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Combating Marine Debris to Enhance Blue Economy in the Niger Delta

Daniel Tamunodukobipi, Nitonye Samson

Department of Marine Engineering, Rivers State University, Port Harcourt.

daniel.tamunodukobipi@ust.edu.ng; and sammson.nitonye@ust.edu.ng

Abstract

Marine debris poses a major threat to realizing the potential of the blue economy in the Niger Delta region of Nigeria. This study examined the sources, composition and impacts of plastic pollution along the Port Harcourt-Okrika waterfronts. A total of 20 marine debris types were collected and identified at the three selected stations along the Port Harcourt-Okrika waterfronts. These were Marine Base waterfront (Station 1); Okrika Mainland waterfront (Station 2); and Okrika Island waterfront (Station 3). Marine Base waterfront (Station 1) was the most affected by marine debris with 241.52 kg (44.31%) of the debris. This was followed by Station 3, Okrika Island waterfront, with 213.63 kg (39.19%) of the debris. While Station 2 had 89.90 kg (16.49%) of the marine debris. The types of debris found include plastic bottles, fibres, Styrofoam, fishing nets, glass bottles and plant materials. Collected wastes after sorting and classification were given to scavengers for recycling, while the remnants were disposed of at Government approved dumpsites. The participants were sensitized to be part of the solution/ winning team and were taught how to imbibe the culture of Waste to Wealth advocacy. Findings underscore the urgent need for concerted action to curb plastics influx into the ocean to support sustainable maritime sectors, protect livelihoods, and foster a circular economic system. Tackling this ecological crisis necessitates collaborative strategies aligned with the blue economy vision.

Key words: Marine Pollution; Marine Debris; Pollution Prevention and Control; Enhancing Blue economy; Environmental Degradation.

1. Introduction

The world's oceans, seas and marine resources present tremendous opportunities for socioeconomic development and environmental sustainability, encapsulated as the 'blue economy' concept (Ekegren, 2018). However, the growing menace of marine debris, especially plastics, threatens to undermine the promise of this new development paradigm. Figure 1 shows the degradation of the coastline by marine debris. Marine debris is human induced contamination and degradation of the marine ecosystem by directly or indirectly introducing noxious solid substances into the marine environment causing deleterious effects on living resources, hazards to human

health, hindrance to marine activities including fishing, impairment of quality for use of sea water, reduction of amenities and navigation. Combating plastic pollution is thus critical for ocean health and the expansion of sustainable maritime sectors (Beaumont et al., 2019). This paper discusses research conducted on assessing and mitigating marine debris along the Niger Delta coastline and examines the implications for transitioning Nigeria towards a sustainable blue economy. The Niger Delta is home to vibrant coastal communities that rely on the rivers and seas for food, jobs, and transport. Nevertheless, plastics from municipal solid waste, oil industry activities, fishing, and maritime transport are increasingly clogging up these waterways.

Fig 1: Marine debris at Marine Base waterfront

The rapid industrialisation and other anthropogenic activities result in massive waste influx into the oceans, forests and landfills, harming ecosystems, and human health (Kirchherr et al., 2017). Plastics accumulate in sediments, wash up on beaches, entangle or are ingested by organisms, and hamper navigation and operations (Ajao et al., 2022). Figure 2 indicates the harmful impacts of marine debris on sea animals. The ubiquitous presence of plastic bottles, bags, containers, nets, and tires along the coastline pose a persistent threat to the productivity and health of marine ecosystems, with detrimental impacts on local populations (Ajah & Abam, 2019).

