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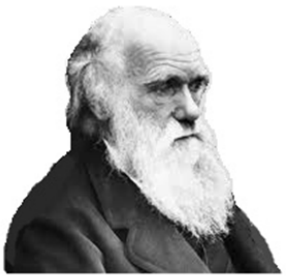

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Seagrass resources as supporting the potential of ecotourism in Menjangan Besar Island, Karimun Islands, Java, Indonesia

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ABSTRACT

This study looks for to determine the biophysical potential of seagrass ecosystems as a support for ecotourism activities on Menjangan Besar Island. By generating ecotourism suitability values as seagrass supports, generating carrying capacity values for seagrass ecotourism areas, and assessing community perception and participation on Menjangan Besar Island, Karimun Islands, Java, on the opportunities for seagrass ecosystem carrying capacity as a support for ecotourism. On Menjangan Besar Island in the Karimun Islands of Java, the research was carried out in April and May of 2017. The observation approach, which involved gathering data in the field and reading relevant literature, was employed in this study. According to Yulianda, 2007, appropriateness is the weight used to assess the suitability of seagrass ecotourism. Seagrass cover, seagrass species, fish species, brightness, temperature, depth, current velocity, substrate type, salinity, infrastructure and facilities, accessibility, and observing the community's reaction are a few of the parameters that have been observed. Following the processing of field survey data using Microsoft Excel 2010 and ArcGIS 10.1, the outcomes were evaluated against regional suitability standards for ecotourism activities in seagrass ecosystems. Menjangan Besar Island is included in the "Compliant" criteria with the computation of values from station 1 to station 4, namely: 64%, 64%, 66%, 66%, based on the results of observations and data processing. The seagrass ecotourism activity area on Menjangan Island has a carrying capacity that is

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large enough to accommodate 113 people per day for snorkeling. The results of perceptions, attitudes, and community participation towards ecotourism activities themselves are that they agree and will participate in ecotourism activities in seagrass ecosystems.

***Keywords*:** Regional Carrying Capacity, Seagrass Ecotourism, Regional Suitability, Karimun Islands

1. INTRODUCTION

Seagrasses are a type of flowering plant classified an Angiosperm that thrives in shallow marine waters and submerges itself in the water column. One of the most prolific marine ecosystems is the seagrass community, which means that it has a high resource potential [1]. Seagrass covers an estimated 30,000 km^2 of land in Indonesia and is found in 13 different species [2]. With at least four families and approximately 12 genera, seagrasses are monocots [3]. A root, stem, leaf, flower, fruit, and seed comprise the morphological structure of this plant [4, 5]. Propagules, a sexually generated fruit, are dispersed by seagrasses to colonize an area [6]. The bulk of seagrasses can only be found below 20 meters in depth, yet seagrass can grow from the intertidal zone to a depth of about 90 meters [7, 8].

Seagrass ecosystems serve as supports in coastal waters that are significantly impacted by processes that take place on land and at sea [9]. The presence of seagrass ecosystems has a significant ecological and biological impact on and dependence on several creatures [10, 11]. In coastal areas, seagrass ecosystems serve as primary producers [12], nutrient recyclers, bottom stabilizers, [13], habitat for biota, a place for spawning, a place for nurturing and foraging for various marine biota [14–18], and it protects the coast from erosion by acting as a wave absorber and trapping sediments [19–22]. The community benefits economically from seagrass beds since they generate fish and serve as a popular tourist destination. The seagrass beds themselves serve a variety of ecological purposes, including: (1) serving as the primary source of primary productivity; (2) providing food for organisms in the form of detritus; (3) stabilizing the water's bottom with roots that can trap sediment; (4) providing shelter for marine life; (5) serving as a spawning ground, nursery ground, and source of food for marine life; (6) protecting the coast by reducing currents; and (7) producing oxygen.

Seagrass beds, one of the more productive shallow-water habitats [23], can store carbon reserves in marine environments [24–27]. The main production of this ecosystem can range from 1400 to 5100 mg C m^2 per day depending on the amount of cover [11]. Seagrass is capable on a pharmaceutical level in addition to its biophysical and ecological potential. The findings indicated that seagrass contained bioactive substances, specifically secondary metabolites, which may be used to create novel medicines, dietary supplements, and nutraceuticals for the treatment of a number of diseases and metabolic disorders [28].

