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Sustainable Tourism as the Management Option for Litter Problems in Tasik and Leuweung Sancang Garut Coastal Areas, Indonesia

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ABSTRACT

Indonesia's extensive tropical coastline faces significant environmental threats from marine debris, particularly plastic waste, exacerbated by the tourism industry's growth. This study examined the Tasikmalaya and Garut Coast (TGC) on the southern coast of West Java, focusing on marine debris and tourism impacts. Using the Sector Analysis approach, beaches were categorized into remote, rural, and village types, assessed through the Coastal Scenic Evaluation System and Coastal Clean Index. Remote beaches like Sancang Cikolomberan and Sancang Cetut maintain high scenic quality with minimal litter, while rural beaches such as Bubujung and Karang Tawulan show moderate scenic decline due to increased human activity. Village beaches like Cipatujah, Sindangkerta, and Pamayangsari face severe pollution, affecting both scenic and cleanliness values. The study suggests management options tailored to each type of beach, emphasizing nature tourism through the development of special interest tourism and sustainable mass tourism.

INTRODUCTION

Indonesia, with the longest tropical coastline in the world, continues to develop its coastal areas as tourist destinations **(Handiani *et al.*, 2022)**. However, various studies reveal that Indonesia's coastline faces severe environmental degradation due to marine debris, particularly plastic waste **(Cordova & Nurhayati, 2019; Hermawan *et al.*, 2021; Hernanda *et al.*, 2022; Sari *et al.*, 2022; Hakim *et al.*, 2023)**. To address this issue, the government has implemented the Indonesian Ocean Policy and blue economy documents since 2017 to promote sustainable economic growth aligned with the 2015 Sustainable Development Goals **(Wuwung *et al.*, 2024)**. Unfortunately, the growth of tourism has exacerbated environmental challenges, as beach visits by tourists significantly contribute to increased coastal litter **(Mejjad *et al.*, 2023; Zhang *et al.*, 2023)**. The widespread use

of single-use products, such as food and beverage packaging, plastic bottles, and polystyrene, among beachgoers further adds to the accumulation of plastic waste on beaches **(Makov *et al.*, 2019; Abdah *et al.*, 2020; Frigione *et al.*, 2021; Moy *et al.*, 2021; Onyena *et al.*, 2021; Inocente & Bacosa, 2022)**. Additionally, ineffective waste management systems and the lack of cleaning personnel in coastal areas exacerbate litter pollution **(Green *et al.*, 2018; Zielinski *et al.*, 2019; Salazar *et al.*, 2022; Meyer *et al.*, 2023)**. The low awareness of proper waste management among populations in developing countries further compounds this issue **(Ferronato & Torretta, 2019)**.

West Java Province on the island of Java, Indonesia, is one of the provinces that utilizes its southern coast directly facing the Indian Ocean as a natural tourist destination **(Rizal *et al.*, 2020)**. However, tourism development on the southern coast of West Java has not been evenly distributed, because generally the beaches that are often visited are bay areas that have relatively low waves. One of the lesser-known coasts in southern West Java as a tourist destination is the Tasikmalaya and Garut Coast (TGC), which has high waves. Beaches with morphological conditions without bays and facing the Indian Ocean causes the coastal area not to be developed into a port city, so it remains in a rural and natural condition **(Taofiqurohman *et al.*, 2023)**. The beaches in TGC have potential as natural tourism areas **(Taofiqurohman *et al.*, 2018; Ngarbingan & Suryantari, 2022; Ngarbingan *et al.*, 2023)**. Like coastal areas around the world, TGC certainly experiences litter problems on its beaches. Several studies have shown that beaches in the south of Java Island are threatened by marine debris **(Suteja *et al.*, 2021)**. Therefore, tourism development in TGC should not only focus on the utilization of natural beauty, but also on environmental management and preservation, so that negative impacts on nature, especially the problem of waste, can be minimized.

Understanding the negative environmental impacts of tourism activities at TGC, particularly in relation to litter, requires a structured approach that focuses on long-term solutions. The Sector Analysis (SA) approach is one method that offers a comprehensive approach to understanding the influence of litter on the beach environment, by assessing aspects such as coastal scenery and cleanliness levels based on beach typology **(Williams, 2016)**. This approach helps in designing beach management plans that consider geographical diversity and the impact of human activities on cleanliness **(Rangel-buitrago *et al.*, 2017)**. Research using the SA approach has been conducted in several regions such as in Colombia **(Williams *et al.*, 2016; Rangel-Buitrago *et al.*, 2017, 2018)**, Brazil **(Corraini *et al.*, 2018)**, Spain **(Asensio-Montesinos *et al.*, 2020a)**, and Morocco **(Er-Ramy *et al.*, 2023)**, with the output being recommendations for management options for their beaches to address environmental issues. By integrating the Sector Analysis approach with coastal typology, this study aimed to determine the most suitable form of sustainable tourism for TGC. Through an assessment of litter's impact on beach cleanliness and scenery, this approach lays the groundwork for developing long-

term waste management strategies tailored to local geographical and ecological characteristics, thereby promoting sustainable coastal tourism development.

