MOMOH NDORBOR MASON JR.
PLASTIC WASTE AND ITS IMPACT ON THE MARINE ENVIRONMENT IN MONROVIA, LIBERIA
MSc. THESIS
Nicosia
JUNE, 2023

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Approval

We certify that we have read the thesis submitted by **MOMOH NDORBOR MASON JR** titled **"PLASTIC WASTE AND ITS IMPACT ON THE MARINE ENVIRONMENT IN MONROVIA, LIBERIA"** and in our combined opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Environmental Sciences and Engineering.

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Declaration

I hereby declare that all information, documents, analysis, and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of the Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Momoh Ndorbor Mason Jr.

…./...../2023

Acknowledgments

Thank you so much for your time and consideration, Associate Professor Dr. Fidan Aslanova, and Professor Gozen Elkiran. Moreover, I owe a big debt to the wealth of knowledge and assistance provided by my defense committee.

I would be remiss if I didn't also express my appreciation to my parents, Mr. Joseph Hinna Kpator and Mrs. Jassah Ndorbor Kpator. Their support, faith, and encouragement in me has kept me going strong through all of this.

I also like to express my gratitude to my colleagues, especially Marilyn Hannah Godwin and Marcus Paye Quaigoah I, for the comments, recommendations, and moral support I received from them during the course of this research. In addition, I also appreciate Mr. David P. Tokpah for his moral support during the course of this academic journey.

God is ultimately to be thanked for everything that has happened to me during the course of this journey.

Abstract

PLASTIC WASTE AND ITS IMPACT ON THE MARINE ENVIRONMENT IN MONROVIA, LIBERIA

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June, 2023 Page,75

The demand for plastic has consistently increased globally, which has caused an increase in plastic trash in the environment, including oceans, rivers, and landfills, which has profound ecological and health implications. Plastic waste pollution is a global environmental challenge, and the long coastline location of the Liberian city of Monrovia makes it imperatively not exempted from the vulnerability of plastic waste pollution. Inadequate waste management policies and practices and the need for proper waste management infrastructure compound the issue of plastic waste pollution in Liberia.

The sample consisted of 259 with 32% respondents aged 20-30, 31.3% aged 31-40, 22% aged 41-50, and 13.9% aged 51 and above. The gender distribution was uneven, with more males than females. A significant percentage completed higher education, with college graduates making up the majority. Moreover, 40% of respondents had income above $300, 31.7% between $151-$300, and 28.2% between $1-150. In addition, 60% spent more than $150 per month due to high living costs. Henceforth, Food wrappers, takeaway containers, takeaway cups, sanitary products, and fishing nets were the common plastic waste that accumulated in the brackish river.

The possible harmful consequences of plastic waste accumulation in brackish water include; reduced crop yield, crop diseases, reduced fish supply, fish entanglement or death, and the possibility that fish may consume plastics contaminated with chemicals. Diseases increase due to an increase in the number of rodents and mosquitoes with the impact on the aesthetics and decoration of the environment around the riverbanks.

Most respondents believe that individuals, traditional rulers, and government efforts can significantly reduce plastic waste. Using strategies such as proper plastic waste disposal bin placement at key riverside locations, government regulations, and individual efforts to reduce plastic waste can be beneficial in reducing plastic waste accumulation.

Keywords: Plastic waste, Impacts Marine environment, Brackish water

Özet

MONROVIA, LİBERYA'DAKİ PLASTİK ATIKLAR VE DENİZ ÇEVRESİ ÜZERİNDEKİ ETKİSİ

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Haziran, 2023 Sayfa,75

Plastiğe olan talep küresel olarak sürekli olarak artmakta ve bu da okyanuslar, nehirler ve çöplükler dahil olmak üzere çevrede derin ekolojik ve sağlık etkileri olan plastik çöp artışına neden olmaktadir. Plastik atık kirliliği küresel bir çevre sorunudur ve Liberya'nın Monrovia kentinin uzun kıyı şeridi olmagi nedenye, onu plastik atık kirliliğinin savunmasızlığından zorunlu olarak muaf tutmaz. Yetersiz atık yönetimi politikaları uygulamadaki ve uygun atık yönetimi altyapısına duyulan ihtiyaç, Liberya'da plastik atık kirliliği sorununu artırıyor.

Örnekleme, %32'si 20-30 yaşları, %31,3'ü 31-40 yaşları, %22'si 41-50 yaşları ve %13,9'u 51 yaş ve üstü olmak üzere 259 kişiden oluşmaktadır. Cinsiyet dağılımı eşit değildi, erkekler kadınlardan daha fazladır. Önemli bir yüzde, üniversite mezunlarının çoğunluğu oluşturduğu yüksek öğrenimi tamamlamistr. Ayrıca, yanıt verenlerin %40'ının geliri 300$'ın üzerinde, %31,7'si 151-300$ arasında ve %28,2'si 1-150$ arasında gelire sahipti. Ayrıca, %60'ı yüksek yaşam maliyetleri nedeniyle ayda 150 dolardan fazla para harcamaktadir. Muserado nehrinde biriken yaygın plastik atıklar, yiyecek ambalajları, paket servis kapları, paket bardaklar, sıhhi ürünler ve balık ağlarıdir.

Acı suda plastik atık birikiminin olası zararlı sonuçları arasında; mahsul veriminin azalması, mahsul hastalıkları, azalan balık arzı, balıkların birbirine dolanması veya ölümü ve balıkların kimyasallarla kirlenmiş plastikleri tüketme olasılığıdir. Akarsu kenarlarında çevrenin estetik ve dekorasyonuna da etki eden kemirgen ve sivrisinek sayısındaki artışa bağlı olarak hastalıklar artmaktadır.

Ankete katılanların çoğu, bireylerin, geleneksel yöneticilerin ve hükümet çabalarının plastik atıkları önemli ölçüde azaltabileceğine inanmaktadir. Önemli nehir kenarı konumlarına uygun plastik atık imha kutuları yerleştirme, hükümet düzenlemeleri ve plastik atığı azaltmaya yönelik bireysel çabalar gibi stratejilerin kullanılması, plastik atık birikimini azaltmada katki sajloyacckhr.

Anahtar Kelimeler: Plastik atık, Etkiler Deniz ortamı, Acı su

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CHAPTER I

Introduction

Background of the Study

Plastics are long-chain polymer molecules that are extracted as by-products of coal, petroleum, and natural gas (Thompson et al., 2009) and are widely used in various daily activities and applications (Andrady, 2011). According to Amaral-Zettler et al. (2020), there has been a consistent rise in the worldwide demand for plastic. A report by the United Nations Environment Programme (UNEP, 2022) indicated that about 300 million tons of plastic waste are produced globally every year, and only about 9% of this waste is recycled. This has resulted in the accumulation of plastic waste in the natural environment, including oceans, rivers, and landfills, which has profound ecological and health implications.

The impact of plastic waste pollution on the environment is an increasingly important aspect for research, policymakers, businesses, and the general public; and it has received significant global attention, as noted by Chowdhury et al. (2020) and Nielsen et al. (2020). Municipal plastic waste (MPW) is a significant solid waste component in developed and developing countries (Areeprasert et al., 2017). Due to the chemical structure of plastic waste, it is harmful to the health of the environment and its inhabitants. Jambeck et al. (2015) estimated that roughly 10% of the total plastic produced globally becomes waste and ultimately makes it into the ocean. The impact of plastics is not limited to their influence on human lifestyle but also extends to the Earth's physical environment.

Plastic waste pollution is a global environmental challenge, and the long coastline location of the Liberian city of Monrovia makes it imperatively not exempted from the vulnerability of plastic waste pollution. The issue of plastic waste pollution in Liberia is compounded by inadequate waste management policies and practices and the need for proper waste management infrastructure (David, John, & Hussain, 2020), coupled with a lack of public awareness. In a similar context, Apeh, C. C. (2018) reasoned that Liberia is a country that has been severely affected by civil war, which has led to inadequate infrastructure and weak governance systems. As a result, waste management is a significant issue in the country, with only 18% of waste being collected and disposed of properly. Waste management remains a significant problem in Monrovia, Liberia's largest city. In urban Liberia, plastic garbage accounts for more

than half of all solid waste. Plastic waste and pollution have become widespread in marine ecosystems, transforming the Earth's surface (Bility & Aslanova, 2022). The situation of plastic waste in the ocean is a global problem that poses a "transboundary challenge." In situations where plastic waste is found in areas beyond national jurisdiction (ABNJ), it can be difficult to hold one particular entity (country) responsible for its removal (Vince & Hardesty, 2018).

The marine environment is a critical ecosystem that supports various forms of life and provides a source of sustenance for millions of people globally. The threat posed by marine debris, particularly plastic marine debris, is on the rise and poses a significant danger to aquatic habitats and wildlife (Kandziora et al., 2019). Additionally, communities that depend on natural resources feel the negative impact of marine debris, as highlighted by Vince and Hardesty (2018) and Kandziora et al. (2019). Amaral-Zettler et al. (2020), stated that plastic marine debris is the most prevalent and persistent form of environmental pollution since it does not undergo biodegradation. Therefore, it has a long lifespan in the environment. A brief by IUCN (2021) stresses that plastic waste pollution poses a significant threat to marine life, as it can entangle and suffocate marine animals. Plastic waste pollution can disrupt the food chain, adversely impacting human health. Studies have shown that plastic waste pollution in the marine environment has increased significantly in recent years, with estimates suggesting that by 2050, there will be more plastic (IAEA, 2022) in the ocean than in fish. The issue of marine debris is a multifaceted environmental crisis interconnected with other environmental challenges, such as climate change, loss of biodiversity, and health issues affecting humans (Vince & Stoett, 2018). Most of the ocean's debris is generated from sources on land, with roughly 75% being attributed to waste that has not been collected or disposed of properly and approximately 25% arising from the waste management systems themselves (Ocean Conservancy & McKinsey Cente, 2015). This extensive buildup of plastic contamination in the ocean is mainly composed of non-biodegradable polymers (Goldstein, 2012). Precisely, the deterioration of marine biodiversity is attributed mainly to plastic contamination since the materials are not intended to decompose in aquatic environments but disintegrate into smaller pieces, causing considerable disturbance to the marine ecosystem (Perez, 2017). Roughly 60% to 80% of plastics in the ocean are derived from petroleum, making them highly harmful contaminants that seriously threaten the marine

ecosystem (Derraik, 2002). Marine litter pollutants can enter the food chain, putting people worldwide at risk of various hazardous chemicals, usually when humans consume seafood that has consumed some form of human-made debris (Cressey, D. 2016). Therefore, the worldwide marine litter crisis poses a significant risk to the environment, the economy, and human health (Sun, J. et, al., 2022).

