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DEPARTMENT OF BIOLOGICAL AND ENVIRONMENTAL SCIENCES

ENVIRONMENTAL MANAGEMENT OF MARINE PLASTIC LITTER IN NIGERIA AND WEST AFRICAN REGION: STATE, IMPACT AND MITIGATION MEASURES

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Abstract

As a natural part of our lives, the advantages of plastics remain tangential that we can barely do without it. Marine plastic has remained a major challenge in the West African country's coastline causing several degrees of environmental concern. These effects have destabilized the marine ecosystem and in-turn affecting humans. Based on these ideologies, it is paramount that the environmental impacts of marine plastic litter in Nigeria and West African regions is studied taking note of the current state and mitigation measures. The method used in this thesis is a literature review format by consulting past and recent research papers related to the topic. The focus is on West African setting with a major interest in Nigeria as a nation. Collective researches were reviewed on the occurrence of plastics in the marine ecosystem and their sources, adapted endpoints of plastic litter, economic impacts, preventive measures and government policies against marine plastic litter. Some of the search words used are marine plastic litter, mitigation measure, governmental policies, Nigeria, West Africa, marine plastic impact. Significant number of findings were made on the sources of these plastic litter in the marine and where they end up in the environment. Several economic impacts were exposed stating how devastating marine plastic litter could be. However, findings were also made on the preventive and government policy measures towards tackling the negative effects of marine litter pollution. At this point, it will be educating to ensure that all agencies (government and nongovernmental organizations) should escalate every means through awareness creation and active roles towards crippling the impact of marine plastic pollution in order to maintain a health ecosystem.

Keywords: Aquatic organisms, Environment, Literature review, Marine ecosystem, Marine plastic litter, Nigeria, Pollution.

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1. Introduction

1.1 Background

The West African coastline is home to major industries, mining activities, peri-urban and agro-industry, fishing activities, tourism shipping ports, as well as urban and seaside residences, all of which generate waste and cause pollution. The sustainable plastic waste management has remained a major challenge across the entire West Africa Sub-region comprising 16 member countries of the Economic Community of West African States (ECOWAS), which 13 of these member countries are boarded by the ocean, further aiding the trans-boundary marine plastic litter in the region. Many areas along the coast also lack adequate wastewater and solid waste management systems. As a result, large volumes of untreated wastewater and solid waste are dumped into the open, polluting the land and water (World Bank, 2016). Most municipal and industrial effluent in West Africa ends up in coastal areas with little or no pretreatment, posing risks to public health and environment/ecosystems. Less than 10 percent of urban areas in Africa have access to sewage services. As a result, only a small fraction of sewage is treated (World Bank, 2012). Additionally, large volumes of plastic waste, and electronic end-of-life material (E-waste) is being taken into countries in the region, further adding to the waste problem (Maes and Preston-Whyte, 2022).

Plastic debris is inflicting enormous damage on Africa's environment, especially marine ecosystems. This debris jeopardizes the survival of marine species that ingest or become entangled in it, poses a threat to human health, increases the risk of flooding and reduces the attractiveness of the region to tourists. Among the many different types of marine litter, plastic is very common and considered the most harmful to the marine environment and marine wildlife (Barnes *et al.*, 2009). Plastics are the most abundant and persistent (Rios *et al.*, 2010) type of litter, accounting for 60–80% of the litter (David, 2016) that can be found in the marine environment (Da Costa, 2018). Maybe here an introductory sentence about that plastic litter comes in many different polymer origins into numerous products and packaging, which also break down in the environment. Plastic marine litter objects are often divided into the broad categories of macro, micro, mega, meso and nano-plastics (Abalansa *et al.*, 2020). Several factors account for the abundance of plastics in the marine environment especially in the average world like West Africa; (i) the wide use of plastics for many purposes (Lebreton *et al.*, 2017); (ii) its physical features such as its durability and non-degradable (Szeteiova, 2010); (iii) the low-recycling rates and poor waste management infrastructure (Barnes *et al.*, 2009) and finally, the excess shipping of electronics (e-plastics) by individuals to Nigeria especially.

Plastic waste poses several threats to the marine environment; hence, marine species have been known to become entangle in plastic waste leading to reduced/restricted movement, laceration, amputation and infection (Kuhn *et al.*, 2015). They also reported that plastic litter can be ingested leading to physical

damage and reduce or block the intestinal tract, which could result in starvation. This is of particular concern in marine birds, as research shows that they may regurgitate plastic waste when feeding their chicks (Wade, 2018). Multiple laws have been devised, enacted, and enforced in response to the numerous harmful environmental effects of plastic debris in the ocean, for instance, plastic ban has been reported in different West African countries like Nigeria (Odunsi, 2019) and Ghana (Adam *et al.*, 2020).

1.2 Marine Plastic Litter and their Sources

Plastic pollution has been dubbed "one of the largest environmental issues of this lifetime" due to the persistent properties and high contamination rates in the environment (UN environment, 2018). Currently, the majority of emphasis is focused on plastic trash in marine habitats. In 1972, the first detection of buoyant plastics in the waters was made (Carpenter and Smith, 1972). Since then, numerous studies have been conducted to improve understanding of the general overview of marine plastic litter (Law *et al.*, 2010; Goldstein *et al.*, 2012; Lebreton *et al.*, 2012; Maximenko *et al.*, 2012) and beach pollution (Derraik, 2002). More recently, studies by Lechner *et al.* (2014), Siegfried *et al.* (2017) and Gall and Thompson, (2015) focused on riverine plastic pollution, transport of plastics and the environmental impact of plastic on aquatic species.

Plastics are organic polymers that are synthetic or semi-synthetic, their associated chemical additives and are often inexpensive, durable, strong, lightweight, and corrosion-resistant (Derraik, 2002; Thompson *et al.*, 2009). When exposed to UV radiation, whether in seawater or in direct sunshine, as a result of polymer oxidation, they turn brittle, break down into small pieces, and may finally become mineralized (Moore, 2008). However, according to Andrady (2005), the exact time it takes for plastic to disintegrate entirely in the marine environment is highly uncertain and depend on environmental conditions and plastic chemistry. Many types of plastic litter, such as plastic bags, fishing nets, packaging films, ropes, sanitary items, drinking bottles and caps; can be found in nature. According to Hopewell *et al.* (2009), 50 percent of plastic products are designed for one single short life use, such as plastic bags and utensils.

Polyvinyl chloride, high-density polyethylene, polystyrene, low-density polyethylene, polyethylene terephthalate, and polypropylene are the most extensively used and plentiful polymers, accounting for roughly 90% of total plastic output worldwide (Andrady and Neal, 2009). As a result, these polymers are the most frequent plastics discovered in the environment; for instance, some materials like PVC which is used in relatively high production volumes are mainly used in buildings that have a long-life span, while others, for example, polyethylene that is to a very large extent used in packaging with a very short life span and often spread to the environment in differently modes (Engler, 2012). Most plastics are classified as

"hard-to-degrade" materials because of their corrosion resistance, and they can survive up to a century in the environment, according to Cole *et al.* (2011). Since the beginning of manufacture, large plastic items known as macroplastics have been recorded in the marine environment (Derraik, 2002). There are two major broad sources of plastic litter, which are described below.

Land-based sources of plastic debris account for majority of the plastic debris in the marine environment, with littering, plastic bag use, and solid waste disposal being the most common sources in heavily inhabited or industrialized areas (Li *et al.*, 2016). The majority of floating and beached plastic waste, according to Lee *et al.* (2013), comes from coastal leisure activities and land-based sources. Other researchers discovered that substantial amounts of plastic waste originating from raw production ingredients was accidentally spilled onto beaches during handling and other activities (Karlsson *et al.*, 2018). According to Browne *et al.* (2010), other land-based sources include wastewater effluent and discard site leachate. Ocean-based sources, on the other hand, account for the remaining 20% of marine plastic litter, with commercial fishing being the most significant human contributor. The drowning of a fishing fleet in 1975 resulted in 135,400 tonnes of plastic fishing gear and 23,600 tonnes of synthetic packing material being dumped into the sea (Cawthorn, 1989). The amount of fishing gear lost to the environment has quadrupled in recent years: an estimated 640,000 tonnes of abandoned fishing gear is added to the ocean every year, accounting for almost 10% of all marine debris (Good *et al.*, 2010). These discarded fishing materials, such as monofilament lines and nylon nets, float at specified depths in the water, causing "ghost fishing," which has a negative impact on marine life (Lozano and Mouat, 2009).

1.3 Plastic Litter: Nigeria and West African Region in Perspective

West Africa (**Figure 1**) includes Nigeria, Benin, Liberia, The Gambia, Ghana, Cape Verde, Senegal, Mali, Burkina Faso, Niger, Guinea Bissau, Sierra Leone, Ivory Coast, Togo, Mauritania, and Guinea (Masson and Pattillo, 2001). Although her population is estimated to be at 381 million people as of 2018, she is one of the fastest growing regions on the African continent, both economically and demographically (West Africa Gateway, 2021).

West Africa not only has some of Africa's highest population densities, but it also has the most varied environmental conditions and encompasses three distinct agro-ecological zones, as opposed to one or two in other African regions. West Africa has the widest range of mineral ores, and the terrain is generally flat, making it ideal for the construction of trains and highways. Only three of the sub-country's regions are landlocked. Despite its natural wealth, the sub-region is home to some of the poorest countries in the world, including Benin, Cape Verde, Guinea, Guinea Bissau, Liberia, Mali, and Burkina Faso (Blasko *et al*., 2022).