MATERIALS AND METHODS

1. Area of interest (AoI)

This study covers the Tasikmalaya and Garut Coast (TGC), which includes five beaches in Tasikmalaya Regency—Bubujung, Cipatujah, Sindangkerta, Pamayangsari, and Karang Tawulan—and two beaches in Garut Regency, Sancang Cetut and Sancang Cikolomberan (Fig. 1). The selected beaches align with the World Class Tourism Destination Development Master Plan of West Java Province, Indonesia. Sancang Cetut and Sancang Cikolomberan, located on the Tasik-Garut border, are part of the Leuweung Sancang Nature Reserve, enriching the analysis. Observations were conducted during the low season to reflect natural and stable beach conditions, representing routine waste volumes.

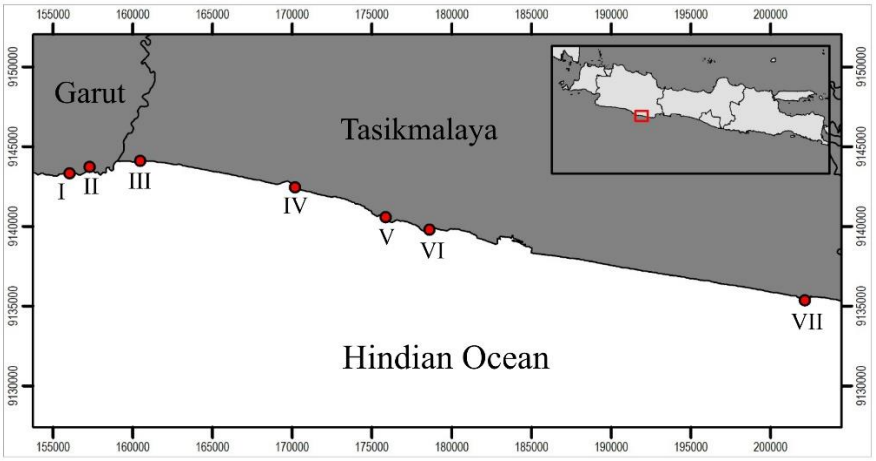


Fig. 1. The area of interest

Table 1. Code names of beaches in AoI

Code	Beach Name	Code	Beach Name
I	Sancang Cetut	V	Sindangkerta
II	Sancang Cikolomberan	VI	Pamayangsari
III	Bubujung	VII	Karang Tawulan
IV	Cipatujah		

2. Sector analysis

The sectoral analysis is shown in a matrix with coastal scenery classes in the rows and beach cleanliness classes in the columns **(Corraini *et al.*, 2018)**. The color indicators in the matrix represent management strategies based on the combination of scenery quality and cleanliness level. **Rangel-Buitrago *et al.* (2018b)** modified the original 5x4 matrix into a 5x5 matrix (Fig. 6), utilizing the Coastal Scenic Evaluation System for scenic quality and the Clean Coast Index for cleanliness. The following describes the management strategy of each color indicator **(Rangel-Buitrago *et al.*, 2018b)**:

- Left upper quadrant (green): Indicates a clean beach with good scenic class, where protective measures are required.
- Right upper quadrant (orange): Representing a dirty beach with a good scenic class, where cleanup actions are required.
- Left lower quadrant (yellow): Indicates a clean beach but poor scenic class, where efforts should be focused on other scenic variables, such as noise or horizon.
- Lower right quadrant (red): Depicts a dirty beach with a poor scenic score, where emergency intervention and even restoration measures are required.
- Center cell (white): Places shores with contradictory results that require in-depth analysis of the causes to focus management on specific tasks

3. Beach typology

Coastal typology is used to classify the condition of the AoI region. Based on this typology, environmentally friendly tourism in AoI will be recommended. Beach typology classifications are divided into five main groups based on The Bathing Area Registration & Evaluation (BARE) assessment system **(Wiliams & Micallef, 2009; Khattabi *et al.*, 2011)**, which is:

- Remote: characterized as coastal areas that are difficult to reach (usually by walking), have no permanent residents and no public facilities.
- Rural: has almost the same characteristics as remote, but there are already a few residents.
- Village: this area already has basic public facilities on a small scale, such as schools, markets and places of worship. The area is served by public transportation.
- Urban: characterized by a large population which is supported by adequate public facilities, such as banks, terminals, hospitals, commercial centers and government centers.
- Resorts are the most advanced beach typology, with locations and environments that vary according to commercial objectives and highlighted attractions. They avoid industrial areas to maintain the comfort of tourists. The public and transportation facilities of this type are the most advanced, with large hotels, restaurants, and water recreation activities such as surfing and jet skiing.

4. Coastal scenic evaluation system (CSES)

The coastal scenic evaluation system (CSES) is a method of evaluating beaches and coastal scenery. CSES makes decisions objectively by assessing 26 physical and human parameters (Table 2) to create a coastal scenic evaluation index **(Ergin *et al.*, 2004)**. The CSES calculation produces attribute values compared to the Fuzzy Weighted Average (FWA) and Membership Degree (MD) values. Attribute values range from 1 (very bad impact) to 5 (very good impact). In the FWA histogram, the attribute values compare physical and human impacts on coastal scenery. In the MD curve, a right-hand skew (RHS) indicates a high scenic rating, while a left-hand skew (LHS) indicates a low scenic rating. The final result of CSES is an elevation index (D), which categorizes the coastal scenery into five different categories (Table 3).

