Pollution and Small-Scale Fisheries

Impacts of Shipbreaking Activities on the Chattogram Coast

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Ships beached to be dismantled on the Chattogram coast. (Photo: Md. Abu Redwan Khan, 2022).

Hundreds of small-scale fishing communities live along the Chattogram coast in Bangladesh's southeast area. They have maintained their hereditary rights to the adjacent coastal space for fishing and other ancillary activities such as beaching boats and drying nets. However, the expanding shipbreaking industry threatens their tenure rights and livelihoods. Being extremely hazardous, shipbreaking industry was evicted from developed countries in the 1960s and has since gradually established a foothold in developing countries. Based on fishers' perceptions and literature review, this chapter assesses the impacts of shipbreaking on the coastal environment and small-scale marine fisheries. Pollutants discharged from shipbreaking yards affect the surrounding marine ecosystem and biodiversity, having a devastating impact on small-scale fisheries. The quantity and variety of fish species have decreased dramatically as the industry has grown. Fishers are confronted with enormous obstacles; fishing effort has increased, while catch per unit effort has reduced. They are also competing for coastal space at an increasing rate, putting their fishing and fishing-related activities in jeopardy.

Introduction

Shipbreaking is the process of dismantling ships to reuse the parts and scrap recycling, with the hulls being discarded in ship graveyards and materials such as steel and wood being extracted for reuse or recycling. During the shipbreaking process, almost all of the ship's total weight can be recovered for recycling or reuse, making ship breaking an environmentally friendly exercise that reduces the need for mining and raw metal manufacturing (Neşer et al., 2008). On a micro-scale, however, due to weak environmental and labour legislation in developing countries, toxic materials are frequently disposed of and spilled from scrap yards, causing havoc on the surrounding coastal ecosystem and marine biodiversity (Mikelis, 2008; Hossain et al., 2016). Until the 1960s, shipbreaking activities were mostly centralized in highly industrialized countries like the USA and Europe. However, stricter labour and environmental legislation have gradually made it economically unfeasible for these industries to operate in western countries. Eventually, in the 1960s, shipbreaking activities went to South Korea and Taiwan, and then, in the 1970s, to India, Bangladesh, Turkey, and Pakistan (Frey, 2015).

In Bangladesh, the long, flat, and uniform intertidal zone in Chattogram has provided ample space for beaching and dismantling ships. Further, a lack of environmental awareness, weak environmental regulations, inconsistent law enforcement, cheap labour, and substantial local demand for iron and steel drive the shipbreaking activities in Bangladesh. The industrialists of the Chattogram region took advantage of the situation and established a shipbreaking industry along the Bay of Bengal. Over the years, as predicted, weak environmental legislation and industry owners' reluctance to maintain standards have allowed large quantities of highly hazardous substances from shipbreaking yards to escape into the environment, blending primarily with the beach soil and seawater around them. Oil and greasy compounds, persistent organic pollutants (POPs), asbestos, and other trace and heavy metals are among the toxic wastes accumulated in the marine biota (Hossain & Islam, 2006).

The physical and chemical characteristics of soil and seawater have changed significantly in shipbreaking areas over the last few decades. The high turbidity of wastewater generated from shipbreaking has caused a higher concentration of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), electric conductivity (EC), and a lower concentration of dissolved oxygen (DO). In addition, the presence of ammonia (NH3), oil, and grease in the wastewater, elevated the seawater pH value around shipbreaking areas (Hossain et al., 2016). Toxic pollutants have caused low abundances of phytoplankton, zooplankton, benthos, and microorganisms, leading to an increase in trash fish and a decrease in fish species diversity, and even death. As a result, the catch per unit effort (CPUE) has been reduced by more than half compared to the last few decades (Barua, 2011).

The social cost of the shipbreaking activities is also immense. Shipbreaking activities harm the communities around the entire Chattogram coast and beyond, where small-scale fishing communities are most affected. Hundreds of fishing communities are located along the Chattogram coast, from Mirsharai to Patenga, and thousands of fishers, predominantly lower-caste Hindus, fish in the neighbouring coastal waters. The negative consequences of shipbreaking activities have jeopardized these fishing communities' livelihoods and health conditions. This chapter assesses the impacts of shipbreaking on the coastal environment and small-scale fisheries based on a literature review and individual interviews.

