UNIVERSITY OF CAPE COAST

SOCIO-ECONOMIC EFFECTS OF COASTAL PLASTIC POLLUTION: A STUDY ON THE COASTLINE OF CENTRAL REGION, GHANA

BY

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DECLARATION

Candidate's Declaration

I confirm that this thesis is the outcome of my original research and has not been previously submitted for academic credit at this or any other university. By signing this document, I attest to its authenticity.

Signature of Candidate ……………………… Date: ………………………

Name: Philomena Aboagye-Danso

Supervisor's Declaration

I confirm that I followed the University of Cape Coast's guidelines for supervising this thesis and that the candidate adhered to the standards. By signing this document, I verify my supervision in the preparation and presentation of this thesis.

Supervisor's Signature: ……………………… Date:…… ………………..

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ABSTRACT

Coastal areas provide employment, tourism, food, transportation, recreation, trade, etc. However, with increased coastal plastic pollution, these benefits have dwindled, causing harm to the socio-economic lives of fishermen. A review of the literature found limited empirical information on the socio-economic impacts of coastal plastic pollution. This study fills the gap by examining in depth how plastics affect fishermen's social and economic lives along the coastline of the Central Region of Ghana. The study used a mixed method approach, combining quantitative (questionnaires) and qualitative methods (interviews and observations) to collect data from 280 fishermen and 12 key informants (6 chief fishermen and 6 fishmonger queens).

The results showed that plastics were the most common beach litter. Plastic mixed with fish catch reduces income. The study also identified various social impacts of plastic pollution, including loss of aesthetic value, impact on tourism, reduced social identity and pride, health impacts, educational impacts, problems in meeting basic needs, and psychological and emotional impacts. The economic consequences were lost income, the cost of repairing fishing equipment, and wasted time and human resources. Fishermen's coping strategies include reducing fishing days, saving money in banks, engaging in side jobs, obtaining loans from banks, and purchasing fishing equipment in advance during prosperous times.

The study recommends education, Clean-up exercises, recycling and the proper location of coastal landfills in coastal areas to minimize further losses.

KEYWORDS

The coastline of the central region, of Ghana

Coping mechanism

Fishermen

Plastic pollution

Socio-economic

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DEDICATION

I dedicate this thesis to my Parents: Mr. Francis Aboagye-Danso and Mrs. Elizabeth Aboagye-Danso.

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CHAPTER ONE

This chapter includes a broad overview of the research: background information, problem statement, research questions, and objectives, importance of the study, study limits, and organization of the study.

1.1 Background of the Study

Coastal areas are the boundaries between the land and the sea (Qiang, et al. 2020). Despite representing only 10% of the global landscape, coastal regions host over 60% of the world's populace, with coastal fishing providing a vital livelihood for 10% of the global population, particularly benefiting small and developing nations (FAO, 2016). It serves as a hub for the exchange of processes and activities in the physical, biological, social, cultural, and economic spheres. Coastal areas offer a lot of benefits to coastal communities and the world at large. These include transportation, trade, provide various forms of energy, such as oil and gas as well as renewable energy from wind and waves. Coastal areas continue to hold enormous potential for modern society, particularly due to the productivity of coastal lagoons, tidal bays, salt marshes, and estuaries. These play crucial roles in food production through fisheries and aquaculture and in nature conservation and biodiversity (Davidson-Arnott, 2010).

The coastal environment and coastal resources are under a lot of stress and demand due to the growing coastal population. Beach litter and coastal pollution are the results of many of these activities, which produce significant amounts of litter in coastal areas (FAO, 2016). A beach is a narrow, gently sloping strip of land that lies along the edge of an ocean, lake, or river (National Geographic Headquarters, n.d).

One of the major ecological issues facing several coastlines from various regions of the globe is coastal pollution. The prologue of chemicals or contaminations into the environment along the shore that impair marine life and human health is known as coastal pollution; these harmful materials are called pollutants (Bergmann, et al. 2022). Most coastal communities across the world are dealing with problems and hazards of pollution as a result of development pressure and an increase in garbage disposal operations (Clark, 2018). Coastal pollutants may be found in both rural and heavily traveled recreational beaches across the world.

Marine litter refers to the accumulation of litter and pollutants in oceans and on beaches (Qiang, et al. 2020). It encompasses any solid material that has been manufactured or processed and has been discarded, lost, abandoned, or improperly disposed of in the marine and coastal environment (Andrady, 2011). This term also covers objects that enter the marine ecosystem through various means such as rivers, sewage outlets, stormwater outlets, or wind (Willis et al, 2017).

Marine litter may be categorized, as solid, liquid, and gas. While some of the solid litter is decomposable, some are not (Vikas & Dwarakish, 2015). Solid litter is the subject of this study. The primary ocean contaminants among these are plastics (Rosevelt et al., 2013). Research on marine litter has shown that plastics consistently are the majority, accounting for 60-80% of all marine debris over the past three to four decades, as a result of the introduction of synthetic materials such as plastics. The increased utilization of synthetic products, particularly plastics, has correspondingly led to a significant increase in plastic litter being discarded into the ocean (Sheavly, 2012; Van et al. 2013; Rosevelt et al., 2013; Vikas & Dwarakish, 2015).

Plastic litter has accumulated in aquatic ecosystems from a range of direct and indirect causes. Land and ocean-based sources play a major role in the contamination of coastal and marine ecosystems with plastic through both in-situ and ex-situ routes. Land-based plastic pollution is primarily caused by freshwater intake, domestic and residential activities, tourism, and other economic activities like harbour operations (Jambeck et al., 2015). The main sources of marine plastic on land are sewage overflows, beachgoers, inappropriate waste management, industrial operations, building projects, and unlawful dumping. Additionally, the fishing industry, nautical pursuits, and aquaculture are sources of ocean-based plastic (Jambeck et al., 2015).

Plastics can be categorized based on size into four groups: megaplastics (>1 m), macroplastics (1 m), mesoplastics (0.025 m), and microplastics (0.005 m), as described by Wang et al. (2019). Barnes et al. (2019), also categorized plastic litter based on length into four categories: megaplastics (>100 mm), macroplastics (20-100 mm), mesoplastics (5-20 mm), and microplastics (5mm). The size range between macroplastics/ megaplastics and microplastics is referred to as mesoplastics. According to Lavers and Bond (2017), macroplastics and megaplastics are visible to the naked eye and make up over 65% of non-degradable garbage, with a significant portion ending up in the oceans from land-based sources. This research focuses on macroplastics and megaplastics.

Macroplastics have been found in coastal regions worldwide, not only in urban areas with high population densities but also in remote locations such as the waters around Antarctica (Suaria et al., 2020), arctic beaches (Bergmann, et al. 2022) and other uninhabited islands in all sea basins (Lavers & Bond, 2017; Lavers et al., 2019). The presence of marine plastics on coasts and in nearby waters poses a significant environmental threat to the diverse species that live in coastal areas (Patterson et al., 2020). Coastal species face a major threat from marine plastic debris stranding on coasts and floating in nearby seas (Patterson et al., 2020).

Ocean pollution from plastics is now a major worldwide problem not only because of its impact on marine life, and the ecosystem but especially its impact on social and economic aspects of human life. Regarding social life, fish is a source of food for many people. Many coastal communities, especially those in poverty, depend on fish as a source of protein and necessary nutrients (FAO, 2016). Food security may suffer from marine plastics' detrimental effects on fisheries and fish supplies (FAO, 2016; Benkenstein & Chevallier, 2021). Marine plastics may have detrimental effects on health, such as when consumed through seafood (Smith et al., 2018). In terms of the transfer of chemicals from plastics through the ingestion of seafood, humans are the most impacted on the food chain (Rist et al., 2018; Lu et al., 2019; Kelly et al., 2021).

Additionally, the plastic litter on beaches leads to aesthetic issues and negatively impacts tourism revenue and recreational activities (Krelling, et al. 2017). Marine plastic debris also diminishes the beauty and pleasure derived from oceanic surroundings; thus affecting people's quality of life (Thushari & Senevirathna, 2020). The loss of visual attractiveness not only impacts how people use the maritime environment for pleasure, but it may also be a simple degradation of a once beautiful vista. A loss of aesthetics could have a severe impact on the marine environment's ability to inspire creativity because the marine environment frequently serves as the inspiration for various forms of creative expression, such as paintings, literature, and motion pictures (Yang, & Cheng, 2023). Due to both the diminished aesthetic value of a beach and worries about the health and safety problems posed by accumulations of marine plastic litter, other recreational users such as sailors and divers are similarly discouraged by marine litter (Singh & Devi, 2019; Alharbi & Rangel-Buitrago, 2022); consequently affecting both recreational activities and tourism.

Recreational beachgoers are more frequently exposed to plastic and suffer from a variety of well-being effects (Hammer et al., 2012). It is common knowledge that tourists will spend less time in these habitats or avoid specific places if they suspect they will be littered due to their aversion to trash on the coast (Hammer et al., 2012). The social effects of coastal pollution are caused by how marine debris reduces people's quality of life, including fewer recreational opportunities, aesthetic value loss, and non-use value loss (Mouat et al., 2010; Adam, 2021; Windsor et al, 2021).

Economically, plastic pollution has various impacts on different sectors such as commercial fishing, tourism, shipping, human health, and waste disposal. A large amount of plastic pollution in oceans and coastal areas has a direct impact on commercial fishing, aquaculture, and tourism. Cleaning up debris, including plastic items from fishing nets, results in lost fishing time and additional cleaning costs (Thushari & Senevirathna, 2020).

Ghost fishing (accidental fishing caused by discarded, abandoned, and lost fishing gear) has been identified as one of the negative economic impacts on the commercial fishing sector (Gilman et al. 2022). Ghost fishing results in significant reductions in fish stocks, which are critical to both commercial and recreational fisheries (Anderson & Alford, 2013). According to Gilman et al. (2022), the estimated costs associated with ghost fishing in the United States for three and six months are US$145 and US$168, respectively.

Aside the huge economic impact, ocean plastic debris impacts safety. Entangled propellers and rudders are the most frequent problem faced by vessel operators. These problems can substantially damage vessels, necessitating costly repairs, staff downtime, and crew safety concerns (Gilman et al. 2022). While both commercial shipping and pleasure craft may be affected, the vast majority of events go unreported, making it extremely challenging to determine the full scope of the issue (Mouat et al., 2010).

The fishing sector is directly and negatively affected by plastic debris in the sea. Discarded fishing lines, rope, and plastic bags can become entangled near boat propellers, damaging them or even ending up in boat engines (UNEP, 2010). Financial losses to marine fisheries include, for example, the value of discarded catch, the cost of repairing nets and fishing gear, the overall cost of pollution incidents, and missed payments resulting from reduced fishing time due to the removal of debris from the nets (Mouat et al., 2010).

Due to the time and money spent clearing stuck marine debris, and maintaining equipment, the fishing sector also suffers significant financial losses (Mouat et al., 2010). The expense of restoring damaged fishing boats and aquaculture systems is one of the direct economic effects (Iñiguez et al., 2016; Mcllgorm et al., 2011).

Ghana has approximately 550 km of highly productive coastline on the Gulf of Guinea (EPA, 2012). The abundant natural resources along the coast are extremely beneficial to the country's economy (Clark, 2018). Coastal plastic pollution is having major social and economic impacts on the coast of Ghana. Ghana produces almost 1.1 million tons of plastic litter annually, and only about 5% of this is collected for recycling (Stoler et al., 2012), and majority of the rest ends up in the sea, harming the lives of coastal communities, especially fishermen. This is a testament to the fact that plastic has become the most visible form of litter, particularly along the coast of Ghana. Plastics form the dominant type of litter on Ghana's beaches (Essuman, 2017; Adjei & Lamptey, 2021). Therefore, this study examined the socio-economic impacts of marine plastic pollution on fishermen in selected coastal communities along the central coast of Ghana.

1.2 Statement of the Problem

Despite the numerous benefits provided by coastal areas including housing, employment, tourism, food, transportation, recreation, trade and commerce, energy, revenue, shipping, and harbor activities, these regions face significant challenges. The primary issues include flooding, erosion, storms, and pollution. Currently, the most critical and globally recognized problem is coastal plastic pollution. This issue not only affects marine life and the environment but also significantly impacts the socio-economic well-being of coastal communities. The proliferation of plastic pollution along coastlines directly affects the livelihoods of fishermen, who rely on the sea for their income and are among those most severely impacted by this environmental crisis.

The 2021 IUCN annual report states that at least 14 million tons of plastic enter the ocean. Plastic debris is currently the most abundant marine debris accounting for 80% of all marine debris from surface waters to deep-sea sediments (IUCN, 2021). According to Jambeck et al. (2015), there will likely be more plastic in the ocean than all fish by 2050 if appropriate action is not taken.

Marine animals such as seabirds, whales, fish, and turtles often mistake plastic litter for prey, leading many to starve to death as their stomachs fill with plastic. They also suffer from lacerations, infections, limited swimming ability, and internal injuries (Smith et al., 2018). Floating plastics contribute to the transport of invasive marine species that threaten marine biodiversity and the food web (IUCN, 2021). Food security can suffer from the detrimental impacts of marine plastic on fisheries and fish supplies (Benkenstein & Chevallier, (2021); FAO, 2016). In addition, sea plastics can adversely affect health when consumed through seafood; especially microplastics with physical and chemical toxicity (Smith et al., 2018).

Coastal plastic pollution reduces people's quality of life, including reduced recreational opportunities, loss of aesthetic value, and loss of non-utility value (Mouat et al., 2010). It damages the reputation of fishing communities and discourages tourists and other consumers from buying fish products. Fisherfolks are losing their identity, pride, and cultural heritage, which have an additional impact on their economic well-being. The above provides evidence of the impact of coastal plastic pollution on the well-being of fishermen who depend on the sea for their livelihood.

It is obvious that plastic pollution harms the life and well-being of fishermen, notwithstanding, most of the currently available literature primarily focuses on the prevalence of plastic marine litter (Thushari et al., 2020; Smith & Turrell, 2021), monitoring of plastic marine litter (Smith & Turrell, 2021), and impact on marine water (Reisser et al 2013; Vince & Hardesty, 2017; Windsor et al, 2021). Others also touched on the impact on marine life (IUCN, 2021), the impact on the marine environment (Wang et al 2019), and plastic waste management gaps (Vince & Hardesty, 2017) with little said about the socio-economic impacts of plastic litter on fishermen. Moreover, Willis et al. (2022) studied how local management successfully reduced coastal plastic pollution with no emphasis on the socio-economic livelihood of the fishermen. These studies show that there is limited information on the socio-economic effects of coastal plastic pollution on fishermen; evidencing a gap in the literature.

However, little is said about the socio-economic impact on fishermen. Therefore, this study seeks to bridge that gap and broaden the understanding of how coastal plastic pollution affects the social and economic life of fishermen to influence informed decisions and policies for context-specific interventions in addressing the problem.

1.3 Research Questions

The research questions for the study.

1. What types of litter are accumulated on the beaches?
2. How does coastal plastic pollution affect the social life of fishermen?

3. What economic consequences does coastal plastic pollution have on fishermen?
4. How are the fishermen coping with this menace?

1.4 Objectives

The main objective is to examine the socio-economic effects of coastal plastic pollution on the fishermen in some selected coastal communities along the coastline of the central region, of Ghana (Winneba to Elmina).

The Specific objectives

1. To survey the beach litter along the coastline of the central region, of Ghana.
2. To ascertain the social effects of coastal plastic pollution on fishermen.
3. To analyze the economic consequences of coastal plastic pollution on fishermen.
4. To explore the coping strategies of fishermen towards the plastic pollution menace.

1.5 Significance of the Study

The study on the socio-economic effects of coastal plastic pollution on fishermen is significant because of its contribution to knowledge in the following ways:

1. Economic Impact: The study explored the economic impact of plastic pollution on fishermen, including income reduction and job losses suffered by fishermen due to reduced fish catch and market value.
2. Social impact: The study examined the health implications of consuming plastic-contaminated fish on the public. Plastic pollution can lead to the accumulation of toxic chemicals in fish and other

marine organisms, which can pose a health risk to humans who consume them. Other social effects like education, basic needs, and recreation, mental health were examined.

3. Environmental Impact: The study shed light on the impact of plastic pollution on the coastal ecosystem and its effect on marine life. Coastal plastic pollution is a growing environmental concern that affects the health of the ocean and the livelihood of fisherfolks.
4. Policymaking: The study will provide policymakers with insights on how to address the problem of plastic pollution and its socio-economic impact on fisherfolks. The findings of the study can inform the development of policies and strategies aimed at reducing plastic pollution and supporting the affected fishing communities.

The study on the socio-economic effects of coastal plastic pollution on fishermen is crucial in understanding the impact of plastic pollution on both the environment and society. The findings of this study can inform decision-makers, policymakers, and the public of the need to take urgent action to address plastic pollution and its devastating effects on the oceans and communities.

1.6 Delimitation of the Study

Coastal plastic pollution is a broad topic, but this study is interested in the socio-economic effects on fishermen. Geographically, there are several beaches in the Central Region and Ghana at large but only six communities along the coastline from Elmina to Winneba were used for the study.

1.7 Organization of the Study

This study is divided into five chapters. Chapter one is the general introduction which is made up of the background of the study, the statement of the problem, the objectives of the study, research questions, delimitation, and the organization of the study. Chapter two is about theories, conceptual framework, and literature review.

Chapter three deals with the methodology: study area, research type and design, population, sample and sampling techniques, research instruments, data collection procedure, data analysis plan, and ethical considerations. Chapter four looks at the results and discussions. This covers the bio-data of respondents and appropriate subheadings based on the objectives. Chapter five gives a summary of the entire findings of the study, conclusion, and recommendation.

CHAPTER TWO

REVIEW OF LITERATURE

The literature review delves into coastlines (coastal zone) and their benefits, the history of plastic, plastic marine debris, types (physical characteristics) sources and their effects on marine life, and socio-economic effects on fishermen. This study is nested in two theories: Hardin‘s Theory of the Commons Pool Resources and Ecological Theory of Change and Development (Wilkinson & Boulding, 1973), and examined the conceptual framework of how these concepts have had an influence on the fishermen in the study areas.

2.1 Definition of Coastal Zone

The definition of a coastal zone can vary depending on the management regulations that apply to it. Davidson-Arnott and Houser (2019), explain that it is a general term used to describe the area that is impacted by its proximity to the coast. The boundary between the onshore and offshore areas is intentionally not clearly defined, and the limits are established based on policy and definition. In areas with high topography, the limit on land may vary from a few to several meters, depending on the overall height of the land.

Carter (2013) defines the coastal zone as the region where the coastal ocean and the land bordering the coast interact, affecting the coastal waters. The coastal ocean encompasses the part of the ocean that has a direct influence on the land, through physical, biological, and biogeochemical processes. Davidson-Arnott and Houser (2019) refers to it as the oceanic region that encompasses the continental shelf or margins.

The coastal zone can be described as the region located between the 30-meter landward and seaward contour and the 100-fathom mark from the shore. The point where land and water meet is called the shoreline, which is typically where waves cross at the base of a cliff or cliff line (Thushari et al., 2020). In terms of management, a broader zone is defined by the 75-meter contour line, which includes all areas that could potentially affect the coastal zone due to their connection to the watershed (FAO, 2016).

2.1.2 The World's Coastline

Depending on the techniques employed, the coastline's length varies throughout the world. Around 500,000 km is how far it is thought to be. But when the intricate details of indented bays, promontories, and offshore islands are taken into account the overall length will be close to a million kilometers (Windsor et al, 2021). A large portion of the coastlines of the Pacific Ocean islands are volcanic coasts, which are characterized by volcanic activity. Among these are the coasts of Vanuatu, Papua New Guinea, Tahiti, Solomon Island, Fiji, Hawaii, Maui, and New Caledonia. Iceland has several volcanic coasts as well. Other regions of the world's coastline are likewise rocky, with sandy coastlines in between. Around 20% of the world's coastline is made up of sand, and 70% of those sandy beaches have been retreating (Vince & Hardesty, 2017).

2. 1.3 The Ghanaian Coastline and coastal plain

The overall length of the Ghanaian coastline is approximately 539 kilometers (Anim & Nyarko, 2017). Out of this, sandy beaches make up around 253 kilometers, or 47%, of the total length. The coastline is made up of rocky beaches (53%) with 286 km of alternating sandy beaches and bays

(Adjei & Lamptey, 2021). Numerous locations have sandy cliffs in bays, and the presence of beach rock 45 meters offshore in some locations, such as lower Prampram and Takoradi, indicates coastal retreat. Sea cliffs have drastically receded in regions where the coastline is composed of extensively worn sedimentary or igneous rocks or poorly-consolidated beach sand. This is especially apparent in regions with sandy beaches, like Saltpond, where sandy cliffs have greatly eroded (Anim & Nyarko, 2017).

According to studies on the Ghanaian coastline, the huge sandstone of the same formation creates promontories that are about 12 meters high while the "Accraian" (Devonian Sandstone) shale creates sandy bays. The cliff walls and rock boulders at the base of these headlands were distinctive features. Precambrian and Palaeozoic age-old rocks form the foundation of the Ghanaian coastal plane. The Dahomean (schist and lavas) and Togo-Akwapim quartzites are two examples of these (Anim & Nyarko, 2017).

The majority of these had faults and were tightly joined, and folded. Devonian sandstone outcrops could be found in the area of Accra and between Cape Coast and Takoradi. In Cape Coast and Takoradi, these sandstones are referred to as Sekondian (Rist et al., 2018). There are a few unconsolidated Jurassic conglomerates at Saltpond among the heterogeneous Sekondian rocks, which range from shales to conglomerates of the Sekondi sandstone. In the Precambrian and Palaeozoic rocks along several shorelines, such as those around Dixcove, Saltpond, Apam, and Cape Coast, granite and pegmatite intrusions were frequent. (Anim & Nyarko, 2017)

The Atlantic Ocean washes the 168 km of coastline that runs along coastline of central region, Ghana. The coast and the nation's whole coastline are similar in a few ways. It was primarily composed of sandy beaches that were interspersed between rocky outcrop beaches (Essuman, 2017). There were only a few places, like the stretch from Kormantse through Saltpond and on to the Amissano estuary and beyond that lacked rock outcrops. Between Cape Coast and Takoradi, isolated outcrops of Devonian sandstone can be found (Adjei & Lamptey, 2021). The region was underlain by ancient rocks from the Precambrian and Palaeozoic periods.

In Ghana, a physical boundary has identified 21 coastal districts in the Western, Central, Greater Accra, and Volta regions. Severe sea erosion and coastal plastic pollution occur in parts of these districts' territories within the 30 m contour erosion (FAO, 2016). However, the zone presents valuable opportunities for the country's development, including ports and harbour infrastructure, tourism, recreation, and fisheries (Jambeck et al., 2015).

The Environmental Protection Agency (EPA) and the World Bank reported significant changes to Ghana's coastline region in 2012, resulting from both natural and anthropogenic factors. The area is also rich in natural resources, including rivers, which drain the region, and other resources that are crucial to various economic sectors. While fishing is the primary activity, other activities, such as agriculture, salt production, oil and gas exploration, sand mining, recreational activities, and industrial improvements, also take place in the region (Boateng, 2012).

2.1.4 Significance of the coastal zone

Throughout history, human society has heavily relied on the coastal region for development and progress (Adam, 2021). The settlement was made possible by the benefits of sea transport and trade, as well as the abundance of food from the highly productive coastal seas (Davidson-Arnott, 2010). Many coastal communities and villages have a long-established history and way of life that stretches back centuries. However, the coastal region still holds great potential for modern society. The salt marshes, estuaries, tidal inlets, and coastal lagoons in the area are vital for supporting fisheries and aquaculture, as well as preserving the environment and biodiversity (Davidson-Arnott, 2010).

Coastal areas play a considerably more varied and extensive role. Generally speaking, coastal zones serve purposes that are connected to the creation of jobs, economic development, improvement of the quality of life, and agricultural output on coastal plains. These are effectively achieved through the utilization of coastal water resources, such as lagoons, aquifers, and desalination of seawater for irrigation and fishing, as well as encouraging tourism to provide labour and revenue for the working population. According to Davidson-Arnott (2010) it has artistic merits in its lovely landscapes.

Coastal areas generate energy through traditional means such as oil and gas, as well as through sustainable methods like wind and wave power. Developing ports, harbours, and coastal transport systems not only strengthens global transportation networks but also enhances trade and mobility. Coastal regions act as buffer zones and are in charge of absorbing and degrading pollutants. Coastal areas and their natural resources, both marine and terrestrial, are of strategic importance for meeting the needs and aspirations of coastal communities, both in the present and in the future (Davidson-Arnott, 2010).

Estuaries, contain both freshwater and saltwater and supply a variety of nutrients for marine life, the shoreline, and its surrounding areas, both on and offshore, and because of these, they have a notable impact on the ecosystem within the immediate area. The diversity of plants, animals, and insects that are supported by salt marshes and beaches is also vital to the food chain. Since humans have been drawn to high levels of biological activity for millennia (Anderson & Alford, 2013), a high level of biodiversity is a necessary condition for such activity to occur. The population of coastal areas is rising dramatically. According to Clark (2018) many of the major cities around the world are located either directly on or near top-notch harbours and possess port infrastructure. Coastal regions, particularly those with beaches and warm water, are major tourist attractions.

2.2 History of plastics

Wood, stone, metal, clay, and animal skin were just a few of the materials that man utilized to create his garments in the beginning before plastics were invented (Anderson & Alford, 2013). In recent times, plastic has become a crucial aspect of human existence, playing a significant role in both personal and professional aspects of life. Man appears to rely nearly totally on plastics and kindred materials for daily existence from dawn till dusk. Around 1835, famed French chemist Regnault conducted one of the several experiments that resulted in the development of plastics. Many years ago, he created vinyl chloride and transformed it into a white powder. This powder has since undergone modifications and is now recognized as polyvinyl chloride (PVC) (Barnes, 2019).

Plastics were unknown before Alexander Parkes officially introduced plastics in 1855 at the Great International Exhibition in London. The chemical camphor, which is used in mothballs, and the chemical nitrocellulose, which is used in many current lacquers for automobile bodywork, was combined to create plastics which were then known as Parkesine after Parkes (Barnes, 2019). After Parkes in 1855, significant advancements in the quest to produce plastic were noted. The growth of the plastic industry was supported by several factors such as the demand for more goods, chemicals, steel, and power, as well as the acknowledgment of the usefulness of plastics as a useful material for domestic and professional applications.

In the 1900s, polymers gained widespread use, and further research was conducted to develop newer forms of plastics for improved functionality (Teye, 2012). According to UNEP (2016), plastics are now classified as polymers, which are composed of large molecules made up of smaller units known as monomers that are linked together through a process called polymerization. Polymers are mainly composed of carbon and hydrogen, and may also contain other elements such as oxygen, nitrogen, chlorine, and fluorine (UNEP, 2016). Teye (2012) explained that plastics are a type of polymer, which is an organic macromolecule made up of many repeating units called "mers" that are joined together in a chain-like structure. Plastics are created using polymers and additives (Teye, 2012).

Plastic is a valuable material made by combining different polymers, and it has been extensively used in manufacturing for the last thirty years due to its various applications. Plastics are preferred for making a range of products because they are durable, cost-effective, lightweight, sturdy, and chemically unreactive (STAP, 2011). These same characteristics make them a severe societal concern since they generate plastic pellets, which are non-biodegradable items that instead fracture into smaller pieces (Rosevelt et al., 2013). The following section will give more information about the problem of plastic pollution in the oceans and how it is impacting both the marine environment and those who make a living through fishing.

2.2.1 Plastic marine debris

Industrialization has led to the discovery of many materials, but most of them do not have the necessary means to be recovered and end up being disposed of as waste (Allsopp et al. 2016). Plastic, a new type of garbage created in the previous three to four decades, is one of these elements that has been helpful in today's industrialization (Rist et al., 2018). Synthetics and plastics are now a part of human waste, and they have inexorably made their way into the oceans of the planet. According to an internationally approved definition by UNEP (UNEP, 2010; Butterworth et al., 2012), any solid debris that is created, produced, or treated and then discarded, disposed of, or left in the marine and coastal environment is classified as marine litter.

The presence of plastic debris on beaches worldwide is becoming a growing concern, as it poses a threat to the environment. Whether it is large containers or tiny pellets, plastic debris is increasingly being found on beaches across the globe (Butterworth et. al., 2012), including in Ghana (Essuman, 2017). Studies have shown that plastics are the most common type of marine debris and account for the majority of marine trash (Allsopp et. al., 2016; STAP, 2011; Butterworth et. al., 2012). Although historical trends may differ by location and evaluation methodologies may vary, plastics consistently make up between 60 to 80 percent of total marine debris (Jambeck et al., 2015).

Anderson and Alford (2013) explains that plastics have properties such as low weight, strength, durability, corrosion resistance, and thermal and electrical insulation that make them useful in manufacturing various items. However, these same properties also make plastics non-biodegradable. This has led to a significant global problem as plastic debris accumulates in the marine environment, affecting the entire ecosystem and harming marine life from the ocean floor to the surface (Barnes et al. 2010).

According to Andrady (2011), over 75% of plastic objects that enter the ocean originate from sources on land. In the whirling convergences that make up roughly 40% of the world's ocean surfaces, there are billions of pounds of plastic (Richmond, 2015). If current trends continue, Richmond (2015) predicts that by 2050, the plastic debris in the ocean will surpass that of all fish. A study by Roosevelt et al.(2013) demonstrates that plastic litter is more widespread in the ocean ecosystem than other forms of waste such as glass, fabric, paper, food waste, metal, rubber, biological waste, smoking/firework materials, and wood. Jambeck et al. (2015) further reveal that between 4.8 and 12.7 million tons of plastic debris from land enters the ocean annually.

