



Analysis of Marine Ecotourism Suitability for Diving and Snorkeling Activities in Enggano Island

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Abstract

Enggano Island has the potential to be developed into an ecotourism destination area, especially marine ecotourism. The ecosystems found in Enggano Island are coral reefs, mangroves and seagrass beds. This study aimed to analyze the suitability of marine ecotourism of Enggano Island for marine ecotourism activities, namely diving and snorkeling. The primary data collection was done by sampling, direct observations in the field. The secondary data were collected by exploring various references and relevant institutions. The research results showed that Enggano Island had three categories for marine ecotourism suitability of diving categories, namely suitable (S1), quite suitable (S2) and not suitable (N), while the marine ecotourism of snorkeling categories had only two categories: suitable (S1) and quite suitable (S2).

Keywords: coral reef; marine ecotourism; regional suitability; Enggano Island.

1. Introduction

Small islands consist of renewable resources and nonrenewable resources as well as coastal and marine environmental services. Among the renewable resources, coral reef ecosystems are one of the typical ecosystems of tropical waters with a high diversity of biota species [1].

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One of the main functions of coral reefs is to provide human life services in that they offer ecotourism attraction with their great beauty and fascination. Small islands also become the regions for the development of various utilization activities [2]. Related to ecotourism utilization activities, according to Bjork [3], in the management there is an educational component which is carried out continuously. Marine ecotourism is an activity that offers tourists the opportunity to enjoy the beauty of nature under the sea by protecting and maintaining the environment so that it remains sustainable. Marine ecotourism prioritizes underwater resources [4], whereas, according to [5], marine ecotourism is an activity developed with a marine conservation approach. Marine ecotourism is very appropriate and efficient in maintaining the integrity and authenticity of the ecosystem. The management of ecotourism deals with conservation and utilization approaches. Both approaches are implemented with an emphasis on conservation rather than utilization, and there should be a synergy with partiality to the community. The involvement of local communities helps maintain the integrity of the ecotourism area, sustain local community cultures, and open an opportunity to position the community as part of joint management with other stakeholders [6]. The availability of data and information on the suitability of Enggano Island area in relation to the preparation of marine ecotourism development and management plan is important to support the policy of Bengkulu Provincial Government in the period 2013-2025 to make Enggano Island as the center of fishery and tourism industry. Therefore, this study aimed at analyzing the suitability of marine ecotourism in Enggano Island for diving and snorkeling activities.

2. Material and Methods

2.1. Research sites

This research was conducted in Enggano Island, Bengkulu Province, for 6 months. The research sites and the coordinates can be seen at the sampling points of the research which are presented in Figure 1.

2.2. Research Tools and Materials

The tools and materials used in the research were Self Contained Underwater Buoyancy Apparatus (SCUBA), Digitized basemap, motorboat, underwater stationery, Stop watch, Underwater Camera, Hand Global Positioning System (GPS) G 60, 50 meter Rollmeter, Underwater Stationery (Slate and Pencil), Coral Identification Book, Secchi Disc, Thermometer and Refractometer.

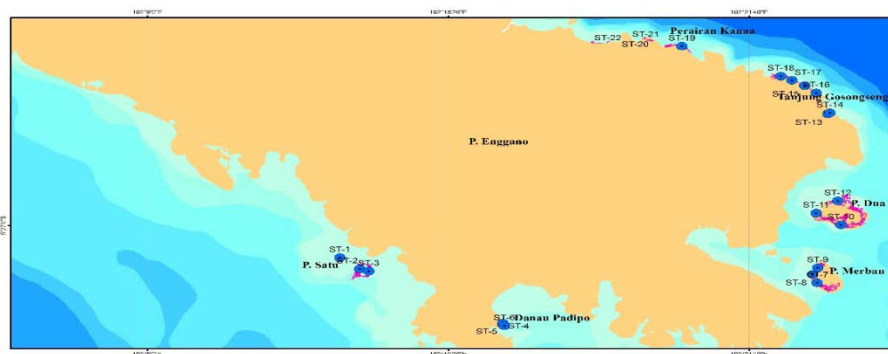


Figure 1: Site Map of Enggano Island Research

2.3. Data Types and Sources

The types and sources of data collected consisted of primary and secondary data.

