



Assessing the Impact and Management of Plastic Pollution in Freetown: A Comprehensive Situational Analysis

Musa Kamara ^a, Mohammad Imran Azizi ^{a,b},
Richard Edmond Victor Sesay ^a, Bahirullah Rahmani ^{c,d++#}
and David Bangura ^{a*}

^a College of Environmental Science and Engineering, Tongji University 1239 Siping Road, Shanghai-200092, UNEP- Tongji Institute of Environment and Sustainable Development, 1239 Siping Road Shanghai 200092, China.

^b Department of Environmental Protection, Faculty of Environmental Science, Badghis Higher Education Institution, Badghis, Afghanistan.

^c Research and Development Department, Khurasan University, Nangarhar, Afghanistan.

^d Civil Department, Khurasan University, Nangarhar, Afghanistan.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ijecc/2024/v14i94450>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/122252>

Systematic Review Article

Received: 27/06/2024

Accepted: 29/08/2024

Published: 10/09/2024

ABSTRACT

This paper aimed to identify the sources, types, challenges, and impacts of plastic pollution in Freetown, providing a comprehensive situational analysis. The study employed a qualitative and integrative literature review, contextualizing data from various sources, including government

⁺⁺ Head;

[#] Lecturer;

^{*}Corresponding author and Email: banguradavidd@gmail.com;

Cite as: Kamara, Musa, Mohammad Imran Azizi, Richard Edmond Victor Sesay, Bahirullah Rahmani, and David Bangura. 2024. "Assessing the Impact and Management of Plastic Pollution in Freetown: A Comprehensive Situational Analysis". *International Journal of Environment and Climate Change* 14 (9):718-36. <https://doi.org/10.9734/ijecc/2024/v14i94450>.

reports and international organizations. Databases such as Google Scholar, Scopus, and Web of Science were utilized to compile and analyze relevant information. Findings showed that 80% of Freetown's 40,600 tons/year of plastic waste is dumped in the streets. Sachet bags are the dominant, accounting for 70-80% of plastic waste, mainly from households. The study reveals that plastic pollution in Freetown is a critical environmental issue exacerbated by inadequate waste management infrastructure, rapid urbanization, and socio-economic challenges. Key impacts include threats to public health, disruption of marine and terrestrial ecosystems, and significant economic costs, particularly in the tourism and fishing industries. The study underscores the urgent need for policy interventions, such as banning single-use plastics, enhancing waste management systems, and promoting community engagement in recycling efforts. The broader implications of this research suggest that addressing plastic pollution in Freetown could significantly contribute to global sustainable development goals (SDGs), particularly those related to poverty alleviation, health, and environmental sustainability. Finally, the findings offer valuable insights for policymakers, urging them to implement comprehensive waste management strategies and to engage local communities in efforts to mitigate plastic pollution, thereby fostering a more sustainable urban environment.

Keywords: *Plastic pollution; situational analysis; freetown; sachet water; waste management; sustainable development goals.*

1. INTRODUCTION

Plastic pollution is a global issue, significantly impacting ecosystems and human health. Over the past six decades, plastic production has surged, reaching over 400 million metric tonnes annually, with only 16% recycled [1]. Global plastic production increased to 380 million tons in 2022 from 353 million tons in 2019; by 2050, it is expected to reach over 590 million tons. It is estimated that 1.23 billion Plastics will be produced by 2060, according to OCED, 2022. (Fig. 1) [2]. However, there are challenges in managing plastic garbage, as evidenced by the 40% mismanagement rate [3,4]. This accumulation leads to severe environmental degradation, as plastics can decompose up to 500 years [5]. Packaging materials account for half of global plastic waste, with projections of a double-digit increase in plastic production over the next ten to fifteen years. The World Bank estimates that plastics in municipal solid trash in low- and middle-income nations are 6.4% and 11% respectively [2]. The most impoverished individuals and the ecosystems that support us all suffer from unchecked plastic waste.

Urban waste management of plastic pollution is a pressing issue exacerbated by rapid urbanization and population growth. Research indicates that many cities, particularly in developing countries, lack effective plastic waste disposal systems, leading to significant environmental degradation. A study in Hyderabad revealed that 50% to 60% of residents improperly dispose of plastic waste, contributing to unhygienic conditions [6]. In

contrast, smart city initiatives in Poland and Turkey highlight the potential of integrating technology into waste management, promoting recycling, and circular economy practices to mitigate plastic waste [7]. However, despite legislative efforts in various countries to ban single-use plastics, such measures often need robust management systems [8]. Furthermore, urban planning policies that adapt to socioeconomic factors are crucial for effective waste collection, as demonstrated in case studies from India and the Philippines [9].

In Freetown, Sierra Leone, the situation is exacerbated by inadequate waste management practices, where common disposal methods include burning waste, which releases harmful pollutants. The prevalence of plastic waste, particularly in domestic settings, contributes to health risks and environmental diseases, as plastics often harbor parasites and toxins [10]. Improper construction material disposal is a major contributor to plastic pollution in Freetown, necessitating stricter regulations and improved management strategies. This requires community education, improved waste management infrastructure, and policy interventions to mitigate its negative impacts [11].

Plastic waste is a major problem in the slums bordering Freetown, Sierra Leone's capital city. Water sachets (used for drinking), empty bottles, and jerry cans litter the streets and clog up drains, causing flooding in disaster-prone areas. The World Bank study highlights a critical issue in Sierra Leone, where approximately 84% of

plastic waste is inadequately managed, adversely affecting public health, the economy, and marine ecosystems. This situation is exacerbated by insufficient waste management infrastructure and public awareness [12].

The estimated daily garbage produced in the metro Freetown region is 742 tons. Over 84% is biodegradable organic waste, mostly from houses and vegetable markets. Freetown City Council faces challenges in handling solid waste, including plastic, in communities like Susan's Bay, Kingston, Kroo Bay, and Old Wharf. These areas suffer from negative environmental effects from mismanaged sachet plastic waste due to limited budgets, inadequate equipment, and challenges in collecting large amounts. The Susan's Bay neighborhood produces 30 tons of plastic waste annually, with 70% ending up in open landfills or unlicensed facilities, highlighting the need for proper disposal. Since the end of the Civil War, the Freetown municipality has experienced a yearly rapid urbanization rate. As a result, congestion is now inevitably causing slumps and poorly managed informal communities to emerge [13].

Solid waste management in Freetown is crucial for health, economic, and environmental concerns. Inadequate waste management techniques lead to congestion, downturns, and casual networks. Uncollected refuse mixes with animal and human waste, causing flooding, rat and bug vector growth, and illness spread. Environmental solid waste decomposition, leachate destruction, air pollution, disease transmission, and high methane levels are examples of environmental solid waste resulting from inadequate removal. This leads to financial and welfare losses and risks to people and animals' health and well-being.

The current research on plastic pollution in Freetown needs to be more extensive, with fragmented data and anecdotal evidence about plastic pollution in Freetown. This research aims to fill the gap by assessing the impacts and management of plastic pollution in Freetown, Sierra Leone, to provide a comprehensive understanding of the city's sources, impacts, and management of plastic waste.