Due to improper disposal of waste, there are over 5 trillion plastic pieces that are floating around in oceans worldwide, weighing over 260,000 tons (Eriksen et al. 2014). Thevenon et al. (2014) stated that at least 8 million tons of plastic enter the oceans every year. Currently, the most widespread form of marine litter is floating plastic debris, which accounts for around 80% of all marine debris. All of the continents' shorelines have been found to contain plastic, with more plastic items being discovered close to well-known tourist attractions and densely populated places.

The shape of pellets or round particles makes it easier for them to go through an organism's digestive system, while broken particles and fibers can result in internal injuries or even pierce the tissue, leading to infections and irritations (Wright et al., 2013; Mueller et al., 2020). Therefore the shape of the plastic is very important.

Important considerations include the colors of these plastics. Their resemblance to food, due to their colors makes it difficult for organisms to differentiate plastics from food. These organisms end up consuming plastics. White, brown, and yellowish particles are the most commonly consumed colors, followed by brown and yellowish (Wright et al., 2013). As different types of dyes and pigments influence colors, and as the negative effects of these substances are also unknown, such preferences could be problematic (Campanale et al., 2020).

Due to their prevalence, extended survival rates, and capacity for long-distance transit, plastics account for the majority of marine litter and pose a serious hazard to the marine environment. Plastics make up between 50 and 80 percent of marine litter (Barnes et al., 2019), even though they only account for 10 percent of all rubbish produced (Thompson, 2015), and this number is anticipated to keep increasing in the future (Thompson, 2015). Plastic objects can move over very great distances and continue to endanger marine life for a very long time since they are lightweight and durable (Thompson & Sadri, 2014).

Considering that plastics can cause harm to wildlife directly (Sheavly, 2012), damage benthic ecosystems (Moore, 2020), facilitate the spread of invasive species (Kelly et al., 2021), and accumulate toxic chemicals from seawater, it can be inferred that plastics constitute a significant and enduring danger to marine ecosystems. The possible effects of microplastic particles, which are now prevalent in all oceans and beaches throughout the world, are an increasing source of worry, although their environmental significance remains unknown (Thompson & Sadri 2014).

2.2.2 Plastic accumulation sources

Macroplastics are found in coastal environments and come from both land and sea sources. Although it is generally accepted that around 80% of marine litter is plastic from land and the remaining 20% is plastic from the sea, determining the precise origin of an item is often difficult (Kelly et al., 2021). Litter, river runoff, and sea transport are observed as sources of marine litter in coastal and estuarine areas (Willis et al., 2017). Plastic pollution of aquatic ecosystems is influenced by both land and sea sources, which can enter through different pathways.

2.2.2.1 Land-based Sources of marine plastic litter

Marine plastic litter can originate on land in locations such as beaches, ports, docks, marinas, and in areas several kilometers from shore, as plastic litter can travel long distances in the environment (Ten et al., 2018). Activities such as coastal tourism, improper waste disposal by small businesses, fly-tipping, and inadequate waste management can lead to litter being intentionally or unintentionally discharged into the environment (Allsopp et al., 2016; UNEP, 2010).

The main causes of plastic pollution on land are freshwater discharge, household and residential activities, tourism, and other economic activities such as port operations. Studies by Ten et al., (2018) found that land-based plastic debris is the most common form of marine debris in Central and South America. Andradys's (2011) study shows that over 75% of marine plastic debris comes from land-based sources. Sources of plastic pollution on land include urban and storm drains, sewer overflows, and improper waste disposal by beachgoers, industrial plants, buildings, and illegal landfills. Sources of plastic in the sea include the fishing industry, nautical activities, and aquaculture.

A considerable fraction of plastic trash is released or escape into the sea, even from treatment systems according to Browne et al. (2016). Such plastic garbage then accumulates in naturally occurring freshwater environments like rivers and streams or has the propensity to seep into groundwater before reaching the deep sea. Most of the plastic debris found in coastal areas can be attributed to fast-moving freshwater habitats that flow in a specific direction. For instance, approximately two billion pieces of plastic are released into the water in three days in the ocean system encircling California, where trash from two freshwater habitats has accumulated (Moore, 2020). According to Lima et al. (2014), damage to the river basin is a leading cause of the buildup of microplastics in the Goiana Estuary located in South America.

Allsopp et al. (2016) identify several land-based sources of marine litter: public littering, poor waste management methods, industrial operations, sewage-related debris, and storm water discharges. Public littering is the most significant source, accounting for 42% of identified materials in the 2012 UK Beachwatch survey (Beachwatch 2012b). Poor waste management and industrial activities also contribute significantly, while sewage-related debris and storm water discharges are less prominent but still notable sources as highlighted by ENCAMS (2017).

Furthermore, Thushari et al. (2017a) discovered that residential activities near coastal areas and on-site waste management practices significantly contribute to the accumulation of debris in coastal environments. Evidence suggests that tourism and recreational activities also play a significant role in the buildup of plastic in the ocean and coastal ecosystems. Thushari et al. (2017b) reported that more than 60% of beach litter on specific beaches along Thailand's eastern coast was attributed to tourism and recreational activities. This litter introduces secondary plastics and microplastic fragments into the water (Cole et al., 2011). During the period from August to November 2017, which marks the end of the south-west monsoon, researchers from Sri Lanka, an island located in the Indian Ocean, recorded an average density of 140.34/13.99 plastic items per unit in the western coastal waters (Athawuda et al., 2018).

The northern Brazilian urban beach has been found to have plastic particles and pieces that are considered pollutants. These fragments mainly come from the disintegration of bigger plastic debris that was previously collected on the beach. On the other hand, the plastic pellets that were found are believed to have come from the port facilities nearby. Additionally, the fishing boats that are constantly active in the area could also be a source of plastic pollution, according to literature records (Costa et al., 2011; Ivardo Sula et al., 2013).

According to Thompson and Sadri (2014), severe weather conditions such as storms, hurricanes, and floods can increase plastic accumulation in the ocean. Moore (2020) found that the concentration of microplastic debris in water collected from California was six times higher during stormy weather. Thushari et al. (2017b) observed that intense monsoons during the rainy season resulted in the transportation of coastal debris to offshore or deep-sea areas, leading to lower levels of coastal debris on beaches along Thailand's eastern coast during the wet season compared to the dry season. Additionally, Lattin et al. (2014) discovered that the southern coast of California, on average, experienced debris density levels around 18 times higher during storm events.

Various sources originating from land contribute to pollution in the ocean, encompassing factors such as rivers, stormwater, sewage, and improper or illegal waste disposals practices like littering and dumping (Lebreton & Andrady, 2019). It is widely acknowledged that rivers significantly introduce land-based pollution into the ocean (Lebreton et al., 2017; Schmidt et al., 2019). Regions with a greater prevalence of mismanaged plastic debris, such as Southeast Asia and Africa, tend to exhibit higher levels of land-based plastic pollution entering the ocean (Jambeck et al., 2015; Lebreton & Andrady, 2019).

Law et al. (2020) conducted a study revealing that the United States is among the leading contributors to pollution caused by inadequate management of domestic plastic debris and the exportation of debris to other countries, particularly Hong Kong and China.

2.2.2.2 Ocean-based Sources of marine plastic litter

Plastic debris on beaches can be carried into the open sea by coastal currents. In some cases, fishing nets made of monofilament (fishing line made from a single fiber of plastic material) are discarded during harbour activities and can remain afloat on the water's surface. The distribution of floating plastic debris across different areas of the water is influenced by ocean currents (Cole et al., 2011). The detection of synthetic polymers in subsurface plankton samples near Saint Peter and Saint Paul Archipelago in the Equatorial Atlantic Ocean has coincided with an increase in average plastic density. This indicates that plastic items have the potential to travel considerable distances through ocean currents (Ivar do Sula et al., 2013).

In a nutshell, Allsopp et al. (2016) identify several ocean-based activities as sources of plastic waste in the ocean. These include the fishing industry, which contributes through discarded or lost nets, ropes and other rubbish are purposely discarded, unintentionally lost or left behind. Offshore oil and gas exploration also results in waste, including protective gear and exploration-related debris. The shipping industry, despite international laws, often unintentionally or deliberately releases waste, with up to 10,000 cargo containers lost annually (Podsada, 2013). The leisure industry adds to the problem through recreational boaters disposing of plastic items, such as food containers, plastic bottles, and fishing gear used for recreational purposes (Sheavly, 2012).

Numerous studies, including those by Asensio-Montesinos, et al., (2019) in Spain and Mghili et al. (2020) in Morocco and found that individuals who visit beaches and leave behind litter are the source of microplastic pollution. Hardesty et al. (2016) conducted extensive observations across Australia and discovered that beaches near urban areas experience a greater burden of marine debris. They also highlighted that illegal disposal of waste is a prominent factor driving pollution, particularly in coastal areas that are less accessible but located near densely populated regions.

Hengstmann et al. (2017) observed the accumulation of marine debris on the backshore, while Olivelli et al. (2020) conducted a study combining real-world observations and statistical modeling. They demonstrated that the amount and size of plastic debris in coastal areas increase gradually from the shoreline to the vegetation on the backshore. This suggests that the debris becomes trapped in the backshore and is less likely to be redistributed.

2.3 Effects on Marine Life

The following explores some of the consequences that plastic marine debris has on marine life, some of which have been widely reviewed.

2.3.1 Entanglement and Ingestion

Plastic fishing gear such as lines, nets, ropes, and packaging from consumer products, when dropped in the ocean, can become entangled accidentally or intentionally, putting aquatic creatures like fish and crabs at risk of being trapped and killed. Even if the fishing gear has become outdated or worn out, it can still cause harm if left in the water and carried away by currents (Matsuoka et. al., 2009).

The entanglement of marine litter is a significant contributor to animal suffering, leading to the death of many birds and marine creatures each year, as noted by Butterworth et al. (2012). The type of debris and the animal's body shape and behavior are key factors in determining the type of entanglement, which varies depending on the species. This entanglement can have various impacts on marine life, such as preventing animals from eating and limiting their mobility due to extra material, resulting in strangulation and death (Allsopp et al., 2016). Marine creatures can also suffer from amputations or major wounds caused by ropes resulting in infections and sores. Loops and hooks can create deep incisions in the skin and muscles. Additionally, because plastics are not biodegradable, they can continue to entangle marine animals even after the initial creature has died and decomposed, as Butterworth et al. (2012) have noted.

According to Gall and Thompson (2015), plastic fragments pose two major problems: entanglement and ingestion. However, in coastal and marine environments, entanglement is a much greater issue than consumption by organisms. The authors discovered that the majority of entanglement cases involved a single organism, plastic rope, or fishing nets in fishing equipment. On the other hand, consumption is closely associated with specific organisms and plastic debris. Gall and Thompson (2015) provide more detailed information about the consequences of these issues and the harm caused to wildlife. They argue that both eating plastic debris and getting entangled in it can result in death or serious injury for coastal and marine organisms. Entanglement or ingestion can directly lead to death or fatal harm to biotic organisms in these environments.

Sub-lethal effects can manifest in various ways such as reduced ability to obtain and ingest food, impaired ability to reproduce, decreased sensitivity, hindered escape from predators, limited mobility, slowed growth, and deteriorating physical condition. Plastic pollution poses a greater threat to marine creatures including sea turtles and seabirds, which are more vulnerable to entanglement and ingestion. Several species such as the Right whale, Green sea turtle, Hawksbill turtle, Fulmar, Seals, Sea Lions, Puffin, Albatross, and Greater Shearwater have been identified as suffering from the aforementioned negative impacts (Hammer et al., 2012; Galgani et al., 2019).

Large air-breathing marine creatures like whales, dolphins, seals, sea lions, manatees, and dugongs are at a high risk of harm from Abandon, Lost, or Discarded Fishing Gear (ALDFG) because they can become ensnared and ultimately drown (Lusher et al., 2018).

Hong et al. (2013) emphasized that fishing hooks and lines pose a significant threat as ingestible plastic waste for seabirds. They discovered a black-tailed gull that had swallowed a hook and become entangled in a fishing line, preventing it from moving and foraging. The study also revealed that nearly half of the northern Fulmar population had plastic debris in their digestive tracts. Furthermore, Murray and Cowie (2011) found that 83% of commercially valuable lobster species, specifically *Nephrops norvegicus* in the Norwegian Ocean, contained plastic filaments within their bodies. Supporting these findings, Chiappone et al. (2012) reported that 49% of debris originating from abandoned fishing hooks, lines, and plastic lobster traps caused harm, injuries, and fatalities among sessile species in Florida Keys.

According to the US EPA (2012), 59% of 135 species had ingested plastic between 1962 and 2012, and it was predicted that by 2050, 90% of all species would have done so (Wilcox et al., 2015). The type of debris ingested can greatly determine the potential harm caused. Fragmented pieces and fibers can harm an animal's insides or even infiltrate its tissues, leading to infections and irritation. On the other hand, pellets or spherical particles possess an advantage as they can pass more smoothly through an organism's digestive system (Wright et al., 2013).

Polystyrene spheres, even when they are spherical, have been shown to have negative impacts on nematode reproduction rates, indicating their potential harm to human health (Mueller et al., 2020). It is important to consider the color of these plastics, as it can affect how creatures that rely on visual cues to find food ingest them. White, brown, and transparent particles that are yellowish are less likely to be consumed than opaque ones (Wright et al., 2013). However, since the dyes and pigments used to create these colors may have unknown harmful effects, such preferences can be problematic (Campanale et al., 2020).

2.3.2 Ghost fishing

Ghost fishing refers to the phenomenon in which abandoned fishing equipment remains active in catching fish and other marine organisms. It encompasses various types of fishing gear, both passive and active, that continue to capture marine life even after being lost, discarded, or abandoned. This persistent fishing activity poses a significant threat to marine ecosystems (Hardesty et al., 2021). The equipment involved is considered derelict and can be unintentionally dropped, misplaced, or intentionally left in the environment.

It has the potential to entangle and harm marine creatures, cause habitat damage, and pose navigation hazards. Since fishing gear is typically made of synthetic materials that do not degrade, it can continue to ensnare marine animals, creating a cycle where trapped animals attract predators that may also become entangled. This cycle perpetuates as decomposing organisms in the nets attract more crustaceans, leading to further entrapment. According to the United Nations Environment Program and the Food and Agriculture Organization of the United Nations, an estimated 640,000 tons of fishing gear are abandoned in the waters each year.

Ghost fishing for marine creatures cause both direct harm through entanglement and ingestion, as well as indirect impact through habitat degradation and ecosystem disruption. The World Animal Protection International estimated that ghost fishing gear results in the deaths of countless birds, turtles, fish, and other animals, as well as a minimum of 136,000 seals, sea lions, and large whales annually. Additionally, the Wildlife Disease Association (WDA) reported that over 10% of treated pelican, gull, and pinniped species in California's coastal wildlife rehabilitation facilities were admitted due to entanglement in fishing gear or ingestion of it. Although the performance of ghost fishing equipment is affected by the environment, research has shown that a single net can be used for decades of fishing (Mouat et al., 2010). Ghost fishing can have negative effects on the ecosystem, cost fisheries money, and reduce opportunities for recreational fishing (Mouat et al., 2010).

Ghost fishing can have a severe impact on fish populations that are crucial for both commercial and recreational fishing (Anderson& Alford, 2013). Records show that the costs associated with ghost fishing can be substantial, with estimates of US$145 and US$168 for three and six months, respectively (Al-Masroori et al., 2020). A cost-benefit analysis conducted in Puget Sound, Washington, USA, revealed that the cost of ghost fishing for commercial crab fisheries annwas approximately US$19,656 (Gilardi et al., 2010). Fishing gear was identified as a significant contributor to marine litter in Indonesia, with litter accumulation causing major changes to fishing grounds and negatively affecting the artisanal fishing industry (Nash, 2017). According to UNEP (2010), ghost fishing equipment resulted in an annual loss of US$250 million in the lobster fisheries industry.

2.3.3 Unfamiliar Species Introduction and Habitation Destruction

The existence of marine plastics has the potential to inflict considerable damage on marine biodiversity and ecosystems by enabling the introduction of non-native species. These plastics can serve as transportation mechanisms for aggressive invasive species, endangering vulnerable coastal habitats. Moreover, there is an increasing concern regarding microplastic debris acting as carriers for harmful viral and bacterial pathogens, which can be disseminated to new regions. Vibrio spp. bacteria, known to cause disease outbreaks, have been discovered in higher quantities in plastic debris (Browne et al., 2015; Gregory, 2012).

The actions of humans have resulted in the movement of different species from their original ecosystems to non-native environments, a phenomenon known as biological invasion (Allsopp et al., 2016). While some marine animals have always used natural floating debris such as marine algae, plant stems, and seagrasses as a means of transportation (Allsopp et al., 2016), the introduction of massive amounts of marine debris, mostly plastics, into the marine environment over the last 50 years has considerably increased the likelihood of the spread of marine creatures (Gregory, 2012; Mouat et al., 2010). Furthermore, the slow movement of marine debris provides foreign organisms with more opportunities to modify ecological conditions (Moore 2020). Entangled debris can also result in more turbidity and siltation, which can prevent seagrass or corals from receiving vital sunlight (Gregory, 2012).

2.4 Social Effects

2.4.1 Human Health

According to multiple sources (Teuten et al., 2013; Thompson & Sadri, 2014; Gold et al., 2013; UNEP, 2014; Galloway, 2015), plastic pollution poses hidden dangers that can directly or indirectly impact human health. The chemical and physical properties of plastics can contribute to the accumulation of toxins present in seawater, leading to potential adverse health effects such as illnesses and reproductive abnormalities caused by industrial and agricultural pollutants like aqueous metals, polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), and others (Teuten et al., 2013). These toxins form the foundation for the concentration of marine plastic waste, which can be hundreds of times more prevalent on plastic surfaces than seawater (EPA, 2011). For example, plastics may contain up to a million times more PCBs than what is found in seawater (Gold et al., 2013; EPA, 2013).

Moreover, the use of chemicals in polymer production may lead to an increased presence of harmful contaminants in the surrounding environment. Plastic waste often contains additives like bisphenol A (BPA) and flame retardants such as polybrominated diphenyl ethers (PBDEs), which have been linked to endocrine disruption in both humans and animals (Gold et al., 2013). This raises concerns about the potential bioaccumulation of toxins in food chains when smaller organisms consume marine plastic waste.

Furthermore, plastics accelerate the spread of diseases caused by viruses and bacteria in regions where they would not typically occur. Plastic litter in the ocean has given rise to its ecosystem known as the "plastisphere," which harbours unique species not found in the surrounding water (Gold et al., 2013). Numerous studies (Lippsett, 2013; Campanale et al., 2020) have identified that the bacteria present in plastic samples are associated with illnesses such as cholera and gastrointestinal disorders. Consequently, invasive species and foreign materials in marine debris can pose significant health risks.

Additionally, there is considerable apprehension that microplastic waste may act as carriers of hazardous infections like viruses and bacteria that can pose a threat to both humans and animals by transmitting them to new places (Browne et al., 2015). It has been observed that plastic debris contains more Vibrio bacteria, which are responsible for a surge in disease outbreaks when compared to natural non-plastic particles (Browne et al., 2015). As a result, marine plastic debris jeopardizes human health and safety (US EPA, 2012).

The health and safety concerns related to marine litter include the dangers of toxic substances and navigation risks, among others (Macfadyen et al., 2011; Cheshire et al., 2010; Thompson & Sadri, 2014). However, accurately determining the extent and frequency of these occurrences is difficult because many incidents involving vessel damage and casualties remain unreported (Sheavly, 2012). This underscores the need for further research to fully understand the risks that marine debris poses to human well-being.

2.4.2 Food security

Fishing plays a vital role in providing food and generating income. It is particularly essential for coastal communities, especially those living in poverty, as they rely on fish as a source of protein and essential nutrients (FAO, 2016). However, the harmful impact of marine plastics on fisheries and fish supplies may lead to food insecurity (Benkenstein & Chevallier, 2021). Furthermore, marine plastics can affect human health when consumed through seafood, with microplastics being a significant concern due to their physical and chemical toxicity (Smith et al., 2018).

Kelly et al. (2021) found that among all the organisms in the food chain, humans are the ones most affected by the transfer of plastics' chemical form through consuming seafood. Ingesting microplastics by consuming fish can have adverse effects on human health due to their potential to carry harmful infectious agents (Lu et al. 2019). Nonetheless, the toxicity of the plastic material will play a significant role in determining the degree of harm (Rist et al. 2018).

According to Rist et al. (2018), marine plastic pollution can elevate the levels of Persistent Organic Pollutants (POPs) in the tissues of fish and shellfish, posing additional risks to consumers. Although further controlled studies are required to understand the human health implications, current literature suggests that the health impacts of marine plastic are minimal (Galloway, 2015; Lusher et al., 2017). Nonetheless, the perception of seafood containing microplastics as a potential risk might have detrimental effects on fisheries.

2.4.3 Navigational Dangers

The primary concern with marine debris, including discarded fishing equipment such as nets, ropes, and lines, is entanglement which poses significant safety risks for boats. Plastic bags are a common cause of clogged water intakes, leading to malfunctioning water pumps in recreational vessels (Sheavly, 2012).

The major hazards for navigation associated with marine litter, especially abandoned fishing gear, can be summarized as follows:

- If a vessel's propeller gets tangled or fouled, it can reduce the stability and maneuverability of the vessel, which can be dangerous for the crew, especially in rough weather.
- When a vessel collides with marine litter, it can cause damage to the propeller shaft seal. This is because debris on the seafloor and underwater can clog equipment and anchors used by trawlers and research vessels, creating a hazard for the crew and vessel.
- In some cases, divers may need to clear the debris, but this can be very risky if done too close to the vessel's hull. Many accidents of this kind go unreported, and there are plenty of anecdotal stories of incidents that put the safety of vessels at risk.

In 2005, a Russian submarine was trapped on the seafloor near the Kamchatka Peninsula for four days because it had become entangled in discarded fishing nets located 600 feet below the surface (Allsopp et al., 2016; Chivers & Drew, 2015). Another example occurred in 1993, when a passenger ferry off the west coast of Korea capsized and sank, resulting in the loss of 292 of the 362 passengers, after its right propeller and both propeller shafts became entangled in a 10mm plastic rope (Macfadyen et al., 2011). These incidents demonstrate the dangers that marine debris poses to all kinds of vessels and the serious consequences, including the potential loss of life, that result from its presence.

Ocean plastic debris creates obstacles to safe navigation and poses a serious threat to shipping (US EPA, 2012 & STAP, 2011). Abandoned fishing gear, such as nets, ropes, and lines that have degraded and become part of marine plastic debris, can entangle vessels and cause damage. This concern is shared by Mouat et al. (2010), who reported incidents of vessels being seriously damaged by deteriorated fishing gear. In addition to vessel damage, abandoned gear can also put boaters and crew in danger by trapping propellers and rudders or piercing the bottom of boats. Such situations are especially perilous during storms or when the steering is impeded, making collision unavoidable (Gregory, 2012).

Marine litter pollution poses immediate risks, such as obstructing ship propellers and causing collisions with floating or partially submerged objects like plastic containers (Frey & DeVogelaere, 2014). The US Coast Guard attributed 269 maritime accidents in 2005 to submerged debris, which caused 15 deaths and 116 injuries. Between 1996 and 1998, 9% of South Korea's maritime accidents were caused by floating marine debris (Letcher & Vallero, 2019). The most devastating of these accidents occurred when a fishing rope got tangled in a ship's propellers, causing it to capsize and resulting in 292 deaths (UNEP, 2016b).

2.4.4 Aesthetic value

Marine debris can harm people's quality of life by reducing their enjoyment of the environment (Cheshire et al. 2010). This could be due to the deterioration of the visual appeal of the beach, which could affect how people use and enjoy it. The damage to the aesthetics of the marine environment could also affect the ability of people to derive inspiration from it, which is vital for creative expressions such as literature, paintings, and movies (Naturvrdsverket, 2013). The presence of marine litter in beautiful rivers and shorelines diminishes their aesthetic beauty and enjoyment, negatively impacts tourism, and spoils the overall appeal of these places (Rockefeller, 2013). Coastal pollution's social consequences result in a decrease in the quality of life for individuals, who experience a decrease in recreational opportunities, aesthetic value, and non-use value (Cheshire et al., 2010; Mouat et al., 2010).

2.4.5 Recreation and Tourism

Numerous leisure activities occur along beaches, coastlines, and seas, including swimming, diving, boating, recreational fishing, and water sports. Extensive research by Ballance et al., 2014 and Sheavly (2010) has demonstrated that marine debris can significantly deter individuals engaged in recreational activities from visiting polluted areas. When choosing a travel destination, cleanliness is the foremost consideration for beachgoers, as indicated by studies conducted by Ballance et al., 2014 and ENCAMS (2017). The accumulation of marine litter not only diminishes the visual appeal of a beach but also raises concerns about health and safety, discouraging other recreational users like sailors and divers (Sheavly, 2012; Cheshire et al., 2010).

Discarded fishing gear, which encompasses nets, ropes, and lines, constitutes marine debris that poses a hazard to divers, swimmers, wildlife, and boats (Cheshire et al., 2010). The entanglement caused by such debris can be particularly dangerous due to poor visibility and the marine organisms on the objects, making it challenging for individuals to extricate themselves or seek assistance. An incident in January 2009 exemplifies this issue: an experienced diver, along with a seal pup, became entangled in fishing net measuring 50 meters in length and at least 2 meters in height in Plymouth Sound, located off the southern coast of England. Notably, fishing nets were prohibited in that area, indicating that the net may have traveled a considerable distance, as highlighted (Holt, 2011).

In 2012, Hammer et al. conducted research that revealed recreational beachgoers experience a higher frequency of exposure to plastic and suffer various negative impacts on their well-being. It is widely known that tourists tend to avoid littered areas on the coast or spend less time in these habitats due to their dislike of trash (Hammer et al., 2012; Ballance et al., 2014; Tudor & Williams, 2016; WHO, 2013). Individuals who engage in recreational activities, particularly swimmers, snorkelers, and SCUBA divers, face a potential danger of becoming entangled in debris floating on the water's surface or submerged beneath it, such as fishing nets or ropes. According to a report from the British Sub-Aqua Club, accidents resulting from entanglement, often caused by monofilament netting, occur approximately once or twice a year in the UK and can have fatal consequences (Mouat et al., 2010).

Tourists and marine workers face various types of accidents, such as cuts from sharp plastic debris, getting entangled in nets, and coming into contact with unhygienic objects, in addition to the risks mentioned earlier (Santos et al., 2015). Additionally, research by Wyles et al. 2016 found that being in coastal areas littered with debris can impact an individual's mental well-being and emotional state. Removing plastic bottles from popular tourist destinations could increase tourism and recreational activity by 33% and 29%, respectively, as discovered by researchers (Qiang et al., 2020).

Plastic pollution can lead to shorter stays for visitors in certain locations and can also cause marine contamination (Qiang et al., 2020). A recent study in South Africa found that an overwhelming 97% of beachgoers and tourists would avoid beaches with 10 or more large pieces of litter per meter. In addition, 85% of both visitors and locals said they would detour beaches with more than two pieces of debris per meter (Krelling et al. 2017). Moreover, beach litter creates aesthetic concerns that diminish the economic benefits derived from tourism and recreational activities (Patterson et al., 2020).

2.5 Economic effects

In recent times, the issue of plastic pollution in coastal regions has emerged as a significant environmental concern. Despite being extensively studied for its environmental effects, the economic consequences of this problem have not been given much attention. The economic impact of plastic pollution is far-reaching and affects various sectors such as commercial fishing, tourism, shipping, public health, and waste management. The prevalence of plastic debris in coastal areas and ocean basins has a direct impact on industries such as aquaculture, commercial fishing, and tourism, leading to increased expenses for waste management. Additionally, the affected nation's economy may suffer due to the need for additional funds to tackle this problem. The economic impacts of coastal plastic pollution include the following.

2.5.1 Losses to Fisheries

The oceanic environment plays a vital role in various economic endeavors, including fishing, commercial shipping, and tourism, and holds immense significance for communities globally. In the United Kingdom, for instance, it was approximated that the marine environment made a substantial contribution of approximately £38.9 billion (equivalent to nearly 5% of GDP) to the country's economy in 2009, (Pugh & Skinner 2012). However, marine debris can diminish the economic advantages of marine and coastal activities or increase costs related to such endeavors.

Assessing the overall economic cost associated with marine litter presents significant challenges, primarily due to the wide range of impacts it generates. Some consequences are more easily assessable in monetary terms compared to others. For example, quantifying the direct economic effects of cleaning up litter is relatively straightforward, whereas evaluating the economic impacts of environmental degradation or reduced quality of life is more complex.

Furthermore, estimating the financial implications of marine litter becomes more complicated due to the diverse methods available for assessing the value of the environment and the effects of human activities. To tackle this complexity, several techniques have been developed to estimate the economic value of ecosystem products and services, considering both tangible and intangible outcomes. Nevertheless, despite these efforts, the significance of marine debris is still overlooked or underestimated. (Ten et al., 2018)

Moreover, the fisheries sector is experiencing a substantial detrimental effect due to microplastics. Smaller organisms positioned at the lower tiers of the food chain unintentionally ingest microplastics alongside their regular food, as highlighted by Wright et al., 2013. Consequently, these microplastics have the potential to accumulate in the bodies of larger animals, such as fish, resulting in the buildup of harmful chemicals. This has serious consequences for both the capture-fishing and aquaculture industries. The financial loss resulting from decreased demand for contaminated fish supplies is a major concern.