The primary data were obtained through observations and direct measurements at the study sites.

Meanwhile, the secondary data obtained through a literature study in the form of reports and publications.

2.4. Method of Data Collection

2.4.1. Data of Environmental Parameters

Data collection of the environmental parameters was done purposively (purposive sampling) based on the existence of coral community with 19 sampling points at 6 observation locations, each at a depth of 3 meters and 10 meters. The environmental parameter data collected in this study can be seen in Table 1.

Table 1: Data of Environmental Parameters

No	Parameter	Unit	Tool and Material	Description
1	Transparency	meter	Secchi disc	In situ
2	Depth	meter	Measurement Rope and Consul	In situ
3	Current Speed	cm/sec	Flow meter and stop watch	In situ

2.4.2. Data of Coral Community

The data collection method of coral communities using Line Intercept Transect (LIT) method was by determining the coral lifeform and the percentage of coral cover by looking at the category valuea [7] and this can be seen in Table 2.

2.4.3. Data of Coral Fish

The data of reef fish in this study were obtained by a method of Underwater Visual Census (UVC) on the same coral reef transect, namely a method to identify reef fish through the observation of reef fish found at a distance of 2.5 m to the left and right in the transect line.

The existence of reef fish was recorded based on the picture guide of reef fish species carried by divers and the determination of the number of reef fish species was based on the latin names of the species [7].

Table 2: List of the classification of basic components of the coral reef ecosystem based on coral reef lifeform and its code [7]

Category	Code	Description
Dead Coral	DC	Just died, white or greyish white
Dead Coral with Alga	DCA	Still standing, skeleton structure still seen
Branching	ACB	At least 20 branches. Having axial and radial coralit
Encrusting	ACE	It is usually the basis of the immature acropora form
Acropora	ACS	Upright with a wedge-like shape
Digitae	ACD	Branching no more than 2o
Tabulate	ACT	The shape is like a flat table
Branching	CB	At least 2o Branching. It has axial and radial coralite
Encrusting	CE	Mostly bound to the substrate (encrusted). At least 2o branching
Foliose	CF	Coral is bound to one or more dots, such as a leaf, or a plate
Massive	CM	Like a boulder or a mound
Non-Acropora	CS	The shape is like a small pole, knob or wedge
Mushroom	CMR	Solitary, living corals are free of genera
Heliopora	CHL	Blue coral
Millepora	CML	Fire coral
Tubipora	CTU	Like Small pipes
Soft Coral	SC	Soft coral
Sponge	SP	
Zeanthids	ZO	
Others	OT	Ascidians, anemon, georgonian etc.
Alga assemblage	AA	
Corallinee alga	CA	
Alga	HA	Halimeda
Macroalga	MA	
Turf Alga	TA	
Sand	S	Sand
Rubble	R	Small coral fracture
Abiotic	SL	Muddy sand
Silt	SL	
Water	W	Water
Rock	RCK	Rock

2.5. Analysis of Marine Ecotourism Suitability of Enggano Island

Assessment analysis of the suitability of marine ecotourism of diving categories consisted of 6 (six) parameters and 3 (three) categories. The marine ecotourism suitability parameters of diving categories, among others, were

water transparency, coral community cover, lifeform species, reef fish species, current speed, and coral depth, which can be seen in Table 3.

Table 3: Matrix of diving ecotourism suitability

No	Parameter	Weight	Score		
			1	3	5
			N	S2	S1
1	Transparency of waters (%)	5	<50	50-75	>75
2	Coral community cover	5	<50	50-75	>75
3	Type of lifeform	3	<4	4-7	>7
4	Coral fish species	3	<20	20-<50	>50
5	Current Speed (cm/sec)	1	>50	>30-50	0-15
6	Depth of coral reef (m)	1	>15, <3	<6, >10-15	6-10

Source: [4] S1 = Suitable, with a value of 75-100%, S2 = Quite suitable, with a value of 50-<75 % , N = Not suitable, with a value of <50% and Maximum value = 90

The suitability of snorkeling ecotourism considered 7 (seven) parameters with 3 (three) categories. The parameters of the suitability of marine tourism in of snorkeling categories were water transparency, coral community cover, lifeform type, reef fish species, current speed, coral reef depth, and wide flat stretch of coral reefs, as can be seen in Table 4.

