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A Study on Marine Plastic Debris from Local Ship in Mongla Port Area

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Abstract

Marine life faces a critical threat from escalating marine plastic debris, notably in rivers and oceans, originating from both land and rivers, with ships, especially local ones, being major contributors. Focusing on Mongla Port, Bangladesh's second-largest port situated within a vital mangrove forest, this study aims to profile the scale and forms of plastic waste generated by local vessels. A survey involving 100 randomly selected local ships was conducted to gather plastic waste management data. Waste bins were distributed on these ships, and waste was analyzed through a sieve and modular screen methods. The study revealed that local ships predominantly produce plastic cooking oil bottles and polythene bags of different sizes, averaging 8 to 10 bottles and 21 to 30 bags per month. Regrettably, 20% to 30% of ships discard these plastics into rivers, 30% onto nearby shores or Mongla Port Municipality landfill, while 40% sell them to buyers arriving in small boats. This underscores the substantial contribution of local ships in Mongla Port to marine plastic debris. Urgent waste management strategies are imperative for material flow control and sustainable practices in the maritime industry.

Keywords: *Local Ship; vessel; Mongla Port; Marine debris; plastic; Material Flow Analysis.*

1 Introduction

Marine pollution has become a burning question in the present. Oceans and seas becoming polluted by different types of waste like solid waste, sewage, industrial waste, etc. This waste contains paper, metal, cloth, plastic, etc. (Schneider et al., 2018). Among this waste plastic debris is the most harmful material due to its complex bonding (Barnes et al., 2009). This debris comes to the ocean from four sources: Land (via waterways; 44% or through the atmosphere 33%); Maritime activity (12%); other Rest (11%) (Potters, 2013). The UNEP (2021) estimated that about approximately 8 million metric tons of plastic waste enter the world's oceans each year. If this plastic somehow enters the human body from the food chain, then toxins and other harmful chemicals ultimately harm human health (Jambeck et al., 2015). Each year About 1.15-2.41, metric tons of plastic waste flow into the ocean from the global riverine system (Ardiansyah et al., 2022). It can be said as 95% of plastic waste enters the ocean via rivers, and 10 rivers are mainly responsible for this (Schmidt et al., n.d.). Eight of those rivers are in Asia and the remaining two are from Africa. Bangladesh is a riverine country and most of the rivers are connected by the sea. A total of 0.12-0.31 million metric tons/year of plastic marine debris enters the coastal areas of Bangladesh (Chowdhury et al., 2021). The geographic connectivity of Bangladesh with the Bay of Bengal, coupled with the proximity of its cities to riverbanks, contributes to the entry of plastic marine debris into its coastal areas. Over the past 15 years, there has been a notable threefold increase in annual per capita plastic consumption in urban areas, rising from 3.0 kg in 2005 to 9.0 kg in 2020 (Mourshed et al., 2017). As this plastic waste infiltrates, the marine environment, it transforms into a hazardous substance, posing a gradual yet significant threat to the marine ecosystem and overall environmental sustainability. The proliferation of marine plastic debris is a global concern, and its impact is felt in the waterways of Bangladesh as well. Situated in the southwestern part of the country, Mongla Upazila in the Bagerhat District of Khulna Division (Hossain et al., 2016) boasts the world's largest contiguous mangrove forest. Bounded by major rivers, the Indian border to the west, and the Bay of Bengal to the south (Amin et al., 1970), this region holds immense ecological significance. Mongla serves as the second-largest port in Bangladesh and has witnessed a surge in importance due to expanding marine trade and capacity constraints at the Chittagong port. The government has made substantial efforts to enhance port infrastructure and performance, including dredging the Pussur channel and integrating the Padma Bridge. These developments have boosted the port's container and cargo handling capacity, playing a crucial role in the growth of industries such as the Rampal power plant, Mongla EPZ, Special Economic Zone, and jute industry restoration. Additionally, the port plays a vital role in connecting Nepal and Bhutan, with an ongoing exploration of opportunities for regional collaboration (Khondoker & Hasan, 2020). However, the heavy influx of ships, approximately 1000 to 1500 foreign ships and 8400 to 12000 local ships per year, respectively, pose the risk of introducing marine plastic debris into the Pussur River. Regrettably, limited research has been conducted on the scale and characteristics of plastic waste generated by local ships in the Mongla Port area. Therefore, the primary objective of this study is to examine the sources, composition, and distribution of plastic debris originating from local ships in the Mongla Port area. The findings will offer valuable insights into the nature and magnitude of the marine plastic pollution problem in this region, ultimately informing the development of effective mitigation strategies.