According to [29], tourism is one way that natural resources are used for human enjoyment. Ecotourism, on the other hand, focuses on natural tourism that always preserves the environment. Seagrass conditions in Indonesia have recently been deteriorating due to a number of tourism-related activities, including visitor activities, construction activities, pollution, and others that might impair their function and disturb the ecological balance in the marine environment itself [30]. Based on the findings of monitoring conducted in several nations, it is evident that seagrass ecosystems all over the world are in danger of being harmed by disturbed habitat and decreased area [31, 32]. The author's interest in seagrass ecotourism is sparked by

the existence of tourism-related activities that can harm the ecosystem of seagrasses. In an effort to increase efficiency and improve sustainability and the environment.

In addition to harm to the ecology, one in five species of seagrass are classified as being at high risk of extinction and on the IUCN Red List, according to [33]. Seagrass habitats are facing a lot of pressure to disappear in Indonesia [34, 35]. For instance, the amount of seagrass on Pari Island (one of the Seribu Islands) fell by 25% between 1999 and 2004 [36], possibly as a result of the island's numerous activities. Seagrasses of the *Cymodocea rotundata*, *Thalasia hempricii*, and *Enhalus acoroides* species can be found in the Menjangan Besar region [37]. Many different species of seagrass may be found in the Menjangan Besar area, including sea cucumbers of the type *Holothuria atra*, sponges, amphripoin fish, algae, anemones, and other fish that use the seagrass area as a nursery ground [38]. Seagrass can recover because, in accordance with [39-41], it can recolonize disturbed grasslands thanks to the growth of rhizomes, the availability of seed banks, and rehabilitation activities.

The purpose of this study was to determine the biophysical potential of seagrass ecosystems as a support for ecotourism activities on Menjangan Besar Island, and to determine community perceptions and participation on Menjangan Besar Island, Karimun Islands, Java on the opportunities for carrying capacity of seagrass ecosystems as a support for ecotourism. The usefulness of this research is that it can provide information regarding the suitability of the seagrass ecosystem area as a support for ecotourism in the waters of Menjangan Besar Island so that it can be used as a reference for the government or the community in utilizing seagrass ecosystems as a support for ecotourism locations.

2. MATERIALS AND METHODOLOGY

The research was carried out in the months of April and May 2017, with the initial data gathering process taking place in the waters surrounding Menjangan Besar Island, which is located in the Karimun Islands, Java. To identify seagrass data collection stations using four points that can represent the seagrasses on Menjangan Besar Island for future study. In total, 17 tools were used in this study, including a GPS, an ADS, a roll meter, a raffia rope, a stake, a chest board, stationery, a digital camera, a seagrass identification book, a questionnaire, an ArcMap, a laptop, a secchi disk, a trekking float, a thermometer, and a refractometer. Slate and pure water were the materials employed in this research.

On Menjangan Besar Island in the Karimun Islands, Java, observation stations include seagrass observation stations and oceanographic observation stations. In order to produce data that accurately reflects the state of the seagrass ecosystems in the region, seagrass stations are chosen based on the Menjangan Besar Island area's highest density of seagrass communities. This study took at least 4 stations on Menjangan Besar Island with coordinates namely 5° 52'57.12" LS and 110° 25'9.74" LU for stations 1.5° 53'2.28" LS and 110° 25' 12.42" South Latitude for station 2, 5° 52'53.90" South Latitude and 110°25'36.65" South Latitude for station 3, and the last 5° 52'51.98" South Latitude and 110°25'35.43" North Latitude for station 4.

The three components of primary data gathering are biological data, physical and chemical data, and infrastructure data. biological information, specifically information on Sambangan Besar Island in the Karimun Islands, Java, in order to learn more about the seagrass cover, seagrass species, and fish species there. According to [42].a quadrant transect method

(50 × 50 cm^2) with three line transects was employed to collect data from each station (**Figure 1**) below.

