PHYSICOCHEMICAL ASSESSMENT OF WATER POLLUTANTS DUE TO THE SHIP BREAKING ACTIVITIES AND ITS IMPACT ON THE COASTAL ENVIRONMENT OF CHITTAGONG - BANGLADESH

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The present research work deals with the assessment of water pollution due to shipbreaking activities and its impact on the coastal zone of Chittagong, Bangladesh. In order to study the different physicochemical parameters, water samples from thirty Ship-breaking yards were collected and analyzed during the hydrological year 2011-2012. The laboratory findings were compared with the recommended values set by Department of Environment (DoE), and standard calculated on the BSTI and WHO value. Some parameters recorded as higher value compare to the international permissible limits in water. The study reveals that pollutants due to ship-breaking are highly toxic in nature. This affects not only the aquatic environment and human beings of the surroundings but also poses a serious threat to ground and surface water resources of the adjoining areas and the coastal environment of Chittagong region. Also it is indicated that the water of ship breaking yards are continuously polluting the Bay of Bengal and the rivers of Chittagong, especially the water of Karnafuli River is being polluted greatly. The polluted water of the Karnafuli River may affect the biodiversity of the Halda River. Though Ship-breaking has earned a good reputation for being a profitable industry in developing countries it could be said that, the ship breaking operation involves serious environmental and human health hazards. It is one of the manmade hazards in the coastal region of Bangladesh.

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Introduction

Ship-Breaking industry is one of the manmade hazards in the coast of Bangladesh like many other developing countries. It has a high importance in terms of its environmental impact, since it produces considerably large amounts of inorganic and organic chemicals. A major environmental problem in Ship-breaking industries is the discharge of these pollutants to the environment, causing pollution of sea water and nearby soil in the coastal zone of Chittagong. [1]

Ship-breaking yards along the coast of Chittagong (Faujdarhat to Kumira) confined in an area of 10 km, among the total coastline of 710 kilometers, has become a paramount importance in the macro-and micro-economic context of poverty- stricken Bangladesh.[1] Now there are about 84 ship breaking yards in Sitakundhu. The coastal area is ecologically important as the marine environment of the coastal area is vital to global mankind. Ship-breaking activities offer direct employment opportunities for about 25,000 people. Moreover about 200,000 are also engaged in different business related to Ship -breaking activities in Bangladesh.[2] Bangladesh retained second position after India in terms of volume of recycling and showed that about 52% of big ships were dismantled in Bangladesh. Almost everything on the ship and the ship itself is recycled, reused and resold. The scrapping of ships provides the country's main source of steel and in doing so saves substantial amount of money in foreign exchange by reducing the need to import steel materials. It generates large amounts of revenue, almost 9000 million Taka per year, for various Government authorities through the payment of taxes. Ships contain a wide range of hazardous wastes; PCBs, asbestos and thousands liters of oil. Scrapped ships spread different types of heavy metals (Fe, Cr, Hg, Zn, Mn, Ni. Pb, Cd) that are being accumulated into the marine biota. [3]

The aquatic environment with its water quality is considered the main factor controlling the state of health and disease in both cultured and wild fishes. Pollution of the aquatic environment by inorganic and organic chemicals is a major factors posing serious threat to the survival of aquatic organisms including fish. [4]

Metal ions can be incorporated into food chains and concentrated in aquatic organisms to a level that affect their physiological state. Of the effective pollutants are the heavy metals which have drastic environmental impact on all organisms. Trace metals such as Zn, Cu and Fe play a biochemical role in the life processes of all aquatic plants and animals; therefore, they are essential in the aquatic environment in trace amounts. [5]

At present, the position of Bangladesh is third in the world for ship-breaking.The largest ships of the world are cut in the ship yard of Bangladesh. Bangladesh needs eight million tons of building materials per year, in which most needed material is iron and Ship-breaking industry is supplying 90% iron materials to the country. [6] During the liberation War in 1971, a Pakistani ship "Al Abbas" was damaged by bombing. Later on this was salvaged by a Soviet salvation team from Chittagong port and bought to the Fauzdarhat seashore. In 1974 the Karnafully Metal Works Ltd bought this as scrap, which is considered as introduction of commercial Ship-breaking in Bangladesh. [7]

