Situational Analysis of Plastic Pollution in Freetown

Abstract

It is estimated that 8.3 billion metric tons of plastic have been produced since the 1950s. Approximately 80 percent have ended up in the ocean, landfills, or open flames. 742 tons of plastic waste is produced daily in Freetown and 84% are not effectively handled. 1.23b plastics will be produced by 2060. Plastic waste is a major problem in the slums bordering Freetown. Water sachets, empty bottles, and jerry cans litter the streets and clog up drains, causing flooding in disaster-prone areas. The study provides a situational analysis of plastic pollution with a comprehensive understanding of the sources, impacts, and waste management in Freetown.

The study employed a qualitative and integrative literature review. Contextualizing data from various reputable sources including government reports and international organizations. Databases such as Google Scholar, Scopus, and Web of Science were utilized to compile and analyze relevant information.

Data showed that, 80% of the 40,600 tons/year of plastic waste is dumped on streets. Sachet bags are the dominant accounting for 70-80% of plastic waste and are mainly from homes. This underscores the noteworthy challenges presented by plastic pollution in Freetown, further compounded by the city's swift population expansion, financial constraints, and inadequate infrastructure. Numerous plastic waste sources, most notably sachet water, pose a hazard to the environment and economy and jeopardize public health, municipal resources, and land and marine ecosystems.

To address these issues, the study proffers recommendations for the GoSL to invest in better infrastructure for waste management, strengthen legal frameworks, and encourage public involvement and awareness.

The study concluded that addressing Freetown's waste management challenges, especially plastic waste, requires cooperation between governmental bodies, businesses, civil society organizations, and the community.

Keywords: Plastic pollution; situational analysis; Freetown; sachet water; waste management; sustainable development goals

1.0 Introduction

It is estimated that 1.23 billion Plastics will be produced by 2060 according to OCED, 2022. (Figure 1). Since the 1950s, an estimated 8.3 billion metric tons of plastic have been manufactured**.[1]** Roughly 80 percent have been burned openly, dumped in landfills, or ended up in the water. Not even five percent has been recycled**.[1](only one time write the ref no. for whole paragraph)**Packaging materials that are thrown away after only one use account for around half of the plastic trash that is produced worldwide.**[2]** The production curve is rising. Although plastic has been produced since the early 20th century, its development in the last few years has been astounding. Approximately 50% of all plastic made to date has been produced in the previous 15 years,**[3]** with over 400 million tonnes of plastic produced annually worldwide.**[3](only one time write the ref no.3)** The predictions are concerning: during the next ten to fifteen years, the amount of plastic produced worldwide is expected to double, and this will unavoidably surpass and overwhelm any waste management systems that are implemented. The World Bank estimates that the weight percentage of plastics in municipal solid trash in low- and middle-income nations is 6.4% and 11%, respectively.**[3](This total paragraph should contain ref no. 3)**The most impoverished individuals and the ecosystems that support us all are suffering as a result of unchecked plastic waste.

(There is repetition of same no after one or two sentence)

Plastic has significantly improved our quality of life since it is an inexpensive, hygienic, and adaptable material that can be used for a wide range of purposes, such as food packaging, home appliances, buildings, and medical equipment. However, improper handling of plastic garbage can turn it into an environmental hazard if it is not recycled, burned, or stored in sealed landfills. Every year, between one and two million tonnes of plastic enter our waters, harming ecosystems and wildlife alike. Tackling this issue requires improving the global management of plastic trash, particularly in developing nations where the majority of ocean plastics originate.

Plastic waste is a major problem in the slums bordering Freetown, Sierra Leone's capital city. Water sachets (commonly used as drinking containers in the country), empty bottles and jerry cans litter the streets and clog up drains, causing flooding in disaster-prone areas. A "World Bank" study stated that almost 84% of plastic waste in Sierra Leone is not effectively handled, which is hurting the people, economy, and marine and coastal habitats of the nation.**[4, 5].**Plastic waste also poses public health issues, as blocked drainage causes water to stagnate and

mosquitoes to breed in a region where malaria is endemic. In times of floods, water contaminated by mud and waste is washed into open drinking water wells and can lead to disease.(Ref..)

The estimated daily garbage produced in the metro Freetown region is 742 tons. More than 84% of this is biodegradable organic waste, mostly from houses and vegetable markets.**[6]**Disposing of plastic garbage is a necessary activity since the Freetown City Council is now facing several difficulties in handling solid waste, including plastic. Communities like Susan's Bay, Kingtom, Kroo Bay, and Oldwharf are experiencing negative environmental effects from mismanaged sachet plastic waste because of a restricted budget, inadequate equipment for waste collection, and challenges collecting large amounts of sachet plastic waste produced by homes, businesses, and markets throughout the city.

Moreover, because there is little to no waste infrastructure in the Susan's Bay neighborhood, the increasing amount of improperly handled sachet plastic trash poses a severe problem for garbage disposal. The neighborhood produces thirty tons of plastic rubbish a year, most of which winds up in open landfills, unlicensed disposal facilities, or the environment. Consequently, 70% of plastic waste in Freetown is improperly handled. **[6] (kindly summarize the sentence in proper way and write the ref. no.6)** Since the end of the Civil War, the Freetown municipality has experienced a yearly rate of rapid urbanization. As a result, there is now congestion, which inevitably causes slumps and poorly managed informal communities to emerge.

Solid waste management is an expensive and time-consuming task in Freetown. Inadequate equipment, low service coverage, low budgets, and serious inefficiencies such as high labor expenses, low labor efficiency, unfavorable public perceptions, and a pervasive illegal dumping site are all present. The resulting economic crises, political unrest, domestic insurgency, and a growing population all put pressure on the skeleton solid waste management (SWM) infrastructure.

There is solid waste everywhere, stacked or dispersed in different amounts, and a lot of it is burned off regularly. In Freetown, the amount of plastic waste generated greatly exceeds the amount collected and transported. The ongoing buildup of plastic waste is mostly to blame for the city's dramatic increase in diseases spread by vectors. Most of the city's drains are currently choked with plastic waste. Due to capacity constraints, insufficient collection efforts, or environmentally irresponsible public behavior, plastic waste is often dumped outside in areas

where designated dumps or public "dustbins" or containers including skips are accessible. Open dumps are a common source of unpleasant and dangerous smells, and they give animals, flies, and informal waste pickers free access.

Therefore, solid waste management (SWM) in Freetown is crucial; as a result health, economic, and environmental concerns should be addressed, and they should be integrated with other general socioeconomic circumstances. Due to this congestion, downturns and casual networks with subpar waste management techniques have inevitably grown. Consequently, garbage is periodically covered in the streets, drainage channels, and unpaved and cleansed drains of many networks.

The refuse that has not been picked up is thrown carelessly into channels, banks of rivers, and roadways where it mixes with animal and human waste, causing flooding, the growth of rat and bug vectors, and the spread of illness. The decomposition of waste into air, soil, and water, leachate's destruction of surface and groundwater, air pollution from waste consumption, disease transmission by insects, birds, and rodents, and the uncontrollably high levels of methane produced by anaerobic waste disintegration are all examples of environmental solid waste resulting from inadequate waste removal. Due to this, there are serious financial and other welfare losses as well as risks to the health and well-being of people and animals.

The current research on plastic pollution in Freetown is limited, with fragmented data and anecdotal evidence about the extent and implications of the issue. This research aims to fill the gap by conducting a thorough situational analysis of plastic pollution in Freetown, Sierra Leone, to provide a comprehensive understanding of the sources, impacts, and management of plastic waste in the city.

The situational analysis of plastic pollution in Freetown holds significant importance on several levels. Firstly, it will provide crucial insights for policymakers, local authorities, and environmental organizations to develop evidence-based strategies and interventions to tackle plastic pollution effectively. Additionally, the research findings can raise awareness among the public and local communities about the impacts of plastic waste and the importance of responsible consumption and waste management practices. Moreover, by addressing plastic pollution, the research can contribute to environmental protection, public health improvement, and the sustainable development of Freetown, aligning with global efforts to combat plastic pollution and achieve a cleaner and healthier urban environment.