Table 2. Coastal scenic evaluation system **(Ergin *et al.*, 2019)**

No	Physical Parameters		Rating				
			1	**2**	**3**	**4**	**5**
1	Cliff	Height (*H*)	Absent (< 5 m)	5 m ≤ *H* < 30 m	30 m ≤ *H* < 60 m	60 m ≤ *H* < 90 m	*H* ≥ 90 m
2		Slope	< 45°	45° – 60°	60° – 75°	75° – 85°	Circa vertical
3		Special features	Absent	1 special feature	2 special features	3 special features	Many > 3 special features.
4	Beach face	Type	Absent	Mud	Cobble/ boulder	Pebble/ gravel	Sand
5		Width (*W*)	Absent	*W* < 5 m or *W* > 100 m	5 m ≤ *W* < 25 m	25 m ≤ *W* < 50 m	50 m ≤ *W* ≤ 100 m
6		Colour	Absent	Dark	Dark tan	Light tan/ bleached	White/ gold
7	Rocky shore	Slope	Absent	< 5°	5° – 10°	10° – 20°	> 20°
8		Extent	Absent	< 5 m	5 m – 10 m	10 m–20 m	> 20 m
9		Roughness	Absent	Distinctly jagged	Deeply pitted and/or irregular	Shallow pitted	Smooth
10	Dunes		Absent	Remnants	Foredune	Secondary ridge	Several
11	Valley		Absent	Dry	Stream (< 1 m)	Stream (1 m – 4m)	> 4 m
12	Skyline landforms		Not visible	Flat	Undulating	Highly undulating	Mountainous
13	Tides		Macro (> 4 m)		Meso (2 m – 4m)		Micro (< 2 m)
14	Coastal landscape features		None	1 feature	2 features	3 features	>3 features

15	Vistas	Open on one side	Open on two sides		Open on three sides	Open on four sides
16	Water colour & clarity	Muddy Brown/ grey	Milky blue/green; opaque	Green/grey blue	Clear blue/ dark blue	Very clear turquoise
17	Vegetation cover	Bare (< 10% vegetation only)	Scrub/Garigue/ grass (marram/ ferns, etc)	Wetland/ meadow	Coppices, maquis (mature trees bushes)	Variety of mature trees/ mature natural cover
18	Vegetation debris	Continuous >50 cm high	Full strand line	Single accumula-tion	Few scattered items	None
No	**Human Parameters**	**Rating**				
		1	**2**	**3**	**4**	**5**
19	Disturbance factor (noise)	Intolerable	Tolerable		Little	None
20	Litter	Continuous accumula-tions	Full strand line	Single accumulation	Few scattered items	Virtually absent
21	Sewage (discharge evidence)	Sewage evidence		Some sewage evidence		No evidence of sewage
22	Non-built environment	None		Hedgerow/ terracing/ Monoculture		Field mixed cultivation ± trees/natural
23	Built environment	Heavy industry	Heavy tourism and/or urban	Light tourism and/or urban and/or sensitive industry	Sensitive tourism and/or urban	Historic and/or none
24	Access type	No buffer zone/heavy traffic	Buffer zone/light traffic		Parking lot visible from coastal area	Parking lot not visible from coastal area
25	Skyline	Very unattractive	Un-attractive	Sensitively designed	Very sensitively designed	Natural/ historic features
26	Utilities	>3 utilities	3 utilities	2 utilities	1 utilities	None

Table 3. The evaluation index of coastal scenery **(Ergin *et al.*, 2019)**

Class	D values	Coastal scenery condition
1	$D \geq 0.85$	Top natural: Extremely attractive sites with very high landscape value
2	$0.85 > D \geq 0.65$	Attractive natural sites with high landscape value
3	$0.65 > D \geq 0.40$	Average natural sites with medium landscape value
4	$0.40 > D \geq 0.00$	Unattractive sites with medium landscape value and light development
5	$D < 0.00$	Poor sites with low landscape value and intensive development

5. Clean coastal index (CCI)

Technically, measuring the level of beach cleanliness using CCI is based on transect observations **(Alkalay *et al.*, 2007)**. The CCI formula and classification (Table 4) was presented **(Rangel-Buitrago *et al.*, 2018a)** as follows:

$$CCI = \frac{\Sigma \text{ Litter item}}{\text{Transect length (m)} * \text{Width (m)}} * 20$$

Table 4. Clean coast index classification **(Alkalay *et al.*, 200**7)

Clean Coast Index	Very Clean	Clean	Moderate	Dirty	Very Dirty
Numeric Index	0 - 2	2 - 5	5 - 10	10 - 20	> 20

RESULTS

The results show that the beaches in Area of Interest (AoI) are classified into remote, rural and village types. Each beach type has its own CSES and CCI characteristics. Photographs representing the typology of each beach are shown in Fig. (2), while the CCI classification of each beach is presented in Table (5).