Figure 1: Map of West African countries (Source: ThisIsSierraLeone, 2022)

Almost half of West Africa's population resides in cities, which are experiencing rapid population growth, urbanization, and the emergence of a middle class (United Nations Population Fund, 2018). These traits highlight the region's strong preference for plastic goods. Plastic packaging items are increasingly replacing traditional kinds of packaging (Miezah *et al.*, 2015). West Africans' lifestyles are socio-culturally linked with plastic products. West Africa's economy is informal, with a focus on the primary and service industries, which are dominated by small, independently held companies (Stoler *et al.*, 2012). Plastic is the major packing and carrying material used by food vendors and hawkers in towns and cities (Matsuguma *et al.*, 2017). Plastic garbage is ubiquitous in both landlocked and coastal countries across the sub-region as a result of these socio-cultural variables. Plastic litter is a cause of pollution in the environment, polluting water bodies, clogging storm drains, and killing livestock (Bashir, 2013). Plastic waste poses a severe threat to the region's marine ecosystems, affecting livelihoods such as fishing and tourism (Quartey *et al.*, 2015). Much of the plastic trash in West Africa, as in the rest of Africa, is mismanaged due to ineffective and unavailable waste and plastic waste management systems (Quartey *et al.*, 2015).

Plastic garbage generated on land, primarily through the use of plastic bags, supermarket bags, sachet water bags, straws, and plastic beverage and water bottles, is inadequately managed as waste and eventually ends up in drains, landfills, and inland water bodies, where it is washed into the marine environment (Addo *et al.*, 2017; United Nations Environmental Programme, 2018). For example, 20 coastal countries, including Nigeria, are responsible for the majority of plastic pollution. Nigeria is ranked 9th in the world in terms of coastal plastic pollution and waste management (Jambeck *et al.*, 2015). Nigeria is also thought to produce more than 32 million metric tonnes of rubbish each year, including plastic litter, with Lagos State alone

producing around 10,000 metric tonnes of waste per day (Anichebe, 2019). Plastic garbage accounts for around 30% of the tonnes of solid waste generated annually, with Nigerians collectively producing about 7.5 kg per capita (Rigasa, 2018).

Due to a scarcity of potable water, widespread usage of plastic drinking water sachets is creating marine plastic pollution in Nigeria, compounding the problem of marine plastic pollution across the country (Egbas, 2019; Adam *et al.*, 2020). Discarded plastic sachets damage water bodies and clog storm drains, posing a serious threat to aquatic and marine ecosystems and exacerbating the detrimental effects of plastic pollution in the region (Dumbili and Henderson, 2020). A clear observation on **Table 1** shows that Nigeria when compared to other African countries except Egypt has the highest quantity of mismanaged plastic waste and plastic marine debris. The Nigerian government passed the Plastic Bags Prohibition Bill in May 2019, joining other governments that have already enacted prohibitions against the manufacturing, sale, and use of plastic bags (Adam *et al.*, 2020). The Plastic Bags (Prohibition) Bill 2018 is a manifestation of Nigeria's efforts. The bill outlaws the usage, manufacturing, import, and sale of plastic bags, and it is now being processed by the Nigerian National Assembly to become an Act (Law). The Bill is divided into two parts, the first of which deals with prohibitions and the second with sanctions (Asadu, 2019; Egbas, 2019; Nwabughiogu, 2019).

Section 1: Prohibition of Plastic bag

I. "*The use, manufacturing, importation or sale of plastic bag [sic] is prohibited*".
II. "*A retailer shall offer a plastic bag to the customer at the point of sale*".
III. "*Any –*
    a. *Retailer [sic] who provides customer [sic] with the plastic bag at a point of sale is guilty of an offence [sic].*
    b. *Person [sic] who manufacture [sic] plastic bag for the purpose of selling [sic] is guilty of an offence.*
    c. *Person [sic] who import [sic] plastic bag whether as a carryout bag or for sale is guilty of an offence*".

Section 2: Sanctions.

I. "*Any person found guilty of the offences under clause1 shall be liable on conviction to a fine not exceeding Five Hundred Thousand Naira (₦500,000) or to*
II. *Imprisonment for a term not exceeding Three years or to both such fine and imprisonment*".

Table 1: Top 20 countries ranked by mass of mismanaged plastic waste and plastic marine debris.

Rank	Country	Quantity of mismanaged plastic waste (Mmt/year)	Quantity of plastic marine debris (Mmt/year)
1	China	8.82	1.32-3.53
2	Indonesia	3.22	0.48-1.29
3	Philippines	1.88	0.28-0.75
4	Vietnam	1.83	0.28-0.73
5	Sri Lanka	1.59	0.24-0.64
6	Thailand	1.03	0.15-0.41
7	Egypt	0.97	0.15-0.39
8	Malaysia	0.94	0.14-0.39
9	Nigeria	0.85	0.13-0.34
10	Bangladesh	0.79	0.12-0.31
11	South Africa	0.63	0.09-0.25
12	India	0.60	0.09-0.24
13	Algeria	0.52	0.08-0.21
14	Turkey	0.49	0.07-0.19
15	Pakistan	0.48	0.07-0.19
16	Brazil	0.47	0.07-0.19
17	Burma	0.46	0.07-0.18
18	Morocco	0.31	0.05-0.12
19	North Korea	0.30	0.05-0.12
20	United States	0.28	0.04-0.11

Mmt = million metric tonnes; Adapted from Jambeck *et al.* (2015).

1.4 Impact of Marine Plastic Litter

Plastics in the marine deteriorate into tiny fragments as result of the radiation, oxidation, mechanical movements and abrasion from waves and currents, even beyond the point where they are no longer visible to the naked eye (Zettler *et al.*, 2013). Microplastics are consumed by marine species ranging from zooplankton to fish, who mistake them for food (Murray and Cowie, 2011; Cole, 2013; Davison and Asch, 2013). Plastic eating by marine organisms introduces harmful, persistent, and bio-accumulative chemicals into the aquatic food chain (Almroth and Eggert, 2019). However, it is unclear whether plastics have a net effect on transmitting persistent contaminants or limiting their bioavailability. Because of their small size, they can to some extent pass through biological barriers, penetrate tissue, and collect in organs (Von Moos *et al.*, 2012). The harmful compounds found in macro, micro, and nanoplastics accumulate in aquatic life forms, causing significant difficulties such as mortality or sub-lethal effects, physical damage, and promoting numerous molecular modulations (Ganesh *et al.*, 2019). In terms of ingestion, several scientists

have discovered that many marine species mistake plastic for food (26–31). Sea birds were the first marine species to be found with plastic in their stomachs in 1973. (32). Ingestion of microplastics by marine creatures can induce a variety of impacts, including inflammation, reproductive impact, intestinal blockage, oxidative stress, hormone disruption, behavioural and metabolic abnormalities, according to research by Wright *et al.* (2013). Recent study, on the other hand, has discovered that exposure to smaller nanoplastic particles is more likely to result in negative consequences (Rochman *et al.*, 2016).

Many other marine creatures, including whales (Stephanis *et al.*, 2013), sea turtles (Bjorndal *et al.*, 1994), cetaceans (Baulch and Perry, 2014), shearwaters (Lavers *et al.*, 2014) birds and mammals, have plastics in their stomachs (Laist, 1997; Kuhn *et al.*, 2015). Plastic marine litter has an economic impact on aquaculture, fishing, coastal beautification, and tourism services (Sheavly and Register, 2007). Newman *et al.* (2015) provided precise figures on the expense of clearing marine litter from the UK and Belgian coasts, which resulted in an increased mortality of crabs caught in fishing nets, as well as losses in aquaculture and agriculture. Hagen (1990) claims that the US government will have to spend a significant amount of money to clean up the shore, but he also explores many perspectives on the economic losses caused by plastic litter.

Although plastic debris has been identified as a possible human health hazard, the direct effects of marine plastics on human health have not been clearly proven, and no research expressly explore this topic (Vethaak and Leslie, 2016). Plastic bags, for example, may cause direct harm when they impede drainage paths, resulting in rising floodwaters, or when plastic waste provides mosquito breeding grounds (Gubler and Clark, 1996). In addition, pathogens have been found to colonize microplastics (Zettler *et al.*, 2013). Due to particle toxicity, microplastics may have an impact on human health (Rist *et al.*, 2018), and microplastics are increasingly being identified in human food, particularly seafood (Rochman *et al.*, 2015). Microplastics are mistakenly consumed by marine creatures as zooplankton. Sea creatures are eaten by humans. As a result, ingesting this particle moves up the seafood chain (GESAMP, 2016; Nollet and Siddiqi, 2020). Fadare *et al*., (2021) investigated microparticles and microplastics contamination in African table salts and discovered that South Africa has the highest microplastics concentration (0-1.33±0.32 particles/kg), followed by Nigeria, Cameroon, and Ghana (0-0.33±0.38 particles/kg each). As microplastic accumulates in the human body over time, the consequences could be disastrous. According to Barboza *et al*. (2020), "consumption of microplastic-contaminated fish may lead to an increased risk of bisphenol exposure and detrimental consequences on human health throughout a lifetime of exposure."