Table 4: Matrix of snorkeling ecotourism suitability

No	Parameter	Weight	Score		
			1	3	5
			N	S2	S1
1	Transparency of waters (%)	5	<50	50-75	>75
2	Coral community cover	5	<50	50-75	>75
3	Type of life form	3	<4	4-7	>7
4	Coral fish species	3	<20	20-<50	>50
5	Current Speed (cm/sec)	1	>50	>30-50	0-15
6	Depth of coral reef (m)	1	>6, <1	>3- 6	1-3
7	Size of flat stretch of coral (m)	1	<20	20-500	>500

Source: [4] S1 = Suitable, with a value of 75-100%, S2 = Quite suitable, with a value of 50-<75 % , N = Not suitable, with a value of <50% and Maximum value = 95

Some suitability parameter values for diving activity such as lifeform type, coral fish and coral community cover are adjusted to the potential conditions of coral reef and fish species which become the attraction of marine ecotourism.

Index of Ecotourism Suitability (IKE) is a continuation of the assessment obtained from the ecotourism suitability matrix of diving and snorkeling categories using a computer software. Meanwhile, the IKE used refers to [4].

$$IKE = \sum [Ni/Nmaks] \times 100\%$$

Note:

IKE = Index of ecotourism suitability

Ni = Parameter value (weight x score)

Nmaks = Maximum value of ecotourism categories

3. Results and Discussion

3.1. Marine Ecotourism Suitability

The weighting of the suitability of marine ecotourism areas for diving and snorkeling was conducted by considering the limiting factors consisting of waters transparency, coral community cover, lifeform type, coral fish species, current speed, coral reef depth and wide stretch of coral reefs.

All limiting parameters were given weights and scores based on the importance level for diving and snorkeling activities. The parameter of waters transparency has the highest weight because this parameter can help tourists to see clearly the beauty and conditions of the existing coral reef ecosystem. Waters transparency is the determinant of light penetration for the survival for the coral reef ecosystem itself. Meanwhile, the coral community cover is a tourist attraction in enjoying the beauty of the underwater views. Waters transparency invites the curiosity of tourists to see the beauty of the underwater views, especially the coral reef community and the diversity of colorful reef fish with various sizes, which are a special attraction that can be enjoyed by tourists. Current speed is a factor related to the safety of tourists in conducting marine ecotourism of diving and snorkeling categories [8]. All the limiting parameters were viewed and assessed to determine the scoring and weighing system, leading to the grouping of marine ecotourism suitability as follows:

3.2. Suitability of Marine Ecotourism Area of Diving Categories

Based on observation results, of all criteria parameters for marine ecotourism of diving categories, the lowest IKE value was 46.67 and the highest IKE value was 93.33. One of the purposes of marine ecotourism of diving categories is the tourists can see the beauty of the underwater ecosystem. The suitability values of marine ecotourism of diving categories can be seen in Table 5.

