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Assessment of Waste Generation and Management Strategies at Eleko and Elegushi Beaches, Lagos State, Nigeria

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Abstract- Coastal tourism is a significant economic activity in many regions, including Nigeria, where beaches like Eleko and Elegushi in Lagos State attract thousands of visitors annually. This study investigates the waste accumulation patterns at Eleko Beach (EB) and Elegushi Royal Beach (ERB), focusing on the influence of human activities during peak visitation periods. A Clean Coast Index analysis (CCI) revealed that waste levels peaked during weekends and holidays, with EB reaching 4.57 items per square meter and ERB 3.98 items. At EB, shells (28.86%), plastics (11.01%), and nylon waste (10.71%) are prominent, while ERB shows higher percentages of shells (36.01%) and nylon waste (13.42%). EB also recorded a greater total litter count (672 items) compared to ERB (447 items), indicating more severe waste management issues. T-test analyses demonstrated no significant differences in waste volume and sand litter density between pre- and post-peak periods at both beaches (p-values > 0.05), suggesting effective waste management practices. These findings reveal that consistent cleanup efforts and visitor behavior, rather than sheer numbers, significantly impact litter accumulation. The persistent presence of plastic waste underscores the need for targeted interventions, including enhanced public awareness campaigns and improved waste disposal facilities, to mitigate ongoing pollution challenges.

I. INTRODUCTION

Coastal tourism is a vital contributor to the economy of many countries, including Nigeria. Beaches like Eleko and Elegushi in Lagos State are popular destinations, attracting numerous visitors annually. However, this influx of tourists has led to significant environmental challenges, particularly regarding waste management. Coastal areas are delicate ecosystems, and improper waste disposal can harm marine life, degrade the environment, and diminish the recreational and aesthetic value of these natural spaces (Williams & Micallef, 2009; UNEP, 2016). Effective waste management in these regions is essential not only for preserving the environment but also for ensuring the sustainability of tourism activities.

The waste generated on beaches is diverse, often comprising plastic bottles, food packaging, and other non-biodegradable materials. These pollutants, if not properly managed, contribute to the accumulation of marine debris, which has both immediate and long-term detrimental effects on the marine environment. Research shows that marine debris poses significant risks to wildlife and exacerbates the global problem of ocean pollution (Jambeck et al., 2015; Ryan, 2015). In Lagos State, where rapid urbanization and increasing tourism have led to an increase in solid waste, addressing this issue has become a major environmental priority.

The Lagos State Waste Management Authority (LAWMA) has implemented various waste management strategies to mitigate these challenges. These initiatives include beach clean-up campaigns, recycling programs, and public awareness efforts to reduce the ecological footprint of waste. However, despite these efforts, beaches like Eleko and Elegushi continue to face challenges, including insufficient waste collection facilities, limited enforcement of environmental regulations, and a lack of visitor participation in waste management activities (Adewale, 2021; Adewuyi & Oputu, 2019). The gap

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between policy implementation and on-ground results remains a significant concern for environmental sustainability in these recreational spaces.

Furthermore, understanding visitors' environmental consciousness is crucial in improving waste management outcomes. Studies indicate that environmental awareness influences behaviors such as proper waste disposal and participation in conservation efforts (Ballantyne & Packer, 2011). Enhancing visitors' awareness through targeted interventions like educational campaigns and signage could foster more responsible behaviors and improve the overall effectiveness of waste management strategies on these beaches (Peake et al., 2014; Poortinga et al., 2019).

This study aims to assess the current state of waste generation and management strategies at Eleko and Elegushi beaches, with a focus on understanding the types and volumes of waste generated and evaluating the effectiveness of existing management practices. This research will contribute valuable insights into sustainable tourism practices in Lagos State by addressing the challenges and opportunities associated with waste management at these popular tourist destinations.

