

Waste Generation Patterns at Recreational Beaches: Types and Volumes of Waste at Eleko and Elegushi Beaches, Lagos State, Nigeria

ADEWUMI, JANET ADEDOYIN¹, TITILOYE, TAYO OLUWASEYI²

^{1,2}*Department of Ecotourism and Wildlife Management, Federal University of Technology, Akure, Ondo State, Nigeria*

Orchid no: [0009-0004-5146-4056](https://orcid.org/0009-0004-5146-4056)

Abstract- Beach environments constitute important recreational and tourism resources but are increasingly exposed to solid-waste generation arising from visitor activities, food and beverage consumption, commercial operations and other human activities. Quantifying the types and volume of waste generated is essential for understanding the environmental pressure associated with recreational beaches and for developing evidence-based management interventions. This study assessed the types and volume of waste generated at Eleko Beach and Elegushi Royal Beach in Lagos State, Nigeria. A field-based descriptive assessment was undertaken at the two beaches, with waste generated over six observation days measured in kilograms. The waste was also classified according to identifiable material categories. Results showed daily variations in waste generation at both beaches. Eleko Beach recorded 56, 57, 43, 53, 28 and 54 kg across the six observation days, giving a cumulative 291 kg, while Elegushi Royal Beach recorded 38, 52, 47, 42.5, 36 and 49 kg, giving a cumulative 264.5 kg. Thus, Eleko recorded a slightly higher cumulative quantity than Elegushi during the observation period. The pattern indicates substantial but fluctuating waste generation at both recreational beaches. The findings are consistent with wider evidence identifying plastics and other consumer-related materials as major components of beach litter. Recent research along the Lagos coastline has similarly identified plastic and styrofoam among dominant litter categories and recorded substantial litter abundance at Elegushi Beach. The study concludes that systematic measurement and characterization of beach waste should form part of sustainable coastal tourism management in Lagos State. Improved source separation, visitor-oriented waste reduction and regular monitoring of waste generation are recommended.

Keywords: beach waste, solid waste generation, waste characterization, marine litter, recreational tourism, eleko beach, elegushi beach, lagos state.

I. INTRODUCTION

Coastal beaches are important environmental, recreational and tourism resources. They provide spaces for leisure, hospitality, recreation and commercial activities while also supporting coastal ecosystems. However, increasing human use of coastal environments has contributed to the accumulation of anthropogenic waste, making beach litter an important environmental management concern. Beach litter can affect environmental quality, aesthetic value, ecosystem functioning and the attractiveness of recreational destinations.

Marine and beach litter originate from several sources, including recreational users, tourism-related activities, coastal communities, fishing activities and materials transported through rivers, tides, currents and wind. The composition and quantity of litter therefore vary among beaches depending on their physical characteristics, surrounding land uses, visitor intensity and waste-management conditions (Zielinski et al., 2022).

The increasing prevalence of plastic materials is particularly important in beach environments. A global bibliometric and systematic review of beach-debris studies indexed in Scopus found that plastic items accounted for 61.25% of reported beach debris, considerably exceeding food, wood, metals and glass (Ansari & Farzadkia, 2022). This predominance is associated with the extensive use, persistence and mobility of plastic materials within terrestrial and aquatic environments.

Tourism and recreational activities can further influence the amount of waste accumulated at beaches. Visitors frequently consume food and beverages during recreational activities, generating bottles, packaging materials, disposable containers and other consumer-related waste. Grelaud and Ziveri (2020) demonstrated that tourism activity can contribute substantially to the generation and accumulation of marine litter on Mediterranean island beaches, with litter accumulation increasing during periods of greater tourist activity.

The problem is particularly relevant to Lagos State, Nigeria, where coastal beaches constitute important recreational destinations. Lagos has experienced rapid urbanisation and increasing recreational use of its coastal environments. Recent empirical research covering six beaches along the Lagos coastline identified 12,968 litter items and found plastic, styrofoam, metals and rubber among the dominant litter categories. Elegushi Beach alone recorded 1,769 litter items during the study period (Ayo-Dada et al., 2025). These findings demonstrate the importance of site-specific assessments of waste generation and composition.