(a) (b)

Figure 2: Death of aquatic animals: (a) Turtle entangled in abandoned net and (b) Whale ingested plastic debris

The research aims to quantify the abundance, diversity, and sources of marine debris along the Port Harcourt-Okrika waterfronts as a first step towards achieving marine environmental solutions. Engaging local populations in the assessment and cleanup is also vital for awareness and ownership (Hartley et al., 2018). Transitioning to a regenerative circular system is imperative, where waste is transformed into valuable resources (Geissdoerfer et al., 2017). However, changing the status quo requires evidence-based policymaking and multi-stakeholder partnerships (Oyake-Ombis et al., 2018). Unassumingly, the outcomes of this research can guide interventions by government, private sector, and civil-society stakeholders to beat plastic pollution and optimize the vast promise of growth in the nation's blue economy.

2. Statement of Problem

The proliferation of non-biodegradable plastics has disrupted fragile marine ecosystems and impacted downstream economic activities, threatening the sustainability and equity goals of the blue economy (Mulia et al., 2020). These debris emanate from anthropogenic activities such as shipping, Port operations, fishing, offshore installations or dumping of refuse at sea (Mira et al., 2016). Most marine solid pollutants or debris are unsightly, detrimental to fisheries and tourism, kill and injure a wide range of marine life, have the capacity to transport potentially harmful chemicals and invasive species, and constitute a significant threat to marine transportation and human health. Figure 3 shows the massive environmental degradation of a waterfront in the Niger Delta. According to a report by the United Nations, the number of marine debris in the world's oceans is increasing at an alarming rate, and if no action is taken, there will be more plastic in the

oceans than fish by 2050 (Kershaw, 2016). Therefore, this menace, if not curbed, will have severe consequences on marine operations, wildlife, habitats, and ultimately, human health.

(a) **(b)**

Figure 3: Environmental degradation and hazard to marine operations

3. Significance of Study

Stemming the tide of plastic pollution is integral to harnessing the blue economy potential of the Niger Delta in a sustainable manner. Keeping coastal and marine ecosystems healthy will promote productivity in fisheries, maritime trade, tourism, aquaculture, and offshore oil and gas (Pawar et al., 2018). Implementing the recommendations of the study will prevent plastics from degrading the marine ecosystems: thus, ensuring food security, jobs creation, biodiversity, preservation of marine infrastructure, and enhancement of revenues that power socioeconomic development along the coast (Jambeck et al., 2015). The research outcomes can inform policies and innovation to advance circular models that eliminate plastic waste flooding the marine ecosystem while creating value from recovered plastics (Kirchherr et al., 2017).

4. Literature Review

The life cycle of plastics begins with extraction of raw materials; design, and production of item; packaging and distribution; use and maintenance; and reuse, recycling, recovery, or final disposal (Borrelle et al., 2020). The used plastics are disposed through several different routes. Some are gathered, sorted, classified, and recycled through formal or informal waste management schemes

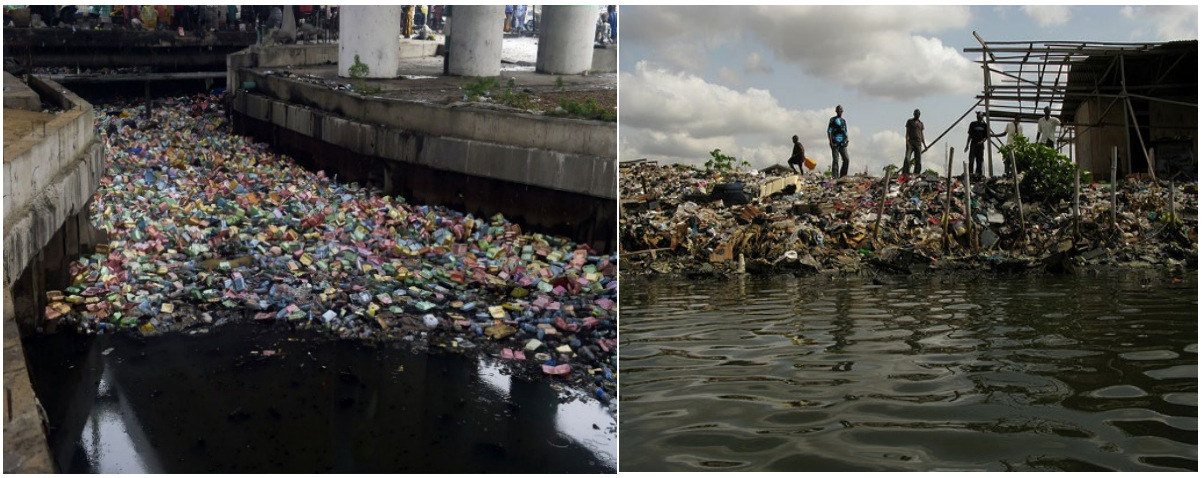
and turned into plastic pellets or flakes, and re-enter the production and use phase. However, most are incinerated, disposed in the river, or used as landfills/dumpsites. Plastics ingested by fish and shellfish pose risks to food safety and human health when consumed (Smith et al., 2018). Entanglement in derelict nets and debris can impair productivity and catch rates for artisanal fishers, threatening nutrition, incomes, and wellbeing. The visual impact of shoreline littering reduces the aesthetic appeal for recreation (Wyles et al., 2016). Microplastics can also enter and bioaccumulate in marine food chains with potential long-term consequences (Barboza et al., 2020).