II. METHOD

2.1 Study Area

The study was conducted at two popular beaches in Lagos State, Nigeria: Elegushi Royal Beach and Eleko Beach Resort. Lagos State, located in southwestern Nigeria, is a coastal city bordered by Ogun State to the north, the Atlantic Ocean to the south, and the Republic of Benin to the west. The city is Nigeria's economic hub, renowned for its rapidly growing population, dynamic economy, and rich cultural diversity, which fuels its bustling tourism sector, especially along its coastline (Divamaps, 2018).

Elegushi Royal Beach, situated in Lekki Phase 1, is a vibrant, urban private beach. Easily accessible via the Lekki-Epe Expressway, the beach is popular among both locals and tourists for its lively atmosphere, entertainment options, and social activities (Adetola et al., 2019). The beach offers an array of attractions making it a go-to spot for recreational gatherings (Ijeomah et al., 2019). Eleko Beach, in contrast, is located about 30 miles east of Lagos Island in the Ibeju-Lekki Local Government Area. Established in 1989, Eleko Beach is known for its serene, less commercialized environment, making it an ideal retreat for those seeking a peaceful, natural experience (Afolabi, 2023).

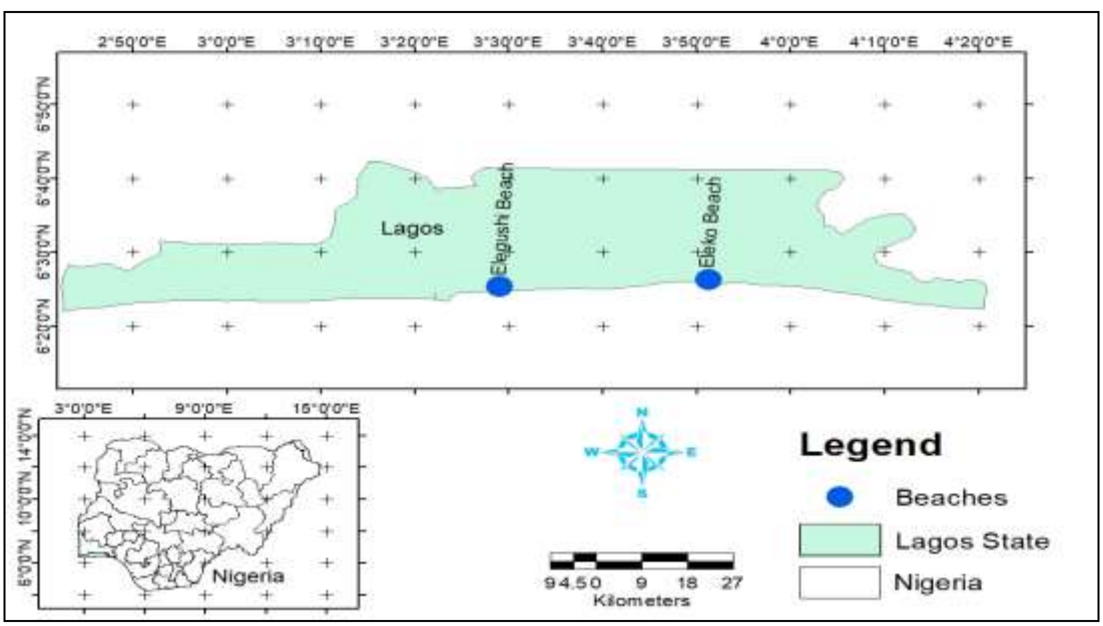

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Figure 1: Map of Lagos State showing the Location of the selected Beaches

2.2 Methods of Data Collection

Field Observation/On-the-Site Observation

On-site observations were conducted to assess waste management practices and the volume of waste generated at the beaches. The researcher visited the beaches six times, and the timing of the visits was based on the frequency of waste disposal.