Statement of the Problem

In Monrovia, the capital city of Liberia, waste management is impoverished, and plastic waste is a significant component of the waste stream. Plastic waste is often disposed of in open areas or dumped in rivers, ultimately finding its way into the ocean. The Liberian government has made efforts to address this issue, including establishing a waste management authority and implementing waste management policies. However, these efforts have been largely ineffective, and plastic waste pollution remains a significant problem in Monrovia (Bility & Aslanova, 2022). The Effect of plastic pollution on the marine environment is significant, as it cannot biodegrade; instead, it can only break down into smaller fragments (microplastics) that enter the food chain and cause harm to marine animals (Adeniran et al., 2022). The author added that Plastic waste damages marine life's habitats and reduces the marine environment's aesthetic value. This plastic waste pollution has economic implications for the fishing industry, tourism, and human health (Chowdhury et al., 2021; Nielsen et al., 2020). The recycling culture prevalent in many developed countries is nonexistent in Liberia. Technologies for recycling plastic trash are still in their infancy. Nevertheless, these initiatives need to catch up and lag in crucial areas like process financing and the use of cutting-edge technologies. In light of the above, this thesis research aims to determine Plastic waste's impact on Liberia's brackish water by noting its origins, occurrences, and impact on the marine environment through self-prepared questionnaires.

The Study Questions:

- What are the Causes/origin and occurrence of plastic waste in the marine environment?
- What is the Effect of plastic waste on the marine environment?
- What are the measures aimed at controlling Plastic Waste in the marine environment?

The Study Objectives:

- To identify the Causes/Origin and occurrence of plastic waste in the marine environment
- To describe the impact of plastic waste on the marine environment
- To determine measures aimed at controlling plastic waste in the marine environment

Limitations of the Study

The determination of plastic waste impacts the marine environment, emphasizing the brackish water in Liberia. The study was limited to data collection using a structured questionnaire, which narrowed the response of the participants instead of using an interview. In addition, observation of the brackish water to get rich data; despite this limitation, the researcher carefully reviewed related literature on the topic and formed a comprehensive questionnaire that helps in getting an adequate response to overcome the hurdles.

Significance of the Study

The study identifies the impact of plastic waste in the brackish water of Liberia by noting the origins, occurrences, and marine environment. The study results will benefit farmers, fishermen, and researchers, the local community, and the Government of Liberia by formulating appropriate recommendations and policies to help address issues related to plastic waste and the marine environment. Henceforth, it will add to the existing literature on the topic and be a requirement for the award of a postgraduate degree.

CHAPTER II

Literature Review

Types Of Plastic Commonly Found in The Natural Environment

Several studies have investigated the presence and distribution of plastic waste in the natural environment. A study by Jambeck et al., (2015) estimated that eight (8 million metric tons of plastic waste enter the ocean each year and that by 2025, this amount could increase to 17.5 million metric tons. The study found that PET and HDPE were the most occurring types of plastic found in the ocean.

A study by Cózar et al. (2017) investigated the distribution and abundance of plastic waste in the Mediterranean Sea. The study found that microplastics (plastic particles smaller than 5 mm) were present in all samples collected, with an average concentration of 1,116 particles per square meter. The study also found that the most common types of plastic found were PP and LDPE. Similarly, Andrady (2011) investigated the environmental impact of plastic waste. The study found that plastic waste can release harmful chemicals when exposed to sunlight and that these chemicals can adversely affect wildlife and human health. The study also found that plastic waste can absorb pollutants from the environment, which can accumulate in the food chain. The plastic wastes that are commonly found in the natural environment are as follows:

Polyethylene Terephthalate (PET) PET is commonly used for water bottles, food packaging, and other consumer goods. It is lightweight, transparent, and durable. However, PET is not biodegradable, and when it ends up in the natural environment, it can take hundreds of years to break down. PET bottles are one of the most common types of plastic found in the ocean (Li, 2021). High-Density Polyethylene (HDPE) is used for various products, including milk jugs, detergent bottles, and plastic bags. It is a challenging and durable plastic resistant to chemicals and UV radiation. HDPE is also not biodegradable and can persist in the environment for a long time (Li, 2021). Polyvinyl Chloride (PVC) PVC is used for pipes, window frames, and other construction materials. It is a complex and rigid plastic resistant to weathering and chemicals. However, PVC is not biodegradable and can release harmful chemicals when it breaks down (Li, 2021). Low-Density Polyethylene (LDPE) LDPE is used for various products, including grocery bags, bread bags, and plastic wraps. It is a flexible

and lightweight plastic resistant to moisture and chemicals. LDPE is also not biodegradable and can accumulate in the environment (Li, 2021). Polypropylene (PP) is used for various products, including yoghurt containers, bottle caps, and straws. It is a challenging and durable plastic that is resistant to heat and chemicals. PP is not biodegradable and can accumulate in the environment (Li, 2021).

Sources of Plastic Debris

There are two main sources of debris: land-based and marine-based debris (i.e., land-based and marine-based debris).

Land-based debris: Land-based debris is a term used to describe the accumulation of human-made materials, such as plastic, metal, and glass, in terrestrial environments such as beaches, forests, and urban areas. Land-based debris is a growing problem that negatively impacts the environment and human health (Jambeck et al., 2018). Several studies have focused on the sources, composition, and impacts of land-based debris. For instance, a study by Cózar et al. (2014) estimated that there are 5.25 trillion plastic particles in the world's oceans, with 4.8-12.7m metric tons of plastic accessing the ocean every year from land. This study also found that most of the plastic pollution comes from 20 countries, with China being the largest contributor. Another study by Lebreton et al. (2017) estimated that 88-95% of plastic entering the ocean comes from just ten rivers, eight of which are in Asia. The study also found that plastic pollution in the ocean is projected to increase by a factor of ten by 2025.

Thus, the composition of land-based debris varies depending on the location and sources. Aliani et al. (2020) found that microplastics (<5 mm) were the most common type of debris found on Mediterranean beaches, followed by macroplastics (>5 mm) and other materials. The study also found that the sources of land-based debris included tourism, fishing, and urbanization. The impacts of land-based debris on the environment and human health are well-documented. For example, plastic debris can entangle and suffocate wildlife, while microplastics can be ingested, leading to health problems. A study by Jambeck et al. (2015) estimated that up to 12.7mmtn of plastic waste generated by coastal populations could enter the ocean annually, causing harm to marine ecosystems.

Marine/Ocean-based debris: This refers to human-made materials that enter the ocean, such as plastic bags, bottles, and fishing gear. Marine debris can come from land-based sources, such as littering, and ocean-based sources, such as abandoned or

lost fishing gear (Moore & Phillips, 2011). Marine debris is a global environmental problem affecting marine ecosystems, human health, and the economy. It is estimated that eight (8 million metric tons of plastic waste each year enter the ocean every year, with devastating consequences for marine life.

Research on marine debris has focused on understanding its sources, distribution, and impacts and developing solutions to reduce its generation and promote sustainable waste management practices. Several studies have identified land-based sources, such as littering, poor waste management practices, and stormwater runoff, as the main contributors to marine debris (Jambeck et al., 2015; Schmidt et al., 2017). Other studies have highlighted the role of ocean-based sources, such as abandoned or lost fishing gear, in accumulating marine debris (Eriksen et al., 2014; Law et al., 2014). The impacts of marine debris on marine life are well documented, with many species being affected by entanglement, ingestion, and habitat degradation (Laist, 1997; Gall & Thompson, 2015). In addition, marine debris has negative economic impacts, including lost tourism revenue and costs associated with cleanup efforts (Pham et al., 2020).

To address the problem of marine debris, a range of solutions have been proposed, including better waste management practices, education and outreach campaigns, and technological innovations to reduce plastic waste (Galgani et al., 2015; Rochman et al., 2018). Governments, NGOs, and industry groups also work together to develop policies and regulations to reduce marine debris (Staples et al., 2018). Generally, the two sources of debris (I.e. land and Marine debris) are closely interconnected. For example, land-based debris can be (Jambeck et al., 2018) carried into the ocean by rivers, wind, and stormwater runoff, while marine debris can wash up on beaches and shorelines. The author added that land-based and marine-based debris significantly negatively impacts the environment and wildlife, and efforts are being made to reduce their generation and promote sustainable waste management practices.

Plastic Waste Sources In Monrovia And The Current Method Of Waste Management.

According to David et al., (2019), the production of municipal solid waste, including plastic waste, has increased significantly in Monrovia due to the city's population growth from rural-urban migration. However, garbage management in the

city needs to be improved, resulting in a large amount of solid waste generated daily, especially household plastic waste. Local water manufacturing industries are identified as the city's primary producers of plastic waste. Monrovia, Liberia's capital city, has been facing significant challenges in waste management, resulting in high levels of solid waste pollution.

The current method of waste management in Monrovia involves a combination of formal and informal waste collection systems, with the majority of waste disposal taking place in uncontrolled dumpsites or open burning, leading to environmental and health problems (Tchakouté et al., 2019; Wu et al., 2021). Monrovia's formal waste collection system is operated by the Monrovia City Corporation (MCC), which covers only a tiny portion of the city due to limited resources and inadequate infrastructure. The MCC collects waste from commercial areas and a few residential neighborhoods using compactor trucks, but the collection frequency is irregular, and the service is inadequate (Tchakouté et al., 2019; David et al., 2019). On the other hand, the informal waste collection system involves the "logos" (street children), who collect and sell recyclable materials such as plastic, aluminum cans, and scrap metals. While this system provides a source of income for street children, it poses health and safety risks as they work in unsanitary conditions without protective gear (Tchakouté et al., 2019).