Major pollutants and impacts on fisheries biodiversity

Oil

Black oil residues from dismantled ships are frequently mixed with beach soil and seawater near the shipbreaking yard and are mainly composed of hydrocarbons and sulphur-containing chemicals. Mineral oils that get spilled from shipbreaking are usually present in hydraulic fluids, oil sump (engine, lubricating oil, gear, separator, etc.), and oil tank residuals (cargo residues) (Hossain & Islam, 2006). Because of the old-fashioned beaching approach, engine oil, bilge oil, hydraulic oil, lubrication oil, and grease are inducing acute toxicity, reducing light intensity in seawater, and inhibiting oxygen and carbon dioxide exchange across the air-seawater interface. As a result, the growth and diversity of marine species, including plankton, fish, marine mammals, and benthos, get seriously affected, posing a threat to coastal and marine biodiversity as a whole (Hossain et al., 2016).

Oil spills have adverse effects on both fish and humans. Adult fish exposed to oil may experience stunted growth, enlarged livers, heart and respiration rate abnormalities, fin erosion, and reproductive issues. Fish eggs and larvae are particularly vulnerable to both fatal and sublethal effects. Many young fish species spend their early life stage in shallow vegetative regions (less than 10 meters) and become susceptible to the hazards. Furthermore, fish and shellfish exposed to oil-related hazards become unsafe for human consumption (Saadoun, 2015).

Heavy metals

On ships, heavy metals can be found in paints, coatings, anodes, and electrical equipment, among other places. These are dismantled and reused without precautionary safeguards in place. As a result, these parts are frequently thrown or burned on beaches, polluting the nearby soil and water (Hossain & Islam, 2006). Heavy metals are not biodegradable and can accumulate at dangerous levels in aquatic habitats. The benthos (benthic creatures) accumulates the metals and eventually get integrated into the bottom sediment (Shah, 2017). Off all the heavy metals secreted from the shipbreaking activities, lead (Pb), mercury (Hg), cadmium (Cd), iron (Fe), aluminum (Al), zinc (Zn), copper (Cu), chromium (Cr), and manganese (Mn), pose the most significant hazards (Hossain et al., 2016). Fish suffer from delayed hatching, a reduction in body defense systems, and increased mortality because of the elevated concentration of heavy metals. For mollusks, delayed development and maturation systems happen due to the presence of heavy metals. The ingestion of heavy metals causes increased mortality, delayed development, and irregular cell division of crustacean species, while benthos becomes irregular in structure, face retardation of growth, and acute toxic conditions at the bottom (Ansari et al., 2004).

Persistent organic pollutants (POPs)

Persistent Organic Pollutants (POPs) are carbon-containing toxic chemical substances that do not degrade quickly, tend to accumulate in food chains, and pass from one species to the next through the food chain. Due to their high persistence and toxicity, POPs continue to pose a risk to the environment, and aquatic lives, especially benthos and organisms at the top of the food chain (fish), get exposed to high levels of POPs through bioconcentration and biomagnification (Miniero & Iamiceli, 2008). Marine vertebrates at early life stages face negative consequences at much lower concentrations than those in juvenile and adult stages because crucial biochemical and molecular processes occur during tissue differentiation and organization. For example, POPs disrupt thyroid function in fish, which affects their development, metabolism, and growth (Johnson et al., 2013). POPs include various toxic chemicals, but the ones that are released from shipbreaking activities cause significant harm to marine organisms.

Polychlorinated biphenyl compounds (PCBs)

PCBs are a group of man-made organic compounds with 1–10 chlorine atoms attached to a biphenyl molecule. PCBs drew much attention from scientists due to their toxicity, resistance to degradation, ability for long-distance transport, and proclivity to bioaccumulate via food chains (Johnson et al., 2013). Ships dismantled in Chattogram often contain POPs in cables, electrical equipment such as capacitors and transformers, gaskets, watertight seal material, and painted surfaces (Hossain et al., 2016). PCBs released from shipbreaking activities continue to settle in the sediment and are accumulated by the marine invertebrates such as amphipods that feed on benthic animals. This way, the PCBs pass through the food chain through different trophic levels. Since the fish consume many amphipods, the number of PCBs in their bloodstream increases over time. As a result, the effects of PCBs in benthos are amplified because they accumulate in the tissue of higher trophic feeders, such as humans.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are a chemical group with two or more condensed aromatic rings primarily formed during the incomplete combustion of organic matter. The toxicity of PAHs has negative consequences on marine animals, especially fishes. Endocrine disturbance, immunotoxicity, and embryonic development are among the effects these chemicals have on fish. During the early development of fish, the heart is vulnerable to chemical pollutants such as PAHs, and any disturbance of cardiac function influences fish survival at all life stages (Honda

& Suzuki, 2020). PAH exposure induces bone disruption in fish and marine mammals, causing bone metabolism. In addition, benthic or bottom-feeding fish living in habitats contaminated by PAHs suffer from bioaccumulation that harms liver metabolism (Johnson et al., 2008). Similarly, PAHs induce a detrimental impact on the formation, growth, osmoregulation, behaviour, and reproduction of different marine organisms. PAHs released from shipbreaking activities are also genotoxic and carcinogenic for humans. They interfere with enzymatic degradation, causing malignant tumors in the lungs, stomach, intestine, and skin (Collier et al., 2013).