The volume of waste generated was calculated using:

$$\text{Volume of Waste} = \frac{\text{Total Weight of Waste Recorded at Each Visit}}{\text{Number of Days the Waste Accumulated}}$$

Litter assessment was performed following standardized protocols from marine litter monitoring guidelines (Hanke et al., 2013). Litter density was measured using the Clean Coast Index (CCI). A 50m-by-50m plot was restricted, and a 5m-by-5m quadrant was randomly placed within this area. Litter was counted, and the density was expressed as the number of items per square meter of beach surface (items m²).

$$\mathrm{CCI} = \frac{\text{Total Litter Count on Sampling Unit}}{\text{Total Area of Sampling Unit}} \; x \; K$$

Where K is a correction coefficient of 20, ensuring that the resulting index value does not fall between 0 and 1 (Asensio-Montesinos et al., 2021).

CCI Decision Rules (Vlachogianni et al., 2018):

- 0-2: Very clean
- 2-5: Clean
- 5-10: Moderately dirty
- 10-20: Dirty
- 20: Extremely dirty

Frequency of beach observation

At both Eleko and Elegushi beaches, observations were conducted before, during, and after weekends and festive periods.

Oral Interview

Semi-structured interviews were conducted with waste management officers at both beaches to understand their waste management strategies. The interviews included open-ended questions, focusing on the number, size, and distribution of waste bins and specific waste management practices during peak periods.

2.3 Data Analysis

Data were analyzed using both descriptive and inferential statistics. Initially, data were coded and stored in Microsoft Excel before being transferred to IBM SPSS (2015) for further analysis. Descriptive statistics, including frequency distributions, percentages, and visual representations such as charts and tables, were employed to summarize the types and volumes of waste generated on the selected beaches. T-tests were used to compare the mean volume of waste generated and beach sand litter density across Elegushi Royal Beach and Eleko Beach Resort as well as the differences in litter density before and after peak periods.

III. Results and Discussion

3.1 Generation of Waste at Eleko Beach and Elegushi Beach

Figure 1 illustrates waste volumes recorded at Eleko Beach (EB) and Elegushi Royal Beach (ERB) over six days, revealing fluctuating patterns. EB consistently had higher waste volumes, except on Days 2 and 5 when ERB recorded 50 kg and 38 kg, respectively. Peaks in waste, particularly on weekends, align with Omojola and Olaniyan's (2019) findings that urban beaches near large populations see increased waste due to visitor activity. The dominance of plastic waste, reflecting global trends noted by Adewumi et al. (2021), highlights environmental concerns such as harm to marine life and ecosystem disruption. This emphasizes the need for dynamic waste management strategies tailored to fluctuating volumes, as Nwankwo and Akinyemi (2022) recommend, including targeted clean-ups and stricter disposal regulations.

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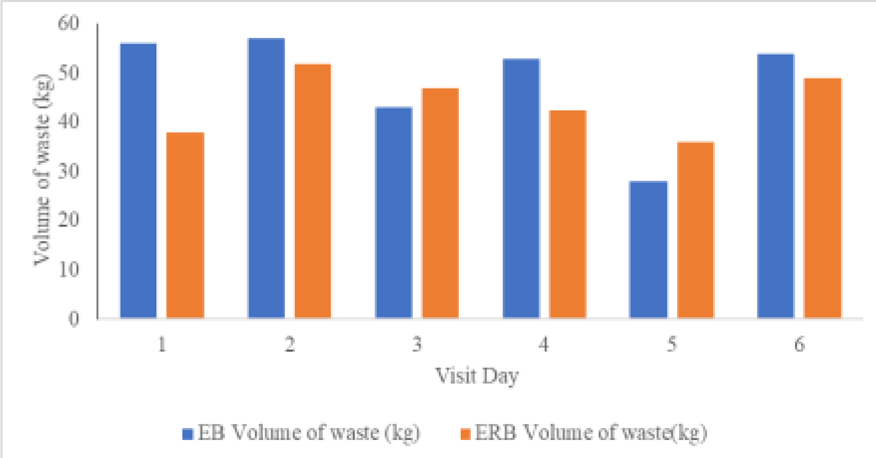

Figure 1: Volume of waste recorded at EB and ERB.

