

## Marine Pollution in Chittagong: Present Condition, Possible Impacts and Suggestive Mitigation Measures

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### **Abstract**

*A combination of human activities are responsible for marine pollution. It affects the health of the ocean and makes the coastal area vulnerable. Both the developed and developing countries both are affected by marine pollution. Coastal regions and ecosystems are facing diversified environmental pressure throughout the world. Regular discharge of industrial effluents, untreated sewages, oil spills, plastics, chemicals and other hazardous pollutants from different sources are continually affecting Chittagong coastal area. Wide range of pollution in the coastal environment of Chittagong cause threats to the livelihoods of coastal communities, contaminated contaminates seafood and affects marine ecosystems. In this paper, the effort has been made to: examine the issues concerning marine pollution, identify the effect of pollution in the environment and suggest preventive measures for minimizing pollution in this selected area through careful management.*

**Keywords:** Marine Pollution, Possible Impacts, Coastal Environment, Integrated Management

### **1. Introduction**

Bangladesh is a riverine country surrounded by Indian states to the west, north, east and the southern portion is open to the Bay of Bengal by sharing a boundary with Myanmar to the south. Chittagong is in the southeastern part of Bangladesh, the second largest city and also known as the port city of Bangladesh and one of the busiest port which handles 92% export-import trade. The Karnaphuli is the main river of the Chittagong and the whole city is located on the banks of the river. According to CPA report, it handle 3,764 (“Chattogram Port Handles Record 3,807 Vessels in 2019” 2021) ships in 2019-2020. So, pollution from the ship is a serious threat to the Karnaphuli River and Chittagong anchorage area through handling, transportation, ballast and bilge water,

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accident and also dumping of wastes (Rahman, n.d.). Beside, a lot of industries are established on the banks of the river and these areas are considered and to be the industrial hotspots for Chittagong. (Shahadat Hossain et al. 2005) Pesticides and fertilizers come from the agricultural lands and are mixed with the river water. So pollution from land-based sources is also a major concerning issue of marine pollution in Chittagong. The UNCLOS defined that ‘pollution is the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of the sea water and reduction of amenities’ (“United Nations Convention on the Law of the Sea,” n.d.). NOAA said that 1.4 billion pounds of trash per year enter into the ocean. (“Ocean Pollution | National Oceanic and Atmospheric Administration” 2021) Agricultural practices, coastal tourism, port and harbor developments, damming of rivers, urban development and construction, mining, fisheries, aquaculture, and manufacturing, among others, are all sources of marine pollution threatening coastal and marine habitats. (“UNEP Regional Seas Programme Definition | Biodiversity A-Z” 2021) According to the GESAMP (2018) in the “Global Trends in Pollution of Coastal Ecosystems” (*Global Pollution Trends: Coastal Ecosystem Assessment for the Past Century | GESAMP 2021*), the impacts of pollution are related to the release of contaminants to the environment.

According to the world perspective, it is recognized that marine pollution is mainly generated by human based on land and ship based activities. Based on the review of different papers, pollution Impacts on the aquatic environment happened in different ways including:

- Pollution by oily, hazardous and toxic substances from intentional or unintentional discharges from ship or land based sources;
- Accidental spill or chemical pollution;
- Discharging ships waste, industrial waste and domestic wastes;
- Release of toxic chemicals from shipbreaking and dismantling yard like anti-fouling paints, PCBs, asbestos, TBT or other heavy metal dust etc.

These effects are mainly noticeable in busy shipping industries and from river side industrialization. As a result, ecologically sensitive areas which associated with coastal line are hampered very quickly.

From the review of different literatures, it is clear that the introduction of different types of contaminants into the environment cause adverse effect. It makes adverse change on living or non-living resources, interferes with human health, quality of life and the functioning of ecosystems. It is also recognized from these literatures that how many

countries try to minimize waste by the side of human activities and it is also important for every member of the society to ensure that all wastes are disposed in ways that cause the minimum environmental impact.

Based on the above discussions in mind, the present study was undertaken to: (1) identify the sources involved in marine pollution, (2) highlight the possible impact of pollution in Chittagong and (3) provide suggestive strategies to mitigate this problem.

## **2. Methodology**

This study was carried out to find out the impact of marine pollution in Chittagong coastal area. In order to fulfill this research, a questionnaire survey was conducted. This paper was completed by using both primary and secondary data collection method. For this matter, various published thesis, articles, Journals, and leaflets were reviewed, examined and analyzed. Pictures related with recent pollution condition were collected by field survey. Simple statistical method was used for data presentation. The statistical data were presented by diagrams, charts, rows, columns, table etc.

