentration of Lead in Sediment of the Ship Breaking Areas with Recommended Value

Year	Area	Concentration Observed	Recommended Value	Source
1996	Karnafuly River Mouth	23.18 µg.g-1	19 µg.g-1	[14]
2000	Yards	4,232 mg/kg to 5733 mg/kg (Dry Weight Basis)	144mg/kg	[7]
2008	Yards	41.57 µg.g-1	N/A	[19]
2012	Yards	0-137.05 mg/kg	22 mg/kg (Sandy Soil)	[2]
2013	Yards	55.93 mg/kg	40 mg/kg	[3]

N/A: Not Applicable

Lead (Pb) may enter into human body system, mainly in blood and bones, through ingestion and inhalation, causing brain and kidney damages [12]. In ship breaking yards, workers are not provided with minimal protection. They work with bare hands and feet, which makes them vulnerable to become victim of heavy metal exposure like lead toxicity. Moreover, lead is harmful for environment since lead cannot be naturally broken, but it can convert into other forms. It cannot be removed from water and soil by self-purification and it may accumulate in the continental shelf regions where high level of land derived activities happens [2]. Aquatic and soil organisms can accumulate lead in their bodies so they get affected by lead pollution. Moreover, phytoplankton body functions also get interrupted due to lead accumulation. These lead can also enter into the food chain since fishing activities also occur near this ship breaking industry [15]. Marine fisheries are at stake due to the heavy metal pollution since these metals can be accumulated in marine biota [19].

6 DISCUSSION

The trend line shows that ship dismantling is increasing exponentially. As a result of the International Maritime Organization's regulation, ship breaking will be dramatically raised in near future [10]. With the increasing number of ship dismantling lead (Pb) generation will be also increased. From the above data, present lead (Pb) generation in sediment is 55.93±18.70 mg/Kg and for water was 0.134-0.904 mg/l then by 2020 it will cross the EPA value which is 60 mg/kg and due to that it will be highly polluted. Several factors are involved in the variance of the lead concentration. Seasonal variation, time, type of experiment and selected standard values are the factors involved in lead (Pb) variation. Generally, the highest concentrations of heavy

metals are observed during winter and lowest in monsoon and summer [17]. However, due to the unavailable data of the time period and season of sediment and water collection coming up in a conclusion is hard. According to EPA guidelines, the sediment is moderately polluted, but if the value crosses 60 mg/kg then it will be highly polluted [3]. Overall, based on the Potential Ecological Risk Index, study shows that Sitakunda Ship breaking yard is moderately polluted by lead and poses low risk to the ecosystem [3].

7 CONCLUSION AND RECOMMENDATION

Since ship breaking is important and cannot be stopped as it is a great source of economy, iron and employment opportunities. Researchers and scholars need to work on a feasible and sustainable management of ship breaking where the ecosystem pollution through lead (Pb) will be mitigated and economic growth will be also balanced. Ship breaking growth is increasing in an exponential rate, so lead (Pb) generation is also increasing with time and it is already above the standard value. Since lead (Pb) is toxic to both human and environment, so further studies are required to observe the lead (Pb) polluted areas in Chittagong and finding out future projection of lead (Pb) generation. No primary data have been used for this study. The growth of ship breaking is estimated from the data sets available online. Due to lack of past data sets lead (Pb) concentration trend could not be observed. Following are some recommendations:

- An urge of sustainable-well planned designed dismantling procedure and ship breaking yard which ensure the development of the industry, environmental protection, high productivity, occupational health and safety [13]
- Hazardous materials need to be treated and disposed properly [7]
- Environmental and health damage can be reduced and ship breaking profit can be increased by recycling and reprocessing petrochemical products [13]
- Help from stakeholders, scientists and scholars is needed to find a cheaper and sustainable way to ship dismantle without harming the environment
- Department of Environment (DoE) needs to regulate the ship breaking industry strictly

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