Table 5: The suitability values of marine ecotourism of diving categories

o	N	Research Site	Samplin g point	Parameter						TOTA L	IKE	KT G
				KP	TKK	JL	JIK	KA	KTK			
1	Satu Island	ST-1	100.00	52.20	5.00	30.00	1.00	3.00	64.00	71.11	S2	
		ST-2	100.00	11.00	6.00	20.00	1.00	10.00	52.00	57.78	S2	
		ST-3	100.00	39.86	5.00	30.00	1.00	3.00	54.00	60.00	S2	
2	Lake Padipo	ST-4	100.00	61.00	2.00	30.00	0.90	3.00	58.00	64.44	S2	
		ST-5	100.00	66.60	2.00	30.00	0.90	3.00	58.00	64.44	S2	
		ST-6	100.00	65.93	2.00	30.00	0.90	3.00	58.00	64.44	S2	
3	Merbau Island	ST-7	100.00	24.72	8.00	59.00	2.00	10.00	70.00	77.78	S1	
		ST-8	100.00	24.96	6.00	59.00	2.00	10.00	64.00	71.11	S2	
		ST-9	100.00	0.66	3.00	20.00	2.00	3.00	42.00	46.67	N	
4	Dua Island	ST-10	100.00	26.06	6.00	29.00	3.00	10.00	58.00	64.44	S2	
		ST-11	100.00	25.10	4.00	29.00	3.00	3.00	54.00	60.00	S2	
		ST-12	100.00	10.50	5.00	29.00	1.00	10.00	58.00	64.44	S2	
5	Gosongseng Cape	ST-13	100.00	77.38	9.00	40.00	11.00	3.00	80.00	88.89	S1	
		ST-14	100.00	20.84	7.00	40.00	18.00	10.00	58.00	64.44	S2	
		ST-15	100.00	87.64	10.00	40.00	32.00	3.00	78.00	86.67	S1	
		ST-16	100.00	51.00	8.00	40.00	32.00	10.00	72.00	80.00	S1	
		ST-17	100.00	37.30	9.00	40.00	11.00	3.00	60.00	66.67	S2	
		ST-18	100.00	20.84	10.00	40.00	11.00	10.00	64.00	71.11	S2	
6	Kaana	ST-19	100.00	47.84	7.00	30.00	11.00	10.00	58.00	64.44	S2	
		ST-20	100.00	53.52	10.00	30.00	18.00	10.00	74.00	82.22	S1	
		ST-21	100.00	13.72	8.00	30.00	18.00	3.00	60.00	66.67	S2	
		ST-22	100.00	87.90	9.00	30.00	19.00	10.00	84.00	93.33	S1	

Notest: KP = Transparency of waters, TKK = Coral community cover, JL= Type of lifeform, JIK= Coral fish species KA= Current Speed, KTK= Depth of coral reef, IKE= Index of ecotourism suitability, and KTG= Category

The matrix analysis result of the marine ecotourism suitability of diving categories showed that the suitable

location (S1) for the marine ecotourism of diving categories was Merbau Island at ST-7, Tanjung Gosongseng at ST-13, ST-14 and ST-16, Kaana waters at ST-20 and ST- 22, whereas the unsuitable location (N) was found in Merbau Island at ST-9, probably because it had a coral community cover value of 0.66%.

The highest coral community cover of suitable categories was in line with a value of 24.72-87.90% ie at all points of observation location.

The transparency level of each station was 100%. [9] stated that only the eastern part of Liukang Loe was suitable for diving, where the transparency level at Bate Baroso and Ujung Baturapa stations reached 100%. Transparency is the main requirement that must be met for diving activities.

Marine ecotourism of diving categories is closely related to the presence of coral reef ecosystems. They provide a new challenging experience and beautiful underwater scenery [10].

According to [11], relatively weak current is an ideal requirement for the marine ecotourism of the diving categories because it is related to the comfort and safety of tourists.

The best current speed for marine ecotourism of diving categories is 0-17 cm / sec. According to [12], the depth of coral reefs is related to water quality such as water movement, temperature and salinity, and in general, the proper depth for a coral reef ecosystem growth is 10-15 meters.

3.3. Suitability of Marine Ecotourism Area of Snorkeling Categories

The overlay result of of all criteria parameters for the marine ecotourism of diving categories showed that the lowest IKE value was 53.68 and the highest IKE was 87.37. The criteria parameters for the marine ecotourism of snorkeling categories in Enggano Island showed areas with the categories of suitable (S1) and quite suitable (S2) and not suitable (N). The flat stretch of the coral reefs was between 91.06-468,23 meters. The Ecotourism Suitability Values of the snorkeling categories are presented in Table 6.

The matrix analysis results of the marine ecotourism suitability of snorkeling category showed that the suitable location (S1) for marine ecotourism of snorkeling categories was found in Merbau Island at ST-7, Tanjung Gosongseng at ST-13, ST-14 and ST-16, Kaana waters at ST-20 and ST-22.