The ecosystem impact of marine litter includes alterations to the coastal ecosystem and harm to marine life. Plastic pollution damages the health of the marine habitat to the point where it is impossible for marine species to live (Elenwo and Akankali, 2015). Some marine creatures, such as seabirds, fish, and sea turtles,

are harmed by plastic entanglement and ingestion. Entanglement is a major concern since it endangers larger marine creatures such as sea turtles and seals. Sea turtles consume trash bags instead of jellyfish, while larger fish consume microplastic via their smaller fish offspring (GESAMP, 2016; Ogunjobi and Surulere, 2020). Another issue with plastic in the ocean is that it acts as a medium for the spread of invasive organisms. Small fish and microbes adhere to floating plastic and are taken to a new habitat where they proliferate and expand their area, significantly affecting the ecosystem's diversity (Gregory, 2009). Invasive species can be both good and bad depending on their ability to adapt in their new environment (Dorcas *et al*., 2012). According to Ganesh *et al.* (2019), further research on the nature and behavior of plastic in the ecosystem, as well as its transfer across species in the food web, is encouraged. The toxicity of plastic litter in the marine is believed to be influenced by contamination dose, polymer type, size, surface chemistry, and hydrophobicity. These findings imply that long-term exposure to high amounts of micro and nanoplastics may change the marine environment's entire food chain. **Figure 2** presents the impact pathways of marine plastic pollution showing the key policy levers.

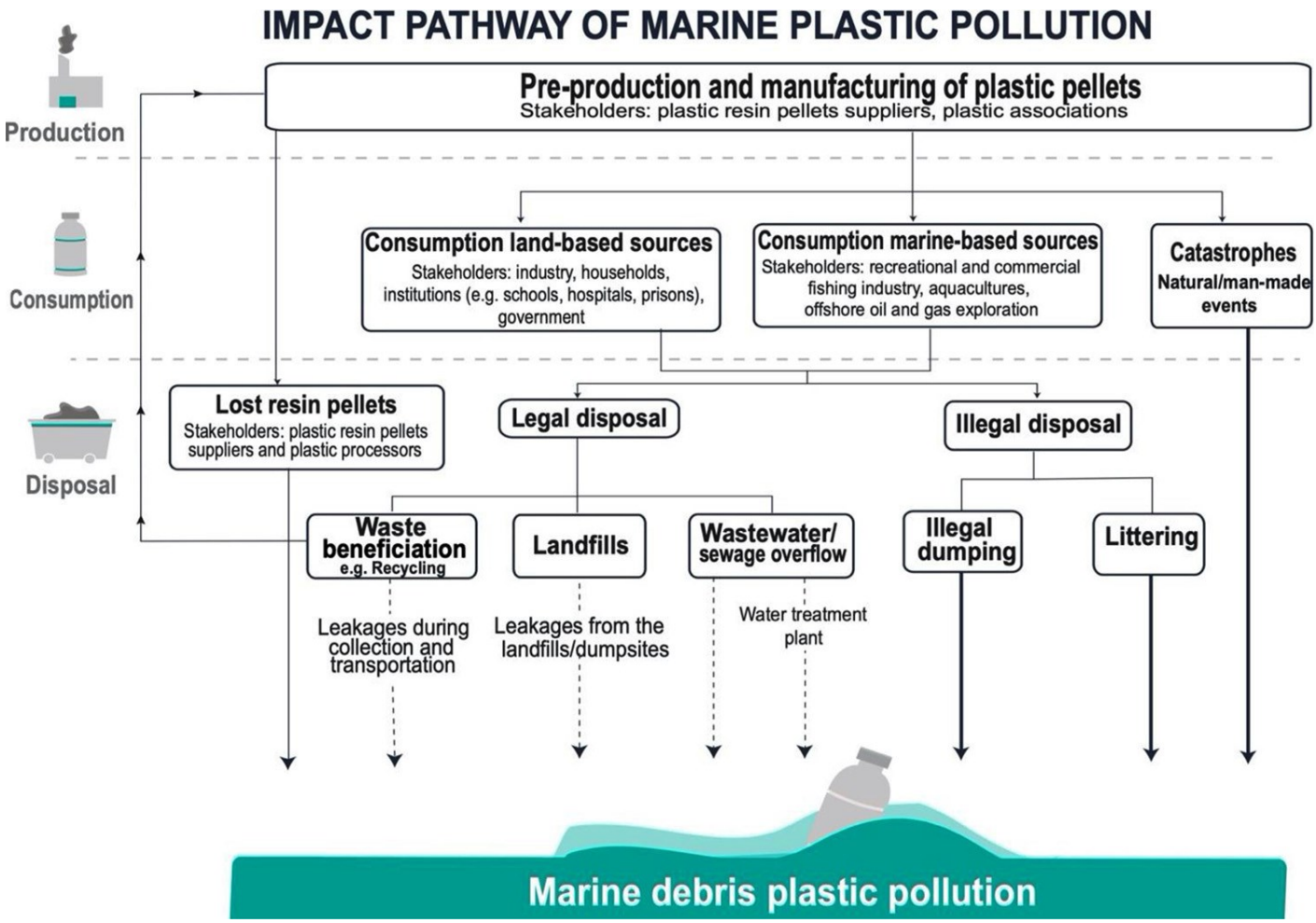

Figure 2: Impact pathway of plastics into the ocean and key policy levers (Source: Alpizar *et al*., 2020).

1.5 Mitigation Measures against Marine Plastic Litter

If many coastal economies and populations across the world continue to expand without adopting steps to manage their municipal solid litter, the volume of plastic waste traveling from land to sea is likely to increase in the coming decades. Because it represents a "fundamental market failure" on a global scale, not only in West Africa or Nigeria, marine plastic pollution will remain a grand challenge. As a result, plastic production is increasing, but society is unable to keep up with the litter (Alabi *et al*., 2019).

Prevalent worldwide marine litter solutions can be used to kick start solutions centered on sustainable development (Gari *et al.*, 2015) where both short and long-term solutions will be given, as well as connections to the specific SDGs. Marine litter concerns are structured in a variety of ways in the literature. According to studies, if waste management does not improve dramatically in the next years, the amount of plastic litter entering the ocean from land will increase by an order of magnitude by 2025 (Jambeck *et al.*, 2015). To attain a 75 percent reduction, Jambeck *et al.* (2015) stated that waste management in the top 35

percent of countries with mismanaged plastic trash must be improved by 85 percent. Improving waste management infrastructure, on the other hand, would necessitate significant investments and effort, particularly in emerging regions like West Africa were the main focus will be on collection of plastic litter. Another major means of tackling marine plastic litter negative impact is via policy making. Countries have devised a variety of policies to cope with plastics because of their considerable impact on marine ecosystems, as well as their diverse sources, paths, and persistence. Because marine plastic litter is trans-boundary, measures to deal with it are multi-layered, involving efforts at the municipal, regional/state, national, and international levels. Policies on marine and environmental protection and pollution span from broad worldwide instruments to regional marine debris action plans and specific product restrictions at the national, state, and municipal levels (Vince and Hardesty, 2017; Jambeck *et al.*, 2018).

According to the literature, both market-based methods and legislation, rules, and regulations are widely acknowledged, but governments or states execute them selectively. Many countries, on the other hand, are still trailing behind in terms of taking steps to alleviate the ongoing environmental repercussions of plastics (Xanthos and Walker, 2017). According to Behuria (2019), the plastic industry's structural and instrumental influence has led to some governments' refusal to take action against the uncontrolled proliferation of plastics. Plastic-reduction programs have mostly been implemented at the state level, with no policy coordination from the federal government (Xanthos and Walker, 2017). Legislative bans on plastics and, to a lesser extent, taxes are the most popular plastic-reduction measures in Africa (Schnurr *et al.*, 2018). Generally, bans are aimed at certain forms of plastics, such as plastic bags (Jambeck *et al.*, 2018; Behuria, 2019).

A deeper knowledge of the economic constraints is required to address the plastic litter problem since it focuses on better business practices that could allow for higher recapture, recovery, and reuse. Then there will be he need to identify and build a set of regionally appropriate solutions that are both profitable and beneficial to the marine environment (Spheres of Influence, 2015).

1.6 Aim of the Study

The aim of this project is to determine the environmental impacts of marine plastic litter and the governmental policies in West Africa and especially in Nigeria. The specific objectives are:

- To determine the occurrence of plastics in the marine ecosystem, and their sources.
- To determine the adapted endpoint of plastic litter in marine ecosystem.
- To determine the economic impact of marine plastic litter.
- To determine how to prevent marine plastic litter.
- To determine government policies towards mitigating marine litter pollution.

2. Methodology

The main focus of this research was to determine the environmental impacts of marine plastic litter and the governmental policies in West Africa (Nigeria) which specifically tends to explore the marine ecosystem pollutants; their sources and risk, endpoint of plastic litter in marine ecosystem, economic impact of marine plastic litter, how to prevent marine plastic litter spread and the government policies towards mitigating marine litter pollution.