Al-Masroori et al. (2020) drew attention to the adverse economic impact of ghost trap fishing, which refers to the unintended capture of fish through abandoned or lost fishing equipment (ALDF), on the commercial fishing industry. Ghost fishing significantly reduces fish stocks that are valuable for both commercial and recreational fishing. (Anderson & Alford, 2013). Recent studies have reported the estimated costs of ghost fishing for three and six months to be US$ 145 and US$ 168, respectively. (Al-Masroori et al., 2020)

The fishing industry is directly and adversely affected by plastic debris in the sea. Improper disposal of fishing lines, rope, and plastic bags can result in them becoming entangled around boat propellers, causing damage or even penetrating boat engines (UNEP, 2010). This has significant implications for marine fisheries, including financial losses from discarded catches; costs associated with repairing fishing gear and nets, overall costs due to pollution incidents, and reduced revenue due to the time spent removing litter from nets (Mouat et al., 2010). In addition, the fishing industry suffers significant financial losses due to the time and money spent on debris disposal and equipment maintenance (Mouat et al., 2010). Iñiguez et al. (2016) confirmed that repairing damaged fishing boats and aquaculture systems is a direct economic impact of plastic debris obstructing cooling systems or getting caught in propellers.

Toxic plastics in ocean basins and coastal areas directly affect the commercial fishing industry, aquaculture, and tourism (Mcllgorm et al., 2011). In Scotland, the necessity to remove debris, including plastic like fishing gear and PVC pipes, results in a loss of fishing time and increased cleaning costs (Ten et al., 2018). Ghost trapping fishing, which refers to the accidental capture of fish by abandoned or lost fishing equipment, is a negative consequence observed in the commercial fisheries industry (Al-Masroori et al., 2020). This form of fishing has been found to significantly deplete fish stocks, which are essential for both commercial and recreational fishing, according to Anderson & Alford (2013).

2.5.2 Losses to Tourism

Marine debris could discourage tourists due to its unappealing and potentially hazardous nature. This could result in a decrease in tourist spending and negatively impact coastal economies. When choosing a beach destination, cleanliness is a factor most tourists consider. However, it is difficult to accurately measure how much marine litter impacts tourist spending because we are uncertain about the specific point at which tourists decide not to visit a destination or spend less money due to the presence of marine litter. This uncertainty makes it challenging to determine the precise extent of the impact of marine debris on tourist spending. (Ballance et al., 2014; ENCAMS, 2017).

According to a study conducted in South Africa, a decrease in beach cleanliness standards can result in a 52% decline in tourism revenue. The research found that 85% of beachgoers would avoid visiting a beach with two or more large debris items per meter, while 97% would avoid a beach with ten or more such items per meter. The study also identified litter densities ranging from 2 to 10 large items per meter that deterred tourists. Interestingly, only 44% of survey respondents considered the beach they were on to be "clean," indicating a significant gap between people's aspirations and their actual behavior. (Ballance et al., 2014)

Swedish research indicates that marine litter causes a decline in tourism of 1 to 5%, which results in a loss of revenue amounting to £15 million and 150 person-years of employment (Ten et al., 2018). Additionally, in rare cases, marine debris led to the closure of beaches, for instance, in New Jersey and New York in 1988. This closure can lead to a loss in tourist and other earnings, ranging from $379 million to $3.6 billion for the local economy. (Ballance et al 2014; ENCAMS 2017)

2.5.3 Costs to shipping

Marine litter results in increased costs for shipping due to vessel damage, downtime, litter removal and management in harbours and marinas, and emergency rescue operations (Ten et al., 2018; UNEP, 2010; Macfadyen et al., 2011). The most common problem faced by vessel operators is entangled propellers and rudders, which can lead to significant vessel damage, expensive repairs, staff downtime, and crew safety concerns (Gilman et al.

2022). The problem affects both commercial shipping and pleasure craft, but most incidents go unreported, making it difficult to fully understand the extent of the issue (Sheavly, 2012).

Harbours and marinas need to spend more money to manage marine debris to maintain safety and user-friendliness. They may need to perform extra dredging and remove floating debris to keep the seabed clear. The removal of debris from UK harbours could amount to £15,000 annually, with up to four physical cleanings of the harbour required each week. During a study, 82% of harbours reported incidents of propellers becoming fouled, which is the responsibility of ship owners to address. The same study obtained anecdotal information from marinas, some of which require daily manual cleaning that could cost up to £10,000 per year. (Pendleton, et al., 2012)

Emergency rescues of vessels damaged by marine litter can be expensive, with the majority of these operations resulting from entangled or fouled propellers. A 1998 study found that in UK waters, there were 230 rescues of ships with clogged propellers, costing £2,200 to £5,800 per occurrence, depending on the type of lifeboat used. This resulted in a total expense of £506,000 to £1,334,000 for that year (Gilman et al. 2022). In the US, there were 269 rescues involving marine litter, which resulted in 15 fatalities, 116 injuries, and $3 million in property damages (Moore, 2020).

2.5.4 Cost of cleaning litter

In Scotland, getting rid of debris, such as fishing gear and PVC pipes, leads to a decrease in fishing time and an increase in cleaning expenses (Ten et al., 2018). To maintain the attractiveness and safety of beaches for potential users, marine debris needs to be removed, which typically incurs high cleaning costs (Ten et al., 2018). Local governments are responsible for most beach cleanups, but community organizations and landowners can also organize their initiatives (Gilman et al. 2022). Other expenses, such as contract management, program administration, and volunteer time (Macfadyen et al., 2011) as well as the cost of collecting, transporting, and disposing of litter (OSPAR, 2010), may also arise. However, due to a lack of reporting methods, the use of volunteer labour, and the absence of a defined approach specifying what qualifies as a cost, it is difficult to measure and compare litter cleaning expenses.

There has been a lack of research conducted to estimate the expenses associated with removing marine debris, leading to predictions based mainly on anecdotal evidence. Gilman et al., (2022) found that 56 local authorities in the UK spent £2,197,138 each year on beach cleaning, taking into account the cost of collection, transport, disposal fees, labour, equipment, and administration. More recent estimates suggest that all UK local governments combined are likely to spend around £14 million annually on marine debris clearance (OSPAR, 2010).

In 2006, it took approximately 100 individuals four months to clean up the Swedish Skagerrak shore for 15 million SEK (approximately €1.5 million), and only about 30% of the marine litter was removed during this effort, according to prior research in the area (OSPAR, 2010). Additionally, a study conducted in Poland indicated that cleaning up marine debris from the coastlines of 5 municipalities and 2 ports cost €570,000 (Naturvrdsverket, 2013).

There are numerous volunteer beach clean-up initiatives, including the International Coastal Clean-up, organized by the Ocean Conservancy, Coastwatch in the Netherlands, and Beachwatch, which typically have multiple goals, such as cleaning up litter, monitoring the amount and types of litter, and raising awareness of marine debris problems. Local community organizations also often arrange their beach clean-ups, such as the Voar Redd Up event held annually in the Shetland Islands, UK, which is well-regarded and often done in collaboration with local authorities. Despite the considerable volunteer effort devoted to cleaning up marine debris, estimating the costs can be challenging, particularly regarding volunteer time (OSPAR, 2010). Local governments and non-profit organizations now pay for the clearance of marine debris, indicating that the polluter does not bear the cost (Ten et al., 2018).

2.5.5 Control and Eradication of invasive non-native Species

Moore (2020) and Gregory (2012) suggest that one way invasive species can spread is by occupying marine debris. It is believed that marine debris has increased the likelihood of marine organisms moving to latitudes higher than 50° by more than three times and doubled the chances at tropical latitudes. However, it is challenging to establish a direct link between the presence of non-native species and marine debris (Allsopp et al., 2016). Gregory (2012) agrees that introducing invasive non-native species can have significant economic costs and negatively impact the environment.

The discovery of invasive species leads to a significant increase in the expenses related to monitoring, controlling, and eradicating them. Moreover, their presence can cause additional harm, such as the contamination of equipment and ships, the reduction of ecological functions, the decline of recreational value, and negative impacts on human health. Invasive species have the potential to destroy ecosystems in a short period and can also lead to the collapse of industries that rely on the ecosystem. For example, the introduction of American comb jellyfish into the Black Sea in the 1990s is widely recognized to have caused the collapse of anchovy fisheries, resulting in a financial loss of €240 million (Naturvrdsverket, 2013).

The appearance of the Carpet sea squirt (Didemnum vexillum) in Holyhead Harbour, Wales in 2009 highlights the expenses involved in controlling and eliminating invasive species. The Carpet sea squirt is a threat because it can smother organisms and marine habitats, and it has no natural predators. Although it is unclear how the Carpet sea squirt arrived in Holyhead Harbour, it is estimated that a monitoring and eradication program for the next decade will cost around £525,000. However, if left unmanaged, the mussel fisheries in the vicinity alone could incur costs of up to £6,875,625 during the same period. Moreover, the expenses could be considerably higher if the Carpet sea squirt established itself elsewhere in UK waters (Holt, 2011).

Furthermore, the presence of marine debris could play a crucial part in the propagation of non-indigenous species. CIESM (2014) has identified that the rise of plastic debris and the proliferation of algae may have harmful consequences. These algae have the potential to grow excessively causing hazardous algal blooms that can harm the environment and lead to a decrease in income from fishing and tourism. Moreover, it damages the habitats where the seafood is bred and raised, diminishes fragile underwater ecosystems such as coral reefs, and results in a substantial reduction in the amount of fish caught for commercial purposes (GEF, 2012).

2.5.6 Losses to Aquaculture

Aquaculture producers may suffer financial setbacks due to marine debris, which can cause harm to equipment and vessels, necessitate debris removal, and result in staff downtime (UNEP 2010). The most common issues encountered by aquaculture operators are entangled propellers and clogged intake pipes, which can lead to costly repairs and lost productivity. While limited research has been conducted on this subject, Gilman et al., (2022) found that removing debris could take up to an hour each month, and repairing fouled propellers could cost as much as £1,200 per incident.

2.5.7 Costs to coastal agriculture

The agricultural industry may face various hazards and financial burdens due to marine litter, which can include negative effects on livestock, time-consuming cleanup efforts, damage to property and equipment, and an increase in veterinary expenses (Hammer et al 2012). However, there is a dearth of research examining the magnitude and significance of these consequences. A study of farming practices in Shetland revealed that 96% of farmers who participated in the survey experienced issues with litter invading their fields, which may have resulted in annual expenses of up to £400 (Gilman et al. 2022).

If plastic pollution harms marine biodiversity and affects the safety and availability of seafood, it could ultimately have a global economic impact, especially in impoverished nations or islands where fish is a crucial source of food. Countries such as Bangladesh, Cambodia, Ghana, Indonesia, Sierra Leone, and Sri Lanka rely on fish for more than 50% of their animal protein intake, and their economies could be immediately affected by the depletion of fisheries caused by plastic pollution. This could lead to socio-economic and health problems, as reported by McKinley and Johnston (2010), Nerland et al., (2014), and FAO (2016).

2.6 Conceptual Framework

This conceptual framework was adapted from Reinhard et al. (2012) which explored the potential impacts of marine litter. Their study looked at coastal pollution in general and its effects. This study builds upon their framework to examine the socio-economic effects of plastic pollution specifically on fishermen and their coping mechanisms.

The framework of this study provides a comprehensive understanding of this study's concept. The research examines how plastic pollution affects the socio-economic aspects of the lives of fishermen. Plastic litter is generated through various socio-economic activities, with the primary sources of pollution being land-based (such as littering by beachgoers, illegal dumping, and waste from eateries) and sea-based (including fishing activities, industrial activities, rain, and longshore drift). These factors collectively contribute to coastal plastic pollution, which in turn adversely affects the social and economic well-being of fishermen. The study recognizes that the more their economic life is impacted, the greater the impact on their social life.

The coping mechanisms employed by fishermen are strategies that help them endure the challenges posed by plastic pollution. These mechanisms aim to sustain their livelihoods in the face of this persistent environmental problem. The details are shown in Figure 1.

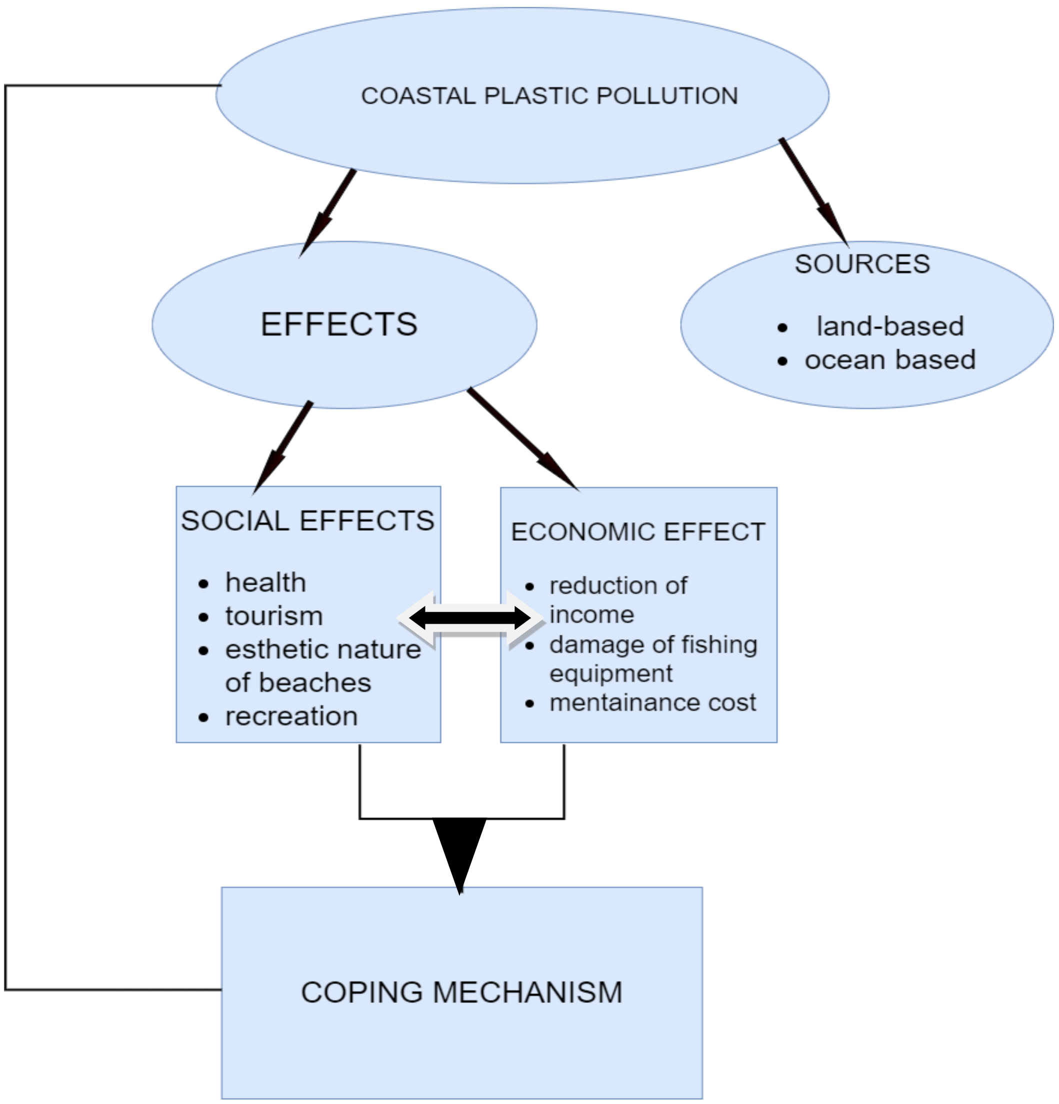


Figure 1: Conceptual framework socio-economic effects of coastal plastic pollution on fishermen
Source: Adapted from (Reinhard et al., 2012)

2.7 Theoretical review

2.7.1 The common pool resource theory

According to Garret Hardin's theory (1968), a common pool resource, or "commons," refers to any natural resource, such as water or pasture that offers tangible benefits to users but lacks exclusive ownership. A significant issue with common resources is overuse, particularly when there are insufficient social-management systems to safeguard them. Overuse often results in economic problems, exemplified by the "tragedy of the commons."

This phenomenon occurs when individuals, driven by self-interest, overconsume a resource, ultimately depleting it and negatively affecting the entire community. Hardin's theory is demonstrated through the example of herdsmen using pasture to feed their animals, where each herdsman adds a new animal without considering the overall impact on the pasture, ultimately leading to its destruction. The tragedy of the commons leads to over-consumption, under-investment, and resource depletion, as individuals prioritize personal gain over societal well-being. Feeny et al. (1990) explain the concept of the Tragedy of the commons and Latta (2002) acknowledges its relevance to the issue of unchecked population growth.

This study adapted this theory since plastic pollution has led to the reemergence of the Tragedy of the common looking at its effects on fishermen. Plastic pollution comes as a result of population growth and socio-economic activities. Pollution involves not taking anything from the commons but introducing new substances into it, such as chemicals, sewage, heat waste, radioactive water, toxic fumes, and unsightly advertising signs. This pattern is also evident in the degradation of other common resources, including forests, fisheries, water supplies, grasslands, and the atmosphere (Garret, 1968; Adhikari, 2001). However, this study focuses on the ocean as a common. As a result, rational individuals realize that the cost of purifying their waste before releasing it is greater than their share of the expense of the waste they discharge into the commons. Consequently, by behaving as independent, rational, free-enterprisers, they are stuck in a cycle of polluting the environment (Garret, 1968).

Alternatively, another school of thought suggests that the Tragedy of the commons theory occurs only when resources are openly accessible without property rights for community members. Cousins, (1993) differentiate between open-access land and common property. In a common property system, no individual has sole control over the use of the resource, and the group expects future access. Moreover, active membership requirements, methods of enforcing deviant behavior, and established guidelines for resource use are in place.

The concept of an open-access property system implies the absence of social structures required to acknowledge and protect the entitlements of individuals or groups to exploit a resource, and each user of such a resource ignores the impact of their conduct on others (Cousins, 1993). This viewpoint suggests that tragedies arise when the entity responsible for the property, be it a community or an organization, is unable to enforce internal rules and regulations that govern the communal utilization of common resources to regulate access to them (Adhikari, 2001).

Plastic has a wide range of applications worldwide, but its proliferation in oceans can be attributed to insufficient enforcement of regulations and policies, as well as incorrect disposal practices and insufficient recycling facilities. Data indicates that plastic debris is consistently the most prevalent form of marine debris (STAP, 2011). Given that the oceans represent 72% of the planet's surface and the majority of the air we breathe originates from them, the well-being of the oceans is directly linked to human health (Gillam & Charles, 2018).

Once again, the oceans are not confined by man-made boundaries such as the exclusive economic zones (an area where sovereign states have jurisdiction over resources), so any mistreatment on one side can have disastrous consequences for the entirety of the world's oceans. The biodiversity of aquatic environments has significantly decreased due to various human activities, such as overfishing, the disposal of biodegradable and non-biodegradable waste, oil extraction, land reclamation, dredging, and climate change (Derraik, 2009). One particularly alarming example of human impact is the pollution of water by synthetic materials like plastic debris, which poses a serious threat to humans, especially fishermen.

2. 7.2 Ecological Theory of Change and Development

The study also used the Ecological Theory of Change and Development, which is nested in the work of Wilkinson and Boulding (1973). The theory centers on the challenges of development and change in contemporary societies, specifically concerning environmental shifts and their impacts on population growth, and the need to develop effective strategies for addressing development issues.

Based on the concept, when a community's size increases, each individual in the community faces greater competition for scarce resources like land and other natural resources, which they require to sustain themselves (Ocheri, 2013). As a result, they participate in economic activities that harm the environment and society and add to pollution, either directly or indirectly. These scholars classify socio-economic activities as comprising both the commercial and industrial activities of people residing in urbanized industrial societies, as well as the subsistence farming activities of those in agrarian cultures.

According to the notion, when a society surpasses its resources and the production system, progress becomes necessary. The concept suggests that civilizations are obligated to modify their practices when the current economic system of a specific society or environment is ineffective and troublesome (Ocheri, 2013). For example, when a society's population outstrips its resources, particularly in agrarian societies, people are compelled to migrate to urban areas or cities in search of employment opportunities. Some individuals sell their labour, while others invest in commercial and agricultural activities such as buying cattle. Others also establish and operate technological and entrepreneurial firms to survive. However, the establishment and operation of industrial activities by urban and city residents contribute to environmental pollution. Wilkinson and Boulding (1973) concluded that these activities directly or indirectly pollute the environment, which harms biodiversity.

The theory presented in this study holds significant importance as it elucidates the ongoing pollution of coastal areas with plastics, primarily driven by socio-economic activities and illegal dumping. By outlining the connection between the polluted environment and its subsequent impact on the socio-economic well-being of fishermen, the theory provides a valuable framework for understanding the complex dynamics at play. It underscores the interdependence between environmental degradation and the livelihoods of fishermen, highlighting the detrimental effects of plastic pollution on their social and economic conditions.

CHAPTER THREE

METHODOLOGY

This chapter provides detailed explanation of the study area such as the location, climate, vegetation, soil, population, settlement patterns, and economic activities of these communities. Secondly, the chapter outlines the steps and procedures for data collection and analysis. It includes a discussion on the philosophical foundations of the research methodologies employed. Key topics covered are research philosophy, research design, study population, sample and sampling processes, data collection techniques, research instruments, fieldwork, ethical considerations, and data analysis. The chapter also provides a comprehensive explanation of the research methods in relation to the study topic.

3.1 Study Area

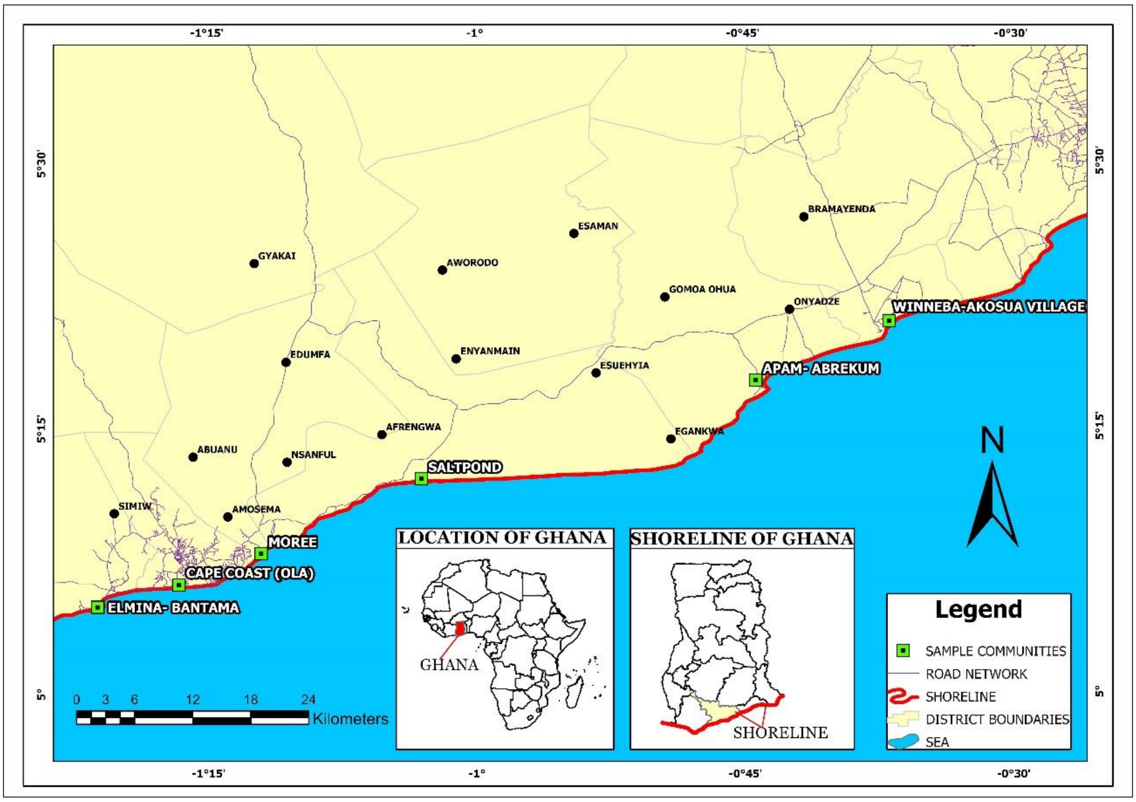


Figure 2: Selected communities along the coastline of central region, Ghana
Source: UCC Geography Department

3.1.1 Location

The Central Region of Ghana can be roughly divided into two distinct parts: the coast characterized by undulating plains with occasional hills and cliffs, sandy beaches, and marshland, and the hinterland where the landscape gradually rises to an elevation of 250m to 300m above sea level. This area spans both the wet semi-equatorial zone and the dry equatorial zone.

3.1.2 Climate

The annual rainfall in the communities within the region varies, ranging from approximately 2000 mm in the inland areas to 1000 mm closer to the coast. The wettest periods occur from May through June and September through October, while December through February and a brief period in August are the driest months. The average monthly temperature ranges from around 30° C during the warmer months to 24° C in the coldest month, August, specifically in March and April (GSS, 2021). Despite the region experiencing high temperatures and humidity, factors such as decreased rainfall anomalies, ranging between 700 and 1000mm annually, were observed. These anomalies can be attributed to the moist southwest monsoon winds that blow nearly parallel to the coastline. The absence of mountains to direct these moist winds upward, where they would typically condense into rain, contributes to the reduced rainfall. Additionally, the upwelling of the cold Benguela current along this shoreline is believed to bring fog instead of rain. The fluctuation of rainfall has a greater influence on the climate variability in the region than temperature (Anim & Nyarko, 2017).

3.1.3 Soil

Lateritic soils predominated and are mostly composed of worn granite and schist. Sand deposits are common in valleys and marshy places, and the local rainfall pattern has an impact on the vegetation (Anim & Nyarko, 2017).

3.1.4 Vegetation

The pattern of rainfall in the region has an impact on the vegetation. It mainly consists of dense shrubs, transitioning into coastal savannah grasslands with poor drainage and scattered trees. In marshy areas, mangroves dominate the vegetation, typically found in protected locations such as behind bars, lagoons, and estuaries, and rarely in areas where high tides could reach (Anim & Nyarko, 2017). Coastal Savannah grassland and few trees are found along the shore, while semi-deciduous forests dominate the inland regions. However, extensive agricultural clearing, charcoal burning, bushfires, and other human activities have displaced the initial dense vegetation (Anim & Nyarko, 2017). There are fewer trees in the region than in the interior forested areas, except for occasional acacia plantations and bamboo shrubs found in a few preserved sites that have not yet been deforested (Anim & Nyarko, 2017).

3.1.5 Population, Settlement, and Economic Activities

In Ghana, particularly by the Fante ethnic group, the coastline (coastal zone) of the study region has been one of the areas where people have settled. For instance, the coastal region makes up 6.5% of Ghana's total surface area, and about 25% of the country's people live there (Hillmann & Ziegelmayer, 2016). The economic activities are farming, fishing, manufacturing, salt mining, charcoal burning, and other commercial pursuits are among them, as are more recent sources of economic growth like historical and ecological tourism (GSS 2021). The common fish in the central region include small pelagics (Sardinella), billfish, burrito (Galeoides decadactylus), threadfin (Brachydeuterus auritus), anchovy (Engraulis encrasicolus), Atlantic small tuna (Euthynnus alleratus), scad mackerel (Caranx rhoncus), chub mackerel (Scomber colias and Scomber japonicus), and frigate mackerel (Auxis thazard) according to the Coastal Resource Center report (2021). Tuesday is the central region's fishing holiday. Additionally, the region has gotten an excessive amount of economic growth and population redistribution (Fuseini, & Kemp, 2015).

A critical examination of the coastline is now necessary due to the expansion of the local tourism business. This is because, while tourism on the one hand fosters development and opens up employment opportunities, it also puts pressure on development, which causes pollution with high prevalence on plastics in the sea and on the beaches (Coastal Resource Center 2021).

Six communities were purposively selected based on these criteria: prevalence of plastics on the beaches, the practice of beach seine fishing (Tweewui), and beaches that are not landfills. The communities selected for the study were Akosua Village in Winneba, Abrekum in Apam, Saltpond, Moree, Ola in Cape Coast, and Bantoma-Anwona in Elmina.

3.2 Philosophical Paradigm

Pragmatic philosophy guided this study. According to pragmatism, real effects or practical repercussions are essential components of both meaning and truth. According to pragmatism, each concept's meaning may be equated with the potential operational or practical effect of whatever it symbolize (Shannon-Baker, 2016). According to pragmatics, reality and people work together to create truth; the truth is not something that is "ready-made." According to Frels, & Onwuegbuzie (2011), pragmatism opposes the idea of ultimate dualism, such as objectivism or rationalism verse empiricism, and instead favors a more reasonable and practical interpretation of philosophical dualisms. It encourages fallibilism and considers the nature of truth to be relative, ever-evolving, and contingent (Mertens, 2012). The goal of research inquiry, according to pragmatists, is merely to find solutions to problems since research results can never be seen as flawless and absolute.

In deciding on their research framework, proponents of pragmatism start with the research question. According to Freshwater and Cahill (2013), pragmatists see research philosophy as a continuum rather than an alternative that takes up opposing ends of the spectrum. They think that subjectivity and objective viewpoints may coexist. Therefore, it is appropriate to approach and comprehend social phenomena using a combination of ontology, epistemology, and axiology.

