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Changing Pattern of Heavy Metals Accumulation in and around in Ship breaking Area Over the 40 years and Its Impact on Fish Diversity in Adjacent Areas of Bangladesh

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Abstract:

Coastal area of Bangladesh is one of the significant ecologically productive areas and full of rich biodiversity that includes variety of species that are endemic to this region. The Shipbreaking activity has turned out to be more significant within the economic situation of the poverty-stricken Bangladesh. The study vicinity was alienated into the Shipbreaking zone and control site for proportional investigation. The study was administered to assess the changing pattern of the concentration of trace metals in soil Soil samples of the study areas and its impact on fish diversity of the ship breaking area in Bangladesh over the 40 years. From the finding of the study, it had been found that the concentration of the heavy metals found within the ship breaking area followed a pattern within the following fashion Fe>Pb>Cr>Mn>Zn>Ni>Cu>Cd>Hg. The finding of this heavy metal analysis of sediments demonstrated that there has been in an increment of two to eight times of selected heavy metals from the finding of 1980 to 2019. The study compared with the two relatively pristine or less impacted (undisturbed) areas, that served because of the reference zone. These studies also found that about 30 species of fishes became irregular or are threatened with extinction than they were 40 years ago.

Keywords: Ship breaking activity, Heavy metals, Coastal area, Fish species, Pollution, Aquatic habitat, Estuarine zone.

1.0. Introduction

Ship breaking is usually remarked because the entire or fractional assembling of the ships soon recover resources like steel and rubbish for reprocessing and reclaim. This includes an intensive level of challenging actions, starting with the elimination of all equipment's and device for cutting down and salvaging the structure of the ship. Ship breaking activities are detained accountable for the polluting of the surrounding environments and precious resources like steels along with wood products which are being recuperated for reclaim or recycling reasons [1-8]. Ship breaking may be a demanding procedure, thanks to the structural difficulty of ships and therefore the numerous ecological, safety and health related hazards concerned [9]. There are about 50,000 ships are operating in the seaSoil of the present world [10]. After 25-30 years of ship life, the value of re-investment to accumulate the credential is not any stretched lucrative and the consequences of this problem, around 700 ships are sold per year and among them at least one of the Asian ship breaking yards. Most of the ship breaking yards is now operating within the South Asian countries thanks to lower labor costs and fewer stringent environmental regulations, handling the disposal of lead paint and other toxic substances [4].

Bangladesh has appeared as a large actor in the global ship breaking recycling Industries due to contemptible costing of labor, enough Government support, elevated required for recovering equipments from the scrapping ships and above the lacking of severe environmental legistrative activities [8, 11]. Over the last 43 years, from 1976 to 2019, Bangladesh has assembled the extremely large amount of the scrapped ships in terms of coarse tonnage within the globe due to the country remains the foremost productive dumping field for end-of-life ships laden with toxicities [12]. There's large scale knowledge of the irreparable damage due to dirty and dangerous practices round the coastal tidal mudflats, yet benefit is that the only clincher for many the ship yard business man when selling their ships for breaking. From the different literature and documents, it is found that scrapping ship in the Bangladesh, increasing sharply among all other countries of the earth. In 2000, Bangladesh scrapped a total of 73 ships and which was 892, 756 MT and global share of the country is 10%, while in 2006 the ship scrapping increased 87 and global share of the country becomes 57% among all other countries. In 2019, Bangladesh scrapped 236 ships and which was 7.8 million MT and global contribution found 45% [8,9,13-16]. Ship breaking activities have generated thousands of straight and circuitous employment chances for the foremost marginalize community, who are in frantic requirement of an income generating activity in Bangladesh.

Table 1. Total Scrapping Ship in Bangladesh and global contribution for ship breaking

Year	Scrapping Ship	Amount of LDT (MT) handled	Global Contribution
2000	73	892,756	10
2001	152	1,909,055	28
2002	84	1,519,735	22
2003	88	1,088,338	14
2004	145	1,333,667	40
2005	94	840,927	45
2006	187	132,0170	57
2007	103	774,065	42
2008	172	1,660,212	49
2009	175	2,192,751	38
2010	107	1,296,831	35
2011	150	1,896,102	40
2012	230	3,456,380	33
2013	170	2,250,456	30
2014	172	2,110,120	22
2015	195	2,396,280	25
2016	222	6,240,100	33
2017	197	6,456,150	36