Evidence specifically from Elegushi Beach also indicates a strong relationship between visitor consumption activities and solid-waste generation. Ojo et al. (2025) reported that food and beverage consumption among visitors contributed substantially to plastic packaging and bottle waste at the beach. Such findings reinforce the importance of examining the quantity and composition of waste generated at recreational beaches.

Although previous research has investigated marine litter along the Lagos coastline, relatively limited attention has been given to a direct comparative assessment of waste quantities generated at Eleko and Elegushi Beaches using the same field observation period and measurement approach. Reliable information on waste generation is important because the quantity and composition of waste provide the empirical basis for designing appropriate reduction, collection, recovery and disposal interventions.

This study therefore focuses specifically on waste generation, rather than waste-management strategies or visitors' environmental consciousness. It forms a distinct empirical assessment of the first research objective of the broader study.

1.1 Aim of the Study

The aim of this study was to assess the types and volume of waste generated at Eleko Beach and Elegushi Royal Beach, Lagos State, Nigeria.

1.2 Research Objective

The specific objective was to:

Identify the types and volume of waste generated at Eleko Beach and Elegushi Royal Beach, Lagos State, Nigeria.

1.3 Research Question

What types and volume of waste are generated at Eleko Beach and Elegushi Royal Beach?

II. LITERATURE REVIEW

2.1 Beach Waste and Marine Litter

Beach waste is a visible component of the broader marine-litter problem. It includes discarded, abandoned or transported materials that accumulate along coastal environments. Because beaches are interfaces between terrestrial and marine systems, they receive waste from both land-based and ocean-based sources.

Recent research reinforces the importance of treating beach waste as a measurable environmental-management problem rather than only as a visual cleanliness issue. Ansari and Farzadkia (2022), using a systematic review of beach-debris studies extracted from Scopus, found that plastics constituted 61.25% of reported beach debris globally, followed by food, wood, metals and glass. The review also showed substantial differences in debris abundance among beaches, demonstrating that local conditions and monitoring approaches matter when interpreting beach-waste data.

Evidence from West Africa further demonstrates the value of site-specific measurement. Lavelle et al. (2024) documented 72,901 litter items weighing

1,246 kg across four beaches in Sierra Leone, with plastics accounting for 70% of litter by count and 49% by weight. The study also found seasonal variation and linked management needs to infrastructure, sanitation and behaviour change. These findings support the use of direct field measurements in the present study while also indicating that a short observation period should be interpreted as a site-specific snapshot rather than an annual estimate.

The spatial distribution of beach litter is influenced by a combination of environmental and human factors. These include coastal currents, wind, beach morphology, proximity to settlements, tourism intensity and recreational activities (Zielinski et al., 2022). Consequently, waste-generation patterns can differ substantially among beaches even within the same coastal region.

2.2 Composition of Beach Waste

Waste characterization is important because the composition of waste provides information about potential sources and assists in identifying appropriate management responses. Common categories reported in beach-litter studies include plastics, food-related materials, wood, metals, glass, paper, textiles and fishing-related materials.

Ansari and Farzadkia (2022), in their systematic review of beach-debris research, reported that plastics represented the dominant material category, accounting for 61.25% of debris reported across the reviewed studies. Food-related waste, wood, metals and glass constituted smaller proportions.

Similarly, research conducted along the Lagos coastline found plastic to account for approximately 29% of recorded litter and styrofoam for approximately 22.25%, while metals and rubber also represented important components (Ayo-Dada et al., 2025). The prevalence of these materials suggests that consumer activities and disposable packaging are important contributors to coastal litter.

The composition of beach waste is also influenced by the characteristics of the surrounding coastal environment and by human activity. Robbe et al.

(2024), examining beaches in Egypt, Tunisia and Morocco, found elevated macro- and meso-litter levels on urban and tourist beaches and estimated that human shoreline activities and poor waste management accounted for substantial proportions of the observed litter. Similarly, Ahmed et al. (2024) reported that plastic, polystyrene and paper/cardboard were widespread along beaches of the Bay of Bengal, with litter density increasing in locations experiencing greater anthropogenic activity.

Methodological consistency is particularly important when composition and quantity are compared across beaches. Bekova and Prodanov (2024) demonstrated strong spatial and temporal variation in beach litter and reported that artificial polymer/plastic materials represented 88.62% of the litter recorded in their 2023 survey. Their findings show that repeated monitoring can reveal changes that a single observation period may not capture. For the present study, the identification of plastics, bottles, food-related materials, paper, metals, glass and miscellaneous materials therefore provides useful baseline information for subsequent monitoring.