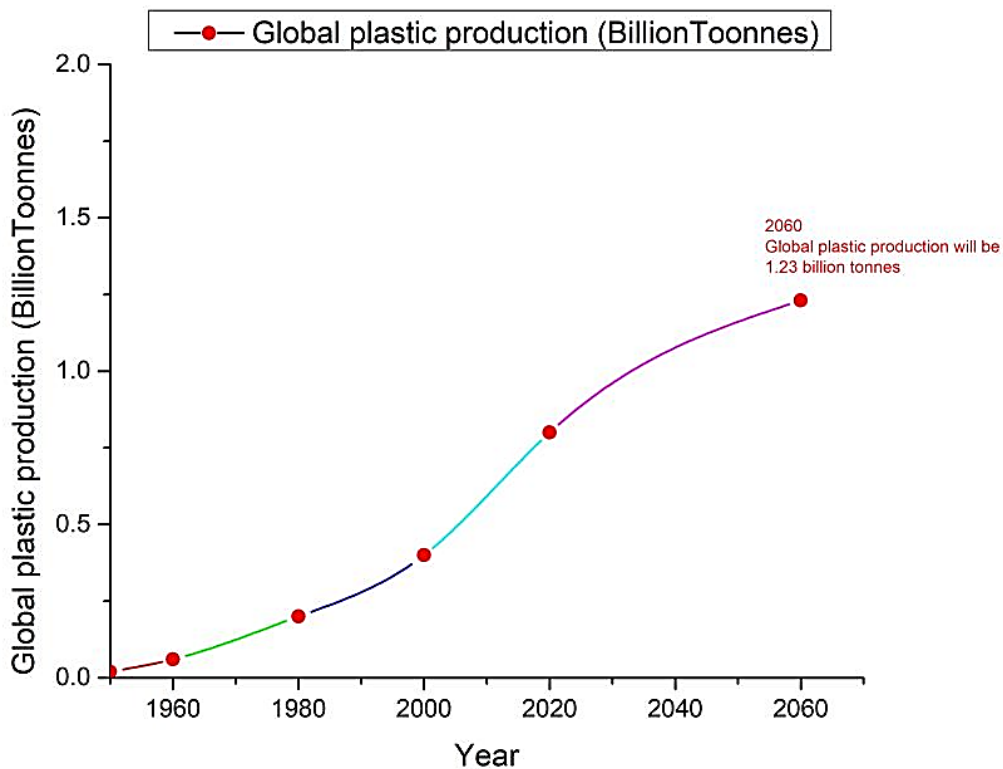


Fig. 1. Global Production of Plastic Projections from 1950 – 1960
 Data Source: OCED, 2022 Accessed 2024/02/10

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 best waste management practices. Thus, this study could also be relevant for cities facing similar challenges. 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.

The introduction outlines the severe impacts of plastic pollution on global and local scales, emphasizing its pervasiveness and the challenges it poses to waste management. It highlights the rapid increase in plastic production and the significant percentages of plastic waste mismanaged worldwide, setting the stage for a detailed investigation of these issues within Freetown, Sierra Leone. Plastic pollution in Freetown poses severe environmental and public health challenges, driven by inadequate waste management and rapid urbanization. Comprehensive waste management strategies are critical.

2. PLASTIC POLLUTION IMPACTS ON SUSTAINABLE DEVELOPMENT GOALS (SDGS)

The 2030 Agenda for Sustainable Development, encompassing 17 SDGs, was introduced by the UN in 2015 to address social, economic, and environmental issues [14,15]. These include poverty, hunger, health, education, gender equality, water resources, energy, work, industry, inequalities, cities, consumption, climate, marine life, peace, and justice. However, over half of the SDGs are directly impacted by plastic pollution. Partnerships are needed to advance these interconnected themes.



2.1 Goal 1: End Poverty

This subsection highlights how plastic pollution exacerbates poverty and disrupts livelihoods, particularly in agriculture, fishing, and tourism sectors.

Plastic pollution significantly impacts poverty in urban areas, with the informal recycling sector playing a crucial role. High population density and economic structures contribute to increased microplastic pollution, as seen in Ningbo, China [16]. The informal recycling sector can mitigate plastic waste, provide livelihoods, and empower workers, helping millions escape poverty [17]. Addressing plastic pollution through inclusive policies promotes environmental sustainability and economic resilience among vulnerable urban populations [1,18]. In Sierra Leone, plastic pollution blocked drainage and waterways, causing damage to homes and businesses, and increasing poverty.



2.2 Goal 2: End Hunger, Achieve Food Security and Improved Nutrition, and Promote Sustainable Agriculture

Here, we explore the detrimental effects of plastic pollution on food security and agricultural sustainability, emphasizing its impact on biodiversity and soil quality.

Plastic pollution threatens biodiversity and food production, contaminating water, oceans, forests, and soils. Fishing contributes to 20% of protein intake for 3 billion individuals, and a significant portion of protein in diets of SIDS, South Asia, West Africa, and Southeast Asia [2].

Plastic pollution significantly impacts the Zero Hunger Goal in urban African cities by threatening food security and sustainable urbanization. The proliferation of plastic waste disrupts ecosystems, which are vital for urban agriculture, a key strategy for enhancing food production in densely populated areas [19]. Case studies from Nairobi and Dakar show plastic waste challenges, including inefficient waste

management systems [20]. Freetown residents' fishing sector faces obstacles despite potential improvements in nutrition and food security.



2.3 Goal 3: Ensure Healthy Lives and Promote Well-being for all at all Ages

This part discusses the significant health risks of plastic pollution, including the spread of diseases and the direct impacts of toxins released from plastics.

Plastic pollution leads to flooding, water-induced illnesses, and increased risks of cancer and heart disease. It significantly impacts Sustainable Development Goal 3 (SDG 3), aiming for healthy lives. Urban areas, like Ningbo, China, face unique challenges due to rapid urbanization, leading to microplastic pollution in freshwater systems [16]. Uncollected waste causes 400,000 to 1 million deaths annually in low- and middle-income nations, with Freetown facing a significant challenge due to the dominant burning of plastic in major landfills. This behavior leads to lung and cancer problems, especially for residents. Throwing plastic in gutters during rains also feeds mosquitos, causing malaria and cholera. Malaria accounts for over 2.5 million cases and 6,800 deaths in Sierra Leone in 2019 reported in 2019 by the Centers for Disease Control (CDC) [2].



2.4 Goal 14: Conserve and Sustainably Use the Oceans, Seas, and Marine Resources for Sustainable Development

This subsection highlights plastic pollution's critical challenges to marine ecosystems and

biodiversity, underlining the urgent need for marine conservation efforts.

Ocean pollution from plastic is endangering marine life and is a serious threat to biodiversity. Every year, 8 to 12.7 million tons of plastic are thought to enter the ocean [12]. By 2050, more plastic will be in the ocean than fish [21]. Alqarni's study reveals that urban runoff, particularly during heavy rainfall, significantly transports microplastics into marine environments, causing high concentrations in coastal waters and sediments, causing stress and damage to species like coral reefs [22]. Plastic waste has inadvertently entangled 914 marine animals, including seabirds, fish, turtles, and sea mammals, and impacted 17% of 693 listed species on the International Union for Conservation's National Red List [23]. In Freetown, 80% of 40,600 tons/year of plastic waste is dumped on streets and rivers, causing pollution that flows into coastal communities and the ocean [24].



2.5 Goal 15: Protect, Restore, and Promote a Sustainable Terrestrial Ecosystem

It focuses on the impacts of plastic pollution on terrestrial ecosystems, detailing how land-based plastic waste affects soil health and biodiversity.