Polyvinyl chloride (PVC)

PVC is a thermoplastic polymer widely used worldwide on many ship machinery and materials. PVC waste is difficult to dispose of at the end of its use because, when burned, it releases hydrogen chloride (HCl) fumes. When buried, it releases toxic chemicals into groundwater and the atmosphere. PVC is persistent and estimated to take up to hundreds of years to decompose completely. Some of them break down into tiny particles much quicker, which in turn end up in the stomachs of marine fish, and ultimately in the human body through seafood consumption. In addition, PVC can promote pathogen growth in the ocean, making marine organisms vulnerable to diseases (Lusher et al., 2017).

Table 1. Pollutants discharge from shipbreaking activities and impacts on fish species

Pollutants	Impact on fish species
Oil	▪ Fatal and sublethal effect on eggs and larvae. ▪ Stunted growth, enlarged livers, damaged heart and respiration rates, fin erosion, and reproduction problems of adult fish.
Heavy Metals	▪ Delayed hatching, a reduction in body defense systems, deformities, and increased mortality in fish species. ▪ Bioaccumulation within the food web.
Polychlorinated Biphenyl Compounds (PCBs)	▪ Reproductive and immunological complications, as well as hormonal imbalances. ▪ Bioaccumulation within the food web.
Polycyclic aromatic hydrocarbons (PAHs)	▪ Bone disruption, liver metabolism issues, endocrine disruption, immunotoxicity, disturbance of cardiac function, and severely affected embryonic development.
Polyvinyl chloride (PVC):	▪ Anthropogenic stressor. ▪ Accumulates in the stomachs of fish.

Organotins

Organotins are a group of nerve toxins. Tributyltin (TBT) is a toxic organotin (that kills living organisms) used in anti-fouling paints since the 1970s. TBT is considered one of the most toxic compounds that disrupt the endocrine system of marine shellfish, leading to the development of male characteristics in female marine snails. TBT also has an endocrine-disrupting effect on fish (Hossain & Islam, 2006).

Change in physicochemical properties of seawater and its impacts on the food chain

The marine ecosystem is made up of a complicated food chain that connects primary producers such as phytoplankton to various levels of consumers. The entire marine food chain depends on the abundance and composition of primary producers, zooplankton, and benthic organisms and how they respond to water quality changes (Lipi et al., 2020).

The physicochemical properties of seawater and sediments have a substantial impact on the state of the food web. Over the last few decades, shipbreaking activities in Chattogram have increased total suspended solids (TSS), total dissolved solids (TDS), turbidity, and biochemical oxygen demand (BOD) in the surrounding areas. Shipbreaking activities also reduced dissolved oxygen (DO) levels, indicating a disruption in the food web (Hossain & Rahman, 2011). Firstly, oil floating over vast areas inhibits light penetration and reduces photosynthesis, resulting in lower primary productivity, i.e., phytoplankton production. Phytoplankton is the primary food producer of the aquatic habitat and forms the base in the food chain. The composition of zooplankton, an intermediary species that transmits energy from phytoplankton to larger carnivores, in the shipbreaking area of Chattogram is much lower than in the non-shipbreaking area (Khan et al., 2015). Finally, sediment pollution in shipbreaking sites inhibits the growth of benthic organisms. Benthic bottom-dwelling organisms are ecosystem architects because they create optimal conditions for fish spawning, shelter, and foraging. The absence and presence of numerous taxa of benthic organisms in shipbreaking areas, both of which are pollution indicators, demonstrate the negative effects of shipbreaking activities on the quantity and variety of benthic organisms (Lipi et al., 2020). Changes in phytoplankton, zooplankton, and benthic organism abundance and diversity due to changes in physicochemical parameters have resulted in a drop in fish species populations and diversity in the shipbreaking area. Additionally, the higher turbidity increased BOD and COD and decreased DO elevate anthropogenic stress, making fish species vulnerable to other physiochemical changes. According to the fishers interviewed, the number of trash fish has increased, several commercially important fish species are endangered, and overall fish abundance has declined. Although fishing efforts have grown significantly, the catch has decreased by 50-60% (Barua, 2011).