The ship breaking activities contaminate the coastal soil and sea water environment mainly through the discharge of heavy metals, ammonia, burned oil spillage, floatable grease balls and various other disposable refuse materials together with high turbidity of sea water. The high pHof sea water and soil observed may be due to the addition of ammonia, oils and lubricants. High turbidity of water may cause decrease the concentration of DO and substantially increase the BOD. Furthermore, 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. As a result the growth and abundance of marine organisms especially plankton and fishes may seriously be affected. Thereby indiscriminate expansion of ship breaking activities poses a potential threat to the coastal intertidal zone and its habitat. [8] Figure 1 shows unskilled worker are working without any protection.

Figure 1. Unskilled worker are working without any protection in Sitakundo Ship yards of Chittagong **(Photo:Author, 2012).**

In the coastal areas, metals are remobilized, released or accumulated in different forms due to the wide variations in physicochemical parameters, high sedimentation rates and influence of wave motion, variable redox conditions and organic matter contents. [9] The concentrations of heavy metals in aquatic environment and marine organisms have been of considerable interest because of their toxic effects which are important in human beings. [10] The present work aimed to investigate the pollutants levels in water of the ship breaking region of Chittagong, Bangladesh.

EXPERIMENTAL

Selection of study area

The study was conducted in the different coastal zones of Chittagong (connected with the Bay of Bengal) *viz.* Fauzdarhat, Bhatiary, Kumera, Potenga etc. For the selection of industries preliminary, a reconnaissance survey was conducted to know the names, locations & apparent status of various Ship-breaking industries in Chittagong. From the reconnaissance survey Thirty (30) important Ship-breaking industries were selected randomly for the current study.

Figure 2. Map showing the sampling points at study area

Sample Collection

Samples are collected for various examinations under different conditions. An ideal sample should be one which is both valid and representative i.e., the sample must represent the conditions that exist at the sampling point. A survey work was conducted for the identification of sampling spots and the current water quality conditions for a large part of the Ship-breaking area of Chittagong. Statistical methods of sampling have been used for collecting samples. Multiple samples were collected from same spot for continues monitoring. The samples were also collected in different seasons to study the seasonal variation of the results during the hydrological year 2011-2012.Sample collection points are shown in Figure 3. Samples were collected in amber color polyethelene bottle cleaned by rinsing thoroughly with 8 M HNO_3, followed by repeated washing with distilled water. Multiple samples were collected from the same spot in different seasons to study the seasonal variation of the results. The surface water samples were collected in the boat if possible in the middle of the flow. Two to four equal volumes were collected from vertical section. The water samples were collected within 3-9 inches from the surface of the water. Water samples were collected from the tube wells after discarding water for the first 2 minutes. The samples were mixed well and a sample of 1.0-1.5 L was transferred for analysis in the laboratory.

Preservation of Sample

Once a sample is taken, the constituents of the sample should be maintained in the same condition as when collected. When it is not possible to analyze the collected samples immediately, samples should be preserved properly. Biological activity such as microbial respiration, chemical activity such as precipitation or pH change, and physical activity such as aeration or high temperature must be kept to a minimum. Methods of preservation include cooling, pH control, and chemical addition. Freezing is usually not recommended. The length of time that a constituent in wastewater will remain stable is related to the character of the constituent and the preservation method used. Sample collection and preservation were done in accordance with standard procedures. [11]

Table 1. Average water quality parameters of different (30) Ship-breaking industries in Chittagong region.