Plastic pollution poses a significant threat to terrestrial life, especially in urban environments, with high levels of microplastic contamination in urban soils. Studies in Yeosu City reveal 1,108 pieces per kg in roadside soils and 664 pieces per kg in agricultural soils, primarily from tire dust [25]. Microplastics disrupt soil health by altering biophysical properties, reducing microbial activity, and potentially introducing toxic substances into the food chain [26,27]. Plastic pollution is endangering terrestrial biodiversity and contaminating terrestrial ecosystems in Freetown. An estimated third of all plastic debris is thought to end up in freshwater or soil [28]. The single-use plastics most frequently encountered in the environment are straws, food

wrappers, plastic bottles, water sachets, supermarket bags, and disposable plates. Synthetic fabrics, tires, personal hygiene items, city dust, road markings, and plastic pellets are possible sources of microplastics [29]. Despite the growing body of research, there still needs to be a significant gap in understanding the full extent of plastic pollution's impact on terrestrial ecosystems, particularly in urban settings [30]. Addressing these issues requires urgent management strategies to mitigate plastic waste and its ecological consequences [27].



2.6 Goal 17: Strengthen Global Partnership for Sustainable Development

Here, we discussed how it's critical to collaborate on each goal to achieve the objectives of the other sustainable development goals.

Freetown faces a significant plastic pollution challenge, requiring additional financial resources like Official Development Assistance (ODA). The city council's budget could be increased, but waste management, particularly plastic, is a serious challenge due to low staff, vehicles, and technology transfers. The amount

allocated to waste management is about 0.3% [31]. Addressing plastic pollution is crucial for Sierra Leone to achieve its Sustainable Development Goals (SDGs) by 2030. As plastic production companies increase production without proper checks, people seek cheap alternatives like sachet bags and PET bottles (commonly used for soft drinks and water) (Fig. 6). Sierra Leone lacks laws on plastic pollution and does not intend to ban plastic production. The accumulation of plastic waste in oceans, streets, and landfills increases public health risks and impacts people, the ecosystem, and waste management systems.

The section highlights the link between plastic pollution and Sustainable Development Goals (SDGs), highlighting its negative impacts on poverty reduction, food security, human health, and marine life, emphasizing the need for integrated solutions.

3. METHODOLOGY

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 databases; 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

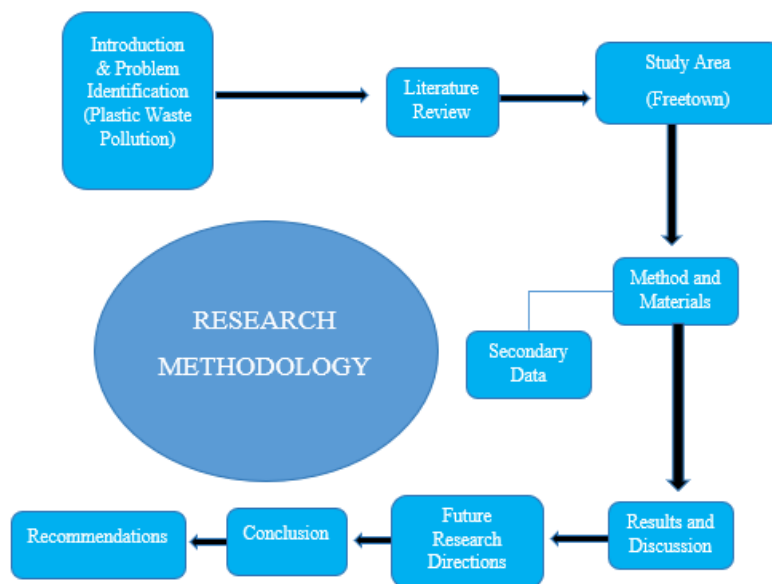


Fig. 2. Research methodology flow chart (Source: Researcher)

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 terms mentioned above were entered into the Google Scholar search engine, an average of 1,850 results and the metadata of academic publications were shown.

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

Moreover, physical observations made along key roadways and neighborhoods 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 associated with improved environmental sustainability and public health. Using this qualitative study design, the authors proved that the demand for sachet water led to the emergence of the plastic pollution issue.

The methodology section outlines the integrative review approach used to gather and analyze

Freetown's plastic pollution data. It details the sources and types of data considered, including peer-reviewed articles, government reports, and physical observations, which collectively inform the comprehensive analysis of plastic waste.

4. DESCRIPTION OF SITE SPECIFIC

The study site is specifically Freetown, the capital of Sierra Leone, located on the West Coast of Africa (Fig. 3). 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 [32].

According to [33,34], it is located on an igneous intrusion with a funnel form along the Atlantic Coast. Tropical weather prevails in Freetown, located 47 meters above sea level. In most months of the year, there is much rainfall.

In research by [35], 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), experienced in April. July has the lowest average temperature, at 25.6°C/78.0°F, making it the coldest month.

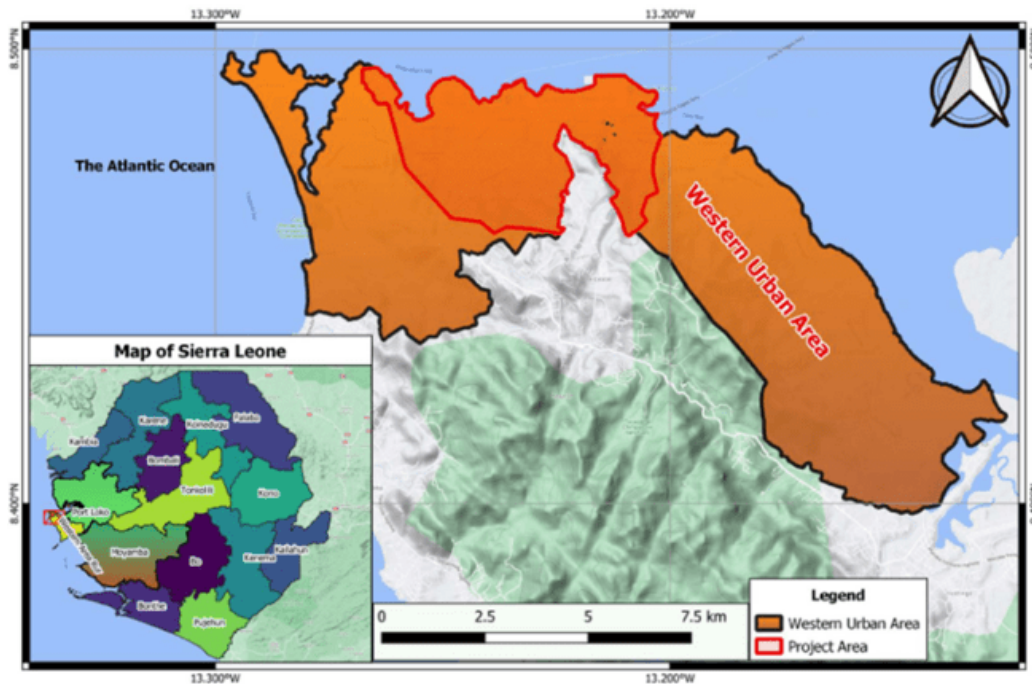


Fig. 3. Map of Sierra Leone and Site Specific (Freetown)

Freetown City's three main municipal regions are East End, Central, and West End, with eight electoral wards. The East End region has the densest population. As the population surges, waste management becomes a challenge. The Sierra Leone Mid-Term Population and Housing Census shows a 1,268,757 population in 2021, with the World Bank 2020 predicting a 1% growth in 2024. (Fig. 4).