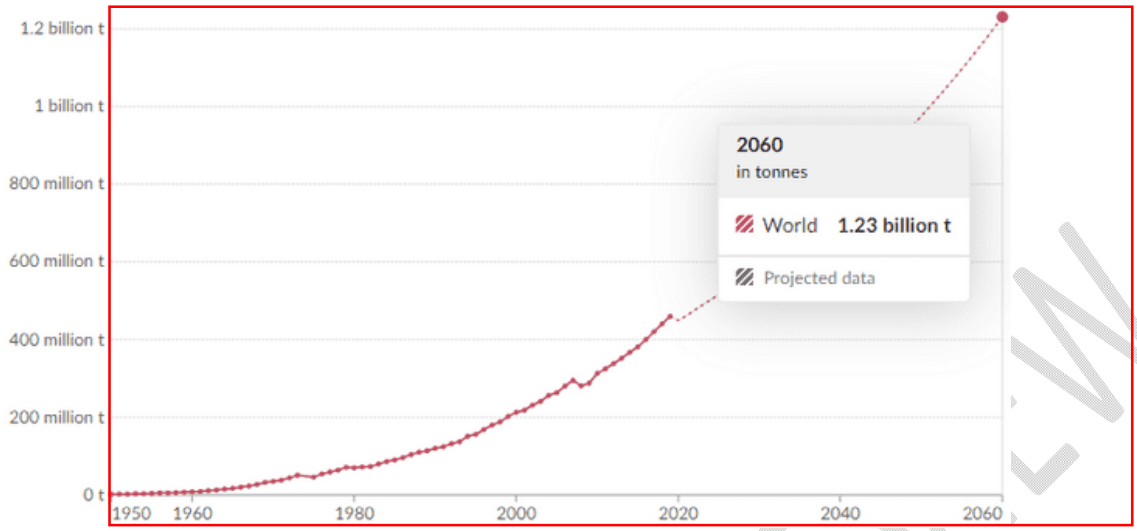

Figure 1**.** Global Production Plastic Projections from 1950 – 1960

Data Source: OCED, 2022 **Accessed** 2024/02/10

2.0 How Plastic Pollution Impacts the Sustainable Development Goals (SDGs)

The 2030 Agenda for Sustainable Development was accepted by every member state of the United Nations in 2015. As for peace and prosperity for people and the earth, now and into the future, it offers a "shared blueprint”**.[7]**It contains the 17 Sustainable Development Goals (SDGs), which demand that all nations take immediate action. Over half of the Goals are directly impacted by plastic pollution.

2.1Goal 1: End poverty in all its forms everywhere

Due to its direct impact on livelihoods in agriculture, fishing, and tourism, as well as its capacity to cause natural disasters like flooding and harm to people's health and ability to work, plastic pollution exacerbates poverty and vulnerability.

In Sierra Leone, plastic pollution blocked drainage and waterways which caused damage to homes and business shops especially those in slum settlements. This results in increased poverty as people have to make shifts in public markets or shops to sleep at night.

2.2Goal 2: Put an end to hunger, ensure food security, enhance nutrition, and advance sustainable agriculture

Plastic pollution is endangering biodiversity, which is necessary for the production of wholesome food, and contaminating our waters, oceans, forests, and soils.

For almost 3 billion individuals, 20 percent of their protein intake comes from fishing. Fifty to sixty percent of the total protein in the diets of Small Island Developing States (SIDS), South Asia, West Africa, and South-East Asia comes from fish. **[8]**For Freetonians especially those living along the coast, fishing plays a significant source of income and food security for fishermen and traders, however, plastic pollution has deterred the fishery sector which has considerable effects in enhancing nutrition and food security.

2.3Goal 3: Ensure healthy lives and foster wellness for everyone, regardless of age

Flooding and the spread of water-borne illnesses including**(It should be water borne or water induced illness because few diseases written are water induced as malaria aand dengue)**. cholera, dengue fever, malaria, and dysentery are brought on by plastic. Burning plastic pollutes the air and raises the risk of cancer and heart disease, among other illnesses.

Diseases linked to uncollected waste cause between 400,000 and 1 million deaths annually in low- and middle-income nations. That is one person every 30 seconds. This in Freetown is a serious challenge as burning plastic is the most dominant method in the two major landfills

(Bomeh and Kingtom???). This behavior leads to lung and cancer problems, especially for residents around those landfills. The attitude of throwing plastic during the rains in the guitars also serves as breading for mosquitos that cause malaria and cholera and is a public health challenge. In areas where malaria is endemic, blocked drainage leads to stagnant water and mosquito breeding, which further poses a health risk to the public from plastic garbage. During floods, sewage and mud-contaminated water can wash into exposed drinking water wells, spreading illness.

Malaria accounts for a large proportion of death and disease in Sierra Leone with more than 2.5 million cases and over 6,800 deaths reported in 2019 by the Centers for Disease Control (CDC, 2019).**[9]**

2.4Goal 14: Preserve and responsibly utilize the seas, oceans, and marine resources for sustainable development

Ocean pollution from plastic is endangering marine life and is a serious threat to biodiversity. Every year, between 8 and 12.7 million tons of plastic are thought to enter the ocean.**[10]** By 2050, there may be more plastic in the ocean than fish.[11] In Freetown, around 80% of the 40,600 tons/year of plastic waste is currently being dumped on streets and rivers where it flows down to coastal communities and then into the ocean.**[12]**

2.5Goal 15: Preserve, repair, and encourage the sustainable use of terrestrial ecosystems; manage forests sustainably; stop desertification; stop and reverse land degradation; and stop the loss of biodiversity.

Plastic pollution is endangering terrestrial biodiversity and contaminating terrestrial ecosystems in Freetown. It is estimated that a third of all plastic debris is thought to wind up in freshwater or soil.**[13]**

2.6Goal17: Enhance the methods of execution and reinvigorate the worldwide alliance for sustainable development

To address the plastic pollution challenge in Freetown, additional financial resources such as Official Development Assistance (ODA) are required by international organizations and development agencies. The budget allocated to the Freetown City Council is relatively low and therefore tackling waste management, especially plastic is a serious challenge as there are low numbers of staff, vehicles, and technology transfers. The amount of ODA now allocated to waste management is about 0.3%.**[14]**

Therefore, Sierra Leone, specifically Freetown cannot fully attained the Sustainable Development Goals (SDGs) that are to be achieved in 2030, if we don't tackle plastic pollution. We are at a crossing point, as more plastic production companies especially sachet water increase production of plastic without being properly checked by the government authorities. This is because plastic is a cheap commodity and persistent poverty in the country, people look for cheap products like sachet water (Figure 2) and polyethylene terephthalate (PET) bottles, most commonly used for soft drinks, including water (Figure 3), and other plastic products that they can afford. As there are no laws on plastic pollution in Sierra Leone and the country doesn't intend to even ban plastic production like other countries have pledged, our oceans, streets, guitars, and landfills will be piled up with plastic waste, causing more public health risks. This will overwhelm our waste management systems and people and animals will continue to suffer.

Additionally, the task itself is very dangerous. Informal waste pickers (Those normally called Klin Salone) are more susceptible to cholera, diarrhea, and other health problems**.(Ref…)** Working without gloves and face-mask expose them to needles and other sharp objects that are

dangerous, and open wounds are prone to infection. Even while their engagement can improve the welfare and lives of some of the poorest individuals in Freetown and simultaneously save expenses for Freetown City Council, they are frequently left out of framework for waste management. It is high time the Government of Sierra Leone and the global community act.