Parameters	Study area value Minimum	Maximum	Mean value of water quality parameters	BSTI [17] value	WHO [18] value
pH	6.79	8.22	6.85	6.4-7.4	6.0-8.5
EC/ μScm^{-1}	15940	32500	23970	3000	3000
TDS/ mgL^{-1}	9370	17740	15630	Max. 500	Max. 500
DO/ mgL^{-1}	3.01	6.89	4.93	Max. 6	Max. (4-6)
BOD/ mgL^{-1}	0.51	3.17	1.92	6.0	5.0
COD/ mgL^{-1}	178	338	274	4.0	5.0
T. Hardness/ mgL^{-1}	750	1100	975	Max. .500	Max. 500
Chloride/ mgL^{-1}	10138.70	21535.87	17834.89	Max. 600	Max. 250
NO_3^--N/ mgL^{-1}	0.256	0.781	0.504	0.01	<0.01 or Nil
o-PO_4^{3-}-P/ mgL^{-1}	1.062	2.177	1.794	1.5	0.5
SO_4^{2-}-S/ mgL^{-1}	540.12	608.64	592.42	Max. 400	Max. 200
As/ mgL^{-1}	0.0103	0.9505	0.0531	0.05	0.01
Cd/ mgL^{-1}	0.024	0.037	0.034	0.005	0.005
Cr/ mgL^{-1}	0.047	0.352	0.102	0.05	0.05
Co/ mgL^{-1}	0.020	0.081	0.051	0.05	0.05
Cu/ mgL^{-1}	.023	0.152	0.126	Max. 1	Max. 1
Fe/ mgL^{-1}	19.025	33.40	27.22	0.3-1.0	0.1-1.0
Pb/ mgL^{-1}	0.015	0.038	0.035	0.05	0.05
Mn/ mgL^{-1}	1.21	2.648	2.012	0.05	0.05
Ni/ mgL^{-1}	0.011	0.049	0.035	0.05	0.05
Ag/ mgL^{-1}	0.023	0.074	0.045	0.05	0.05
Zn/ mgL^{-1}	0.350	0.870	0.776	5	5

Experimental Methods

Some physical, quantitative and semi-quantitative tests were done at the sampling spots, such as temperature, color, pH, DO, BOD, COD, EC, TDS. Acidity and alkalinity were measured immediately after sample collection at the laboratory. Fresh samples were used for analyzing chloride, hardness, nitrite, nitrate, sulfate, phosphate immediately after sample collection at the laboratory. For the analysis of trace metals by UV/Visible spectrophotometry and atomic absorption spectrophotometry (AAS) samples were digested according to wet-digestion method.[12] For chemical analysis, standard preservation techniques and methods of analysis (APHA, 1992; Chattopadhyay, 1998; Manivasakam, 2000; De, 2000) were used.

HANNA HI-9142 portable waterproof Dissolved Oxygen (DO) meter has been used for the determination of Dissolved oxygen (DO) and Biochemical oxygen demand (BOD). COD was measured by open reflux method. Combined Meter, Model –HI 255, HANNA, Combined meter has been used for the determination of pH, Electrical Conductance, Total dissolved solid (TDS) and % NaCl. UV-Visible spectrophotometer, Model-UV 1800, Shimadzu, Japan has been used for the determination of Iron, Manganese, Phosphate, nitrite, nitrate and sulphate. [11, 13,14] Nitrite-N was determined by calorimetric method by formation of a reddish purple azo dye produced at pH 2.0 to 2.5 by coupling diazotized sulfanilamide with N-(1-naphthyl)-ethylenediamine (NED dihydrochloride)[11]. Chloride was determined by argentometric method in a neutral or slightly alkaline solution using potassium chromate as indicator by standard silver nitrate as titer. Phosphate was determined by calorimetric vanadomolybdophosphoric acid method after extraction of soil with Bray and Kurtz no. 2 extractant. Iron was determined by calorimetric method using 1, 10-phenanthroline as chelating agent. Manganese was determined by calorimetric per-sulfate oxidation method. In colorimetric methods a Shimadzu, Model-1800 UV-Vis spectrophotometer was used. Arsenic was determined by silver-dietyldithiocarbamate method.[11] Cadmium, chromium, copper, cobalt, nickel, silver, lead, zinc was determined by Varian Model-AA240FS fast sequential atomic absorption spectrophotometer. [15, 16] The obtained data were subject to statistical analysis to test the analysis of variance (ANOVA) and correlation among all the parameters using SPSS statistical package.