## **3. Pollution Status in Chittagong**

The coastal environment of the Bay of Bengal has also been affected by industrial discharges, waste from agricultural and human activities like deforestation and irrational expansion of coastal shrimp farming, etc. resulting in ecological degradation. Overfishing and dumping of discarded fishes and fishing nets in these areas are becoming a threat to the resourcefulness of the fishing grounds. Metal pollution and toxic organic compounds are the hazards for human health and environment. The primary sources of marine pollution, which may create impact on Chittagong coastal environment basically comes from maritime activities, people living in the coastal areas and industries along with the coastline that can be the causes of intentional accidental pollution. Sources of marine pollution that is happening in Chittagong are usually divided into two segments, which are described below:

1. Ship- sourced pollution
2. Land -based pollution

## **4. Ship- sourced Pollution**

Shipping is one of the marked sources of the pollutants that pollute the waterways of Chittagong. There are different sorts of unfriendly impacts due to these pollutions. Due to the lack of applicable laws and resource deficiencies of the concerned government departments, pollution by shipping has become common incident in Bangladesh. For such operation of the vessels, the marine environment has been exposed to massive pollution. The factor that related with ship -based pollution are discussed below

### 5. Pollution from Fishing Vessel

The fishing vessels are a source of pollution in Chittagong. A total of 205 registered fishing trawlers are running through the Karnaphuli River and they continuously dump waste, garbage, sewage, bilge water, materials washout from deck and engine room, processing wastage, solid materials (can, plastic bottle etc.), discarded food waste, galley wastage, rotten fish, etc. including other items such as discarded fishing nets cause harm to the marine environment or create a navigational hazard. There are no sewage treatment plants in fishing vessels, so all vessels discharge sewage directly in river water (Figure 1). According to IMO standard, all fishing vessels over 400 gross tonnage are required to be fitted with oily water separator, which ensures the oil content is less than 15 parts of oil to one million parts of water (15 ppm). Fishing vessels over 400 gross tonnage must also comply with the discharge regulations. In most of the cases, this means that oily mixtures (diesel, hydraulic fluids and bilge water with any concentration of oil) must be stored onboard for disposal at port waste reception facilities. (“International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) PRACTICAL GUIDE 2015 MARPOL 73/78 Practical Guide” 2015) But there has been no oily water separator used on this vessels, which are over 400 gross tonnage as well as no port waste reception facilities in Chittagong and these vessels are not surveyed for the anti-pollution arrangements. So all these fishing vessels kept on polluting coastal areas continuously.



*Figure 1: Waste disposal from fishing vessel in the Karnaphuli River (Courtesy: Eva shill).*

## 6. Pollution in Chittagong Outer Anchorage

Because of draft restrictions in the river, most of the foreign vessels wait at the anchorage area for transshipment of cargo. By taking advantage of lax law and implementation, some of the ships dump waste materials in the outer anchorage of the ports by defying international regulations. (Karim 2009) Not only foreign ships, local ships and fishing vessels also use outer anchorage as a safe dumping zone, where any other international port would have imposed heavy penalties or even seized and blacklisted ships if found to be violated marine laws and polluted the sea.

## 7. Oily-water Discharge from Ship

During ship operation, spills of lubricating oil, fuel oil, grease and water etc. are collected in bilge area. The resulting emulsified water and oil, if pumped into the sea or river where oily-water separator is not fitted it, will cause oil pollution (Figure 2). If oily water separator is not fitted or inactive, the direct discharge of oily water mixture is against the international regulations. Also the cleaning process of crude oil tanks from the large oil tankers contribute to marine pollution because cleaning process contains detergent, solid matters, rusty scales from corrosion, which are discharged overboard.



Figure 2: oil spill from ship in the Karnaphuli river (courtesy: Eva shill).

### 8. Accidental Spillage during Terminal Loading

The malfunctioning of valves, pumps and rupture of pipes or operational fault can cause oil spillage during loading or unloading of crude oil at oil terminals, oil refinery, related industries and oil storage sites. Canals, rivers and surroundings are reported to be polluted by releasing oil, oily water and sludge. Loading bunker oil or lubricating oil for vessels and spills for operational purposes spills may also occur. An undetermined amount of oil spill was occurred in Chittagong port area due to hose rupturing in 2016. The tanks overflow could happen if someone is not watching the level of oil loading into the ship's tanks.

### 9. Tanker and Freight Train Accidents

Oil spills are most commonly associated with ship-based pollution. There are always risk of collision, grounding, explosion or fire, which are normal incidents faced by oil tankers, and chemical and gas carriers. The exploration, exploitation and transportation of oil, and gas have a devastating impact, causing various accidents. Effective measures are usually taken to combat this spillage when it occurs. In order to show the vulnerability of Chittagong marine environment, a number of vessel casualties and other oil spill records are examined (Table 1). These oil spillages had adverse effects on the environment.