The uncontrolled dumpsites in Monrovia constitute a significant concern as they are often located in residential areas and lack basic waste management infrastructure. The waste is often burned, leading to air pollution and respiratory problems for residents in the surrounding areas (Wu et al., 2021). In conclusion, the current method of waste management in Monrovia needs to be improved, leading to environmental and health problems. The formal waste collection system is limited, while the informal system needs to be more regulated and poses worker risks. The uncontrolled dumpsites also pose environmental and health hazards. Therefore, there is a need for an improved waste management system in Monrovia to address these challenges.

Plastic Waste Occurrence in Water Bodies and Beach Sediment

The occurrence of plastic waste in water bodies and beach sediments has become a major environmental issue worldwide. Plastic waste, especially microplastics (particles less than 5mm in size), is pervasive and can cause harm to marine ecosystems and organisms. Several studies have been conducted on the

presence and distribution of plastic waste in water bodies and beach sediments. Notably, a study conducted by Eriksen et al. (2014) estimated that 5.25 trillion plastic particles are floating on the ocean surface globally, a total weight of 269,000 tons. Another study by Jambeck et al. (2015) estimated that (eight 8 million metric tons of plastic waste enter the oceans yearly, with rivers being the major pathway for plastic debris. Microplastics (plastic particles less than 5mm in size) are also a significant concern, with one study estimating that there are over 5 trillion microplastics in the world's oceans (Cózar et al., 2014).

Figure 1. Beach sediments referencing particles and materials that makes up the surface of a beach (Young, 2017).

Beach sediments are typically composed of sand, gravel, rocks, shells, and other debris transported and deposited by waves, tides, and currents. The composition of beach sediments can vary depending on the location and geological history of the beach. It can be influenced by wave energy, sediment supply, and coastal land use (Young, 2017). Beach sediments provide essential habitats and nesting areas for a variety of marine organisms, including crabs, clams, and sea turtles. However, they are also susceptible to contamination from pollutants such as plastic waste, which can harm the beach ecosystem and human health (Young, 2017). Plastic waste is also commonly found in beach sediments, negatively impacting coastal ecosystems and wildlife. Li et al. (2018) found that plastic debris was present in all beach sediments sampled in China, with concentrations ranging from 7.1 to 102.9 items per square meter. Similarly, a study by Alomar et al. (2018) found high concentrations of

microplastics in beach sediments in the Balearic Islands, Spain. These microplastics were found to be ingested by marine organisms, indicating the potential for ecological impacts.

Aside, the accumulation of plastic waste in water bodies and beach sediments negatively impacts aquatic organisms and ecosystems. Plastic debris can entangle and suffocate marine life, disrupt food webs and alter the behaviour of organisms (Browne et al., 2015). Microplastics are also a concern, as they can be ingested by marine organisms and potentially enter the food chain (Rochman et al., 2015). In addition to ecological impacts, plastic pollution also has economic and social impacts, including impacts on tourism and human health (UNEP, 2016).

In a conclusive context, plastic pollution is a significant environmental problem that affects water bodies and beach sediments. The ubiquity of plastic waste in these environments indicated the need no action to address plastic pollution and reduce the amount of plastic waste entering the environment.

The Effect of Plastic Waste on Marine Habitats

Effect of plastic waste on marine habitats

The Effect of plastic waste on marine habitats is a growing concern among environmental scientists and policymakers. Plastic waste is known to cause harm to marine animals and disrupt ecosystems. Nonetheless, one of the significant impacts of plastic waste on marine habitats is entanglement. Marine animals such as turtles, whales, and birds can become trapped in plastic waste, which can cause injury or death. A study by Wilcox et al., (2015) found that 52% of all sea turtles had ingested plastic. That entanglement in plastic waste was a significant cause of injury and mortality in these animals. However, ingesting plastic waste is another significant impact on marine habitats. Plastic debris can be mistaken for food by marine animals, leading to ingestion and potentially fatal consequences. A Gall and Thompson (2015) study found that over 90% of sea birds had ingested plastic waste, which was a growing problem in both coastal and oceanic habitats.

Microplastics (less than 5mm in size), also concern marine habitats. Marine animals can ingest Microplastics and accumulate in the food chain, potentially affecting the health of humans who consume seafood. A study by Rochman et al.

(2015) found that microplastics were present in 100% of marine turtle species and that ingesting these particles can cause blockages in the digestive system and other health problems. The impact of plastic waste on marine habitats extends beyond the direct harm to animals. Plastic waste can also affect ecosystems by altering water quality, habitat structure, and nutrient cycling. Plastic waste can affect the composition and diversity of benthic communities and alter nutrient cycling and sedimentation rates (Thiel et al., 2013).

In conclusion, plastic waste significantly impacts marine habitats, with entanglement, ingestion, and microplastics being some of the main concerns. The impacts of plastic pollution on the marine environment are complex and can have far-reaching consequences beyond the direct harm to animals. Urgent action is needed to reduce the amount of plastic pollution in waste in the marine environment and to mitigate the damage already done.

Effect Of Plastic Waste On Human Health

There are worries about the harmful substances in plastics and their Effect on the environment, particularly in the ocean. These synthetic pollutants can have a long-lasting impact and may even contaminate water supplies and enter the food chain. United Nations Environment Project (i2016) report stated that microplastics in the ocean pose a potential threat to human health as they could be consumed through seafood.

BPA and phthalates, two chemicals commonly found in plastics, have been detected throughout the marine ecosystem. BPA, present in plastic water bottles and other types of packaging, can disrupt normal hormonal function due to its endocrine-disrupting properties Birnbaum, L. et. al. (2010). Meanwhile, studies involving laboratory rats have suggested that phthalates can harm reproductive systems, raising concerns about potential impacts on human health (UNEP, 2016).

Seafood makes up over 20% of the per capita animal protein consumption for over 1.5 billion people worldwide. These individuals' risk-averse health effects due to plastic contamination in their seafood. Small islands and developing countries are particularly vulnerable due to their heavy reliance on seafood for up to 90% of their animal protein Rochman, C. M. et. al., (2016). In addition, toxic chemicals from

plastics have been found to contaminate local water supplies, posing potential health risks such as hormonal problems and nervous system damage for humans.

Effects of Plastic Waste on the World Economy

Worldwide plastic production exceeds 300 million tons yearly, with much of it being disposed of after a single use Rochman, C. M. et. al., (2016). This results in high economic costs for managing and extracting plastic pollution from the ocean, while coastal and fishing communities also suffer negative impacts (Perez, 2017). The current plastic economy's drawbacks highlight the need to reconsider the future of plastic production. Increased plastic production harms natural resources and clogs urban infrastructure, causing detrimental effects on the global economy (Ellen McArthur Foundation, 2017).

The negative impacts of plastics on the marine environment result in substantial economic losses globally, amounting to billions of dollars each year. Single-use plastics are particularly problematic, with only 14% being recycled annually, resulting in an $80-100 million loss. Most end up in the ocean and pose significant threats to the natural world. The economic cost of ocean plastics is estimated to be $13 billion each year due to the damage they inflict on marine life and their release of chemical pollutants, adversely affecting the fishing and tourism industries (Kirby, 2014). Cleanup costs are also high, with some US states spending almost $500 million annually to remove plastic waste from the Pacific coastline (Morden, K. 2019). Governments worldwide spend additional millions on extracting plastics from the ocean, utilizing valuable tax dollars to support these efforts.

Pollutants from plastics affect the quality of fish in various parts of the world, potentially impacting the 240 million people working in the fishing industry. Additionally, debris entanglement poses high costs for fisheries as they lose thousands of fish during the process of extracting plastic waste, resulting in monetary losses Rochman, C. M. et. al., (2016)

Control Measures for Marine Plastic Waste Disposal

There are various control measures for marine plastic waste disposal, including waste reduction, recycling, and implementing effective waste management systems.

One of the most effective control measures for marine plastic waste disposal is waste reduction. This involves reducing the amount of plastic waste generated at the source. Adopting sustainable practices, such as reusable bags, bottles, and others, can significantly reduce the amount of plastic waste generated. A study by Derraik (2002) found that plastic waste reduction campaigns can effectively reduce plastic waste entering marine environments. Another critical control measure is the implementation of effective waste management systems. This involves the proper collection, treatment, and disposal of plastic waste. A study by Jambeck et al. (2015) found that improving waste management practices in coastal countries could reduce the amount of plastic waste entering the ocean by up to 75%.

Recycling is another control measure for marine plastic waste disposal. This involves the collection and processing of plastic waste to produce new products. A study by Law et al. (2017) found that recycling can significantly reduce the environmental impact of plastic waste, including its impact on marine ecosystems. Implementing policies and regulations can also be an effective control measure for marine plastic waste disposal. For example, the European Union has introduced regulations to decrease the use of single-use plastics and to promote recycling (European Commission, 2018). Similarly, the United Nations has launched the Clean Seas campaign to reduce marine litter, including plastic waste (United Nations, 2017).

In a conclusive context, various control measures are available for marine plastic waste disposal, including waste reduction, recycling, and implementing effective waste management systems. These measures can significantly reduce the amount of plastic waste entering marine environments and mitigate the impact of plastic waste on marine ecosystems. The adoption of sustainable practices and the implementation of policies and regulations are essential for the effective control of marine plastic waste disposal.

Review of The Related Methodologies Adopted By Authors On Plastic Wastes

Research on plastic waste and its impact on the marine environment has been conducted by different researchers using various methods. Some of the methods adopted by researchers are: Field studies involve collecting data on plastic waste in the marine environment through direct observation and sampling. These studies provide

valuable information on plastic waste distribution, composition, and abundance in different marine habitats. For example, in a study conducted by Lebreton et al. (2018), the author used field data to evaluate the amount of plastic waste that enters the oceans annually.

