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Beach Sand Litter Composition and Density at Eleko and Elegushi Beaches, Lagos State, Nigeria: Implications for Sustainable Coastal Tourism

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Abstract
This study determined the composition and density of beach sand litter at Eleko Beach (EB) and Elegushi Royal Beach (ERB), Lagos State, Nigeria, with particular attention to variation across observations conducted before, during and after weekends and holidays. Field observations were conducted at the two beaches using a standardized litter-assessment procedure. A 50 m × 50 m sampling plot was demarcated, within which a 5 m × 5 m quadrant was randomly positioned. Litter items were identified, counted and expressed as items/m², while beach cleanliness was assessed using the Clean Coast Index (CCI). Six observations were undertaken at each beach. Ten litter categories were recorded. Shells constituted the dominant category at both beaches. The highest recorded shell densities were approximately 0.056 items/m² at Eleko and 0.057 items/m² at Elegushi, whereas ropes recorded the lowest densities of approximately 0.012 and 0.011 items/m², respectively. CCI values at Eleko ranged from 1.86 to 4.57 and therefore fell within the very-clean or clean categories under the classification used in this study, while Elegushi values ranged from 1.42 to 3.98 and similarly fell within the very-clean or clean categories. The reported t-test for Elegushi showed no significant difference in litter density before and after the peak period ($t = -0.96542$, $p = 0.3476$). The study provides site-specific evidence on litter composition, density and temporal variation at two important coastal tourism destinations in Lagos State and highlights the need for continued monitoring and targeted beach-management interventions.

Keywords: beach litter; litter density; Clean Coast Index; coastal tourism; marine debris; Eleko Beach; Elegushi Beach; Lagos State.

1. Introduction

Marine litter is a persistent environmental problem affecting coastal and marine environments, with consequences for ecosystem condition, recreational value, tourism and human activities associated with coastal spaces (UNEP, 2023; Zielinski et al., 2022).

Beach-litter assessment is important because the abundance, composition and spatial distribution of debris provide evidence of pollution pressure and can support decisions about monitoring, source reduction and coastal management (OSPAR Commission, 2023; Zielinski et al., 2022).

Plastic materials are frequently prominent in beach-litter inventories, although the relative contribution of different litter categories varies among locations according to coastal processes, human activities, waste-management systems and local sources (Akarsu et al., 2022; Yona et al., 2023; OSPAR Commission, 2023).

Tourism is particularly relevant to beach-litter management because visitor activity can influence litter accumulation, while tourism businesses and destination managers can also contribute to cleaning and prevention measures (Garcés-Ordóñez et al., 2020; Inteca et al., 2023).

The assessment of litter density provides a quantitative basis for comparing litter abundance among locations or observation periods, but comparisons should be interpreted cautiously when sampling

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units, size thresholds, frequencies and classification systems differ (Cesarano et al., 2023; Zielinski et al., 2022).

The Clean Coast Index (CCI) is one established approach for expressing beach cleanliness from litter abundance and has been applied in comparative beach-litter studies in different coastal settings (Alkalay et al., 2007; Akarsu et al., 2022).

Evidence from Nigeria also demonstrates that beach-litter pollution is a relevant coastal-management issue. A recent assessment of six beaches along the Lagos coastline, including Elegushi Beach, recorded substantial litter abundance and spatial and temporal variation in litter composition (Ayo-Dada et al., 2025).

The Lagos coastline therefore provides an important setting for examining litter conditions at recreational beaches because management needs to account for local litter profiles rather than assuming that patterns observed elsewhere apply uniformly (Ayo-Dada et al., 2025; Barik et al., 2024).

Recent studies have also shown that beach-litter composition can differ substantially between sites, with some investigations reporting plastic dominance while others identify strong contributions from locally derived or natural materials (Aranoco et al., 2023; Perumal et al., 2023; Barik et al., 2024).

Although existing research has examined marine litter along Lagos beaches, focused comparison of Eleko and Elegushi using repeated observations around weekend and holiday periods remains useful for site-specific monitoring and management (Ayo-Dada et al., 2025; Asensio-Montesinos et al., 2021).

Therefore, this study determined the beach-sand litter composition and density at Eleko Beach and Elegushi Royal Beach, Lagos State, Nigeria, and examined observed temporal differences in litter conditions across the study observations.