The method of this study is a literature review where previous research and experiments were used collectively in an assessment on the environmental impacts of marine plastic litter and the governmental policies. According to Ramdhani *et al*. (2014), literature review discusses published information in a particular subject area, and sometimes information in a particular subject area within a certain time period. A literature review of a mature topic addresses the need for a critique of, and the potential reconceptualization of, the expanding and more diversified knowledge base of the topic as it continues to develop. Knopf (2006) reported that a literature review should contain; first a concise summary of the findings or claims that have emerged from prior research efforts on a subject. Secondly, it should reach a conclusion about how accurate and complete that knowledge is and it should present a considered judgments about what is right, what is wrong, what is inconclusive and what is missing in the existing literature.

The method of this research was applied on the objective of the research in several steps. Firstly, marine plastic litter sources were exposed coupled with their impact in the environment. Nigeria as a West African country was the major focus. However, mitigation measures were also identified for creating more awareness to the government and the general public against the negative impacts of marine plastic litter, thereby suggesting policies that will help in curtailing this environmental pollution. The first part of this research was the background review of previous research in the literature, but this study's contribution is however presented in result and discussion headings.

Webpages from relevant organizations and authorities were also used in gathering basic information. Some examples of these organizations or webpages are: World Bank (WB), West Africa Gateway (WAG), United Nation Population Fund (UNPF), United Nation Environmental Programme (UNEP), ThisIsSierraLeone, Plastic Europe (PE) and other News agencies in Nigeria like Daily Post and Vanguard Nigeria. It is my belief that the use of challenging and explorative research from researchers that have done their own experimental work within the fields of human health and nature science within the last decade, can give this research the most informative, interesting, and accurate shape that it needs. The search words were in a wide range of different formulations and single words depending on which chapter it is related to. Some examples of search words used are as follows:

- Plastic (macroplastics, microplastics, plastic pollution, plastic litter, plastic debris, marine litter, marine debris).
- Marine plastic.
- Marine plastic litter.
- Mitigation measures.
- Governmental policy.
- Marine plastic impact.
- West African.
- Nigeria.
- Plastic litter etc.

3. Results and Discussion

Marine litter is defined as "any persistent, manufactured or processed solid material that is discarded, disposed or abandoned in the marine or coastal environment" (Van Dyck *et al*., 2016; Lachmann *et al*., 2017). Marine litter including plastic litter is a man-made solid pollutant causing devastating effects on the ecosystem, marine and human lives (Gall and Thompson, 2015). This section attempts to review what exist in the literature regarding the objectives of the study. It provides documented evidence from other authors on effect of marine plastic in the ecosystem. Then, this section will be divided into five different headings consisting of marine ecosystem plastics: their sources; several endpoints of plastic litter in marine ecosystem; economic impact of marine plastic litter; how to prevent marine plastic litter spread and government policies towards mitigating marine litter pollution. All these will help in answering the questions presented in the research question section thereby fostering a better understanding of the topic in the area of interest.

3.1 Marine Ecosystem Types and State of West Africa

Marine ecosystems are broadly defined as aquatic ecosystems with saline water. Depending on the type of marine ecosystem, the salt content may vary from oligohaline to hypersaline and may be highly variable or relatively constant through time (Nybakken and Bertness, 2005). A simple definition of an ecosystem may be the interaction between biotic and abiotic components, functioning as a whole in a particular location (Castro and Huber, 2012). Within these waters, there are distinct ecosystems, often interconnected, such as estuaries, coastal wetlands, sand beaches, seagrass beds, coral reefs, deep-sea etc. (Dolbeth and Arenas, 2021). According to Diop *et al*. (2011), three large marine ecosystems are identified in West Africa: The Canary Current marine ecosystem to the north, the Benguela Current marine ecosystem in the south, and the Guinea Current marine ecosystem in between. The Canary and Benguela currents are two of the world's major coastal upwelling systems (Koranteng and McGlade, 2001; McGlade *et al*., 2002). A number of major rivers also influence the Western African large marine ecosystems through their inputs of sediments, nutrients and freshwater. These include the Senegal, discharging into the Canary Current system; the Volta, Niger, and Congo rivers discharging into the Guinea Current system; and the Gariep (Orange) River, discharging into the Benguela Current system (Arthurton *et al*., 2002). Tracts of West African marine ecosystems is labelled lawless comprising of illegal fishing, sea piracy and armed robbery, drug and human smuggling and marine plastic pollution is not an exception. It has become common knowledge that individual nations can do little on their own. The solution of cooperation at regional level is simple but

difficult to sell to a critical mass of African governments that are often suspicious of collective agendas (ThisDay, 2018).

3.2 Marine Ecosystem Plastics and their Sources

Emerging pollutants are wreaking havoc on the environment's ability to support life on all levels (Munn *et al*., 2000; Richardson and Kimura, 2017). Plastic, a generic word for polymeric materials that may incorporate other compounds to increase performance and/or lower cost (Vert *et al*., 2012), is one such contaminant. These polymeric materials are combined with additives in order to boost efficiency, lower costs, or achieve the desired appearance (Hahladakis *et al*., 2018). Plastic materials are made from a variety of polymers, including seven common distinct polymer resins (Bashir, 2013). According to Yalwaji *et al*. (2022), they include polystyrene, low-density polyethylene, polyethylene terephthalate, polyvinyl chloride, polypropylene, high density polyethylene and a final class known as 'others' are among them.

Africa is home to a number of significant and well-known marine habitats that connect to other worldwide water networks. The Nile River in Egypt, the Congo River in Central Africa, the African Great Lakes in East Africa, and Lake Chad in West Africa are just a few of the continent's enormous aquatic systems. Africa is also known for being one of the leading contributors to worldwide plastic contamination of marine habitats (Jambeck *et al*., 2018). Four African countries including Nigeria, Algeria, Egypt and South Africa are at the top of a global list of 192 countries based on plastic litter generation (Jambeck *et al*., 2015). Given the lack of substantial implemented plastic management procedures in most of its countries, the African continent may continue to increase worldwide plastic contamination of marine habitats (Jambeck *et al*., 2018).

To successfully manage the increasing challenge of marine litter entering the marine environment, prevent it from leaving its source, as managing marine litter on land and rivers before it enters the ocean is significantly more economically and environmentally sustainable (Barnardo and Ribbink, 2020). Plastic bags and other single-use plastics such as utensils, glasses, plates, straws, takeaway meal packs, and other items are widely used in Nigeria for instance. Plastic garbage enters the Nigerian marine environment in two forms from distinct sources; primary and secondary forms (Abubakar, 2021). The primary form is that which the plastic took when it first entered the marine environment; it can be micro or macro plastic. However, the secondary form is when plastic enters the marine environment in a broken and fragmented state as a result of abrasion, chemical, heat, weathering, sunlight or other physical processes (Ebere *et al*., 2019; United Nations, 2021).

Furthermore, importation is Nigeria's principal supply of plastic, which includes various polymer resins used in the creation of plastic materials, products, and components of imported commodities (Babayemi *et al*., 2018). Different plastic forms penetrate various environmental matrices during manufacturing, use, and disposal. Plastic litter in Nigeria is primarily made up of sachet water (60cl plastic bags) and shopping bags (Dumbili *et al*., 2020). Once discarded into the environment, a single plastic bag takes 1000 years to disintegrate (Bashir, 2013). Educational institutions are a major source of plastics in Nigeria as reported by Adeniran *et al*. (2017) when they studied the waste generated at the University of Lagos. It was discovered that, polyethylene bags and plastic made up 24% and 9% of the total waste generated at the university, respectively. In another similar study, plastic bottles, polyethylene bags and plastic food packs were found to account for the highest percentage of litter generated at Covenant University in Ogun State (Okeniyi and Udonwan, 2012). From household reports in Abuja, plastic litter is made up of 7.30 to 10.10 percent of the litter fraction from low to high-income groups (Ogwueleka, 2013). According the article by Yalwaji *et al*. (2022), **Table 2** presents different sources of plastic in the Nigerian environment.

Table 2: Sources of plastic in various environment in Nigeria.

Environment	Routes of Entry	Sources	Plastic forms
Marine Ecosystems (Babatunde and Uche, 2018; Akindeke *et al*., 2019; Ilechukwu *et al*., 2019; Fred-Ahmadu *et al*., 2020; Oni *et al*., 2020)	Sewage and effluent discharges, atmospheric deposition, refuse dumping and inflow		Micro and macroplastics
	Waste water treatment plant	Tire wear, bio-solids	Micro and macroplastics
	Fishing activities, deposition by wind, flooding, river banks.	Cigarette butts, Fishing ropes and gears, foil, nylon, straw, polyethylene plastic bags and bottles.	
	Wastewater treatment	Cosmetics, clothing, degradation of large plastic items	Microplastics
Agricultural Lands (Enyoh *et al*., 2020; Olarinmoye *et al*., 2020)	Plastic mulch film, sludge, fertilizer application, run-off, wastewater irrigation, littering.		Micro and macroplastics
Uncultivated Land (Oyelola and Babatunde, 2008; Bichi and Amatobi, 2013; Ogwueleka, 2013; Sindiku *et al*., 2015; Adeniran *et al*., 2017; Adam *et al*., 2020; Dumbili *et al*., 2020)	Miscellaneous	Water sachets	
	Retail shops, businesses	Shopping bags, bottles, packaging and others	Macroplastics
	Educational institutions	Polybags, food packs, bottles, Others	
	Households (residential)	Rice bags, cell phone bags, sachets, nylon, bottles etc	
	Commercial (markets)	Shopping bags, bottles, nylon, packagings etc. e-waste - Mobile phone components, electrical and electronics, miscellaneous	

A study in Ghana, West Africa on the analysis of marine plastic litter policies by Ashai (2021) discussed the sources of marine plastic litter. Plastic is clogging the world's oceans, rivers, and coastlines. This occurs as a result of improperly managed plastic garbage generated by coastal people, which travels a great

distance with ocean currents and winds found in the marine and coastal environment (Moro, 2017). In extreme cases, such as the Odaw River and Korle Lagoon in Accra, they have become deteriorated as a result of being littered with plastic debris (Global Environmental Facility, 2019; Muntaka, 2019). Tourists leave a lot of litter on the beach, mostly cigarette butts, plastic bags, packaging and plastic bottles around the coastline (Moro, 2017). The majority of Ghana's beaches are free to visit. Private operators, on the other hand, offer tourists with sunshades and chairs, as well as cleaning up the beach on occasions. In addition, most beaches do not have adequate waste containers to handle plastic litter. Due to the lack of a shower, beachgoers wash themselves with plastic bottles and 'pure water' sachets, and they do not properly dispose of these plastic litter (GESAMP, 2020). At Jamestown Beach in Accra, Ghana and Ogun River in Nigeria, **Figure 3** displays the nature of marine plastic trash.