RESULTS AND DISCUSSION

The results of different physicochemical parameters of sea water of Ship-breaking area of Chittagong region with Standard calculated on the WHO and BSTI are shown in Table 1.

The descriptive statistics of the water pH value shows that most of the samples were found in the alkaline pH range, 8.22 to 6.79 **(Table 1)**. The pH of water was positively correlated with alkalinity and negatively correlated with acidity **(Table 2).**The EC of water was found to vary from 32500µS cm^{-1} to 25150 µS cm^{-1} .The EC of water was found to be positively correlated with %NaCl and TDS.TDS ranged from 17740 mg L^{-1} to 9370 mg L^{-1} . Higher values

Table 2. Pearson Correlations among the different parameters of water.[19]

	pH	EC	TDS	TSS	NaCl	DO	BOD	COD	ACIDITY	ALKALI-NITY	HARD-NESS	CHLO-RIDE	SULP-HATE	PHOSP-HATE	NITRITE	NITRATE	Cr	Cu	Ni	Pb	Zn	Co	Ag	Cd
pH	1	-.482 (**)	.028	-.201	-.730 (**)	-.066	.127	.183	.443 (*)	.400 (*)	.287	.296	-.010	.250	-.007	-.256	.189	.096	-.053	-.068	-.302	.168	.316	-.451 (*)
EC	-.482 (**)	1	.237 (**)	.306 (**)	.532 (**)	.043	.269	-.386(*)	-.311	.005	-.202	-.111	.167	-.311	.250	.058	-.263	-.005	-.230	-.119	.194	-.384 (*)	-.180	.307
TDS	.028	.237 (**)	1	-.033	.150 (**)	-.440 (*)	-.031	.221	-.200	-.015	-.153	.129	.182	.163	.429 (*)	-.316	-.235	-.231	-.203	-.106	.225	.174	.302	.118
TSS	-.201	.306 (**)	-.033	1	.246	.216	.187	-.460(*)	-.090	.038	.169	-.203	-.299	.115	-.005	.451 (*)	-.133	.494 (**)	-.126	-.160	.264	-.370 (*)	-.184	.164
NaCl	-.730 (**)	.532 (**)	.150 (**)	.246	1	-.079	.009	-.002	-.518 (**)	-.281	-.323	-.337	-.061	-.065	.153	.118	-.097	-.182	.027	-.157	.150	-.083	-.277	.421 (*)
DO	-.066	.043	-.440 (*)	.216	-.079	1	.048	-.173	.235	.434 (*)	.255	.035	-.229	-.176	-.076	.167	-.004	.006	.110	.370 (*)	-.332	.068	-.436 (*)	-.038
BOD	.127	.269	-.031	.187	.009	.048	1	-.224	.040	.230	.190	-.449 (*)	-.267	.112	-.255	-.217	-.068	.221	-.261	-.352	.105	-.163	-.043	-.288
COD	.183	-.386 (*)	.221	-.460 (*)	-.002	-.173	-.224	1	.243	.108	-.085	.238	-.023	.173	.016	-.101	.269	-.496 (**)	.036	.028	-.422 (*)	.379 (*)	.118	-.022
ACIDITY	.443 (*)	-.311	-.200	-.090	-.518 (**)	.235	.040	.243	1	.617 (**)	.398 (*)	.093	.060	-.105	-.159	.009	.604 (**)	.060	.079	.181	-.225	.008	-.054	-.320