Pragmatists like dealing with both quantitative and qualitative data, according to Neuman (2011), since it helps them better grasp social reality. Mertens (2012) asserts that although positivism and interpretivism use different methodologies and discourses for knowledge construction, there is room for both viewpoints to be combined to balance out any potential weaknesses in each perspective. This is the main thrust of the argument made by proponents of pragmatism. Combining research methodologies is seen by pragmatics as adopting a pragmatic mindset (Creswell, 2012) based on the idea that the researcher must employ all available tools and procedures to fully address complicated research topics (Freshwater and Cahill, 2013).

The study adopted the pragmatic research paradigm to direct the techniques of data collection, analysis, and interpretation concerning the research questions, per the descriptions of the tenets of the various research paradigms. According to Creswell (2013), pragmatism research prefers dealing with both quantitative and qualitative data since it helps them better comprehend social reality. A mixed method is necessary to address the study's main subject since, in the researcher's opinion, understanding the socio-economic consequences of plastics on fishermen are a complicated and comprehensive issue.

3.3 Research design

According to Creswell (2012), research design encompasses determining the necessary data, selecting appropriate methods for data collection and analysis, and ensuring that the entire process effectively addresses the research question. Its purpose is to structure data and methods in research projects to identify research problems and ensure that the evidence obtained allows the researcher to logically and unambiguously address the research problem (Bryman, 2012). Aning-Agyei (2018) argues that societal problems are intricate and multifaceted, thus necessitating the use of a mixed methods design to adequately tackle such issues. The decision to adopt a mixed methods design was influenced by the research objectives.

The research employed a concurrent triangulation mixed-method design, utilizing both quantitative and qualitative techniques simultaneously to validate and corroborate findings within the same study. With the concurrent triangulation mixed-method design, the study combines both quantitative and qualitative research techniques, methods, approaches, and concepts into a single study (Johnson & Onwuegbuzie, 2015). Hence in this kind of study design, quantitative and qualitative data on the research problem are collected and analyzed separately yet simultaneously. Triangulation as used in this research involves the use of multiple methods and instruments to collect data to strengthen the interpretation and conclusions that was drawn from this research (Teye, 2012; Bryman, 2012).

Mixed-method approach is recognized for providing a more comprehensive and compelling comprehension of the research problem than the traditional use of quantitative and qualitative methods in isolation. With the mixed-method approach, one complements the other as each maximizes strength and minimizes the limitations of the other (Babbie, 2010). This study aims to add to the global body of research on plastic marine debris and its impact on the socio-economic well-being of fishermen. To gain a more thorough understanding of the fishing industry, it is recommended to employ a mixed-method approach rather than solely relying on either qualitative or quantitative methods.

3.4 Types and Sources of Data

The study used primary data. The sources of the primary data were: the collection of beach litter, segregation of litter, counting of litter, and the weighing of plastics mixed with fish catch and those on the beaches, and assessing their socio-economic effects through questionnaires, interviews, and field observation. In addition, secondary data form the Geographic Information System (GIS) from the department of Geography and Regional planning, UCC and vast array of information from various institutional libraries, journals and scholarly articles on the phenomena under study were used.

3.5 Population

The target population for the study was fishermen especially those who use the beach seine fishing method (Tweewui) in the six selected communities with at least five years of working experience. The study was interested in fishermen because they experience the direct effects of coastal plastic pollution. Chief fishermen and the queen of fishmongers in the areas served as key informants. The entire population of fishermen in the six communities was 1558 (Coastal Resource Center 2021).

3.6 Sample size

Proportional sampling is a technique for selecting participants in a study when the population is made up of multiple subgroups that differ significantly in size. The number of participants from each subgroup is determined in proportion to their representation in the overall population (Kuranchie, 2016). The population of the fishers in the various communities differs. Elmina (Batoma-Awona)- (494), Saltpond - (109), Moree - (155), Cape Caost (Ola)- (256), Winneba (Akosua Village)- (380), Apam (Abrekum)- (164), (Coastal Resource Center, 2021). A simplified formula for proportions by Taro Yamane (1967) was used. A simplified formula for proportions Yamane (1967) provides a simplified formula to calculate sample sizes. The Yamane sample size states that, $n = N / (1 + N e^2)$.

3.6.1 Sample size calculation

A simplified formula for proportions Yamane (1967) provides a simplified formula to calculate sample sizes. The Yamane sample size states that, n = N /

$(1 + N e^2)$. At 95% confidence level and P = 0.05. Where n is the sample size, N is the population size, and e is the level of precision.

Target population (N): (the total population of fishermen in the 6 coastal communities) = (380+ +164+ 109+494+256+155) = 1558

N= 1558

Sample size (Yamane, 1967): $n = N / (1 + N e^2)$

$n = 1558 / (1+1558(0.05^2) = 280$

n= 280

The total sample size is 280

Therefore with a 0.05 sample error and a 95% confidence level, the sample size was 280. The specific details for each community are presented in Table 1 (refer to Appendix A for the detailed calculation).

Table 1: Sample size of the various communities

COMMUNITY	SAMPLE SIZE	PERCENTAGE (%)
Akosua Village	68	24
Moree	28	10
Ola	46	16
Abrekum	29	11
Bantam-Anwona	89	32
Saltpond	20	7
TOTAL	**280**	**100**

Source: Authors construct 2022

3.7 Sampling technique

The study area was clustered into six groups; Mfantsiman Municipal Assembly, Cape Coast Metropolitan Assembly, Abura- Asebu-Kwamankese District, Komenda-Edina-Eguafo-Abrem District, Efutu Municipal Assembly, and Gomoa West District. In cases where multiple fishing communities were meeting these criteria, a simple random (lottery) method was employed to select the communities for the study. The communities were purposively selected based on the occurrence and widespread of plastics on the beaches, where the beach seine fishing method (Tweewui) is practiced, and where the beach is not used as a landfill. Purposive and convenience sampling techniques were used to administer questionnaires and interview.

3.8 Data collection procedure and instrument

3.8.1 Observation

3.8.1.1 Beach litter survey

The study used observation, questionnaires, and interviews. The observation was done for one month (November 2022) in six communities (Figure 2; Ola, Bantoma -Anwona, Akosua village, Abrekum, Moree, and Saltpond) and every community was visited four times. The observation was done for two major purposes. Firstly it was done to monitor marine litter and secondly to check the quantity and weight of plastics found in fish catch and on the beaches. Gathering data on marine beach litter allows for the identification of the quantity, patterns, and origins of such debris. This information can be utilized to develop effective strategies for reducing marine litter and to assess the efficacy of current laws and regulations. The ultimate objective is to minimize the amount of litter that enters the marine environment.

Throughout the month, following the OSPAR (2010) guidelines for surveying marine litter on beaches, solid debris on the beaches was collected, counted, and recorded. The guide has two sections; part one is the OSPAR Marine Litter Beach Questionnaire which helps to get detailed information about the study area and the second part is the OSPAR Marine Litter Beach survey where the types of litter, codes, and quantity are recorded (refer to appendices C & D for the original form).

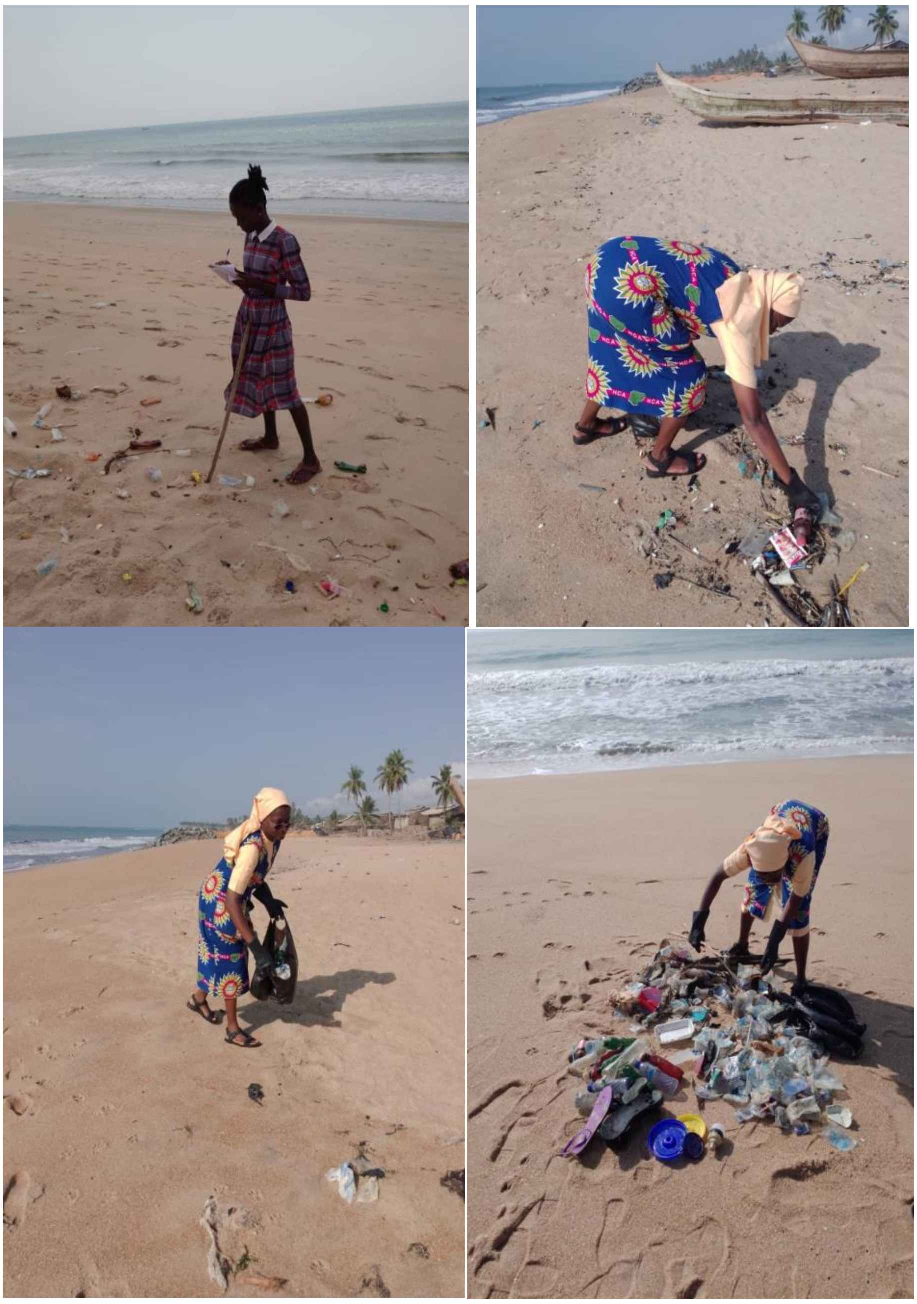
On each beach, a sample unit (a fixed section of beach covering the whole area between the water edges to the back of the beach) of 100m (horizontal) was measured from the end of the high tide along the oceanic coastline of the study area. A 5m-wide transect was delimitated from the highest high water line to the end of the backshore. The Global Positioning System (GPS) coordinates were taken for the starting and ending points to mark the sample unit for the study. The same marked area was visited throughout the study. In areas where due to network challenges it was impossible to get the GPS coordinates, the starting and ending points were marked with either vegetation, rock, or building (refer to Appendix C for the details of the surveyed areas of the study). All the litter were collected and stored in duly identified plastic bags. Only macro litter was collected. Sampling was done early in the morning to avoid possible direct interferences with municipal cleaning activities.

3.8.1.2 Identification of litter

As part of the study, litter was collected and categorized. The OSPAR litter identification codes were used when recording the nature of each litter item (OSPAR, 2010). The OSPAR identification codes describe the litter items and place them into thirteen litter types (plastic, rubber, cloth, medical, sanitary, etc.) Litter when sorted was classified according to its composition (plastic, metal, glass, wood, cloth, others) and type of object (*e.g.*, plastic bag, beverage cans, barbecue wooden sticks, plastic fragments, etc.). During the observation, photographs were taken, and whatever was observed, accumulated, and disposed of was recorded on the OSPAR marine litter monitoring survey form. This was done to check the distribution and accumulation level of plastics and their social and economic consequences. The instruments used were a ruler, measuring tape, datasheet, clipboard, hanging weighing scale, and hand gloves.

3.8.1.3 Quantity and weight measurement

The plastics mixed with fish catch were counted, weighed, and recorded throughout the study period to analyze their financial effects. A hanging scale was used to weigh the plastics and the counting was done manually. The plastics found on the beaches were also quantified and weighted. In cases where it was difficult to separate the plastics from other litter and weeds, photographs were taken to prove that. Below are pictures from the field showing the processes involved.



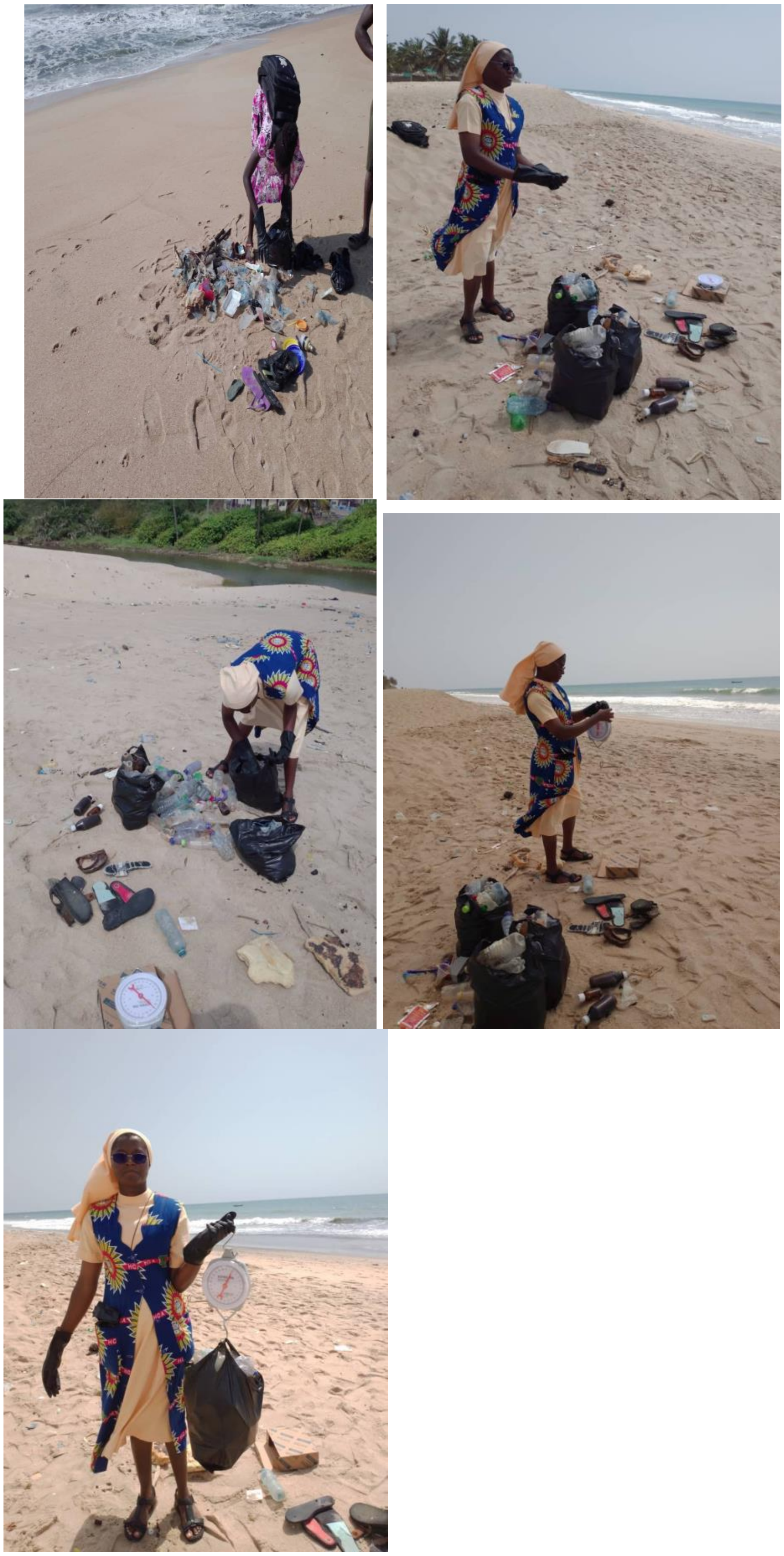


Plate 1: Procedure for data collection and fieldwork
Source: field survey, 2022

3.9 Questionnaire and Interview

3.9.1 Questionnaire

In this study, questionnaires with a combination of Likert scale and open-ended questions were used. The Likert scale used a five-point scale (Disagree - 1, Strongly Disagree – 2, Neutral-3, Agree -4, and Strongly Agree -5) to allow respondents to indicate their level of agreement or disagreement with specific statements or questions. This approach allowed participants to express the extent of their agreement or disagreement, providing a measure of the positive to negative strength of their responses to the given statements or questions. The questionnaire was self-constructed with the help of my supervisor.

The questionnaire was grouped into five sections. Section A examined the social demographic background of the respondent; such as their age and number of years in fishing to appreciate their level of experience and knowledge in fishing. Marital status and number of dependents were taken to know the people who relied on the respondent's income. The question on main occupation, other occupations, and level of education was to know if they have another source of income or work. Section B examines the awareness and causes of coastal plastic pollution, section C examines the social effects of coastal plastic pollution. Section D analyzes the economic consequences and section E examines how fishermen are coping with the menace of coastal plastic pollution and recommendations to curb the problems. The items in the questionnaires were based on the research questions and objectives of this study (refer to Appendix B for the questionnaire sample).

3.9.2 Reliability of the instrument

The reliability of the instrument was done using Cronbach's alpha value. Table 2 gives detailed results of the reliability test.

Table 2: Reliability of the instrument

	Cronbach's Alpha
Coastal Plastic Pollution	.793
Economic Effects	.818
Social Effects	.988

Source: Author's Construct from Field Data (2022)

Reliability refers to the consistency of results obtained from a measurement instrument across multiple applications (Hair et al., 2010). Various statistical methods can be used to assess the reliability of a study. In this research, the researcher utilized the Cronbach alpha value, which exceeded 0.70. The study's findings are presented in Table 2 and demonstrate that all the scales employed to measure the variables in this study surpassed the generally accepted standards. The Cronbach's Alpha coefficients for coastal plastic pollution, social effect, and economic effects were 0.793, 0.988, and 0.818, respectively. These findings suggest that the items utilized to measure the respective variables were highly dependable and consistent for analysis. In summary, the study's measures for all the variables formed a coherent structure for describing them.

3.9.3 Interview

A structured interview was done for chief fishermen and queen of fishmongers. The questions were in three sections. Section A on social effects, section B on economic effects, and section C on laws or mitigation factors. They were asked questions about the negative effects of coastal plastic pollution on their social and economic life. Their views were recorded and transcribed. These interviews were done to check for similarities or disparities in the responses of the fishermen from the questionnaire. These were designed by the researcher and approved by the supervisor. The items in the interviews were based on the research questions and objectives of this study (refer to Appendix B for the interview guide).

3.9.4 Data Analysis

The collected beach litter was segregated, coded according to the OSPAR format, counted, and tabulated. A descriptive analysis was conducted to assess the quantity and weight of plastics found on both the beaches and in the fish caught. The results were then expressed as percentages and presented in tables, maps, and charts. Spatial analysis was performed to elucidate the distribution of litter across various coastal communities. The plastics collected from the beaches were weighed, and those found in the fish were analyzed in relation to their economic and social implications.

The researcher manually analyzed the interview responses using Braun and Clarke's thematic analysis method. This method consists of six steps: 1) becoming familiar with the data, 2) generating codes, 3) generating themes, 4) reviewing themes, 5) defining and naming themes, and 6) locating exemplars (Braun & Clarke, 2019). The researcher first transcribed the audio recordings and read them over and over again to be familiarized with the data. Manually using colors to highlight, codes were created to contextualize segments. The several codes were sorted into higher–level topics to generate themes. These themes were put into tables with their subthemes. The themes were reviewed, and similar ones were merged and named into three major themes; social effects, economic effects, and recommendations to curb the menace. The report was made with examples to support the quantitative data in the discussion section.

The responses obtained from the questionnaire were coded in Excel and then imported into Statistical Product and Service Solution (SPSS) version 26. Various analyses were conducted, including descriptive, correlation, and simple linear regression analyses. The results were organized in tables, percentages, and charts. Frequencies and percentages were the primary descriptive measures utilized in the analysis.

Additionally, the researcher conducted a descriptive analysis of the demographic characteristics of the respondents and their coping mechanisms and presented the results in tables and pie charts as percentages respectively. The variables examined for their demographics included sex, age, education level, marital status, number of dependents, occupation, and source of funding, all of which were analyzed in terms of their impact on social and economic factors.

Before the regression analysis was done the data was transformed for the following variables coastal plastic pollution (CPP), social effects (SE), and economic effects (EE). The response of each fisherman was added and divided by the number of questions. Therefore the formula below

CPP = (CPP1+CPP2+CPP3+CPP4+CPP5 +CPP6+CP7+CPP8+CPP9+CPP10) /10

SE = (SE1+SE2+SE3+SE4+SE5+SE6+SE7+SE8) /8

EE = (EE1+EE2+EE3+EE4+EE5) / 5

The results from the above gave the total score of each respondent and the index. These were used to run the correlation (association) and regression (impact) of the study.

The correlation test was done as a prior test to ascertain the strength of the linkage between sampled variables before a regression test is performed. The correlation effect indicates the linear association between the variables. Correlation is a tool that indicates the direction and strength of the association between variables, without implying any causality. The purpose of this endeavor was to verify whether there was the possibility of association between the variables of coastal plastic pollution, social effects, and economic effects.

The study applies a simple linear regression model to examine the impact of coastal plastics pollution on the social and economic lives of fishermen in specific coastal areas in central Ghana. Simple linear regression is a modelling technique that involves a single independent variable (Abdulazeez et al., 2020). It is commonly used in mathematical research methods, allowing the measurement of predicted effects and their correlation with multiple input variables. This method of data analysis and modelling establishes linear relationships between dependent and independent variables (Lim, 2019). In simple linear regression, the equation $y = \beta 0 + \beta 1x + e$ represents the dependence of the variable, where y is the dependent variable, x is the independent variable, β0, and β1 are coefficients, e is the error term. Simple regression helps distinguish the influence of independent variables from the interaction of dependent variables (Acharya et al., 2019).

The model is based on several assumptions, including:

1. No serial correlation exists between the errors and independent variables.
2. The mean of the error term is zero.

3. The covariance of the error term is constant.
4. There is no perfect multicollinearity among the independent variables.
5. The covariance of the independent variables is zero.

The model is represented by two equations: Model (1): $Y = \beta0 + \beta1X + e$ Model (2): $Z = \beta0 + \beta1X + e$

In these equations:

- Y and Z represent the dependent variables.
- $\beta0$ represents the intercept.
- $\beta1 \ldots. \beta2$ represent the coefficients of regression.
- X1 … X2 represents the independent variables.
- “e’ represents the error term

In this context, "Y" represents the Social Effect (SE), and "Z" represents the Economic Effect (EE). The coefficients β0, β1, and β2 remain constant in the models. The independent variable, X, represents coastal plastic pollution (CPP), while "e" denotes the error term.

Model (1)………………SE = β0 + β1 CPP + e

Model (2)………………EE = β0 + β1 CPP + e

3.10 Ethical Considerations

The ethical standards for conducting fieldwork or primary data collection of the University of Cape Coast were respected as the researcher embarked on this study. The consent of the chief fishermen, queen of fishmongers, and fishermen were sought before administering the questionnaire and granting the interview. The purpose of the study (socio-economic effects of coastal plastic pollution) was elucidated to the respondents and participants. It was also made known to them that views and opinions were only for academic purposes.

Again, all responses given by the participants were held confidential and made anonymous. The respondents answered the questions of their free will with no coercion or payment.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter focuses on results and discussion. It is divided into two sections; the demographics of the respondents and objectives. The demographics are the respondents' background information including age, work experience, level of formal education, marital status, number of dependents, occupation, and source of funding. The main objective of this study was to investigate the socio-economic impact of coastal plastic pollution on fishermen.

4.1 Demographic Characteristics of Respondents

To achieve the objectives of this study, 280 fishermen were sampled. This section presents their demographic characteristics. Gathered background information included; Age, work experience, level of formal education, marital status, number of dependents, occupation, and source of funding. The details of the descriptive statistics of the respondents with background information are shown in pie charts and discussed below.

Respondents were aged between 21 and 40, with a majority in the 21-30 and 31-40 age groups, accounting for 94% of all respondents. This shows that the majority of them were in their youth. This means that fishing is a physically demanding activity that requires manual labour and therefore young and able-bodied males were preferred. Figure 3 gives the details.

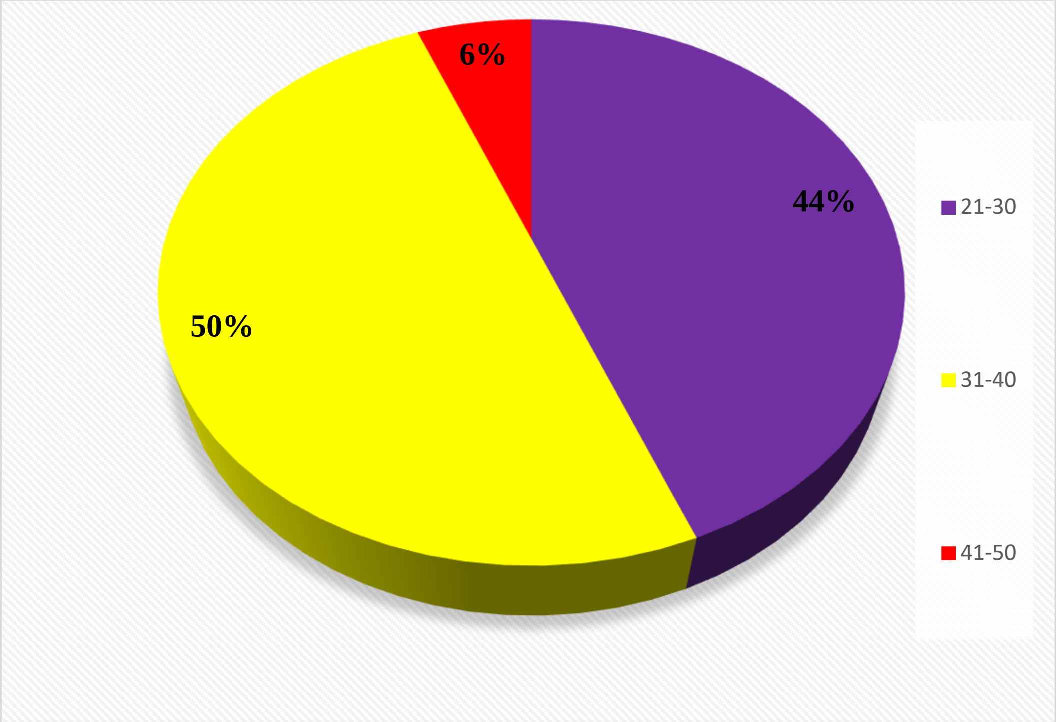


Figure 3: Age of respondents
Source field survey, 2022

Furthermore, as shown in Figure 4, the majority of respondents (67.9%) had received no formal education, while 25.7% had completed elementary school. A small proportion (5.4% and 1.1% respectively) had attended middle or high school but dropped out due to financial constraints or poor performance on standardized exams such as BECE and WASSCE. Therefore, based on the data provided, it can be concluded that people with minimal education make up a significant part of the fishing industry. This also has an impact on the education of children (under 18) who should be in school but are involved in fishing.

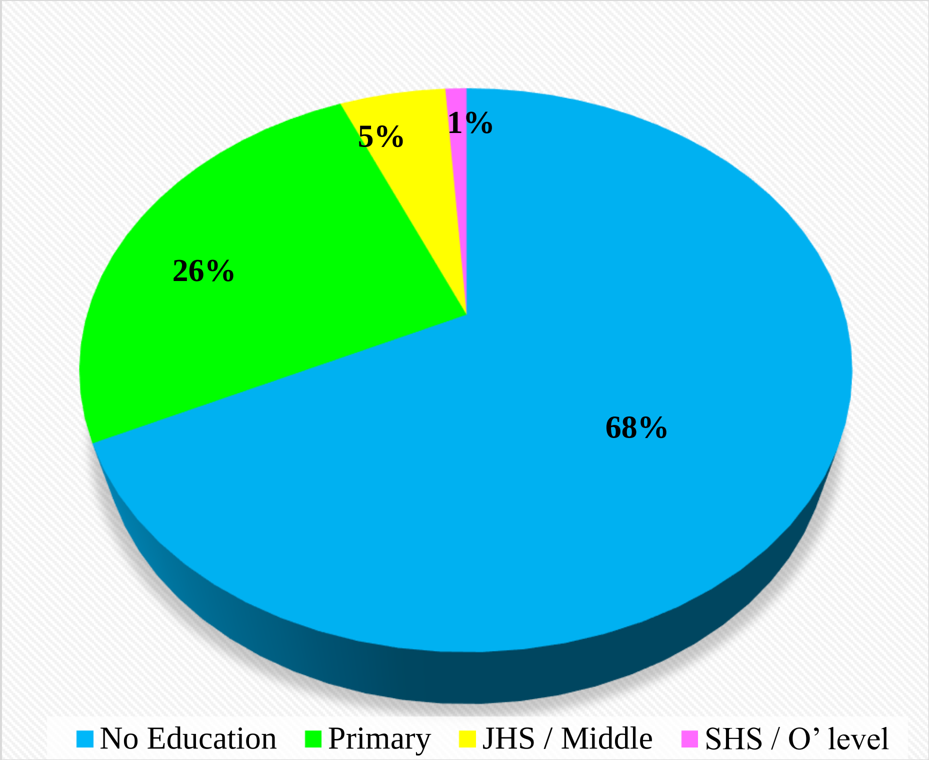


Figure 4: Level of education
Source: Field survey, 2022

On-site observations and the explanations of a 40-year-old chief fisherman also confirmed that these children were involved in fishing because of poverty, where plastic pollution is a factor. These were his remarks:

> *"The children you see fishing are our children. They are not in school, because of the reduction of catch due to plastics. We cannot afford their education so they join us in fishing for their needs".*

Plate 2: Children involved in fishing
Source: Field survey, 2022

In addition, Figure 5 illustrated that the majority of respondents (76.1%) were married, while a notable proportion (15.0%) cohabited with women who were not their spouses and had between six and ten dependents. Furthermore, 3.6% of respondents reported being single, whereas the remainder were either separated (3.6%) or widowed (1.8%). Figure 6 indicated that all respondents had family members, with 48.2% having between six and ten family members, and 6.4% having more than 20 relatives. This data suggested that all fishermen bore significant social and financial responsibilities for their dependents. Consequently, any reduction in their income directly affected their dependents. Therefore, an increase in plastic debris relative to fish catch resulted in substantial financial constraints for them.