Figure 3: First frame: Jamestown beach, Accra, Ghana (Muntaka, 2019); Second frame: A section of Ogun River, Abeokuta, Ogun State, Nigeria (Akindele and Alimba, 2021).

3.3 Several Endpoints of Plastic Litter in Marine Ecosystem

Speaking of the endpoints of marine plastic litter, it points towards the destination of the plastic litter when they get into the marine world. In addition, an assessment endpoint is defined in Guidelines for Ecological Risk Assessment (U.S. EPA, 1998) as “an explicit expression of the environmental value to be protected, operationally defined as an ecological entity and its attributes.” An ecological entity for example, might be an important fish species, such as *coho salmon*, with its attributes being fecundity and recruitment. The receiving agent is always the organisms residing in the marine. Anthropogenic litter is accumulating in the marine world, posing a threat to the aquatic biodiversity (Li *et al*., 2016). The number of species reported to have become entangled in or eaten marine anthropogenic trash more than doubled between 1997 and

2015, from 267 to 557 (Kühn *et al*., 2015). Furthermore, due to underreporting in the scientific literature, such overall figures are likely to underestimate the occurrence of entanglement and ingestion, example, Parton *et al* (2019). While entanglement and ingestion impact mechanisms function at the individual organism level, the consequences may scale up to species populations and ecosystems (Browne *et al*., 2015).

Ecosystems and species can be exposed to marine environmental plastic litter through a variety of routes, including entanglement, ingestion, rafting, smothering and the invasive species introduction. Ingestion exposure is species-specific and has been proven in a variety of marine creatures (Egbeocha *et al*., 2018; Karbalaei *et al*., 2019). Different marine species are exposed by potentially swallowing plastic bits of varying sizes. Microplastic particles are known to be consumed by filter feeders, deposit feeders, and detritivores (Thompson *et al*., 2004). Microplastic particles (0.08 mm - 0.67 mm) and fibres (0.21 mm - 4.90 mm) were found in deep sea invertebrates, a star fish (*Hymenaster pellucidus*) and a brittle star (*Ophiomusium ilymani*) in the Rockall Trough sample site at a depth of 2200 m. Over a four-decade study period, the average percentage of individuals with ingested microplastics was 22 percent for *H. pellucidus* and 51 percent for *O. lymani* (Courtene-Jones *et al*., 2019). From the African aquatic environment, **Figure 4** has shown that at least six animal species have been recorded to have consumed plastics of various sizes (Akindele and Alimba, 2021).

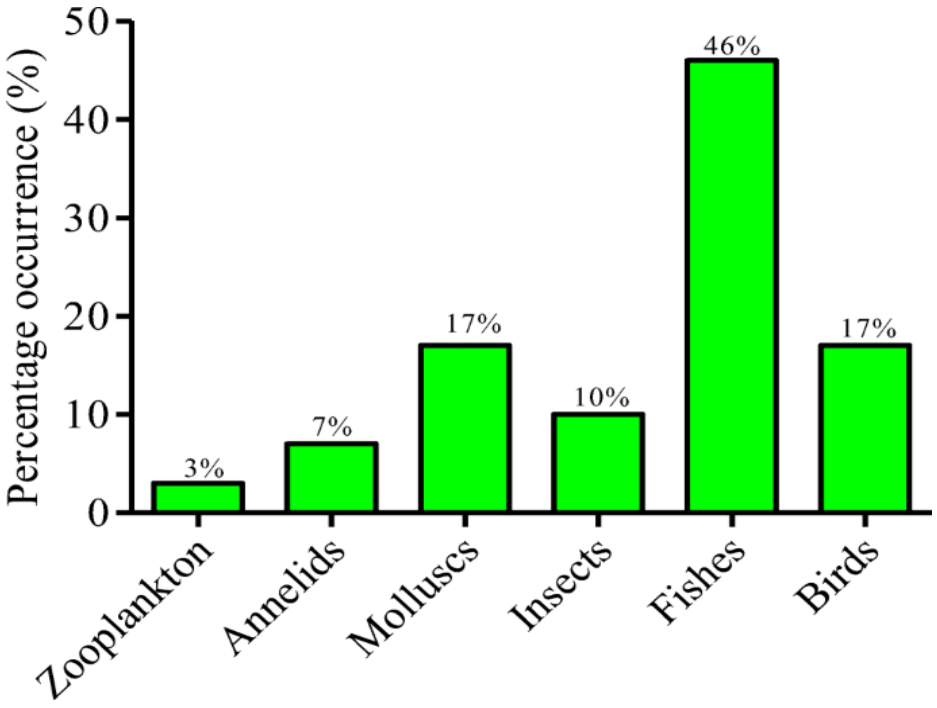

Figure 4: Between 1987 and September 2020, the following aquatic species were utilized as bioindicators of plastic pollution in research from African aquatic environments (Akindele and Alimba, 2021).

Humans consume between 39,000 and 52,000 plastic particles per year, according to Cox *et al*. (2019) which occur via marine environment. As indicated in section 2.3.1, marine organisms can consume plastic either directly from the seawater or through the eating of an organism that has already consumed plastic (Woods *et al*., 2021). According to Wright and Kelly (2017), in addition to the effects of marine plastic waste, individuals can be exposed to microplastics (nanoplastic) via inhalation. Microplastics, like those present at the water's surface, are known to be easily photo-degraded into finer particles that plankton can consume (Padervand *et al*., 2020). These organisms contribute to the food chain by transporting hazardous plastic particles up the food chain. This includes fish that are consumed by humans (Wright and Kelly, 2017), causing carcinogenic consequences, skin irritations, and organ failure. Phthalates, styrene and bisphenol-A are among the hazardous chemicals released in plastic materials when they degrade. These chemicals cause neurotoxic or carcinogenic effects in humans (Thompson *et al*., 2009; Deng *et al*., 2014). Microplastics in the food chain can reduce nutritional diet value and expose people to infections (Padervand *et al*., 2020). Microplastics in drinking water are abundant, with numerous causes attributed to their occurrence (Comanita *et al*., 2016; Asmonaite and Almroth, 2019).

3.4 Economic Impact of Marine Plastic Litter

In addition to some of the objectives covered in the preceding subsections, marine plastic litter can have a variety of economic consequences (**Figure 6**), both increasing the costs of marine and coastal activities and decreasing the economic advantages received from them. Measuring the full economic cost of marine plastic litter is difficult due to the variety of economic, social, and environmental repercussions, the variety of sectors impacted by marine plastic litter, and the geographic spread of individuals affected. Some of the economic consequences are easier to assess since they are more direct, such as higher marine litter cleaning expenses (Newman *et al*., 2015). Others are more complex, such as the repercussions of environmental damage or declines in quality of life, which are less immediate and/or more intangible. Furthermore, the spatial and temporal complexity of the impacts of marine litter results in costs that are not necessarily obvious or immediate, but are nonetheless significant for sustainability (National Research Council, 2008).

According to Sulaimon (2019), marine plastic litter recently made headlines when the Africa Blue Economy Forum (ABEF) showed that plastic pollution alone costs $13 billion per year in damages to marine ecosystems. He went on to say that while oceans are increasingly being recognized as a major driver of global economic development, conservative estimates for the next 12 years suggest that the ocean economy would add around $3 trillion in annual global value and 40 million direct full-time jobs to the global labor

market. It also stated that African nations have a significant responsibility to play in combating marine pollution, particularly plastic litter, given that Africa is the second largest continent.

The aquatic environment, like any other biophysical environment, provides the four major categories of ecosystem services according to Peterson and Lubchenco (1997):

- Cultural services, for example, ecotourism and recreational benefits.
- Provisioning services, for example, food resources, potable water and irrigation water.
- Support services, e.g., biodiversity sustenance.
- Regulating services, e.g., carbon sink through photosynthetic activity of algae and sink for inland runoff.