2 Methodology

2.1 Study Area

Mongla, situated at 22.4833°N 89.6083°E in Bangladesh's Bagerhat District, is a pivotal municipality in the Khulna Division. It boasts the world's continuous mangrove forest and is enclosed by rivers, the Bay of Bengal, and the Indian border. As Bangladesh's second-largest seaport, Mongla plays a crucial role in the nation's maritime trade, particularly due to capacity limitations at Chittagong Port. Government initiatives, such as dredging the Pussur channel and integrating the Padma Bridge, have enhanced its infrastructure and cargo capabilities. The port is essential for industries like the Rampal power plant, Mongla EPZ, Special Economic Zone, and the jute sector. Additionally, it aids regional collaboration between Nepal and Bhutan. The port hosts a significant volume of foreign and local ships, potentially contributing to marine plastic debris in the Pussur River. This study focuses on Mongla Port's role in this context (Khondoker & Hasan, 2020).

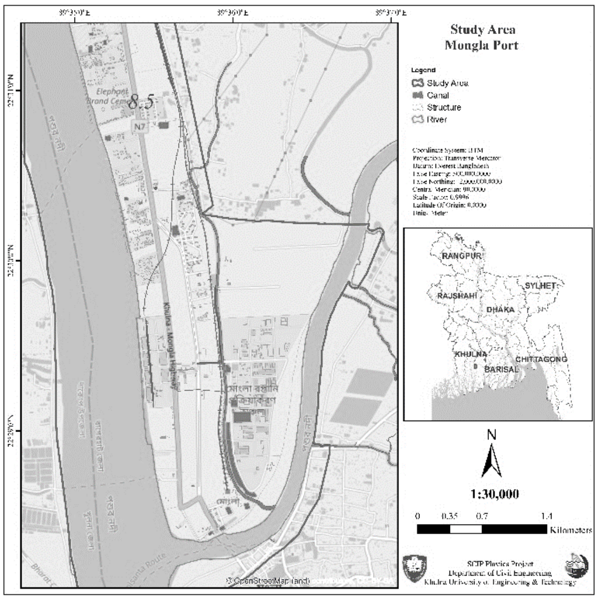

Figure 1: Map of the study area

2.2 Marine Debris

Gall & Thompson (2015) define "marine debris" as any solid substance that is manufactured or processed, durable, dumped, disposed of, or abandoned in the marine or coastal environment, including items made or lost by people, intentionally or unintentionally. This includes a range of items such as plastic, wood, metal, glass, rubber, clothing, and paper, which may be intentionally discarded or lost in the marine environment (Schneider et al., 2018). Numerous studies have consistently shown that plastic is the most common type of marine debris globally, making up 60% to 80% of total marine litter depending on the source (Alagha et al., 2022; Black et al., 2020; Gall & Thompson, 2015; Schneider et al., 2018). Marine Plastic debris can be classified according to size, material & chemical composition, based on the literature review the types of marine debris according to size are shown in Table 1.

Table 1: Marine debris size

Reference		Classification	Size
Authors Name	**Name of the Journal**		
Loganathan & Kizhakedathil, (2023)	A Review on Microplastics- An Indelible Ubiquitous Pollutant	i. Macro	>20mm
		ii. Meso	Between 5mm and 20 mm
		iii. Mega	>100mm
Xiang et al., (2022)	Microplastics and Environmental Pollutants: Key interaction and toxicology in aquatic and soil environments.	i. Macro	>20mm
		ii. Meso	Between 5mm and 20 mm
		iii. Mega	>100mm

2.3. Data Collection:

For this study, a questionnaire survey was conducted on 100 local ships. Based on the survey, waste bins were provided to the local ships. The survey was carried out by first visiting the Pussur River and identifying the types of ships that arrive at the Mongla Port. A boat was hired to survey the area and conduct the questionnaire survey. The questionnaire was administered by randomly selecting willing participants from the local ships.