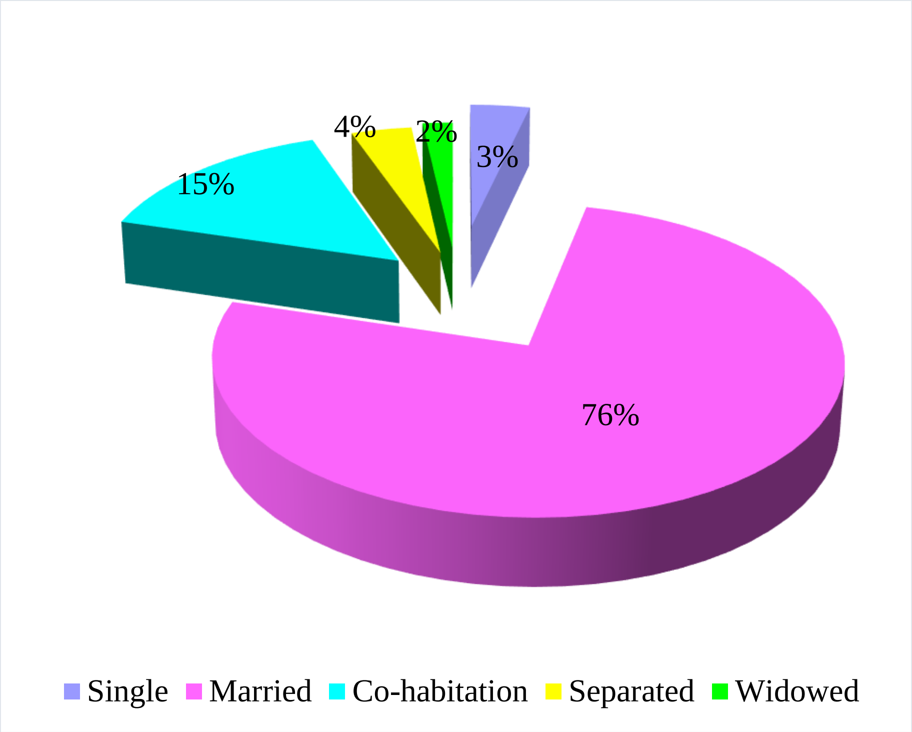


Figure 5: Marital status
Source: Field survey, 2022

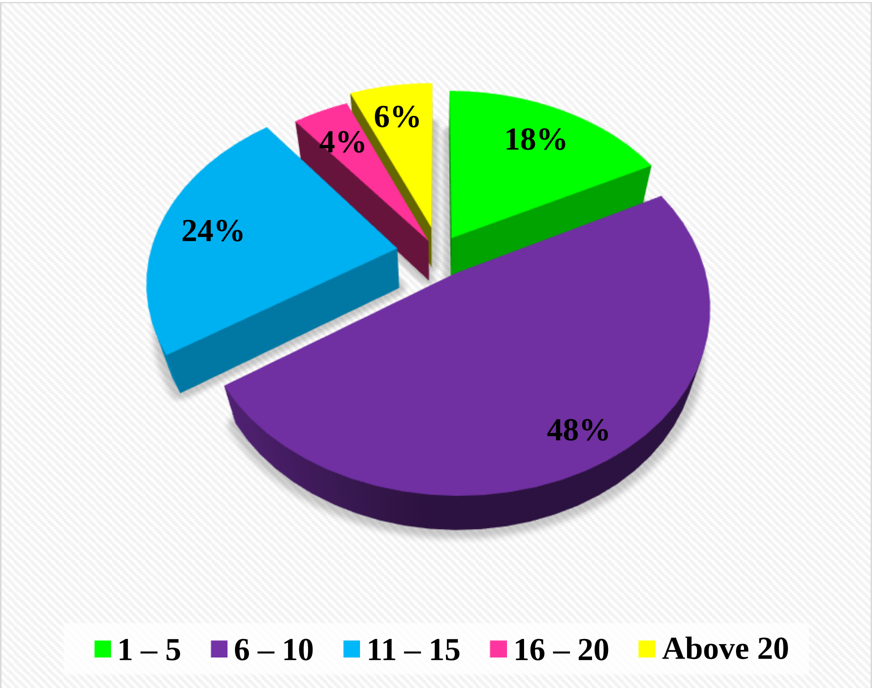


Figure 6: Number of dependents
Source: Field survey, 2022

Furthermore, the study revealed that the primary occupation of respondents was fishing. According to Figure 7, 72.9% of the respondents did not have side jobs, while only 27.2% had side jobs to supplement their income. This indicated that 204 (72.9%) fishermen had no alternative source of income, particularly at a time when plastic pollution was significantly disrupting their livelihoods. As indicated in Figure 8, 185 out of 280 respondents (65%) reported that they financed their business independently. Additionally, 54 respondents (19.3%) stated that they took out loans from financial institutions to support their business. This suggested that any loss of income due to plastic pollution, however small, had both social and economic implications. Furthermore, businesses that were self-funded or reliant on loans suffered significantly when faced with challenges such as plastic pollution.

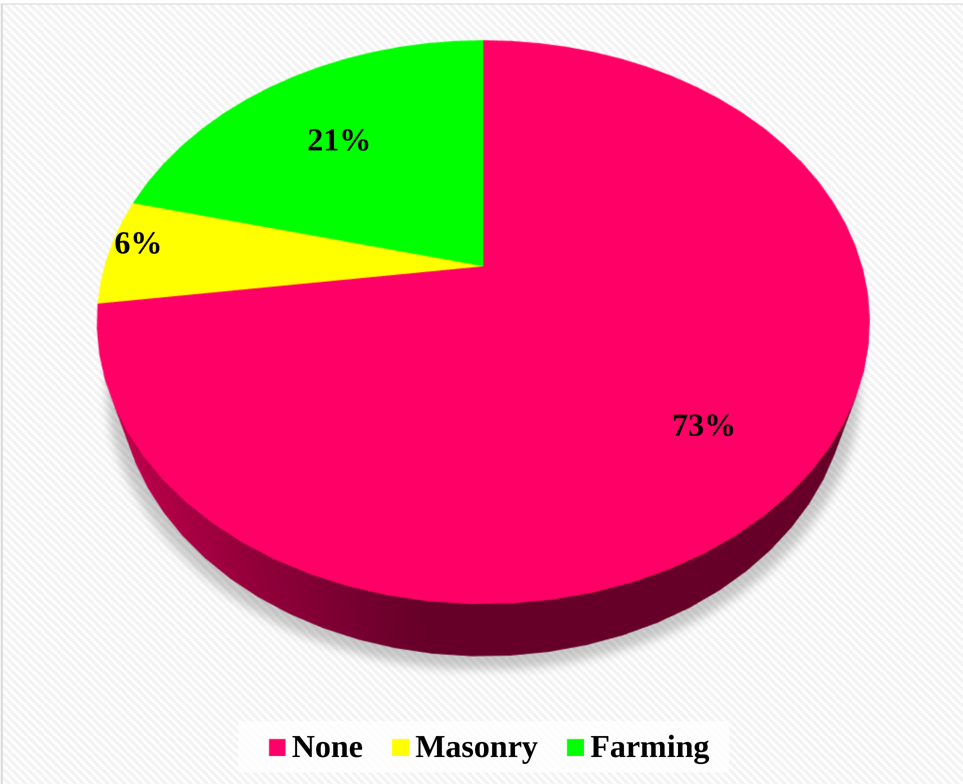


Figure 7: Other occupations
Source: field survey, 2022

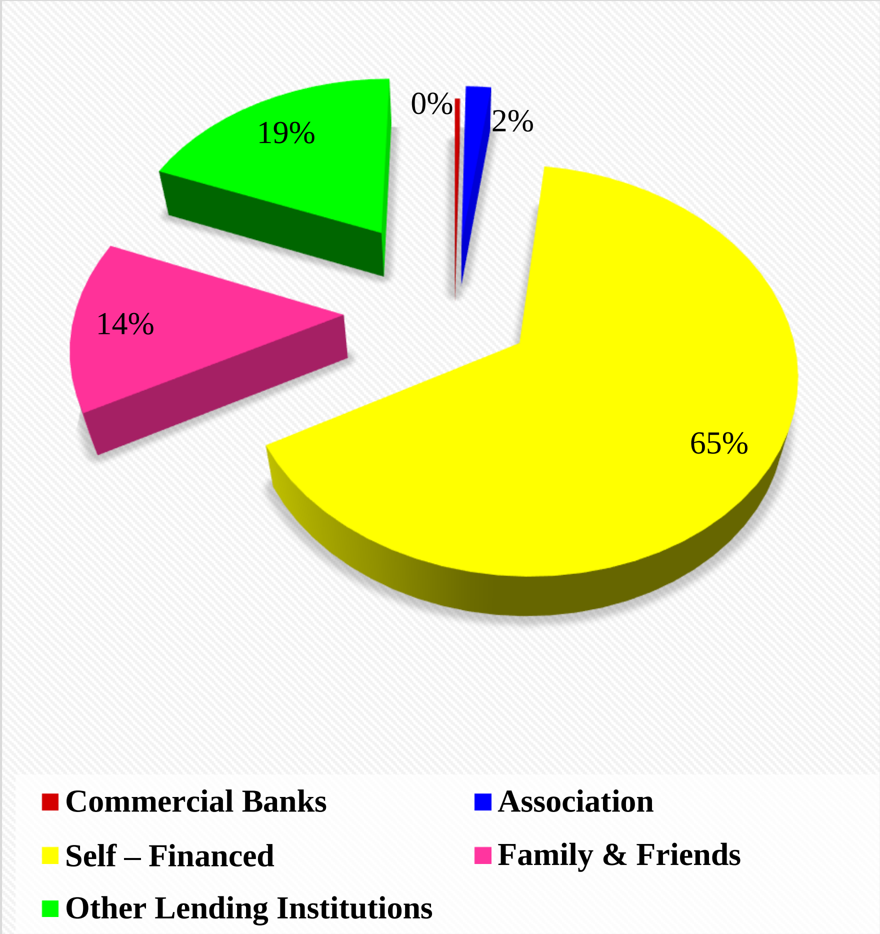


Figure 8: Source of fund
Source: field survey, 2022

4.2 Marine Litter Survey

The first objective involved conducting a beach survey to check the types, quantities, and weights of plastic litter, as well as the quantities and weights of plastic found in fish catches. Table 3 and Figure 9 present the results of the OSPAR Marine Litter Monitoring Survey. Table 3 details the findings of the beach litter survey across various communities, including the dates when different types of litter were collected. The specific types of items and their corresponding OSPAR IDs were also provided.

Table 3: OSPAR Marine Litter Monitoring Survey Form (100metre area)

ITEMS	OSPAR ID	DATES: 2nd ,9th ,16th ,23rd November, 2022 COMMUNITIES		DATES: 3rd ,10th ,17th ,24th November, 2022 COMMUNITIES		DATES : 4th ,11th ,18th ,25th November, 2022 COMMUNITIES	
		OLA	**BANTOMA-ANWONA**	**MOREE**	**SALTPOND**	**ABREKUM**	**AKOSUA VILLAGE**
PLASTIC/POLYSTYRENE							
Bottles	**12**	350	200	1844	800	565	460
Bottle top	**15**	50	55	500	95	166	50
Cups	**21**	55	23	50	125	10	17
Cosmetics	**7**	30	40	77	67	45	26
Sachet water packet	**48**	385	450	1080	115	470	400
Fishing Rope	**33**	1			5	2	
Abandon fishing net	**115**			6	4	6	5
Comb	**18**					1	
Biscuit/sweet packets	**19**	50	50	201	100	200	40
Cutlery	**22**	61				10	10
Polythene bags	**3**	100	50	295	310	335	178
Engine oil container	**8**					5	
Straw	**22**	10			32		
Sack (rice/corn)	**46**				5	10	20

Foam	**45**	20		56	20		15
Styrofoam	**48**	10			20	3	15
Fast food container	**6**	43			75		15
Shoes/sandals /slippers	**44**	16	26	10	15	32	10
Carpet pieces	**46**					10	
Pen	**17**				15	5	10
TOTAL		**1181**	**894**	**4119**	**1803**	**1875**	**1271**
Drink cans	**78**	40	10	16	30	5	6
Knife	**89**					2	
TOTAL		**40**	**10**	**16**	**30**	**7**	**6**
Sanitary pad	**99**	5	6	2	32	3	6
Diapers	**102**	4	2	20	7	2	3
TOTAL		**9**	**8**	**22**	**39**	**5**	**9**
Bottles	**91**	40	5	5	25	5	10
Light bulbs/tube	**92**	5	1			1	1
TOTAL		**45**	**6**	**5**	**25**	**6**	**11**
Coconut husk/branches/sticks	**74**	20	30	115	25	40	45
Cork	**68**	6			5		
Barbecue sticks	**74**	40			30		
TOTAL		**66**	**30**	**115**	**60**	**40**	**45**
Mosquito net	**59**					5	5

Clothing	**54**	10	30	15	20	21	15
Shoes(leather)	**57**	3	5	6	2	4	7
Socks	**59**		6				
TOTAL		**13**	**41**	**21**	**22**	**30**	**27**
Cement	**67**		35	5			
Cartons (paper drinks)	**62**	50			20	10	15
Newspapers & magazines	**66**	5	5	10	5	20	5
papers from exercise books and A4 sheets	**67**	10	15	20	25	30	40
TOTAL		**60**	**55**	**35**	**50**	**60**	**60**
Tyres						3	
TOTAL						**3**	

Source: Field survey, 2022

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SUMMARY OF MARINE LITTER SURVEY

The figure 9 shows the major litter types found on the beaches with their corresponding percentages

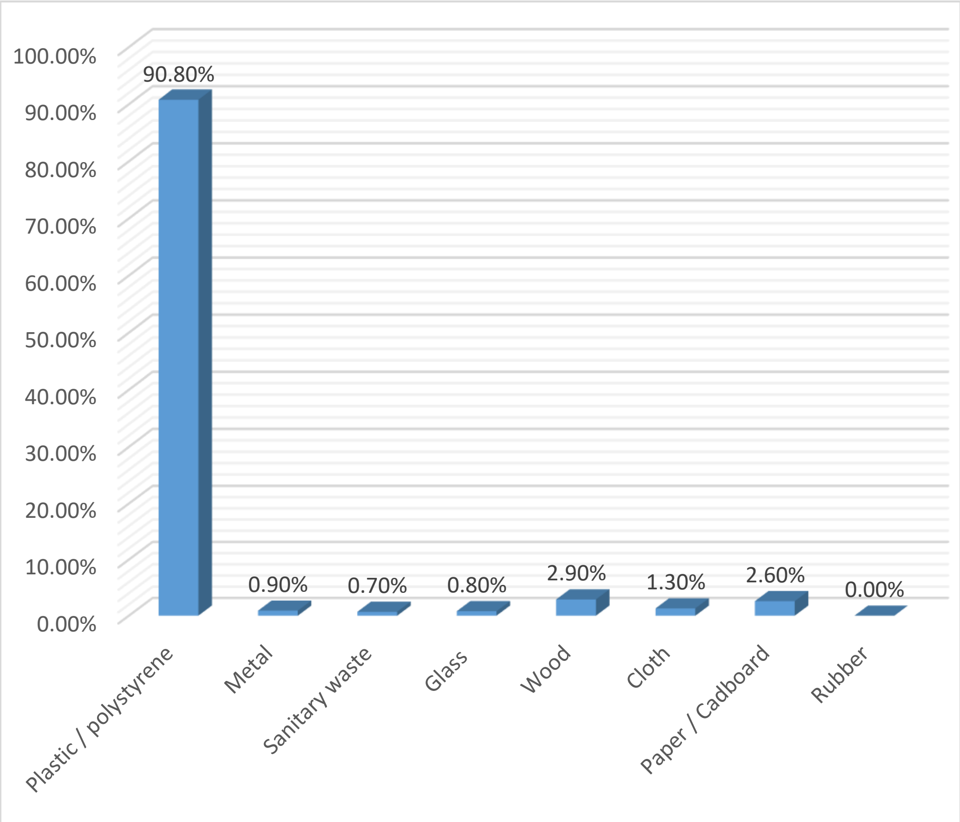

Figure 9: Summary of Marine Litter Survey
Source: Field survey, 2022

Following the OSPAR guidelines for surveying marine litter on beaches, solid debris on the beaches were collected, counted, recorded, and coded. The debris were divided into eight categories: plastic/polystyrene, metal, sanitary waste, glass, wood, cloth, paper/cardboard, and rubber. According to Figure 9, 90.8% of the general litter collected within 100 meters on the six beaches were plastics, while the remaining 9.2% represented the other seven litter types. Rubber (tyre) was recorded as the lowest, as presented in Table 5 and Figure 9. Plastics were the dominant litter on the beaches. These results commensurate with global studies (STAP, 2011; Butterworth et al., 2012; Allsopp et al., 2016) that found plastics to account for the majority of marine debris worldwide.

The plastics found included common objects used for cooking, eating, drinking, recreation, and other daily activities. Plastics are used more extensively than other materials. Field observations of this study indicated that the primary sources of these plastics were land-based, originating from domestic waste, hawkers, fisherfolks, and beach users. This further confirmed Andrady's (2011) study, which found that more than 75% of marine plastic debris comes from land-based sources.

4.3 Spatial distribution of marine litter

Figure 10 illustrates the distribution of various litter types across different communities. Each pie chart represented an area, showing the quantity of specific litter types as percentages. This provided a detailed spatial representation of the beach litter.

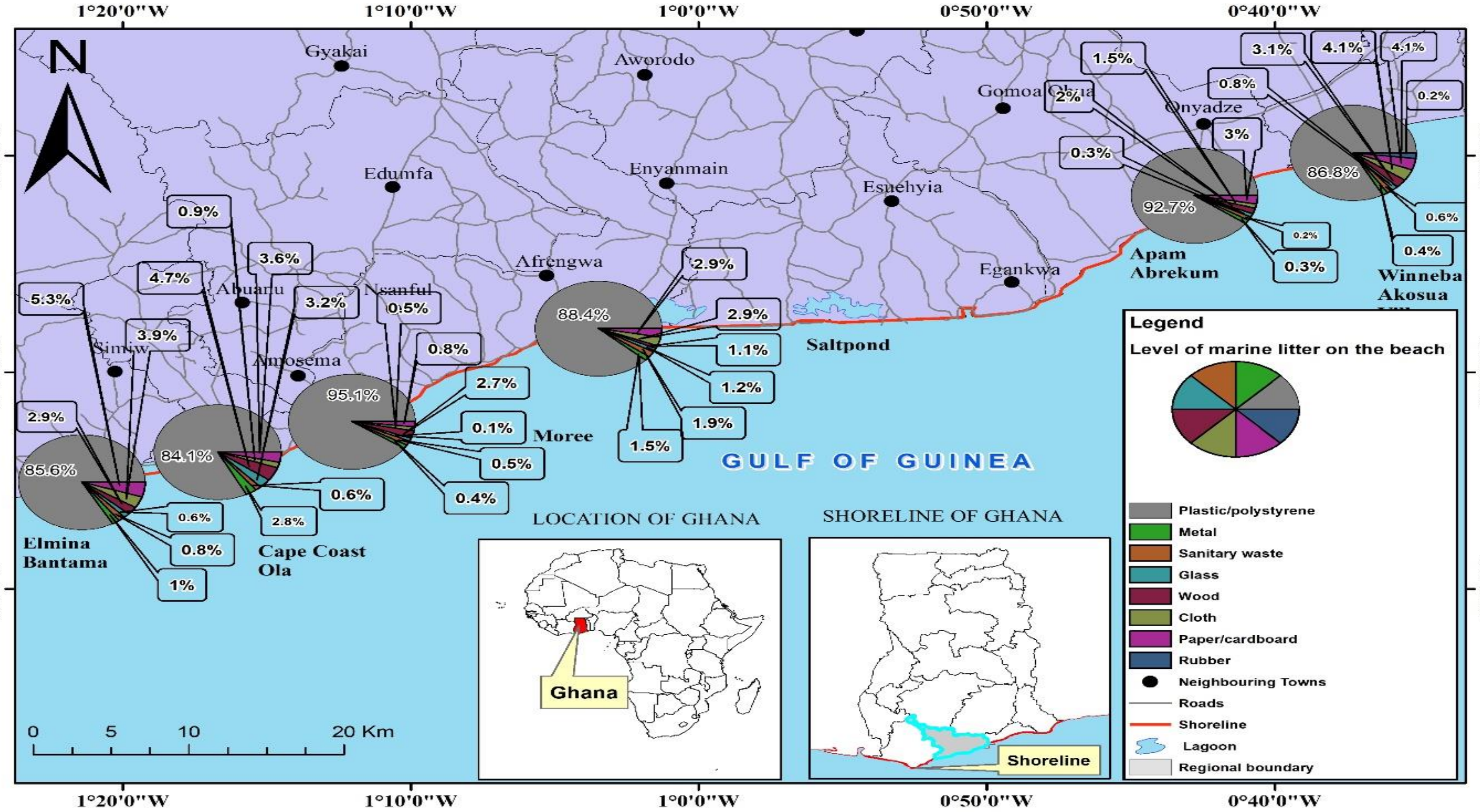

Figure 10: Spatial Distribution of Marine Litter
Source: Field survey 2022

According to Figure 9, Moree recorded the highest amount of plastics at 95.1%, while Ola recorded the least amount of plastics at 85.6%, which is still relatively high. Wood, paper, and cloth were found on all beaches. Rubber was only found in Abrekum, representing 0.2%. Beaches with eateries recorded more metal cans, with 2.8% in Ola, 1.5% in Saltpond, and 0.3% in Abrekum. Sanitary waste was more prevalent on four beaches: Saltpond (1.9%), Moree (0.1%), Ola (0.8%), and Akosua Village (0.8%).

From observation and interview, it was noted that only two of the beaches were cleaned daily: Ola, by Zoomlion, and Elmina (Bantoma–Anwona), by the community. Only Ola, part of Saltpond, and Abrekum had eateries at the beach. Hawkers were present on all other beaches, selling food and other items, with all their food packages made of plastic.

According to Figure 10, Moree recorded the highest amount of plastics at 95.1% and 37% of the total plastics collected (Figure 8). This high percentage was attributed to the lack of frequent cleaning exercises, resulting in a significant accumulation of plastics, especially plastic bottles. Residents reported that a majority of these plastics originated from plastic waste mixed with fish catch, which were left on the beach after fishing. The main landing beach, about 2 km from the study area, served as a landfill site, causing plastics to be carried by waves to the beach where the beach seine fishing method was practiced. Additionally, a lagoon 100 meters behind the beach, used for dumping refuse, contributed to the plastic pollution. Rainfall washed more plastics onto the beach from this lagoon. The absence of regular clean-up exercises led to a high accumulation of plastics on these beaches.

Bantoma-Anwona (Elmina) recorded the least amount of plastics at 8% of the total plastics collected during the study. This low percentage was attributed to the daily cleaning of the beach by the community and the effectiveness of local laws, as indicated by the chief fisherman. The community conducted communal labor every month, during which thorough clean-up exercises were performed, and the beach was swept every morning. Failure to attend communal labor, dumping, or defecating on the beach or into the sea resulted in a fine of eight bags of cement. Due to the strict enforcement of these laws, the people complied, leading to a significantly cleaner beach compared to the other five beaches. This supports Garret's (1968) claim that pollution is less prevalent in areas where laws are effectively enforced.

The Ola Beach in Cape Coast was cleaned each morning by Zoomlion, a government waste management organization, and restaurants on beaches. As a result, it recorded only 10% of the plastic litter compared to other areas. Despite daily cleaning efforts, issues of coastal plastic pollution persisted. This observation aligns with previous studies (Garrett, 1968; Wilkinson & Boulding, 1973), which demonstrated that the sea's lack of boundaries allows for the transfer of pollutants between different regions. Consequently, debris discarded into the sea was found to return to the shore.

Abrekum faced a similar issue to Moree, as it was significantly affected by the litter from Apam, the nearby landing beach. Apam experienced illegal dumping and lacked any clean-up efforts, resulting in its litter being carried to Abrekum, which is about a kilometer away. Despite the constant cleaning efforts at the beach resort in Abrekum, the actions of rain, wind, and ocean drift led to a high percentage (92.7%) of plastic debris on its beaches. In Akosua Village, the beach was dirty and faced issues of illegal dumping.

The other communities (Ola, Elmina, and Saltpond) recorded relatively high amounts of plastic despite daily cleaning efforts through communal labor, Zoomlion, and eatery owners. Plastics remained the dominant litter on all beaches, which became dirtier when it rained.

Field observations revealed that all six beaches had issues of illegal dumping of domestic litter into the sea and nearby lagoons. Although the beaches themselves were not landfill sites, they were located very close to them, about 200 meters away. Littering by hawkers, fisherfolk, and beach users, as well as dumping from homes, were the major causes of pollution in these areas. Consequently, the primary source of pollution on these beaches was land-based and anthropogenic. Andrady (2011), who found that more than 75% of marine plastic debris comes from land-based sources, supports this finding.

Plate 3 shows the study areas filled with litter.




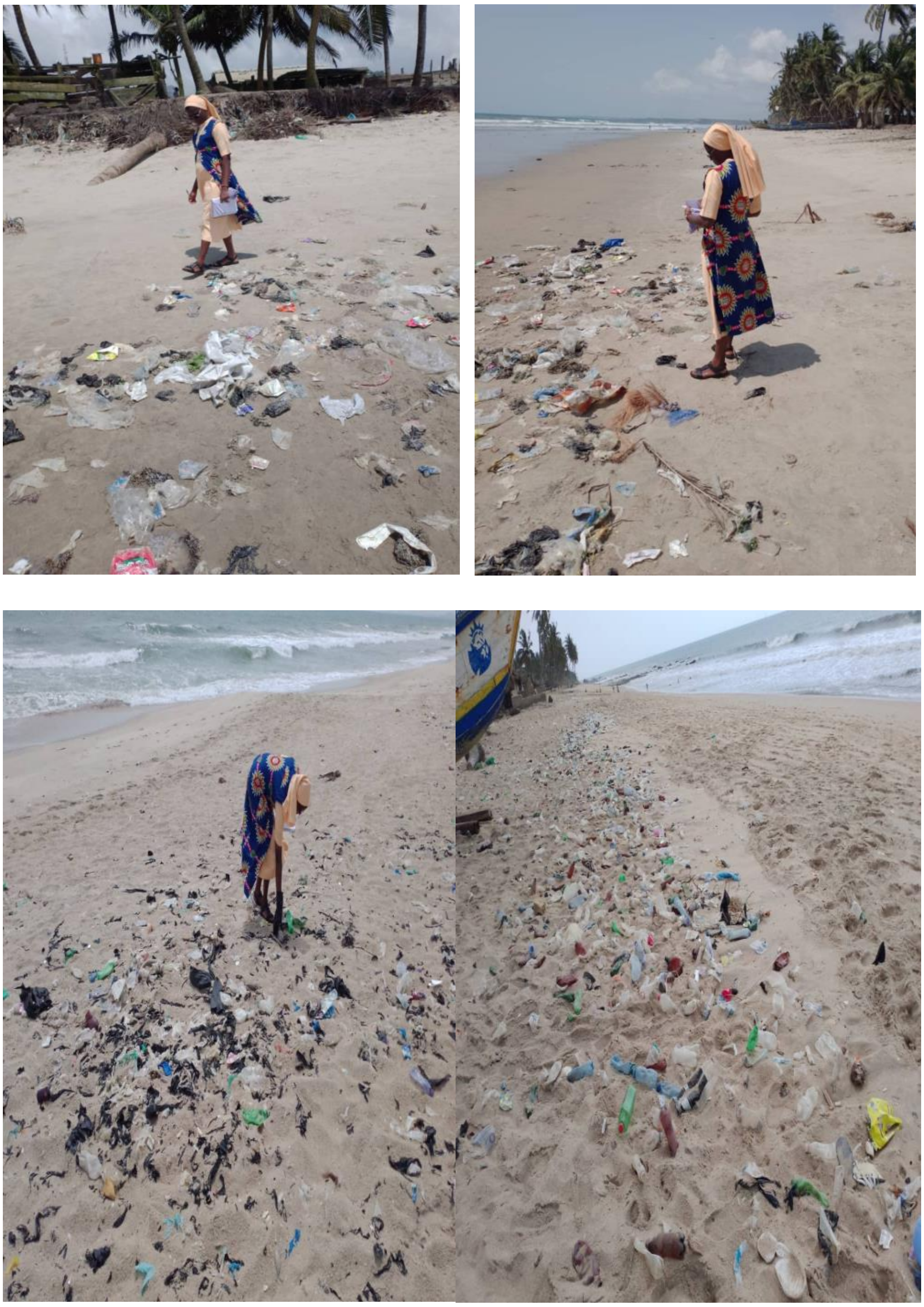

Plate 3: Plastics found on beaches
Source: Field survey, 2022

4.3.1 Quantity and weight of plastics found on beaches

Figures 11 and 12 indicate how plastic litter was distributed along the coastline of central region, Ghana with their total number of plastic and weight respectively.