3.0 Methodology

The study used an integrative review to provide the results of the investigation into the pollution caused by plastic garbage in the Municipality of Freetown. The phenomena was examined using statistical analysis and observations represented in numerical drawings. This study effort used comprehensive evaluations of web resources and contextualized real-world data on the current level of plastic pollution in Freetown municipalities. The focus of this study project is Freetown, Sierra Leone's largest urban metropolitan settlements for plastic pollution. Even though solid waste is less dangerous when dry, proper management always calls for more careful handling and thought. **(Ref..)**

The purpose of the study was to collect qualitative data by evaluating the situation of plastic pollution in Freetown. "Peer-reviewed online resources like publications on plastic pollution situations, mostly from popular data base; Google Scholar, PUB MED, Scopus, Research Gate, Web of Science, Government of Sierra Leone Reports; World Bank, WHO, EPA-SL, and UNEP reports. For this study, dependable and consistent data and facts were obtained using key phrases such as plastic pollution, Freetown City Council, waste management practices, sources of the primary plastic waste, challenges facing waste management practices, and plastic waste impacts on the environment, social, and economy in Freetown. When the aforementioned terms were entered into the Google Scholar search engine, an average of 1,850 results and the metadata of academic publications were shown.

Furthermore, to get consistent information on quantitative situational studies of plastic pollution in Freetown, the data were condensed and sorted.

Moreover, physical observations made along key roadways and neighborhoods that were explicitly stated in the scientific literature and publications were compared with the findings and reports from other sources, including the World Bank, WHO, and UNEP. Ninety-five percent of the chosen reports and peer-reviewed articles demonstrate recurrent influencing elements that are associated with improved environmental sustainability and public health. With the use of this

qualitative study design, the authors were able to prove that the demand for sachet water led to the emergence of the plastic pollution issue.

4.0 Description of Site Specific

The study site specific is Freetown, the capital of Sierra Leone, located on the West Coast of Africa (Figure 4). With a total size of 357 square kilometers, Freetown was established on March 11, 1792, and is situated at 8.48˚N and 13.23˚W. As Per**[15]**

According to**[16]**and Redshaw et al. (2019)????,**(Either write no. or use the name)** it is located on an igneous intrusion with a funnel form along the Atlantic Coast. Tropical weather prevails in Freetown, which is located 47 meters above sea level. In most months of the year, there is a lot of rainfall.**[17]**

According to research by Peel, Finlayson, and McMahon (2007)**,[18]** the "Am"-Tropical Monsoon Climate classification sub-type corresponds to this climate. It is typically 26.2˚C/79.2˚F in Freetown. About 3657 mm of rain falls here annually. The average temperature for the hottest month is 83.0˚F (28.3˚C), which is experienced in April. July has the lowest average temperature, at 25.6˚C/78.0˚F, making it the coldest month.**[18] (only one time write the ref no. for whole paragraph)**

However, situated on a portion of the Sierra Leone River estuary, the city serves as the commercial, financial, and cultural hub of Sierra Leone. The city's economy is centered on its harbor. Queen Elizabeth 11 Quay, a natural harbor, is among the biggest in the whole globe.

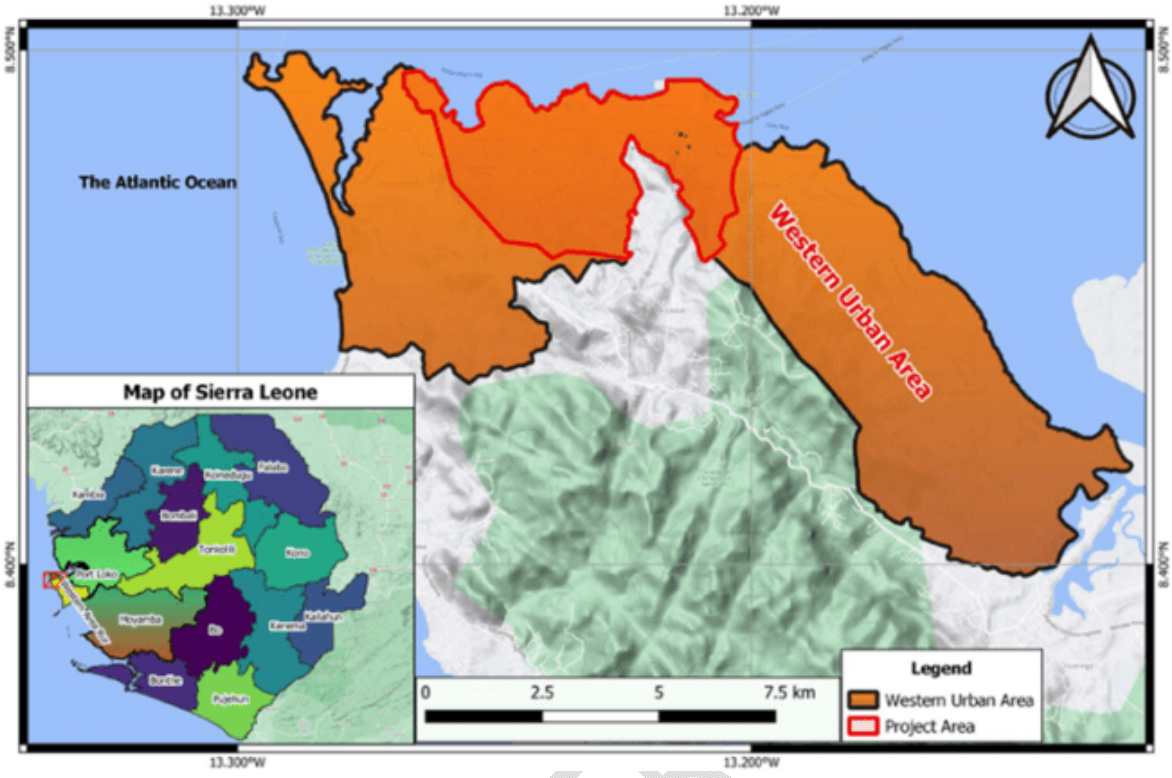

Figure 2**.** Map of Sierra Leone and Site Specific (Freetown)

The three main municipal regions of Freetown City are the East End, Central, and West End. Eight electoral wards comprise these regions: East I, East II, East III, and Central I, Central II, West I, West II, and West III. According to the Government of Sierra Leone, among the three regions in Freetown, the East End region has the densest population.

Freetown's economy and infrastructure development were severely hampered by the ten-year, horrific conflict, which broke out in 1991 and ended in 2001. These included, but were not restricted to, the destruction of equipment used for trash disposal, such as big skip containers, Lorries, and other associated facilities.

Additionally, as the population surges in Freetown for the hunt for better opportunities the management of waste becomes a challenge. The population of Freetown as of 2021 MTPHC, surged to 1,268,757 an increase from 563,000 in 1991.**[19].** More so, it is estimated high in 2024 to be 1.3 million population (Figure 3) a growth by 1% (World **[20].** World Statistics Day 2020-Global connectivity with reliable data **[21]** **(there must be a kind of rectification in writing of ref… or more sentences should be added)**

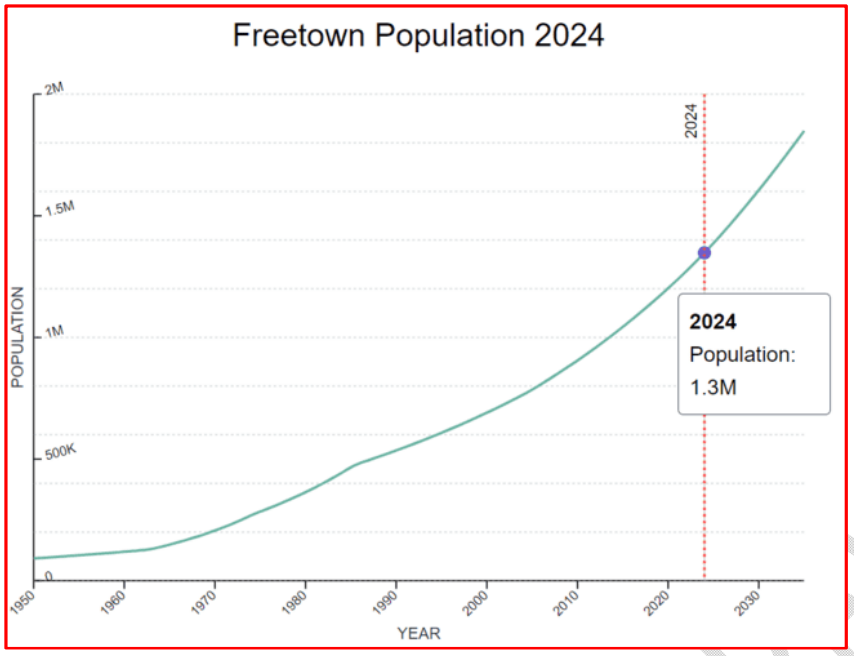

Figure 3**.** Freetown City population growth between 1991-2021, yearly increase to date, and projected population (2024).