ALKALI-NITY	.400 (*)	.005	-.015	.038	-.281	.434 (*)	.230	.108	.617 (**)	1	.434 (*)	.067	-.164	.033	-.077	-.060	.442 (*)	.030	.191	.226	-.329	-.026	-.044	-.252
HARDNESS	.287	-.202	-.153	.169	-.323	.255	.190	-.085	.398 (*)	.434 (*)	1	-.071	-.523 (**)	-.034	-.271	.088	.160	.310	.052	.174	-.054	.061	-.250	-.463 (**)
CHLORIDE	.296	-.111	.129	-.203	-.337	.035	-.449 (*)	.238	.093	.067	-.071	1	.055	-.117	.363 (*)	-.001	.008	-.302	.026	.408 (*)	-.222	-.025	.267	.112
SULPHATE	-.010	.167	.182	-.299	-.061	-.229	-.267	-.023	.060	-.164	-.523 (**)	.055	1	-.162	.197	-.303	.109	-.158	-.118	.040	.066	-.054	.150	.110
PHOSPHA-TE	.250	-.311	.163	.115	-.065	-.176	.112	.173	-.105	.033	-.034	-.117	-.162	1	.097	.018	.030	.137	.029	-.093	.132	.170	.154	.115
NITRITE	-.007	.250	.429 (*)	-.005	.153	-.076	-.255	.016	-.159	-.077	-.271	.363 (*)	.197	.097	1	-.070	.108	-.377 (*)	.085	.286	-.084	-.095	.020	.380 (*)
NITRATE	-.256	.058	-.316	.451(*)	.118	.167	-.217	-.101	.009	-.060	.088	-.001	-.303	.018	-.070	1	.051	.546 (**)	-.142	.249	.072	-.390 (*)	-.113	.042
Cr	.189	-.263	-.235	-.133	-.097	-.004	-.068	.269	.604 (**)	.442 (*)	.160	.008	.109	.030	.108	.051	1	-.076	.374 (*)	.270	-.061	-.140	-.041	-.043
Cu	.096	-.005	-.231	.494 (**)	-.182	.006	.221	-.496 (**)	.060	.030	.310	-.302	-.158	.137	-.377 (*)	.546 (**)	-.076	1	-.259	-.033	.351	-.370 (*)	.107	-.236
Ni	-.053	-.230	-.203	-.126	.027	.110	-.261	.036	.079	.191	.052	.026	-.118	.029	.085	-.142	.374 (*)	-.259	1	.176	.132	.002	.063	.214
Pb	-.068	-.119	-.106	-.160	-.157	.370 (*)	-.352	.028	.181	.226	.174	.408 (*)	.040	-.093	.286	.249	.270	-.033	.176	1	-.152	-.230	-.190	-.115
Zn	-.302	.194	.225	.264	.150	-.332	.105	-.422 (*)	-.225	-.329	-.054	-.222	.066	.132	-.084	.072	-.061	.351	.132	-.152	1	-.170	.195	.201
Co	.168	-.384 (*)	.174	-.370 (*)	-.083	.068	-.163	.379 (*)	.008	-.026	.061	-.025	-.054	.170	-.095	-.390 (*)	-.140	-.370 (*)	.002	-.230	-.170	1	.017	-.024
Ag	.316	-.180	.302	-.184	-.277	-.436 (*)	-.043	.118	-.054	-.044	-.250	.267	.150	.154	.020	-.113	-.041	.107	.063	-.190	.195	.017	1	.183
Cd	-.451 (*)	.307	.118	.164	.421 (*)	-.038	-.288	-.022	-.320	-.252	-.463 (**)	.112	.110	.115	.380(*)	.042	-.043	-.236	.214	-.115	.201	-.024	.183	1