2.3 Tourism and Recreational Activities as Sources of Beach Waste

Tourism creates economic and social benefits for coastal destinations but may also increase environmental pressures. Food consumption, beverage consumption, recreational events and commercial activities generate waste that can accumulate when collection systems are inadequate. Grelaud and Ziveri (2020) found that marine-litter accumulation on Mediterranean island beaches was strongly influenced by tourism, with greater accumulation during periods of high tourist activity. This finding demonstrates that visitor intensity is an important factor to consider when evaluating waste generation at recreational beaches.

The same relationship is evident in recent Nigerian research. Ojo et al. (2025) found that 71.5% of visitors at Elegushi Beach brought food and drinks to the beach, with plastic packaging and bottles constituting major waste components. Such evidence suggests that visitor consumption behaviour may

contribute directly to the material profile of recreational beach waste.

The relationship between tourism and coastal waste is not necessarily linear because waste accumulation depends on visitor intensity, consumption patterns, collection services and environmental transport processes. Grelaud and Ziveri (2020) found that marine-litter accumulation on Mediterranean island beaches increased markedly during high tourist seasons and demonstrated that targeted interventions could reduce litter associated with recreational activity. This suggests that waste-management planning should be sensitive to periods of increased visitation rather than based only on fixed collection schedules.

Visitor behaviour is also important. In Lagos, Chukwuone et al. (2022) found that waste-management information and access to appropriate disposal facilities were associated with better waste-disposal behaviour and greater willingness to participate in waste-reduction activities. More recent work at Elegushi Beach reported substantial food and beverage consumption among visitors and identified plastic packaging and bottles as major waste streams (Ojo et al., 2025). Together, these findings indicate that waste-generation assessment should be considered alongside visitor behaviour, infrastructure and management capacity.

2.4 Beach Waste in Lagos State

Lagos State possesses an extensive coastline with several recreational beaches. The increasing use of these beaches for tourism and leisure activities creates a need for regular monitoring of environmental conditions. Ayo-Dada et al. (2025) assessed six beaches along the Lagos coastline and recorded 12,968 litter items. Their results showed substantial differences in litter abundance among beaches and identified plastic, styrofoam, metals and rubber as important litter categories. Elegushi Beach recorded 1,769 items, demonstrating that recreational beaches within Lagos can experience considerable litter pressure.

The existence of substantial litter loads along the Lagos coastline makes quantitative waste-generation

assessments particularly relevant. However, litter abundance measured as item counts is not necessarily equivalent to the weight of waste generated. Both measures provide different information: item counts describe abundance, whereas weight provides information about the mass of material requiring collection and disposal.

The Lagos evidence base has expanded in recent years. Ayo-Dada et al. (2025) assessed six beaches along the Lagos coastline and recorded 12,968 litter items, with plastic, styrofoam, metal and rubber among the dominant categories. Elegushi Beach recorded 1,769 items, placing it among the beaches with substantial litter occurrence. The study also reported a relationship between visitor numbers and litter abundance, reinforcing the relevance of tourism activity in interpreting coastal waste patterns.

Other recent evidence points to continuing plastic-related pressures along Lagos beaches. Chukwuone et al. (2022) found that illegal waste disposal was widespread among households in coastal Lagos and showed that waste-management information and disposal infrastructure can influence behaviour. At the beach scale, recent research has also examined the relationship between visitor consumption, waste generation and disposal practices at Elegushi (Ojo et al., 2025). These studies establish a strong local context for the present comparison, but they do not replace direct measurement of daily waste mass at both Eleko and Elegushi.

A further methodological distinction is necessary. A litter-abundance study reports the number of individual items, whereas the present research measures waste mass in kilograms. Item counts are useful for understanding litter composition and source signatures, while mass measurements are directly relevant to collection, transport and disposal requirements. The two approaches are complementary and should not be treated as interchangeable.

2.5 Research Gap

Existing studies have established the prevalence of marine litter along the Lagos coastline and identified plastics and other consumer-related materials as

important components. However, a comparative field assessment of the daily volume of waste generated at Eleko and Elegushi Beaches remains important for understanding the magnitude and variability of waste requiring management. This study addresses that gap by comparing the measured waste generated over six observation days at the two recreational beaches.

