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Suitability Of Seagrass Ecosystem For Marine Ecotourism In Mertasari Beach, Bali

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ABSTRACT

Seagrass ecosystem in Indonesia has disrupted or damaged, due to the anthropogenic pressures by using the utilization zone around the seagrass ecosystem. This study aims to determine and measure the potential of seagrass ecosystems to support ecotourism activities in Mertasari Beach. This study was conducted in April - July 2019 at Mertasari Beach, Bali by collecting primary data through field observation and secondary data through literature study. The method used in this study is a survey method. Furthermore, the data is processed and analyzed descriptively with tourism suitability analysis carried out by calculating the tourism suitability index and regional carrying capacity. The results of the tourism suitability index indicate that the seagrass ecosystem in Mertasari Beach is included in the category S2 (suitable) for the station I and station II with a value of 69% and station III show the category N (not suitable) with a value of 47%. The results of calculations for the carrying capacity of seagrass ecotourism activities in Mertasari Beach for snorkeling activities reached 64 people every day.

Keywords: *carrying capacity, ecotourism, marine ecotourism, seagrass*

1. Introduction

Seagrasses are highly productive underwater systems of flowering marine plants (angiosperms) that grow fully submerged and rooted in estuarine and marine environments (Green & Short, 2003). Seagrass ecosystems are one of the most productive marine ecosystems, so they can support high potential resources (Agardi, 2003).

Seagrasses are underwater flowering plants that are distributed across the globe. They often occur in vast meadows and provide nurseries, shelter, and food for a variety of commercially, recreationally, and ecologically important species such as fish, sea turtles and crustaceans. They also protect shorelines from coastal erosion and act as a net sink for carbon, playing a key role in mitigating the impacts of climate change.

While the economic function of seagrass that is useful for the community is as a fishing ground because the presence of seagrasses can increase fish productivity, and as a tourist destination for tourists. Seagrasses grow widely in coastal zones throughout the world, from temperate regions such as the United Kingdom to tropical regions such as the Indo-Pacific. Seagrass cover has declined in many estuaries on a worldwide basis in recent decades, due largely to anthropogenically induced declines in water quality and other human impacts (Orth and others, 2006).

The condition of seagrasses in Indonesia many have experienced interference or damage, this is caused by various factors, both natural and human factors. Human activity in the utilization of seagrass ecosystems presents its threat to the sustainability of the ecosystem (COREMAP-LIPI, 2017). One of the uses of seagrass resources that prioritize aspects of nature conservation and aspects of socio-economic empowerment of sustainable local communities is to apply the concept of ecotourism.

Ecotourism is an environment-oriented tourism activity that connects environmental conservation and the tourism industry. Seagrass ecotourism is seagrass tourism based on nature by including aspects of education and interpretation of the natural environment and management of ecological sustainability. The component of seagrass ecotourism consists of seagrass vegetation and biota associated with seagrass beds (Tuwo, 2011).

Mertasari Beach is a beach tourism object which is included in the Sanur Beach tourism area. The tourism potential offered by Mertasari Beach is the beauty of the scenery and various tourist activities which are the main destinations of the visitors. Mertasari Beach region also has a seagrass ecosystem that can be developed for ecotourism areas.

The purpose of this study is to determine the potential of seagrass ecosystems as support for ecotourism in Mertasari Beach so that it can be useful as basic data in building a seagrass ecotourism planning. The usefulness of this research is that it can provide information about the suitability of seagrass ecosystem areas as one of the considerations for the management of Mertasari Beach in the development of ecotourism so that it can be used sustainably.

2. Methods

2.1. Study Area

The study was conducted in April - July 2019 which consisted of several stages, namely the survey stage, the stage of data collection, and data processing. The location of this research was conducted at Mertasari Beach, Sanur Village, East Denpasar District, Denpasar City, Bali Province which is one of the tourist destination. Locations especially the seagrass ecotourism as part of efforts to strengthen the marine ecotourism activities. The research location is conducted in the waters of Mertasari beach 8˚42'31.09" S - 8˚42'55.56" S and 115˚15'1.81" E - 115˚ 15'38.62" E. Monitoring the seagrass ecosystem was done using quadrant transects (50 x 50 cm^2) sized-square at the location of the seagrass in coastal waters on Mertasari Beach with data collection at each station is 3 times (three-line transects) (Malikusworo and Nontji, 2014).