2018	185	2,396,077	36
2019	236	7,849,569	45

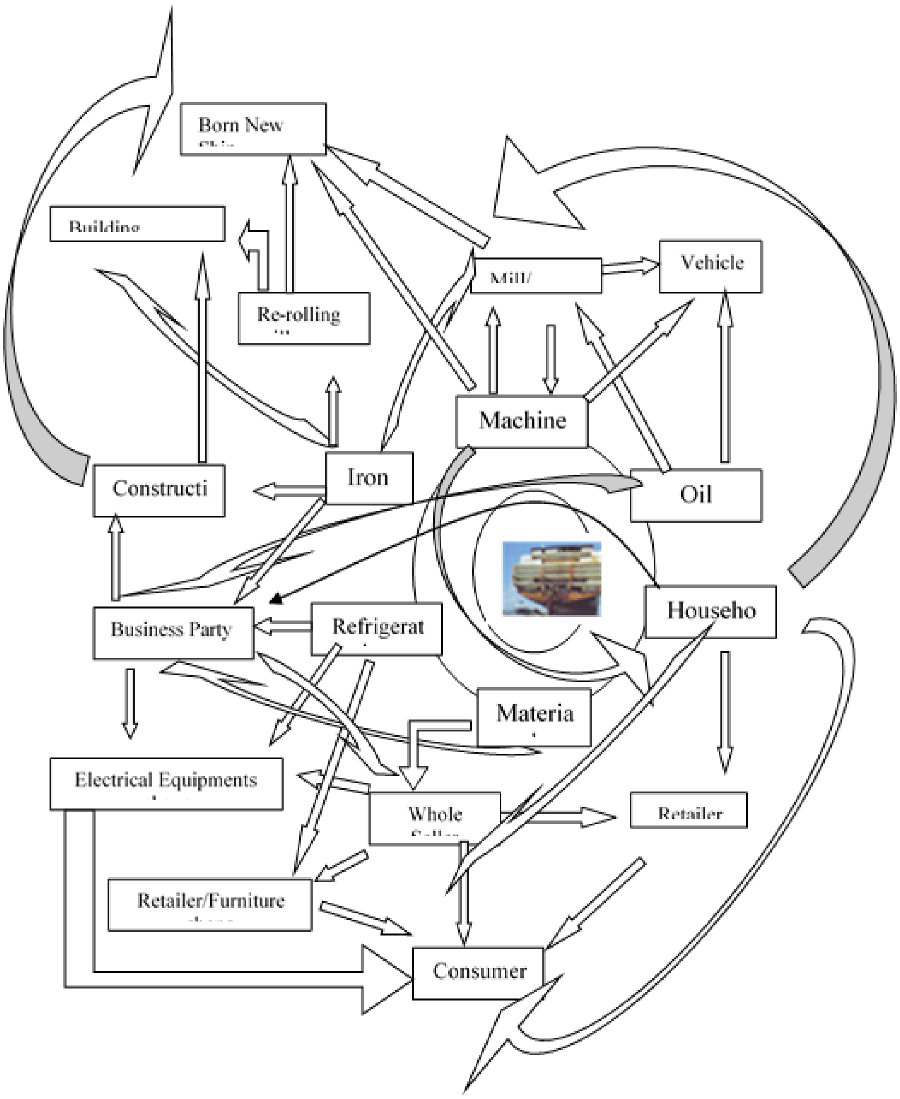

Figure 1. Distribution Channel of Scrapped items from ship breaking activity

Ship breaking industries supported for direct professional job opportunities for nearly 40,000 people and about 200,000 people are also involved with the various trades related to ship scrapping sectors of Bangladesh [17,18]. Ship breaking industry is the major causes for marine pollution in Bangladesh through the contamination of the coastal Soil along with sea Soil which subsequently impairs the ecological setup. Soil pollution becomes a main concern when the chemical concentration within the Soil is adequate to persuade of health risks, Soil contamination of aquatic systems from heavy metals has been a grave problem worldwide. In prospect of the economic significance of the coastal zones and therefore the significant impacts of metal contamination on the living organisms, present study was conducted to assess the changing patterns of the buildup of 9 heavy metals (Fe, Mn, Cr, Ni, Zn, Pb, Cu, Cd, Mg and Hg) within the core sediments Soil over the span of 40 years from the 1980 to 2019 and its influences on fish diversity in and around the ship breaking zone of Bangladesh.

2.0. Materials and Methods

2.1. Study area profile

The location of the ship breaking area of Bangladesh located in Sitakund Upazila (sub-districts) of Chittagong district. The eastern portion of this sub-district is hilly area, and the Bay of Bengal located on the western portion. The zone is situated approximately 20 km southwest of Chittagong city on the coast of the Bay of Bengal in Bangladesh. Geographical position of the ship breaking area located between the latitude $22^{0}25'$ and $22^{o}28'$N, and longitude $91^{o}42'$ and $91^{o}45'$E (Figure 2).

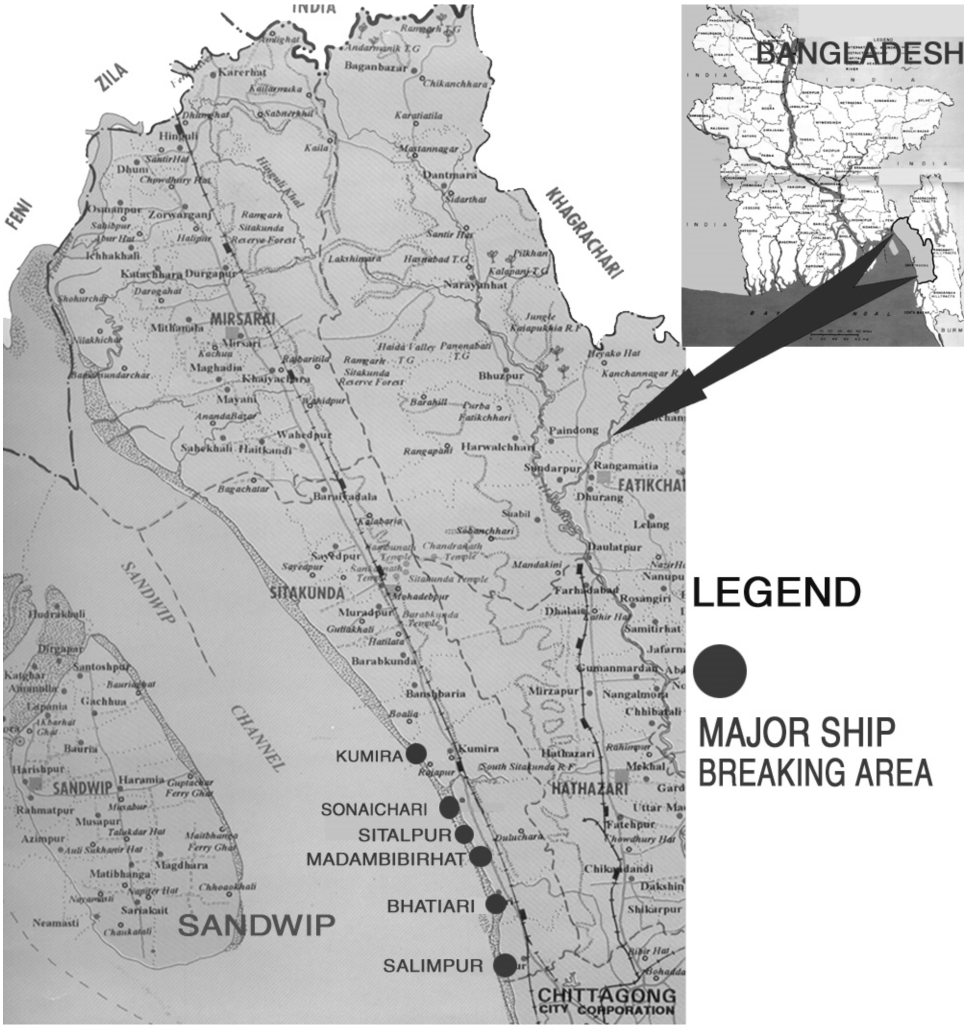

Figure 2. Map of Ship breaking area indicated black spot and Sandwip as the control area