The population of Freetown has grown by 38,391 in the last year, representing a 2.93% annual

change, according to the latest UN World Urbanization Prospects revision, indicating a significant urban agglomeration of Freetown.

The projected 1.8 million population in Freetown by 2035 poses significant challenges in solid waste management, especially in handling plastic waste, due to factors like rapid urbanization and historical conflicts affecting waste management infrastructure.

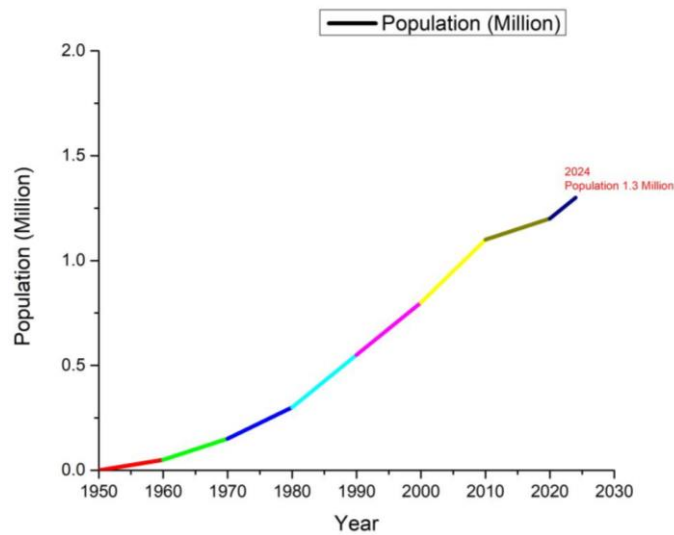


Fig. 4. Freetown City population growth between 1991-2021, yearly increase to date, and projected population (2024)

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

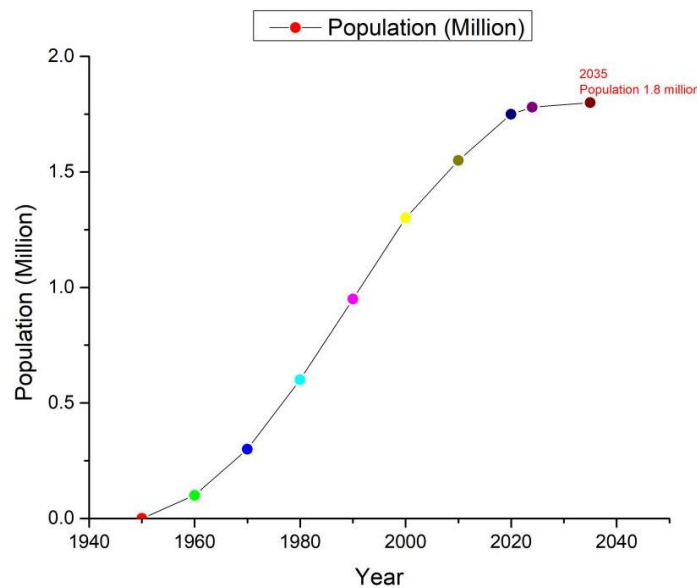


Fig. 5. Freetown City projected population growth between (2024-2035)

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

This section explores Freetown's vulnerability to plastic pollution due to rapid urbanization and historical conflicts, highlighting its socio-economic profile and impact on waste management infrastructure.

5. DISCUSSION

5.1 Main Sources and Types of Plastic Pollution in Freetown

Low-density polyethylene (LDPE) water sachets have made safe drinking water accessible in low-income countries. In the Global South, rapid population growth, poor infrastructure management, and globalization have led to the creation of a new business centered on packaged water, marketed in mechanically sealed plastic sleeves [36].

Sierra Leone imports over \$283,000 worth of plastic from Ghana in 2018, with the nation producing 8,750 metric tons annually through its small domestic plastic manufacturing industry [34]. The country generates 1.3 million kg of MSW daily, with a 0.45 kg per capita daily waste. However, 83.8% of this waste needs better management. Plastic waste, accounting for just under 9% of Municipal Solid Waste, contributes to 116,000 kg of daily waste generation. 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.

Freetown faces a significant plastic waste problem, mainly from LDPE bottles. A 2014 survey revealed that households generate 136 kg of plastic waste annually, mostly discarded. To address this, residents should collect and recycle LDPE sachets. Governments and donors should invest in water, sanitation, and hygiene projects, especially for constructed pipe-borne water.

Poverty has led to households using cheaper sachet water bags instead of pipe-borne bills, resulting in significant plastic waste, including bottled water and polythene bags in Freetown. Sachet water in Niamey and Niger is stigmatized as linked to poverty [37], with plastic waste mainly generated by households unwilling to pay for their waste. Most market traders dispose of their waste in the street or gutters, instead of paying (NLe10 per bag) for it by scavengers (Klin Salone). Fig. 7 show this issue of plastic waste.

5.2 Waste Management Practices in Freetown

Annual waste generation and disposal increase, causing environmental, economic, and public health harm. Addressing waste reduction and better management in Freetown is crucial.

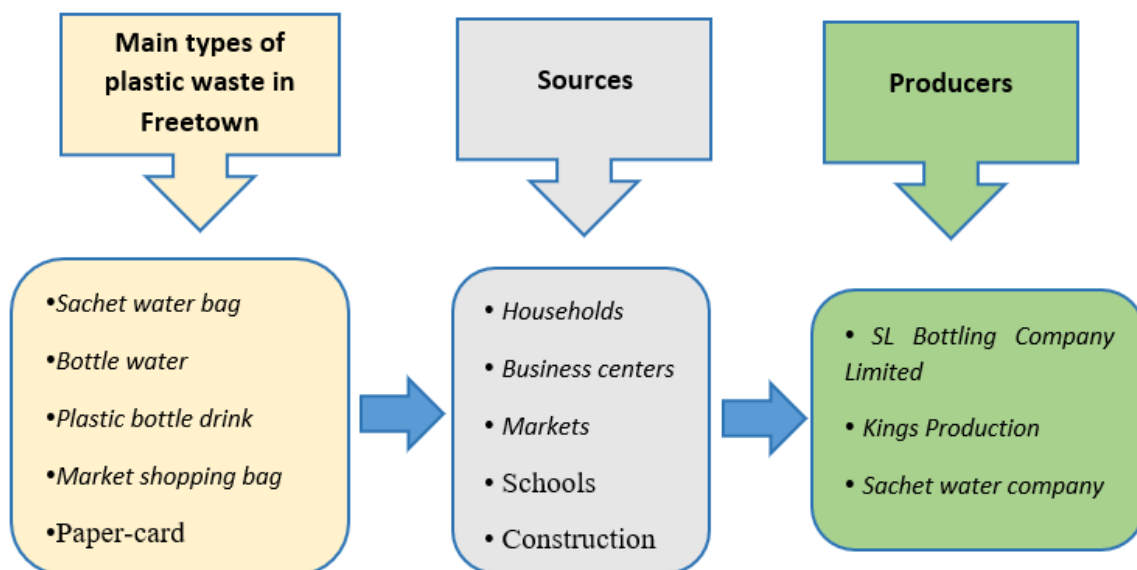


Fig. 6. Main types of plastic waste and how they are generated in Freetown



Fig. 7. Plastic litters in Freetown

Letcher and Vallero define waste management as the process of dealing with waste after it has already accumulated. Organizing the placement, transportation, warehousing, material handling, on-site operations, segmentation, recycling, reuse, and disposal processes [38].