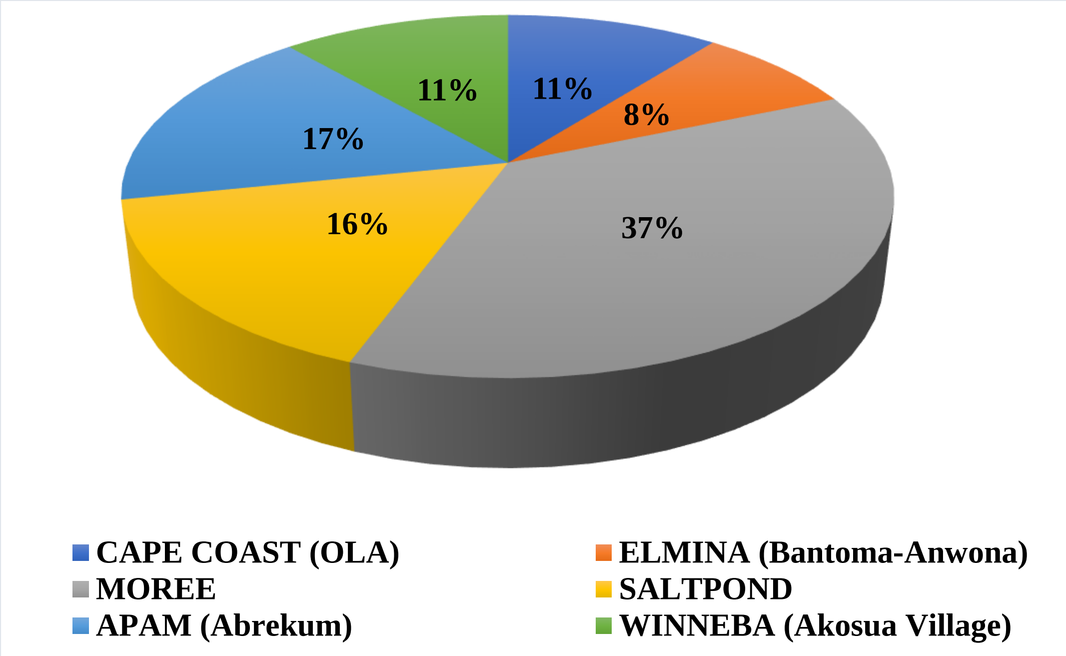

Figure 11: Quantity of plastics found on beaches
Source: Field survey, 2022

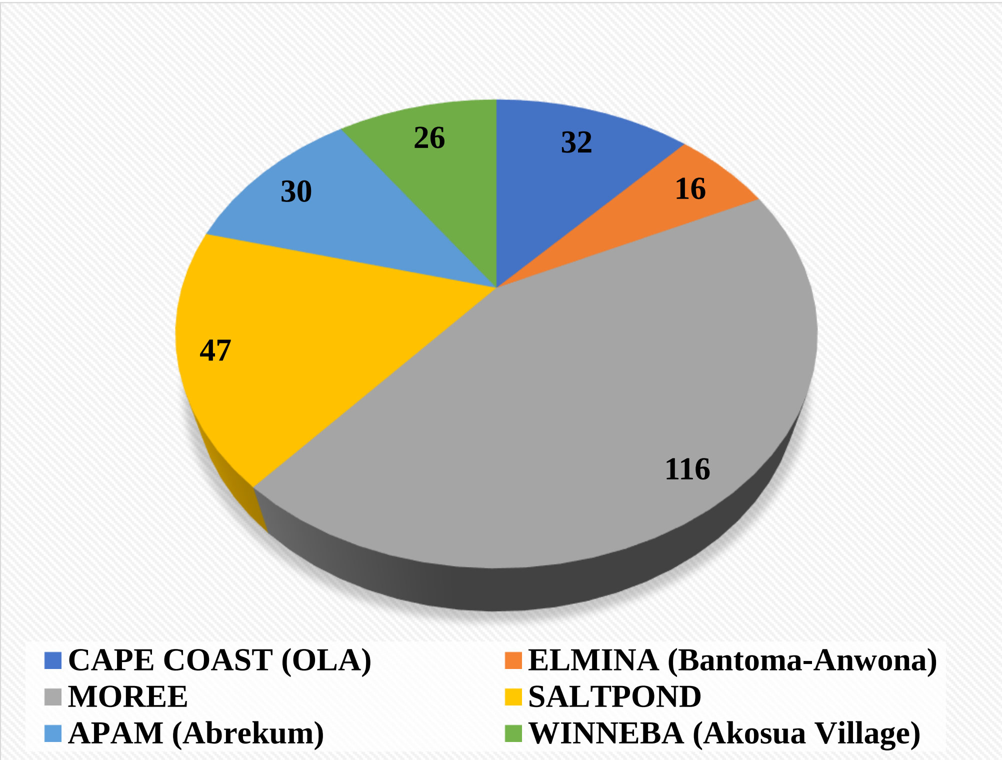

Figure 12: Weight of plastics found on beaches
Source: Field survey, 2022

Focusing on marine plastic debris, Figures 11 and 12 showed that Moree recorded the highest amount, accounting for 37% of the total plastics found on the beaches, with a weight of 116 kg. Bantoma-Anwona had the least amount of collected plastics, making up 8% of the quantity and weighing 16 kg. Saltpond recorded 16% of the quantity and 47 kg in weight. Areas with higher weights had more plastic bottles.

4.4 Plastics found in fish catch

Beach seine fishing method (Tweewui)

Based on field observations from this study, the beach-seine fishing method involved a team of 5-7 crewmembers and two additional helpers. The distance between the shoreline and the net location typically ranged from 1 to 2 kilometers. The beach-seine nets varied in size, with lengths ranging from 480 meters (excluding ropes) and a depth of 8 meters to 1,640 meters in length and 22 meters in depth. These nets were primarily deployed in areas where juvenile pelagic or demersal species were concentrated. Hauling a small net required 10 to 20 individuals, while a larger net necessitated the involvement of over 20 people. It was noted that children under 15 years old, who should have been in school, sometimes participated in this process.

A canoe is required to reach offshore locations for net casting. Once set, the net could be left in the sea overnight or for one to two days before being hauled. The hauling process demanded significant energy and could take several hours. In one observed instance, hauling commenced at 6 am and continued until around 4 pm. It required considerable time and effort before the net, filled with fish, was finally brought ashore. Despite the challenges, the catch was sorted by size and sold by the net owner. The other men, approximately 30-50 in number, who assisted in hauling received a portion of the earnings and some fish. However, their earnings were not substantial and were primarily used to support their families.

When the net contained more plastics than fish, it caused financial and social hardships for the crewmembers and everyone involved. Coastal plastic pollution disproportionately affected those engaged in the beach-seine fishing method. An increase in the amount of plastic caught signifies financial loss, waste of time, labour, human energy, and fuel. This clearly illustrated the negative impact of plastic debris on fishermen and participants in the fishing process.

Plate 4 shows the Images plastics mixed with fish caught from various study areas.




Plate 4: Pictures of plastics mixed with fish catch
Source: Field survey, 2022

The plastics found in the fish catch consisted of polythene bags, bottles, and sachet bags (pure water). Although these plastics did not weigh much, they had significant economic and social impacts. Areas with higher weights of plastic catch contained more plastic bottles. The increased plastic catch reduced the quantity of fish, thereby decreasing income. This reduction affected fishmongers by giving them fewer or no fish to sell, impacting their businesses, especially those relying solely on the sea. It also influenced household consumption and nutrition. During the interview, a forty-year-old queen of fishmongers lamented that

> "*Plastics affect our business especially when the plastics are more persistent*"

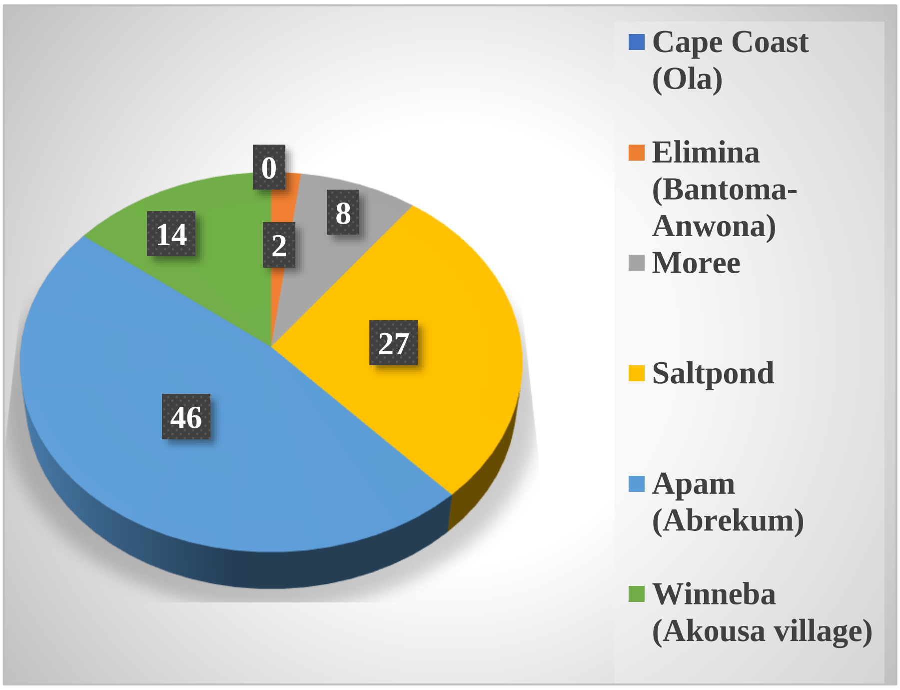

Figure 13: Weight of plastics found in fish catch
Source: Field survey, 2022

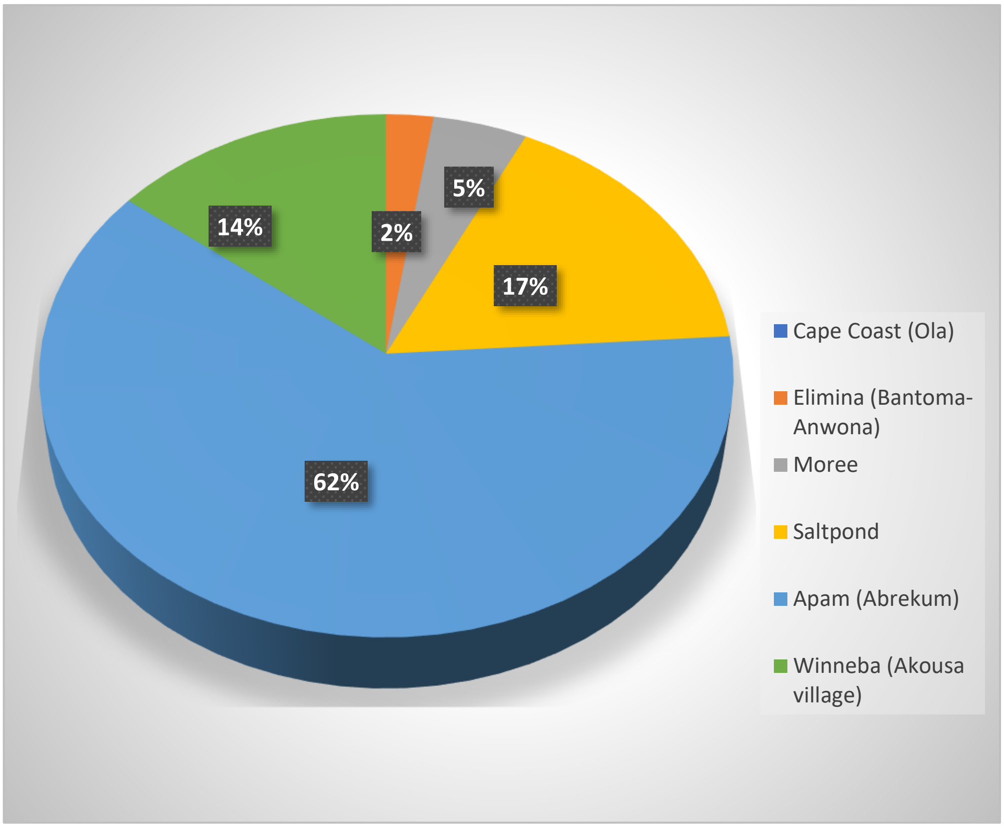

Figure 14: Quantity of plastics mixed with fish catch
Source: Field survey, 2022

Figures 13 and 14 showed that Abrekum recorded the highest amount of plastic at 62% with a weight of 46 kg, followed by Saltpond with 17% and 27 kg, Akosua village with 14% and 14 kg, Moree with 5% and 8 kg, and Bantoma-Anwona with 2% and 1 kg. Ola recorded no plastic throughout the study. Areas with higher weights of plastic caught contained more plastic bottles. The plastics found in the fish catch from the six beaches included polythene bags, bottles, and sachet bags (pure water). Regarding the issue of plastics found in fish catches, one of the queens of fishmongers lamented.

> *"The quantity and weight of plastics found in fish catch have negative economic effects on us. The more the plastics the lesser the fish caught. This reduces the number of fish and money that day. This situation is worst during the raining*

season. Sometimes we virtually get nothing. In selling and buying fish, the quantity, weight, and size are very important because the prizing of the fish depend on these."

Several chief fishermen also reported similar experiences, indicating that this issue affected both fishermen and fishmongers. However, a few queens of fishmongers stated that the price of pre-mixed fuel influenced the price of fish. A 40-year-old queen of fishmongers stated that plastic pollution did not impact their business.

"*The pricing of fish is determined by fuel prices and not plastics mixed with fish catch. Plastics do not affect our business."*

A 45-year-old chief fisherman added that other resources, such as time, labor, and energy, were also affected.

"*We spend more time fishing and removing these plastics from the net. A lot of people are involved in hauling the net to the shore and the energy used is all wasted when we catch more plastics than fish. Our fishing equipment like nets are torn and damaged and this brings financial loss to us"*.

This confirms the study by Mouat et al., 2010 which found that the time and money spent getting stuck in maritime debris, clearing trash out, and maintaining equipment, causes financial losses to fishermen.

Plastics found in the fish caught were more polythene bags, bottles, and sachet bags nonetheless, the economic impact cannot be ignored. According to Figure 13, the combined weight of plastics in the fish catch across six communities totaled 97 kg, equivalent to GH¢5820.00 as estimated by fishmongers. This substantial economic loss detrimentally affects both fishermen and fishmongers alike. The presence of coastal plastic pollution directly diminishes fishermen's income, exacerbating financial losses with increased plastic contamination in fish catches.

4.5 Correlation Matrix for the Study

The correlation effect indicates the degree of linear association between two variables. The correlation matrix for all the variables employed in the regression model is shown in Table 4.

Table 4: Correlation Matrix for the Study

		Coastal plastic pollution	**Social effects**	**Economic effects**
Coastal plastic pollution	Pearson Correlation			
Social effects	Pearson Correlation	.233**		
Economic effects	Pearson Correlation	.142*	.082	

Source: *Author's Construct from Field Data (2022)*

The correlation provides an index direction and the extent of the association between two sets of variables without implying any causality. In statistics, correlation tests become necessary as a prior test is to be conducted to ascertain the strength of association between sampled variables before a regression test is performed. From the results, it was observed that there is a significant positive association between Social effects and Coastal Plastic Pollution [r= .233**] and a significant positive association between Economic Effects and Coastal Plastic Pollution [r= .142*]. In other words, Coastal Plastic Pollution is positively and significantly associated to Social and Economic Effects. There is a positive association of 8.2% between the economic effect and social effects of coastal plastic pollution on fisher folks. This implies that when their economic lives are being affected by pollution it also affects their social lives. There was also a significant positive association between economic effects and coastal plastic pollution, $r = .142$, $p < .01$

4.6 Regression Analysis for the Study

From the correlation indices presented in Table 4, the study established an association between the variables under investigation. The impact of coastal plastic pollution on social and economic livelihoods was a key focus. A simple linear regression was conducted to estimate the effects of the independent variable, coastal plastic pollution, on the dependent variables: the social and economic lives of fishermen. This analysis was based on quantitative data collected from respondents via a questionnaire. Table 5 provides the statistical results. The subsequent sections explain and discuss these findings, beginning with the economic effects and followed by the social effects.

Table 5: A simple linear regression results on the socio-economic effect of coastal plastic pollution on fishermen

Variables	B	S.E.	Df	Sig.	R square	Adjusted R Square	F
Social effects	.265	.48594	1	$.007^{b}$	.054	.047	7.541
Economic effects	.320	.60174	1	$.018^{b}$	.020	.017	5.712

$P< 0.007^{b}$; $P<0.05$, $P< 0.018^{b}$

Source: Author's Construct from Field Data (2022)

4.6.1 The economic effect of coastal plastic pollution on fishermen

According to Table 5, the coefficient of multiple determination (R^2) and the adjusted R^2 indicated that coastal plastic pollution explained approximately 20.0% of the variations in economic effects. This result implies that 80.0% of the variation is due to other omitted variables not included in this model. Based on this result, it was concluded that coastal plastic pollution significantly explains 20.0% of the variance in economic effects. It was observed that a 1% change in coastal plastic pollution caused a change in the economic lives of the fishermen ($\beta = 0.320$, $p < 0.05$).

The study revealed several direct and indirect impacts of coastal plastic pollution on their economic lives, including reduced income, costs associated with repairing and purchasing new fishing equipment, fuel and labor costs, and wasted time and energy. These challenges contribute to difficulties in meeting the basic needs of their families. Specifically, income from fishing activities had declined as they increasingly caught plastics, particularly during the rainy season. The reduction in revenue was attributed to additional expenses incurred by the fishermen, including repair costs, fuel costs, and labor costs, among other factors. A 45-year-old chief fisherman explained that:

> "*Plastics damage our fishing equipment, tearing net and destroying outboard motors and propellers. It takes a lot of money to repair them. Time is money, we spend a lot of time removing plastic from the net. These plastics affect us financially because we spend the whole night and day fishing and we get plastics instead of fish and we do not even break even, talk less of making a profit. It is sometimes difficult to provide the basic needs of our family.*"

All these factors caused reductions in income, making it difficult for fishermen to provide basic needs and education for their children, often resulting in school dropouts. These findings were consistent with previous research by

Iñiguez et al. (2016) and Mouat et al. (2010), who found that marine debris reduced income and that the time spent removing debris from nets adversely affected working time and income.

A small percentage of respondents, 6.1%, had a different perspective, indicating that plastic pollution had increased their income. They argued that fish tended to feed on substances carried by the waste materials, making them more accessible to the fishermen. Therefore, they believed that plastic pollution brought more fish within their reach. This finding contradicts the studies by Iñiguez et al. (2016) and Mouat et al. (2010), which claimed that plastic pollution reduced the income of fisheries.

4.6.2 The social effect of coastal plastic pollution on fishermen.

According to Table 5, the coefficient of multiple determination (R^2) and the adjusted R^2 indicate that coastal plastic pollution explained approximately 54.0% of the variations in social effects. This result implies that 46.0% of the variation is due to other omitted variables not included in this model. Based on this result, it was concluded that coastal plastic pollution significantly explains 54.0% of the variance in social effects. It was observed that a 1% change in coastal plastic pollution caused a change in the social lives of the fishermen ($\beta = 0.265$, $p < 0.05$).

The study revealed some of the social effects in terms of health and food security, tourism, the aesthetic nature of beaches, recreation, and education, social identity, value and pride, and psychological and emotional effects.

Effects linked to plastic pollution have a direct and indirect impact on human health (Teuten et al. 2013; Thompson, 2015; Gold et al. 2013; UNEP

2014; Galloway 2015). All the respondents strongly agreed that the consumption of fish that has ingested plastics is detrimental to health and the study by Smith et al., (2018) confirms this.

In relation to the aesthetic appeal of beaches and tourism, all respondents concurred that their beaches had lost their aesthetic beauty and failed to attract tourists due to coastal pollution. The deterioration in their aesthetic quality has deterred tourists from visiting the area. A 35-year Queen of Fishmongers expressed lament over this issue:

> *"Nobody would like to be on a dirty beach and the tourist who even come do not spend much time. Plastics have destroyed the beauty of our beaches, deterring visitors. Recreating on a littered beach also creates discomfort. We can no longer pride ourselves on our beautiful beaches. It also contribute to the breeding of mosquitoes".*

All of these findings corroborate Wyles et al.'s study (2016), which asserted that spending time on littered coasts detrimentally affected people's emotions and mental health. Tourists spent less time in these environments or avoided specific locations due to their aversion to coastal litter (Hartley et al., 2015; Ballance et al., 2014; Tudor and Williams, 2016; WHO, 2013). It was noted that residents, accustomed to plastic debris, were less affected emotionally, although they still appreciated beautiful beaches.

The presence of marine debris significantly affected recreational activities such as swimming and sightseeing for tourists. This is consistent with other studies by Ballance et al. (2014) and Sheavly (2010), which highlighted that accumulations of marine debris could deter recreational users from polluted areas. When choosing travel destinations, beachgoers prioritized cleanliness above all other factors (Ballance et al., 2014; ENCAMS, 2017). The buildup of marine litter not only diminished the visual appeal of beaches but also raised concerns about health and safety, which discouraged other recreational users such as sailors and divers (Sheavly, 2010; Cheshire et al., 2010).

Furthermore, plastic pollution's impact on education emerged as a significant social issue. Figure 4 depicted the demographic characteristics of the respondents based on their educational levels: 67.9% had no formal education, 25.7% had primary education, while a small percentage had Junior High School/Middle (5.4%) and Senior High School/O'level education (1.1%), with some dropping out due to financial constraints or poor performance in exams such as the B.E.C.E and WASSCE. Observations indicated that many children under 18 years were involved in fishing, citing financial hardships due to recent declines in fish catches. This underscores the long-term educational impacts of coastal plastic pollution in these areas. A 40-year-old chief fisherman commented:

> *"The children you see fishing are our children. They are not in school, because of the reduction of catch due to plastics. We cannot afford their education so they join us in fishing for their needs".*

This finding confirms Ucbasaran et al.'s (2013) study, which demonstrated that when a business faces struggles, providing certain basic needs for one's family becomes very challenging.

. *Plate 5:* Children involved in fishing *Source: field survey 2022*

Furthermore, the presence of coastal plastic pollution can have significant psychological effects on fishermen. Constant exposure to the sight of polluted waters, entangled marine life, catching of plastics instead of fish, and damaged ecosystems can contribute to feelings of distress, helplessness, and anxiety. Thirty-five-year-old Chief fishermen explain that:

> *"We rely on the sea for our livelihoods and have a deep connection with the marine environment but we experience a sense of grief and loss as we witness the degradation of our once thriving fishing grounds. Now we fish and get more plastics than fish. We are not satisfied with the output of our work and this sometimes brings stress and depression to some of us."*

The catching of plastics also had emotional effects on fishermen. A chief fisherman shared that:

> *"Some of us are unable to earn a sufficient income due to the decline in fish populations caused by plastic pollution. We put*

in more and earn something small or sometimes nothing. How do we even pay for the loans we are working with? All these sometimes affect us emotionally leading to anger, sadness, fear, anxiety and sometimes despair and this affects our relationship with others".

These findings corroborated Ucbasaran et al.'s (2013) study, which highlighted that business failure could result in psychological and emotional issues that impacted relationships with colleagues and family members.

On the issue of the effects on their social identity, value, and pride a chief fisherman shared that:

> *"Fishing is more than just a job, it gives us a social identity and we take pride in our profession. The output of our work gives us job satisfaction. Coastal plastic pollution is affecting our work output negatively. How do we pride ourselves as fishermen when we are catching more plastics than fish? This is affecting our social identity, pride, and value as fishermen".*

This implies that anything that affects their work and output affects their sense of identity, value, and pride. This supports the study by Holland et al. (2020), which demonstrated that many fishermen consider their work more than a means of income. They value fishing as a way of life, deriving job satisfaction. Additionally, they experience a deep sense of identity, pride, and attachment to their profession, considering it a significant non-material benefit of being in the fisheries sector.

4.7 Fishermen coping mechanisms

Figure 15 shows the coping mechanism of fishermen in this plastic pollution menace.

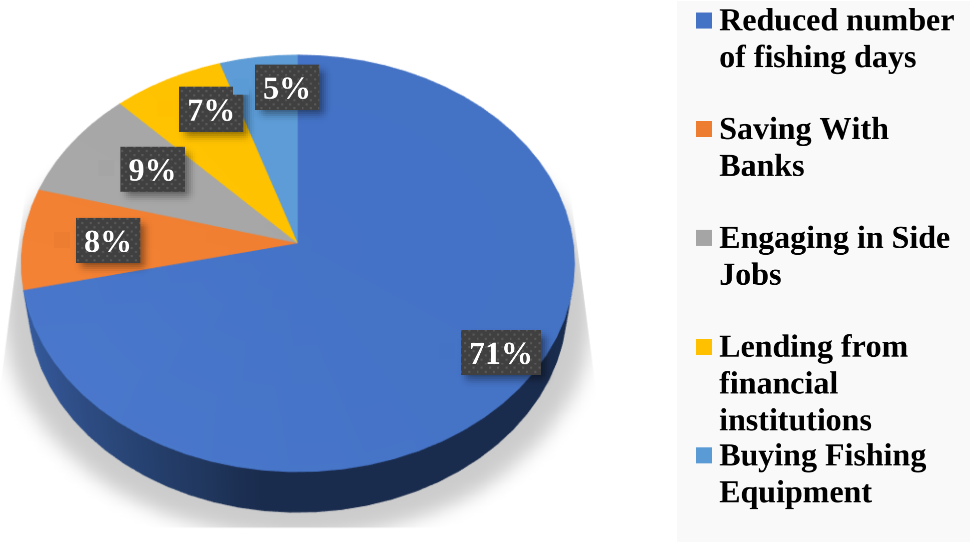

Figure 15: Coping mechanism of fishermen *Source: Field survey, 2022*

First and foremost, one coping mechanism that the majority (71%) of fishermen adopted in response to coastal plastic pollution was to reduce the number of fishing days. This was because plastic pollution made it more difficult for them to catch fish and increased the likelihood of their nets and other fishing gear being damaged. By reducing their fishing days, they reduced their costs and minimized their exposure to plastic pollution. This approach helped to reduce the time spent fishing in polluted waters to minimize the risk of catching contaminated fish. While this resulted in a reduction in income, it helped protect the health of the fishermen and their families, as well as preserved the quality of the catch for future fishing expeditions. Additionally, this coping mechanism helped to reduce the amount of plastic pollution that was generated, as less fishing activity meant less equipment was being used, and less litter was being produced. By reducing the number of fishing days, fishermen conserved their resources (time, human, and money) and ensured that they could continue fishing in the long term.

Secondly, 9% of the fishermen engaged in side jobs or other income-generating activities when fishing was not as productive. These included activities such as farming, small-scale trading, or working as laborers in other industries. By diversifying their income streams, fishermen reduced their reliance on fishing as their sole source of income, thereby reducing their vulnerability to fluctuations in the fishing industry. This also provided a more stable financial foundation for the fishermen and their families and helped to mitigate the financial impact of plastic pollution on their businesses. This supported the study of Sessions et al. (2020), who claimed that engaging in side jobs helped to supplement one's income.

Furthermore, another coping mechanism of the fishermen (8%) was to save money with some banking institutions. This involved setting aside a portion of their income in a bank account for future use. These strategies provided a safety net in case of unexpected expenses or income fluctuations due to coastal plastic pollution or other factors. Savings also helped fishermen to plan for future investments in fishing equipment or other income-generating activities. Fishermen chose to save money in banks to build up a financial cushion to fall back on during difficult times, such as when fishing was less profitable due to coastal plastic pollution or when plastic pollution reduced fish populations. Through savings, fishermen ensured that they could continue providing for themselves and their families even when they were unable to fish as much as desirable. Saving with banks also provided a safe place to store their earnings and potentially earn interest on their savings. This was consistent with the study of Dupas et al. (2017), who believed that by saving with banks, fishermen had the opportunity to access credit and loans, which could expand their investment in new equipment or other business opportunities that might be more profitable.

Moreover, in some cases, 7% of fishermen borrowed money from financial institutions to finance their fishing activities or cover other expenses related to coastal plastic pollution. This included loans for purchasing new fishing equipment, repairing damaged boats or nets, or covering medical expenses related to health problems. Through taking out loans, the fishermen ensured that they could continue fishing even when their financial resources were limited due to coastal plastic pollution. While borrowing money helped fishermen address short-term financial needs, it was important to carefully consider the terms and conditions of the loan to ensure that it was manageable and sustainable.