For the collection of soils, Soil fish and fisherman communities; the whole ship breaking area was divided into six sampling stations, according to some characteristics such as on the basis of the importance of fishing, proximity to village, canals or ditches and density toward the ship breaking zone. Thus, the total investigated area was separated into (a) Ship breaking zone (St. 1, 2, 3, 4, 5 6) sites in and around ship breaking activities) & (b) Reference Site (St.7), which is far away from the ship breaking area) for comparative analysis (Table 2). Sandwip island which is located eastern site of the Sitakund and surrounding by Bay of Bengal has been selected as the control site (St. 7) because these are diagonally opposite and off the Ship Breaking Yards and the Soil and Soil qualities are apparently fresh from pollutants as revealed from the earlier studies.

Table 2. Geographical location of the study areas

Station No.	Station Name	Location
1	Sonaichari	lat. 91^0 65" E and long. 22^0 56" N
2	Sitalpur	lat. 91^0 68" E and long. 22^0 52" N
3	Madambibirhat	lat. 91^0 70" E and long. 22^0 49" N
4	Bhatiari	lat. 91^0 73" E and long. 22^0 44" N
5	Salimpur	lat. 91^0 73" E and long. 22^0 44" N
6	Kumira	Lat 91^0 41″E and 22^0 84″ N
7	Sandwip	Lat $91^0$42//E and $22^0$29//N

2.2. Sample Collection and Preparation

Soil Soilsamples from inter-tidal zone were collected throughout the year 2019 during the high tide from the six sampling stations namely Salimpur, Fauzdarhat , Sonaichari, Kumira, Madambibirhat, Sitalpur and Sandwip island . All the samples were collected during pre-monsoon season , monsoon season and post monsoon season. At each study areas, samples were collected by using Ekman Grab Sampler in airtight polythene bags from three different depths, viz., 0–10, 10–20, and 20–30 cm depth of the surface layer of soilsSoil in three zones—(a) beaching zone (which is the high tide area near the shore until where seaSoil reaches during high tide and the ships which are to be dismantled cannot be brought any nearer to the shore than this area), (b) intermediate processing or cutting zone (this is the area where dismantled portions of a ship from the beaching zone are brought and cut into more smaller usable sizes), and (c) storage zone (where different portions and items of the dismantled ships are stored before selling) with two replicate samples at each point.

Collected soilSoil samples were then dried in the open air and followed by sieved to remove stones and organic fractions and prepared into a composite for each of the Soilsoil sampling location through the taking of equal amount from harmonized samples for three depths, Then the soilSoil samples were digested by addition of Hydrochloric acid (HCL), Nitric acid (HNO_3), Sulfuric acid (H_2SO_4) and Perchloeic ($HClO_4$) acid into the experimental instruments.

The standard solution of the elements of heavy metals Fe, Cu, Hg, Zn, Pb, Cr, Cd, Ni and Mn were made through pipetting the necessary quantity of the appropriate solution from the stock solution, made by the Fisher-Scientific Company, New Jersey, USA. The standard solution was made before every analysis assessment of the present study and after that 100 g from every soil Soilsamples were filled into the laboratory jar and sealed into the room temperature before sample being immediately handover to the laboratory representative of BCSIR (Bangladesh Council of Scientific and Industrial Research) laboratories, Chittagong, Bangladesh. Then collected soil Soil samples were investigated by the AAS (Model: is 3300, Thermo Scientific, designed in UK, Made in China) applying the standard analytical procedure (Table 3).

Table 3. Spectral lines used in emission measurements and the instrumental detection limits for the elements measured by using AAS

Elements	Wavelength (nm)	Instrumental detection limit (mg/l)
Fe	248.3	0.0043
Pb	217.0	0.013
Cr	357.9	0.0054
Co	240.7	0.01
Cd	228.8	0.0028
Mn	279.5	0.0016
Ni	232.0	0.008
Zn	213.9	0.0033
Cu	324.8	0.0045
Al	309.3	0.028

Collected soilSoilsamples were cautiously griped and during the sample handing, clean powder free latex gloves and lab coats were used for the mitigation of contamination risk. Experimental Glassware was correctly washed by the Chromic acid solution and the distilled Soil. Analytical marks, chemicals and reagents were applied throughout the research study. Blank determinations were applied to obtain the accurate machinery readings. The samples were weighed correctly through an appropriate amount (10–20 g) in a tarred silica dish. After that the Soil samples were put in dry into the laboratory oven with the temperature of 120°C. These Soil sample dishes were then kept up in the muffle furnace at ambient temperature and gradually increased the temperature to 450 °C at a rate of 50 °C/h. The soilSoil samples were catching light into the Muffle furnace at 450 °C for at least 8 hours. The authors take precaution for avoiding losses by volatilization of the collected elements. After sometimes, cooled samples were removed from the furnace. Then collected samples were assimilated in the desired amount of 50% HNO_3 on a hot plate. After that the Soilsoil samples were filtrated into a 100 ml volumetric flask applying Whatman No. 44 filter paper and washed the residue samples. All the preparation moment of each sample solution was prepared up to the mark with distilled soil Soilsamples.