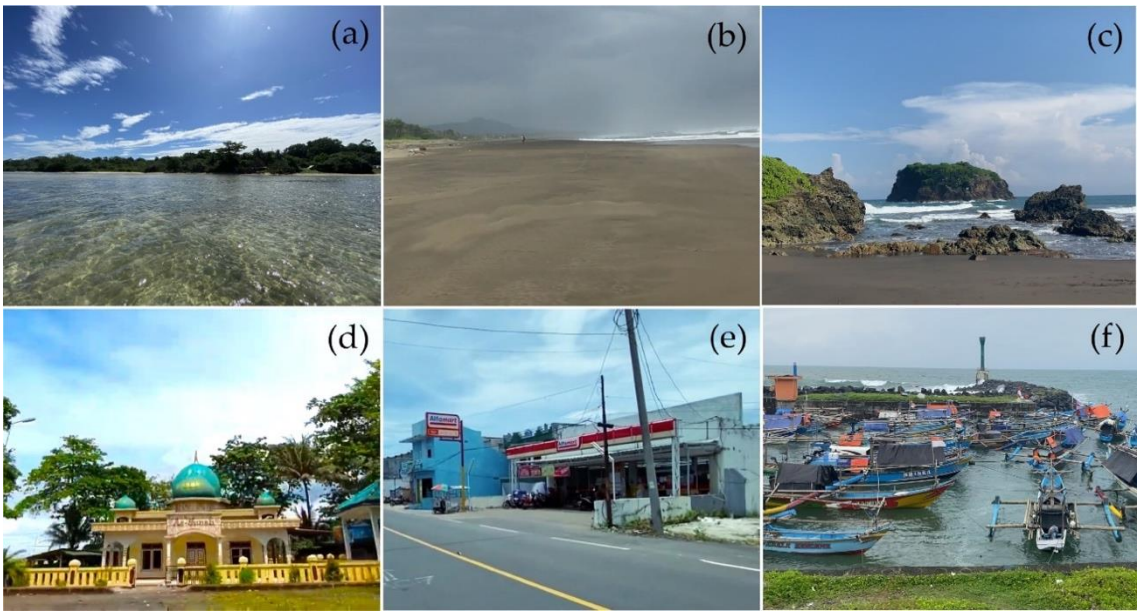


Fig. 2. Typological conditions of beaches in AoI **(a)** tidal pool in Sancang, **(b)** gentle beach in Bubujung, **(c)** rock island in Karang Tawulan, **(d)** mosque in Cipatujah, **(d)** retail shop in Sidangkerta, **(e)** traditional port in Pamayangsari

Table 5. The CCI classification of each beach

Category	**Station Code**						
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**
Drinking bottles or only the cap	3	6	11	27	15	20	19
Grocery bag, toiletries, Cleaning products	1	0	5	9	7	7	5
LDPE food/drink packaging	8	4	40	35	21	15	14
Rope	1	2	2	4	4	12	2
Fishing net	0	2	1	0	1	5	0
Snack or noodle packaging	2	3	32	30	13	28	12
Cutlery, straw	4	2	4	10	6	4	8
polystyrene food/drink packaging	1	1	6	21	18	13	16
Lighter, toys, pens	0	0	0	1	0	2	0
Sandal, rubber	0	0	1	0	0	1	0
Cloth	0	0	2	2	2	6	1
Other materials, such as metal or asbestos	0	0	3	6	4	6	3
Total items	20	20	107	145	91	119	80
Area (m2)	82,57	99,56	437,30	153,48	98,54	166,98	162,58
CCI	4,84	4,02	4,89	18,89	18,47	14,25	9,84
Status	Clean	Clean	Clean	Dirty	Dirty	Dirty	Moderate

1. Remote areas

Sancang Cikolomberan and Sancang Cetut beaches are located in the Leuweung Sancang forest, which has been designated as a nature reserve **(Amalia *et al.*, 2021)**. These two remote beaches have no residents and minimal facilities, can only be accessed by boat or on foot for 30-45 minutes, have shelters for visitors, and have clear tidal pools (Fig. 2). These tidal pools are formed because both beaches have coral beds that will be submerged at high tide while holding back the waves. Both beaches are surrounded by tropical vegetation with no obvious geological features such as cliffs or rocky shores. The human aspect of both beaches is minimal, with almost no disturbances such as litter pollution or buildings interfering with the scenery. The histograms of these two beaches, shown in Fig. (3), are provided for scenic assessment.

The FWA of Sancang Cikolomberan and Sancang Cetut beaches shows dominance in the "very good impact" attribute, particularly in human parameters, while physical parameters are evenly distributed (Fig. 3). This indicates human parameters strongly influence the coastal scenery value. The right-hand skew of the MD curve (Fig. 3) reflects high scenic quality. The CSES results classify both beaches as attractive natural sites with high landscape value, with Cikolomberan receiving a D value of 0.82 and Cetut receiving a D value of 0.69. The coastal clean survey found equal waste amounts on both beaches, but with different types and distribution. Cikolomberan has more plastic waste, while Cetut has less variety. Despite having the same total waste, Cikolomberan's larger survey area leads to the classification of both beaches as clean (Table 5).