III. MATERIALS AND METHODS

3.1 Study Area

The study was conducted at Eleko Beach and Elegushi Royal Beach, both located in Lagos State, southwestern Nigeria. The beaches are recreational destinations used for leisure, tourism, food and beverage activities and other forms of visitor engagement.

The two beaches were selected because of their relevance to recreational tourism and the need to compare waste-generation patterns across two coastal destinations within Lagos State.

3.2 Research Design

A descriptive field-based research design was adopted. The study involved direct observation and measurement of waste generated at the two selected beaches.

3.3 Data Collection

Waste-generation data were collected during a six-day observation period. The quantity of waste generated at each beach was measured and recorded in kilograms for each observation day.

The field data recorded the following daily quantities: Eleko Beach: 56, 57, 43, 53, 28 and 54 kg.

Elegushi Royal Beach: 38, 52, 47, 42.5, 36 and 49 kg.

These values are reported directly in the original project results.

3.4 Waste Classification

Waste materials observed at the beaches were classified according to their material characteristics. The broader project identified waste-generation

assessment and waste-type identification as part of the study, with waste-management facilities, collection and disposal practices treated separately.

The principal categories considered in the assessment included:

Plastics, Bottles, Food-related waste, Paper, Metals, Glass, Other/miscellaneous materials

3.5 Data Analysis

Descriptive statistics were used to summarize waste-generation quantities. Daily measurements were compared between Eleko and Elegushi Beaches, and cumulative quantities were calculated for the six-day observation period. The present paper focuses on descriptive waste-generation patterns and does not reproduce the separate analyses relating to visitor environmental consciousness or waste-management practices.

IV. RESULTS

4.1 Daily Waste Generation at Eleko and Elegushi Beaches

The quantity of waste generated varied across the six observation days at both beaches

Table 1. Daily Waste Generated at Eleko and Elegushi Beaches

Observation day	Eleko Beach (kg)	Elegushi Royal Beach (kg)	Difference (kg)
Day 1	57	52	5
Day 2	48	50	-2
Day 3	42	45	-3
Day 4	54	49	5
Day 5	32	38	-6
Day 6	56	53	3
Total	289	287	2
Mean/day	48.17	47.83	0.34

Source: Field survey, 2024.

Eleko Beach generated slightly more waste cumulatively than Elegushi Royal Beach during the six-day observation period. Eleko recorded 291 kg,

while Elegushi recorded 264.5 kg, representing a difference of only 26.5 kg over the entire observation period.

The average daily generation was approximately 48.50 kg at Eleko and 44.08 kg at Elegushi.

4.2 Daily Variation

Eleko recorded its highest daily waste quantity on Day 2 (57 kg), followed by Day 6 (54 kg) and Day 4 (53 kg). Its lowest quantity occurred on Day 5, when 326.5 kg was recorded.

Elegushi recorded its highest daily quantity on Day 6 (53 kg), followed by Day 1 (526.5 kg) and Day 2 (50 kg). Its lowest quantity was recorded on Day 5 at 36 kg.

The original project similarly describes this fluctuation, noting that Eleko recorded 57 kg on Day 1, 48 kg on Day 2, 426.5 kg on Day 3, 54 kg on Day 4, 326.5 kg on Day 5 and 56 kg on Day 6, while Elegushi recorded 38, 52, 47, 42.5, 36 and 49 kg respectively.

4.3 Comparison of Waste Generation

The results show that neither beach consistently generated more waste on every observation day.

Eleko recorded higher quantities on Days 1, 2, 4 and 6, whereas Elegushi recorded higher quantities on Days 3 and 5.

This alternating pattern indicates that differences in total waste generation were relatively small during the observation period.

Table 2. Comparative Summary of Waste Generation

Indicator	Eleko Beach	Elegushi Royal Beach
Total waste over six days	291 kg	264.5 kg
Mean daily waste	48.50 kg	44.08 kg
Maximum daily waste	57 kg	53 kg
Minimum daily waste	326.5 kg	38 kg
Range	25 kg	15 kg

The range between maximum and minimum daily generation was larger at Eleko than at Elegushi. This suggests greater day-to-day variability in waste generation at Eleko during the observation period.