2. Literature Review

2.1 Beach litter and coastal environmental quality

Beach litter comprises discarded, lost or deposited solid materials occurring along shorelines and can affect ecological, aesthetic and socioeconomic values of coastal environments (UNEP, 2023; OECD, 2022). The persistence of manufactured materials, particularly plastics, makes marine litter a continuing management challenge because litter can remain in the environment and be transported among land, rivers, beaches and marine waters (UNEP, 2023; OSPAR Commission, 2023).

2.2 Composition and spatial variation of beach litter

Beach-litter composition is spatially heterogeneous, and plastics often dominate international inventories, although the relative contribution of shells, wood, glass, rubber, cigarette waste, fishing-related materials and other categories varies by site (Akarsu et al., 2022; Yona et al., 2023; De Veer et al., 2023). Studies in the Philippines and India, for example, reported strong plastic contributions but also demonstrated differences in litter abundance among beach types and locations (Aranoco et al., 2023; Perumal et al., 2023). A 2024 assessment of the Odisha coast similarly identified plastic and rubber as important litter categories and linked litter patterns to tourism and river discharge (Barik et al., 2024).

2.3 Tourism, visitation and beach litter

Tourism can influence beach-litter patterns through visitor numbers, recreational activities and associated consumption, although tourism may also contribute to beach-cleaning capacity and destination management (Garcés-Ordóñez et al., 2020; Inteca et al., 2023). Garcés-Ordóñez et al. (2020) found higher litter and user quantities during high tourist seasons on Santa Marta beaches, whereas Inteca et al. (2023) reported that beaches with tourism activities in Mozambique accumulated less litter, illustrating that tourism effects depend on management context. These findings support the need to distinguish observed temporal associations from causal claims when visitor numbers and management activities are not directly measured.

2.4 Methods for beach-litter assessment

Reliable beach-litter assessment requires transparent sampling units, consistent classification, repeated observations and clearly defined reporting metrics (Cesarano et al., 2023; Zielinski et al., 2022).

OSPAR monitoring, for example, uses fixed beach sections, repeated surveys and predefined litter categories to improve comparability across time and sites (OSPAR Commission, 2023). Van Loon et al. (2020) similarly emphasized the importance of standardized assessment approaches when establishing threshold values for coastline litter. The present study uses a defined 50 m × 50 m plot and a 5 m × 5 m sampling quadrant, while recognizing that its smaller sampling design and limited observation frequency constrain direct comparison with large-scale monitoring programmes.

2.5 Clean Coast Index and beach cleanliness

The CCI was introduced as a practical index for evaluating beach cleanliness from litter abundance (Alkalay et al., 2007). Subsequent applications have used the index to compare spatial and temporal differences in beach cleanliness, including studies of Istanbul and other coastal environments (Akarsu et al., 2022; Asensio-Montesinos et al., 2021). However, CCI results should be interpreted using the exact classification thresholds adopted in a study and in conjunction with the underlying litter counts or densities (Zielinski et al., 2022).

2.6 Evidence from African and Nigerian beaches

African coastal studies demonstrate that beach-litter patterns are shaped by local socioeconomic and environmental conditions. Inteca et al. (2023) found differences associated with tourism, fishing and population density in Mozambique, while the Lagos coastline assessment by Ayo-Dada et al. (2025) documented substantial variation among beaches. Such evidence indicates that national or regional beach-management strategies should incorporate site-specific litter profiles rather than relying only on generalized international patterns (Ayo-Dada et al., 2025; Inteca et al., 2023).

2.7 Research gap

Existing literature provides extensive evidence on beach-litter composition, monitoring methods and tourism-related pressures, but methodological differences can limit direct comparisons across studies (Zielinski et al., 2022; Cesarano et al., 2023). In Lagos State, recent work has established the importance of continued monitoring, but focused repeated observations at Eleko and Elegushi remain useful for understanding short-term changes in litter composition, density and beach cleanliness (Ayo-Dada et al., 2025). This study addresses that gap by comparing the two beaches using the same field-observation framework.

3. Materials and Methods

3.1 Study Area

The study was conducted at Eleko Beach (EB) and Elegushi Royal Beach (ERB) in Lagos State, Nigeria. Both locations are recreational coastal destinations used for leisure and tourism activities.

3.2 Beach Litter Sampling

The study employed field observation to assess beach-litter distribution and density. A 50 m × 50 m plot was demarcated at each beach, and a 5 m × 5 m quadrant was randomly positioned within the sampling area. Litter items found within the sampling unit were identified and counted. Litter density was expressed as the number of items per square metre (items/m^2). Six assessments were conducted at each beach.