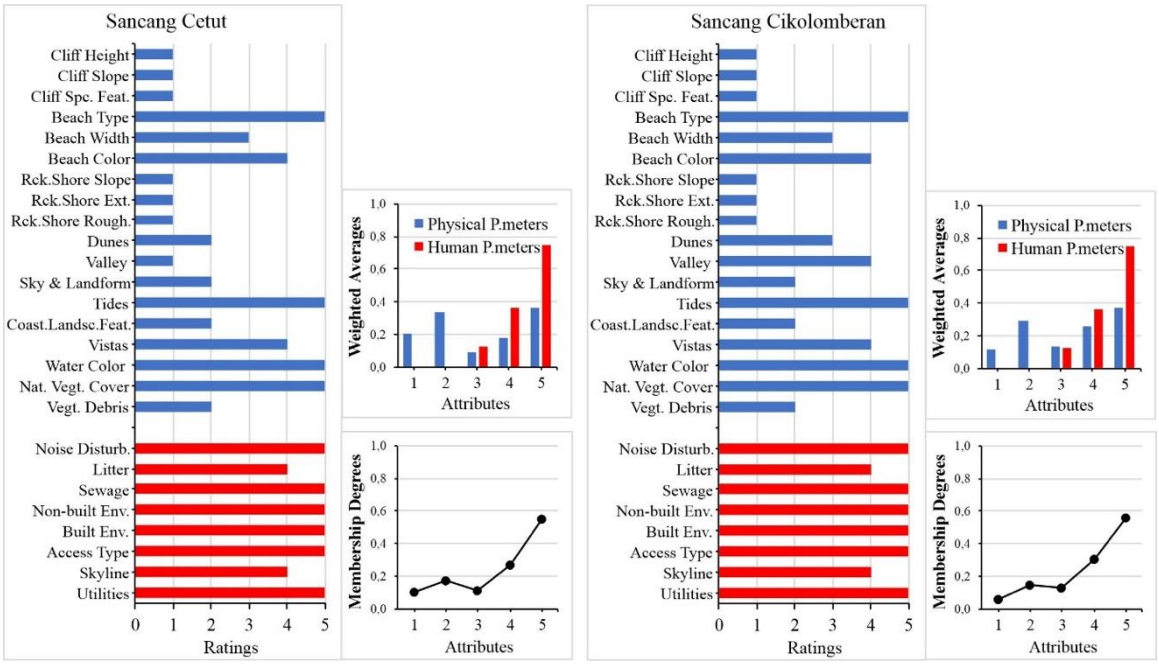


Fig. 3. The CSES results of Sancang Cetut and Sancang Cikolomberan

2. Rural areas

Bubujung and Karang Tawulan are two rural beaches that can be accessed by motorized vehicles. The typological conditions on these two beaches are still natural but not as natural as remote beaches. The population is still sparse with minimal public facilities. Bubujung Beach has a wide, gently sloping beach without cliffs (Fig. 2), while Karang Tawulan has cliffs and interesting natural features such as rock island and breaking waves (Fig. 2). Both beaches do not have professional lodging, but simple guesthouses owned by local residents are available.

In terms of FWA values (Fig. 4), Bubujung Beach has maximum weight in the "good impact" attribute, particularly in the human parameter, but low in the "very good impact" attribute, leading to skewness instability in the coastal scenery calculation. In contrast, Karang Tawulan shows maximum weights for "moderate impact" and "good impact" physical attributes with low human parameter attributes. Bubujung's unstable MD curve classifies it as moderate scenic quality, while Karang Tawulan's left-hand skew indicates low scenic quality (Fig. 4). Bubujung has a D value of 0.57, classified as average natural sites with medium landscape value, and Karang Tawulan has a D value of 0.25, categorized as unattractive sites with medium landscape value and light development. Bubujung also exhibits a higher level of trash, particularly LDPE (Low-Density Polyethylene) packaging, which suggests a higher frequency of picnic activities. Based on CCI, Bubujung is clean, while Karang Tawulan is moderate (Table 5).