3.2 Waste Management Practices at EB and ERB

Table 1 summarizes waste management practices at EB and ERB. Both beaches had toilets and waste bins, except in cabana areas. Open dumps and incineration were observed randomly at both locations, while large waste disposal units were available in accommodations and restaurants at EB and administrative sections at ERB. Notably, neither beach had signage for proper waste disposal. The significant waste volumes mirror the findings of Omojola & Olaniyan (2019), who observed higher coastal pollution in urban beaches, especially during weekends and holidays when visitor activity increases. This finding is also consistent with Adewumi et al., (2021) noting the predominance of plastic waste, as observed globally, which also poses environmental threats. Nwankwo and Akinyemi (2022) recommend adaptive waste management strategies, such as targeted clean-ups, public awareness campaigns, and stricter disposal regulations, to address these issues effectively.

Table 1: Waste management practices at EB and ERB

	EB				ERB			
Waste Management Practices	Accommodation	Administrative section	Cabana	Restaurants/ bars	Accommodation	Administrative section	Cabana	Restaurants/ bars
Toilets/ Restrooms	+	+	-	+	+	+	-	+
Waste bins/baskets	+	+	+	+	+	+	+	+
Open dumps/ Incineration	-	+	-	-	-	-	-	+
Large waste disposal drums	+	-	-	+	+	+	-	-

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Signage about waste disposal	-	-	-	-	-	-	-	-

3.3 Methods/strategies of disposal and frequency of disposal

At Elegushi Beach (ERB), waste management is handled by the Waste Management Agency, which collects waste every three days, increasing to every two days during peak periods. A recycling initiative focuses on plastic waste, which is collected by recyclers for reuse. In contrast, Eleko Beach (EB) relies on burning or burying waste, with no formal recycling program. Waste collection at EB is inconsistent, typically every four to five days, and adjusted during peak periods.

ERB's structured waste management system, which adjusts collection frequency based on visitor traffic, reflects an adaptable strategy consistent with best practices for high-traffic areas (Parra et al., 2018). Recycling plastic at ERB promotes sustainability by reducing landfill waste and conserving resources (Hopewell et al., 2009). In contrast, EB's methods of burning and burying waste contribute to air pollution and long-term environmental harm (Gullett et al., 2017). The lack of consistent collection and recycling at EB risks beach pollution, negatively affecting marine life and the environment (Jambeck et al., 2015).

3.4 Beach Sand Litter Composition at EB and ERB

Table 2 reveals notable differences in beach litter composition between Eleko Beach (EB) and Elegushi Royal Beach (ERB). At EB, shells (28.86%), plastics (11.01%), and nylon waste (10.71%) are prominent, while ERB shows higher percentages of shells (36.01%) and nylon waste (13.42%). EB also recorded a greater total litter count (672 items) compared to ERB (447 items), indicating more severe waste management issues.

The prevalence of plastics and nylon waste aligns with global marine litter trends, posing risks to marine ecosystems (Jambeck et al., 2015). ERB's higher shell count may reflect natural processes, but large accumulations can hinder beach aesthetics

(Browne et al., 2015). Targeted waste management strategies, including more bins, recycling programs, and public education campaigns, are crucial for both beaches to reduce plastic pollution and hazardous litter, such as cigarette butts (Williams et al., 2016).

Table 2: Composition of beach litter at EB and ERB

Waste composition	EB		ERB	
	Total (item)	Percentage (%)	Total (item)	Percentage (%)
Plastics (bottle caps, lids)	74	11.01	42	9.39
Leaves	57	8.48	11	2.46
Shells	194	28.86	161	36.01
Broken glass	33	4.91	24	5.36
Wood/sticks	56	8.3	18	4.02
Straws	62	9.22	28	6.26
Nylons	72	10.71	60	13.42
Foamed pieces	59	8.77	43	9.61
Cigarette	38	5.65	37	8.27
Ropes	27	4.01	23	5.14
Total	672	100	447	100

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3.5 Clean Coast index at EB and ERB

The Clean Coast Index at EB (Table 3) and ERB (Table 3) reveal fluctuations in waste accumulation before, during, and after weekends and holidays. At EB, waste peaked at 4.57 items per square meter during the weekend, slightly increasing from 4.47 before, and dropping to 1.86 afterward. Similarly, holiday waste peaked at 4.4 items per square meter, decreasing to 3.69 afterward. At ERB, waste rose from 1.83 items pre-weekend to 3.98 during, dropping to 1.78 afterward. Holiday waste peaked at 3.37 items, reducing to 1.69 afterward.