In general, when an aquatic ecosystem is plastic-laden, its ability to continuously supply its services may be compromised. An aquatic environment that is unsuitable for biodiversity sustenance may lose some other ecosystem functions. As a result, a danger to biodiversity caused by plastic pollution may be a warning indication of the impending loss of other ecosystem services (Akindele and Alimba, 2021). The constant discharge of plastics from river banks into the open water zone diminishes their ability to contain huge quantities of water, which can lead to river overflow and flooding of terrestrial plains. As a result, there may be a loss of biodiversity in both aquatic and terrestrial habitats, as well as a loss of livelihoods thereby affecting the economic standard of any place (Khan *et al*., 2018).

Another impact of plastic pollution in Africa's aquatic environment is the loss of aesthetic value, which affects cultural ecosystem services. Many rivers' and coasts' shorelines are being taken over by plastics, making them unappealing to eco-tourists and visitors (Tudor and Williams, 2006; McKenna *et al*., 2011). The presence of plastics on the coasts or shorelines of aquatic systems may have an indirect impact on human health, particularly for those in need of treatment for depression or heart disease (Hambler and Canney, 2013). Any action that is capable of affecting the health of human is indirectly negatively affecting the economy of that area. Eco-tourists visit coastlines in several African countries for some type of green activity, i.e. activity in the presence of nature or in a green place (Hambler and Canney, 2013). This is also seen along the shorelines of inland waters, and such activities can be seen in rural, semi-urban, and urban locations, as long as the shorelines are clean and free of plastic garbage. The ability of aquatic habitats to provide this unquantifiable ecosystem service and aid enhance human health in the upcoming years is jeopardized if their shorelines are polluted with litter (Akindele and Alimba, 2021).

Marine litter has an economic impact on coastal municipalities, largely through the immediate cost of keeping beaches clean (**Figure 5**) and the broader ramifications for tourism and pleasure (**Table 3**). Direct costs include litter collection, transportation, and disposal, as well as administrative expenses like contract

management. Municipalities prioritize beach cleanliness, attractiveness, and safety for tourists when the economic argument for maintaining the local economy and tourism industry covers the expenditures of rubbish removal (Newman *et al*., 2015).

Figure 5: The UNDP resident representative in Ghana during beach clean-up (United Nations Development Programme, 2022).

Table 3: The contribution of tourism to the national economies of countries in the Abidjan Convention area

Country	**GDP Contribution (%, using 2011-2014 average)**
Benin	6.0
Angola	4.0
Cameroon	6.6
Cabo Verde	43.4
Gabon	2.4
Ghana	7.7
Gambia	20.5
Guinea	4.5
Nigeria	4.0
Senegal	11.4
Togo	8.9
Sierra Leone	5.6

Source: United Nations Conference on Trade and Development (2017).

Furthermore, plastic litter and other litter on the beach make it less appealing and dangerous. Clean-up costs are imposed on governments and communities. Loss of financial sources for coastal communities and the government as tourists abandon the polluted beach, has been reported by Sheavly and Register (2007). According to Barnardo and Ribbink (2020), the economic repercussions of marine plastic litter include diminishing fish stocks, damage to watercraft, property depreciation, and driving tourists away from the beach. Fishing in Africa is largely subsistence, and it is a vital source of income for the populace in terms of food security and daily protein intake from the region's marine and freshwater fish (UNEP, 2018). According to Polidoro *et al*. (2016), the marine industry employs around 400 million people in West and Central Africa, both directly and indirectly. As a result, any threat to fisheries and the maritime environment has serious economic ramifications for Africans; Afolasade *et al*. (2019) supported this claim. They investigated effective waste management in Nigeria, where coastal communities saw the effects of marine plastic litter as more economical than environmental. This is because plastic marine litter discourages visitors and beach goers from visiting the beach, resulting in a loss of customers and income for coastal towns. Marine litter jams the fishing boats of fisherman, stopping them from fishing or dredging. For example, the navigation channels in Akwa-Ibon, Nigeria, are plagued by a recurring problem of suspended marine litter, which obstructs vessel navigation and makes sailing over them extremely difficult (Babatunde and Arinze, 2018).

Finally, agriculture, as a terrestrial economic activity, is not the most obvious sector to suffer economic losses as a result of plastic marine litter. Indeed, similar to the fishing industry, it is increasingly recognized as a source of marine litter (De Stephanis *et al*., 2013). However, debris can blow, drift, or wash up on coastal agriculture in some areas, causing damage to buildings and equipment and posing a risk to cattle through ingestion and entanglement. All of these consequences may result in economic losses in addition to the preventative litter removal cost (Newman *et al*., 2015).

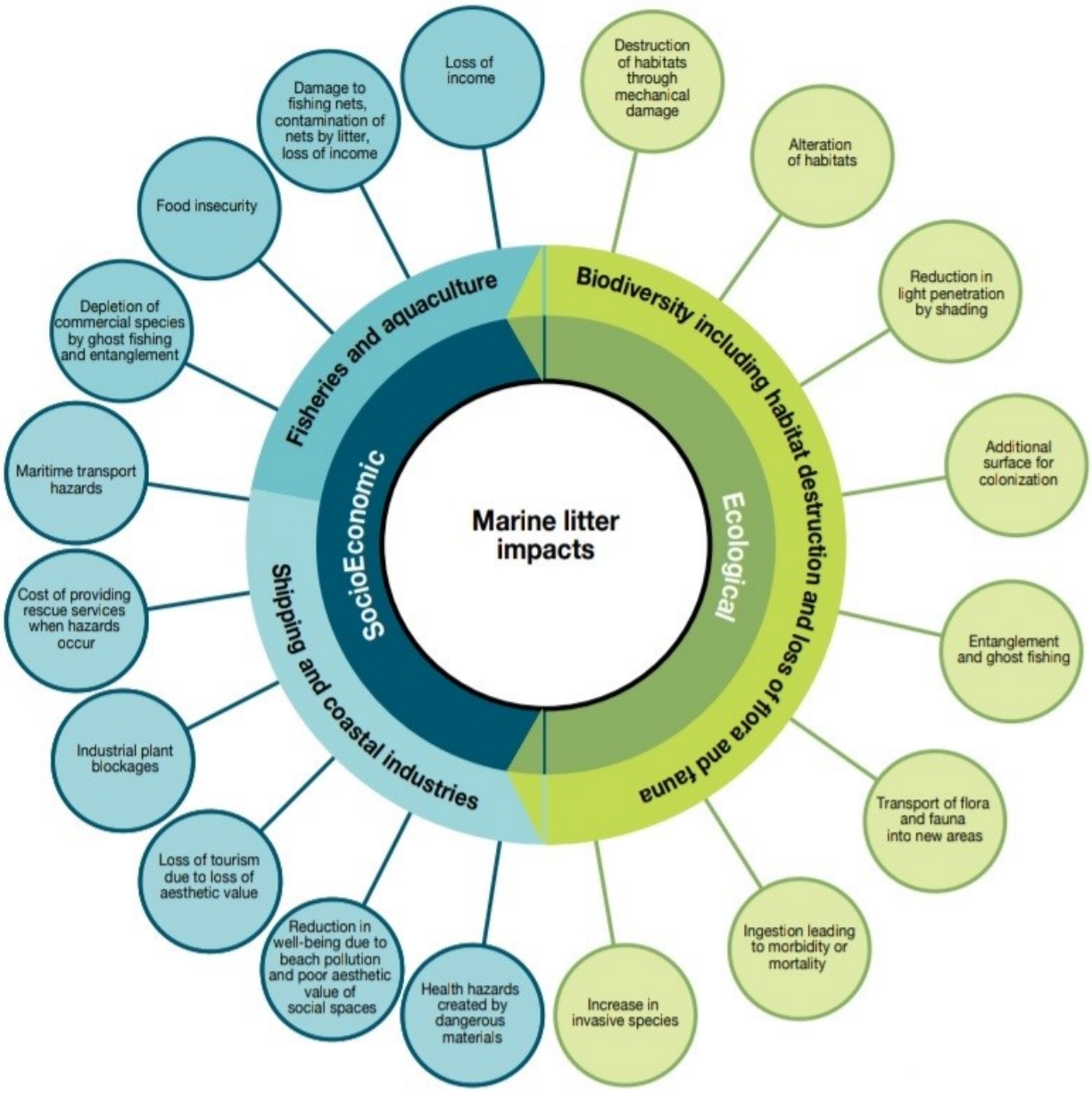

Figure 6: Economic impacts (blue colour) of marine plastic litter (GRID-Arendal, 2020).