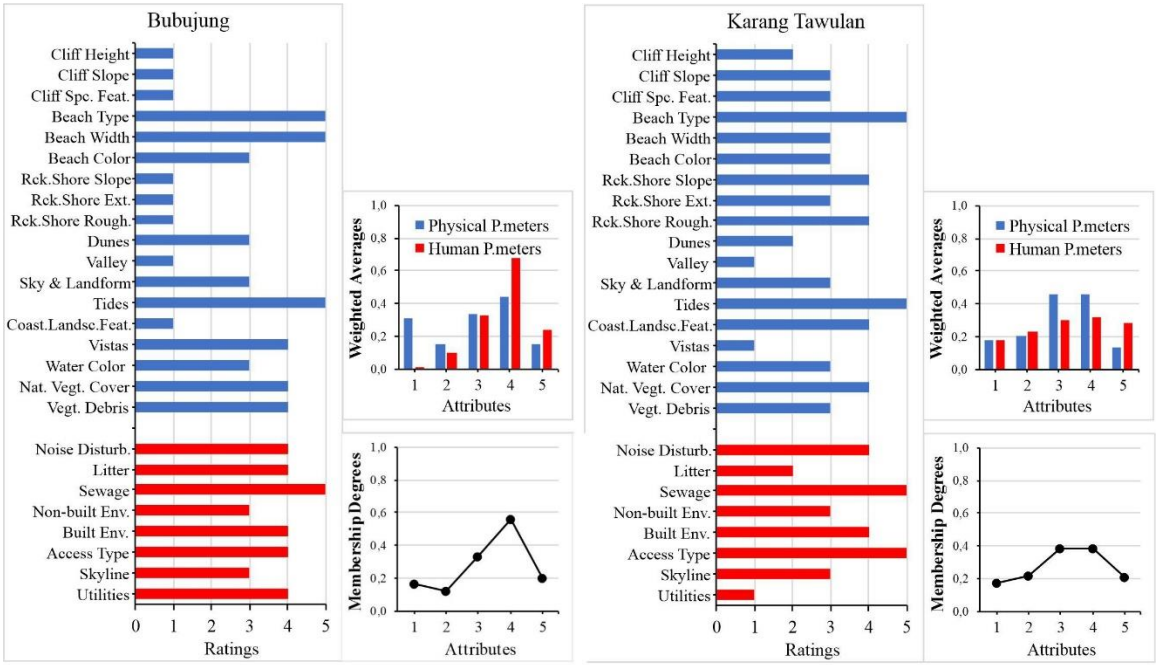
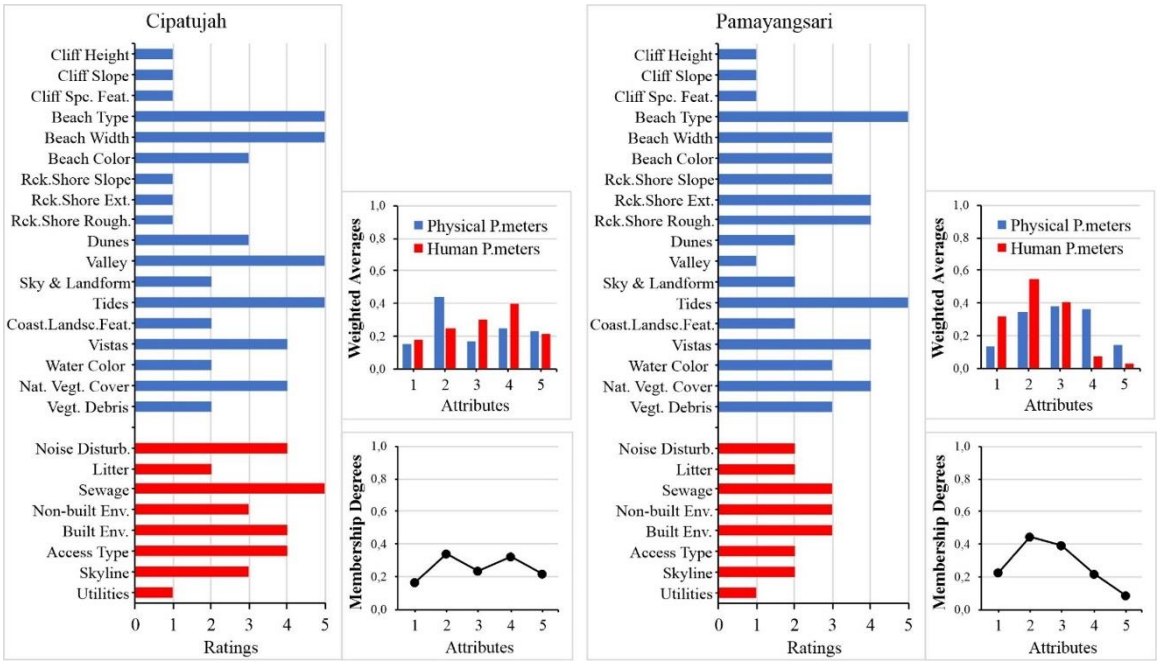


Fig. 4. The CSES results of Bubujung and Karang Tawulan

3. Village areas

Cipatujah, Sindangkerta, and Pamayangsari are village-type beaches with easy access via private and public transportation. Cipatujah and Sindangkerta have public facilities like government offices and mosques, but no harbor. Pamayangsari, near the main provincial road, also has a fishing port and auction site (Fig. 2). All offer guesthouses and B&Bs, but no star hotels.

For the FWA assessment (Fig. 5), Cipatujah Beach shows maximum weight on the "bad impact" attribute for physical parameters, with a balanced "good impact" on human parameters, indicating human activity strongly influences its scenery. Sindangkerta has almost equal weights in "good impact" and "bad impact," with a slight left-hand skew in the membership degree curve (Fig. 5). Pamayangsari shows high attributes in "bad impact," especially for human parameters, with a left-hand skew in its MD curve (Fig. 5). CSES values are D = 0.02 for Cipatujah (unattractive sites with medium landscape value and light development), D = -0.01 for Sindangkerta, and D = -0.4 for Pamayangsari (poor sites with low landscape value and intensive development). Waste management challenges are evident, with Cipatujah having the most waste, dominated by plastic. Sindangkerta and Pamayangsari also face similar issues (Fig. 7). The relatively high Coast Clean Index (CCI) values (dirty and very dirty) highlight the need for improved waste management and cleanliness (Table 5).



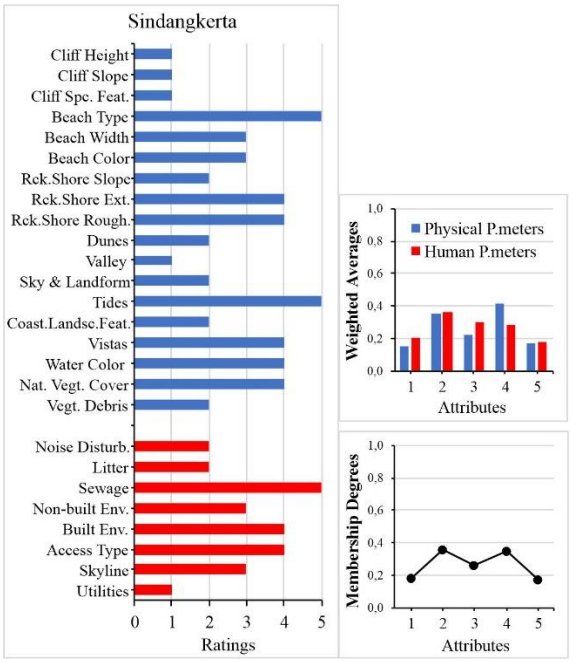


Fig. 5. The CSES results of Cipatujah, Pamayangsari and Sindangkerta

DISCUSSION

Managemen option

The beaches in the Area of Interest (AoI) do not qualify the criteria of "top natural" according to the Coastal Scenic Evaluation System (CSES) category, but each beach has unique characteristics that distinguish it. Sand color, rock formations and diverse topography as well as variations in other physical parameters, can give a good impression to visitors **(Di Giorgio *et al.*, 2018; Asensio-Montesinos *et al.*, 2020; Cengisz *et al.*, 2021)** but based on the results of waste data collection, the naturalness of the beaches in the AoI is threatened by plastic pollution. The litter collected was mostly on the backshore rather than the foreshore, indicating that human activities on the coast dominate litter in the AoI. The remote beaches such as Sancang Cikolomberan and Sancang Cetut are still at risk of pollution, despite being isolated from direct human activities.