2.4 Waste sample collection

In Mongla Port about 700-1000 local ships come to collect material from mother vessels. They stay there for 7 to 10 days and start their voyage again (Roksana et al., 2023). About 15 to 1 month later they come to Mongla Port. To collect samples from the local ship firstly questionnaire survey was done. Based on those questionnaire surveys the ships who were willing to assist in this research a bin was given to them. The following information was taken: the ship’s name, the respondent person’s name, phone number, and the next probable arrival time at Mongla Port; to collect plastic waste from them. Figure 2 shows the waste bin distribution to local ships/vessels.

Figure 2: Waste bin distribution to local ship

2.5 Waste Sorting and Weighting

The plastic waste from nearby ships was gathered and labeled with the corresponding ship's name and weight. Next, it was taken to the waste laboratory of the SCIP Plastics Project for sorting via sieving. Two types of sieves were used: a Rotatory Drum sieve with a 120mm sieve size and an Individual Modular Screen sieve with sizes of 40mm and 10mm. Any plastic waste that was retained through the 120mm sieve was collected in a bucket, weighed, sorted, and weighed individually. The plastic waste that did pass through the 120mm sieve was then placed on the Individual Modular Screen and subjected to the same process of weighing and sorting as before (shown in Figure 3)

a) Total Weight b) Empty Bucket Weight c) Cooking oil bottle Weight d) Poly Bag Weight

Figure 3. Plastic waste weighting and sorting

2.6 Material Flow Analysis (MFA)

MFA measures material flows in a defined system, following mass conservation where the entering mass stays within the system. The mathematical expression of the mass balance for a given system is as follows (Brunner & Rechberger, 2016; Bureecam et al., 2018)

$$\sum INPUT = \sum OUTPUTS + \Delta STOCK \ldots\ldots\ldots\ldots\ldots (1)$$

Conducting a material flow analysis allows for the identification of sources and rates of plastic waste generation. Notably, several prior material flow analyses have been undertaken in Khulna City, as evidenced by studies conducted by Bari et al., 2012; Moniruzzaman et al., 2011, with a focus on recycling shops. From the provided definition, it becomes clear that a crucial first step in conducting an MFA involves delineating a system boundary. For the study in question, the boundary was set within the Mongla Port area, where local ships anchor. The materials of interest encompassed all types of plastic waste originating from these local ships.

3 Results and Discussion

3.1 Ship Characteristics, Waste Management Practices, and Waste Disposal at Mongla Port: Key Findings

This section covers the primary findings from a questionnaire study done at Mongla Port, with an emphasis on ship characteristics, waste management procedures, and waste disposal. The survey sought information on the sorts of vessels operating in the port region, their waste management techniques, and the disposal of plastic waste. The findings shed light on critical areas of ship operations and waste management, giving significant information for understanding the then-current condition of waste management at Mongla Port. The questionnaire survey found that all the local vessels originated in Bangladesh. Their crew members range from a minimum of 9 members to a maximum of 12 members. Some vessels' voyage path is Mongla to India, Mongla to Noapara, Mongla to Dhaka, etc. But maximum vessels go to India. Most of the vessels carried coal, clinker, gypsum, fly ash, fertilizer, slag, food grains, etc. Depending on the materials being unloaded from foreign ships (mother vessels) to these vessels, they stay in port for 1 to 10 days. This time duration can also change depending on the weather problems. After loading these materials, they go to the desired location set up by their company to unload the materials. These vessels' next arrival time at Mongla port varies from 15 to 20 days, 1 to 1.5 months, and 2 to 4 months. This time difference is found mainly because the vessel's company assigns its destination, that's why in every vessel survey they answer "We don't know when we will come again here exactly or when we will leave the Mongla Port"**.** The surveyed vessels at Mongla Port exhibit varying waste management and disposal practices. Some of the vessels reported separating their waste into different categories, such as food waste and plastic waste. They utilize bins or paint buckets for waste storage and separation. Certain vessels also specifically mentioned the separation of plastic bottles. It was observed that some vessels engage in the selling or reuse of plastic waste, particularly plastic bottles. For example, they sell plastic bottles to recycling entities or reuse them for storage purposes. However, not all vessels mentioned specific waste separation practices, and some did not generate any plastic waste. In terms of waste disposal, the most commonly mentioned method is dumping the waste into nearby rivers or landfill areas. The specific disposal practices vary, with some vessels mentioning regular dumping intervals or daily waste dumping. It should be noted that some vessels did not provide detailed information about their waste management and disposal systems.