The related study conducted another related study was conducted by Rochman et al. (2014), who used laboratory experiments to investigate the physical and chemical effects of plastic waste on marine organisms and ecosystems. The research demonstrated that microplastics could transfer chemicals to fish tissue. These experiments help to identify the mechanisms of plastic toxicity and assess the long-term impacts of plastic waste on marine ecosystems. Similarly, Modeling approaches simulate the transport and fate of plastic waste in the marine environment. These models help to identify the sources and sinks of plastic waste and estimate the potential impacts on marine ecosystems. For example, a study by van Sebille et al. (2015) used a global ocean model to simulate the distribution of plastic waste in the oceans.

Moreover, remote sensing is also adopted by Peng et al. (2018), where satellite imagery estimates the amount of plastic waste floating on the ocean's surface. The investigation further detects and maps out plastic waste in the oceans. The methods provide a comprehensive view of plastic waste's spatial distribution and extent in different marine habitats. Social science involves the participation of volunteers in data collection and analysis. This approach remarkably succeeded in collecting data on plastic waste in the marine environment on a large scale and over long periods (Ocean Conservancy, 2021).

Therefore, studying plastic waste and its impact on the marine environment is diverse and multidisciplinary. Thus, a qualitative approach, which would provide a comprehensive understanding of the problem and develop effective mitigation strategies, is adopted in this context.

CHAPTER III

Methodology

Study Design

The research study was conducted using a cross-sectional survey design. The cross-sectional survey design enabled the researcher to determine the impact of Plastic waste by noting its origins, occurrences, and impact on the marine environment through self-prepared questionnaires among the respondents after data collection and analysis.

Research Location

The study was conducted in Montserrado County, which is one of the 15 counties in Liberia. Situated in the county is the *Muserado River*. The river is located near the coast and is linked to the Atlantic Ocean by a channel. It covers an area of approximately 25 kilometers (16 miles) and is a vital ecological resource. The river is home to various aquatic plants and animals, including fish, shrimp, crabs, and waterfowl. It forms an important breeding ground for many fish species and a popular fishing spot for local communities. In addition, the river is an essential source of fresh water for nearby neighborhoods.

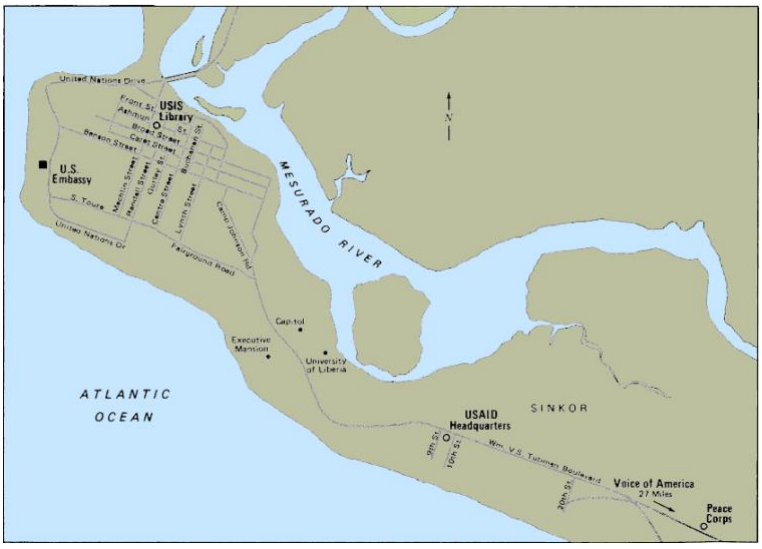

Figure 2 Map of Monrovia with the study area

Research Design

In this study, survey research was conducted using a quantitative data type. More specifically, a descriptive research design which is a theory-based design method was performed to collect, analyze, and present the collected data.

Sample Size Determination

From an approximate population of 800 which are perceived to be inhabitants of the study region, the required sample size was calculated/determined using Slovin's formula as follows: $N= N/ (1 + N*e^2)$

$800/ (1+800*0.05^2) = 267$

Where: N is the total number of population (800); e represents the margin of sampling error $(0.05)^2$. Eight hundred (800) people were therefore taken into consideration for the study to obtain the needed data.

Field Data Sampling Techniques

The core data was gathered via a structured questionnaire survey to determine how people around the Mesurado River felt about plastic waste and its impact on the marine environment. It also contained information on the socioeconomic characteristics of the respondents, an income-expenditure scenario, their opinions of plastic waste, the causes, mitigation options, and coping mechanisms. To gather a survey population in the research region, a purposive sampling strategy was utilized. Then, to choose representative subjects for the study, a random selection strategy was used. Before giving out the questionnaires, participants were asked if they would be willing to participate in the survey, which was done to ensure the data's accuracy and dependability. They were given specific instructions on how to react to each question after they had agreed to it.

Field Data Collection Procedures

The study data collection was conducted through primary sources from individuals believed to be inhabitants around the Mesurado River in Monrovia, Liberia, through google forms. The analysis lasted for a month or two. Data were entered into Excel spreadsheets as well as the Statistical Package for Social Sciences in order to perform a -value analysis on the acquired data. This enabled us to draw

accurate conclusions from our research findings while ensuring the accuracy of our results at all times.

Analysis Of Data

In order to accomplish the study's objectives, the collected data from the survey were analyzed using Statistical Package of Social Sciences (SPSS) software version 22.0; descriptive statistics of frequency and percentage were used for data description and analysis. The data was presented using figures, charts, and tables with written explanations

Study Instruments

The instrument for data collection is a self-developed tool based on the literature review related to the topic. The total number of items in the questionnaire consists of 49 items. 10 Items form part of demographic characteristics, 13 items form part of Causes/Origin and occurrences, 18 items measure the impact of plastic waste, and eight items measure waste control measures.

Ethical Aspect

Ethical approval from the Near East Institutional Reviews Board (IRB) of Near East University was obtained before conducting the study. Approval was also obtained from relevant waste control agencies and the community where the Brackish water is located. Informed consent was obtained from the participants, participants were allowed at any time to withdraw from the study, all information obtained was used for the research only, and the privacy and confidentiality of the participants were assured.

CHAPTER IV

Findings and Discussion

This section presented the data analysis and interpretation with a total of 259 respondents as participants. Out of the 259 respondents, 168 were males and 91 were females. According to the data, from (**Table 1**), 154 were single, 76 respondents were married, 18 were divorced and 11 were said to be widowed, respectively. Therefore, in this category, the single population made up the majority of the respondents, and also the male population waste higher than the female population.

Table 1**.** Total number of respondents, their gender, and marital status

		Single	Married	Divorced	Widowed	Total
Gender	Male	98	53	9	8	168
	Female	56	23	9	3	91
Total		154	76	18	11	259

(Source: Author, field data, 2023)

The respondents ranging in age from 20 to 30 years were 32%. While 31 to 40 years accounted for 31.3%, between 41 – 50 years amount to 22% and the remaining 13.9% are between the age range of 51 years and above. The majority of the respondents are college graduate suite, to be precise 50.6%. Those that completed high school also played a major part in this category with 41.7%, furthermore, 5.8% of the respondents are illiterate, and finally, 1.9% only completed elementary.

Table 2**.** Educational background and total percentage of respondent

		College (50.6%)	Graduate	Elementary (1.9%)	High School (41.7%)	Illiterate (5.8%)	
Age	20-30	24		1	56	4	85 (32.8%)
	31-40	48		2	30	1	81(31.3%)
	41-50	38		1	11	7	57(22%)
	51 and Above	21		1	11	3	36(13.9%)
Total		131		5	108	15	259(100%)

(Source: Author, field data, 2023)

Respondents' socioeconomic status was taken into account while recording their income and expenses. As a consequence, 40% of the participants admitted that

their income was above $300 dollars. While 31.7% stated that their income ranges from $151 dollars to $300 dollars and 28.2$ earned between 1$ to 150$. Regarding their expenditure, 60.6% of the respondents said they are spending more than $1 dollar to $150 dollars per month, because of the cost of living in the country. As indicated in table 3.

Table 3. Socioeconomic Status of The Respondent's Income and Expenditure

		Frequency	Percent
Income	>$301	104	40.2
	$1-$150	73	28.2
	$151-$300	82	31.7
Expenditure	>$301	15	5.8
	$1-$150	157	60.6
	$151-$300	87	33.6

(Source: Author, field data, 2023)

In Table 4, participants were asked to state how close they are to the study area (Muserado River). According to the data gathered, the majority of the respondents 166 accounts for 64.1% lives closer to the rivers, and just 93 (35%) of respondents stay far away from the study area.

Table 5 indicates the residential status of respondents in with regards to how long they have lived in the study area. From the data gathered, almost half of the respondents have lived closer to the study area for 1 – 10 years, (**Table 5**).

Table 4. Residential status of the respondents living around the Muserado River

	Frequency	Percent
Close to the River Side	166	64.1
Far Away from River Side	93	35.9
Total	259	100.0

(Source: Author, field data, 2023)

Table 5. Indicates the Length of Time Each Respondents Has Stayed in The Study Area

	Frequency	Percent
1-10 years	124	47.9
11-20 years	69	26.6
21 years and above	66	25.5
Total	259	100.0

(Source: Author, field data, 2023)

Respondents' Knowledge of Plastic Waste in the Marine Environment

When asked whether they have heard about plastic waste, 78.8% of the respondents said they have, while 21.2% said they have not heard about plastic waste as indicated in table 6. Additionally, there were asked to identify the source of their knowledge, and the responses were as follows: 14.8 % heard about this topic from television, 19.7% from radio, 9.6% from the newspaper, 15.8% acknowledged that they heard about plastic waste from the internet, with 13.8% and 10.9% said they heard about plastic waste from a government agency and friends/family respectively. Finally, 15.4 heard about plastic waste from other sources that were not mentioned; respondents had the option to select more than one option (table 7)

Table 6. Indicates Respondents' Knowledge of Plastic Waste

	Frequency	Percent
Yes	204	78.8
No	55	21.2
Total	259	100.0

(Source: Author, field data, 2023)

Table 7. Medium through which the respondents received information of plastic waste

Source of Information	N	%
Television	146	14.8
Radio	194	19.7
Newspaper	95	9.6
Internet	156	15.8
Government Agency	136	13.8
Family/Friends	107	10.9
Others	151	15.4
Total	985	100

(Source: Author, field data, 2023)

The Causes and Occurrences of Marine Plastic in the Marine Environment

In this section, we concentrate our attention on the causes and occurrences of plastic waste in the marine environment which is one of the objectives of this research.