The collection method, preservation process and heavy metals analysis of Soilsoil sample did not change since 1980. The authors review the finding of different studies related toheavy metals concentration in sedimentsSoil around ship breaking area of Chittagong coastal area from 1980 to 2015 at the archives of the Institute of Marine Sciences and Fisheries and Institute of Forestry and Environmental Science, University of Chittagong, Bangladesh. The authors then assess the changing pattern of heavy metals in sedimentsSoilof ship breaking and non-ship breaking zone between the present study finding and values of earlier 40 years (1980-2019) record on selected parameters. The long-term trends are interpreted as signals of climate change and their possible implications to the fisheries biodiversity are briefly outlined in this first-order analysis. A detailed analysis will be the focus of a forthcoming study. Status of fish diversity of the 25 km adjacent area of shipbreaking area known as Chittagong coastal area were collected by the application of Rapid Participatory Rural Appraisal (RRA/PRA) technique. PRA methodology was used by applying observation, questionnaire and worker level semi-structured interviews with different groups following [19,20]. Participatory appraisal involved a series of qualitative multidisciplinary approaches to learn about local-level conditions and local fishermen perspectives. A total of 200 questionnaire surveys, personal interview of 250 fishermen and 20 semi-structured interviews were conducted in the 10 fishermen villages with fish landing being the center of the study area for the purpose of primary data collection.

In order to identify the abundance of fish diversity in the study area, collected samples were taken and analysis was carried out three times for catch composition representing pre-monsoon ,monsoon and post monsoon seasons for the catch composition from the Estuarine Set Bag Net (ESBN). Identifications of species were carried out on the physical feature of the collected specimens. Catch Per Unit Effort (CPUE) was referred to as the "catch per boat per day in kg". This was expressed by the following formulae

$$\text{CPUE} = \frac{\text{Total fish landed (mt)} \times 1000\text{ kg}}{\text{Total boat landed}}$$

The average total catch weight of each boat was found out by the following formulae.
Average catch weight of each boat = Average catch weight of the each basket ×Average number of basket in each boat.
Total catch of the landing center = Average catch of boat × Total number of boat.

3.0. Results and Discussion

The Soilontamination because of heavy metals is a worldwide environmental concern nowadays, and it is attracting much more important attention with rapid industrialization. SoilSoil analysis plays an important role in the assessment of metal contamination in the aquatic environment [21-23]. Iron (Fe) is the most important transition metal in all living organisms and most widely used metals, accounting for over 90% of the worldwide metal production. It is common that primary sources of the Fe are land, runoff and waste disposal and industrial releases into the environment [8]. Fe coming from ship breaking settles down in the mud in shallow Soils. There it consumes dissolved Soil and thus depletes the oxygen of the Soil so important to all aquatic life.

Concentration of Fe was found highest level in Madambibirhat and Sitalpur area that are most prominent place of ship breaking and lowest in the control site Sandwip in all the experiments over the 40 years. Quantitatively, the Fe concentrations have risen by 3.82 to 6.55 times over the 40 years in the ship breaking zone and 1.08 to 3.17 times higher levels than the standard range of Fe concentration 27000 $\mu g.g^{-1}$. On the other hand, level of Fe recorded in the control area Sandwip island was risen by 3.20 times during 1980-2019 but the concentration of Fe was found as 4,200 C which was 0.142 times lower than the standard concentration (Table 4).

Fe has been habitually used as a hint / indicator of the usual changes in the heavy metals carrying capacity of the aquatic Soil and its concentartion found connected to the abundance of trace metal hasty compounds not considerably pretentious through the men action. This finding of Fe level is very similar compared to the finding in the Karnaphuli river Soils and Chittagong coast of the Bay of Bengal, respectively [24, 25]. The authors found that Mn concentration was raised by 2.10 to 4. 56 times in the ship breaking area and in control area this rate of increase found 2.87 between 1980-2019. On the other hand, during the present study Mn level was found 2.77 times to 8.63 times higher than the standard range of Mn concentration 1.17 μg.g^{-1} in shipbreaking area which was proposed by IAEA The authors assess the increasing trend of Mn level in the control area to 1.96 times higher than the standard range of Mn level in Soils (Table 4). During the result of the present study, the value of Ni increased 4.54 to 9.17 times in the affected sites whereas 8.8 times increased at Sandwip over the 40 years (Table-4). Comparatively Ni level in a study area of ship breaking zone found higher range 1.05 to 1.37 times than standard level. On the other hand, Ni level found 0.19 times lower in the control area than IAEA proposed standard level of Ni in soilsamples.

Cu is closely related to the aerobic dilapidation of organic matter in the Soils nearby aquatic environment [16]. This metal is an indispensable trace metals for the mechanism of animal metabolism while during the high levels of this metal should be very toxic substance in the aquatic environment and biodiversity. The major basis of Cu availability in the coastal environment are antifouling paints and this trace metal come into the Soil body during the time of industrial discharge containing $CuSO_4$ applied in the metal plating and fishing activities [26]. IAEA sets up the standard range of Cu level in soil sample was 33 μg.g^{-1} . The authors found that Cu level in the study areas during the present analysis time were 49.45 μg.g^{-1} to 90. 45 μg.g^{-1} which provide that the Cu level increased 4.65 to 6.7 times higher compared to the result of soil analysis in the ship breaking area during 1980 to 2019. All the range of Cu level increased 1.50 to 2.74 times higher compare to the standard level of 33.00 μg.g-1 (Table 4). Although Cu level in soils of control area increased 5 times over the years, but still the concentration of Cu level is below than the standard range of IAEA. This result of Cu levels found in the collected soil is s recorded as higher than the finding of Ashraful for the soils of the Chittagong coast [25].

Cr allocation in the ship breaking area was very multifaceted in the nature. The level of Cr did not pursue any usual pattern of the distribution in the study areas. Concentration of Cr were varied from 85.40-109.40 μg.g^{-1} in the ship breaking zones where 28.45 μg.g^{-1} in the control site. But the recommended value of Cr is 77.2 μg.g^{-1} . It was also found that Cr concentration has been raised up 4.52 to 5.90 times over the last 40 years and rate of increased compare to the standard level were 1.11 -1.42 times but less range in the control area (Table 4).