The observations covered six periods: before weekend; during weekend; after weekend; before holiday; during holiday; and after holiday.

The litter categories recorded were plastics, leaves, shells, broken glass, wood/sticks, straws, nylon, foamed pieces, cigarette waste and ropes.

The use of defined sampling areas and repeated observations is consistent with the general principle of standardized beach-litter monitoring, although the present design is smaller than large-scale protocols such as OSPAR monitoring (Cesarano et al., 2023; OSPAR Commission, 2023).

3.3 Clean Coast Index

The Clean Coast Index was used to evaluate beach cleanliness. The study applied the CCI using the total litter count, sampling area and a correction coefficient of 20. The classification adopted was: 0–2

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= very clean; 2–5 = clean; 5–10 = moderately dirty; 10–20 = dirty; and >20 = extremely dirty (Alkalay et al., 2007).

CCI value	Classification
0–2	Very clean
2–5	Clean
5–10	Moderately dirty
10–20	Dirty
>20	Extremely dirty

3.4 Data Analysis

Descriptive analysis was used to summarize litter composition, CCI values and litter density. The reported t-test was used to assess the specified before-versus-after peak-period comparison at Elegushi Royal Beach. Statistical significance was evaluated at the 0.05 level. Because the field design comprised six observations per beach, inferential findings are interpreted cautiously and are not generalized beyond the study sites and observation periods.

4. Results

4.1 Beach Sand Litter Composition

Ten categories of litter were recorded across the two study beaches. These comprised plastics, leaves, shells, broken glass, wood/sticks, straws, nylon, foamed pieces, cigarette waste and ropes.

At Eleko Beach, shells recorded the largest values across the observation periods in the supplied field table, followed by several anthropogenic categories including nylon, plastics, glass and foamed pieces. The composition varied across observation periods.

At Elegushi Royal Beach, shells similarly represented the most prominent litter category across the reported observations. The results demonstrate that the dominant litter category at these sites was not necessarily the same as the plastic-dominated pattern reported by several international studies (Akarsu et al., 2022; Yona et al., 2023).

Table 1. Beach sand litter composition and Clean Coast Index at Eleko Beach

Litter category	Before weekend	During weekend	After weekend	Before holiday	During holiday	After holiday
Plastics	0.38	0.48	0.19	0.41	0.48	0.41
Leaves	0.16	0.51	0.19	0.28	0.44	0.22
Shells	1.18	1.40	0.73	0.86	1.18	0.83
Broken glass	1.16	0.13	0.03	0.25	0.22	0.25
Wood/sticks	0.16	0.28	0.22	0.28	0.38	0.44
Straws	0.32	0.51	0.25	0.22	0.44	0.22
Nylon	0.35	0.60	0.03	0.35	0.51	0.44
Foamed pieces	0.35	0.22	0.06	0.44	0.41	0.38
Cigarette	0.22	0.22	0.16	0.06	0.25	0.28
Ropes	0.19	0.22	0.00	0.12	0.09	0.22
Total	4.47	4.57	1.86	3.27	4.40	3.69

Source: Field Survey, 2024.

4.2 Beach Sand Litter Composition at Elegushi Royal Beach

The supplied Elegushi table was reordered to match the observation sequence used for Eleko, thereby improving comparability between the two beaches.

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Litter category	Before weekend	During weekend	After weekend	Before holiday	During holiday	After holiday
Plastics	0.19	0.48	0.16	0.12	0.35	0.03
Leaves	0.00	0.03	0.16	0.00	0.09	0.06
Shells	0.96	0.96	0.76	0.54	1.02	0.89
Broken glass	0.06	0.22	0.06	0.22	0.12	0.06
Wood/sticks	0.00	0.16	0.09	0.09	0.22	0.00
Straws	0.09	0.35	0.06	0.12	0.09	0.16
Nylon	0.19	0.70	0.28	0.12	0.48	0.12
Foamed pieces	0.25	0.35	0.12	0.09	0.44	0.09
Cigarette	0.03	0.51	0.09	0.09	0.28	0.16
Ropes	0.06	0.22	0.00	0.03	0.28	0.12
Total	1.83	3.98	1.78	1.42	3.37	1.69

Source: Field Survey, 2024.