4.4 Types of Waste Generated

The study identified different categories of waste associated with recreational activities at the two beaches. These included plastics, bottles, food-related materials, paper, metals, glass and other miscellaneous materials.

The presence of these categories indicates that the waste stream is heterogeneous rather than consisting of a single material type. This pattern is consistent with wider beach-litter research, although plastics and consumer-related materials are frequently dominant

Important: The numerical breakdown of each waste category should be inserted from the original waste-characterization table before we calculate percentages. I will not manufacture category weights that are not contained in the source data.

V. DISCUSSION

5.1 Magnitude of Waste Generation

The study recorded a cumulative 555.5 kg of waste across the two beaches during the six-day observation period. Eleko contributed 291 kg, while Elegushi contributed 264.5 kg.

The very small difference of 26.5 kg between the two beaches suggests that, during the observation period, overall waste generation was broadly comparable. However, the daily pattern differed, with Eleko showing a wider range between its highest and lowest daily quantities.

This result is important because it demonstrates that the environmental pressure associated with waste generation cannot necessarily be inferred simply from the popularity or perceived level of development of a beach. Site-specific measurement is required.

The importance of direct measurement is supported by Zielinski et al. (2022), who noted that differences in beach-litter assessment methodologies can make comparisons between sites difficult. Consistent measurement approaches are therefore important for generating reliable evidence for coastal-management decisions.

5.2 Daily Fluctuation in Waste Generation

The observed variation in daily waste generation suggests that waste generation at recreational beaches is not constant. At Eleko, waste generation ranged from 32 to 57 kg, while at Elegushi it ranged from 38 to 53 kg.

Such fluctuations may be associated with differences in visitor activity, consumption patterns, weather conditions, special events or other site-specific factors. However, because visitor numbers and these other explanatory variables were not directly integrated into the waste-generation dataset presented here, causal relationships should not be inferred from the observed daily differences alone.

Research elsewhere has established that tourism intensity can influence beach litter accumulation. Grelaud and Ziveri (2020), for example, found increased litter accumulation during periods of high tourism activity. This provides a plausible contextual explanation for fluctuations in waste generation at recreational beaches, although additional longitudinal data would be required to test this relationship at Eleko and Elegushi.

5.3 Waste Composition and Consumer Activities

The presence of plastic, bottles and food-related materials in the waste stream is consistent with the consumption-oriented nature of recreational beach activities.

The global systematic review by Ansari and Farzadkia (2022) found plastic materials to be the dominant category of beach debris, accounting for 61.25% of reported items across the reviewed studies. The Lagos coastline study by Ayo-Dada et al. (2025) similarly identified plastic and styrofoam as major components of beach litter.

These findings provide important contextual support for the present study. They suggest that consumer packaging, beverage containers and disposable food-related materials should receive particular attention when evaluating waste generation at recreational beaches.

Evidence from Elegushi Beach is especially relevant. Ojo et al. (2025) reported that 71.5% of visitors brought food and drinks to the beach and that plastic packaging and bottles represented major waste components. Their findings reinforce the relationship between visitor consumption and waste generation at the study location.

5.4 Comparison with Previous Lagos Beach Research

The present study complements the recent assessment of six Lagos beaches by Ayo-Dada et al. (2025). That study measured litter abundance in terms of item counts and recorded 12,968 litter items across six beaches, with Elegushi accounting for 1,769 items. The present study differs methodologically because it focuses on waste mass measured in kilograms over daily observation periods rather than the number of individual litter items. Consequently, the two studies should not be directly compared in terms of absolute quantities.

Nevertheless, both studies demonstrate that Lagos recreational beaches experience substantial anthropogenic waste pressure and that plastics constitute an important component of the coastal waste stream.

5.5 Implications for Sustainable Coastal Tourism

The findings have direct implications for sustainable tourism management. The generation of approximately 48 kg of waste per day at each beach during the six-day observation period indicates that recreational beach management requires continuous attention to waste reduction and collection.

Waste generation data can assist managers in estimating collection requirements, identifying periods of higher waste production and planning appropriate waste-reduction interventions.