The authors found the Pb concentration in the soil sample of the ship breaking zone from 65.45 μg.g^{-1} to 196.90 μg.g^{-1} and for the Sandwip island this range was 16.45 μg.g^{-1} proved that Pb concentration of affected areas were found 2.99 to 3.70 times higher range than recommendation level 22.8 μg.g^{-1}. Although the range of this trace metal was raised by 2.84 times over the 40 years where the level of this metal found lower than the standard range in the control area (Table 4). Cadmium is one of the most toxic metals considered in this research [27]. The present level of Cd concentration in the study area becomes much upper compared to the recommended level of trace metals in Soil and increased 7.5 to 12 times within 40 years in the ship breaking zone (Table 4). On the other hand, Cd level increased 9 times higher over the periods in the control zone, but still found in a lower range than standard level of Cd concentration in the control area. The higher concentration might be ascribed to the collective impacts through oil and oil spillage, petroleum hydrocarbons from the ships, tankers. Mechanized boats etc.

The concentration of Zn was found higher range in all the study area adjacent to ship breaking area than compared level of IAEA,. Zn concentration in the soil samples increases 3.80 to 4.56 times higher over the 40 years in the ship breaking area and this result indicated higher range compare to the standard level (Table 4). This also found that Zn concentration in control area increased 4.21 times over the study periods but the range of this metal found low level than standard value of Zn in soil. A group researchers' study of coastal pollution on ship breaking area of Bangladesh [2,8, 28, 29]. They all stated that Fe, Cd. Zn, Mn, Ni, Pb, Cr and Cu level in soils of ship breaking area found higher range in soils samples than standard value that recommended [30].

Table 4. Concentration of heavy metals in the shipbreaking zone and control area over the 40 years

Station	**1980**	**1985**	**1990**	**1995**	**2000**	**2004**	**2007**	**2010**	**2015**	2019	Standard concentration of selected metal in soils (IAEA, 1990)	Times of Increases over the 40 years	Comparative result than standard level
Concentration of Fe**(μg/g)**											27,000		
Station-1	12456	15,854	18,850	21,500	22,552	30,450	41361	45565.8	52,456.9	57,560		4.21	+1.94
Station-2	20,520	28,450	35,450	48,040	50,657	55,870	64,895	70,900	85,556.6	94,590		4.17	+3.17
Station-3	18,980	26,408	31,870	45,350	49,450	54,875	60,580	64,560	72,654	80,760		3.82	+2.69
Station-4	10, 390	12765	15800	18,210	20,445	25,654	35,216	37,654	44,345	50,879		4.27	+1.64
Station-5	4,456	7,980	10,650	12,120	15,450	18,650	22,932	25,564	29,213	35,890		6.55	+1.08
Station-6	6,450	8,390	10,654	13,500	15,800	19,800	20,971	22,450	35,653	40,240		5.52	+1.32
Station-7	1,200	1,487	2,010	2587	2,765	3,265	3,393	3,545	3,845	4,200		3.20	-0.142
Concentration of **Mn(μg/g)**													
Station-1	2.40	2.80	3.40	3.90	4.65	6.05	6.89	7.90	8.25	8.90	1.17	3.43	7. 05
Station-2	3.80	4.20	4.90	5.90	6.50	7.10	8.25	9.50	9.89	10.25		2.6	8.45
Station-3	4.80	5.90	6.00	7.09	8.16	9.00	9.80	10.02	10.10	10.80		2.108	8.63
Station-4	2.00	2.90	3.80	4.90	5.40	7.00	8.25	8.50	9.12	11.23		4.56	7.79
Station-5	1.00	1.20	1.75	1.90	2.10	2.50	2.64	3.50	3.95	4.30		3.95	3.37
Station-6	0.90	1.10	1.01	1.50	1.90	2.00	2.32	2.90	3.25	4.26		3.61	2.77
Station-7	0.8	0.9	1.0	1.20	1.30	1.50	1.8	2.0	2.3	2.8		2.87	1.96