**Table 1:** Oil spills record in Chittagong coastal area last decade (Compiled by researchers)

Year	Source of oil spill	Causes of incident	Place of incident	Amount of spill
2019	Oil tanker	Collision	Karnaphuli channel (Padma Jetty)	10
2016	Freight train	Derailed	Halda canal	25
2016	Oil tanker	Collision	Karnaphuli channel (Dangarchar)	5 to 6 tons
2015	Jetty	Discharging pipe ruptured	Karnaphuli river near port area	Undetermined
2014	Freight train	Derailed	Kithabchar canal	24
2014	Freight train	Derailed	Sitakunda (canal)	66
2013	Freight train	Derailed	Karnaphuli channel (near the Kalurghat)	33
2011	Oil tanker	Sunk	Karnaphuli channel (Dolphin jetty)	180

## 10. Anti-fouling paints

Anti-fouling paint is a specialized paint used to the ship's hull to prevent or slow the growth of marine organisms, which can affect the vessel performance and durability. This paint also acts as a barrier of hull corrosion. However, these chemicals have contaminated the marine environment and even caused havoc to the human health. These chemical also releases a poison into the water by falling off from old ship. Some antifouling chemicals such as, TBT, which was one of the active components used in anti-fouling and leading to indirect impacts on marine wildlife further up the food chain. Human also face health hazard after eating contaminated food. TBT has hormone disrupting properties and at low concentration, it causes genital change of snail and deformation of oyster (Iduk and Samson 2015). It also can cause severe damage to reproduction or immune system.



*Figure 3: Removing paint from ship (Courtesy: Eva shill)*

## 11. Sound Pollution

The noise produced by ships, submarines, offshore operations, fishing, and other maritime activities are disturbing marine species. These sound forces change diving patterns, migration to newer places, and damage to internal organs, and overall panic response.(Iduk and Samson 2015) Noises interrupt communication, and disrupt migration, communication, hunting and reproduction patterns for many marine animals.



## 12. Land based pollution

The coastline of Karnaphuli River is full of industries. Due to increasing industrialization, more of industrial wastes are released into the river water directly. The south and north side of Karnaphuli, Kalurghat, Patenga, Bhatiary, Sitakunda, Nasirabad, Anwara, and Kaptai are considered as industrial hotspots.(Shahadat Hossain et al. 2005) Most of the major land-based sources, which are polluting Chittagong coastal environment are described below:

## 13. Ship breaking Industries

The most dangerous pollution source in Chittagong is the ship breaking and recycling industry. This sector contributes to different types of marine pollution. Due to the long heritage of practices, the impact of the shipbreaking activities involves various environmental issues along the coast of Chittagong intertidal zones that are connected to the Bay of Bengal. At present, there are 125+ ship-breaking yards in this area and space extends from over 14 km along Fauzdarhat to Kumira Coast. (“ADVERSE EFFECTS OF POLLUTION FROM CTG SHIP BREAKING YARD,” n.d.) Generally, tankers, cargo ships, and container ships are scrapped in the Chittagong ship breaking yard. The wastes from scrapped ships, including oils and persistent organic pollutants (POPs), asbestos, heavy metals, polyvinyl chloride (PVC), PCBs (mainly cables), ODS (mainly polyurethane foam), paints (metals, tributyltin and PCBs), waste organic liquid, waste inorganic liquids (acids), Reusable organics liquids and miscellaneous (mainly sewage).



Figure 4: ship breaking activities in Bhatiary (Courtesy: Eva shill).



#### 14. Fertilizer Factories

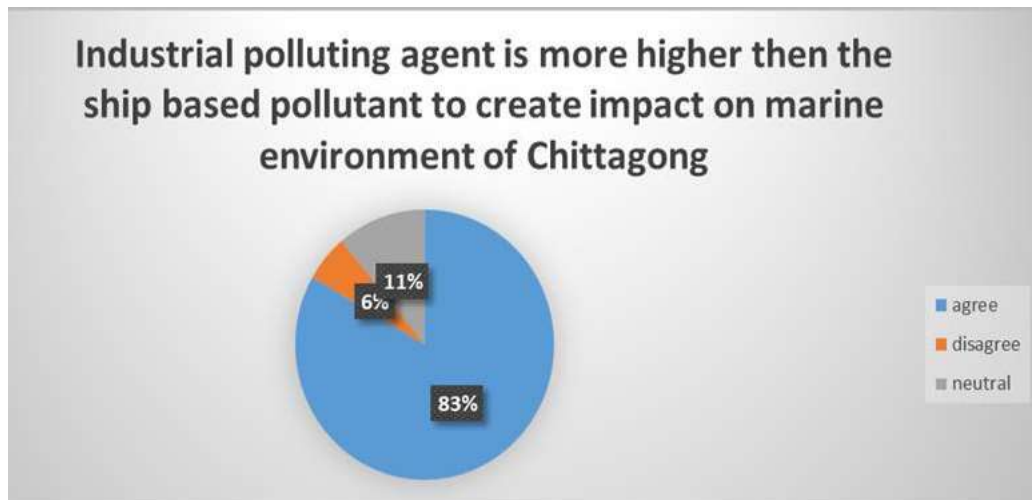
Fertilizer factories on the banks of the Karnaphuli River discharge different chemicals like sulphuric acid, phosphoric acid, waste loaded with fluoride and sulfur etc. TSPC Chittagong Urea Fertilizer Limited (CUFL) and Karnaphuli Fertilizer Company are the major fertilizer factories in Chittagong. Wastewater with high ammonia content also contain sulfates, phosphates, methanol, hydrogen sulfide, fluorides, urea etc.