Accessed 2024/02/13 **raw data source**: (World Population Statistical data, 2020).

Freetown's 2024 population is now estimated at 1,347,559. In 1950, the population of Freetown was 91,554. Freetown has grown by 38,391 in the last year, which represents a 2.93% annual change. These population estimates and projections come from the latest revision of the UN World Urbanization Prospects. These estimates represent the urban agglomeration of Freetown, which typically includes Freetown's population in addition to adjacent suburban areas.

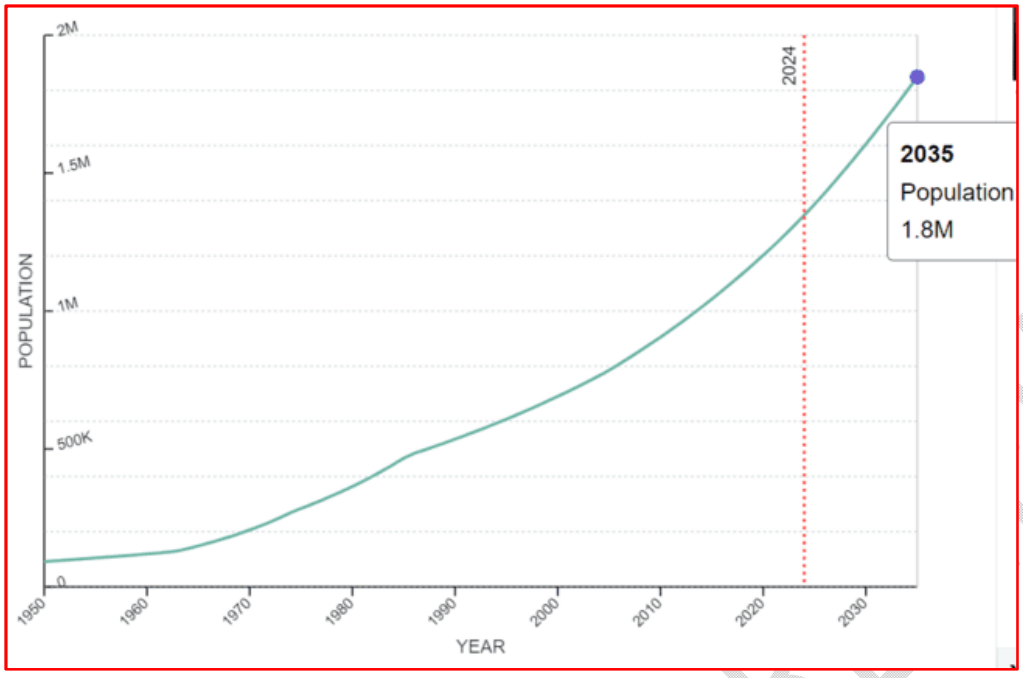

Figure 4**.** Freetown City projected population growth between (2024-2035),

Accessed 2024/02/15 **raw data source**: (World Population Statistical data 2020).

However, it is estimated that by 2035 by the World Population Statistical data, that the population in Freetown would be 1.8 million. This could also seen as a challenge for solid waste management especially plastic waste.

5.0 Discussion

5.1 Main Sources and types of plastic pollution in Freetown

Low-density polyethylene (LDPE) water sachets have made safe drinking water accessible to those who previously couldn't afford it in many low-income nations.

In the Global South, the private sector still supplies local communities with drinking water. Rapid population growth, poor infrastructure management, and the globalization of consumer

markets have combined in West Africa to create a new business centered upon packaged water, namely "sachet water," marketed in plastic sleeves that are mechanically sealed.**[22]**

According to a 2019 national brief titled “Plastic Waste Inputs from Land into the Ocean”, Sierra Leone is a net importer of plastic. Nine million kg of plastic were imported into the nation in that one year alone. About 92% of Sierra Leone's plastic needs were supplied by Ghana, the country's principal source. According to the United Nations Comtrade database, which compiles comprehensive worldwide yearly and monthly trade information by product and trading partner for use by governments, Sierra Leone imported a little over $283,000 worth of plastic from Ghana in 2018. Approximately 8,750 metric tons of plastic items are produced yearly by the nation's tiny domestic plastic manufacturing industry.**[5]**

Sierra Leone generates 1.3 million kg of MSW daily, with a 0.45 kg per capita daily waste. However, 83.8% of this waste is inadequately managed. Plastic waste, accounting for just under 9% of MSW, contributes to 116,000 kg of daily waste generation, with 83.8% being inadequately managed. Additionally, 17,223 kg of plastic waste leaks into the environment daily. Additionally, Freetown, Sierra Leone's capital, faces a growing plastic waste problem due to inadequate waste management. Around 80% of the 40,600 tons/year of plastic waste is dumped on streets and rivers, causing it to flow into coastal communities and the ocean. The Aberdeen Lagoon is a major issue, with large amounts of plastic from Freetown ending up in the Atlantic Ocean**[12].**

However, approximately 70 – 80% of solid waste in Freetown are made up of plastic waste and sachet bags are the most dominant of the plastic waste as many residents use it as a source of drinking water.

In Freetown and in most African cities, low-density, polyethylene, or flexible plastics make up the majority of plastic waste. High-density polyethylene is used to make plastic bottles like the Mega-Cola bottles and bottled water containers. Plastic waste poses issues in Freetown. Unwanted plastic is a health danger often strewn across fields, roads, complexes, and gutters. Plastic garbage can be seen at almost every street corner, gutter, drainage ditch, and corner in Freetown. A survey was conducted by the Freetown City Council in 2014 to ascertain the volume and kind of plastic garbage produced in the neighborhood. According to the report, "136 kg of plastic waste every year" was generated by homes. That weighs about the same as three large rice sacks. The poll also showed that since there is limited access to pipe-borne water

available, residents depended on sachet water packets. Sachets thrown away made for over 80 percent of the plastic garbage that Freetown households produced. The collection and recycling of the LDPE sachets is a quick fix for this issue.

To ensure that people have access to safe water without having to purchase it in plastic sachets, governments and donors should also expand their investment in water, sanitation, and hygiene (WASH). This is the apparent longer-term solution, as it is more economically and environmentally sustainable.