Station	**1980**	**1985**	**1990**	**1995**	**2000**	**2004**	**2007**	**2010**	**2015**	2019	Standard concentration of selected metal in soils (IAEA, 1990)	Times of Increases over the 40 years	Comparative result than standard level
Concentration of **Ni (µg/g)**													
Station-1	12.9	15.9	20.7	35.8	40.9	45.8	48.96	55.90	60.65	68.50	56.1	5.31	1.22
Station-2	14.8	20.8	28.9	35.8	48.8	52.8	55.8	60.8	65.60	70.45		4.76	1.26
Station-3	16.9	22.9	34.7	50.8	55.5	58.5	60.9	64.5	68.32	76.80		4.54	1.37
Station-4	8.5	14.9	21.8	24.8	30.6	32.8	35.12	58.5	62.43	67.45		7.93	1.20
Station-5	6.8	10.9	15.9	20.8	28.1	35.7	45.12	50.7	55.98	60.55		8.90	1.08
Station-6	6.4	11.6	14.8	16.8	22.7	28.6	35.36	40.65	48.45	58.69		9.17	1.05
Station-7	1.2	1.7	1.9	2.1	2.5	3.2	3.98	5.8	8.5	10.56		8.8	-0.19
Concentration of Cu **(µg/g)**													
Station-1	8.66	10.9	15.9	20.71	25.33	28	30.67	36.77	40.90	50.90	33.0	5.88	1.54
Station-2	12.55	15	20	31.9	38.9	42.7	46.9	51.55	59.56	66.70		5.31	2.02
Station-3	16.8	20.77	28.9	38.07	45.75	50	52.8	73.50	80.65	90.45		5.38	2.74
Station-4	12.66	15.19	22	28.9	30.55	35.1	39.85	45.22	50.55	58.90		4.65	1.78
Station-5	7.8	10	13.76	15.7	17.8	20.9	21.05	35.66	42.45	50.45		6.47	1.53
Station-6	9.15	13	16.87	19.08	22.76	27.65	28.01	34.88	40.34	49.45		5.40	1.50
Station-7	0.8	0.9	1.2	1.5	1.8	1.9	2.05	2.5	3.0	4.0		5	-0.12
Concentration of Cr **(µg/g)**													
Station-1	19.90	33.80	39.80	54.80	70.70	75.90	78.36	85.70	92.33	96.70	77.2	4.86	1.25
Station-2	22.00	34.90	40.60	56.50	72.90	92.80	90.50	96.60	99.30	100.15		4.55	1.29
Station-3	22.80	35.70	40.80	55.00	70.80	88.80	95.60	98.70	102.35	109.40		4.80	1.42
Station-4	20.90	30.80	35.70	50.80	65.90	79.00	86.72	90.50	98.43	105.40		5.04	1.36
Station-5	18.90	25.90	30.60	45.80	50.40	60.60	68.35	70.90	79.00	85.40		4.52	1.11
Station-6	15.34	20.80	28.00	35.90	50.80	60.80	69.89	75.50	85.34	90.40		5.90	1.17
Station-7	4.75	5.00	5.90	7.80	10.70	15.80	19.00	22.40	23.45	28.45		5.99	-0.37
Concentration of **Pb (µg/g**													
Station-1	45.7	66	89.8	100.8	130.9	140.5	147.83	152.9	160.44	165.34		3.62	7.25
Station-2	58.8	75.9	98.79	120.8	142.9	150.8	160.4	168.60	172.33	175.89	22.8	2.99	7.71
Station-3	65.5	84.9	110.85	135.9	150.8	160.8	175.65	185	190.44	196.90		3.00	8.63
Station-4	40.66	48.9	58.5	78.76	92.89	100.9	122.03	135.9	145.50	150.45		3.70	6.60
Station-5	20.2	22.9	25	28.8	30.5	35.8	36.78	50.50	60.66	65.45		3.24	2.87
Station-6	22.5	25.6	29.8	32.7	35.9	40.5	41.57	59.45	65.90	70.23		3.12	3.08
Station-7	5.8	6	6.2	7	7.3	7.5	8.82	12.54	15.44	16.45		2.84	-0.72
Concentration of **Cd (µg/g)**													
Station-1	0.19	0.25	0.39	0.59	0.6	0.8	0.94	1	1.45	1.70	0.19	8.95	8.94
Station-2	0.4	0.5	0.61	0.79	0.8	1	1.2	1.5	1.9	2.2		5.5	11.58
Station-3	0.4	0.6	0.7	0.85	0.9	1.1	1.5	1.6	2.0	2.8		7.0	14.74
Station-4	0.15	0.25	0.39	0.50	0.75	0.79	0.83	0.9	1.2	1.7		11.33	8.94
Station-5	0.20	0.25	0.30	0.38	0.40	0.48	0.57	0.60	1.20	1.50		7.5	7.90
Station-6	0.10	0.25	0.30	0.38	0.45	0.50	0.59	0.65	0.7	1.2		12.0	6.31
Station-7	0.02	0.03	0.05	0.07	0.09	0.1	0.13	0.16	0.17	0.18		9.0	-0.94
Concentration of **Zn (µg/g)**													
Station-1	38.75	56.9	80	95.65	110.6	128.8	142.85	150.2	158.90	165.20	95	4.26	1.74
Station-2	42.89	65.5	84.9	100.3	120.65	130.3	148.9	162	170.56	175.67		4.09	1.85
Station-3	50.7	75.4	90.8	110.2	128.7	148.8	165.5	185.4	195.90	199.34		3.93	2.10
Station-4	35.8	45.7	58.8	75.8	85.8	100.8	102.05	115.5	125.90	135.86		3.80	1.43
Station-5	25.79	30.2	50.7	69.8	75.8	80.65	83.78	99.8	110.50	117.54		4.56	1.24
Station-6	32.8	39.9	59.7	78.9	85.77	115.8	119.86	125.8	130.89	138.20		4.21	1.45
Station-7	7.1	10.2	15.3	18.1	19.9	21.8	22.22	24.8	26.90	29.90		4.21	-0.31

3.1. Heavy Metals toxicity Impact on fish species diversity

Coastal environment of Bangladesh is extremely active and ecologically assorted with serious terrestrial and aquatic environment such as mangrove swamps, coastal wetland and tidal flats. These resourceful coastal ecosystems presently existing at jeopardy because of environmental effects and people disturbance. DoF stated that the fish diversity of marine and freshSoil species of the aquatic environment of Bangladesh, reducing gradually because of over the last two decades and the harvesting of fish diversity declined 40% contrast to the last 20 years. This is also finding that principal causing of fish reduction from the aquatic environment are the amplified pressure of fishing and habitat devastation due to coastal pollution [29].

Various research findings indicated that the metal concentration in the estuarine soil comparatively superior because of swift hastening of the industrial sector. Metal contamination found higher accumulated in the fish rather than the accumulation of soil and samples. Oil pollution is accountable for deterioration of aquatic environment because of the adverse influence's aquatic biodiversity. Industrialization is desirable for the economic development of the country, but this significantly required to introduce eco-friendly for the effectual and sustainable development and protection of the aquatic environment. The poisonous chemical pollutants like Hg, Pb, Cd, COD and DO were recorded in higher concentration rather than the EQS value which is hazardous for whole aquatic ecosystem and public health in the coastal area of Bangladesh. extreme release of Nitrogen, Sulphur and Phosphorus compounds in the aquatic environment could responsible for creating eutrophication problem in the coastal environment [31-33].

Aquatic pollution, soil erosion, siltation, declination of wetland and biodiversity as well as right management problem are the feasible causes for the reduction of the fishery resources [34]. The fishery resources in the coastal area of Chittagong seem to be affected by the ship breaking activities as revealed by increased fishing efforts, reduced catch per unit effort (CPUE) per boat/day, reduced species diversity and increased amount of trash fish destruction and collection of fish fry. There are 10 fisheries landing center in Chittagong coastal area and the Department of Marine Fisheries Survey of Chittagong records data every month. From the study of 15 years data (2005-2019) it is found that only few out of 20 commercial species, are high in catch (*Harpadon nehereus*, *Acetes* sp. *Arius* sp. and *Coilia sp.*) dominated by *Harpodon nehereus* (35.40%) and *Acetes* sp. (10.56%) and the rest are negligible (Table 5).