Within the research area, almost 82% of the respondents believed that the high population along the riverside is one of the major causes of plastic waste pollution in the marine environment, while 13.9% disagree with this. The remaining 4.2% are not sure whether it is true or not and 0.8% was missing in this area. (**Table 8**). Additionally, a large percentage of the participants said that riverside residents are mostly responsible for plastic waste in brackish water. According to **Table 9,** more than half of the respondents believe that river plastic pollution is also caused by fishing and water recreation activities. To be precise, 57.1% attested to this, 37.8% totally disagreed with this, and 4.6% are not sure in this area.

Table 8. Respondents' perception on high population at riverside as it relates to plastic waste

		Frequency	Percent
	Yes	210	81.1
	No	36	13.9
	I don't Know	11	4.2
	Total	257	99.2
Missing	System	2	0.8
Total		259	100.0

(Source: Author, field data, 2023)

Table 9. Respondents' perception on river plastic waste accumulation

		Frequency	Percent
	Yes	148	57.1
	No	98	37.8
	I don't know	12	4.6
	Total	258	99.6
Missing	System	1	.4
Total		259	100.0

(Source: Author, field data, 2023)

When asked about the type of plastic waste mostly found in the riverside, participants indicated a variety of the plastic waste that includes: food wrappersgaretteatte butts, takeaway containers, cotton buds, and fishing nets. Sanitary products with 19.2% and food wrappers with 18.9% dominated this section according to the data gathered

Table 10. Indicates the types of plastic waste often found at the riverside

Plastic Waste Commonly Found at River Side	N	%
Food Wrapper	222	18.9
Cigarette Butts	106	9
Takeaway Containers	155	13.2
Cotton Bud Sticks	107	9.1
Takeaway Cup	193	16.5
Sanitary Products	225	19.2
Fishing Nets	165	14.1
Total	1173	100

(Source: Author, field data, 2023)

A sizeable number of the participants (177) stated that other activities such as the sales of sachet water along the riverside and agricultural activities are also contributing factors towards plastic pollution in the marine environment, 70 participants completely said otherwise and 12 did not know if it is a cause (**Figure 3**)Indicates other factors that contribute to plastic pollution in the marine ecosystem

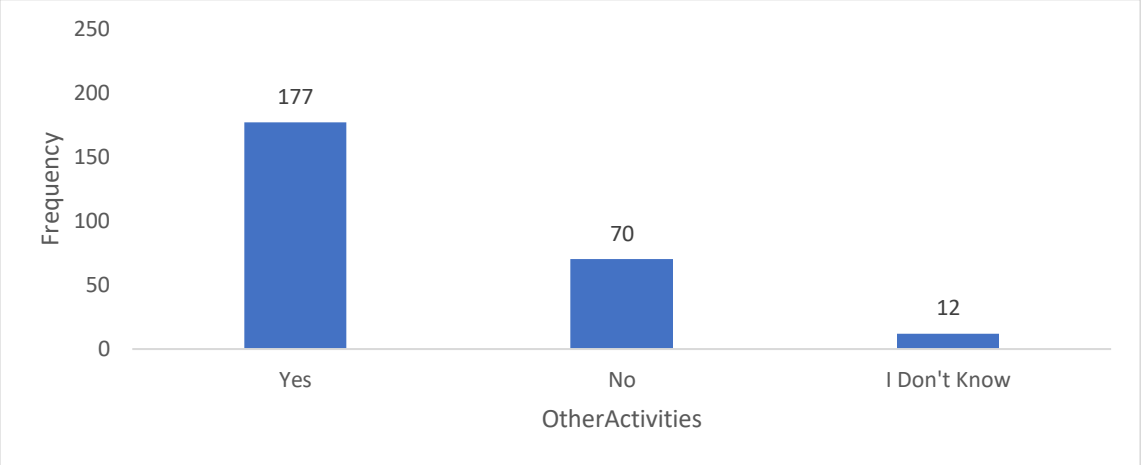

Figure 3. Perception on the impact of plastic waste on the marine environment
(Source: Author, field data, 2023)

The Impact of Plastic Waste on Fishing Activities

The evaluation of resident views on the impact of plastic waste on the marine environment was one of the main goals of this study. In the figures and table below, by collecting information from respondents about their knowledge of the subject, the analysis ascertains their knowledge of the subject. The analysis also ascertains their

level of knowledge and the sources from which they obtained it. It was crucial to understand the cause of plastic waste on the marine environment before attempting to comprehend the population's perspective on the impact of plastic waste on the marine environment. According to the data in **Figure 4**, 83% of the respondents believe that plastic pollution on the marine ecosystem has a negative impact on fishing activities, while 13.5% disagreed. The majority of the participants further stated that these could affect fish production and endangers other marine species. 82% of the respondents accepted this statement, while 13% think otherwise of this and the remaining 5% are not sure as indicated in **figure 5**

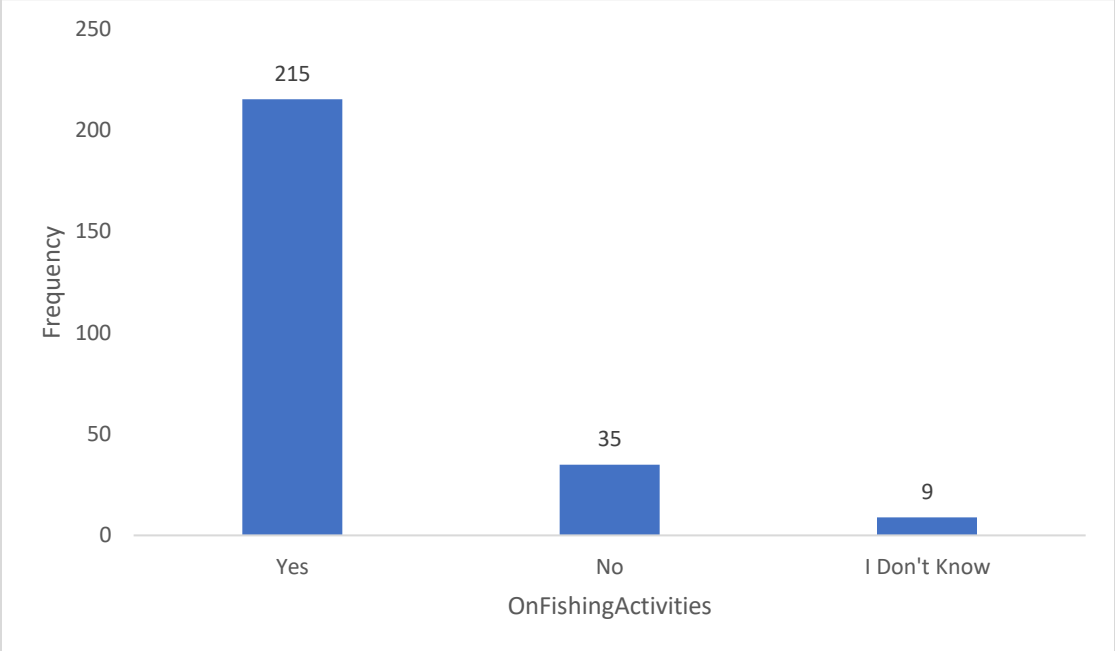

Figure 4. Respondents' perception on the impact of plastic waste (Source: Author, field data, 2023)

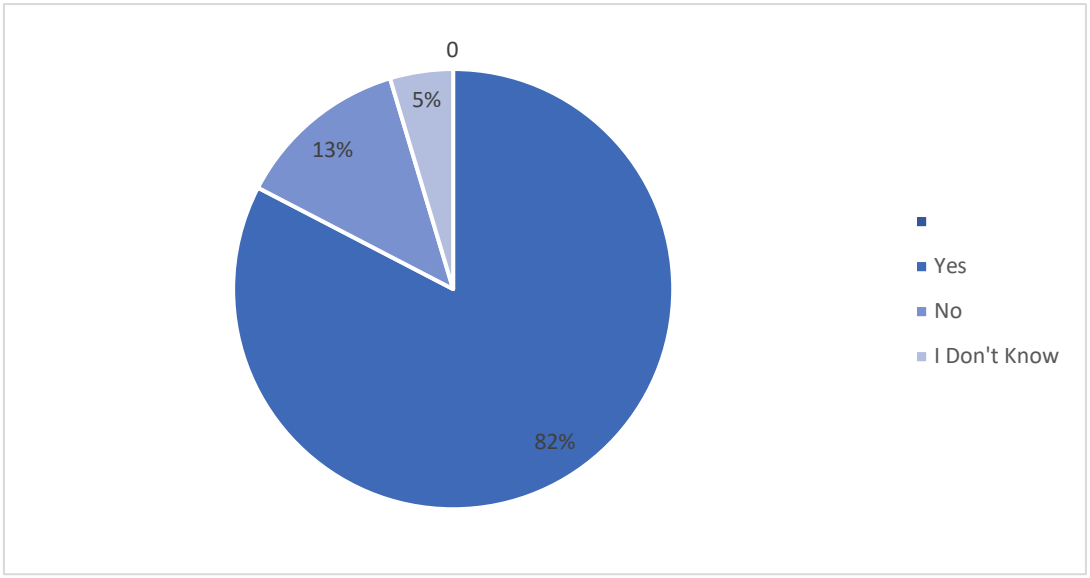

Figure 5 Depicts the impact of marine plastic waste on fish reproduction

(Source: Author, field data, 2023)

According to **figure 6** of this research, more than 85% of the respondents said that plastic pollution in the marine environment can contribute to the increasing population of insects, thereby posing a serious risk to human health such as malaria, chloral, lassi fever, and typhoid as indicated in **Table 11**. Only a small portion of 9% of the respondents think otherwise.Increment in the population of insects due to the high accumulation of plastic waste in the marine environment