*Figure 5: Effluent discharge from KUFCO (courtesy: Eva shill).*

Despite the use of a scrubber, there has been significant air emission of sulfur dioxide and trioxide, fluoride, and nitrous oxide. (“World Bank Document | Enhanced Reader” 2021) In another case, the water from the scrubber is simply drained into the river. All factories discharge waste into the river and also causes air pollution. A large amount of toxic ammonia gas was released from the Di-ammonium Phosphate Factory Limited, known as DAP-1 in 2016 due to an overpressure explosion of a 500-ton ammonia tank where ammonia is toxic, corrosive, and can rapidly penetrate the eye even in low concentration. The toxic ammonia gas was spread over several kilometers and nearly 250 peoples were felt sick, inhaling the toxic ammonia gas and 10 ton of fish nearby pond was found to be dead due to this explosion. (“Chittagong Fertiliser Factory Blast: Gas Disaster Averted” 2021)

### 15. Textile Industries



*Figure 6: Respondents response on industrial pollution impact in Chittagong (Compiled by the researchers).*

The textile industry is the most significant contributor in our national economy, encompassing both small and large-scale operations worldwide. This industry providing 45% of industrial manpower with employment. More than 4 million people of our country are associated with these industries. As Chittagong is the heart of the country's economy, most of the textile industries are situated in Chittagong city and are also discharging their waste as other industries. About 26 textile mills are located in the coastal zone of Chittagong.(Rahman, n.d.) Although the industry is a significant contributor, the manufacturing process generates a significant amount of waste that is associated with environmental problems like water body pollution by the discharging of untreated effluents, air emission, notably volatile organic compounds (VOC)'s and excessive noise or odor as well as workspace safety. During every stage of production, different types of chemicals are used for improving the product quality.

### 16. Pollution from Domestic Activities

Water is needed for various types of domestic activities. In everyday life, people produce different kinds of wastes. For example, sewage and waste water from cooking and cleaning activities, and use of organic materials to inorganic chemicals, plastics, bottles, packages etc. Usually, people from urban and rural areas dump the household wastes in the nearby water sources and all these gradually flows into river that leads to marine pollution. Due to the growth of population and increasing unplanned urbanization, the amount of discharge of wastes from households is high and increasing

day by day. Deficient collection systems and inadequate disposal practices are responsible for increasing pollution rates in Chittagong. The six million peoples of port city produces approximately 2500 tons of waste every day, which are dumped under the open sea. Generally, the domestic sewages are stored in large septic tanks. After collecting these sewages, they are then discharged into the nearby water sources. The Chaktai Khal originates from the Baizid Bostami and Chittagong cantonment area and travels most of the areas of the city and finally falls into the Karnaphuli River. It receives all types of waste materials and effluents from small industries, factories, domestic and municipal users and markets. Public toilet outlets are directly connected with this canal in most of the areas. Wastes from the medical college clinics, hospitals, and slaughterhouses discharge into the vicinity of Karnaphuli. (“Clearing Illegal Structures from Karnaphuli Banks | The Asian Age Online, Bangladesh” 2021)

### **17. Agriculture and Forestry Pollutants**

Agricultural pollutants include fertilizers, wastage of animals, pesticides, insecticides, and sediments. Nitrogenous and phosphoric compounds, and organic compounds in chemical pesticides like DDT are the main substances of modern agriculture that contribute to the pollution of the marine environment. Accumulation of agrochemicals in surface water and groundwater is still limited, as their use, apart from urea, is still comparatively low in Bangladesh.

### **18. Siltation and Sedimentation**

The silt load carried by the river systems of Bangladesh is greater than that of any other river system in the world. As the silt-laden waters enter the estuaries, a brackish water interface is formed, slowing the flow of the streams and causing silt to be deposited along the channel banks and on mud islands in the estuary. Sometimes deposition is temporary, because of changing river currents. Due to siltation, the carrying capacity of a river decreases and as a result there will be an overflow of water and/or resulting in a flood. Siltation is a blessing for the farmers, but a curse for navigation along the rivers.

### **19. Illegal Infrastructure**

According to a district administration survey, a large number of 2181 (“Clearing Illegal Structures from Karnaphuli Banks | The Asian Age Online, Bangladesh” 2021) illegal structures along the Karnaphuli river banks was found by following an earlier order by the Court. Tin-shed houses and concrete structure builds and filling up the banks of Karnaphuli River at Bakolia in Chittagong. Peoples living on this side drastically discharge different wastes into the river water. If conscious efforts are not made to stop illegal encroachment on its banks and to do away with the unhealthy practice of treating

the river as the dumping ground, the river will slowly lose its beauty and will become a garbage dump.