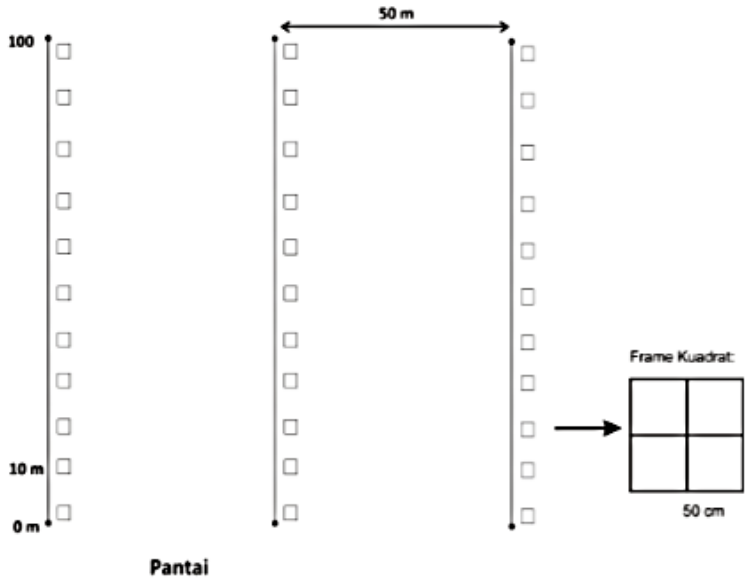

Figure 1. Seagrass Data Retrieval
Source: [42].

Physical and chemical data is data that will support the condition of seagrass ecosystems supporting ecotourism in the waters of Menjangan Besar Island, Karimun Jawa Islands with 5 parameters, namely brightness using a secchi disk, current speed using a trekking float, temperature using a thermometer, type of substrate using a visula, and salinity using a refractometer.

Infrastructure data, namely accessibility data and facilities and infrastructure data to support the ongoing ecotourism activities for tourists seen from the results of primary data on Menjangan Besar Island. Accessibility data, such as good road access, many alternative transportation roads. While the data on suggestions and infrastructure, namely the availability of facilities such as public toilets, clean water, trash cans and the tools needed in seagrass ecotourism [42]. Four phases of data processing will be used to analyze the outcomes of the field data on seagrass.

The final result will be shown as the average percentage of seagrass cover (%) as well as the percentage of each type of seagrass cover, including its composition. The IKW formula, also known as the Tourism Suitability Index, is used to assess the suitability of seagrass tourism. According to [29], the following calculating procedure is utilized:

$$\text{IKW} = \Sigma \left(\frac{Ni}{N\ max}\right) x\ 100\%$$

IKW = Travel Suitability Index.
Ni = parameter value (Weight x Score)
N max = Maximum value of a tourism category

The maximum number of visitors that may physically fit in the place at a given moment without disturbing the environment or other people is the location's carrying capacity, while the following formula is used to determine the area's carrying capacity:

$$DDK = K \times (L_p/L_t) \times (W_t/W_p)$$

K = visitor ecological potential per unit area
Lp = area or length of area that can be utilized
Lt = Area unit for a certain category
Wt = Time provided by the area for tourism activities in one day
Wp = Time spent by visitors for each particular activity

With the help of a Likert scale, social data is used to gauge how the community feels about the growth of seagrass ecotourism [29]. Respondents will use the Likert scale, which is divided into 5 point options, to provide their responses to questions that have been modified to ascertain how the community on Menjangan Besar Island, Karimun Islands, Java, perceives and participates in the opportunities for the carrying capacity of seagrass ecosystems as a support for ecotourism.

3. RESULTS AND DISCUSSION

In the Karimun Jawa archipelago, Menjangan Besar Island is the southernmost island that can be reached in 15 minutes by boat taxi from Karimun Jawa Island. The Menjangan Besar Island region's natural beauty is enhanced by its accessibility, the presence of sharks kept in captivity, turtle egg hatcheries, and healthy coastal ecosystems [37]. Results of the measurements (**Table 1**) below of the physical parameters made on Menjangan Besar Island are as follows:

Table 1. Physical and Chemical Parameter Data

Station	Waters Condition					
	Substrate	Depth (m)	Brightness (%)	Current Velocity (cm/s)	Temperature (°C)	Salinity (ppt)
1	Sand	1.25	100	1,667	31	32
2	Sand	1.37	100	1,667	31	32
3	Coral Sandy	1.42	100	1,667	32	31
4	Coral sandy	1.52	100	1,667	32	31

According to the table above, coral sand is preferable to smaller-sized substrates like clay for usage as a site for tourism activities. Only if there are several activities performed on the

mud substrate will it quickly become cloud. The fact that these waters are still in the 1 m depth category despite their depth indicates that they are shallow waters. Because the results of the measurements are 100% at each station, the percent brightness in these waters is quite good. In addition, this is because the types of substrate that dominate the 4 stations are sand and rocky sand, and there is no type of easily turbid mud substrate found at the location so that it does not interfere with light entering to the bottom.

When the water is at high tide, the current speed is calculated. This calm current speed is a result of Menjangan Besar Island's location, which is flanked by Menjangan Kecil Island and Karimun Jawa Island. Even if each station's temperature is higher than the maximum temperature for optimum growth, the variation in the findings of the temperature data at stations 1, 2, 3, and 4 is just 1 °C, which is still within the tolerance level. When compared to temperate or subtropical climates, tropical climates have higher salinities because of evaporation and precipitation [43].

Seagrass data collection on Menjangan Besar Island is divided into 4 stations on the north side. Six species of seagrass were found, namely *Enhalus acoroides* (EA), *Thalassia hempricii* (TH), *Cymodocea rotundata* (CR), *Cymodocea serrulata* (CS), *Halophila ovalis* (HO), and *Syngrodium isoetifolium* (SI). At the 4 stations taken there were 4 different seagrass cover average values (**Table 2**) below.

Table 2. Results of Seagrass Data Retrieval

Station	Domination Seagrass Species (%)						Average in station
	EA	CS	CR	TH	HO	SI	
1	11.4	13.4	8.3	4.3	0.4	0	30.9
2	1.04	6.18	18.2	2.1	0	0	28.2
3	9.93	10.6	6.46	1.6	0.8	2.4	29.8
4	9.8	15.7	15.7	0	0.3	0.1	26.6
Average	8.0	11.5	12.2	2	0.4	0.6	28.9

The diversity of species that grow in the area is influenced by the quality of the waters. The higher the value of the diversity index of a waters, the lower the level of pollution. Meanwhile, the horizontal spread of seagrass is influenced by the characteristics of the substrate and the conditions of water movement [43, 44].

The map (**Figure 2**) above is a map showing the results of seagrass cover on Menjangan Besar Island.

From the results of data collection in the field (**Table 2**) above, it was found that the average value per station was 30.9% for station 1, 28.2% for station 2, 29.8% for station 3, and 26.6% for station 4. From the results of the 4 stations taken the cover of the existing seagrass ecosystem was included in the medium category [42].