Ultimately, 5% of the fishermen adopted a proactive approach of investing in fishing equipment in advance when business was booming. Through purchasing new equipment during peak fishing seasons, the fishermen ensured that they had the necessary tools to continue fishing even when faced with challenges such as coastal plastic pollution or any other challenges related to coastal activities and coastal livelihoods. By investing in equipment early, they also reduced the risk of being caught off guard by changes in the fishing environment or the impact of plastic pollution on their operations. This approach helped them to maintain their income levels and avoid disruptions to their livelihoods.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATION

Ghana is experiencing a rapid increase in population occasioning urbanization. One of the characteristics of urban lifestyle is the use of untraditional packaging materials such as plastics. The extensive demand for plastics has led to a significant rise in its production. Consequently, due to inadequate waste disposal practices, plastics have permeated the marine environment. This study aimed to investigate the social and economic consequences of plastic pollution along the coastline of the Central Region of Ghana. This Chapter summarises the research purpose, approaches and procedures, the key findings, and provide conclusions and recommendations.

5.1 Summary of key findings

5.1.2 Marine litter survey

The study revealed that plastics ranked higher than all other types of litter on the beaches, primarily due to anthropogenic or land-based causes. This was attributed to littering by beach users, fishermen, and dumping activities. Residents indicated that a significant portion of these plastics originated from debris mixed with fish catches, which were left on the beach after fishing activities. Field observations indicated that the proximity of some beaches to landfills further contributed to the high prevalence of plastic litter. However, in communities where chief fishermen enforced effective regulations, the rate of pollution was notably lower. This demonstrated that effective local leadership significantly contributed to controlling plastic pollution. Additionally, the study noted that many school-aged children engaged in fishing due to poverty, a situation exacerbated by the pervasive issue of plastic pollution.

5.1.3 Plastics mixed with fish-catch

The study found that the presence of plastics in fish catches had significant negative economic effects, as reported by both fishermen and fishmongers. The quantity and weight of plastics in the catch inversely correlated with the number of fish caught, directly reducing daily income. This issue was particularly severe during the rainy season, sometimes resulting in virtually no fish being caught. The economic strain extended beyond reduced fish catches, impacting other resources such as time, labour, and overall income. However, some fishmongers, particularly fishmongers' queens, contended that plastics did not affect their business or the pricing of fish, attributing fluctuations in their business more to fluctuating fuel prices. Plastics found in the catches predominantly included polythene bags, bottles, and sachet bags. Despite their relatively low weight, these items had a substantial economic impact on the fishing industry.

5.1.4 Social Effect of Coastal Plastic Pollution on Fishermen

The research demonstrated that coastal plastic pollution significantly impacted the social life of fishermen in various domains, including health, food consumption, tourism, maritime movement, and recreation. Plastics littered the beaches, degrading their aesthetic appeal and making them uncomfortable for tourists and residents. In terms of health, the consumption of fish that had ingested plastics posed potential health risks, while plastic also contributed to mosquito breeding. In the maritime context, plastic entanglement with propellers hindered movement at sea. Culturally, plastic pollution led to a loss of heritage and pride as the once-beautiful beaches were marred by plastic debris. It led to the waste fuel, time, and human energy in fishing activities. Socially, the pollution resulted in a loss of identity, value, and pride among fishermen, diminishing their job satisfaction. These issues collectively had profound psychological and emotional effects on the fishermen.

5.1.5 Economic effect of coastal plastic pollution on fishermen

The study revealed that coastal plastic pollution significantly affected the economic livelihoods of fishermen, primarily through reduced income and increased equipment repair costs. Plastics caused damage to fishing nets, entangled outboard motor propellers, and harmed other fishing equipment, necessitating frequent repairs and replacements. Additionally, the presence of plastics in the catch, often exceeding the quantity of fish, further diminished their income. The financial burden was exacerbated by wasted fishing time, fuel, and labour, making it increasingly difficult for fishermen to meet basic needs such as food, shelter, and education, thereby compromising their overall quality of life. The businesses of fishmongers were also adversely affected when plastic waste predominated in the catch, further straining the local economy.

5.1.6 Fishermen Coping Mechanism

The study identified several coping mechanisms adopted by fishermen to mitigate the adverse effects of plastic pollution. One strategy involved reducing the number of fishing days, particularly during the rainy season, to conserve resources. Additionally, some fishermen saved money with banks to build financial resilience and stabilize their income. Diversification of income sources was another common strategy, with many fishermen engaging in supplementary jobs rather than relying solely on fishing for their livelihood. Accessing loans from financial institutions also emerged as a coping mechanism to sustain their fishing activities. Moreover, during periods of increased income, some fishermen strategically invested in purchasing fishing equipment in advance to prepare for future needs.

5.2 Conclusion

Grounded in pragmatic philosophy, the study employed a concurrent triangulation mixed-method approach. Data were collected and analysed using SPSS version 26, with descriptive, correlation, and regression analyses conducted for the quantitative data, while Braun and Clarke's thematic analysis was utilized for the qualitative data. Both sets of results were discussed in tandem.

The findings corroborated two theoretical frameworks. Firstly, Garrett's (1968) theory of the common-pool resource illustrated that plastic pollution represents a contemporary tragedy of the commons in the ocean, significantly impacting fisherfolk and exacerbated by poor governance. Secondly, Wilkinson and Boulding's (1973) ecological theory of change and development demonstrated that socio-economic activities contribute to pollution, which in turn affects the social and economic livelihoods of coastal communities.

The study found that plastics were the most prevalent type of marine litter on beaches, primarily due to land-based socio-economic activities such as recreation, operations of eateries, littering, dumping into the sea, and the activities of hawkers and beachgoers.

Socially, the presence of plastics had significant impacts on health, recreation, maritime movement, aesthetic value, tourism, education, breeding of mosquitoes, and caused psychological and emotional distress.

Economically, plastics mixed with fish catches reduced income by necessitating the purchase of new fishing equipment and the repair of damaged equipment. The waste of fishing time, fuel, and labour, human energy further diminished income, making it difficult for fishermen to meet basic needs such as food, shelter, education, and maintaining a decent quality of life.

To cope with the challenges posed by plastic pollution, fishermen adopted several strategies, including reducing the number of fishing days, saving money with banks, engaging in supplementary jobs, borrowing from financial institutions, and purchasing fishing equipment in advance during periods of increased income. Despite the challenges encountered during the research, all objectives were successfully achieved.

5.3 Recommendations

Based on the findings these recommendations were made.

Although some fishermen have indicated that plastic marine debris has not significantly impacted fish catches, the global evidence of harm caused to marine life by marine debris is well documented. Therefore, it is crucial to intensify and reinforce educational campaigns regularly regarding plastic pollution, littering, and dumping. Many fishermen have limited knowledge of plastic waste issues and how it can affect their livelihoods. The Environmental Protection Agency (EPA) in collaboration with local radio stations should conduct these campaigns in the area's native languages and in English to ensure maximum reach.

Additionally, education by traditional leaders, religious leaders, assembly men and other leaders should be provided to residents during various social events such as durbars, churches, festivals, funerals, marriage ceremonies, naming ceremonies, and other relevant occasions. To aid in education efforts, stickers and booklets regarding pollution and its effects should be distributed to residents. Social media platforms such as WhatsApp, text messages, and Facebook should also be utilized to disseminate information to a larger audience about pollution issues in the area. Integrate environmental education into school curricula to foster a sense of responsibility and awareness from a young age.

Research indicates that 80% of all marine debris originates from land. Consequently, waste generated along the beaches, especially by tourists, and indiscriminate dumping of refuse should be collected consistently to prevent it from being washed into the sea. Clean-up exercises should be frequent. Coastal communities should engage in this exercise instead of leaving it to the government. EPA and municipal assemblies should work in partnership with the local leaders to provide dustbins on beaches to help reduce pollution. There is a need for a change of attitude toward dumping and littering on beaches and into the sea. There should be a fine for those who dump, and litter on beaches, and those who fail to join in cleaning up exercise. This can be attained through effective leadership and implementation of laws at the local level.

Most beaches were close to dumping fills. When it rains all the refuse go into the sea. This causes social and economic issues. The EPA, Metropolitan, Municipal, and District assemblies should relocate landfills to areas away from the sea and beaches. The landing beaches should not be used as landfill sites nor should the refuse dump be close.

Ultimately, Studies reveal that only 5% of plastic waste generated in Ghana is recycled. Therefore, the government of Ghana should collaborate with international partners to exchange best practices and technologies in recycling and waste segregation. This partnership would drive the country toward global standards, enhancing cooperation and trade in recyclables. Such collaboration would also facilitate cross-border projects aimed at improving waste management in shared coastal areas, promoting a global approach to sustainable waste management.

Areas for Further Research

Morphodynamics of plastic pollution along the coastline of Central Region, Ghana

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APPENDIXES

APPENDIX A

SAMPLE SIZE CALCULATION

The population of the fishers in the various communities in the municipality differs. Elmina (Batoma-Awona)- (494), Saltpond - (109), Moree - (155), Cape Caost (Ola)- (256), Winneba (Akosua Village)- (380), Apam (Abrekum)- (164), (COASTAL RESOURCE CENTER 2021). A Simplified Formula for Proportions by Taro Yamane (1967) was used. A Simplified Formula for Proportions Yamane (1967) provides a simplified formula to calculate sample sizes. The Yamane sample size states that, n = N / (1 + N e2).

Sample size calculation

A Simplified Formula for Proportions Yamane (1967) provides a simplified formula to calculate sample sizes. The Yamane sample size states that, n = N / (1 + N e2). At 95% confidence level and P = 0.05. Where n is the sample size, N is the population size, and e is the level of precision.

Target population (N): (the total population of fishermen in the 6 coastal communities) = (380+ +164+ 109+494+256+155) = 1558

N= 1558

Sample size (Yamane, 1967): n = N / (1 + N e2)

$n = 1558 / (1+1558(0.05^2) = 280$

n= 280

The total sample size is 280

Community	**Sample size**
Akosua Village (Winneba)	380/ 1558 * 100= 24% 24%of 280 gives: 24/100 *280= **68**
Moree	155/1558 * 100 = 10% 10% of 280 gives: 10/100* 280 = **28**
Ola (Cape Coast)	256 / 1558* 100 =16% 16% of 280 gives: 16/100* 280 = **46**
Abrekum (Apam)	164 / 1558* 100 = 11% 11% of 280 gives: 11/100 * 280 = **29**
Bantam – Anwona (Elmina)	494/1558* 100 = 32% 32% of 280 gives: 32/100* 280 = **89**
Saltpond	109/1558*100 = 7% 7% of 280 gives: 7/100 * 280 = **20**

Author's construct

APPENDIX B
RESEARCH INSTRUMENT

This research is being organized by a graduate student from the Department of Geography and Regional Planning, at the University of Cape Coast, Ghana as partial fulfillment of the degree of Master of Philosophy in Geography. The research seeks to examine the socio-economic effects of coastal plastic pollution, a case study on the coastline of Central Region of Ghana. The selected communities are Batoma-Anwona **(**Elmina), OLA (Cape Coast), Saltpond, Moree, Akosua Village (Winneba), and Abrekum (Apam) along the coastline from Elmina to Winneba. The achievement of this research will depend on the sincere response you give. Please be assured that this research is purely for academic purposes and your identity will be held confidential.

QUESTIONNAIRE FOR FISHERMEN

SECTION A: RESPONDENT'S SOCIAL AND DEMOGRAPHIC BACKGROUND

1. Age a. 21-30 [ ] b 31-40 [ ] c. 41-50 [ ] d. 51-60 [ ] e above 60 [ ]
2. . Number of years in fishing a. 5-15 [ ] b. 16-26 [ ] c. 27-37 [ ] d. above 37 [ ]
3. What is your highest level of education? a. No formal Education[ ] b. Primary [ ] c. JHS/Middle [ ] d. SHS/ O'level [ ] e. Vocational/Technical[]
4. Marital Status a. Single [ ] b. Married [ ] co-habitation [ ] d. Separated [ ] e. Widowed [ ]
5. The number of dependents a. 1-5 [ ] b. 6-10 [ ] c.11-15 [ ] d.16-20 [ ] e. above 20 [ ]
6. Other occupation a. None [ ] masonry [ ] c. Farming [ ] d. Carpentry [ ]
7. Source of fund a. Commercial Banks [ ] b. Association [ ] c. Self–financed [ ] d. Family and Friends [ ] d. Other Lending Institutions [ ]

SECTION B: COASTAL PLASTIC POLLUTION (General Knowledge on Coastal Plastic Pollution)

Please rate from 1-5 your **knowledge of coastal plastic pollution (CPP)**

STATEMENT	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
10. I am aware of the emergence of plastic pollution in the sea.					
11. Plastics are found during fishing					

activities.					
12. Plastics are more than other litter on this beach					
13. Littering on beaches by beach users, tourists, and local people					
14. Dumping on beaches or into the sea					
15. Wind					
16. Industrial activities					
17. Longshore drift					
18. Waste from canoes					
19. Stormwater discharge					
20. Plastic pollution affects the quality of fish.					
21. Plastic pollution damages fish habitats.					
22. Plastic pollution leads to a reduction in fish stock.					
23. Plastic pollution breeds harmful organisms in the sea					
24. Plastic entanglement, ingestion, and laceration lead to fish death					
25. Plastic pollution leads to fish migration					

SECTION C: SOCIAL EFFECTS (SE) OF COASTAL PLASTIC POLLUTION

Please rate 1-5 the social effects of coastal plastic pollution.

STATEMENT	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree

	1	2	3	4	5
26. Plastic pollution prevents tourists to this area.					
27. Plastic pollution affects recreational activities in this area.					
28. Using a plastic-accumulated beach brings discomfort.					
29. Plastic pollution leads to the breeding of mosquitoes which can affect human health.					
30. The consumption of fish that has ingested plastic can be detrimental to human health.					
31. Plastic pollution destroys the aesthetic nature of beaches.					
32. Plastics cause injury to fisherfolks					
33. Plastic pollution affects navigation on the sea.					

SECTION E: ECONOMIC EFFECTS (EE) OF COASTAL PLASTIC POLLUTION.

Please rate from 1-5 the economic effects of coastal plastic pollution on fishermen.

STATEMENT	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
34. Plastic pollution leads to a reduction in annual fish catch (last five years)					
35. Plastic pollution affects income levels (last five years)					
36. Plastic pollution damages fishing equipment					
37. Plastic pollution contributes to the high cost of maintenance of fishing equipment.					
38. Plastic pollution interferes with fishing activities.					

SECTION F: FISHERMEN COPING MECHANISMS

39. What strategies have you adopted to keep you in the fishing business? (last five years)
40. Are these strategies being implemented at the association level or individual level?
41. What do you suggest should be done to curb the plastic pollution menace? ...…….

Thank you for your time

IN-DEPTH INTERVIEW GUIDE FOR KEY INFORMANTS

This in-depth interview is strictly for academic purposes. Your responses will be treated with a high level of confidentiality and the outcome will help the researcher examine the socio-economic effects of coastal plastic pollution, a case study at the coastline of central region, Ghana. Information from this in-depth interview will be used solely for this research. You are therefore assured of full confidentiality, privacy, as well as anonymity. I would kindly request that you answer the following questions and please be frank as much as possible in your responses. Thank you for your cooperation.

CHIEF FISHERMEN

RESPONDENT DEMOGRAPHIC BACKGROUND

1. The number of years spent as a fishmonger
2. Age
3. Marital status
4. The number of dependents
5. Sources of fund
6. Main Occupation
7. Other occupation

SOCIO-ECONOMIC EFFECTS OF COASTAL PLASTIC POLLUTION

8. How has plastic pollution influenced tourism and recreational activities in this area?
9. How has plastic pollution affected the health condition of people here?
10. Have you ever caught plastics while fishing? How is that affecting your work?
11. How has plastic pollution affected fishing activities in general?
12. How has plastic pollution affected your income for the past five years?
13. How has plastic pollution affected your fishing equipment?
14. What other areas of your life has coastal plastic pollution affected and how?

IN-DEPTH INTERVIEW GUIDE FOR QUEEN OF FISH MONGERS
RESPONDENT DEMOGRAPHIC BACKGROUND

15. The number of years spent as a fishmonger
16. Age
17. Marital status
18. The number of dependents
19. Are you the sole breadwinner of the family?
20. Sources of fund
21. Main Occupation
22. Other occupation

SOCIO-ECONOMIC EFFECTS OF COASTAL PLASTIC POLLUTION

23. How has plastic pollution affected your life and business?
24. What threats has plastic pollution brought to you as go about your business?
25. How has plastic marine litter affected your trading activities, in terms of cost, quantity, quality, durability, taste, etc?
26. What measures have the mongers' associations done to solve coastal plastic pollution menace?

APPENDIX C
ADDITIONAL INFORMATION ABOUT THE SIX COMMUNITIES
(Completed form for the six communities)

OSPAR Marine Litter Beach Questionnaire

Name of beach: **Moree**
OSPAR beach ID: ……………………………………………………..
Country: **Ghana**

Beach width at mean low spring tide: **20.48 (m)**

Beach width at mean high spring tide**: 45.75 (m**)
Total length of beach: **1500 (m)**
Back of beach (example dunes): **vegetation, settlement, and lagoon**
GPS coordinates start 100 m: **CM-0918-4725**
GPS coordinates end 100 m: **CM—832-7926**
Coordinates: **5°7´60´´N 1°12´0´´W**
Coordinate system used: **Ghana Post GPS App**
Date position measured: **3/11/ 22**
Prevailing currents off the beach*: **West**
Prevailing winds*: **West**

When you look from the beach to the sea, what direction is the beach facing*: **South**
Type of beach material (% coverage): **100% sand**
Beach topography: **Slope** 5%
Are there any objects in the sea (e.g. a pier) that influence the currents: **Rocks**

Major beach usage (local people, swimming and sunbathing, fishing, surfing, sailing, etc.):
Local people, fishing and swimming, production of concrete blocks and canoes (Whole year round)

Access to the beach: **a. Vehicle** **b. Pedestrian** c. Boats *you may tick one or two

Is there any development behind the beach: **Yes**, please describe: **there is a settlement of about five hundred people whose main work is fishing, the production of concrete blocks from the sea sand, and the production of canoes**.

Are there food and/or drink outlets on the beach**: a. No**

How often is the beach cleaned**: Occasionally**
What method is used: **Manual**
Who is responsible for the cleaning: **Zoom Lion (a waste management company) stopped about 5 years ago because they were not paid so the residents of the community clean there once in a while or occasionally**

Additional comments and observations about this beach: **the beach of Moree is very vast and it has two main parts. One part is the main landing beach occupied with canoes, has a sea defense and the community uses the beach as a refuse dump. The other part is where the survey was done locally called Tweewui (seine fishing method) or Anwiam (sandy beach). The**

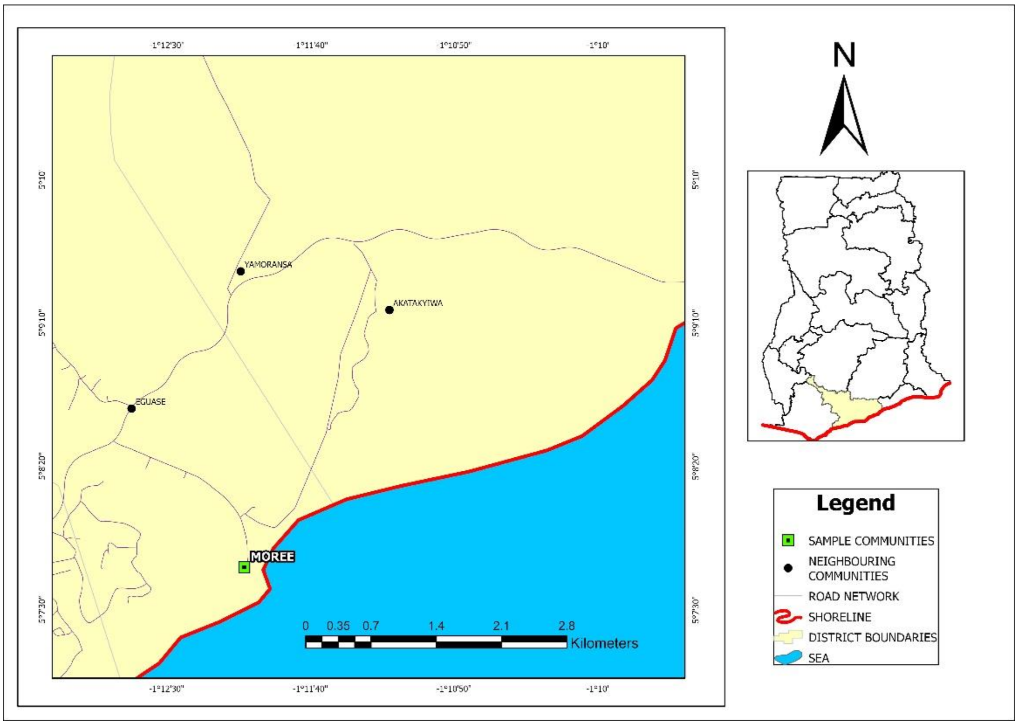
fishing method used at the survey area is the beach seine fishing method. There is a lagoon behind the beach and that is where the residents dump refuse. The beach is full of litter of which plastics are the majority. The distance from the mouth of the lagoon to the sea is 53.34m. The distance from their houses to the sea is 52m. All the refuse from the main landing beach and the lagoon comes to the beach when it rains.

Please include:

1. A map of the beach
2. A map of the beach and the local surroundings. When relevant please mark on this map the following:

Nearest town Food/drink outlets Nearest shipping lane
Nearest harbour Nearest river mouth Discharge or discharges of wastewater

3. A regional map



Is this an amendment to an existing questionnaire: **No**
Date questionnaire is filled in: 3 /11 / 22 (d/m/y)
Name**: Philomena Aboagye-Danso**

Phone number: **0553682151**
E-mail: philomenaaboagyedanso@gmail.com, p.aboagye-danso@stu.ucc.edu.gh

Additional Information *100 m*

Was litter collected during this survey**: Yes**
When the beach was last cleaned: **2years ago**
Did you divert from the predetermined 100 meters: **No**

Did any of the following weather conditions affect the data of the surveys: **No**
If so please tick the appropriate box: a. Wind b. Rain c. Snow d. Ice e. Fog .f. Sand storm d. Exceptionally high tide

Did you find stranded or dead animals: **No**

Please describe the animal, or note the species name if known:
Alive Dead
Sex of animal (if known):
Age of animal (if known):

Is the animal entangled in the litter: Yes No
If so please describe the nature of the entanglement and the type of litter:

Were there any circumstances that influenced the survey. For example tracks on the beach (cleaning or other), recent replenishment of the beach, or others.
Please specify: …………………………………………………..

Were there any events that lead to unusual types and/or amounts of litter on the beach?
For example beach events or other. **No event**
Please specify:

OSPAR Marine Litter Beach Questionnaire

Name of beach: **Saltpond**
OSPAR beach ID: ………………………………………………..
Country: **Ghana**

Beach width at mean low spring tide: **30.48 (m)**

Beach width at mean high spring tide**: 50.75 (m**)
Total length of beach: **1700 (m)**
Back of beach (example dunes): **vegetation, settlement and lagoon, food and drink outlet**
GPS coordinates start 100 m: **CM-0006-5943**
GPS coordinates end 100 m: **CM—0006-1938**
Coordinate system used: **5°12'32.9"N, - 1°08'38.1"W**
Date position measured: **25/11/ 22**
Prevailing currents off the beach*: **West**
Prevailing winds*: **West**

When you look from the beach to the sea, what direction is the beach facing*: **South**
Type of beach material (% coverage): **100% sand**
Beach topography: **gentle slope**
Are there any objects in the sea (e.g. a pier) that influence the currents: **no**

Major beach usage (local people, swimming and sunbathing, fishing, surfing, sailing, etc.):
Local people, beach users, fishing and swimming, (Whole year round)

Access to the beach: **a. Vehicle** **b. Pedestrian** c. Boats *you may tick one or two
Is there any development behind the beach: **Yes**, please describe: **there is a settlement along the beach, whose main work is fishing, and there are several eateries.**

Are there food and/or drink outlets on the beach**: a. Yes**

What is the distance from the survey area to the food and/or drink outlet: ……………… (km)
Present all year round: a. **Yes**, b. No, please specify in month:
Position of food and/or drink outlet in relation to the survey area: **North** e.g.*: N E S W

What is the distance from the beach to the nearest shipping lane: (km)
What is the estimated traffic density: *(number of ships/year)*
Is it used mainly by merchant ships, fishing vessels or all kinds:
Position of the shipping lane in relation to survey area*: N E S W

What is the distance from the beach to the nearest harbour: (km)

What is the name of the harbour:
Position of harbour in relation to survey area*: N E S W
Type of harbour:
Size of harbour (number of ships):

What is the distance from the beach to the nearest river mouth: (km)
What is the name of the river:
Position of river mouth in relation to survey area*: a. N b. E c. S d. W

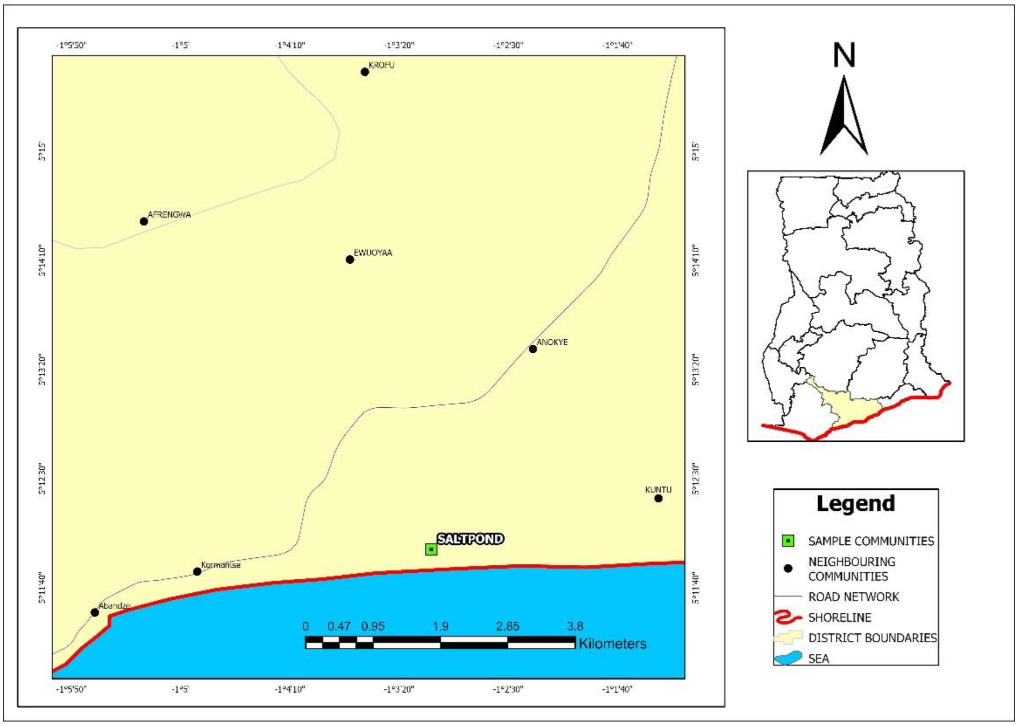
Is the beach located near a discharge or discharges of wastewater:
What is the distance from the beach to the discharge points: ……………… (km)
Position of discharge points in relation to survey area*: a. N b. E c. S d. W
*you may tick one or two boxes

How often is the beach cleaned**: Occasionally**
What method is used: **Manual**

Who is responsible for the cleaning: **Zoom Lion (a waste management company) stopped about 5 years ago because they were not paid so the residents of the community and the eatery operators clean there once in a while or occasionally**

Additional comments and observations about this beach:

Please include:
1. A map of the beach
2. A map of the beach and the local surroundings. When relevant please mark on this map the following:
Nearest town Food/drink outlets Nearest shipping lane
Nearest harbour Nearest river mouth Discharge or discharges of wastewater
3. A regional map


KROFU
AFRENGWA
EWUOYAA
ANOKYE
KUNTU
SALTPOND
Kormantse
Abandze
0 0.47 0.95 1.9 2.85 3.8
Kilometers
N
Legend
SAMPLE COMMUNITIES
NEIGHBOURING COMMUNITIES
ROAD NETWORK
SHORELINE
DISTRICT BOUNDARIES
SEA

Is this an amendment to an existing questionnaire: No
Date questionnaire is filled in: 3 /11 / 22 (d/m/y)
Name**: Philomena Aboagye-Danso**

Phone number: **0553682151**
E-mail: **philomenaaboagyedanso@gmail.com**, **p.aboagye-danso@stu.ucc.edu.gh**

Additional Information *100 m*

Was litter collected during this survey**: Yes**
When the beach was last cleaned:
Did you divert from the predetermined 100 meters: **No**

Did any of the following weather conditions affect the data of the surveys: **No**
If so please tick the appropriate box: a. Wind b. Rain c. Snow d. Ice e. Fog .f. Sand storm d. exceptionally high tide

Did you find stranded or dead animals: **No**

Please describe the animal, or note the species name if known:
Alive Dead
Sex of animal (if known):
Age of animal (if known):

Is the animal entangled in the litter: Yes No
If so please describe the nature of the entanglement and the type of litter:

Were there any circumstances that influenced the survey. For example tracks on the beach (cleaning or other), recent replenishment of the beach, or others.
Please specify: …………………………………………………..