Table 5. ESBN catch composition of commercial fish species (%) for the last 15 years. (2005-10) and (2011-2019) at the coastal area of Chittagong.

Sl. No.	Scientific Name of the species	English name	Local name	Year of Harvesting (Average)		
				2005-2010	2011-2015	2016-2019
1	*Harpodon nehereus*	Bombay duck	Loitya mach	40.56	35.40	32.30
2	*Acetes sp.*	Sergastid shrimp	Gura chingri	15.560	10.20	10.09
3	*Arius sp.*	Carfish	Kata mach	2.04	1.50	1.40
4	*Coilia sp.-1*	Anchoby	Alua mach	1.832	1.34	1.50
5	*Metapenaeus Monoceros*	Speckled/ Brawn shrimp	Harina chingri	3.282	2.90	2.40
6	*Trypauchen vagina*		Lal chewa	0.85	0.50	0.20
7	*Penaeus sp.*	Shrimp	Chingri (Bagda, Dorakata, White)	3.354	1.859	1.390
8	*Lepturacanthus savala*	Ribbon fish	Churi mach	3.50	2.80	2.00
9	*Johnius sp.*	Black jew fish	Kala poa	2.392	2.110	1.990
10	*Thryssa sp.*	Hairpin anchoby Hamilton's	Phasa/Phaisya	1.234	1.150	1.09
11	*Polynemus paradiseus*	Long thread tassel fish	Risshsha Topshe	0.245	0.14	0.12
12	*Sillago domina*	Lady fish	Hundra mach	0.324	0.250	0.190
13	*Tenualsola ilisha*	Hilsha shad	Ilish/ Jati ilish	0.232	0.10	0.20
14	*Mystus gulio*	Catfish	Guilda	0.124	0.**12**	0.09
15	*Pampus sp.*	Pomfret	Rupchanda	0.016	0.010	0.009
16	*Lates calcarifer*	Giant seaperch/ Seabass	Koral/Bhetki	1.450	0.96	0.25
17	*Mugil sp.*	Mullet	Bata	2.709	2.00	1.80
18	*Scomberomorus guttatus*	Spanish mackerel	Maitya	1.790	1.2	1.10
819	*Alepes djeddaba*	Djeddaba crevalle	Moori	0.450	0.230	0.160
20	*Argyrops spinier*	Longspine Sea Bream	Lal Datina	1.890	1.50	1.10

Source: Marine fisheries dept. Chittagong, December, 2019

This result coincides with the results of Deb and Siddiquee [29, 35]. Notably, in contrast of the last 10 years data of fish harvesting from the fishermen, species variety in Set Bag Net (SBN) catch recorded significantly declined and some species (30 species) which are not found in recent years in the coastal area of Chittagong according to the statement of fishermen and market survey. The present study also analyzed the Catch per Unit Effort (CPUE) of fish per boat/day from 15 years data (2005-2019) and both for SBN (Set Bag Net) and ESBN (Estuarine Set Bag Net) catch. The results show a significant decrease of CPUE per boat/day with many fold increase of boat from 2005-20119 (Table 6). Khan identified 51 species of fishes under 23 families were available in the river Karnaphuliwhich was declining trend of Bhuiyan and Gafur who found 74 fish species in Karnaphuli and Kamal observation of 70 fish species [32]. Khan indicated that due to coastal pollution and heavy metals increasing pattern in soils and soil body, fish species are declining in Karnaphuli river estuaries [36].

Table 6. The fish species, which are not found in SBN catches at Sitakund coastal area, Chittagong (Adjacent to ship breaking area) compare to the availability of 30 years ago

Sl. No.	Scientific name of fish species	Local name
1.	*Osteogenous staenocephalus*	Aspisoa katamach
2.	*Scolopsis vosmeri*	Nemipscol mach
3.	*Eleotris fusca*	Dora bailla
4.	*Uranoscopus guttatus*	Faton mach
5.	*Dendrophysa russelli*	Kala poa
6.	*Bahaba chaptis*	Chapti mach
7.	*Pomadasys opercularis*	Grunti mach
8.	*Polynemus sextarius*	Kala tailla
9.	*Gobuis sadanandio*	Nandi bailla
10.	*Gobuis melanosome*	Kalthu bailla
11.	*Sphyraena fosteri*	Khika mach
12.	*Sphyraena obtusata*	Khika mach

13.	*Carangoides melampygus*	Bungda muri
14.	*Saurida elongate*	Tiktiki mach
15.	*Pricanthus macracavthus*	Prica mach
16.	*Pricanthus tayenus*	Prica mach
17.	*Cynoglossus macrolepidotus*	Lamba kukurjib
18.	*Epinephelus lanceolatus*	Bole coral
19.	*Otolithoides brunneus*	Lombu fish
20.	*Cybium guttatuam*	Maitta
21.	*Coilia ramkorati*	Olua
22.	*Sphyraena forsteri*	Dharkuta
23.	*Escualosa thoracata*	Hichiri Machh
24.	*Scomberooides commersonianus*	Chapa Kori
25.	*Priacanthus tayenus*	Pari Machh
26.	*Polynemus paradiseus*	Hriska mach
27.	*Carangoides malabaricus*	Lahmuri mach
28.	*Anodontostoma chacunda*	Koiputi mach
29.	*Arius thalassinus*	Kata mach
30.	*Apocryptes serperaster*	Dora chau mach

3.2. Socio-Economic status of the fishermen communities

During the present survey pre-set questionnaire survey of 250 fishermen from different categories were done from 10 fishing villages. This is found that parallel extension of the ship scrapping yards has pretended threat not only to the coastal biodiversity, but also to the contiguous coastal inhabitants particularly for the fishermen communities. In the course of this research work, some important information has been obtained. The sociological studies were compared and found resemble to this research findings [35,37,38]. During the study, this is found that sanitation status was very much poor in the fishing villages while the communication and drinking waters soil supply facilities were found satisfactory. Besides, among the interviewer, 90% of them were local and full time fishermen and 10% were migrated from Bhola, Barisal, Mymensingh and others districts. The fishermen are displeased with the activities of different NGO activities working their areas while no Government funded was observed for the welfare of fishermen. From the study, it was observed that about 80% of the fishermen had moreover fishing nets or fishing boats or both of the resources and fishermen generally utilized both the mechanized and non-mechanized fishing boats and some conventional fishing crafts for fishing activities. Generally, Set Beg Net and Gill Net are preferable for fishing activities by the fishermen in the study areas. Fishermen reported that harvesting of the artisanal fishing become significantly declined more than half compared to the 10-15 years ago. They also stated that during the fishing in the Bay of Bengal, sometimes they are attacked by pirate and for that many of the fishermen died and their boat and fishing products completely looted. This is common scenario that after return from the fishing, fishermen was surrounded by middle men and influential people in the fish landing center and they failed to get appropriate money through marketing in the local market.