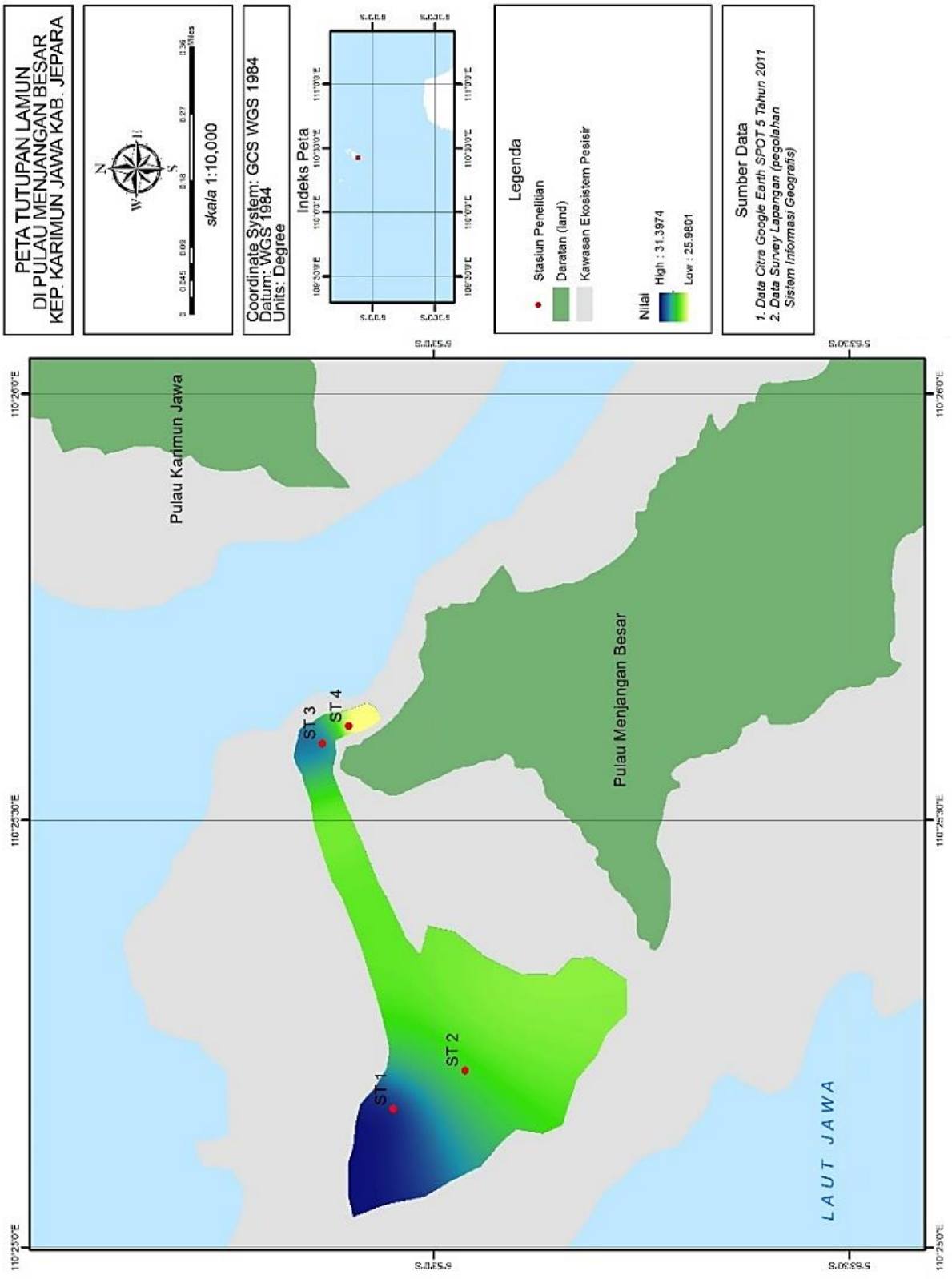

Figure 2. Seagrass Cover Map

Table 3. Travel Suitability Index

No	Parameter	Station 1		Station 2		Station 3		Station 4	
		Result	Value	Result	Value	Result	Value	Result	Value
1	Seagrass cover	30.9	5	28.19	5	29.8	5	26.6	5
2	Water Brightness	100	9	100	9	100	9	100	9
3	Fish type	5	3	5	3	5	3	5	3
4	Seagrass species	5 species on domi nation CS	9	4 species on domi nation	9	6 species on domi nation CS	9	6 species on domi nation CS	9
5	Substrate type	Sand	2	Sand	2	Coral sandy	3	Coral sandy	3
6	Current Speed (cm/s)	1.667	3	1.667	3	1.667	3	1.667	3
7	Seagrass depth (m)	1.25	3	1.37	3	1.42	3	1.52	3
8	Accesibility	Road, Transportation	2	Road, Transportation	2	Road, Transportation	2	Road, Transportation	2
9	Facility and infrastructure	Toilet, Near the main island	2	Toilet, Near the main island	2	Toilet, Near the main island	2	Toilet, Near the main island	2
IKW value		64%		64%		66%		66%	
Category		S2		S2		S2		S2	