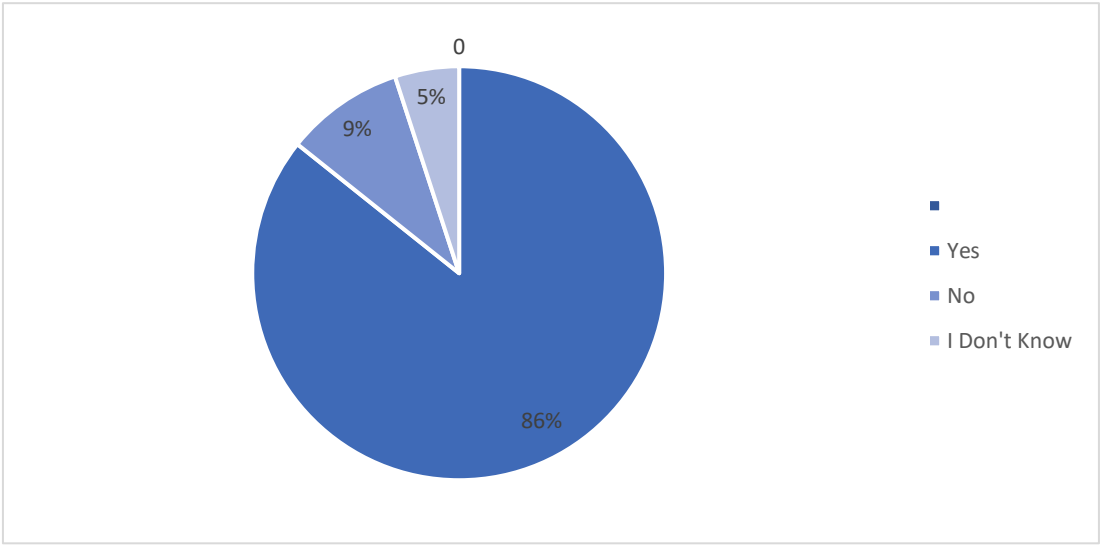

Figure 6. Respondent's perception of the increment in the population of insects due to the high accumulation of plastic waste in the marine environment (Source: Author, field data, 2023)

Table 11. Indicates health problems caused by plastic waste

Health Problems Caused by Plastic Waste	N	%
Respiratory Problem	92	7.7
Infection and Allergies	99	8.3
Cancer	47	3.9
Malaria	205	17.2
Food and Nutrition Diseases	119	10
Cholera	209	17.5
Lassa Fever	202	17
Typhoid	219	18.4
Total	1192	100

(Source: Author, field data, 2023)

Additionally, marine animals such as turtles, seabirds, and dolphins often mistake plastic debris for food or become entangled in it. Furthermore, plastic waste can lead to habitat destruction of marine species. Marne plastic pollution also has economic implications. Marine plastic pollution negatively affects industries such as fishing, tourism, and coastal economies.

Respondents' Perception of Marine Plastic Waste Control and Measure

In this research area, the respondents' perception of marine plastic waste control measures was taken into consideration. According to the data in Figure 5, 85.3% percent of the respondents agreed that educating the public on the impact of plastic waste on the environment is one of the best measures that could be required to control plastic pollution. However, 11.2% of the respondents think otherwise.

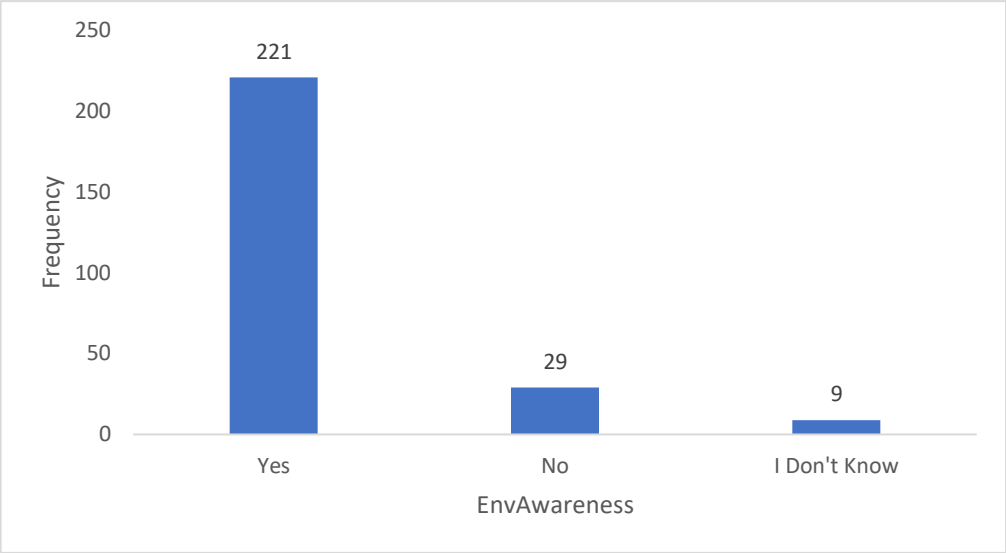

Figure 7. Indicates the respondent's perception on the lack of Marine Environmental Awareness and Protection (Source: Author, field data, 2023)

Figure 6 shows that the majority (83.3%) of the respondents believe that putting plastic bins at strategic locations around the marine environment can also help in tackling plastic pollution. Notwithstanding, a small portion of 10.4% of the population disagreed. Almost all of those that responded (94%) stated that there are other measures that can be implemented to holistically control plastic pollution in the marine environment. It is also important to note that just 3% of the respondents think that nothing more can be done to minimize the pollution of plastic waste in the marine environment. While 3% say they do not know if anything can be done to address plastic pollution as indicated in **Figure 7**.

It is also important to state that respondents believed that government institutions, local residents, and traditional rulers could be the right sources to prevent the disposal of plastic waste in the marine environment.

To address plastic pollution, we must all work together to reduce plastic consumption, improve waste management practices, promote recycling and circular economy models, and raise awareness about the environmental consequences of plastic pollution particularly to our marine ecosystem.

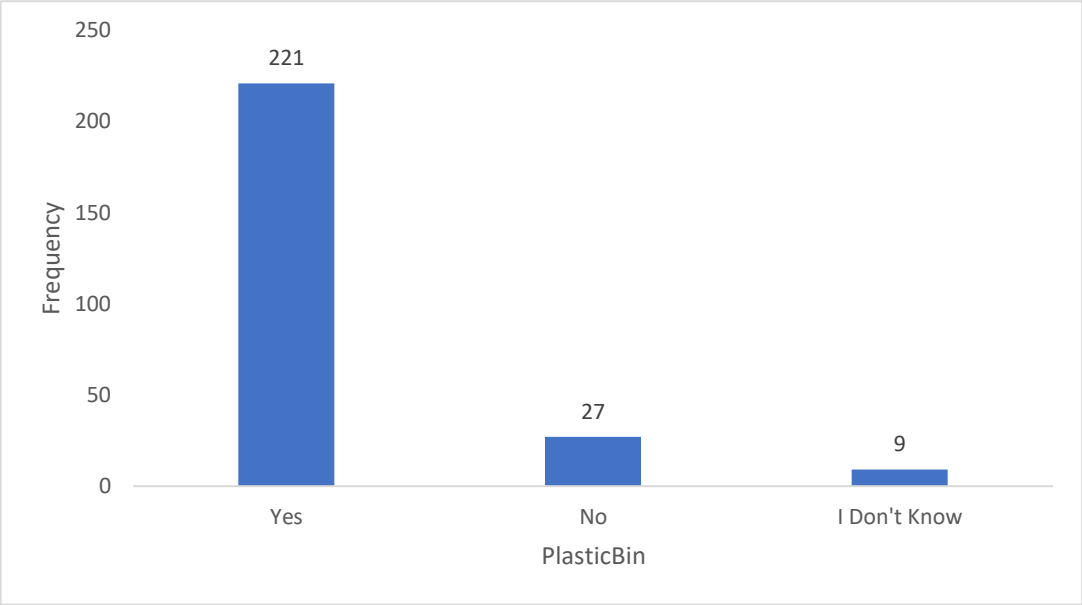

Figure 8. Point at respondents' views on lack of plastic bin disposal at the riverside (Source: Author, field data, 2023)

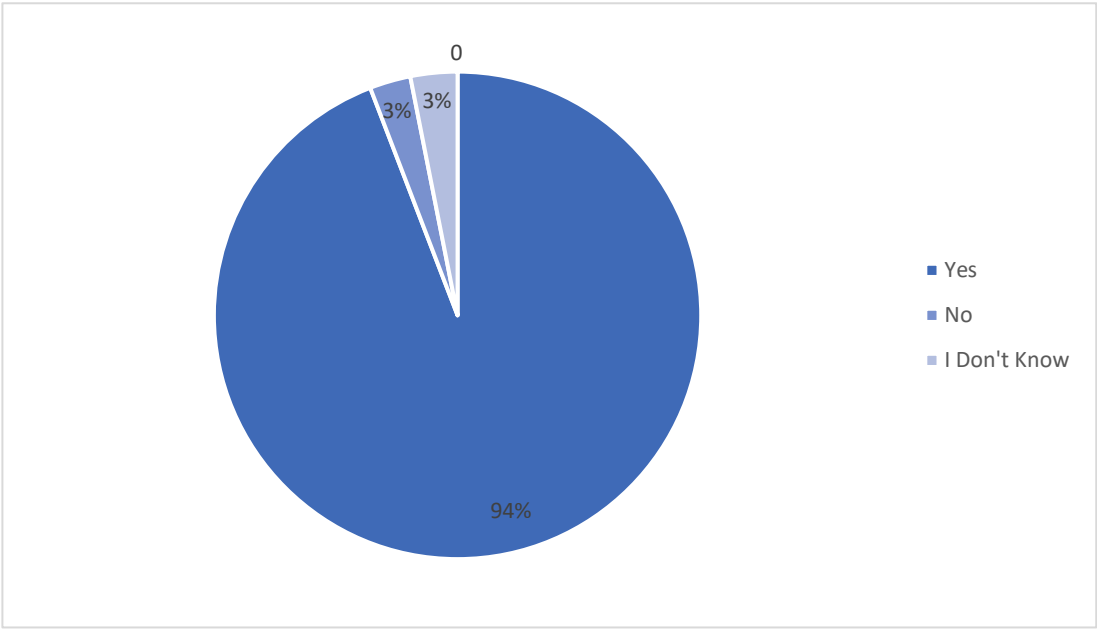

Figure 9. Indicates Respondent's View on Tackling Plastic Waste (Source: Author, field data, 2023)

Table 12 represents a crosstabulation or cross-tab of responses to the question "Do you reuse plastic waste?" based on the respondents' gender. It breaks down the counts of responses for each combination of gender and reusing plastic waste category (Yes, No, I Don't Know). This crosstabulation summarizes the responses to the topic of whether or not plastic waste may be reused according to gender. As a result, we can

examine whether or not there is a correlation between female and male when it comes to recycling plastic.