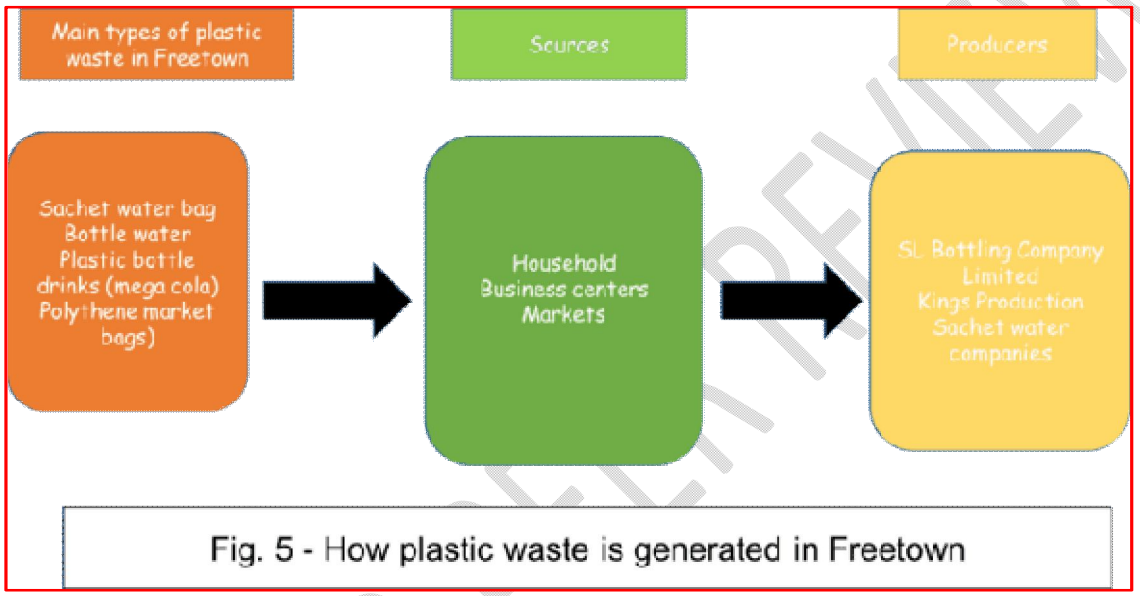

Fig. 5 - How plastic waste is generated in Freetown

The increase in poverty in households made people rely on cheaper sachet water (400 ml NLe5 and NLe10 per bundle of 20 sachet bags) than paying for pipe-borne water bills (NLe 180 water rate per month) distributed by Guma Valley Water Company. Moreover, sachet water bags (Fig. 6) are one of the main types of plastic waste that can be seen everywhere in Freetown including, bottled water, mega cola drinks, and polythene (market bags).

Although it is used by people from a variety of social backgrounds in Niamey, Niger, sachet water is stigmatized as being connected to poverty.**[23].** These plastic wastes are generated mainly by households that are unwilling to pay for their plastic waste (NLe10 per bag) as a result of poverty, and business centers that sell street food (cookery, restaurants, and passerby retailers) also contribute greatly to plastic accumulation. More so, the market also contributes greatly to generating plastic waste in Freetown as most market traders (men and women) choose single-use plastic for the package of foodstuff instead of local market bags, as plastic market bags are

cheaper and easily affordable. Most market traders at the end of the day just sweep their plastic waste and dispose of it in the street or guitars instead of paying for the waste by plastic waste collectors (clean Salone workers). This issue of plastic waste can be shown in Figure 3 below.

Fig. 6 –Pictures of plastic waste clogging in Freetown

5.2 Waste management Practices in Freetown

Waste generation, dumping and burning are growing every year. Inaction on global waste management costs human health, economies and the environment dearly. Waste reduction and improved waste management in Freetown are therefore imperative to handle.

Waste management, according to Letcher and Vallero, is the act of handling waste after it has already been accumulated. Planning for the location, moving, warehousing, handling materials, on-site operations, segmentation, reuse, recycling, and disposal procedures are all included.**[24]**

The land tenure system in Freetown City, where many renters do not have an absolute right to the land they temporarily live on, frequently influences, if not impeded, waste management. Tenants can't properly handle their garbage at home as a result **[25-29]**

According to Aaron Kwasi Nartey (2020), a World Bank report indicated that garbage creation has been increasing, with cities worldwide producing 2.01 billion tons of solid waste in 2016. By 2050, this quantity is anticipated to rise to 3.40 billion tons annually due to a 70% increase in urbanization. In the developed country of the United States, the rate of generation of municipal waste increased from 217.3 million tons per day in 1995 to 254.1 million tons per day in 2013. However, developing nations in sub-Saharan Africa generate 62 million tons of solid trash yearly, proving that waste production increases with national affluence**.[30]**

The most enduring environmental issue facing Freetown Western Urban Settlement is solid waste management. 7.8 million People are living in Sierra Leone, and 1.3 million people live in the Freetown Metropolitan Area.**[21]**

The Sierra Leone Ministry of Health and Sanitation, through its Directorate of Environmental Health and Sanitation, is responsible for municipal waste management (Figure 7). Despite not introducing a specific law for MSWM, the government has developed the National Environmental Health and Sanitation Strategy, which outlines strategies for enhancing waste management, including reuse and recycling.

The Freetown City Council (FCC) regained responsibility for solid waste management in 2017 with Operation Clean Freetown (OCF), an initiative created as part of the President's Recovery Priorities program led by the Sierra Leone government. OCF aims to reduce the risk of epidemics through improved solid waste management, achieved through the integration of organized waste collectors. The program consists of three main strategies: improving waste management infrastructure, equipping and training youth groups as door-to-door waste collection micro-enterprises, and enhancing the sustainability of the system through enforcing bylaws, raising community awareness, discussing with manufacturers and distributors of plastic bags, sachets, and bottles, and hosting an annual competition to reward the cleanest ward in Freetown.

At the moment, recycling in Freetown is quite limited and disorganized. In Freetown, very few private recycling businesses are run for profit. These private businesses manufacture cutlasses, kitchenware, wheelbarrows, watering cans, shoes, and watering cans using recyclable materials. Nevertheless, the lack of fresh materials and the high cost of power are the sole reasons why there isn't a structured trash recycling and recovery program. Long-term economic development requires a capable material waste management system since it helps generate more revenue and resources for waste management. It is difficult for the Freetown City Council (FCC) to create and carry out a material waste management program. Project managers must approach this difficult circumstance. During the rainy season, Freetown is prone to floods every year, and there have been incidents of landfills overflowing. To put in place a suitable waste management system, Freetown sorely needs the assistance of investors, donors, and a strong, independent organization.

The city produces an estimated 550,000 tons of garbage annually (until 2021). If no action is (\ taken to slow down population growth and garbage output, waste generation is predicted to reach 1.000 t/day in 2030 and 2.000 t/day in 2050. However, there is a dearth of environmental regulations in Sierra Leone, and the only means of controlling industrial pollution is via EIA permits. Legislation governing storm water management does not exist. There are no technical decrees in place. Furthermore, solid waste management is now either completely non-existent or at a very rudimentary level in Freetown. The three main disposal sites in Freetown Kingtom, Granville Brook, and Waterloo are not properly maintained. In addition, there are a lot of illegal dumpsites in the city, 68 of them are categorized as "major." On the Freetown waterfront are three large slum settlements: Susan Bay, Kroo Bay, and Rokuper. These settlements, which are home to over 50,000 people overall, are constructed on ground that was reclaimed by backfilling the Sea with solid trash**.[31]**

However, despite the Freetown City Council's managing waste in Freetown, the private sector such as Masada and Klin Salone has been instrumental in fighting for the cleanliness of the city which is battling with plastic pollution that can be found in every corner of the city. Non-governmental organizations like GOAL Salone also play a pivotal role in the current management of plastic waste as they provide vehicles and other waste collection equipment to the Freetown City Council and technical assistance in scaling up good hygiene among Freetown residents. The Freetown Town City Council with the support of GOAL Salone launched the

Wastewater Treatment Plants to foster environmental sustainability with regards to sludge sewage. (Lot many grammer mistakes are there in writing).