This chapter has identified and classified relevant pollution problems and issues. It reveals that the problems and issues faced by Chittagong coastal area due to marine pollution, which are multi-faced and complex in some instances. From a legal point of view, no guidance and frameworks have been provided to control or avoid significant damages. However, competing interests are creating difficulties in cooperation for the common purpose of protecting our coastal valuable resources. Scientific, economic, and legal problems need confronting to control this pollution source.

## **20. The Possible Impact of Marine Pollution on Chittagong Coastal Area**

The coastal zone of Chittagong contains several ecosystems like wildlife sanctuaries, reserve forest, eco-park, Halda river (natural breeding zone of fish and crab), Parki beach (a sanctuary for red crab), mangrove forest, and a lot of beaches that have important conservation values. But marine pollution creates an extensive effect on the esoteric value of beaches, marine flora and fauna, and the entire ecology of the coastal environment. Drastically discharge of hot effluents, untreated sewage, oil spills, plastics, and other forms of debris into our coastal aquatic environment is quite common off the coasts and major industrialized cities of Chittagong.

## **21. Effect from Fishing net and Marine Litter**

The UN General Assembly Resolutions provide a mandate and indeed require action to reduce ALDFG's (Abandoned, lost, or otherwise discarded fishing gear) and marine debris in general. Causes of fishing gear to be abandoned, lost, or otherwise discarded may be intentional and unintentional. It has numerous factors like adverse weather; operational fishing factors including the cost of gear retrieval; gear conflicts; illegal, unregulated, and unreported (IUU) fishing, poor grounding, etc ("Abandoned, Lost or Otherwise Discarded Fishing Gear" 2021). Beside Bangladesh became the first country in the world to ban thinner plastic bags in 2002. However, after 18 years, it appears that the ban is not truly came into force. Peoples are using polythene especially single-use plastics and disposing it everywhere. The Government of Bangladesh took the initiative to decrease the use of plastics through enacting the 'Mandatory Jute Packaging Act, 2010'. ("Concerns on the Use of Polythene | The Daily Star" 2021) The unfortunate issue is that since plastic bags are cheaper than jute bags, so using polythene is still running and contributing to marine litter. This litter comes from shoreline and recreational activities, local and smoking-related activities, ocean/waterway activities, waste dumping, and medical or personal hygiene products and the impact of the factors include:

- Continuously catch target and non-target species;
- Interacts with threatened or endangered species;
- Degrade benthic life;
- Micro plastic affects many species, including seabirds, marine mammals and fish through entanglement and ingestion, and when the micro plastic enters the food chain causes cancer to human beings.
- Creates navigational hazards
- Disrupts amenity of beaches and other coastal tourist areas, Irritated tourists, swimmers or divers, Money need to spend for cleaning purposes.



*Figure 7: boys collecting plastics bottle from the shoreline of Karnaphuli for sale (Courtesy: Eva shill).*

## **22. Habitat Loss**

Pollution, subsidence, sea-level rise, infrastructure development and sediment flow contribute to coastal habitat loss. Wetlands and shorelines are becoming more vulnerable due to soil erosion, seawater entering into the freshwater environments, causing floods, water quality is being degraded, human and wildlife lost their habitat and also losing huge mangrove forests. Human disturbances and environmental change like destructive fishing and coral bleaching are also the causes of harm to coral reefs, which is the hotspot for aquatic life. The coastal population also face economic and social impact because of coastal erosion. They continuously move their habitation and also change their social behavior with others.

### 23. Effect from Oil Spill and Chemical

Most of the time conspicuous effects of oil spills are apparent among larger species of wildlife, like marine mammals, seabirds, crabs, mollusks, and other aquatic organisms. Oil spills are exposed directly to aquatic and coastal wildlife, and cause immediate health problems such as skin irritation, altering of the immune system, reproductive or developmental damage, liver disease, neurological effects (headache, dizziness), etc. through ingestion, absorption and inhalation. People who had worked in cleaning the spill had twice as much mercury in their urine than normal levels. (“ADVERSE EFFECTS OF POLLUTION FROM CTG SHIP BREAKING YARD,” n.d.) Oil spill in Karnaphuli river is also the biggest threat for Ganges river dolphin which use this area as a breeding zone. The WWF reports that the important blind cetaceans are heavily affected and majority of them are likely to have lost their eyesight due to pollution in their home waters. In the reports of AFP, at least 20 dolphins in the last four years have died of unnatural causes including pollution in the river and in the adjacent Halda river (“Oil Spill Causes ‘Major Disaster’ for Ganges River Dolphins Breeding Zone - EcoWatch” 2021). Peoples live in places where the actual oil spill have occurred can be affected by indirect exposure to oil spill by using contaminated water like bathing, swimming, or using household activities and by eating contaminated food. Toxic substances generated by shipbreaking activities pollute the seawater causing harm in the coastal area of Chittagong. In total, 21 species of marine fish in the Bay of Bengal have been depleted from Bangladesh waters due to this reason. According to several surveys, the marine fishes including Aspisoa Katamach, Nemipscol, Dora Barilla, Foton, Kala Poa, Chapter, Grunti, Kala Taille, Nandi Barilla, Kathu Baillah, Koiputi, Price, Lamba Kukur Jib, Kala, Dosa Chau, Chika, Lohamuri, Bungda and Tiktiki are decreasing day by day. In 2007 a dead blue whale was found at Kattali Sea beach. Another dead Bryde's whale was also found on Kolkata beach in 2018. Due to toxic elements, several marine species faced the danger that was released from different ships, scrapping yards, agriculture and different industrial sources. Chemical pollutants also contribute to global warming by human activities. Carbon dioxide, methane, nitrous oxide, and fluorinated gases, methane and nitrous oxide are released mostly through agricultural and industrial activities.