Reference [13] states that one of the objectives of the marine ecotourism of snorkeling categories is to offer tourists to see and enjoy the underwater beauty from the surface of the waters. This activity is assisted by snorkeling equipment without SCUBA tools. According to [14], the marine ecotourism activities of snorkeling categories will step on the colonies of coral reef ecosystem if done at a depth of less than 3 meters.

The depth where tourists can not stand, namely at > 2 meters, will certainly reduce the possibility of coral reef ecosystem to get damaged. According to [15], the depth of waters suitable for marine ecotourism of snorkeling categories was at a depth of 3-6 meters and there is something interesting to see such as a good stretch of coral reef ecosystem.

Table 6: The Ecotourism Suitability Values of the snorkeling categories

No	Research Site	Sampling point	Parameter							TOTAL	IKE	KTG
			KP	TKK	JL	JIK	KA	KTK	LHDK			
1	Satu Island	ST-1	100.00	52.20	5.00	30.00	1.00	3.00	129,65	71.00	74.74	S2
		ST-2	100.00	11.00	6.00	20.00	1.00	10.00	129,65	51.00	53.68	S2
		ST-3	100.00	39.86	5.00	30.00	1.00	3.00	129,66	61.00	64.21	S2
2	Lake	ST-4	100.00	61.00	2.00	30.00	0.90	3.00	70,26	65.00	68.42	S2
	Padipo	ST-5	100.00	66.60	2.00	30.00	0.90	3.00	70,26	65.00	68.42	S2
		ST-6	100.00	65.93	2.00	30.00	0.90	3.00	70,26	65.00	68.42	S2
3	Merbau Island	ST-7	100.00	24.72	8.00	59.00	2.00	10.00	1652.00	71.00	74.74	S1
		ST-8	100.00	24.96	6.00	59.00	2.00	10.00	1652.00	65.00	68.42	S2
		ST-9	100.00	0.66	3.00	20.00	2.00	3.00	1652.00	51.00	53.68	S2
4	Dua Island	ST-10	100.00	26.06	6.00	29.00	3.00	10.00	468,21	57.00	60.00	S2
		ST-11	100.00	25.10	4.00	29.00	3.00	3.00	468,22	61.00	64.21	S2
		ST-12	100.00	10.50	5.00	29.00	1.00	10.00	468,23	57.00	60.00	S2
5	Gosongseng Cape	ST-13	100.00	77.38	9.00	40.00	11.00	3.00	91.06	87.00	91.58	S1
		ST-14	100.00	20.84	7.00	40.00	18.00	10.00	91.06	57.00	60.00	S2
		ST-15	100.00	87.64	10.00	40.00	32.00	3.00	91.06	85.00	89.47	S1
		ST-16	100.00	51.00	8.00	40.00	32.00	10.00	91.06	71.00	74.74	S1
		ST-17	100.00	37.30	9.00	40.00	11.00	3.00	91.06	67.00	70.53	S2
		ST-18	100.00	20.84	10.00	40.00	11.00	10.00	91.06	63.00	66.32	S2
6	Kaana	ST-19	100.00	47.84	7.00	30.00	11.00	10.00	109,81	57.00	60.00	S2
		ST-20	100.00	53.52	10.00	30.00	18.00	10.00	109,81	73.00	76.84	S1
		ST-21	100.00	13.72	8.00	30.00	18.00	3.00	109,81	67.00	70.53	S2
		ST-22	100.00	87.90	9.00	30.00	19.00	10.00	109,81	83.00	87.37	S1

Notest: KP = Transparency of waters, TKK = Coral community cover, JL= Type of lifeform, JIK= Coral fish species KA= Current Speed, KTK= Depth of coral reef, LHDT= Size of flat stretch of coral, IKE= Index of ecotourism suitability, and KTG= Category

4. Conclusion

The suitability of marine ecotourism in Enggano Island had three categories for the suitability of marine ecotourism of diving categories, namely suitable (S1), quite suitable (S2) and not suitable (N), while marine ecotourism of snorkeling categories only had two categories, namely suitable (S1), quite suitable (S2).

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