Waste management is sometimes influenced, if not impeded, by the land tenure structure in Freetown City, where many renters still need an absolute claim to the property they temporarily live. As a result, tenants need help managing their trash at home appropriately [39,40].

The World Bank report shows that global cities produced 2.01 billion tons of solid waste in 2016, with an expected increase of 3.40 billion tons annually by 2050 due to a 70% increase in urbanization. In the US, municipal waste generation increased from 217.3 million tons per day in 1995 to 254.1 million tons per-day in 2013. Sub-Saharan Africa generates 62 million tons of solid trash annually [41].

The most enduring environmental issue facing Freetown Western Urban Settlement is solid waste management. About 7.8 million people live in Sierra Leone, and 1.3 million live in the Freetown Metropolitan Area [32].

The Sierra Leone Ministry of Health and Sanitation is responsible for municipal waste management, but the government needs to develop a National Environmental Health and Sanitation Strategy to enhance waste management, including reuse and recycling. In 2017, the Freetown City Council implemented.

Operation Clean Freetown (OCF) to improve solid waste management and reduce epidemic risks. The strategy includes improving waste

management infrastructure and training youth groups as door-to-door waste collection micro-enterprises. However, there are few private recycling companies in Freetown, and a strong material waste management system is necessary for long-term economic development. Financial constraints make implementing a program challenging, and the city experiences annual floods and nearly full landfills. With 550,000 tons of trash produced annually, the city faces challenges in managing industrial pollution and storm-water management legislation. Donors, investors, and environmental groups are needed to ensure a sustainable waste management system. Figs. 8 and 9 illustrate poor maintenance of primary disposal sites in Freetown, Kingtom, Granville Brook, and numerous illegal dumpsites. The city also has 68 major dumpsites, including Susan Bay, Kroo Bay, and Rokuper, housing over 50,000 people [42].

The Freetown City Council, with private sector support from Masada and Klin Salone, is combating plastic pollution. They received waste-collecting equipment from GOAL Salone, promoting public health and launching the first Wastewater Treatment plant (Fig. 10).

5.3 Plastic Waste Management in Freetown

The Freetown Metropolitan Area, a model municipality for Sierra Leone, requires assistance in managing solid waste. Private garbage organizations like Klin Salone and Masada should be engaged to reduce waste collection and disposal. Delayed household solid garbage collection in hard-to-reach areas is a critical issue, causing trash cans to leak out and fill surrounding areas [42].



Fig. 8 and 9. The Kingtom landfill and Granville Brook dumpsite overlapping residential houses

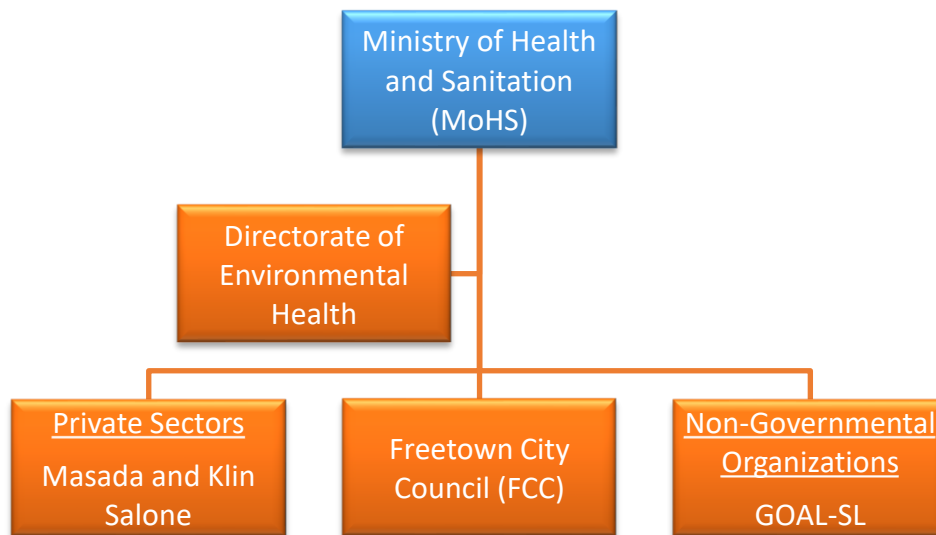


Fig. 10. Waste Management system in Sierra Leone

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 has safety features and compartments

to secure different types of waste during transit.

5.3.2 Informal waste collectors (Scavengers)

Informal waste pickers in Freetown are crucial in waste management practices, collecting recyclable materials from various sources like households, businesses, and streets. They separate recyclables from non-recyclable items, increasing recycling rates and promoting resource recovery. These pickers sell the collected materials to recycling centers, which process and distribute them to manufacturers. Despite challenges like legal recognition and hazardous working conditions, many informal waste pickers contribute to Freetown's plastic

waste reduction efforts. Some cities are working to formalize their activities, including training, protective equipment, and integration into formal waste management systems for improved working conditions and fair compensation. They normally charge per bag of solid waste 10 Leones.

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 collect 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 the United Nations Development Programme and GOAL-Salone have invested in infrastructure and equipment to support formal waste collection operations, enabling efficient waste collection and transport while optimizing resource utilization and minimizing environmental impact.

5.4 The Disposal Method of Solid Waste in Freetown

Open dumpsites entail the disposal of trash in developing metropolitan areas. They are out of control, which makes them a serious health risk that alters the urban environment [43,44]. Unmanaged trash poses a major risk to public health and facilitates the spread of infectious illnesses, especially solid waste originating from households and communities [45].

The two landfills in Freetown are essentially open dumps where waste is disposed. This method, 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 impact Freetown's environment since they lack environmental controls. According to studies by [46], children are particularly susceptible to the health effects of hazardous material exposure at disposal sites. Chemical poisoning results from releasing chemical waste into the environment, whereas direct exposure can cause diseases through chemical exposure [47].

Freetown has two landfills: the Granville Brooke Landfill in the east and the Kingdom Landfill in the west, as seen in Figs. 8 and 9.

6. CHALLENGES OF PLASTIC WASTE MANAGEMENT IN FREETOWN

The Global South produces significantly more poorly managed pollution than the West, despite the West producing far more plastic garbage. In the US, for instance, 98% of the waste stream is controlled; in India, that percentage is barely 12%. The top five countries in terms of plastic emissions into the ocean are those in South and Southeast Asia: China, Indonesia, Malaysia, Philippines, India, and Malaysia. In 2015, the expected release from Asia was 52 Mt, but the projection from Africa was 17 Mt. The estimate for Africa is a startling 88.5%, whereas the former has a 65% mismanagement rate [48]. 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 needs to be improved, with outdated systems leading to inefficiencies in waste collection and disposal (Figs. 8 and 9). The lack of waste collection vehicles, transfer stations, and sanitary landfills results in irregular services, under-served areas, and pollution. The absence of waste treatment facilities and sanitary landfills contributes to open dumping, illegal waste burning, and pollution. The need for recycling facilities and infrastructure for composting, recycling, and incineration helps sustainable waste management practices.

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 under-served 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, which exacerbates environmental pollution and public health risks.