3.5 Prevention of Marine Plastic Litter Pollution

A sustainable approach to both the production and consumption of plastics has been developed, with global efforts aimed at the prevention of marine litter. According to the United Nations Environment Assembly in 2016 and 2017, more countries see marine plastic litter as a worldwide concern that requires a worldwide response (Cvitanovic and Hobdey, 2018). Upstream prevention of the sources of plastic pollutants in the

marine environment is more cost effective than subsequent cleanup efforts (Kershaw and Rochman, 2016). The United Nations Sustainable Development Goals to regional and national levels on the translation of global commitments aided by scientific research relevant to local communities, can serve as the foundation for successful plastic debris management (Cvitanovic and Hobdey, 2018; Walker, 2021). The social slogan "3Rs: reduce, reuse, and recycle," which is used in the management of most wastes found in the environment, has been consistently applied in the case of plastic litters, particularly traditional plastics, whose long carbon chains make them difficult to be degraded by microorganisms (Schuyler *et al*., 2016). The existing international accords primarily address marine-related plastic sources, which are blamed for a minor portion of marine plastic pollution as compared to land-based sources, which is a big concern (Naidoo, 2015). Three examples of these accords are stated below:

- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter; London Convention of 1970's.
- International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) signed in 1973.
- The Honolulu Strategy for Marine Debris Prevention and Management covers the prevention and management of marine debris, with the goal of reducing the volume and effect of marine-based and land-based sources of marine litter, as well as litter buildup (UNEP, 2015)

In terms of coping mechanisms, realizing the enormity of the situation has resulted in a growing global commitment to battle marine plastic pollution, allowing for the establishment of global cleanup initiatives (Aretoulaki *et al*., 2021). The Ocean Cleanup (OC), for example, is widely regarded as the largest marine cleaning operation in history, with a team of more than 90 computational modelers, engineers, biologists and researchers working daily at its Rotterdam headquarters to free the world's seas of plastic (The Ocean Cleanup, 2019).

Green plastics (green chemistry), which entail the use of biodegradable plastics, arose as a result of the search for marine environment-friendly plastics (Thompson *et al*., 2009). Among the considerations for sustainable plastic production and reducing plastic waste, commodity polymers can be produced by using plant-based monomers or by developing an alternative to fuel-based products from plant-based polymers (Garcia *et al*., 2014). As a result, in order to reduce the number of chemicals needed in the manufacture of plastics by adding bio-products, alternatives such as citrates can be employed as plasticizer substitutes (Thompson *et al*., 2009). Furthermore, to prevent plastic litter, market-based instruments, such as bans on certain plastic materials (e.g., plastic bags), taxes and charges and container deposit schemes, have demonstrated certain levels of effectiveness in curbing plastic litter in developed and developing nations (Lohr *et al*., 2017; Alpizar *et al*., 2020). Legal efforts at the international and national levels to monitor

marine pollution have been met with non-compliance, owing in part to a lack of financial means in enforcing those points (Onyena *et al*., 2022).

Understanding marine plastic pollution and its consequences would offer consumers, manufacturers, stakeholders and policymakers with the scientific evidence required to drive suitable legislative, behavioral and technological solutions. It would also promote the development of new products and technology to replace plastics. Government sectors could fight the plastics problem by increasing awareness and offering incentives to individuals (Jakovcevic *et al*., 2014). International concern and awareness through education are critical in improving ecosystem balance and, most likely, the habit of 'throw-away', particularly beginning from childhood (Kuo and Huang, 2014) especially in Africa where it's becoming a norm.

Recycling programs for fishing nets, as well as enhanced waste management facilities for fishing or shipping debris, should be introduced at ports and harbors (GGGI, 2021). Programs to aid in the recovery of abandoned fishing gear should be adopted in many African countries, since they can have both economic and conservation benefits (Walker *et al*., 2019). Schools can help students learn about recycling and marine conservation by introducing these concepts into academic curricula and promoting involvement in citizen science beach cleaning events to promote awareness (Jakovcevic *et al*., 2014; Goodman *et al*., 2021).

At the international level, UNEA launched negotiation of plastic pollution treaty, science body on chemicals with one of the major story highlights being that governments at UNEA 5.2 agreed to negotiate an internationally legal binding instrument by 2024 to end plastic pollution and to establish a science-policy panel on chemicals and waste and to prevent pollution (International Institute for Sustainable Development, 2022).

3.6 Government Policies toward Mitigating Marine Litter Pollution

Governance is a broad notion that includes policy and legal frameworks from binding and voluntary instruments to guiding principles. On the prevention of marine litter, several international and regional agreements have been adopted with direct or indirect measures. The United Nations Convention on the Law of the Sea establishes a global framework for the avoidance of pollution from both land-based and sea-based sources (Abidjan Convention and GRID-Arendal, 2020). Articles 192-195 establish the duty to prevent contamination of the aquatic environment from all sources and are considered customary law (Birnie *et al*., 2009), which means they are binding on all countries regardless of whether an instrument of ratification has been lodged.

According to Ashai (2021), UNCLOS, IMO Action Plan, MARPOL 73/78, Abidjan Convention, UNEP, and Global Programme of Action are among the international legislative frameworks and conventions for the protection of the marine environment, with a focus on marine plastic litter (GPA).

3.6.1 United Nations Convention on Law of the Sea (UNCLOS)

The 1982 UNCLOS, Part XII imparts a special mandate on States to protect and preserve the marine environment (John and Amedu, 2019). This is stated in some of the following selected UNCLOS Articles:

- **Article 211(2)** stipulates that, "*States must enact laws and regulations to prevent, reduce, and control contamination of the marine environment caused by vessels flying their flag or registering under their jurisdiction. Such laws and regulations must have the same impact as generally accepted international rules and standards issued by the relevant international body or general diplomatic conference*" (UNCLOS, 1982).
- **Article 194** stipulates that, "*States are required to adopt the appropriate steps in accordance with the Convention to prevent, minimize, and control marine pollution from any source, using the best practical means at their disposal, and to coordinate their policies in this regard*" (UNCLOS, 1982).
- **Article 192** stipulates that, "*States are under obligation towards preserving and protecting marine environment*" (UNCLOS, 1982).

3.6.2 International Maritime Organization (IMO)

The International Maritime Organization (IMO) adopted the IMO Action Plan to eliminate marine plastic pollution from ships in October 2018 (Resolution MEPC 310 (73), 2018). The action plan supplements existing laws and regulatory frameworks while also introducing new initiatives to address ship-generated marine plastic pollution. The action plan calls for considering ways to improve MARPOL Annex V implementation, improving adequate port receiving facilities, and providing basic training on marine environment awareness centered on marine plastic waste (Louka, 2020). The IMO Action Plan is in line with its support for the United Nations 2030 Sustainable Development Goal 14 on oceans (IMO, 2019). The IMO issued a recommendation advising manufacturers, ports and terminals, ship-owners and operators, cargo owners, and governments to decrease the generation of all types of waste associated with ship supplies, provisions, and cargoes (Resolution MEPC. 295(71), 2017).

3.6.3 MARPOL 73/78

Part XII of the United Nations Convention on the Law of the Sea (UNCLOS) Article 192 and Article 211 paragraph 2 mandate governments to establish the International Convention for the Prevention of Pollution from Ships (MARPOL) to address pollution from ships (UNCLOS, 1982). The MARPOL convention was established on November 2, 1973, at the International Maritime Organization (IMO), although it had not yet come into force when the 1978 protocol was adopted. The 1978 protocol was adopted in response to a spate of tanker incidents in 1976-1977; because the 1973 MARPOL treaty had not yet entered into force, the 1978 protocol subsumed the 1973 convention. Both conventions went into effect on October 2, 1983. The convention was revised on May 19, 2005, with the approval of a protocol that included a new Annex VI. Over the years, the MARPOL Convention has been regularly revised (IMO, 2019). MARPOL 73/78, on the other hand, provides a platform for the management of both accidental and operational pollution, as well as the protection of the maritime environment from harmful substances discharged at sea (Marine Insight, 2021). The six technical Annexes of the convention control diverse sources of ship-generated pollution are listed below according Metonwaho (2018); IMO (2019); John and Amedu (2019).

- **Annex I**: Regulations for the prevention of pollution by oil
- **Annex II**: Regulations for the control of pollution by Noxious Liquid Substances in Bulk
- **Annex III**: Prevention of pollution by Harmful Substances carried in Package Form
- **Annex IV**: Prevention of pollution by sewage from ships
- **Annex V**: Prevention of Pollution by Garbage from ships:
- **Annex VI**: Prevention of Air Pollution from Ships

3.6.4 Abidjan Convention

The Convention for the Cooperation in the Protection and Development of the West and Central African Marine and Coastal Environment (Abidjan Convention) was adopted on March 23, 1981 in Abidjan, Côte d'Ivoire. It is a treaty that was adopted under the auspices of the United Nations Environment Programme (UNEP) and entered into force on August 5, 1984. (Metonwaho, 2018; Abidjan Convention Secretariat, 2014). The Abidjan Convention (1981) reported that, Article 4, 5 and 7 establishes a general requirement for States parties to:

- According to **Article 4(1)**, contracting parties to the convention are required to take all necessary steps to prevent, mitigate, combat, and control pollution, as well as to improve sound management of the maritime environment in the convention area.

- Whereas **Article 5** addresses pollution from ships and requires contracting parties to take appropriate measures in accordance with international law to prevent, reduce, combat, and control pollution in the Convention area caused by normal or accidental discharges from ships, as well as to ensure that the necessary application of internationally recognized rules and standards relating to control is adhered to.
- Furthermore, **Article 7**, which addresses land-based pollution, requires contracting stakeholders to incorporate all appropriate measures to prevent, reduce, combat, and control pollution of the Convention area caused by discharges from rivers, estuaries, coastal establishments and outfalls, coastal dumping, or other sources on their regions.

3.6.5 United Nations Environment Programme (UNEP)

The United Nations Environmental Programme was founded in 1972 to address environmental challenges. UNEP uses its knowledge to create environmental standards and practices, as well as to assist governments in meeting their global and regional environmental duties. The UNEP mission is to examine global, regional, and national environmental conditions and trends, to develop agreements and national environmental institutions, and to enhance institutions for sensible environmental management (United States Environmental Protection Agency, 2021). With the assistance of the Nations Expert Panel, UNEP engages countries in an educational campaign to raise awareness about plastic pollution and supports the reuse and recycling of plastics. Other international cooperative programs launched by UNEP to reduce marine trash and microplastic pollution (Roger, 2020).