From the typology identification results, the beaches in AoI are included in the non-urban typology (remote, rural, village), so the solution chosen for the waste problem in this area is the development of sustainable nature tourism. The sustainable nature tourism approach offers a more holistic solution to keeping beaches clean than technical solutions such as coastal clean-up. Coastal clean-up, although effective if done regularly, is very costly and still requires the involvement of local communities to achieve maximum effectiveness **(Black *et al.*, 2019; Burt *et al.*, 2020; Panwanitdumrong & Chen, 2022)**. On the other hand, sustainable tourism not only addresses pollution issues, but also supports local economic development, cultural preservation, and increased environmental

awareness **(Chen *et al.*, 2020; Wang, 2020)**. This is different from urban beaches, where challenges such as industrial pollution, dense population, and complex infrastructure may require more technical and centralized solutions.

Sustainable coastal development demands collaboration between coastal parameters and the application of adaptive and innovative management principles, which not only focus on mitigating impacts but also preventing future environmental problems **(de Alencar *et al.*, 2020)**. The SA matrix method in beach management emphasizes the importance of integration between beach typology, beach aesthetics, and cleanliness in management strategies. These factors have a direct relationship with beachgoer satisfaction **(Er-Ramy *et al.*, 2023)**. In addition, the evaluation of coastal scenery provides a scientific basis for any coastal management plan **(Mestanza-Ramón *et al.*, 2020)**. The classification of the analyzed sectors for all beaches is shown in Fig. (6). Some additional photos illustrating conditions in the AoI are shown in Fig. (7).

		Litter class				
		Very clean	Clean	Moderate	Dirty	Very Dirty
Scenic class	Top natural: Extreme attractive sites with very high landscape value					
	Attractive natural sites with high landscape value		I, II			
	Average natural sites with medium landscape value		III			
	Unattractive site with medium landscape value and light development			VII	IV	
	Poor site with low landscape value and intensive development				V, VI	

Fig. 6. The classification of the analyzed sectors for all beaches

Fig. 7. Additional photos illustrating conditions in the AoI **(a)** waste in the backshore of Pamayangsari, **(b)** the naturalness of Sancang Cetut, **(c)** tidal pool in Sindangkerta, **(d)** sandspits in Cipatujah

- **Remote area management option**

From the classification of the analysis sector matrix, all remote beaches (beach code I and II) in the AoI are categorized as attractive (Fig. 6), indicating that they have not been affected by overdevelopment and still maintain their authenticity (Fig. 7). This is important considering that indirectly, the coastal area of Sancang Nature Reserve is utilized for fishing activities by the local community **(Wardah & Ariani, 2020)**. Beaches in remote areas have conservation values that require attention and improvement to improve scenic quality and environmental preservation **(Rangel-Buitrago *et al.*, 2018)**. Remote beaches in the AoI are classified in the green sector where in general the management option it suggests is protection.

As part of the Leuweung Sancang Protected Forest, a viable solution for this remote area is to limit the number of visitors and the duration of visitation while also implementing specific standards for tourists. This approach aims to channel tourism activities toward Special Interest Tourism (SIT), ensuring they are more controlled and sustainable in alignment with the conservation goals of the area. SIT activities that can be done in Leuweung Sancang are bird watching and hiking in the forest area, or snorkeling in the tidal pool area. Bird-watching and hiking activities will enrich visitors' experience in enjoying the silence and beauty of nature **(Ocampo-Peñuela & Winton, 2017; Alessandro *et al.*, 2022; Park *et al.*, 2022)**, while snorkeling activities can provide insight into marine conservation **(Piñeiro-Corbeira *et al.*, 2020; Turicchia *et al.*, 2021)**.

Regulating beach access by banning vehicles and building environmentally friendly walking trails could support special interest tourism at Leuweung Sancang. Visitation management such as time restrictions and zoning, as in Koh Chang Marine Park,

Thailand, has been shown to improve ecological and social impacts **(Roman *et al.,* 2007)**. Focusing on special interest tourism in conservation areas will create employment and business opportunities associated with sustainable tourism activities **(Andradi-Brown *et al.,* 2023)**. Therefore, community participation is essential from planning to implementation of tourism activities in these remote areas **(Bello *et al.,* 2018)**.

- **Rural area management options**

Based on the sector analysis, Bubujung and Karang Tawulan beaches are in the white sector (Fig. 6), indicating a balanced situation without extreme litter issues. Bubujung Beach, classified as class 3 in CSES with a clean CCI, can still be managed for protection, though it is vulnerable to degradation if visitation increases. Karang Tawulan Beach, with moderate litter, shows that even mildly developed areas can face pollution. Limiting visitors and promoting nature-based tourism, which suits rural beaches with limited facilities but natural scenery, can address pollution at both beaches, providing authentic experiences, environmental awareness, and economic benefits. The large expanse of sand here supports the development of activities such as picnicking and camping. Both activities have low environmental impact and educate tourists about the importance of conservation. Sustainable camping activities can prevent extensive environmental degradation **(Marion *et al.,* 2020)**. The integration of camping sites with cultural landscapes on the Catalan coast of Spain showed minimal impacts, which helped preserve natural and cultural heritage **(Martin *et al.,* 2020)**.