4.3 Clean Coast Index

At Eleko Beach, the CCI was 4.47 before the weekend, 4.57 during the weekend and 1.86 after the weekend. The corresponding holiday values were 3.27 before the holiday, 4.40 during the holiday and 3.69 after the holiday.

Under the classification adopted in this study, all Eleko values fell within either the clean category (2–5) or the very-clean category (0–2). Thus, none of the reported Eleko CCI values reached the moderately dirty category.

At Elegushi Royal Beach, CCI values were 1.42 before the holiday, 3.37 during the holiday, 1.69 after the holiday, 1.83 before the weekend, 3.98 during the weekend and 1.78 after the weekend. These values similarly placed Elegushi within the very-clean or clean categories.

The temporal variation observed in the present study is consistent with evidence that beach-litter abundance and cleanliness classifications can vary among locations and observation periods (Asensio-Montesinos et al., 2021; Akarsu et al., 2022).

4.4 Beach Sand Litter Density

The litter-density assessment showed that shells had the highest density at both beaches. At Eleko Beach, the highest shell density was approximately 0.056 items/m², while the lowest density was recorded for ropes at approximately 0.012 items/m². At Elegushi Royal Beach, shell density reached approximately 0.057 items/m², while ropes recorded approximately 0.011 items/m².

The supplied observations also show higher total litter-density values during some weekend and holiday observations than during corresponding post-period observations. Because visitor numbers were not directly measured, these patterns are treated as temporal associations rather than evidence of a causal effect of visitation (Garcés-Ordóñez et al., 2020; Inteca et al., 2023).

Beach	Dominant litter	Highest density (items/m²)	Lowest-density litter	Lowest density (items/m²)
Eleko Beach	Shells	0.056	Ropes	0.012
Elegushi Royal Beach	Shells	0.057	Ropes	0.011

Source: Field Survey, 2024.

The magnitude of litter density observed in the present study is lower than that reported in some heavily polluted beach settings. For example, Perumal et al. (2023) reported an average marine-litter density of 6.71 items/m² on beaches in Kanyakumari, India. Such comparisons should nevertheless be interpreted cautiously because sampling designs, litter-size thresholds, beach characteristics and observation periods differ among studies (Zielinski et al., 2022; Cesarano et al., 2023).

4.5 Test of Difference in Beach Sand Litter Density

The reported t-test for Elegushi Royal Beach showed no statistically significant difference in litter density before and after the specified peak period (t = −0.96542, p = 0.3476). Because the p-value was greater than 0.05, the null hypothesis was not rejected.

The result indicates that, although numerical changes in litter density occurred between the compared periods, the reported difference was insufficient to demonstrate a statistically significant temporal change. The inferential result should be interpreted within the limited six-observation field design.

Comparison	t-value	p-value	Decision
Before vs. after peak period	−0.96542	0.3476	Not significant

Source: Field Survey, 2024.

5. Discussion

The present study identified ten categories of beach litter at Eleko and Elegushi beaches, with shells emerging as the dominant category. This finding differs from several recent studies in which plastics were the predominant material (Akarsu et al., 2022; Yona et al., 2023; De Veer et al., 2023). The difference reinforces the importance of site-specific litter characterization because beach-litter composition varies with local sources, beach morphology, coastal processes, human activities and management practices (Zielinski et al., 2022; Cesarano et al., 2023).

The dominance of shells should not automatically be interpreted as evidence of poor waste management because shells can have a natural component associated with coastal biological processes. Their presence should therefore be considered alongside clearly anthropogenic categories such as plastics, nylon, glass, cigarette waste and foamed materials when evaluating management priorities.

The CCI results revealed greater numerical fluctuation at Eleko than Elegushi. Eleko ranged from 4.57 during the weekend to 1.86 after the weekend, while Elegushi ranged from 3.98 during the weekend to 1.42 before the holiday. Importantly, all reported values remained within the very-clean or clean categories under the classification adopted in this study. This corrected interpretation is consistent with the numerical CCI values and avoids overstatement of beach pollution status.

Previous research similarly demonstrates that litter abundance and cleanliness can vary temporally. Asensio-Montesinos et al. (2021) reported temporal differences in beach-litter abundance and CCI classification, while Akarsu et al. (2022) demonstrated spatial and temporal changes on Istanbul beaches. These studies support repeated monitoring rather than reliance on a single observation.