6.3 Disparities in Collection of Waste

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, including waste pickers and small-scale recyclers, plays a crucial role in Freetown's waste management. However, they often face marginalization, inadequate support, and no recognition from authorities. This dominance may hinder efforts to expand formal waste collection coverage. Informal waste pickers fill the gap left by formal waste management authorities. However, 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 waste management challenges due to limited financial resources, hindering investment in new collection routes, vehicles, and infrastructure. This lack of funding leads to insufficient waste collection coverage, inadequate equipment, limited recycling capacity, and regulatory enforcement issues. Freetown needs strategic resource mobilization to address these issues, including increased public investment, public-private partnerships, international donor support, and innovative financing mechanisms like waste-to-energy projects and user fees.

6.7 Population Growth and Urbanization

Rapid population growth and urbanization in Freetown exacerbate the challenge of limited

waste collection coverage (Figs. 4 and 5). 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.

6.8 Inadequate Regulatory Enforcement

The ineffective enforcement of waste management regulations in Freetown is largely due to insufficient capacity, financial constraints, inconsistent application across jurisdictions, and limited public awareness.

However, [49] provides a summary of the issues facing South Africa that may be more broadly applicable as follows: The population as a whole lacks environmental values, institutional corruption, and political patronage systems undercut regulations, and there are few effective waste management methods, such as waste treatment and recycling. The authors recommend a strategy that combines new laws with a widespread effort to change people's moral perceptions. Major cities like Karachi and Lahore have repeatedly flooded as a result of plastic blockages in sewers. Pakistan banned plastic bags in 2019, although it was ineffective due to opposition from both companies and customers [50,51].

7. PLASTIC WASTE IMPACTS IN FREETOWN

About 96,000 metric tons of plastic waste are produced annually in Sierra Leone, 84% of which is improperly disposed of [52]. 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

Freetown, Sierra Leone, faces severe environmental impacts due to plastic pollution. The accumulation of discarded plastics threatens marine life, including sea turtles, fish, seabirds, and marine mammals. Microplastics from plastic fragments can enter the food chain, posing risks to marine organisms and human health. Plastic

pollution also contaminates soil and water bodies on land, releasing harmful chemicals and negatively impacting soil fertility and plant growth. An estimated 8 million metric tons of plastic waste enter the world's oceans annually, with Freetown's coastline being a hotspot for plastic accumulation. Urgent action is needed to preserve the city's natural heritage [53].

7.2 Social Impacts

Plastic pollution significantly impacts 820 million people relying on fisheries for food security. However, more research needs to be conducted on the effects of plastic pollution on fishing communities. In Sierra Leone, plastic pollution was not reported until 2001, when the population grew in Freetown [46]. The pollution has led to public health concerns and livelihood challenges, with inadequate disposal contributing to the proliferation of disease vectors like mosquitoes. Sierra Leone ranks among the countries with the highest malaria burdens, with an estimated 3.5 million cases reported annually [47]. The leaching of toxic chemicals into water sources threatens drinking water quality and increases the incidence of waterborne diseases. Plastic pollution also undermines local livelihoods, particularly those reliant on coastal resources and tourism [11].

7.3 Economic Impacts

7.3.1 Tourism Impacts

African governments' plastic bag bans aim to maintain their reputation with Western tourists, but local substitute material companies struggle due to higher production costs and lack of recycling assistance. The tourism sector in Freetown faces challenges due to plastic waste, affecting the area's beaches and natural settings. Between 2018 and 2020, a 15% decrease in tourist arrivals and a \$5 million revenue loss were attributed to plastic pollution [54].

7.3.2 Waste management costs

Freetown faces financial challenges due to increasing plastic waste, which contributes to 30% of total municipal waste expenditure. Inefficient waste management systems can result in economic losses of 5-10% of GDP. This diverts resources from essential services like healthcare, education, and infrastructure development, and environmental remediation expenses strain municipal finances.

The study primarily examined Freetown, neglecting other major Sierra Leone cities like Bo City, Makeni City, and Kenema City, which also face similar plastic pollution issue.

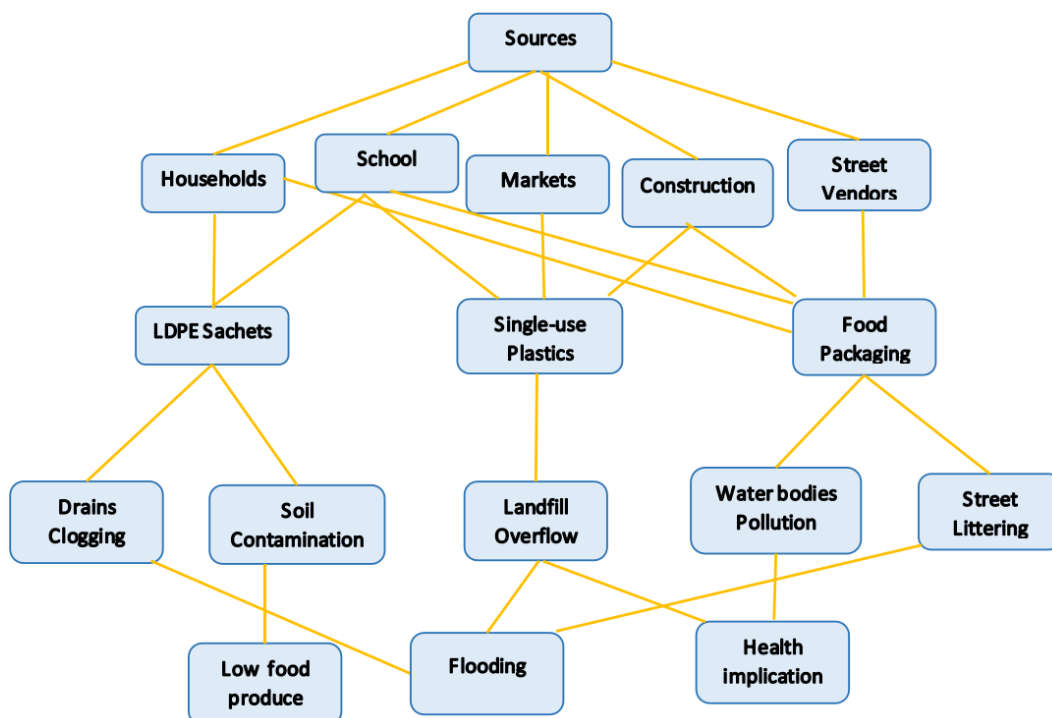


Fig. 11. Sources and impacts of plastic pollution in Freetown

Lack of funding is one of the factors contributing to low collection rates in Least Developed Countries (LDCs); also, there are not enough collection vehicles or the ones that are suffering from poor maintenance, frequent breakdowns (torn tires, low fuel), and frequent outages [55,56,57]. Similarly, in Bissau (Guinea-Bissau) and Kanifing (Gambia), inadequate equipment and inconsistent service impair the efficiency of the garbage collection operation [57,58]. Other LDCs, including Haiti [59], Vientiane (Lao People's Democratic Republic) [60], Honiara (Solomon Islands) [61], Freetown (Sierra Leone) [42], Khartoum (Sudan) [62], and Monrovia (Liberia) [63], have also reported similar findings. 51% of homes in Jimma, Ethiopia, disposed their waste in backyards, open dumps, or refuse pits, while 22% of houses burned their waste [64]. 23% of households in Honiara (Solomon Islands) burn their waste, 17% dump it in their backyard, 10% throw it in rivers, and 8% bury it [65]. Plastic pollution significantly impacts marine life, public health, and local economies in Freetown and other least-developing countries, causing significant environmental, social, and economic impacts.