Fig. 7 – How waste is currently managed in Freetown

5.3 Current practice of plastic waste management in Freetown

Despite serving as a model municipality for other Sierra Leonean municipalities, the Freetown Metropolitan Area's present garbage collection city council has always had a difficult time managing the region's generated solid waste. Therefore, more private garbage organizations???????? must be engaged and encouraged to provide their services to lessen the load associated with waste collection and disposal. The delayed collection of household solid garbage in many hard-to-reach places is a critical problem. There are instances when the wastes are not picked for a week or longer. The trash cans then leak out and fill the surrounding areas.**[26]**The "Collection and Transport" phase of waste management in Freetown is a critical component of the overall system, responsible for gathering waste from various sources and transporting it to designated landfill facilities for disposal.

5.3.1 Collection and transportation of plastic waste

In Freetown, waste management begins at primary collection points, such as bins or dumpsters, where residents and businesses leave their waste for pickup. After accumulation, it is transported to secondary collection centers for further processing. Waste management crews sort and remove hazardous or prohibited items before incineration. Freetown's waste management authorities or contracted private companies operate specialized vehicles for waste transportation, ranging from

compact trucks for residential streets to larger trucks for heavy loads. Each vehicle is equipped with safety features and compartments to secure different types of waste during transit.

5.3.2 Informal solid waste pickers (Scavengers)

In Freetown, informal waste pickers, or scavengers, play a crucial role in waste management practices. They collect a wide range of recyclable materials, including plastics, metals, paper, and glass, from various sources such as households, business centers, marketplaces, streets, bins, and dumping sites. They meticulously sort through the waste, separating recyclables from non-recyclable items. By salvaging recyclable materials that might end up in landfills or littering the environment, informal waste pickers play a significant role in increasing recycling rates and promoting resource recovery. They sell the collected materials to recycling centers or middlemen who further process and distribute them to manufacturers. Informal waste-picking activities often operate outside formal waste management systems, with individuals working independently or in small groups. Despite facing challenges such as lack of legal recognition, social stigma, and hazardous working conditions, many informal waste pickers contribute actively to plastic waste reduction efforts in Freetown. They normally charge per bag of solid waste NLe10????. Efforts are underway in some cities to formalize their activities. Formalization can involve providing training, access to protective equipment such as gloves, and integrating informal waste pickers into formal waste management systems to improve their working conditions and ensure fair compensation for their services.

5.3.3 Formal waste collectors

Formal waste collectors are employed by municipal authorities, private companies, or non-profit organizations to carry out structured waste collection and transport operations. They follow predetermined routes and schedules, ensuring regular and reliable service to Freetown residents. In Freetown, formal waste collectors are responsible for collecting all types of waste, including recyclables, organic waste, non-recyclable residual waste, and liquid waste. They adhere to local regulations, safety standards, and environmental regulations to minimize environmental pollution and public health risks. Development partners like UNDP and GOAL SaLeone invest in infrastructure and equipment to support formal waste collection operations, enabling efficient waste collection and transport while optimizing resource utilization and minimizing environmental impact.(***UNDP AND GOAL abbreviations must be clear)***

5.4 The disposal method of solid waste in Freetown

Open dumpsites entail the careless disposal of trash in developing metropolitan areas. They are out of control, which makes them a serious health risk that alters the urban environment.**[32, 33]**Unmanaged trash poses a major risk to public health and facilitates the spread of infectious illnesses, according to the UNEPA???. This is especially true of solid waste originating from households and communities.**[34]**

The two landfills in the city of Freetown are essentially open dumps where waste is disposed of. This method, which is the most common way to dispose of waste in Freetown, can be categorized as the early stages of landfill development. These unregulated or unhygienic open dumps can seriously endanger public health and have an impact on Freetown's environment since they lack environmental controls. According to studies by Yongsi et al., (2008),**[35]**children are particularly susceptible to the health effects of hazardous material exposure at disposal sites. Chemical poisoning results from the release of chemical waste into the environment, whereas direct exposure can cause diseases through chemical exposure.**[36]**

The city's two landfills, Kingtom and Granville Brooke, which are situated at its eastern and western extremities, respectively, were first intended to be regulated dumps. A substantial amount of waste is also illegally dumped in vacant lots, street corners, roadside, the city's drains (which are primarily choked with trash), and the few streams from the mountainside that flow into the sea in addition to being disposed of at these landfills**(Ref…).** In addition to the city's medical, hazardous, and toxic wastes, the majority of the waste dumped at these landfills is made up of domestic waste and market waste, mostly from public markets. Organic and biodegradable waste makes up the largest portion of the waste, with smaller amounts coming from industry and street waste. Both formal and informal waste collectors dispose of solid waste in these two landfills. Open landfills pose a serious threat to the ecosystem, particularly to the air we breathe. Dumpsites sicken those who live in, near, or around them with their foul scents and smoke.

6.0 Current Challenges Facing Waste Management Practices in Freetown

In Freetown, waste management faces numerous challenges that hinder effective waste collection, treatment, and disposal. These challenges stem from a combination of social, economic, environmental, and institutional factors.

6.1 Inadequate Infrastructure

Freetown's waste management infrastructure is inadequate, with outdated, poorly maintained, and improperly utilized systems leading to inefficiencies in waste collection and disposal. The lack of waste collection vehicles, transfer stations, and sanitary landfills results in irregular and incomplete waste collection services, leaving many areas underserved. The absence of adequate waste treatment facilities and sanitary landfills also contributes to open dumping, illegal waste burning, and pollution of land, water, and air. Waste management crews often lack necessary equipment and resources for safe and efficient operations. The absence of recycling and treatment facilities for specific waste streams limits waste diversion and resource recovery. The lack of infrastructure for composting, recycling, and incineration also hinders efforts to reduce landfill dependence and promote sustainable waste management practices. Weak institutional capacity and lack of strategic planning for waste management infrastructure development further perpetuate the inadequate infrastructure in Freetown. Insufficient investment in infrastructure upgrades, expansion, and modernization exacerbates the city's waste management challenges.

6.2 Limited Waste Collection Coverage

The challenge of limited waste collection coverage in Freetown refers to the insufficient provision of formal waste collection services to all areas of the city, resulting in many communities being underserved or entirely neglected in terms of waste management. Many areas in Freetown, especially informal settlements and peri-urban areas, lack regular waste collection services. As a result, residents resort to improper disposal methods such as open dumping, burning, or littering, exacerbating environmental pollution and public health risks.

6.3 Disparities

Waste collection coverage varies across different parts of Freetown, with urban areas often receiving more frequent and reliable services than peri-urban and informal settlements. Remote or marginalized communities, such as those located in hilly or inaccessible terrain, experience significant challenges in accessing waste collection services.

6.4 Informal Waste Sector Dominance

The informal waste sector, comprising informal waste pickers and small-scale recyclers, plays a significant role in waste management in Freetown. However, the informal sector operates outside

formal regulations and often faces marginalization, inadequate support, and lack of recognition from authorities.The dominance of the informal waste sector in some areas of Freetown may undermine efforts to expand formal waste collection coverage. Informal waste pickers and small-scale recyclers may provide informal collection services in underserved communities, filling the gap left by formal waste management authorities. While informal waste pickers play a crucial role in waste recovery, their activities may not fully address the need for comprehensive waste collection and disposal services in underserved areas.

6.5 Informal Settlements

Informal settlements especially Kroo Bay and Motem, which are characterized by inadequate infrastructure and housing, often have limited or no access to formal waste collection services. Residents of these areas may resort to open dumping, burning, or burying waste within their communities, leading to environmental pollution and public health hazards.

6.6 Financial Constraints

Freetown's municipal authorities face significant challenges in waste management due to limited financial resources. These constraints hinder investment in new collection routes, vehicles, and infrastructure, limiting the city's ability to address waste management challenges comprehensively. The lack of funding can lead to issues such as insufficient waste collection coverage, inadequate equipment, limited capacity for recycling and waste treatment, and regulatory enforcement challenges. Additionally, it hinders efforts to implement innovative solutions, upgrade outdated infrastructure, and address environmental challenges like climate change and pollution. To address this issue, Freetown needs strategic resource mobilization, including increased public investment, public-private partnerships, international donor support, and innovative financing mechanisms like waste-to-energy projects and user fees. By prioritizing waste management and allocating sufficient resources, Freetown can enhance its capacity to manage waste effectively, promote environmental sustainability, and improve the quality of life for its residents.