On this premise, (Sari et al. (2022) examines the generation, composition, and recycling potential of marine debris in the area. Their research reveals a high daily generation of 230 m3 or 303.6 tons, with a composition including various materials such as plastics, biodegradable waste, and metals. The recycling potential is 67.86%, focusing on composting biodegradable waste and recycling PET plastic. These findings can inform government decision-making and guide marine debris management worldwide. (Sebille et al. (2020) addresses the distribution and transport of marine plastic debris, highlighting the need for better understanding and mapping. Their study emphasizes the importance of quantifying the global inventory of marine plastics to develop effective mitigation strategies.

(Marin et al. (2021) explores the use of machine learning and deep learning techniques to automate the cleanup of marine debris. Six deep convolutional neural networks (CNNs) are evaluated for their effectiveness in identifying and classifying underwater marine debris. The best performing model is achieved by fine-tuning the Inception-ResNetV2 feature extractor, with an accuracy of 91.40% and F1-score of 92.08%. As a follow up, Valdenegro-Toro (2019) focuses on the problem of marine debris in coastal areas and its impact on marine life and human health. The study evaluates the use of deep neural networks (DNNs) for detecting marine debris in underwater images: hence, promoting the use of Autonomous Underwater Vehicles for surveying and collecting marine debris in underwater environments.

Agamuthu et al. (2019) consider marine debris as a global concern, with plastics being the major component. Millions of metric tonnes of plastics enter the oceans annually, causing significant harm to marine organisms, the environment, human health, and the economies off nations. Figure 4 displays the prevalence of marine debris around Onne port. Marine mammals mistakenly ingest debris which results in fatality. Plastics can convey harmful chemicals and invasive species to

upset the delicate ecological diversity of the Gulf of Guinea. Humans are exposed to microplastics through seafood consumption. As revealed by Sari et al. (2021) plastic pollution contributes to greenhouse gas emissions and threatens the ocean's ecosystem. Therefore, sustainable production and consumption of plastics is imperative, and community engagement creates awareness on responsible waste disposal behaviours (Xanthos & Walker, 2017).



(a) **(b)**

Figure 4: Marine debris: (a) Onne Port debris collection and (b) Reclamation of coastal land at Ogu community waterfront

The research strategy of building stakeholder partnerships, improving infrastructure and services, employing technologies, and monitoring progress is emphasized as a veritable means of eliminating plastics pollution (Oyinlola et al., 2021). Combating marine plastic debris now will safeguard livelihoods, public health, and the integrity of interconnected marine ecosystems for current and future generations (Newman et al., 2015). This will involve integrated approaches engaging all stakeholders across the plastic lifecycle, from extraction and production to recycling, recovery and reintegration (Borrelle et al., 2020). Nigeria can harness the blue economy to create jobs, promote circular resource flows, and achieve the Sustainable Development Goals (SDGs). However, the realization of this vision depends on proactive efforts to mitigate plastic pollution through a combination of behavioural changes, technological advances, infrastructural investment, and collaborative governance (Oluwatosin et al., 2020).