### 24. Losing Aesthetic Value of Beaches

Aesthetics values do not deal with a health hazard that directly or indirectly affects wellbeing. World Health Organization defines the effect of losing amenity value of marine and riverine environments conclude loss of local, national and international tourist; damage to leisure or tourism center and infrastructure; damage tourism based commercial activities; damage fishery-based activities; and damage to the image of a resort. Chittagong is an area of beaches. A lot of beaches are found in the different areas of greater Chittagong. Most of the domestic tourist visit all these beaches every day.

Various polluting agents' likes plastic litter, oil, etc. pollute all these beaches continuously. A clean beach is one of the most important characteristics of a waterside resort sought by visitors. The deposition of coastal debris raises a variety of concerns: risks to marine life, potential human health hazards, and also threats for the economy of coastal communities basically in tourist areas. In extreme cases, people may avoid visiting a beach or tourist area if it is full of the litter with hazardous and unaesthetic items such as sanitary and medical wastes.

**25. Losing Ecosystem Service**

Marine and coastal ecosystem provide a wide range of service to the human society. These are: provisioning, supporting, regulating and socio-cultural services. The country's ecosystem is comprised of fisheries, mangroves, beaches, coral ecosystems, plankton, sea grasses and seaweeds that provide a range of provisioning and cultural services. Usually, the coastal and marine fishery species are commercially important and also serve as essential sources of animal protein, income, employment, and foreign exchange earnings. Peoples get important provision of services from mangrove ecosystem, which also supplies fish, shrimp, honey, wax, wood, medicinal plants, fodder etc. Marine provisioning services can also support blue growth areas of aquaculture and blue biotechnology. Due to environmental pollution, the coast has already lost a lot of marine species including fishes and mangrove forests. ("BLUE ECONOMY FOR BANGLADESH - Ministry of Foreign Affairs-" 2021) Coastal deforestation, degradation, beach pollution, and other pollution sources are causing havoc to the ecosystem service. This pollution affects the marine biodiversity and blue economy of the whole country (Figure 8).

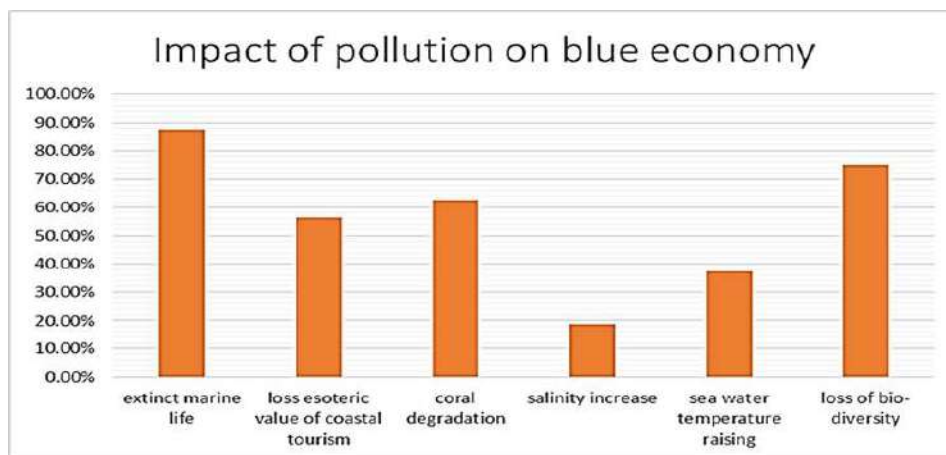


Figure 8: Impacts of marine pollution on the blue economy of Bangladesh (Compiled by researcher).



## 26. Impact on Human Health

Peoples can directly be affected by marine litter in the form of physical damage, for an example, injury from broken glass, medical waste and floating or submerged debris. Chemicals, toxins or other harmful particles such as viruses or bacteria in the water can cause indirect health impact e.g., medical wastes like syringes, bandages, etc. and sewage also pose a serious health hazard through transmission of infectious diseases. Marine pollution also affects People's livelihoods as polluted water and beaches does not attract tourists. As a result, it creates impact on the income of coastal communities. Peoples live in coastal areas are also affected by household activities such as by taking bath in contaminated water or by using water in cleaning purposes. The detrimental effects of coastal water pollution on human health are summarized in Figure 9.