Based on (**Table 3**) above, the results of land suitability calculations for seagrass ecosystems as a support for ecotourism activities, it was found that the value of each station was 64% for stations 1 and 2, 66% for stations 3 and 4, value 50% - < 83% [29]. This can be used as a recommendation as an ecotourism area with seagrass ecosystems as a support, taking into account the ecological conditions of the seagrass resources. The S2 category has the

meaning of maintaining seagrass ecosystems around the area before using it as a place for ecotourism activities. Compared to other stations, station 1's seagrass cover had the best result, reaching in at 30.9 %. The results are nearly identical for fish kind and water brightness. Though there were six different species of seagrass present and *Cymodocea serrulata* (CS) predominated at these four places, the seagrass species at stations 3 and 4 had the maximum yield. Regarding the substrate, there are differences at stations 1 and 2, where it is sandy coral, and at stations 3 and 4. Station 4's depth level of 1.52 is the ideal one. Regarding infrastructure, facilities, and accessibility, the remaining factors are equal. Because it can be reached by roads and there is transit, all four stations receive the same score for accessibility, which is 2. Due to its accessibility from the main island and the presence of toilets, facilities, and infrastructure receive the same score, namely 2. But at stations 1 and 2, the IKW value is 64%, while at stations 3 and 4, it is 66%. But it can be argued that these four stations are S2 suitable. The land suitability value map can be seen as below (**Figure 3**).

The similarity of categories obtained from each station does not guarantee that the value of each parameter belonging to each station is the same. The size of the value obtained is adjusted to the weight of the parameter whose value you want to calculate. In this study I used 9 parameters, namely seagrass cover, water brightness, fish species, seagrass species, substrate type, current velocity, depth, accessibility, facilities and infrastructure [29]. The stability of the ecosystem, the structure of the food chain, the kind of sediment, and organism competition are all factors that affect species diversity [45, 46–47]. It is challenging to characterize these aspects since they are variables whose intricacy interacts with one another.

Analysis of tourism carrying capacity is needed by an area so that these activities can become sustainable activities. The value of the carrying capacity of the area will be different in each place depending on the type and number of activities that can be carried out in that area. In this study, the types of ecotourism activities in the seagrass ecosystem of Menjangan Besar Island, Karimun Jawa islands that can be carried out are snorkeling activities. The carrying capacity value obtained in this study was 1,137 people/day with 500 m^2 per person, because the area of the seagrass ecosystem on Menjangan Besar Island is 28.44 hectares.

According to PP No. 18/1994 concerning the exploitation of natural tourism in the utilization zones of National Parks and natural tourism parks, the value of the carrying capacity of the area is only taken 10% of the original value so that from the field data, the value of the carrying capacity of the utilization that can be used on Menjangan Besar Island is as many as 113 people / day. Indonesia is a country rich in marine resources, with approximately two-thirds of its territory surrounded by water [48].

Seeing the responses from respondents about seagrass itself is agreeing that the seagrass ecosystem is an important thing in the ocean and its use will not harm the local people. The evaluation of coastal landscapes is a crucial factor in aerial comparisons since they are a valuable resource. To identify and filter the key features, the ecosystem's activities and resources were utilised [48].

According to the community, ecotourism activities are activities that benefit the community without destroying the environment itself. Public awareness must be raised about the value of biodiversity as a natural resource, its involvement in ecological processes, and its bearing on social and cultural issues. Additionally, this makes it easier to create conservation strategies. The idea of sustainable development specifically secures the accessibility of biological resources [48-50].