Table 12 Gender * Reusing Plastic Waste Crosstabulation

			Yes	No	I Don't Know	
Gender	Male	Count	151	12	3	166
		Expected Count	151.7	11.0	3.2	166.0
		Residual	-.7	1.0	-.2	
	Female	Count	83	5	2	90
		Expected Count	82.3	6.0	1.8	90.0
		Residual	.7	-1.0	.2	
Total		Count	234	17	5	256
		Expected Count	234.0	17.0	5.0	256.0

Table 13 Chi-Square Analysis in Relation to Respondents' Perception on recycling of plastic waste

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.308[a]	2	.857
Likelihood Ratio	.314	2	.855
Linear-by-Linear Association	.031	1	.860
N of Valid Cases	256		

a. 2 cells (33.3%) have an expected count of less than 5. The minimum expected count is 1.76.

(Source: Author, field data, 2023)

The tabular data in table 13 shows the results of a chi-squared correlation test on how respondents felt about recycling industries purchasing and reusing plastic garbage in order to reduce plastic waste pollution in the marine environment. The test analyzes whether a connection exists between the variables by using the frequencies presented in a contingency table. The test calculates p-values based on a number of test statistics to determine the significance of the link. This test statistic compares the observed

frequencies with the expected frequencies assuming no association between the variables. The p-value associated with the Pearson Chi-Square test is 0.857, which is greater than the conventional threshold of .05. This suggests that there is no statistically significant association between the variables being analyzed.

CHAPTER V

Discussion

The amount of plastic waste generated in Monrovia, Liberia, and its impacts on the maritime environment are mostly related. According to Colorado and Echeverri-Lopera (2020), nations with lower GDPs often create less plastic waste. In Monrovia, Liberia, the study focused on plastic waste and its impacts on the maritime environment. The failure to detect plastic waste early on, however, indicates improper handling of the material, which might have negative effects on the environment and human health.

The respondents ranging in age from 20 to 30 years were 32%. While 31 to 40 years accounted for 31.3%, between 41 – 50 years amount to 22% and the remaining 13.9% are between the age range of 51 years and above. The findings also indicate an uneven gender distribution within the sample, with a more significant representation of males than females (168 males and 91 females, respectively) (**Table 1**); there is a more substantial proportion of single people than married, divorced, or widowed people. According to the data, a sizeable percentage of respondents had completed higher education which accounts for 41.7%, with college graduates making up the majority at 50.6%.

Regarding the respondents' expenditures, 40% of the participants admitted that their income was above $300 dollars. While 31.7% stated that their income ranges from $151 dollars to $300 dollars and 28.2$ earned between 1$ to 150$. Regarding their expenditure, 60.6% of the respondents said they are spending more than $1 dollar to $150 dollars per month, because of the cost of living in the country

The study findings showed that almost all respondents knew of plastic waste in brackish water. This is crucial for raising awareness of environmental issues and future behavioral changes involving plastic waste disposal. The source of understanding was obtained from multiple sources that included local means of information such as radio, television, family, friends, and newspapers; these media channels form an essential basis of information that can be continuously utilized to sensitize further and create awareness on plastic waste control measures that will ultimately help in preventing and controlling plastic waste pollution in brackish water.

Most respondents believe a high population and the people residing near the riverside are responsible for plastic waste pollution in brackish water. This perception emphasizes how crucial it is to address riverside communities' management of plastic garbage to maintain the brackish water's quality and safeguard the environment. This finding agrees with a study by Jambeck et al. (2015), which estimated that up to 12.7 metric tons of plastic waste generated by coastal populations could enter the ocean annually, causing harm to marine ecosystems. In addition, a study by Aliani et al. (2020) found that the sources of land-based debris included human activities from tourism, fishing, and urbanization.

Almost half of the respondents believe there is a link between plastic waste in rivers and ocean-based debris; this finding is in agreement with the results of Eriksen et al. (2014; Law et al. (2014), which highlighted the role of ocean-based sources, such as abandoned or lost fishing gear, in accumulating marine debris.

The majority of respondents believe that agricultural fishing and commercial operations are responsible for plastic waste accumulation in brackish water. This implies that respondents believe there is a link between agriculture, fishing, and commercial activities and the accumulation of plastic waste in the brackish water; this establishes a perceived connection between agricultural, fishing, and commercial operations and the collection of river plastic debris and shows that respondents are aware of or have observed farming practices along the river. This is necessary for managing such operations to lessen their adverse effects on the ecology around waterways. The findings agree with the conclusions of Eriksen et al. (2014; Law et al. (2014).

Most respondents believe the absence of proper plastic waste disposal facilities contributes to plastic waste accumulation in the river. This suggests that respondents recognize the importance of adequate waste management infrastructure to prevent plastic pollution in water bodies. Addressing this issue by providing accessible and appropriate waste disposal options can help mitigate the problem of river plastic waste accumulation and promote environmental sustainability. This finding corroborated that of Moore & Phillips (2011), Jambeck et al. (2015), and Schmidt et al. (2017), which indicated factors such as littering, poor waste management practices, stormwater runoff, and abandoned or lost fishing gear as the main contributors to marine debris.

Most respondents indicated a variety of the plastic waste that included; food wrappers, takeaway containers, takeaway cups, sanitary products, and fishing nets, all common plastic waste accumulating in the brackish river. This is similar to Andrady's (2011) and Li's (2021) results. They found several types of plastic waste accumulation in the studied water bodies.

Another finding indicated that the accumulation of plastic waste could impact crop yields, crop disease, and infestation on farms near brackish water. This finding relates to Chowdhury et al. (2020; and Nielsen et al. (2020). This shows that the effects of plastic pollution on agricultural operations have been considered. To alleviate crop yield decline and safeguard food security in places close to rivers, it can be helpful to acknowledge these consequences to motivate efforts to reduce plastic waste, establish efficient waste management procedures, and promote sustainable agriculture.

Most respondents believed that fish consumption of river plastic waste could hurt the fish; many more also expressed concern over the possibility that fish may consume plastics contaminated with chemicals, and significant numbers believe that plastic waste in rivers can result in fish entanglement and unintentional death. These related findings are evident in the research findings of Gall & Thompson (2015), Pham et al. (2019), and Alomar et al. (2018). Also, in similar results, Browne et al. (2015) showed microplastics are also a concern because they can be consumed by marine organisms and potentially enter the food chain.

Overall, most respondents strongly agree that an increase in rodents and mosquitoes can lead to diseases along the river, and the most common condition identified include Malaria, Cholera, Typhoid, and respiratory issues such as asthma; these findings are related to results of Rochman et al., (2015) and UNEP, (2016) that indicated plastic waste accumulation along the shore of water bodies is associated with impact on human health. Understanding this connection helps highlight how crucial it is to control pest populations and promote good hygiene habits to stop the development of diseases from rats and mosquitoes in river environments.

The vast majority of respondents have a favorable opinion regarding plastic waste control and believe it to be effective; many think some solutions can be implemented by individuals, traditional rulers, and the government.

Most respondents think that neighborhood inhabitants have proper plastic waste disposal bin placement at key riverside locations and comply with government regulations. This may indicate that people understand the value of government action, rules, regulations, and enforcement to solve the issue effectively. They anticipate that the government will lead in implementing policies and programs to fight plastic waste. The above-related findings are seen in the conclusions of Galgani et al. (2015). Roschmann et al. (2018) showed that a range of solutions had been proposed for marine plastic waste accumulation, including better waste management practices, education and outreach campaigns, and technological innovations to reduce plastic waste, while Staples et al. (2018) suggest governments, NGOs, and industry groups worked together to develop policies and regulations to reduce marine debris. To effectively address the problem of plastic waste, the findings highlight the necessity for a collaborative effort that includes individual responsibility, government measures, and community involvement. Comprehensive efforts to address plastic trash contamination can result from cooperation between various parties, including local citizens, the government, and traditional leaders.

The likelihood that plastic waste will be dumped in public spaces and the marine environment is increased by a lack of knowledge about plastic waste treatment facilities, a lack of plastic waste containers and a greater distance to the collection locations, a lack of funds, and the absence of suitable laws and legislation. According to reports, high disposal prices are one of the issues preventing the proper disposal of plastic waste in well-equipped and built landfills. Although it is believed that some people have a predisposition to recycle plastic waste, this is not the case in the study area.

These results demonstrate that municipalities are unable to implement waste separation programs due to a lack of understanding of plastic waste management technology and best practices, a lack of equipment for waste sorted materials, and a lack of decision-makers concerned with environmental issues Tokpah, David P., et al. (2020). Awareness-raising initiatives for plastic waste separation have an effect on people's behavior because they care about the marine environment and want to be involved in solving problems.

Summary Of Major Findings

The primary objectives of this study were to characterize plastic waste and its impacts on the marine environment in Monrovia, Liberia, examine local community participation in plastic waste management techniques, and ascertain if policies and legal frameworks are in place in the research area. 259 respondents from the study areas in Monrovia City, Liberia, were chosen at random to participate in the study; 168 of them were men and 91 were women.

The leading causes of plastic waste accumulation in brackish water include; commercial operations along the riverside, the absence of proper plastic waste disposal facilities, a high population and activities of riverside dwellers, agricultural operations, and the activities of external visitors.

Food wrappers, takeaway containers, takeaway cups, sanitary products, and fishing nets were the common plastic waste that accumulated in the brackish river.