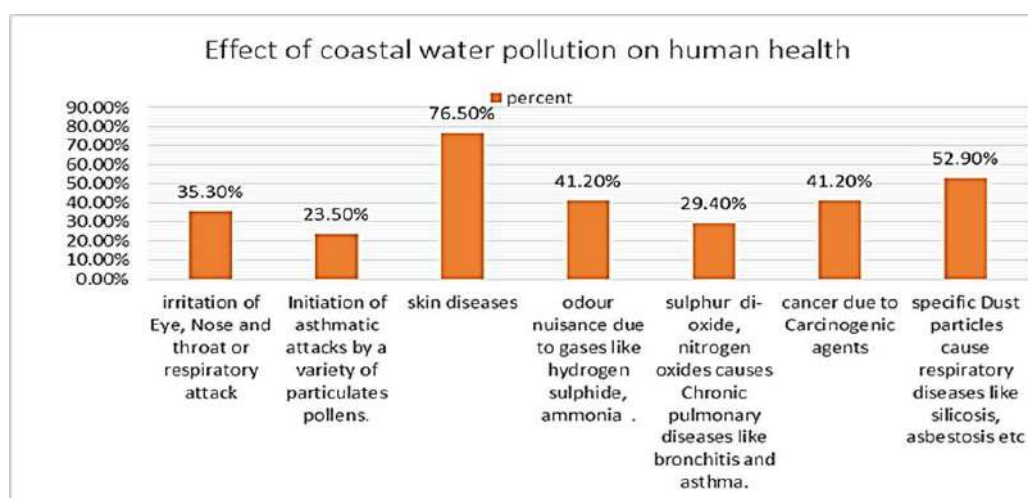


Figure 9: Impacts of water pollution on human health in Chittagong (compiled by researcher).

## 27. Suggestive Strategies to mitigate marine pollution

The prevention of pollution is the initial stage at the reduction of pollution from lower to high level of the source to achieve a pollution-free environment. It leads to fostering a safe environment. The followings strategies should be undertaken to mitigate marine pollution from the Bay of Bengal ecosystem:

### 1. Introducing Green Tax

The green tax or eco-tax or environmental tax is an initiative to ensure green development, which helps to avoid hazardous production systems. It is important to

introduce a green tax from the local level. Identifying the main source of pollution, its impact on the environment, and imposing an eco-tax is a good step for the country's economy and environmental safety. Bangladesh government has also emphasized the green development to minimize the negative impacts of climate change and also introduced a new "green tax" in the budget of 2014/2015 against factories that produce high levels of pollution. ("Bangladesh Introducing 'Green Tax' Against Factories - Industry Tap" 2021) But it is essential to provide a green tax at every point where the pollution generates. The government can also impose green tax on tourism to protect natural beauty .it is true that a green tax makes our blue economy more sustainable and also help the country to achieve SDGs 14.

## **2. Increasing Safety Culture Practice Onboard ships**

To prevent accidents on ships, the international maritime organization has declared that from 1st July 2002, the use of ISM (International Safety Management) code is mandatory for all commercial ocean-going ships and yachts (which can carry more than 500 gross tonnage) to provide an international standard for the safe management and operation of ships and the prevention of pollution. However, several recent incidents suggested that the absence of a fully implemented 'Safety Culture' onboard ships is still a problem. Such a culture is not fully maintained by the ship's crew. They are less willing to inform the company or a captain about their errors and other safety problems because they are afraid of being punished or prosecuted. As a result, Managers and captains are not capable of making the proper decisions to improve safety. This problem can be minimized by adopting a 'just culture' that encourages and rewards people even providing a guarantee for confidentiality. It is an important issue that companies should provide training and information to the employee about their approach to adopting a 'just culture'

## **3. Installation of New Technologies**

### **a. Controlling Oil Spill**

If an oil spill occurs and spreads quickly, it is essential to clean up the spill as soon as possible to minimize danger and damage to persons, property, and the environment. Oil spill causes evaporation, dissolution, emulsification, and oxidation and also causes biodegradation. To combat oil spills, different types of containments and equipment like oil containment booms, skimmers, absorbents, dispersant and spraying system, ("Plastic Pollution: Cleaner Seas and Plastic Recycling with Norwegian Technology - The Explorer" 2021) etc. are used in developing countries by installing such updated technology, country can save the environment from accidental oil pollution.

#### **b. Reducing Plastics Pollution**

The Government of Bangladesh took the initiative to decrease the use of plastics through enacting the 'Mandatory Jute Packaging Act, 2010'. The unfortunate issue is that since plastic bags are cheaper than jute bags, so using polythene is still running and contributing to marine litter. Although people are not maintaining any rules and regulations in our country. In European countries like Norway, they use block chain technology for reducing plastic pollution from the beach area. This technology aims to reduce plastics by recycling stations that provide an incentive to people who deposit picked up plastic waste from the beaches. The financial incentive can be an efficient approach for waste collection in our country.