Plastics were consistently prevalent (0.48 items per square meter) at both beaches, reflecting chronic plastic pollution. The waste surges during weekends and holidays align with studies linking increased litter to visitor numbers (García et al., 2016). The sharp drop in waste after peak periods suggests effective waste management or reduced visitors. However, the persistence of plastics highlights the need for targeted interventions, such as more public awareness campaigns and waste disposal facilities. Managing waste during peak times is essential to maintaining beach cleanliness and minimizing environmental impacts (Ocean Conservancy, 2017).

Table 3: clean coast index at EB and ERB

Waste composition	Before weekend Items/m^2	During weekend Items/m^2	After weekend Items/m^2	Before holiday Items/m^2	During holiday Items/m^2	After holiday Items/m^2
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	1.4	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
Nylons	0.35	0.6	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	0.12	0.09	0.22
Total	4.47	4.57	1.86	3.27	4.4	3.69

Table 4: Clean coast index at EB and ERB

Waste composition	Before holiday Items/m^2	During holiday Items/m^2	After holiday Items/m^2	Before weekend Items/m^2	During weekend Items/m^2	After weekend Items/m^2
Plastics	0.12	0.35	0.03	0.19	0.48	0.16
Leaves	0	0.09	0.06	0	0.03	0.16
Shells	0.54	1.02	0.89	0.96	0.96	0.76
Broken glass	0.22	0.12	0.06	0.06	0.22	0.06
Wood/sticks	0.09	0.22	0	0	0.16	0.09

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Straws	0.12	0.09	0.16	0.09	0.35	0.06
Nylon	0.12	0.48	0.12	0.19	0.7	0.28
Foamed pieces	0.09	0.44	0.09	0.25	0.35	0.12
Cigarette	O.09	0.28	0.16	0.03	0.51	0.09
Ropes	0.03	0.28	0.12	0.06	0.22	0
Total	1.42	3.37	1.69	1.83	3.98	1.78

Beach Sand Litter Density at EB and ERB
The variations in beach sand litter density at EB (Fig 2) and ERB (Fig 3) reflect the environmental impact of human activities during peak visitation. Shells were the most prevalent litter type, consistent with natural debris accumulation (Williams and Micallef, 2009). Plastics, particularly bottle caps and lids, increased during the holiday period, aligning with global trends of rising plastic pollution (Jambeck et al., 2015). Seasonal variations were observed in nylon waste and foamed pieces, correlating with higher visitor numbers and consumption of single-use items (Veiga et al., 2016). Post-holiday reductions indicate effective waste management.