The possible harmful consequences of plastic waste accumulation in brackish water include; reduced crop yield, crop diseases, reduced fish supply, fish entanglement or death, and the possibility that fish may consume plastics contaminated with chemicals. Diseases increase due to an increase in the number of rodents and mosquitoes. In addition to the impact on the aesthetics and decoration of the environment around the river banks.

Most respondents believe that individuals, traditional rulers, and government efforts can significantly reduce plastic waste. Using strategies such as proper plastic waste disposal bin placement at key riverside locations, government regulations, and individual efforts to reduce plastic waste can be beneficial in reducing plastic waste accumulation.

CHAPTER VI

Conclusion And Recommendation

Conclusion

Reducing the impacts of plastic waste in brackish water requires a multi-pronged approach that includes local and global actions. Among these approaches are increasing awareness among the broader public through media and educational materials about how their personal choices can impact plastic waste accumulation in brackish water and providing resources to coastal communities to support their leadership role in developing or improving locally-relevant brackish water plastic waste action plans. Funding and logistical support from governments will also help address the unique challenges brackish water coastal communities face in plastic waste removal from the brackish water.

Recommendations

Considering the results of the study, the researcher recommends the following:

- ✓ The government must make sure there is stringent enforcement of relevant laws that will help in reducing indiscriminate plastic waste disposal
- ✓ Relevant governmental and non-governmental organizations involved in creating awareness regarding plastic waste disposal, control, and associated effects should intensify their efforts through one-to-one and door-to-door individual and group campaigns, especially to the people during the peak activity days around the river site, targeting relevant occupational groups.
- ✓ The government and relevant non-governmental organizations should encourage the development of efficient, environmentally friendly, and innovative recycling technologies for plastic waste to reduce the chance of indiscriminate plastic waste disposal and reduce plastic waste accumulation in brackish water.
- ✓ It is necessary to create more environmentally friendly materials that replace plastic as the familiar packaging material people use.

Suggestion For Further Studies

The researcher suggests further study using a mixed-methods design utilizing the survey method, observational method, and interviews with key stakeholders to get more detailed data to enrich the study findings and ensure the generalization of results.

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APPENDICES

Appendix 1 Ethical Approval

NEAR EAST UNIVERSITY

SCIENTIFIC RESEARCH ETHICS COMMITTEE

05.06.2023

Dear Momoh Ndorbor Mason Jr

Your application titled **"Plastic Waste And its Impact on The Marine Environment in Monrovia, Liberia"** with the application number NEU/AS/2023/192 has been evaluated by the Scientific Research Ethics Committee and granted approval. You can start your research on the condition that you will abide by the information provided in your application form.

Prof. Dr. Aşkın KİRAZ

The Coordinator of the Scientific Research Ethics Committee

Appendix 2**. Questionnaire**

My name is **Momoh Ndorbor Mason Jr**, and I am a student at the Near East University, Institute of Graduate Studies, Faculty of Civil Environmental Engineering, Department of Environmental Sciences and Engineering. I am conducting research titled: **"Plastic Waste And its Impact on The Marine Environment in Monrovia, Liberia"** which partially fulfils my master's degree program within this context. The purpose of this questionnaire is to collect primary data from a sample of respondents in order to complete the investigation. You have been identified as a possible participant for this research. Please respond to this inquiry form, which has been created in order to conduct research, and do not leave any questions unanswered, as your response will serve as the primary source of data, making it significant. Additional safeguards shall be applied to personal information to ensure its secure processing. Your responses will be kept confidential and used only for academic purposes; none of your information will be shared with third parties.

Thank you for your cooperation

A. Biography of respondents'

1. Gender: Female ( ) Male ( )

2. Age: 20- 30( ) 31-40( ) 41-50 ( ) 51 and above ( )

3. Marital status: Single ( ) Married ( ) Divorced ( ) Widow ( ) Other ( )

4. Level of education: Illiterate ( ) Elementary ( ) High school ( ) College graduate ( )

5. Residential area: close the river side ( ) Far away to river side ( )

6. Occupation status: Agriculture ( ) Fishing ( ) Business ( ) Others ( )

7. Average monthly income: $1-$150 ( ) $151-$300 ( ) >$301

8. Average monthly expenditure: $1-$150 ( ) $151-$300 ( ) >$301

9. Do you live in this area (Monrovia)? Yes ( ) No ( )

10. How long have you lived here? 1-10 yrs. ( ) 11-20 yrs. ( ) 21 yrs. - above ( )

B. Causes/Origin and Occurrence of Plastic Waste in Marine Environment

11. Have you heard of "plastic waste"? Yes ( ) No ( )
12. Do you know about plastic waste? Yes ( ) No ( )
13. Where have you heard about plastic waste? Tick as many as you feel apply:

    Television ( ) Radio ( ) Newspaper ( ) Internet ( ) Government agencies ( ) Friends/ family ( ) other ( )

14. Do you think that hhigh population of river side residents causes plastic waste accumulation Yes ( ) No ( ) I don't know ( )
15. Do you think that river side residents are responsible for Plastic waste in the brackish river? Yes ( ) No ( ) I don't know ( )
16. Do you think that river Plastic waste accumulation is originated from ocean base debris Yes ( ) No ( ) I don't know ( )
17. Do you think that external visitors are responsible for river plastic waste accumulation? Yes ( ) No ( ) I don't know ( )
18. Do you think that river Plastic waste accumulation is originated from fishing and water recreation activities? Yes ( ) No ( ) I don't know ( )
19. Do you think that Plastic waste accumulation is originated from agricultural activities around the river side? Yes ( ) No ( ) I don't know ( )
20. Do you think that river Plastic waste accumulation is originated from other business activities of people around the river side? Yes ( ) No ( ) I don't know ( )
21. Does lacks of marine environmental awareness and protection among the people around the river area causes plastic waste accumulation? Yes ( ) No ( ) I don't know ( )
22. Do you think lack of plastic bin disposal at the river side is responsible for river plastic waste accumulation? Yes ( ) No ( ) I don't know ( )
23. What type of plastic waste do you commonly see in River? You can choose more than one answer if applicable

    Food wrappers ( ) Cigarette butts ( ) Takeaway Containers ( ) Cotton bud sticks ( ) Takeaway cups ( ) Sanitary products ( ) Fishing Net

C. **Perception on Impacts of plastic waste**

24. Do you think plastic waste accumulation can have effects on farming around the river side? Yes ( ) No ( )
25. Do you think plastic waste accumulation can have effects crop yield reduction on the farms around the river side Yes ( ) No ( ) I don't know ( )
26. Do you think plastic waste accumulation at the river side can cause crop disease? Yes ( ) No ( ) I don't know ( )
27. Do you think plastic waste dumped at the river side reduces farming space? Yes ( ) No ( ) I don't know ( )
28. Do you think plastic waste dumped at the river side causes crop disease infestation? Yes (

) No ( ) I don't know ( )

29. Do you think river plastic waste accumulation have effects on fishing activities? Yes ( ) No ( ) I don't know ( )
30. Do you think river plastic waste accumulation reduces fish reproduction and supply? Yes (

) No ( ) I don't know ( )

31. Do you think river plastic waste eaten by fish can harm them? Yes ( ) No ( ) I don't know ( )
32. Do you think river plastic waste eaten by fish can lead to chemical poisoning? Yes ( ) No ( ) I don't know ( )
33. Do you think river plastic waste can entrapped fish? Yes ( ) No ( ) I don't know ( )
34. Do you think river plastic waste entrapment can lead to accidental death? Yes ( ) No ( ) I don't know ( )
35. Do you think river plastic waste can affects the commercial activities of the side businesses? Yes ( ) No ( ) I don't know ( )
36. Do you think river plastic waste can increases the growth of rodents and mosquitoes at the river side? Yes ( ) No ( ) I don't know ( )

37. Do you think increase growth of rodents and mosquitoes can increase diseases at the river side? Yes ( ) No ( ) I don't know ( )

38. Do you think river plastic waste can cause health problems to river side residents? Yes ( ) No ( ) I don't know ( )

39. If yes, what type of health problem do you think it can causes? You can choose more than one answer if applicable

a. Respiratory problems such as asthma ( )

b. Infection and allergies ( )

c. Cancer ( )

d. Malaria ( )

e. Food and nutrition diseases ( )

f. Cholera ( )

g. Lassa fever

h. Typhoid

40. Does the river plastic waste have effects on the environmental decoration and beauty around the shores of the river? Yes ( ) No ( ) I don't know ( )

41. Does river plastic waste emit bad odour to the neighboring environment? Yes ( ) No ( ) I don't know ( )

D. Residence Perception On Plastic Waste Control Measures

42. How Do you think about plastic waste control good ( ) Not good ( ) I don't know ( )

43. Do you think anything can be done to tackle plastic waste? Yes ( ) No ( ) I don't know ( )Which institution do you think can stop plastic waste? Local residence ( ) Traditional Rulers ( ) Government ( ) others specify __

44. Do you think adequate plastic bin disposal placed at strategic river side location can control plastic waste disposal in the river? Yes ( ) No ( ) I don't know ( )

45. How do you think the plastic waste can be control? By Government policy () By

creating Plastic environmental effect awareness () By Recycling benefit ()

46. Do you involve in plastic waste control activities? Yes ( ) No ( ) others specify

_____

47. If you are involved in plastic waste control activity, what type of activities?

    Plastic waste collection workers ( ) Plastic waste recycling vendors ( ) othe rs specify

_____

48. Do you think buying plastic waste and reused by the Recycling industries can control plastic waste? Yes ( ) No ( )
49. Do you think buying plastic waste and reused by the Recycling industries can control plastic waste? Yes ( ) No ( )

Appendix 3 More Images of Plastic Waste in the study area

Appendix 4 Turnitin Similarity Report

Thesis

ORIGINALITY REPORT

13%	11%	5%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	docs.neu.edu.tr Internet Source	3%
2	scholarworks.alaska.edu Internet Source	2%
3	W.C. LI, H.F. TSE, L. FOK. "Plastic waste in the marine environment: A review of sources, occurrence and effects", Science of The Total Environment, 2016 Publication	1%
4	web.uri.edu Internet Source	1%
5	hdl.handle.net Internet Source	1%
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7	nicholasinstitute.duke.edu Internet Source	1%
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