5. Materials and Methods

The marine debris assessment was conducted along three stations – Marine Base waterfront, Okrika Mainland waterfront and Okrika Island waterfront in Rivers State. These locations were purposively selected based on preliminary surveys indicating high debris accumulation. The fieldwork was carried out over two days with active participation of community members. The tools employed for the cleaning of the Okrika Island waterfront were: 5 rakes, 4 shovels, 10 refuse baskets, 24 waste disposal bags, 3 wheelbarrows, 1 Spring balance of 120kg, hand gloves, hard hats, nose masks, hard boots, reflector vests, life jackets, 1 dragnet of 2m by 12m, and 3 boats with 10 paddles. Figure 4 displays the marine debris combat team equipped with relevant PPE and sanitary gears while Figures 5 and 6 display the Team combatting marine debris both at the beach and midstream using dragnet, respectively.

Figure 5: Ready to combat marine debris at Okrika Island Waterfront

(a) (b) (c) (d) (e)

Figure 62: Cleanup of marine debris at Okrika Island Waterfront

The authors, who were facilitators, organized a demonstration of the trawling process to the participants, utilizing two hired speed boats. The collected waste was then properly disposed of on land at government-approved dumpsites. This exercise brought about a sense of excitement and optimism among the participants, as they expressed their gratitude to NIMASA's efforts in safeguarding their vital natural resource, the river water, from the destructive impact of waste.

(a) (b) (c)

Figure7: Cleanup of marine debris midstream using dragnet at Okrika Island Waterfront

The debris cleanup procedure entailed gathering all visible waste material along the shoreline and adjoining areas. Rakes and shovels aided collection into bags and baskets. Full bags were transported to the sorting area using wheelbarrows. There, the debris was manually segregated into categories and weighed using the spring scale, with quantities recorded. Signage, demonstrations, and oversight ensured proper waste separation. Finally, the bagged debris was loaded for transportation to designated disposal sites after completion as shown in Figure 8

(a) (b) (c)

Figure 8: Cleanup of marine debris: (a) Segregation process; (b) Transportation; and (c) Disposal at approved landfill

6. Results and Discussion

From the MDCP activity, the following findings were made. The Table 1 shows the different types of marine debris collected at the various stations along the shoreline of the Okrika-Marine Base waterway, Nigeria during the 2023 Marine Debris Combat program. Whereas Figure 9 displays percentage by mass debris from the various stations.

Table 1: The different types of marine debris collected at the stations.

SN	Types of Marine Debris	**Station 1**		**Station 2**		**Station 3**	
		Kg	Kg%	Kg	Kg%	Kg	Kg%
1.	Plastic bottles/ sachets	23.35	9.67	16.34	18.20	10.11	4.73
2.	Plastic drums/ containers	85.67	35.47	28.16	31.36	67.93	31.80
3.	Plastic shoes	-	-	1.78	1.98	3.21	1.50
4.	Plastic bags	15.12	6.26	3.00	3.34	8.11	3.80
	% Plastic contents		**51.4**		**54.88**		**41.86**
5.	Old clothes	3.52	1.46	16.00	17.82	10.27	4.81
6.	Electrical appliances	21.49	8.90	16.00	17.82	9.15	4.28
7.	Netting Materials	1.71	0.71	2.38	2.65	15.14	7.09
8.	Broken Car headlamp	4.29	1.78	-	-	-	-
9.	Old sack Bags	1.25	0.52	0.50	0.56	2.05	0.96
10.	Car tyres	54.20	22.44	-	-	43.22	20.23
11.	Empty Paint tins	-	-	-	-	2.01	0.94
12.	Glass Bottles (whole)	7.52	3.11	-	-	3.89	1.82
13.	Empty cement Bags	-	-	-	-	1.50	0.70
14.	floater/cork Materials	0.37	0.15	1.56	1.74	-	-
15.	Broken glasses/ bottles	-	-	-	-	6.74	3.15
16.	Old cotton (door blind material)	0.20	0.08	-	-	4.00	1.87
17.	Taplin Material	6.77	2.80	-	-	8.14	3.81
18.	Organic waste	7.14	2.96	-	-	6.81	3.19
19.	seaweed	2.73	1.13	3.41	3.80	4.02	1.88
20.	Metal cans/ tins	6.19	2.56	0.67	0.75	7.33	3.43
Total Debris Abundance		**241.52**	**100.0**	**89.90**	**100.0**	**213.63**	**100.0**