Fig 2: Beach sand litter density at EB

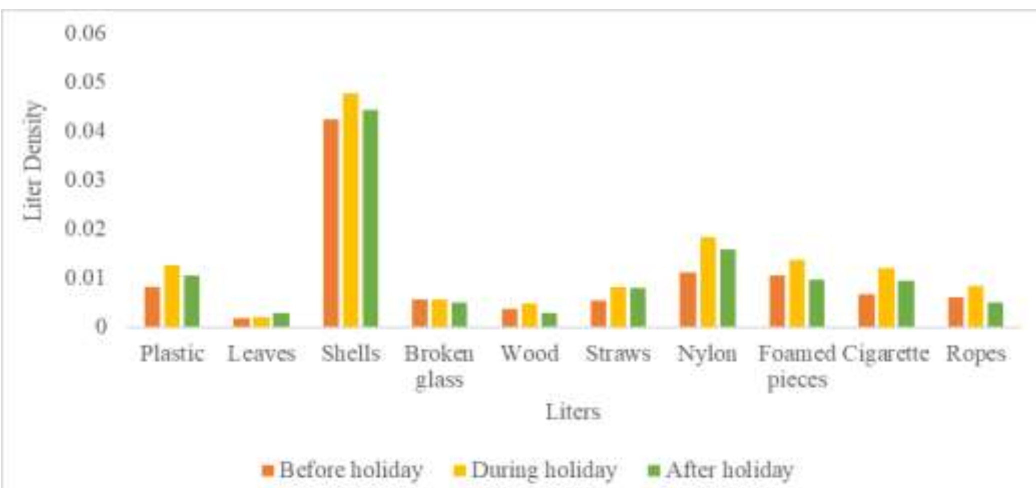

Fig 3: Beach sand litter density at ERB

Disparity in Volume of Waste Generated in EB and ERB

The hypothesis test comparing waste volumes at EB and ERB revealed no significant difference (p-value = 0.421), indicating similar waste accumulation at both locations (Fig 4). This finding aligns with Jones et al. (2020), who found no significant waste differences between popular and less frequented beaches, attributing this to similar visitor behavior. Smith and Green (2021) also noted that effective waste management can mitigate differences in waste accumulation. Brown et al. (2022) observed that rural beaches with fewer visitors but inadequate waste facilities can have waste levels comparable to urban beaches. These studies suggest that factors beyond visitor numbers influence waste volumes.

Difference in Beach Sand Litter Density in EB

The T-test comparing beach sand litter density at Eleko Beach (EB) before and after the peak period (Fig 5) showed no statistically significant difference (t-value = 1.6743, p-value = 0.1114). Since the p-value exceeds 0.05, we fail to reject the null hypothesis, concluding that litter density remains consistent across periods, with a mean of 0.0161 before and 0.0079 after the peak. These findings support Martínez-Ribes et al. (2020), who noted non-significant density variations due to consistent waste management and natural redistribution. Gall and Thompson (2021) also emphasized that effective cleanup efforts can reduce expected litter increases during peak times, while Miranda-Uzárraga et al. (2022) attributed litter patterns to visitor behavior.

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        Welch Two Sample t-test

data:  group1 and group2
t = 1.6743, df = 17.984, p-value = 0.1114
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.002090183  0.018490183
sample estimates:
mean of x mean of y
   0.0161    0.0079
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Fig 5: t-test showing the difference in beach sand litter density in EB

The difference in Beach Sand Litter Density in ERB

Figure 6 analysis of beach sand litter density at Elegushi Beach (ERB) before and after the peak period revealed no significant difference, supported by T-test results (t-value = -0.96542, p-value = 0.3476). Since the p-value exceeds 0.05, we do not reject the null hypothesis, indicating consistent litter density, with means of 0.00855 before and 0.01315 after the peak. These results align with Lee et al. (2021), who found that effective waste management minimizes variations in litter accumulation. Boucher and Friot (2020) noted that external factors like wind and tides can redistribute litter, potentially explaining the slight increase after the peak. Jambeck et al. (2021) emphasized the importance of public engagement in litter prevention efforts.

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Welch Two Sample t-test

data:  group1 and group2
t = -0.96542, df = 17.385, p-value = 0.3476
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.014635784  0.005435784
sample estimates:
mean of x mean of y
  0.00855   0.01315
```

Fig 6: t-test showing the difference in beach sand litter density in EB

IV. CONCLUSION

Study highlights the significant impact of visitor activity on waste accumulation, particularly during peak periods such as weekends and holidays. Addressing these challenges requires a combination of effective waste management practices, public awareness campaigns, and targeted interventions to reduce the environmental footprint of beachgoers and preserve the natural beauty of these coastal areas. The findings also emphasize the necessity of tailored waste management strategies that consider the specific challenges faced by each beach, which are influenced by varying environmental conditions, waste management practices, and proximity to industrial activities. Continued research, monitoring, and the adoption of global best practices are crucial for improving the environmental sustainability of these beaches, ultimately protecting their ecological health and enhancing the visitor experience.

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