2.2 Method of collecting data

The method used in this study is a survey method, measurement data obtained directly from the field, then the data is processed and analyzed descriptively Data taken consists of primary and secondary data. Primary data derived from data measured directly in the field consisting of depth, salinity, brightness, type of substrate, current speed and temperature. While secondary data is a literature study data related to research. The technique of taking sample samples by using a purposive sampling method. Determination of seagrass stations is determined by the conditions of the area based on the closure of the most seagrass communities in the Mertasari Coast area so that it can be a data that represents the condition of seagrass ecosystems in the area.

2.2.1 Tools and Materials

This study uses 17 tools, namely GPS, ADS, roll meters, transect quadrant 50x50cm2, raffia ropes, stakes, chest boards, stationery, digital cameras, seagrass identification books, fish identification books, questionnaires, Arcgis, laptops, Secchi disks, thermometers, refractometer. The materials used in this study are slates and aquades.

2.2.2 Water Quality Parameters

Physical and chemical parameters are data that will support the condition of the seagrass ecosystem supporting ecotourism in Mertasari Beach with 6 parameters are water clarity using a secchi disk, current speed, temperature using a thermometer, type of substrate and salinity using a refractometer.

2.2.3 Fish Identification

The method used in identifying species of fish found in seagrass ecosystems is the UVC (Underwater Visual Census) method, which is the technique of observing fish around the study site (not only at the station) is commented on with an underwater camera at the time of observation seagrass and water quality measurement (English et al 1994)

2.3 Data Analysis Methods

2.3.1 Seagrass Data Processing

The results of data captured in the field are processed using Microsoft Excel tools. Calculation of density and seagrass cover using the method established COREMAP-LIPI (2014) which is divided into 4 stages with stages of searching for cover per quadrant, per-station, to per-location, as well as in determining seagrass density. So that the final result will be found in the form of an average value of seagrass closure (%) and percentage of seagrass closure per type, including its composition.

2.3.2 Regional Suitability

Tourism activities that will be developed should be adjusted to the potential of resources and allotment. The formula used to calculate the seagrass suitability index is the ESI formula or the Tourism Suitability Index, while the calculation method (Yulianda, 2007);

$$ESI = \Sigma \left(\frac{Ni}{N\ maks} \right) x\ 100\%$$

ESI : Tourism Suitability Index.
Ni : Parameter value to-i (Weight x Score)
Nmax : The maximum value of a ecotourism category

This matrix is composed based on seven suitability parameters: the seagrass cover, water clarity, fish species, the seagrass species, substrate type, current velocity, and the seagrass. Each parameter is assigned with weight, while each class of the value of each parameter is assigned with a score. Consequently, the total score is the aggregate of multiplication of score and weight For more details, the matrix of suitability for the seagrass of ecotourism can be seen in Table 1.

Table 1. Suitability Matrix for the Seagrass Ecotourism.

No	Parameters	Weight	S1	Score	S2	Score	S3	Score	N	Score
1	Seagrass Coverage	5	>75	3	>50 – 75	2	25 – 50	1	>25	0
2	Water Clarity	3	>75	3	>50 – 75	2	25 – 50	1	>25	0
3	Fish species	3	>10	3	6 - 10	2	3 – 5	1	>3	0
4	Segrass species	3	*Cymodocea, Halodule, Halophila*	3	*Syringodium, Thalassodendron*	2	*Thalassia*	1	*Enhalus*	0
5	Substrate type	1	Coral sand	3	Sand	2	Muddy sand	1	Muddy	0
6	Current velocity (cm/s)	1	0-15	3	>15 – 30	2	>30 – 50	1	>50	0
7	Seagrass depth(m)	1	1-3 m	3	>3 – 6	2	>6 – 10	1	>10	0

Source: Modified from Yulianda (2007).

The regional carrying capacity is the maximum number of visitors who can be physically accommodated in the area provided at a certain time without causing disturbance to nature and humans, the carrying capacity of the area using the following formula:

$$CC = K\ x\ \frac{Lp}{Lt}\ x\ \frac{Wt}{Wp}$$

CC : Regional Carrying Capacity (person / day)
K : Ecological potential of visitors per unit unit area (people)
LP : Area / Length of area that can be utilized (m^2 or m)
Lt : Unit area for certain categories (m^2 or m)
Wt : Time provided by the region for tourism activities in one day (hours)
Wp : Time spent by visitors for each particular activity (hours)

3. Results and Discussion

3.1 Water Conditions

The results of visual substrate observation showed that station I and II had a type of rocky sand substrate and station III was muddy sand. The type of substrate at the station I and II is rocky sand, so the type of substrate is good to be a tourist activity compared to the type of sand substrate not yet as at station III because the mud will make the waters turbid. The results of the measurement of water quality parameters are as follows (Table 2).