Competition with coastal space and impacts on fishery-based livelihoods

The shipbreaking yards are located in the Salimpur-Kattali region, and the region is one of the most ecologically productive coastal regions. Thousands of hereditary lower caste fishers live in this region. Horizontal shipbreaking yard expansion along the coast makes fishing communities vulnerable in several ways. For example, it increases competition between fishers and shipbreakers for space. An interview with local fishers revealed that the beach along the seashore, which used to be utilized by fishers for drying nets and anchoring boats, is now exposed to encroachment by shipbreaking activities (Figure 1). Similar to coastal land space, the water space is also exposed to encroachment by the imported ships waiting to be dismantled.

Figure 1: Shipbreaking activities have taken over coastal space previously used for beaching boats and drying nets by small-scale fishing communities (Photo: Md. Abu Redwan Khan, 2022).

On the Chattogram coast, small-scale fishers maintain hereditary entitlements in the fishing, known as *Pata*. The *Pata* is subdivided into smaller parts known as *Faar*, where the fishers set Estuarine Set Bag Net (ESBN). The ESBN is the stationary main fishing gear for the coastal fishing communities. These fixed fishing nets are frequently clogged with spilled oil and debris from shipbreaking activities. The fishing gears are frequently damaged when ships are brought to the shore for dismantling. The fishers are given no advanced notice of ships moving into the coast in most cases. One of the fishers explained, "*during the pick-season of the hilsa fish harvest, i.e., August – September, is when the most ships come to the Chattogram coast for dismantling purposes, and this is the time when we must catch enough fish to repay our dadon (loan taken from a moneylender/middleman) back. That situation leads to more damaged nets and less fish catch.*"

The shipbreaking activities are detrimental not only to the coastal environment but also to the coastal fishing communities. The fishers also perceived a direct link between the expanding shipbreaking activities and the decreasing fisheries resources in the coastal areas. The fishers argue that pollutants discharged from shipbreaking are killing delicate juvenile species and forcing fish species to migrate away from the coastal areas. Fishers reported that previously they used to catch a good quantity of fish of different species. However, with increased shipbreaking activities, the diversity of fish species and the Catch Per Unit Efforts (CPUE) is declined. One of the respondents said, "*a couple of decades ago, different highly valued fish species were available in the mangrove creeks along the shore, but now most fish have disappeared.*" This makes small-scale fishers move deeper offshore in search of fish. Nevertheless, they lack the appropriate fishing equipment and face increased competition from large-scale fishing trawlers. One respondent reported "*our ancestors did not go beyond one or two miles from the seashore for fishing, but now we are venturing beyond eighteen to twenty miles and yet returning mostly empty-handed.*" Further, small-scale fishers compete with the industrial fishers for fishing space in the coastal areas. The industrial fishers are supposed to fish beyond the 40-meter depth of coastal water, but often they fish within the 40-meter range, which increases conflicts between those groups. Fishers are aware of the severe environmental repercussions of oil spills caused by shipbreaking activities and the reasons for the depletion of fisheries' resources. "*If tars come in contact with our faces, we can't breathe," one respondent explained. "Similarly, if black oil is spread over the seawater, the fish can't receive oxygen from the air.*"

The survival of fishing communities is in jeopardy as more ships are beached, fishing sites are occupied, and increasing fishing efforts and lower CPUE. Fishing communities have continued to move away from their traditional way of life, which had existed for generations before the growth of the shipbreaking industry. Many fishers have left their communities and migrated to cities, searching for jobs in different parts of the country. Furthermore, shipbreaking yard owners frequently compel fishers to sell their property at a low price to expand their operations, leaving the fishing village shrink. These vulnerable fishing communities have hardly received any support from the government and other organizations. The neighbouring fishing villages have been suffering from unfavourable and adverse conditions for more than three decades. They have submitted several complaints to the governing authorities about uncontrolled shipbreaking and its negative impacts. However, none of them has resulted in any action. One of the respondents stated that "*my memory stretches back to 1991 since when I witnessed my community submit several complaints to authorities, speak with local elected public representatives, and even stage protests on the street, but none were effective.*" Overall, the future of fishery-based livelihoods is uncertain since the owners of the shipbreaking business are wealthy and powerful, and law enforcement is lenient.

Conclusion

While shipbreaking activities on the Chattogram coast have a positive contribution to Bangladesh's economy, these benefits overwhelmingly go to the powerful section of society that import and dismantle the aged ship. This shipbreaking activity imposes enormous environmental and social costs. Unfortunately, small-scale fishing communities are bearing this cost disproportionally without benefiting from shipbreaking activities. The shipbreaking activities on the Chattogram coast illustrate one example of how small-scale fisheries are increasingly marginalized due to ocean-based economic activities. In this context, any policy regulating shipbreaking activities in Bangladesh should emphasize social justice for the affected people, including small-scale fishing communities.

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