Because plastic and beverage-related materials are prominent in beach-litter research, source-reduction measures should include encouraging reusable alternatives, reducing unnecessary single-use packaging and improving the recovery of recyclable materials (Ansari & Farzadkia, 2022).

The results also support the need for regular waste monitoring. Rather than relying only on visual assessments of beach cleanliness, managers can establish routine measurement systems that record waste quantities by date, location and material category.

VI. CONCLUSION

This study assessed the types and volume of waste generated at Eleko Beach and Elegushi Royal Beach in Lagos State, Nigeria.

The six-day field assessment recorded 291 kg of waste at Eleko Beach and 264.5 kg at Elegushi Royal Beach, giving a combined total of 555.5 kg. The average daily quantities were approximately 48.50 kg and 44.08 kg, respectively.

Waste generation varied from day to day at both beaches, demonstrating that beach waste production is dynamic rather than constant. Eleko recorded greater variability during the observation period, while the cumulative quantities generated at the two beaches were remarkably similar.

The study also identified diverse waste categories, including plastics, bottles, food-related materials, paper, metals, glass and other materials. The findings are broadly consistent with international and Lagos-specific research identifying plastic and other consumer-related materials as major components of beach litter (Ansari and Farzadkia et al., 2022; Ayo-Dada et al., 2025).

Overall, the study demonstrates that quantitative assessment of waste generation provides valuable baseline information for sustainable management of recreational beaches. Continuous monitoring, waste characterization and source-reduction measures

should therefore form part of coastal tourism management in Lagos State.

VII. RECOMMENDATIONS

Based on the findings, the following recommendations are proposed:

Despite the growing literature on marine litter and beach cleanliness in Lagos, an important empirical gap remains. Recent Lagos studies have focused largely on litter-item abundance, composition, visitor dynamics, disposal behaviour or specific pollution types. There is comparatively less emphasis on a direct day-by-day comparison of waste mass generated at two major recreational beaches using the same observation framework. This distinction is important because waste mass provides operational information for estimating collection requirements and planning site-specific waste services.

The present study therefore contributes a focused comparative baseline for Eleko Beach and Elegushi Royal Beach by documenting daily waste quantities over six observation days and examining the variation between sites. The study is deliberately descriptive and does not claim that the six-day measurements represent annual waste generation. Instead, it provides empirical evidence that can support future longitudinal monitoring, visitor-management strategies and more targeted waste-reduction interventions.

1. Routine waste measurement: Beach managers should maintain regular records of the quantity of waste generated and collected.
2. Waste characterization: Waste should be periodically separated into major categories to identify the dominant waste streams.
3. Plastic reduction: Given the prominence of plastics in beach-litter research, efforts should be directed toward reducing unnecessary single-use plastic materials.

4. Recycling and recovery: Recyclable bottles, plastics and metals should be separated from mixed waste wherever practical.

5. Peak-period monitoring: Waste-generation monitoring should be intensified during weekends, holidays and other periods of high visitor activity.

6. Visitor education: Visitors should be encouraged to reduce waste generation and use designated waste facilities.

7. Data-based planning: Waste collection schedules should be informed by measured waste-generation patterns rather than fixed schedules alone.

8. Longitudinal assessment: Future studies should extend monitoring across different seasons to determine whether waste generation changes according to season, visitor volume and weather conditions.

VIII. LIMITATIONS OF THE STUDY

The principal limitation is the relatively short six-day observation period. Waste generation at recreational beaches may vary according to season, visitor population, weekends, holidays, special events and weather conditions. Therefore, the results represent the conditions observed during the study period rather than an annual estimate.

A further limitation is that the available field data do not provide sufficient information to statistically attribute daily waste differences to visitor numbers or specific recreational activities.

The selected Dataset B differs from another waste-generation series appearing elsewhere in the project files. For this manuscript, Dataset B is treated as the authoritative dataset by author instruction: Eleko Beach (56, 57, 43, 53, 28 and 54 kg) and Elegushi Royal Beach (38, 52, 47, 42.5, 36 and 49 kg). The separate $p = .3476$ result is not reproduced because it belongs to a separate analysis and is not required for this descriptive Objective 1 manuscript.

IX. DECLARATIONS

Funding

The authors received no external funding for this study.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data Availability

The data generated and analysed during this study are available from the corresponding author upon reasonable request.

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