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

of TDS of all the industries exceeded the limit of BSTI Standard (Max 500 mgL^{-1}). TDS of water was positively correlated with EC, %NaCl.TSS of water was found to vary from 724 mgL^{-1} to 512 mgL^{-1}. TSS of water was positively correlated with EC, %NaCl, Nitrite and Cu.%NaCl of water was found to vary from 60.8 to 30.2 . %NaCl of water was positively correlated with EC, TDS, TSS and Cd.Acidity of water was found to vary from 9.02 mgL^{-1} to 5.40 mgL^{-1} Acidity of water was negatively correlated with pH and positively correlated with Alkalinity, Hardness and Cr. Alkalinity of water was found to vary from 310.19 mgL^{-1} to 229.47 mgL^{-1} . As phenolphthalein alkalinity was not found for any of the samples analyzed, total alkalinity is mainly due to carbonates and bicarbonates. Alkalinity of water was positively correlated with pH, Acidity, Hardness and Cr.

DO of water was found to vary from 6.89 to 3.01 mgL^{-1} . As DO levels in water drop below 4 mg L^{-1}, aquatic life is put under stress. DO of water was positively correlated with alkalinity.BOD of water was found to vary from 3.17 to 0.51 mgL^{-1} . BOD of water was found to have no correlation with the other parameters.COD of water was found to vary from 338 to 178 mgL^{-1} . COD of water was positively correlated with Co.

Hardness of water was found to vary from 1100 mgL^{-1} to 750 mgL^{-1} . Higher values of hardness of all the industries exceeded the limit of WHO standard (Max 500 mgL^{-1}). Hardness of water was positively correlated with Acidity and Alkalinity.Chloride of water was found to vary from 21535.87 mgL^{-1} to 10138.70 mgL^{-1}. Chloride of water was positively correlated with %NaCl, Acidity and Alkalinity. Sulfate of water was found to vary from 608.64 mgL^{-1} to 540.12 mgL^{-1} . According to WHO, the maximum allowable concentration of sulfate is 250 mgL^{-1}. Sulfate of water was positively correlated with Hardness.Phosphate of water was found to vary from 2.177 mgL^{-1} to 1.062 mgL^{-1} . Phosphate has no correlation with other parameters. Nitrite of water was found to vary from 0.030 mgL^{-1} to 0.005 mgL^{-1} . Nitrite of water was positively correlated with TDS, Chloride and Cu.Nitrate of water was found to vary from 0.781 mgL^{-1} to 0.256 mgL^{-1}. Nitrate of water was positively correlated with TSS, Co and Cu.

Iron of water was found to vary from 33.40 mgL^{-1} to 19.025mgL^{-1} . It has been reported that water with high iron content has little effect on aquatic life and irrigation.Manganese of water was found to vary from 2.648 mgL^{-1} to 1.21 mgL^{-1} . According to WHO, the maximum allowable concentration of manganese is 0.05 mgL^{-1}. Arsenic of water was found to vary from 0.0103 to 0.9505 mgL^{-1} . According to WHO, the maximum allowable concentration of arsenic is 0.01 mgL^{-1} Co, Ni, Zn, Cu,Pb and Ag contents of all the samples ranged within the acceptable limits.

So it can be concluded that the studied physicochemical parameters such as EC, TDS, COD, in ship yards of Chittagong region was found to be higher than DoE value, standard value calculated on the BSTI vale and WHO value. Some anions such as Cl^- and SO_4^{2-}, NO_2^-, NO_3^- etc. were found to be higher than the values set by BSTI and WHO which indicates that the sea and adjoining river water are not in good conditions.

Trace and heavy metals namely Fe, Mn, Cr, As and Cd in most of the ship-breaking Yards were present in higher amount than DoE and the standard value calculated on the WHO value and than the control area. The above data indicate that the ship-breaking yards in Chittagong region are highly polluted though concentration of some anions and some metals of some Yards were found within the range of control area and standard values. Therefore these pollutants, when discharged, are polluting the water and nearby soil thus greatly rendering us a highly polluted environment.

CONCLUSIONS

From the present physicochemical study of the water quality of Ship-breaking region, it can be concluded that water of this region is alkaline. Phenolphthalein alkalinity was not detected in any of the samples analyzed. Alkalinity of all these industry is mainly for carbonates and bicarbonates. Maximum EC, TDS, Hardness, chloride and sulfate-S values of these regions. Higher values of o-phosphate-P may be due to the washing out of fertilizer from agricultural fields and detergents used in household purposes. For the water samples higher values of TDS, total hardness and total alkalinity of all these region exceeded the limit of BSTI standard. Chloride content of these sample exceeded the limit of BSTI standard. Lower value of DO and higher value of BOD and COD indicate that water quality of the Ship-breaking yards are deteriorating from waste oil and oily materials. Among the metals nickel, cobalt, zinc, chromium, manganese and lead were found within the acceptable limit of EPA and higher amount of iron content of these sample may be due to the pollution from industrial and municipal sources and geological conditions of soil.

From Pearson Correlation program, significant positive correlation was found for pH with alkalinity and acidity; EC with TDS and %NaCl; acidity with pH, alkalinity, and hardness; alkalinity with pH, DO, acidity, and hardness; chloride with nitrite; nitrite with TDS and chloride.