Table 2. Water Quality

Stations	Water Quality					
	Substrate	Temperature (°C)	Salinity (ppt)	Depth (m)	Waters brightness (%)	Current velocity (m/s)
I	Coral Sand	28	31	1,40 m	100	0,60 m/s
II	Coral Sand	28	32	1,52 m	100	0,60 m/s
III	Muddy Sand	29	32	1 m	100	0,60 m/s

The results of water temperature measurements at the research station found temperature data at the three stations ranging from 28-29 ° C. The temperature range shows normal values for tropical waters. According to Dahuri (2003), the optimum temperature range for seagrass species is 28-30 ° C.

Salinity values obtained at the three research stations ranged from 31-32 ppt. The amount of salinity at the research station is influenced by rainfall, evaporation at the surface of the water, and tides. The depth obtained from the three stations in this study is the depth at the station I of 1.40 m, at station II of 1.52 m and station III of 1 m. These waters are included in shallow waters so that light penetration easily enters the waters which cause the brightness of the waters in each station by 100%.

Current velocity obtained in this study is 0.60 m/s for station I, station II and station III. The dominant factor influencing the speed of the current in these waters is wind. In addition to the wind factor that forms currents, the shape of the seabed topography and surrounding islands can form currents (Hutabarat and Evans, 1985).

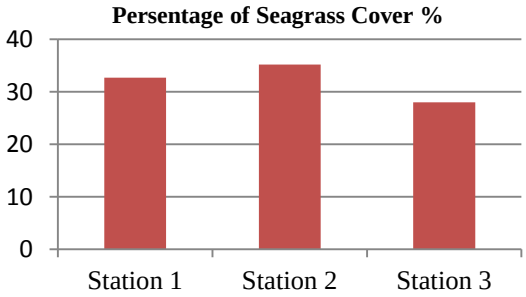
3.2 Seagrass Distribution and Cover

Overall in the Mertasari Beach research area found 8 species of seagrasses with an average seagrass closure of the three stations at 31.9% which entered the medium closure category with a closing percentage of 26-50% according to to COREMAP-LIPI (2014). The eight species of seagrass found were Enhalus acroides (EA), Cymodocea serrulata (CS), Cymodocea rottundata (CR), Halophila ovalis (HO), Halodule uninervis (HU), Halodule pinifolia (HP), Syringodium isotifolium (SI), and Thalassia (Th). hemprichii (TH). One of the types of diversity that grows in the area is influenced by the quality of the waters. According to Simamora (2012), the higher the diversity index value of water, the lower the level of pollution (Table 3).

Table 3. Seagrass Data

Station	Percentage of Seagrass Species Coverage (%)								Average of seagrass coverage (%)
	EA	CS	CR	HO	HU	HP	SI	TH	
I	8,1	11,9	8,9	1,4	1,4	0	0	1,1	32,7
II	7,2	12,3	9,1	1,5	2,6	0,7	0	1,8	35,2
III	20,6	0	0	0	0	0	1,5	5,9	28,1
Average	11,9	8,1	6	1	1,3	0,2	0,5	2,9	31,9

The highest percentage of seagrass cover was at Station II, 35.2%, which was dominated by Cymodocea serrulata type followed by Station I which had a closing percentage of 32.7% which was dominated by Cymodocea serrulata and the lowest percentage of seagrass cover was at Station III 28.1% were dominated by seagrass species Enhalus acroides.



Percent value of seagrass closure at the three stations shows the condition of seagrass in Mertasari Beach is included in the category of damaged with less rich or unhealthy conditions because it is less than 59.9% (KepMen LH No.200 in 2004). Yulianda (2007) suggests that the damaged seagrass ecosystem can be recovered by rehabilitation using seagrass transplant. Meanwhile, the good condition of seagrass must be conserved to maintain the sustainability. Mertasari Beach has a variety of seagrass species, including high with the discovery of 8 species of seagrasses. One of the types of diversity that grows in the area is influenced by the quality of the waters. According to Simamora (2012), the higher the diversity index value of a waters, the lower the level of pollution.