3.2 Waste Composition Analysis

It was found that most of the waste in local ships consisted of cooking oil bottles and polythene bags. Each month, a local ship generates three 5-liter cooking oil bottles and five 2-liter cooking oil bottles. This number varies for local ships with 12 crew members, as they generate about 10 to 15 bottles, including water bottles. Sixty percent of the local ship sells these bottles to fariwala, who come by boat. Therefore, they store and sell these bottles after 3 to 4 months, pricing them at 10 to 12 tk per bottle. The plastic waste collected from the ships ranges between 120 mm and 40 mm. The plastic wastes belong to the PET and LDPE polymer categories.

3.3 Material Flow Analysis

Based on the questionnaire survey it was found that, the local ship anchorage at mongla port area. Some ships separate waste into the required bins, but then they dump the plastic waste into the Mongla Port Municipality or the nearby shore. Where some ship dumps those plastic wastes into the river. The majority sells plastic waste to fariwala, which is plastic bottles. Most of the waste that enters the river consists of plastic bags, including food waste. Some ships reuse these plastic bags. About 20% to 30% of local ships dump this plastic waste into the river; 30% of local ships dump it into the nearby shore or Mongla Port Municipality landfill area, and 40% of local ships sell it to fariwala, who come to them in small boats (material flow shown in Figure 4).

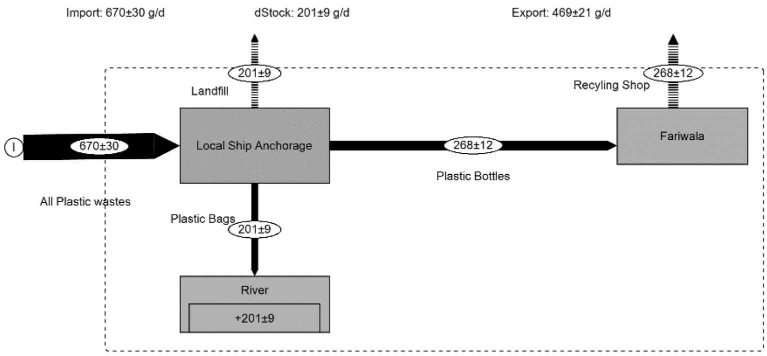

Figure 4: Plastic Waste flow of local vessels

4 Conclusion

"Marine pollution" this term can be fixed for any country just by identifying the sources and taking preventative measures. In this study, findings highlight the significant role of local ships in contributing to marine plastic debris in the Mongla Port area in Bangladesh. It was revealed that local ships primarily generate cooking oil bottles and polythene bags, with an estimated monthly production of 8 to 10 bottles and 21 to 30 polythene bags. The disposal practices of this plastic waste were also examined, showing that approximately 20 % to 30% of local ships dump the waste into the river, 30% dump them into the nearby shore or Mongla Port Municipality landfill area and 40% sell them to fariwala, who collect them in small boats. These practices pose a significant threat to the marine ecosystem and overall environmental sustainability. Effective waste management strategies, based on material flow analysis and collaborative efforts among stakeholders, are urgently needed to address this issue and promote sustainable practices in the shipping industry. By taking proactive measures, it can mitigate the adverse effects of marine plastic debris on the marine ecosystem and protect the environment for future generations.

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