6.7 Population Growth and Urbanization

Rapid population growth and urbanization in Freetown exacerbate the challenge of limited waste collection coverage. As the city's population expands, the demand for waste collection services

increases, placing additional strain on existing infrastructure and resources. Municipal authorities struggle to keep pace with the growing demand for waste management services amid limited capacity and funding. Inadequate regulatory enforcement in Freetown's waste management sector poses significant challenges to the effective implementation of waste management policies, regulations, and standards. Despite the existence of laws and regulations governing waste management practices, enforcement mechanisms are often weak, inconsistent, or poorly implemented, leading to non-compliance, illegal activities, and environmental degradation.

6.8 Inadequate regulatory enforcement

Inadequate regulatory enforcement in Freetown is largely due to a lack of capacity and resources within waste management agencies. Insufficient staffing, training, and technical expertise hinder effective monitoring and enforcement of waste management regulations. Financial constraints and budgetary constraints also hinder enforcement measures. Corruption and collusion between regulatory officials and waste management operators further undermine these efforts. Lack of transparency and accountability in decision-making erodes public trust in regulatory institutions. Inconsistent application of waste management regulations across jurisdictions and administrative levels contributes to regulatory fragmentation and loopholes. Inadequate coordination between agencies results in overlapping mandates and ineffective enforcement strategies. Limited public awareness and engagement about waste management regulations hinder compliance efforts and promote environmental responsibility.

6.9 Poor waste segregation practices

Poor waste segregation practices in Freetown lead to inefficiencies in waste management, hinder recycling efforts, and exacerbate environmental pollution and public health risks. Despite the importance of waste segregation in reducing landfill waste and promoting resource recovery, many residents and businesses lack awareness and access to adequate infrastructure for sorting and separating waste. Mixed waste streams containing recyclable materials, organic waste, and hazardous substances complicate the recycling process, increasing processing costs and reducing the quality and value of recycled materials. Poor waste segregation also contributes to contamination of recyclable materials, making them unsuitable for recycling and limiting their marketability. Inadequate waste segregation also poses environmental and public health risks, as

hazardous materials can leach toxic chemicals, emit harmful gases, and attract pests and disease vectors.

7.0 Plastic Waste impacts in Freetown

Over 96,000 metric tons of plastic waste are produced annually in Sierra Leone, 84% of which is improperly disposed of [37]. Plastic pollution has pervasive and multifaceted impacts on the environment, society, and economy of Freetown, the capital city of Sierra Leone.

7.1 Environmental Impacts

Plastic pollution in Freetown, Sierra Leone, has severe environmental impacts on both marine and terrestrial ecosystems. Marine life, such as sea turtles, fish, seabirds, and marine mammals, is threatened by the accumulation of discarded plastics in coastal waters, mangroves, and coral reefs. Microplastics from plastic fragments can enter the food chain, posing risks to both marine organisms and human health. On land, plastic pollution contaminates soil and water bodies, releasing harmful chemicals, negatively impacting soil fertility and plant growth. This underscores the need for urgent action to preserve the city's natural heritage. According to a study by the United Nations Environment Programme (UNEP, 2018), an estimated 8 million metric tons of plastic waste enter the world's oceans annually, and coastal cities like Freetown face a pressing challenge. In Sierra Leone, it's estimated that over 30,000 metric tons of plastic waste are generated each year, much of which ends up in rivers and ultimately the ocean.**[2].** In Freetown specifically, the marine environment suffers from extensive plastic contamination, with coastal areas and water bodies becoming hotspots for plastic accumulation. Research conducted by the Sierra Leone Conservation and Wildlife Society found that plastic debris is prevalent along Freetown's coastline, with over 80% of surveyed beaches exhibiting varying degrees of plastic pollution **[38].**

7.2 Social Impacts

The impact of plastic pollution on people can be enormous, given that up to 820 million people depend on fisheries for their food security, both directly and indirectly**[8]**Despite this, not much research has been done to determine how fishing communities are affected by plastic pollution. The detrimental effects of plastic pollution and marine debris on small-scale subsistence fishing

communities and livelihoods were not reported in Sierra Leone as long ago as 2001, during the war, when the population began to soar in Freetown and the usage of single-use plastic became inevitable. Due to the significant amount of plastic contamination in the oceans, Sierra Leone was recently prohibited from importing fish.(Need some reference)

Plastic pollution in Freetown inflicts significant social repercussions, manifesting notably in public health concerns and livelihood challenges for local communities. In terms of public health, the inadequate disposal and management of plastic waste contribute to the proliferation of disease vectors, such as mosquitoes, in stagnant water trapped within discarded containers, exacerbating the risk of vector-borne illnesses like malaria and dengue fever. According to the World Health Organization (WHO, 2016)**[39]**, Sierra Leone ranks among the countries with the highest malaria burdens, with an estimated 3.5 million cases reported annually, underscoring the gravity of the public health implications of plastic pollution. Furthermore, the leaching of toxic chemicals from plastics into water sources threatens the quality of drinking water, potentially exposing communities to harmful contaminants and increasing the incidence of waterborne diseases. Beyond public health, plastic pollution undermines local livelihoods, particularly those reliant on coastal resources and tourism. The fishing industry, which sustains the livelihoods of many coastal communities, faces diminished fish stocks and reduced catches due to plastic contamination of marine habitats. This poses a direct threat to food security and economic stability, with approximately 70% of the population in Sierra Leone already living below the poverty line, according to the World Bank report 2023**.[40]**

7.3 Economic impacts

7.3.1 Tourism Impacts: Plastic pollution in Freetown is causing a decline in the tourism industry, affecting the attractiveness of the region's beaches and natural landscapes. The World Bank reports that tourism contributes 7.2% to Sierra Leone's GDP. However, plastic pollution has led to a 15% decline in tourist arrivals and an estimated loss of over $5 million in tourism revenue between 2018 and 2020. The degradation of coastal environments, such as Lumley Beach, negatively impacts visitor experience and deters potential tourists. This decline also affects businesses in the hospitality sector, leading to job losses and revenue decline. The UNEP report highlights the significant cost of plastic pollution to the global tourism industry.(This paragraph need to be rewritten)

7.3.2 Waste Management Costs: The increasing plastic waste in Freetown is posing significant financial challenges for municipal authorities. The city's waste management infrastructure is inadequate, and plastic pollution contributes to a 30% of total municipal waste expenditure. The lack of recycling facilities further increases costs, as a significant portion of plastic waste ends up in landfills or is incinerated. Inefficient waste management systems in developing countries can result in economic losses equivalent to 5-10% of GDP annually. In Freetown, managing plastic waste diverts resources from essential services like healthcare, education, and infrastructure development. Environmental remediation expenses also strain municipal finances.

8.0 CONCLUSION

Sierra Leone's major city of Freetown faces enormous obstacles when it comes to trash management, especially with regard to plastic pollution. The city's waste management system continues to be outdated and insufficient, despite efforts to solve the issue by NGOs, private businesses, and municipal officials. The issue is made worse by rapid population increase, tight budgets, and inadequate infrastructure, which puts public health at risk and pollutes the environment extensively. The abundance of plastic garbage, particularly from drinking water sachets made of LDPE, presents serious environmental, social, and financial problems. It depletes municipal resources, endangers public health, and contaminates land and marine habitats. Inaction will probably cause these problems to worsen, endangering the sustainability and welfare of the people living in Freetown. Comprehensive measures are required to properly address these concerns. This entails making investments in better infrastructure for waste management, strengthening legal frameworks, encouraging public involvement and awareness, and cultivating public-private partnerships. Freetown can lessen the negative effects of plastic pollution and create a more robust waste management system by formalizing the role of informal waste pickers, improving waste segregation techniques, and supporting sustainable waste management practices.