3.3.3 Fish Type

There are 5 species of fish found at station I and II, namely *Amphiprion akindynos, Chrysiptera hemicyanea, Pentapodus porosus, Cheilodipterus parazinatu, and Ostorhinchus angustatus.* Whereas at Station III there were 3 types of fish namely *Pentapodus porosus, Cheilodipterus parazonatus, Ostorhinchus angstatus.* The number of fish parameters is an important parameter in seagrass ecotourism activities. This is due to these parameters being one of the panoramic objects provided in seagrass ecotourism activities. This object is the main attraction of a marine ecotourism activity, especially seagrass ecotourism.

3.4 Land Suitability Analysis for Seagrass Ecotourism

According to Yulianda (2007), there are several parameters used in the suitability analysis of seagrass tourism, namely seagrass cover, water brightness, fish species, seagrass type, substrate type, current speed, and water depth. (Table 4).

Table 4. The Result of Suitability Matrix for the Seagrass Ecotourism

No	Parameters	Station I		Station II		Station III	
		Result	Score	Result	Score	Result	Score
1	Seagrass coverage (%)	32,7	5	35,2	5	28,1	5
2	Water Clarity (%)	100	9	100	9	100	9
3	Fish species	5	3	5	3	3	3
4	Seagrass species	*Cymodocea, Enhalus, Halophila, Halodule*	*9*	*Cymodocea, Enhalus, Halophila, Halodule*	*9*	*Enhalus, Syringonium, Thallassia*	*0*
5	Substrate type	Coral Sand	3	Coral Sand	3	Muddy Sand	1
6	Current Velocity (m/s)	0,60	3	0,60	3	0,60	3
7	Seagrass Depth (m)	1,40 m	3	1,52 m	3	1 m	3
		69%		**69%**		**47%**	
		S2		**S2**		**N**	

The results of land suitability calculations as support for seagrass ecotourism at each station were 69% for station I and station II and 47% for station III. Based on the results of this calculation, shows that stations I and II are in the S2 category (suitable) with a value of 69% for the tourist area category in accordance with the range of values of 67% - 84% according to Yulianda (2007). Meanwhile, the description of the characteristics of each location is based on the seven parameters as presented in Table 4.

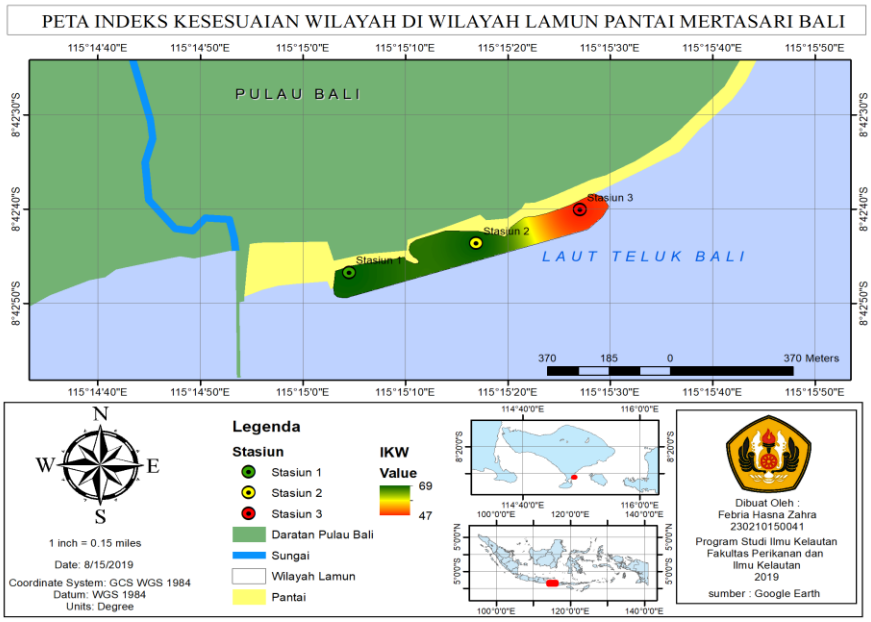


Figure 2. Map of Suitability the Seagrass Ecotourism in Mertasari Beach

The difference in the percentage of the tourism suitability index of each station is thought to be due to differences in each parameter. For example the type of seagrass found at each station is not necessarily the same as other stations, as well as other parameters such as the number of fish species, depth, type of substrate and current velocity. The suitability of ecotourism at the station I and station II shows that the Mertasari Beach area can be used as a seagrass ecotourism area because the area is almost all the physical and biological parameters that have been studied including the appropriate conditions. However, these two stations still have to limit factors that affect the productivity of ecotourism activities. This is due to the parameters that are still classified as S3 category, namely the percentage of seagrass cover and also the number of fish species. Another case at station III which has a low ESI percentage value of 47% which is included in the N category (not suitable). Besides the seagrass parameters that affect the percentage of ESI at this station are the percentage of seagrass cover, seagrass type, fish type and substrate type which have grade S3 level (according to conditional). The percentage of seagrass closure is a core parameter because it has a large influence on seagrass ecotourism areas.