The total debris collected over two days of fieldwork was 545.05 kg. Marine Base had the highest levels at 241.52 kg (44.31%), followed by Okrika Island at 213.63 kg (39.19%) and Okrika

Mainland at 89.9 kg (16.49%). These findings reveal hotspots of high waste accumulation for priority remedial action (Hartley et al., 2015). Marine Base and Okrika Island waterfronts were heavily littered because of several land reclamation sites and waterfront dumpsites. In contrast, the marine debris from Okrika Mainland Waterfront was the least because of the urban lifestyle of the people and the absence of waterfront landfills. While some marine debris were site-specific (e.g., netting materials), others were prevalent across all stations (e.g., plastic bottles), highlighting common usage and disposal practices.

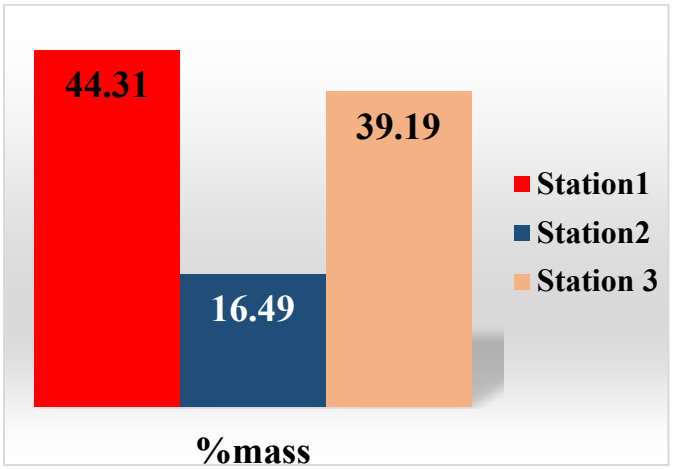


Figure 9: Percent by mass of marine debris from the various stations

The composition analysis shows plastics constituted a high proportion across all three stations ranging from 41-55% by weight, as indicated in Figure 10. Dominant plastic debris types were bottles, containers, bags, shoes, fishing nets and straps. Worn out tires were also a major component. Other waste included appliances, textiles, metals, glass, organics, and foam.