From this study, it was observed that about 75% of the fishermen supposed that ship breaking activities were generating problems to their livelihood and rest of the fishermen did not respond. Besides, 90% of the respondents were worried about their subsistence in future due to continued expansion of ship breaking areas and low availability of fish. They complained about suffering from respiratory difficulties, high decibel sound, huge lightning, fumes, poisonous chemicals and skin related different diseases. This is clear from the sociological assessment that artisanal fisheries diversity has been declined because of the ship breaking activities nearby their locality. Long traditional profession of the fishermen becoming vulnerable position day by day because of high imposed ship breaking activity; fewer access to microcredit and micro-enterprise facilities. But the highly motivating obsession is that fishermen are not cognizant about their secured rights and deficiency. The growing rate of ship breaking activity is exhausting the fisheries diversity which concurrently lessening the catch per unit effort (CPUE) for the fishermen. So this leaning is infuriating the fishermen to shift their habituated livelihoods for what they by no means of comfortable feeling and safe life (Table 7).

Table 7. Last 15 CPUE rate of mechanized boat in Chittagong coastal area

Sl. No.	Year	Landing center	Observed boats	Amount of fish (mt)	Yield day/boat (kg)
1	2005	14	1030	6142.56	139.23
2	2006	12	1151	5010.42	88.08
3	2007	12	1230	4980.80	82.26
4	2008	10	1350	4100.90	65.31
5	2009	10	1450	3950.90	59.76
6	2010	10	1600	3700.30	55.68
7	2011	10	1500	3500.00	53.56
8	2012	10	1500	3200.89	52.50
9	2013	10	1420	3000.45	50.45
10	2014	10	1400	2800.45	48.59
11	2015	10	1380	2600.45	45.00
12	2016	10	1350	2500.56	43.45
13	2017	10	1320	2460.45	41.90
14	2018	10	1200	2270.89	40.90
15	2019	10	1050	2005.20	35.90

Adverse impact on fish species were reported due to heavy metals toxicity that may include decreased fertility rate, challenging time during reproduction, the delay time of hatching, kidney damage, sluggish rate of growth and development, organ malformation, nonstandard behavior and lastly death. The mainly widespread deformities could be found in the vertebral column, sometimes in the swim bladder, cephalic area, different parts of the fins and lateral line of the fish. Moreover, fish species are anticipated to have gill damaged, damage in sensory and gut process of the species under prominent levels of toxic metals [8, 39]. Collision of heavy metal toxicity could be pressure into the fish species through impact on individual growth rates, physiological purposes, mortality and reproduction of fish diversity in the toxicity affected areas. The metals reach in fish bodies through 3 possible ways: by gills, by digestive track and body surface.

The influence of release of waste materials from ship breaking activities on aquatic plants, mangroves, salt marsh, fishes and benthic invertebrates has been documented. Deteriorations of stocking density by 50–100% were found for the fish species Bombay ducks (*Harpadon nehereus*), Hilsa (*Tenualosa ilisha*), prawns, and other fish species around the Soil bodies near ship breaking areas [40,41]. Heavy metal pollutants were recorded significantly higher compared to the maximum allowable concentration in suspended particulate substances, Soils of coastal areas, fish diversity and other seafood products from nearby locations of the ship breaking zone of Bangladesh.

4.0. Conclusions and Recommendation

Ship breaking industry has gained one of the top places in the national economy. The benefits of ship breaking are enormous in sectors like steel company, ship building company etc. Despite having so much benefits, the ship breaking industries have major some problems of environmental pollution. The authors found that the concentration of the heavy metals found within the ship breaking area followed a pattern within the following fashion Fe>Pb>Cr>Mn>Zn>Ni>Cu>Cd>Hg. Due to long term soil pollution in and around ship breaking area, 30 species of marine fishes are not available at present. Ship breaking has turned out to be a most important provider for the development of the national economy of Bangladesh. Bearing in mind about the constructive responsibility of ship breaking activities to the growth of national economy, this sector could not be stopped, but required for taking steps towards a sustainable approach to diminish the negative impacts of ship breaking activities around the coastal zone of Bangladesh. However, subsequent approach should be taken for sustainable management of ship breaking activities in the Chittagong coastal zone which as follows:

- Government should formulate and implement a national policy and principles for safe and sustainable ship breaking after having consultation with relevant organizations, employers and workers.
- Before the broken off the ship, ship breaking yard owner must be taken gas free certificate for respective ship from the respective Government department. Ballast Oil should be released and the oil tanks need to systematically cleaned through both the process manually or chemically and the ship breaking owners should be received oil tanker clearance credential from the respective Government department before beaching.
- Ships have to pump out utmost probable number of ballast oil at the anchorage before the time of beaching. All the available oily slush, rags, rust, sawdust and other wastage materials should be released and disposed off at a safer location.
- An organized and intermittent inspection of the whole ship breaking yard should required before the compliance certificate issued by the Department of Environment (DoE) & Department of Shipping of Bangladesh Government for coastal pollution control during the time of ship breaking activities.
- Waste treatment services with secure management for hazardous resources to be recognized under the control of a respective Government department as independent administration.
- Coastal environment should require for undisturbed as far as feasible for healthy environment for marine biodiversity and disease free human life.

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