While the parameter number of fish species is an important parameter in seagrass ecotourism activities. This is due to these parameters being one of the panoramic objects provided in seagrass ecotourism activities. This object is the main attraction of a marine ecotourism activity, especially seagrass ecotourism.

Furthermore, based on the suitability analysis of seagrass ecotourism, station III is included in the N category (not suitable). Factors influencing the percentage value of suitability at this station are the percentages of seagrass cover, seagrass species and the number of fish species that have a class N level (not suitable). It is suspected that the location of the observation station is still influenced by land and human activities. Besides the seagrass parameters that affect the percentage of value of suitability at this station are the percentage of seagrass cover, seagrass type, fish type and substrate type which have grade S3 level (according to conditional).

The percentage of seagrass cover at the station I and station II successively has a value of 32.7%, station II of 35.2% and station III of 28.1%. In this study the percent seagrass closure at stations I and II was included in the unhealthy category because closure was <59.9% while station III was included in the poor condition category because <29.9% (MNLH 2004).

The percentage of water clarity in all seagrass observation stations is 100%, this value indicates that the waters of Mertasari Beach have a brightness that is very supportive for tourism activities, where tourism activities require good water clarity.

Fish species found in seagrass ecosystems from the three observation stations have several different species. There are 5 species of fish found at station I and II, namely *Amphiprion akindynos, Chrysiptera hemicyanea, Pentapodus porosus, Cheilodipterus parazinatu*, and *Ostorhinchus angustatus*. There were III types of fish at stasion 3 are *Pentapodus porosus, Cheilodipterus parazonatus, Ostorhinchus angstatus*. The number of fish parameters is an important parameter in seagrass ecotourism activities. This is due to these parameters being one of the panoramic objects provided in seagrass ecotourism activities. The result of data analysis of community structure of fish species on the seagrass ecosystem shows that ecologically there is no difference of fish community structure of all locations.

Seagrass species: based on observations of research found there are 8 species of seagrass including *Enhalus acoroides, Cymodocea serrulata, Cymodocea rottundata, Halophila ovalis, Halodule uninervis, Halodule pinifolia, Syringodium isotifolium, and Thalassia hemprichii.*

Types of substrate base of waters of Mertasari beach at stasion I and II is coral sand. Differently, the the station III is dominated by muddy sand. The current velocity of beach in this research areas ranged between 0 – 0.60 m/second. The range of current velocity is very suitable for beach tourism activities. Based on the classification by Dean and Dalrymple (2004), the current velocity in the study areas can be classified into slow currents and fast currents.

The depth obtained from the three observation stations shows that the depth of waters for the existence of the seagrass ecosystem in the study areas ranges from 0 – 1,52 m. The average depth of 1 meter, this means that the waters are included in shallow waters so it is very influential on the safety aspects of tourists. According to Armos (2013) physically, the depth of shallow water is good enough to be used as a recreational object for swimming compared to deep waters.

Regional Carrying Capacity Analysis

An analysis of tourism carrying capacity is needed in an area so that the activity can become a sustainable activity. In this study, the type of marine tourism activities that will be developed in the seagrass ecosystem is snorkeling activities with a carrying capacity of 643 people/day with 500 m^2 per person. Based on PP No.18 / 1994 concerning exploitation of natural tourism in seagrass utilization zones of national parks and nature tourism parks, the area developed was 10% of the area of utilization zones (Yulianda, 2007), the CC value for snorkeling activities at Mertasari Beach as many as 64 people/day.

4. Conclusion

Seagrass ecosystems on Mertasari Beach support ecotourism activities in the area. The research areas are commonly suitable for seagrass ecotourism with regards to the characteristics. This is supported by the discovery of 8 species of seagrass including: *Enhalus acoroides, Cymodocea rottundata, Cymodocea serrulata, Halophila ovalis, Halodule uninervis, Halodule pinifolia, Syringodium isotifolium,* and *Thalassia hemprichii* with cover values ranging from 28-35,2%. The stations that have the potential for seagrass ecotourism activities in the Mertasari beach are found in Station I and Station II with a suitability index of 69%.

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