8. MITIGATION STRATEGIES FOR ADDRESSING PLASTIC WASTE

The UNEP acknowledges the urgent need to tackle plastic waste, a major environmental and health issue. With 300 million tons produced annually, only 9% is recycled. UNEP's strategies focus on a circular economy and bio-plastics [66].

Key Strategies for Addressing Plastic Waste

Circular Economy Implementation: UNEP advocates for a comprehensive global policy agenda that promotes a circular economy, focusing on sustainable production and consumption practices [66].

Enhanced Waste Management: Effective management strategies, including mechanical, chemical, and biological methods, are essential to mitigate plastic waste [66].

Global Cooperation: International collaboration is crucial for improving waste treatment systems and regulatory frameworks, especially in developing regions, where inadequate waste management systems exacerbate plastic pollution [7].

The discussion explores the sources, types, and management of plastic pollution in Freetown, focusing on single-use plastics' environmental, social, and economic impacts.

9. FUTURE RESEARCH DIRECTIONS

The research on plastic pollution in Freetown offers a basic understanding, but there are gaps that require further investigation for improved waste management strategies and policy frameworks.

1. Behavioral Studies on Waste Disposal Practices: Understanding social and behavioral factors influencing waste disposal practices in Freetown could enhance public education campaigns and behavior change strategies, identifying barriers to proper waste segregation and motivating sustainable waste practices.

2. Economic Analysis of Plastic Waste Management: Comprehensive economic analyses of the costs and benefits of different waste management strategies, including recycling, composting, and landfilling, are needed.

10. CONCLUSION

The study concludes that plastic pollution in Freetown significantly impedes sustainable development, affecting public health, environmental integrity, and socio-economic stability. The pervasive nature of plastic waste, coupled with inadequate waste management infrastructure, calls for urgent action from government bodies, businesses, and communities. The findings emphasize the need for improved waste management systems, increased public awareness, and stronger regulatory frameworks to mitigate the impact of plastic pollution. Policymakers are urged to prioritize sustainability in their agendas to protect the environment and public health, ensuring the well-being of present and future generations.

However, policymakers are strongly encouraged to enact and enforce comprehensive waste management policies, invest in recycling and waste reduction technologies, and foster community engagement to address the critical issue of plastic pollution. This can drive significant progress toward achieving the SDGs and ensure a sustainable future for Freetown.

11. RECOMMENDATIONS FOR SPECIFIC POLICIES

- Implement a phased ban on single-use plastics (e.g., plastic bags, straws, and bottles) to reduce plastic waste at the source. Promote alternatives such as reusable local bags.
- Mandate that producers take responsibility for the entire lifecycle of their plastic products, from production to disposal.
- Implement robust waste management systems for plastic segregation, collection, and recycling, involving community recycling centers, incentives, and integrating informal waste pickers into formal systems.

Community Involvement

- Engage community groups to lead campaigns reducing plastic use, littering, and recycling, involving local leaders, schools, and religious institutions to spread the message.
- Implement educational programs in schools and communities to educate about plastic pollution's environmental impacts and responsible consumption, utilizing social media, workshops, and local events using posters, radio, and television.
- Organize collaborative events like "Plastic-Free Freetown" days to engage the community and showcase sustainable practices.

Stakeholder Engagement

- Government should lead policy development and enforcement, provide funding and resources for waste management infrastructure, and support public education campaigns.
- Non-Governmental Organizations should provide technical expertise and support for community-led initiatives.
- Community Members should act as an active participant in reducing plastic pollution through responsible consumption and participation in clean-up activities,
- Freetown can significantly reduce plastic pollution by implementing policies, engaging the community, and fostering collaboration among stakeholders, such as banning single-use plastics, improving waste management, and encouraging community involvement in recycling efforts.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chaudhary M, Garg AP. Global Impact of Plastic Pollution and Its Management for Sustainable Development, in *Quality of Life and Climate Change: Impacts, Sustainable Adaptation, and Social-Ecological Resilience*. IGI Global. 2024;122-152.
2. Geyer R, Jambeck JR, Law KL. Production, use, and fate of all plastics ever made. *Science Advances*. 2017; 3(7):e1700782.
3. Rafey A, et al. A state-of-the-art review on the technological advancements for the sustainable management of plastic waste in consort with the generation of energy and value-added chemicals. *Catalysts*. 2023;13(2):420.
4. Smith E, Bilec MM, Khanna V. Evaluating the global plastic waste management system with Markov chain material flow analysis. *ACS Sustainable Chemistry and Engineering*. 2023;11(6):2055-2065.
5. Mohanan N, et al. Microbial and enzymatic degradation of synthetic plastics. *Frontiers in Microbiology*. 2020;11:580709.
6. Shaikh FA, et al. Plastic waste management: Case study of tower market, Hyderabad. *Mehran University Research Journal of Engineering and Technology*. 2023;42(2):1-9.
7. Tul Muntaha S, Keitsch M. A pathway for plastic waste in construction materials. *Sustainable Development*.
8. Khatun MM, Rahman MM, Showva NN. Plastic waste management through biological methods: An approach towards sustainable development. *Bioresearch Communications-(BRC)*. 2024;10(02):1597-1608.
9. Hoque M. Reviewing the progress and challenges of plastic waste recycling and management; 2024.