3.6.6 The Global Programme of Action (GPA)

GPA is a specific framework established to address land-based pollution challenges. The GPA has been in existence in Hague since 1997/1998, coordinating the UNEP Regional Sea Programme through its regional offices. The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities and the Washington Declaration are the documents used by GPA (1995). The GPA employs soft law tools, which are not legally binding on state parties. The goal of the GPA is to create conceptual and practical advice for national and regional decision-makers dealing with the removal of marine degradation from land-based activities. Furthermore, GPA assists states in developing adequate policies and strategies to protect the marine environment (Ashai, 2021).

A wide spectrum of legislation has an impact on marine plastic pollution, either directly or indirectly. As of 2018, 127 nations had legislation in place to regulate plastic bags, largely in the form of limitations on manufacturing, distribution, use, and imports, but also, to a lesser extent, taxes and recycling targets. Fifty-four African countries have passed legislation restricting the use of plastic bags (Figure 7). Sixteen states have outlawed the use of plastic bags, some without enacting legislation to enforce the restrictions (Kelleher, 2021).

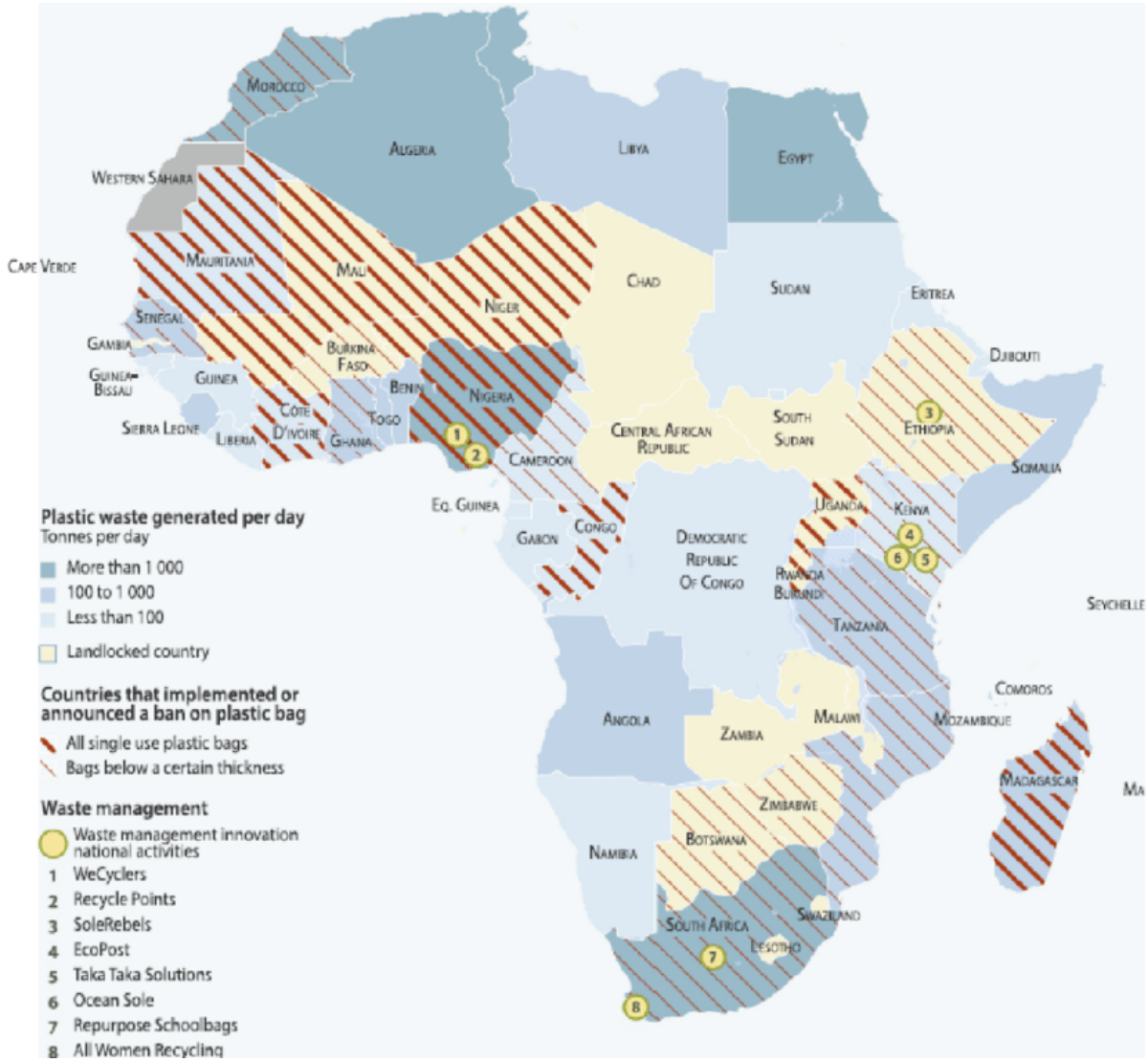

Figure 7: Plastic waste and plastic bag bans in Africa (Jambeck *et al*., 2015).

Fiscal measures can aid in the fight against marine plastic pollution. Taxation of primary plastics and plastic products may not be acceptable for many West African countries, as many are importers of manufactured products. However, certain tariffs may encourage local manufacturing and recycling of certain products. Plastic bag taxes result in cost-effective use decrease. While deposit-refund schemes might be costly, they

also create earning opportunities for informal waste collectors. Garbage collection fees can be a deterrent, yet they may be necessary to cover operational costs (Oosterhuis *et al*., 2014). Fiscal measures are often found to be most successful when combined with awareness campaigns and improved trash disposal plans. Incentives for fishermen to return debris to shore reduce marine litter, supplement income, and give inputs for recycling. There is a possibility that 'plastic taxes' paid to 'environmental funds' would be utilized for purposes other than reducing plastic pollution (Kelleher, 2021).

In terms of policy, Egun and Evbayiro (2020) observed that the lack of a national policy on plastic waste management is one of the key obstacles in the management and regulation of plastic in Nigeria. However, according to the National Policy on Plastic Waste Management (2020), prior to the creation of the 2020 National Policy on Plastic Waste Management, there were six (6) policy memos:

- National Policy on Environment 1999.
- National Policy of Environmental Sanitation 2005.
- National Policy on Chemical Management 2010.
- National Policy on Municipal and Agricultural Waste Management 2012.
- Draft National Healthcare Waste Policy 2013.
- National Policy on Solid Waste Management 2018.

Furthermore, as indicated in the national strategy, there are already 20 laws and regulations governing the management of plastic trash (1991 to 2011). This excludes the plastic bag ban bill, which was found to be outside of any policy framework and has yet to be voted into law and enforced (Nwafor and Walker, 2020). To address the threat of plastic pollution in Nigeria, measures such as advocacy and education among individuals and other stakeholders on the environmental repercussions of plastic pollution are urgently needed. Nonetheless, regulation has been cited as a crucial strategy of reducing plastic pollution in Africa (Adam *et al*., 2020). Actions should include a holistic and indigenous approach to national policy framework, as noted by Egun and Evbayiro (2020).

According to Duru *et al*. (2019), a sustainable policy for plastic management should include essential elements such as public education, home inclusion, collection-focused privatization, data management, waste to energy and international collaboration. Furthermore, a levy on the manufacture and importation of single-use, non-biodegradable plastics can restrict their influx into the country and hence discharge into the environment. Economic incentives can also be provided to encourage plastic recycling and the separation of plastic waste from its source for recycling (Yalwaji *et al*., 2022).

4. Conclusion

Based on this report, the marine ecosystem types and state of West Africa in not something to write home about due to lawlessness and poor management of the ecosystem; example is a section of Ogun River in Nigeria. Different sources of marine plastic sources were also highlighted ranging from land-based to ocean-based sources. With respect to the study area, it has been reported that so many aquatic organisms entangled with some percentage of plastic litter ranging from zooplankton to birds. These occurrences have led to many economic effects on the economy of the study area with tourism sectors being the most affected segment.

Different approaches were highlighted on the best measure in preventing marine plastic litter which the government and NGOs has a big role to play. Several government policies (examples include, UNCLOS, IMO, MARPOL73/78, Abidjan convention, UNEP and GPA) have been made in the past aimed at curbing marine plastic pollution but most of those policies failed because of lack of follow ups on the executing and implementing agencies as a result of corruption. This thesis further concludes that, marine plastic pollution should not be neglected especially in the developing part of the world like Nigeria. For an effective measures to be taken against this pollution, there is need for other West African countries to also been on the alert in order to revive the marine ecosystem. With further research in this area of study either a review or a field work, would be appreciated so as to proffer solutions and better ways of handling marine plastic litter. Based on the findings of this article, the West African region especially Nigeria government and also concerned individuals are now informed on the dangers resulting from marine plastic litter and how to strengthen the existing policies not necessarily creating a new one. This will serve as an awareness creation to her citizens based on the findings of this review towards a sustainable environmental biodiversity.

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