Water pollution of ship-breaking yards is one of the main reasons for the critical condition of the Karnafuli River water. Polluted water of the Karnafuli River may affect the biodiversity of the Halda River by polluted Karnafuli River water intrusion into this river in the pre-monsoon period at high tides. This is indicated by the gradual decrease in spawning of fish fry in the Halda River. Pollution of these aqua systems may also affect the irrigation and household water need of the adjoining areas, dependent on this river's water. Coastal environment is delicate. Harnessing and exploiting its opportunities in systematic and coordinated way is essential to make it a sustainable resource.

Moreover, it contains several important and critical ecosystems. Unfortunately some part of this coast is used for ship breaking, causing huge environmental loss. Now Bangladesh has to decide whether it would allow continuing its coast to be used as a dustbin of developed world or not. It is an urgent need for sustainable development of the coastal resources. Monitoring of the coastal activity is important in order to save the coastal ecosystems.

This monitoring system can give valuable information to the environmentalist, policy maker and different stakeholder interested in coastal environment and resources

RECOMMENDATIONS

Considering the positive role of Ship-breaking in national economy Ship-breaking cannot be stopped. Following steps may be taken for sustainable practice of Ship-breaking activities in Chittagong Coastal area of Chittagong:

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.

Government should include this sector under the ministry of industry defined by the Factory

Act, 1965 and formulate a policy so that, worker's rights and welfare; occupational safety and health (OHP) could be ensured and it could be eco-friendly as well.

As Fauzdarhat has been earmarked for recreational facilities in the Master Plan of Chittagong, the Master Plan is to be revised till a final study is made by the experts on the impact of Ship-breaking being developed in its present site.

a) A gas free certificate (in true sense) must be obtained before any ship is broken. Oil must be removed and the oil tanks must be thoroughly cleaned either chemically or manually and the ship breakers must obtain a tank clearance certificate from the Mercantile Marine Department before beaching.

b) A systematic and periodic inspection of the whole yard should be done before a certificate of compliance is issued by the Department of Environment (DoE) & Department of Shipping for control of pollution during Ship-breaking.

The sea shall be kept undisturbed as far as practicable for healthy growth of marine biodiversity and human health. Because, many of the ship-breaking components are highly toxic, persistent and carcinogenic in nature and they prove fatal for aquatic food chain & human health. Therefore:

a) Short and long term scientific study should be immediately started to assess the impacts of Ship-breaking activities on coastal water, soil and fishery resources, as well as human health.

b) To mitigate the problems and environmental impacts, cooperation & collaboration among scientists, policy makers, owners, local representatives, N.G.O,s, media and different stakeholders must be achieved through consultation, seminars, discussions etc.

No Ship-breaking licenses should be issued to any one unless he produce requisite permission showing that necessary lease of land had already been taken for the purpose

Fire stations and hospitals should be set up near to the yards, for the welfare of the workers and avoiding severe loss by any accident.

The authority should select a "certain isolated and protected scrapper's yard" for dismantling the ships instead of the seashore areas.

The Ship-breaking activities should be carried out in a planned and hygienic way. A layout should be designed before starting to break the ship.

For sustainable Ship-breaking policy and its implementation, linkage with international organizations and NGOs; interagency cooperation, strengthening capacity building of the relevant government department through training is must.

Ship breakers or owners should provide PPE (personal protective equipment) in general and appropriate PPE in specialized cases for workers and labors.

IMO, ILO & Basel convention guidelines are not yet mandatory. So, for sustainable practices these guidelines should be translated into laws and procedures pertaining to the sustainable Ship-breaking activities in Bangladesh.

Awareness of people about the risks, effects and remedies of pollution should be increased so that they can play important role in the abatement of pollution due to Ship-breaking activities.

Assessment data will be published in national magazine, newspaper and international journals so that public awareness will be increased.

Assessment data will be provided to the proper Govt., Authority and NGO'S for taking proper action and making new national and regional policies and appropriate preventive measures against the pollution due to Ship-breaking activities in this region.

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