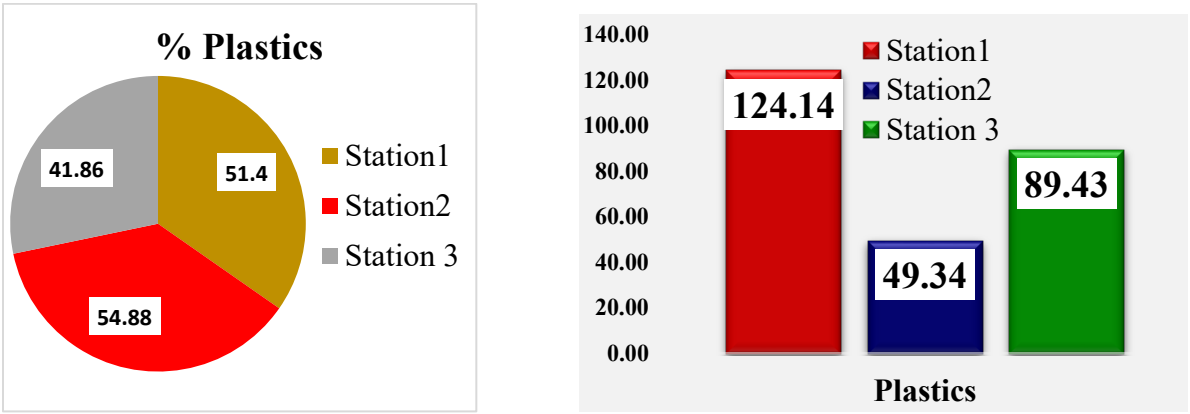


Figure 10: Plastic contents by mass of marine debris for the various stations

7. Recommendations for the Blue Economy

The following 10 measures are recommended to combat marine plastic pollution in the Niger Delta based on the research findings:

(i) Support circular systems to extract value from waste plastics through community-based collection, sorting, and recycling. Provide logistics and financial incentives to optimize recovery (Borrelle et al., 2020).

(ii) Invest in reprocessing technologies to transform recycled plastic into raw materials for manufacturing industries. This helps build a circular economy (Kirchherr et al., 2017).

(iii) Promote product and business model innovations to redesign plastic goods and services to minimize waste generation at source (Mulia et al., 2020).

(iv) Develop infrastructure for integrated and sustainable waste management encompassing transport, sorting, recycling, treatment, and disposal (Ajah & Abam, 2019).

(v) Implement community engagement and awareness campaigns tailored to context to change attitudes and behaviours around plastics (Hartley et al., 2018).

(vi) Strengthen policy and regulatory frameworks to drive systemic shifts in plastic production and usage towards circular models. Incorporate extended producer responsibility (Borrelle et al., 2020).

(vii) Build technical and institutional capacities on plastic waste audits, environmental impact monitoring, and resource recovery solutions (Beaumont et al., 2019).

(viii) Adopt biodegradable or easily recyclable alternatives to conventional plastics to reduce ecological threats from careless waste disposal practices (Xanthos & Walker, 2017).

(ix) Establish robust monitoring mechanisms to periodically evaluate progress on curbing marine plastic pollution using key indicators (Kershaw et al., 2022).

(x) Foster multi-stakeholder collaborations between government agencies, businesses, academia, civil society, and communities for a coordinated strategy against marine plastic debris (Oyinlola et al., 2021).

Advancing the blue economy in the Niger Delta entails keeping coastal and marine ecosystems healthy by beating plastic pollution through a combination of policies, technologies, infrastructure, and behavioural changes.

8. Conclusion

This study highlights the significant, yet surmountable challenge posed by marine plastic debris to Nigeria's aspirations for a thriving blue economy centred on its vast ocean resources. Keeping coastal and marine ecosystems healthy by mitigating pollution is crucial for expanding productive maritime sectors sustainably. The solutions lie in creating an enabling policy environment, enhancing technical capabilities and infrastructure, harnessing Indigenous knowledge, employing appropriate technologies, and fostering innovative business models.

With informed decisions, strategic investments and collective action, Nigeria can secure the natural capital and productivity of its waters to generate economic growth, decent employment, and long-term prosperity across coastal communities. The proliferation of plastic waste is antithetical to the blue economy vision and must be addressed urgently.

The time to act is now by joining hands to combat marine plastics, protect our oceans, and build a sustainable, just, and equitable blue economy. This will require hard choices and compromises by powerful interests vested in the linear plastic economy status quo. However, the gravity of the global plastics pollution crisis calls for ambitious strategies to safeguard the world's oceans for generations to come. Nigeria has a vital leadership role to play in the region and globally by demonstrating replicable models to overcome this challenge through innovation, partnerships, and localized solutions.

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