#### **4. Increasing Environmental knowledge and Awareness**

Starting education about the dangers of marine pollution is extremely necessary for us. By receiving education, peoples can apply the right attitudes when dealing with the environment. It can be started by the integration of environmental education in the curriculum of all school levels. Educational activities get the people informed and help to protect the environment, and this should be encouraged. It helps to enhance critical thinking, problem-solving and effective decision-making skills and can help in protecting the environment. Awareness-raising activities, such as campaign about environmental awareness can help people to know about their activities, which can contribute to pollution control. Another thing is that supporting, appreciating, and rewarding people for not doing any harmful act can help in the awareness generation program. Besides, environmental education and awareness programs can improve an esthetic sense of an individual.

#### **5. Stakeholders Engagement**

To achieve a successful marine and coastal resource, establishment of network among different stakeholders such as managers, policy-makers, civil society, general scientists and specialists, marine service providers and geo-spatial technology stakeholders is necessary. Stakeholder engagement and communication are difficult to achieve sustained funding and actually reap the advantages of integration and joint prioritization in the field of marine and coastal observation. Stakeholders can play a basic role in building, evolving, and sustaining integrated resource management systems. Stakeholders and users should be identified for managing the resources sustainably. Ultimately, by engaging all stakeholders and creating successful partnerships, it is possible to improve economic, societal, and environmental benefits from sustained integrated marine and coastal resources observing systems.

## **6. Implementing and Strict the Existing Laws**

If we go back in 2015, the UN general assembly adopted the 2030 Agenda for sustainable Development, which had aims include “prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution” by 2025. But the concern is that this goal seems very difficult to achieve in our country, because waste management systems and the relevant legislation are very slack. If this pollution continues, it will certainly destroy the total coastal and marine ecosystem, imbalance, and hinder sustainable development. For the survival of human and sustainable development, it is time to comply with the duty to protect the marine environment, and adopt and strict laws and regulations to prevent, reduce, and control pollution. Some of the laws concerning marine pollution were acted a lot of years ago and have not been updated yet. Due to the lack of comprehensive marine environment laws in Bangladesh, there has been limited success in preventing and controlling marine pollution. The government should have to give concentrations on existing regulations and also think forward to implement new laws against marine pollution.

## **7. Adaptive Management**

Adaptive management is a systematic approach to learn by doing the process. It is a tool, which not only used to change a system but also to learn about the system. Because adaptive management is based on a learning process, (Sakib, n.d.)it allows the identification of new research and information which can improve the next round of management and give long-run management outcomes. Through adaptive management, coastal and ocean management programs should be designed to meet clear goals and help to provide new information to improve them for future management. It helps to identify more effective measures for controlling marine pollution and achieve the planned objective.

## **8. Cross Boarder Coordination**

Finally, a cross-border approach is too much essential to address common environmental challenges because natural resources, such as the sea, have no boundaries, and pollution reduction cannot be fully minimized by a single country to the desired improvements in environmental protection. The essential steps will reduce the risks of marine pollution from hazardous waste through the joint cross-border strategies that will integrate the law on the use of technologies in the cleaning of water as well as waste management. Cross-border cooperation allows to exchange of knowledge and best practices between their partnering countries. Using new technologies, cross-border cooperation will help to know another country as well as influence the growth of the area's competitiveness, for superior environmental quality.

## 28. Conclusion and Recommendations

This study has discussed the possible effects of pollution in the coastal areas of Chittagong, which create adverse impact on fisheries, habitat destruction, chemical reaction on human body and food chain, loss in aesthetic value of beaches and affect tourism activities as well as the entire economy of the country. For this reason, effective solutions must be needed that require a substantial financial investment and time. Immediate actions are needed to overcome the situation on an emergency basis. Government bodies, agencies, international organizations and NGO's should give their attention to mitigate the coastal pollution.

### Here, some of the recommendations are summarized as follows:

1. The government should immediately start to charge fines for damaging ecosystem and also strictly implement the "polluter pays" principle for the defaulter to pay all the cleanup and compensation to all affected people.
2. The Chittagong Port Authority must assess the economic and environmental impact of marine pollution and establish an effective monitoring system. It should be better understood to prioritize and inform changes in pollution control policies.
3. Picking up plastics or marine litter is an easy solution to reduce pollution from our beaches. The Chittagong City Corporation should adopt a litter control policy and give the responsibility to the private agency for the weekly marine litter cleanup campaign.
4. Rising public awareness through television, radio, social media, and website can help introducing the public to the impact of pollution, reduce the improper disposal of waste, and develop innovative approaches to reduce marine pollution. The Ministry of Shipping can carry out workshops with the participation of scientists, environmental specialists and professionals in marine sector to define the potential solutions of marine pollution.
5. All ports should have waste reception facilities for the disposal of ship-borne waste and enhance ship monitoring system aid for surveillance. The Port authorities of Chittagong, Mongla and Payra should establish such facilities immediately.
6. The Government should obtain international support for the installation of new technology and increase cross border cooperation in the context of marine pollution.
7. The Ministry of Shipping should give urgent emphasis to review the legal and regulatory instruments and standards in place for dealing with ship-sourced and land-based pollutions.

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