In remote and rural areas, waste prevention plays a critical role. This can be achieved by inspecting items with potential to become waste, especially plastics. Policies requiring visitors to bring back the same amount or more plastic products when leaving the area have proven effective. Additionally, improving basic waste management facilities with attractive and innovative designs can significantly reduce littering behavior **(Portman *et al.,* 2019)**. Local communities in rural beach areas should be actively involved in tourism and conservation efforts, such as guiding eco-tours, participating in conservation projects, or taking roles in sustainable tourism management. These activities enable economic benefits from eco-cultural tourism while promoting environmental conservation and preserving local culture **(Jurjonas & Seekamp, 2018; Sun, 2020; Casimiro *et al.,* 2023)**. Ultimately, nature-based tourism in rural areas can drive community development through improved infrastructure, ecological preservation, and human capital development **(He *et al.,* 2021)**.

- **Village area management options**

Three village beaches in the AoI are in the red zone of the SA matrix (Fig. 6), indicating poor visual quality and serious waste management issues **(Corraini *et al.,* 2018)**. Immediate cleanup and addressing human impacts are crucial **(Perkumienė *et al.,* 2023)**. A long-term strategy involves transforming these beaches into environmentally

friendly, sustainable commercial areas, focusing on sustainable mass tourism **(Baloch *et al.*, 2023)**. Sindangkerta Beach, with coral forming tidal pools, and Cipatujah Beach, at the mouth of a river with a sandspit (Fig. 7), have potential for mass tourism activities like swimming, sunbathing, and beach sports. With proper management, the sandspits can benefit the local community **(Saengsupavanich, 2021)**. Pamayangsari Beach, a traditional harbor, could develop culinary tourism, similar to Mooloolaba, Australia, where seafood boosts the local economy **(Pascoe *et al.*, 2023)**.

The AoI requires a variety of facilities to support sustainable mass tourism and improve visitor experience. Easy beach access ensures enjoyment of its beauty **(Chen & Teng, 2016; Lukoseviciute & Panagopoulos, 2021)**. Private facilities like changing rooms and clean toilets with excellent water quality improve comfort and ecosystem health **(Quilliam *et al.*, 2015; Pouso *et al.*, 2018; Basterretxea-Iribar *et al.*, 2019)**. Eco-friendly practices, such as ecolabels in beach venues and accommodations, benefit both environmental protection and customer loyalty **(Merli *et al.*, 2019; Abdou *et al.*, 2022)**. Waste management should include upgraded sanitation and litter facilities, local recycling approaches, and self-management systems to convert waste into safe products or energy **(Jouhara *et al.*, 2017)**. Additionally, stricter surveillance and innovative reporting systems, like the one in Nowshahr, Iran, can speed up cleanup efforts **(Fatehian *et al.*, 2018)**.

CONCLUSION

The beaches of Sancang Cetut and Sancang Cikolomberan, located in remote areas, are categorized as attractive natural sites with high landscape value according to the CSES. The D value for Sancang Cikolomberan is 0.82, while Sancang Cetut has a D value of 0.69. Both beaches are classified in the SA green sector, where the recommended management strategy is protection. The proposed solution for these two beaches is to limit visits and develop Special Interest Tourism (SIT), such as birdwatching, hiking in the forest, or snorkeling in tidal pools.

Bubujung Beach and Karang Tawulan Beach, both located in rural areas, have D values of 0.57 and 0.25, respectively. Bubujung is classified as an average natural site with medium landscape value, while Karang Tawulan is classified as an unattractive site with medium landscape value and light development. Both Bubujung and Karang Tawulan fall under the white sector classification in the SA. Protection is recommended as a management strategy for these two beaches, as they are vulnerable to an increase in refuse volume with a rise in visitors. The primary difference between remote beaches and rural beaches lies in the type of tourism activities they support. Rural beaches in the AoI are less suitable for nature observation due to their comparatively lower natural beauty.

The proposed solution for these two beaches is to develop them into nature-based tourism areas, offering activities such as picnicking and camping.

The Cipatujah, Sindangkerta, and Pamayangsari beaches are located in village areas with easy access and public facilities. Cipatujah is classified as an unattractive site with medium landscape value and light development, receiving a D value of 0.02 from the CSES. Sindangkerta and Pamayangsari are classified as poor sites with low landscape value and intensive development, with D values of -0.01 and -0.4, respectively. All three beaches, located within the SA red zone, require immediate cleaning as a management measure. Developing sustainable mass tourism tailored to each beach's morphological conditions is the recommended solution. For example, Sindangkerta is suitable for swimming, Cipatujah for beach sports, and Pamayangsari for culinary tourism.

The SA matrix method in coastal management highlights the importance of integrating beach typology, coastal aesthetics, and cleanliness into management strategies. It proves to be an effective tool for addressing the diverse characteristics of TGC's beaches. By applying the SA framework to TGC, the study offers actionable recommendations and contributes to sustainability-oriented policies.

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