The community as a whole, government agencies, business sector partners, and civil society organizations must work together to address Freetown's waste management issues. Freetown can overcome its waste management obstacles and open the door to a cleaner, healthier, and more sustainable future for everybody if it takes coordinated action and remains committed to the cause.

(Lot many grammatical and sentence errors are present in this manuscript , so author has to look over manuscript…).

References

1. J. R. J. ROLAND GEYER , AND KARA LAVENDER LAW, “Production, use, and fate of all plastics ever made,” Science Advances, vol. Vol.3, no. Issue.3, 2017.
2. U. N. E. Programme, Single-Use Plastics: A Roadmap for Sustainability (rev. 2), 2018.
3. S. Y. “Kaza, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank., “What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050,” Open Knowledge Respository, vol. Vol.2, 2018.
4. U. N. D. Programme, Solving Freetown’s waste problem, 2018.
5. Plastic waste risks marine livelihoods in Sierra Leone, 2023.
6. O. P. Forum, Next stop: Freetown, Sierra Leone, 2023.
7. U. Nations, Department of Economic and Social AffairsSustainable Development, 2015.
8. iied, A sustainable future forfisheries: how fiscal policy canbe used to achieve SDG 14, 2016.
9. C. f. D. C. Prevention, CDC in Sierra Leone, 2019.
10. R. G. JENNA R. JAMBECK , CHRIS WILCOX, THEODORE R. SIEGLER, MIRIAM PERRYMAN, ANTHONY ANDRADY, RAMANI NARAYAN, AND KARA LAVENDER LAW, “Marine pollution. Plastic waste inputs from land into the ocean,” Science, vol. Vol 347, no. Issue 6223, pp. P. 768-771, 2015.
11. E. M. FOUNDATION, The New Plastics Economy: Rethinking the future of plastics, 2016.
12. O. P. Forum, Ocean plastic barrier in Freetown, Sierra Leone, 2023.
13. W. K. Anderson Abel de Souza Machado, Christiane Zarfl, Stefan Hempel, Matthias C Rillig “Microplastics as an emerging threat to terrestrial ecosystems,” Global Change Biology., vol. Vol. 4, 2018.
14. D. C. W. David Lerpiniere, Costas Velis, Barbara Evans, Hinrich Voss, and K Moodley, “Review of international development co-operation in solid waste management,” International Solid Waste Association, 2014.
15. C. I. Chalokwu, “Petrology of the freetown layered complex, Sierra Leone: part II. Magma evolution and crystallisation conditions,” Journal of African Earth Sciences, vol. Vol. 32, no. Issue 3, pp. Pages 519-540, 2001.
16. A. M. Sara Callegaro, Hervé Bertrand, Janne Blichert-Toft, Laurie Reisberg, Giancarlo Cavazzini, Fred Jourdan, Joshua H F L Davies, Laura Parisio, Romain Bouchet, Andre Paul, Urs Schaltegger,, “Geochemical Constraints Provided by the Freetown Layered Complex (Sierra Leone) on the Origin of High-Ti Tholeiitic CAMP Magmas ” Journal of Petrology, vol. Vol. 58, no. Issue 9, pp. Pages 1811–1840, 2017.
17. D. B. Peter Redshaw, Grace Campbell, Matthew Willis, Julius Mattai, Matthew Free, Colm Jordan, Simon J. Kemp, Anna Morley, Michael Thomas, “The 2017 Regent Landslide, Freetown Peninsula, Sierra Leone,” Quarterly Journal of Engineering Geology and Hydrogeology, vol. Vol. 52, 2019.
18. B. L. F. M. C. Peel, and T. A. McMahon, Updated world map of the Köppen-Geiger climate classification, vol. Vol. 11, 2007.

19. S. S. L. S. SL), 2021 Mid-Term Population and Housing Census, Statistics Sierra Leone, Freetown, 2022.
20. W. Bank, World Bank Open Data, World Bank, 2020.
21. U. Nations, World Population Prospects 2022, United Nations, 2020.
22. J. Stoler, “From curiosity to commodity: a review of the evolution of sachet drinking water in West Africa,” WIREs Water, 2017.
23. a. Sara Beth Keough, Scott M. Youngstedt, “Pure water’ in Niamey, Niger: the backstory of sachet water in a landscape of waste,” Journal of International African Institute vol. Vol. 88, no. Issue 1, pp. P. 38 - 62, 2018.
24. D. A. V. Trevor Letcher, Waste: A Handbook for Management, 2nd Edition ed., 2019.
25. J. Unruh, “Land Policy Reform, Customary Rule of Law and the Peace Process in Sierra Leone,” African Journal of Legal Studies, vol. Vol. 2, pp. P. 94-117, 2008.
26. T. Komba, “Assessment of Municipal Solid Waste Management for Better-Quality Public Health and Environmental Sustainability in the Freetown Metropolitan City in Sierra Leone,” Journal of Geoscience and Environment Protection, vol. Vol.9, pp. P. 33-49, 2021.
27. P. M. Kaindaneh, “Sierra Leone, Land Governance Assessment Framework,” World Bank Group, 2015.
28. T. Ochiai, “The Bifurcated Development of Land Policy in Sierra Leone.,” Asian Journal of African Studies, vol. Vol. 40, pp. P. 137-172, 2016.
29. A. B. Rexford Ahene, Alvaro Federico Barra, and Claire Galpin, “Support to the Sierra Leone Land Agenda,” World Bank Group, 2019.
30. J. F. Horsakarr Sidique Sesay, Paul Andrew Bourne,Tabitha Muchee, “Investigating Solid Waste Management onEnvironmental Hazard in Freetown, Sierra Leone:A Case Study at Bomeh Dumping Site Western Area Urban,” Global Journal of Ecology, Environmentand Alternate Energy Technologies, vol. Vol. 3, no. Issue 1, 2023.
31. C. O. P. I. a. Preparation, "Transform Freetown Solid Waste Management and Sanitation Project.," 2021.
32. X. Y. Foday Pinka Sankoh, “Problems of Solid Waste Management in Developing Urban Cities: A Case Study of Freetown, Sierra Leone,” American Journal of Environmental Protection, vol. Vol. 2, no. Issue 5, pp. P. 113-120 2013.
33. D. Sood, “Solid Waste Management Study for Freetown (Component Design for World Bank, Draft Report Project No. P078389),” Great Falls, Virginia, 2004.
34. U. N. E. P. A. (UNEPA), Informal Solid Waste Management, 2006.
35. T. H. H.B. Nguendo Yongtsi, A. Lutumba Netu, Christopher Robin Bryant, and Remy Sietchiping, “Environmental Sanitation and Health Risks in Tropical Urban Settings: Case study of Household Refuse and Diarrhea in Yaoundé-Cameroon,” International Journal of Human And Social Sciences, vol. Vol. 3, no. Issue. 3, pp. P. 220-228, 2008.
36. E. Marshal, “Analytical Study to Evaluate Associations between Dumpsites and Birth Effects,” ATSDR CO.LTD, Atlanta, 1995.
37. M. M. Sesay, “ Reducing Landfill Waste in Sierra Leone with Construction Industry Material Waste Management,” International Master of Science in Construction and Real Estate Management, Metropolia Helsinki and HTW Berlin, Berlin, 2022.
38. S. L. C. a. W. Society, Assessment of Plastic Pollution on Beaches in Freetown, Sierra Leone, Sierra Leone Conservation and Wildlife Society, 2020.
39. W. H. O. S. Leone, Tackling malaria in Sierra Leone, World Health Organization, 2016.

40. W. Bank, The World Bank in Sierra Leone, World Bank, Sierra Leone, 2024.