The comparatively lower CCI values at Elegushi indicate better observed cleanliness during the study observations, although this does not mean that the beach is free from litter. Ayo-Dada et al. (2025) independently documented substantial litter occurrence at Elegushi, illustrating why findings from different sampling designs should be interpreted as complementary rather than directly equivalent.

The highest litter densities recorded in this study were shells, whereas ropes recorded the lowest densities. Low numerical abundance does not necessarily imply negligible management importance because some litter types can have disproportionate ecological or operational significance. Monitoring programmes therefore benefit from recording composition as well as total abundance (OSPAR Commission, 2023; Zielinski et al., 2022).

The absence of a statistically significant difference at Elegushi before and after the specified peak period is also noteworthy. The result (t = −0.96542, p = 0.3476) indicates that the reported numerical difference was not statistically significant. Beach-litter distribution can be influenced by several interacting factors, including cleaning, currents, wind, coastal processes and local waste inputs, so visitor activity should not be treated as the sole explanation without direct measurements (Garcés-Ordóñez et al., 2020; OSPAR Commission, 2023).

6. Implications for Sustainable Coastal Tourism

Beach cleanliness is relevant to coastal tourism because litter can reduce the visual and recreational quality of destinations and can generate environmental and socioeconomic costs (OECD, 2022; Zielinski et al., 2022).

The results suggest three major management priorities.

First, regular litter monitoring should be institutionalized at both beaches. Repeated CCI and density assessments can identify periods when litter accumulation changes and can help managers target cleaning and prevention activities (Cesarano et al., 2023; OSPAR Commission, 2023).

Second, weekend and holiday periods should receive intensified monitoring and collection attention where the field observations indicate higher litter values. However, because visitor numbers were not measured directly, the study supports targeted monitoring rather than a claim that visitation caused the observed changes (Garcés-Ordóñez et al., 2020).

Third, management should be based on the actual litter profile of each beach. The shell-dominated pattern observed in this study differs from plastic-dominated patterns reported at several other beaches, demonstrating the value of site-specific evidence for coastal tourism management (Akarsu et al., 2022; Yona et al., 2023; Barik et al., 2024).

7. Study Limitations

The study has several limitations. First, observations were restricted to two beaches and six observation periods per beach, limiting the extent to which the findings can be generalized. Second, visitor numbers, tidal conditions, wind, currents and cleaning frequency were not measured directly, so the study cannot establish causal relationships between these factors and litter density. Third, the sampling design differs from large-scale monitoring protocols, which limits direct numerical comparison with international datasets (Cesarano et al., 2023; Zielinski et al., 2022). Future research should therefore use longer monitoring periods, larger spatial coverage and simultaneous recording of visitor pressure and relevant environmental variables.

8. Conclusion

This study determined the composition and density of beach sand litter at Eleko Beach and Elegushi Royal Beach in Lagos State. Ten litter categories were identified, with shells constituting the dominant category at both beaches. The highest recorded shell densities were approximately 0.056 items/m² at Eleko and 0.057 items/m² at Elegushi, while ropes recorded approximately 0.012 and 0.011 items/m², respectively.

Eleko showed greater numerical fluctuation in CCI than Elegushi, but all reported CCI values at both beaches fell within the very-clean or clean categories according to the classification adopted in this study. The reported statistical analysis at Elegushi revealed no significant difference in litter density before and after the specified peak period ($t = -0.96542$, $p = 0.3476$).

The findings demonstrate the value of continuous, site-specific monitoring of litter composition, density and beach cleanliness for effective coastal tourism management in Lagos State. Management should combine routine monitoring with targeted cleaning, visitor education and improved waste-control measures while recognizing that the causes of short-term litter variation require further investigation.

9. Recommendations

1. Beach managers should conduct routine litter-density and CCI assessments at Eleko and Elegushi.
2. Cleaning and monitoring activities should be intensified during weekends, public holidays and other periods when field observations indicate increased litter accumulation.
3. Waste-management interventions should be based on the specific litter composition of each beach.
4. Waste bins and collection points should be strategically positioned in areas experiencing high visitor activity.
5. Visitor education should emphasize responsible waste disposal and the prevention of littering.
6. Beach authorities should maintain records of litter composition and density to identify long-term trends.
7. Future research should examine the relationship between visitor volume, waste generation, litter density, tidal conditions, wind/current conditions and cleaning frequency.

8. Future studies should use longer monitoring periods and standardized protocols to distinguish short-term fluctuations from persistent litter patterns.

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