Were there any events that lead to unusual types and/or amounts of litter on the beach?
For example beach events or other. **No event**
Please specify:

OSPAR Marine Litter Beach Questionnaire

Name of beach: **Akosua Village (Winneba)**
OSPAR beach ID: …………………………………………………..
Country: **Ghana**

Beach width at mean low spring tide: **20.48 (m)**
Beach width at mean high spring tide**: 50.75 (m**)
Total length of beach: **15000 (m)**
Back of beach (example dunes): **vegetation, settlement, lagoon**
GPS coordinates start 100 m: **CE-748-2498**
GPS coordinates end 100 m: **CE-748-2799**
Coordinate system used**: 5°19'48"N, - 0°38'24"W**
Date position measured: **21/11/ 22**
Prevailing currents off the beach*: **East**
Prevailing winds*: **East**

When you look from the beach to the sea, what direction is the beach facing*: **South**
Type of beach material (% coverage): **100% sand**
Beach topography: **gentle slope**
Are there any objects in the sea (e.g. a pier) that influence the currents: **No**

Major beach usage (local people, swimming and sunbathing, fishing, surfing, sailing, etc.):
Local people, Visitors, fishing and swimming (Whole year round)

Access to the beach: **a. Vehicle** **b. Pedestrian** c. Boats *you may tick one or two

---

Please use official data only for the following questions

What is the distance to the nearest town: 3.5 km
What is the position of the town in relation to the survey area: **Northeast**
What is the (seasonal) population size of this town: about **700 people**

Is there any development behind the beach: **Yes**, please describe: there is a settlement of about seven hundred people whose main work is fishing.

Are there food and/or drink outlets on the beach**: b. No**

What is the distance from the survey area to the food and/or drink outlet:
Present all year round: a. Yes, b. No, please specify in month:
Position of food and/or drink outlet in relation to the survey area:

What is the distance from the beach to the nearest shipping lane: (km)
What is the estimated traffic density: *(number of ships/year)*
Is it used mainly by merchant ships, fishing vessels or all kinds:
Position of the shipping lane in relation to survey area*: N E S W

What is the distance from the beach to the nearest harbour: (km)
What is the name of the harbour:
Position of harbour in relation to survey area*: N E S W
Type of harbour:
Size of harbour (number of ships) :

What is the distance from the beach to the nearest river mouth: (km)
What is the name of the river:
Position of river mouth in relation to survey area*: a. N b. E c. S d. W

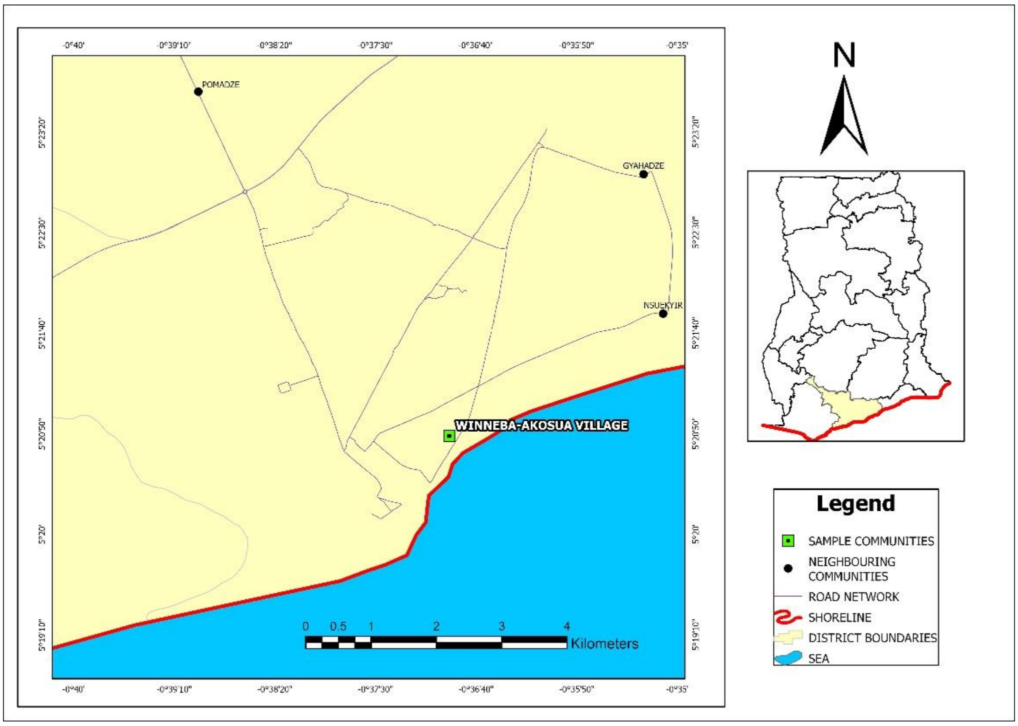
Is the beach located near a discharge or discharges of wastewater:
What is the distance from the beach to the discharge points: ……………… (km)
Position of discharge points in relation to survey area*: a. N b. E c. S d. W
*you may tick one or two boxes

How often is the beach cleaned**: Occasionally**
What method is used: **Manual**

Who is responsible for the cleaning: **Zoom Lion (a waste management company) but have stopped about 5 years ago because they were not paid so the residents of the community clean there once in a while or occasionally.**

Additional comments and observations about this beach**: the beach of Akosua village is very vast with settlements along the beach. The houses are 50 m from the sea. There is a lagoon at the back of the beach. There is a street in between the lagoon and the settlements. The beach has plastics on it because some of the residents throw rubbish into the sea. The sea in turn brings it back to the beach. The people living in this are Ewes and fishermen.**

Please include:
1. A map of the beach
2. A map of the beach and the local surroundings. When relevant please mark on this map the following:
Nearest town Food/drink outlets Nearest shipping lane
Nearest harbour Nearest river mouth Discharge or discharges of wastewater
3. A regional map



Is this an amendment to an existing questionnaire**: No**
Date questionnaire is filled in: 17 /11 / 22 (d/m/y)
Name**: Philomena Aboagye-Danso**

Phone number: **0553682151**
E-mail: philomenaaboagyedanso@gmail.com, p.aboagye-danso@stu.ucc.edu.gh

---

Additional Information *100 m*

Was litter collected during this survey**: Yes**
When the beach was last cleaned: **No idea**
Did you divert from the predetermined 100 meters: **No**

Did any of the following weather conditions affect the data of the surveys: **No**
If so please tick the appropriate box: a. Wind b. Rain c. Snow d. Ice e. Fog .f. Sand storm d. Exceptionally high tide

Did you find stranded or dead animals: **No**

Please describe the animal, or note the species name if known:
Alive Dead
Sex of animal (if known):
Age of animal (if known):

Is the animal entangled in the litter: Yes No
If so please describe the nature of the entanglement and the type of litter:

Were there any circumstances that influenced the survey. For example tracks on the beach (cleaning or other), recent replenishment of the beach, or others.
Please specify: …………………………………………………..

Were there any events that lead to unusual types and/or amounts of litter on the beach?
For example beach events or other. **No event**
Please specify:

OSPAR Marine Litter Beach Questionnaire

Name of beach: **Ola Beach (Cape Coast)**
OSPAR beach ID: …………………………………………………..
Country: **Ghana**

Beach width at mean low spring tide: **30.45 (m)**
Beach width at mean high spring tide**: 51.19 (m**)
Total length of beach: **1500 (m)**
Back of beach (example dunes): **settlement, animal farm, refuse dump, food and drink outlet(eateries or restaurants)**
GPS coordinates start 100 m: **CC-147-1846**
GPS coordinates end 100 m: **CC-147-3844**
Coordinate system used: **5°11'347"N, - 1°28'223"W**
Date position measured:**23/11/ 22**
Prevailing currents off the beach*: **East**
Prevailing winds*: **East**

When you look from the beach to the sea, what direction is the beach facing*: **South**
Type of beach material (% coverage): **100% sand**
Beach topography: **gentle slope**
Are there any objects in the sea (e.g. a pier) that influence the currents: **no**

Major beach usage (local people, swimming and sunbathing, fishing, surfing, sailing, etc.):
Local people, beach users, fishing and swimming, (Whole year round)

Access to the beach: **a. Vehicle** **b. Pedestrian** c. Boats *you may tick one or two

---

Is there any development behind the beach: **Yes,** please describe: **there is a settlement of about five hundred people whose main work is fishing and piggery**

Are there food and/or drink outlets on the beach**: a. No**

What is the distance from the survey area to the food and/or drink outlet: ……………… (km)
Present all year round: a. Yes, b. No, please specify in month:
Position of food and/or drink outlet in relation to the survey area e.g.*: N E S W

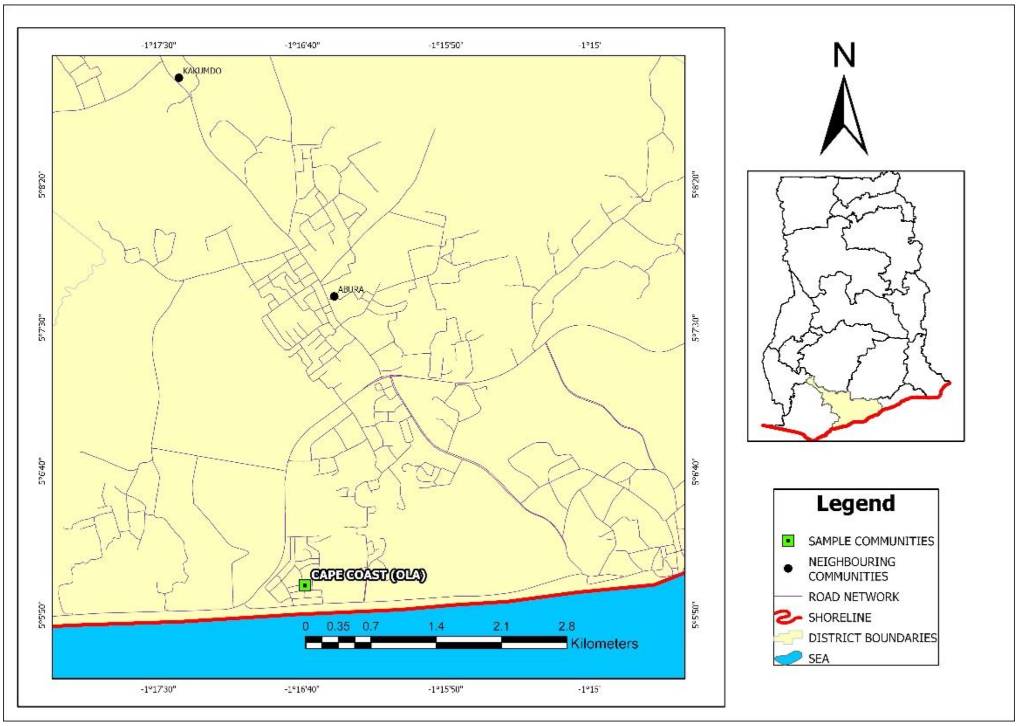
How often is the beach cleaned**: Daily**
What method is used: **Manual**

Who is responsible for the cleaning: **the community**

Additional comments and observations about this beach:

Please include:
1. A map of the beach
2. A map of the beach and the local surroundings. When relevant please mark on this map the following:
Nearest town Food/drink outlets Nearest shipping lane
Nearest harbour Nearest river mouth Discharge or discharges of wastewater

3. A regional map



Is this an amendment to an existing questionnaire: No
Date questionnaire is filled in: 3 /11 / 22 (d/m/y)
Name**: Philomena Aboagye-Danso**

Phone number: **0553682151**
E-mail: philomenaaboagyedanso@gmail.com, p.aboagye-danso@stu.ucc.edu.gh

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Additional Information *100 m*

Was litter collected during this survey**: Yes**
When the beach was last cleaned: **every morning**
Did you divert from the predetermined 100 meters: **No**

Did any of the following weather conditions affect the data of the surveys: **No**
If so please tick the appropriate box: a. Wind b. Rain c. Snow d. Ice e. Fog .f. Sand storm d. exceptionally high tide

Did you find stranded or dead animals: **No**

Were there any events that lead to unusual types and/or amounts of litter on the beach?
For example beach events or other. **No event**
Please specify:

OSPAR Marine Litter Beach Questionnaire

Name of beach: **Abrekum (Apam)**
OSPAR beach ID: …………………………………………………..
Country: **Ghana**

Beach width at mean low spring tide: **20.48 (m)**
Beach width at mean high spring tide**: 45.75 (m**)
Total length of beach: **10000 (m)**
Back of beach (example dunes): **vegetation, beach resort, and lagoon**
GPS coordinates start 100 m: **Cl-0017-0448**
GPS coordinates end 100 m: **Cl-0016-8895**
Coordinate system used**: 5°17'05.4"N 0°44'13.6"W**
Date position measured: **17/11/ 22**
Prevailing currents off the beach*: **East**
Prevailing winds*: **East**

When you look from the beach to the sea, what direction is the beach facing*: **South**
Type of beach material (% coverage): **100% sand**
Beach topography: **gentle slope**
Are there any objects in the sea (e.g. a pier) that influence the currents: **No**

Major beach usage (local people, swimming and sunbathing, fishing, surfing, sailing, etc.):
Local people, food and/or drink outlets, visitors, fishing, and swimming, (Whole year round)

Access to the beach: **<u>a. Vehicle</u>** **<u>b. Pedestrian</u>** c. Boats *you may tick one or two

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Please use official data only for the following questions

What is the distance to the nearest town**: 2km**
What is the position of the town in relation to the survey area: **West**

What is the (seasonal) population size of this town: ……………………..............

Is there any development behind the beach: **Yes**, please describe: **there is a settlement of about five thousand people whose main work is fishing, the production of concrete blocks from the sea sand, and the production of canoes.**

Are there food and/or drink outlets on the beach**: a. Yes**

What is the distance from the survey area to the food and/or drink outlet: **0.032 km**
Present all year round: **a. Yes,** b. No, please specify in month:
Position of food and/or drink outlet in relation to the survey area: **West**

What is the distance from the beach to the nearest shipping lane: (km)
What is the estimated traffic density: *(number of ships/year)*
Is it used mainly by merchant ships, fishing vessels or all kinds:
Position of the shipping lane in relation to survey area*: N E S W

What is the distance from the beach to the nearest harbour: (km)
What is the name of the harbour:
Position of harbour in relation to survey area*: N E S W
Type of harbour:
Size of harbour (number of ships) :

What is the distance from the beach to the nearest river mouth: (km)
What is the name of the river:
Position of river mouth in relation to survey area*: a. N b. E c. S d. W

Is the beach located near a discharge or discharges of wastewater:
What is the distance from the beach to the discharge points: ……………… (km)
Position of discharge points in relation to survey area*: a. N b. E c. S d. W
*you may tick one or two boxes

How often is the beach cleaned**: Occasionally**
What method is used: **Manual**

Who is responsible for the cleaning: **Zoom Lion (a waste management company) but have stopped for about more than 5 years ago because they were not paid so the residents of the community clean there once in a**

while or occasionally. The area where the food and/or drink outlet is, the owners clean the area every day.

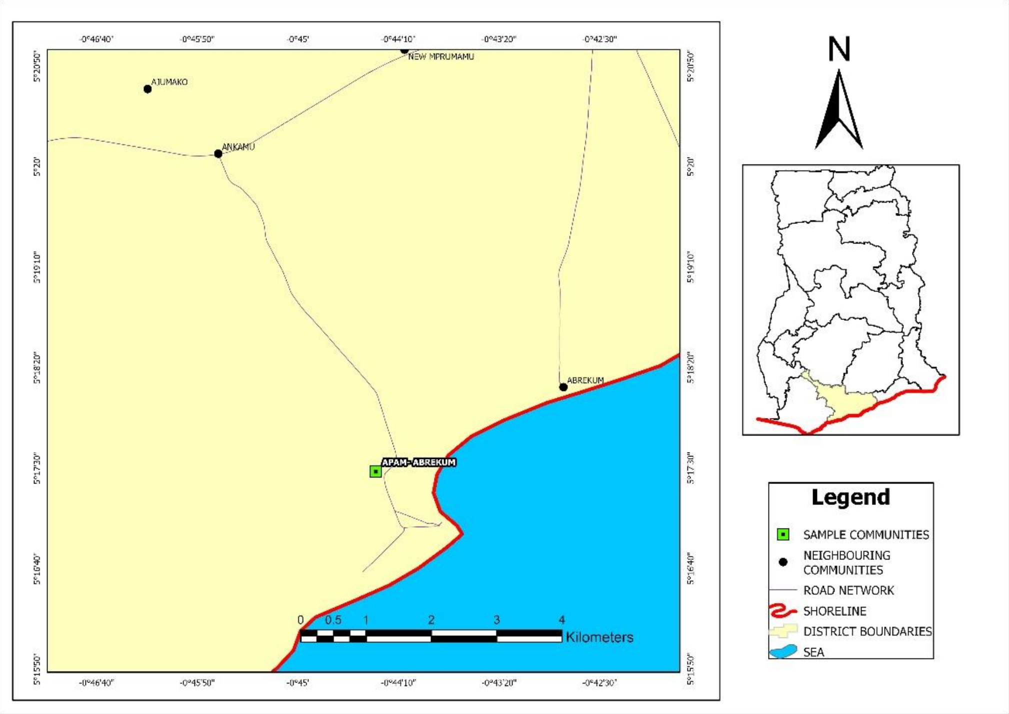
Additional comments and observations about this beach: **the beach of Abrekum is not so dirty but Apam Beach which is a landing beach has a refuse dump just 100m close. This is affecting Abrekum Beach.**

Please include:

1. A map of the beach
2. A map of the beach and the local surroundings. When relevant please mark on this map the following:

Nearest town Food/drink outlets Nearest shipping lane
Nearest harbour Nearest river mouth Discharge or discharges of wastewater

3. A regional map



Is this an amendment to an existing questionnaire: No

Date questionnaire is filled in: **17 /11 / 22** (d/m/y)

Name**: Philomena Aboagye-Danso**

Phone number: **0553682151**

E-mail: philomenaaboagyedanso@gmail.com, p.aboagye-danso@stu.ucc.edu.gh

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Additional Information ***100 m***

Was litter collected during this survey**: Yes**
When the beach was last cleaned: **2years ago**
Did you divert from the predetermined 100 meters: **No**

Did any of the following weather conditions affect the data of the surveys: **No**
If so please tick the appropriate box: a. Wind b. Rain c. Snow d. Ice e. Fog .f. Sand storm d. Exceptionally high tide

Did you find stranded or dead animals: **No**

Please describe the animal, or note the species name if known:
Alive Dead
Sex of animal (if known):
Age of animal (if known):

Is the animal entangled in the litter: Yes No
If so please describe the nature of the entanglement and the type of litter:

Were there any circumstances that influenced the survey. For example tracks on the beach (cleaning or other), recent replenishment of the beach, or others.
Please specify: ……………………………………………………..

Were there any events that lead to unusual types and/or amounts of litter on the beach?
For example beach events or other. **No event**
Please specify:

OSPAR Marine Litter Beach Questionnaire

Name of beach: **Bantoma Anwona (Elmina)**
OSPAR beach ID: …………………………………………………..
Country: **Ghana**

Beach width at mean low spring tide: **30.23 (m)**
Beach width at mean high spring tide**: 50.19 (m**)
Total length of beach: **1500 (m)**
Back of beach (example dunes): **settlement, refuse dump, public toilet facility**
GPS coordinates start 100 m: **no network**
GPS coordinates end 100 m: **no network**
Coordinate system used: **5°10'53"N, - 1°34'21"W**
Date position measured: **9/11/ 22**
Prevailing currents off the beach*: **East**
Prevailing winds*: **East**

When you look from the beach to the sea, what direction is the beach facing*: **South**
Type of beach material (% coverage): **100% sand**
Beach topography: **gentle slope**
Are there any objects in the sea (e.g. a pier) that influence the currents: **no**

Major beach usage (local people, swimming and sunbathing, fishing, surfing, sailing, etc.):
Local people, beach users, fishing and swimming, (Whole year round)

Access to the beach: <u>**a. Vehicle**</u> <u>**b. Pedestrian**</u> c. Boats *you may tick one or two

Please use official data only for the following questions

What is the distance to the nearest town**: 1km**
What is the position of the town in relation to the survey area: **Northeast and west**
What is the (seasonal) population size of this town ……………………..............

Is there any development behind the beach: **Yes**, please describe: **there is a settlement of about five hundred people whose main work is fishing,**

production of concrete blocks from the sea sand, and production of canoes.

Are there food and/or drink outlets on the beach**: a. Yes**

What is the distance from the survey area to the food and/or drink outlet: **100m**
Present all year round: a. **Yes,** b. No, please specify in month:
Position of food and/or drink outlet in relation to the survey area: **North** e.g.*: **N** E S W

What is the distance from the beach to the nearest shipping lane: (km)
What is the estimated traffic density: *(number of ships/year)*
Is it used mainly by merchant ships, fishing vessels or all kinds:
Position of the shipping lane in relation to survey area*: N E S W

What is the distance from the beach to the nearest harbour: (km)
What is the name of the harbour:
Position of harbour in relation to survey area*: N E S W
Type of harbour:
Size of harbour (number of ships):

What is the distance from the beach to the nearest river mouth**:** (km)
What is the name of the river:
Position of river mouth in relation to survey area*: a. N b. E c. S d. W

Is the beach located near a discharge or discharges of wastewater: **NO**
What is the distance from the beach to the discharge points: ……………… (km)
Position of discharge points in relation to survey area*: a. N b. E c. S d. W
*you may tick one or two boxes

How often is the beach cleaned**: Daily**
What method is used: **Manual**

Who is responsible for the cleaning: **the community**

Additional comments and observations about this beach**:**
There is a toilet facility and refuse dump about 3km behind the beach.

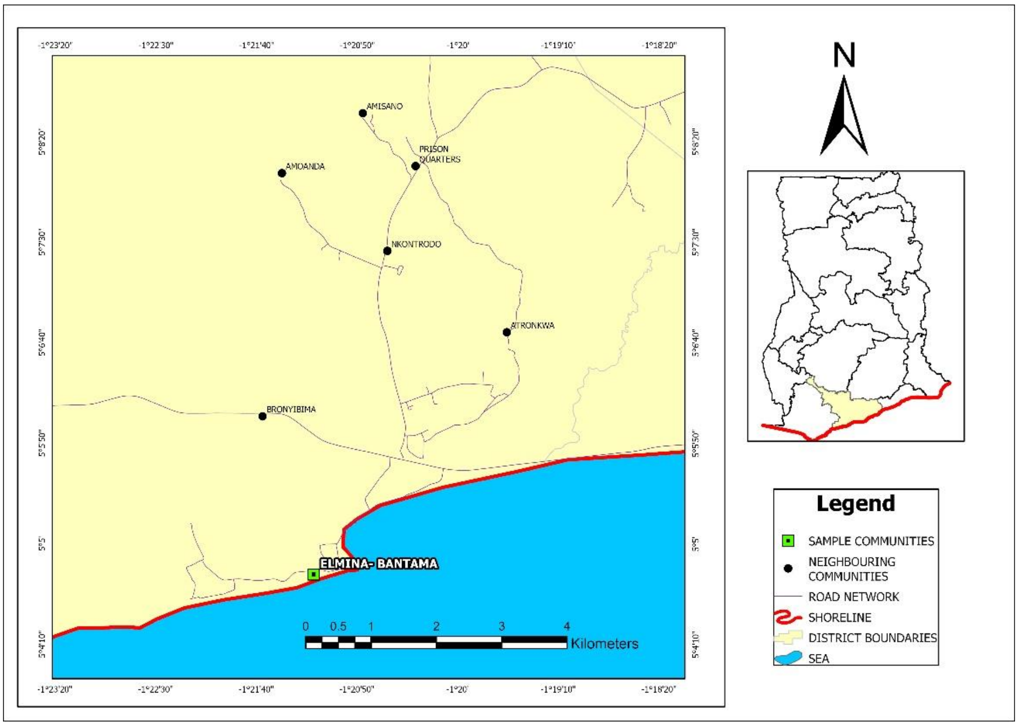
Please include:
1. A map of the beach

2. A map of the beach and the local surroundings. When relevant please mark on this map the following:

Nearest town — Food/drink outlets — Nearest shipping lane

Nearest harbour — Nearest river mouth — Discharge or discharges of wastewater

3. A regional map



Is this an amendment to an existing questionnaire: **No**

Date questionnaire is filled in: **3 /11 / 22** (d/m/y)

Name**: Philomena Aboagye-Danso**

Phone number: **0553682151**

E-mail: **philomenaaboagyedanso@gmail.com, p.aboagye-danso@stu.ucc.edu.gh**

Additional Information *100 m*

Was litter collected during this survey**: Yes**

When the beach was last cleaned: **every morning**

Did you divert from the predetermined 100 meters: **No**

Did any of the following weather conditions affect the data of the surveys: **No**

If so please tick the appropriate box: a. Wind b. Rain c. Snow d. Ice e. Fog .f. Sand storm d. exceptionally high tide

Did you find stranded or dead animals: **No**

Please describe the animal, or note the species name if known:
Alive Dead
Sex of animal (if known):
Age of animal (if known):

Is the animal entangled in the litter: Yes No
If so please describe the nature of the entanglement and the type of litter:

Were there any circumstances that influenced the survey. For example tracks on the beach (cleaning or other), recent replenishment of the beach, or others.
Please specify: …………………………………………………..

Were there any events that lead to unusual types and/or amounts of litter on the beach?
For example beach events or other. **No event**
Please specify:

APPENDIX D

ORIGINAL OSPAR MARINE BEACH LITTER FORM

OSPAR Marine Litter Monitoring Survey Form

Date	OSPAR ID	UNEP ID	ITEMS	TOTAL
	Plastic/polystyrene			
	1		4/6-pack yokes	
	2		Bags (e.g. shopping)	
	3		Small plastic bags, e.g., freezer bags	
	112		Plastic bag ends	
	4		Drinks (bottles, containers, and drums)	
	5		Cleaner (bottles, containers, and drums)	
	6		Food containers incl. fast food containers	
	7		Cosmetics (bottles & containers e.g. sun lotion, shampoo, shower gel, deodorant)	
	8		Engine oil containers and drums <50 cm	

	9		Engine oil containers and drums > 50 cm	
	10		Jerry cans (square plastic containers with handles)	
	11		Injection gun containers	
	12		Other bottles, containers, and drums	
	13		Crates	
	14		Car parts	
	15		Caps/lids	
	16		Cigarette lighters	
	17		Pens	
	18		Combs/hair brushes	
	19		Crisp/sweet packets and lolly sticks	
	20		Toys & party poppers	
	21		Cups	
	22		Cutlery/trays/straws	
	23		Fertilizer/animal feed bags	
	24		Mesh vegetable bags	
	25		Gloves (typical washing-up gloves)	
	113		Gloves (industrial/professional gloves)	
	26		Crab/lobster pots	
	114		Lobster and fish tags	
	27		Octopus pots	
	28		Oyster nets or mussel bags including plastic stoppers	
	29		Oyster trays (round from oyster cultures)	
	30		Plastic sheeting from mussel culture (Tahitians)	
	31		Rope (diameter more than 1 cm)	
	32		String and cord (diameter less than 1 cm)	
	115		Nets and pieces of net < 50 cm	
	116		Nets and pieces of net > 50 cm	
	33		Tangled nets/cord/rope and string	
	34		Fish boxes	
	35		Fishing line (angling)	
	36		Light sticks (tubes with fluid)	
	37		Floats/Buoys	
	38		Buckets	
	39		Strapping bands	
	40		Industrial packaging, plastic sheeting	
	41		Fiberglass	
	42		Hard hats	
	43		Shotgun cartridges	
	44		Shoes/sandals	
	45		Foam sponge	

	117		Plastic/polystyrene pieces 0 - 2,5 cm	
	46		Plastic/polystyrene pieces 2,5 cm > < 50 cm	
	47		Plastic/polystyrene pieces > 50 cm	
	48		Other plastic/polystyrene items (please specify in other item boxes*)	
			RUBBER	
	49		Balloons, including plastic valves, ribbons, strings, etc.	
	50		Boots	
	52		Tyres and belts	
	53		Other rubber pieces (please specify in other item boxes*)	
			CLOTH	
	54		Clothing	
	55		Furnishing	
	56		Sacking	
	57		Shoes (leather)	
	59		Other textiles (please specify in other item boxes*)	
			PAPER / CARDBOARD	
	60		Bags	
	61		Cardboard	
	118		Cartons e.g. tetrapak (milk)	
	62		Cartons e.g. tetrapak (other)	
	63		Cigarette packets	
	64		Cigarette butts	
	65		Cups	
	66		Newspapers & magazines	
	67		Other paper items (please specify in other item boxes*)	
			WOOD (machined)	
	68		Corks	
	69		Pallets	
	70		Crates	
	71		Crab/lobster pots	
	119		Fish boxes	
	72		Ice lolly sticks/chip forks	
	73		Paint brushes	
	74		Other wood < 50 cm (please specify in other item boxes*)	
	75		Other wood > 50 cm (please specify in other item boxes*)	
			METAL	

	76		Aerosol/Spray cans	
	77		Bottle caps	
	78		Drink cans	
	120		Disposable BBQ's	
	79		Electric appliances	
	80		Fishing weights	
	81		Foil wrappers	
	82		Food cans	
	83		Industrial scrap	
	84		Oil drums	
	86		Paint tins	
	87		Lobster/crab pots and tops	
	88		Wire, wire mesh, barbed wire	
	89		Other metal pieces < 50 cm (please specify in other item boxes*)	
	90		Other metal pieces > 50 cm (please specify in other item boxes*)	
Glass				
	91		Bottles	
	92		Light bulbs/tubes	
	93		Other glass items (please specify in other item boxes*)	
Pottery. Ceramics				
	94		Construction material e.g. tiles	
	95		Octopus pots	
	96		Other ceramic/pottery items (please specify in other item boxes*)	
Sanitary waste				
	97		Condoms	
	98		Cotton bud sticks	
	99		Sanitary towels/panty liners/backing strips	
	100		Tampons and tampon applicators	
	101		Toilet fresheners	
	102		Other sanitary items (please specify in other item boxes*)	
Medical waste				
	103		Containers/tubes	
	104		Syringes	
	105		Other medical items (swabs, bandaging, etc.)	
Special observations and notes (please refer to number!) 100m				