10. Turay FB, Kamara OG, Bangura EJ. The effects of domestic waste disposal among communities in the western region of sierra leone-a case study of waterloo, Calabatown, wellington, ferry junction, kingtom, and lumley. *European Journal of Social Sciences Studies*. 2024;10(1).
11. Sesay MM. Reducing Landfill Waste in Sierra Leone with Construction Industry Material Waste Management; 2022.
12. Kaza S, et al. What a waste 2.0: A global snapshot of solid waste management to 2050. 2018: World Bank Publications.
13. Manyara P, Raubenheimer K, Sadan Z. Legal and policy frameworks to address marine litter through improved livelihoods. *The African Marine Litter Outlook*. 2023;137.
14. Kreienkamp J. The United Nations Sustainable Development Goals on Biodiversity, Climate Change and Health.
15. Fox O, Stoett P. Citizen participation in the UN sustainable development goals consultation process: Toward global democratic governance? *Global Governance*. 2016;22:555.
16. Xu Y, et al. Investigation of the urban factors affecting microplastic pollution in Chinese cities: the case of Ningbo. In *Proceedings of the 2020 International Conference on Resource Sustainability: Sustainable Urbanisation in the BRI Era (icRS Urbanisation 2020)*. Springer; 2020.
17. Velis CA, et al. Enabling the informal recycling sector to prevent plastic pollution and deliver an inclusive circular economy. *Environmental Science and Policy*. 2022;138:20-25.
18. Chowdhury GW, et al. The ecological impact of plastic pollution in a changing climate. *Emerging Topics in Life Sciences*. 2022;6(4):389-402.
19. Kumar R, et al. Impacts of plastic pollution on ecosystem services, sustainable development goals, and need to focus on circular economy and policy interventions. *Sustainability*. 2021;13(17):9963.
20. Adebisi-Abiola B, et al. Cleaning up plastic pollution in Africa. *Science*. 2019; 365(6459):1249-1251.
21. Cordova MR. Marine plastic debris: Distribution, abundance, and impact on our seafood, in *Handbook of Research on Environmental and Human Health Impacts of Plastic Pollution*. IGI Global. 2020;94-121.
22. Alqarni A. Quantitative Analysis of Urban Microplastic Dissemination and Accumulation in Marine Ecosystems: Pathways, Processes, and Impacts; 2024.
23. MacLeod M, et al. The global threat from plastic pollution. *Science*. 2021; 373(6550):61-65.
24. Kargbo SJ, et al. A comprehensive overview of the current Fisheries Status in Sierra Leone; 2024.
25. Choi YR, et al. Plastic contamination of forest, urban, and agricultural soils: A case study of Yeosu City in the Republic of Korea. *Journal of Soils and Sediments*. 2021;21:1962-1973.
26. Anunobi T. Hazardous effects of plastic wastes on land biodiversity: A review. *Zoologist (the)*. 2022;20(1):80-86.
27. Chukwuemeka IS, et al. Impacts of microplastics and urbanization on soil health: an urgent concern for sustainable development. *Green Analytical Chemistry*. 2024;100095.
28. Thomas F, et al. Quality of reporting of adverse drug reactions to antimicrobials improved following operational research: A before-and-after study in Sierra Leone (2017-2023). *Tropical Medicine and Infectious Disease*. 2023;8(10):1-9.
29. Kumari A, et al. Microplastic pollution: An emerging threat to terrestrial plants and insights into its remediation strategies. *Plants*. 2022;11(3):340.
30. Ansari AA, et al. Plastics in the soil environment: An overview. *Agrochemicals in Soil and Environment: Impacts and Remediation*. 2022;347-363.
31. Steinbach D, Mohammed EY, Steele P. A sustainable future for fisheries: How fiscal policy can be used to achieve SDG 14; 2016.
32. Chalokwu C. Petrology of the Freetown layered complex, Sierra Leone: Part II. Magma evolution and crystallisation conditions. *Journal of African Earth Sciences*. 2001;32(3):519-540.
33. Callegaro S, et al. Geochemical constraints provided by the Freetown Layered Complex (Sierra Leone) on the origin of high-Ti tholeiitic CAMP magmas. *Journal of Petrology*. 2017;58(9):1811-1840.
34. Redshaw P, et al. The 2017 regent landslide, Freetown peninsula, Sierra Leone. *Quarterly Journal of Engineering*

- Geology and Hydrogeology. 2019;52(4): 435-444.
35. Peel MC, Finlayson BL, McMahon TA. Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences*. 2007;11(5):1633-1644.
 36. Stoler J. From curiosity to commodity: A review of the evolution of sachet drinking water in West Africa. *Wiley Interdisciplinary Reviews: Water*. 2017;4(3):e1206.
 37. Keough SB, Youngstedt SM. 'Pure Water' in Niamey, Niger: The backstory of sachet water in a landscape of waste. *Africa*. 2018;88(1):38-62.
 38. Letcher T, Vallero DA. *Waste: A handbook for management*. Academic Press; 2019.
 39. Unruh J. Land policy reform, customary rule of law and the peace process in Sierra Leone. *African Journal of Legal Studies*. 2008;2(2):94-117.
 40. Ahene R, et al. Support to the Sierra Leone Land Agenda: Policy Note. World Bank; 2019.
 41. Nartey AK, Nyarko P. Solid waste management practices in Ghana: Challenges and prospects. *African Journal of Current Medical Research*. 2020;4(1).
 42. Komba T. 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*. 2021;9(04):33.
 43. Kaindaneh PM. Sierra Leone: Land governance assessment framework. World Bank; 2015.
 44. Ochiai T. The bifurcated development of land policy in Sierra Leone. *Asian Journal of African Studies*. 2016;(40):137-172.
 45. Ahene R, et al. Support to the Sierra Leone Land Agenda. The World Bank Group; 2019.
 46. Yongsi H, et al. Environmental sanitation and health risks in tropical urban settings: Case study of household refuse and diarrhea in Yaounde-Cameroon. *International Journal of Social Sciences*. 2008;3(3):158-166.
 47. Marshal E. Analytic study to evaluate associations between dumpsites and birth effects. ATSDR CO. LTD: Atlanta; 1995.
 48. Lebreton L, Andrady A. Future scenarios of global plastic waste generation and disposal. Palgrave Communications. 2019;5(1):1-11.
 49. Iroegbu AO, et al. Plastics in municipal drinking water and waste water treatment plant effluents: Challenges and opportunities for South Africa—A review. *Environmental Science and Pollution Research*. 2020;27:12953-12966.
 50. Ali Z, Sara S, Rehman OU. How to tackle plastic bags and bottles pollution crisis in Pakistan? A cost–benefit analysis approach. *Environmental and Ecological Statistics*. 2021;28(3):697-727.
 51. Umer M, Abid M. Economic practices in plastic industry from raw material to waste in Pakistan: A case study. *Asian Journal of Water, Environment and Pollution*. 2017;14(2):81-90.
 52. Sankoh FP, Yan X. Problems of solid waste management in developing urban cities: A case study of Freetown, Sierra Leone. *American Journal of Environmental Protection*. 2013;2(5):113-120.
 53. Akobe OD. Access, use and dissemination of information on waste disposal by environmental health workers for hygienic lifestyle, a study of Minna, Nigeria; 2023.
 54. Behuria P. African development and the marginalisation of domestic capitalists; 2019.
 55. Bundhoo ZM. Solid waste management in least developed countries: Current status and challenges faced. *Journal of Material Cycles and Waste Management*. 2018; 20:1867-1877.
 56. Mizero M, Ndikumana T, Jung G. Quantification, caractérisation et voies de valorisation des déchets solides municipaux dans la ville de Bujumbura. *Bulletin Scientifique sur l'Environnement et la Biodiversité*. 2015;1(1-7).
 57. Ferrari K, et al. An international partnership for the sustainable development of municipal solid waste management in Guinea-Bissau, West Africa. 21 Summer School "Francesco Turco"—industrial systems engineering. 2016;113-117.
 58. Badgie D, Muda A, Latifah A. Integrated study of solid waste management system in the Kanifing Municipal Council (KMC), the Gambia. In National Conference on Postgraduate Research (NCON-PGR) 2009. UMP Conference Hall, Malaysia; 2009.
 59. Kumar K, Sahu O. Utilizations of food waste as an anaerobic digester feedstock.
 60. Chittaphone P. Performance assessment of plastic waste management in Vientiane capital, lao pdr.

61. Snapshot CIC. Solid Waste Management in the Pacific.
62. Abubaker B, et al. Investigating the solid waste management problems in Urban Area, Sudan. *International Journal of Engineering Research*. 2014; 3(6).
63. Altınçelep B. Effectiveness of post-conflict environmental assessments of Unep in Afghanistan and Liberia. Middle East Technical University; 2023.
64. Getahun T, et al. Municipal solid waste generation in growing urban areas in Africa: Current practices and relation to socioeconomic factors in Jimma, Ethiopia. *Environmental Monitoring and Assessment*. 2012;184:6337-6345.
65. McEvoy D, et al. Reflecting on a journey from climate change vulnerability assessments to the implementation of climate resilience actions: Honiara, Solomon Islands, in Urbanisation at Risk in the Pacific and Asia. Routledge. 2020;53-73.
66. García-Marín LM, Rentería ME. Fighting plastic pollution with a circular economy roadmap and strategy: Addressed to the United Nations Environment Programme. *Journal of Science Policy and Governance*. 2024;24(01).

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/122252>