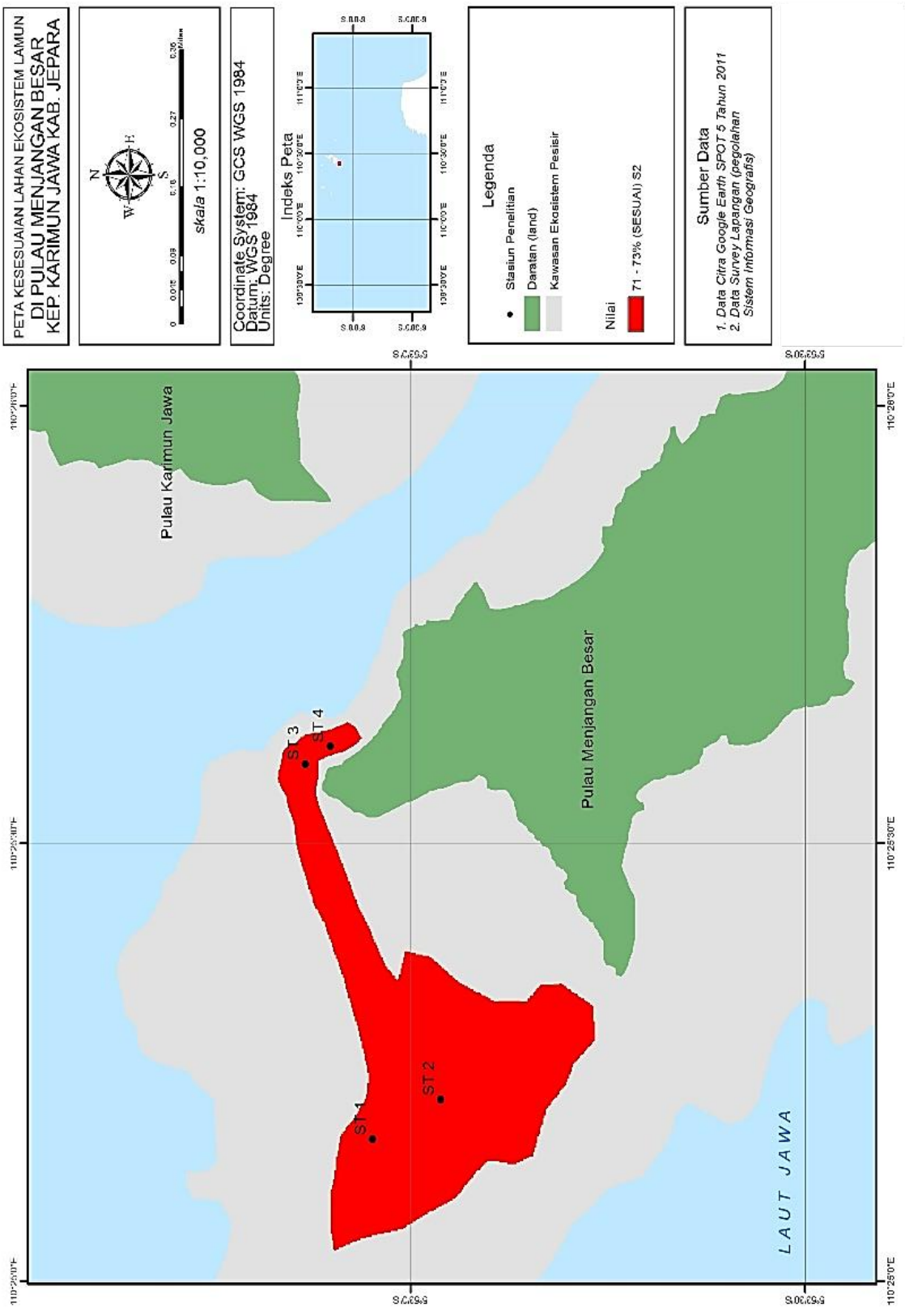

Figure 3. Seagrass Ecotourism Suitability Map

For example, by developing ecotourism activities with seagrass as a support for the economy of the community itself, it will increase due to increased employment opportunities for the community without destroying the beauty of the seagrass ecosystem itself [51-73].

4. CONCLUSIONS

Based on the results of field research conducted on Menjangan Besar Island, Karimunjawa, it can be concluded that 6 species of seagrass were found, namely *Enhalus acoroides* (EA), *Thalassia hempricii* (TH), *Cymodocea rotundata* (CR), *Cymodocea serrulata* (CS), *Halophila ovalis* (HO), and *Syngrodium isoetifolium* (SI) with a cover range at each station of 26-30% which is included in the medium category.

The value of the suitability of seagrass ecosystem tourism as a support for ecotourism activities at 4 stations on Menjangan Besar Island, Karimun Jawa Islands is included in the S2 category, which is appropriate. With the value of each station, namely 64% for stations 1 and 2, 66% for stations 3 and 4. The suitability criteria for seagrass tourism are suitable/very suitable for developing seagrass tourism activities including: snorkeling, seagrass education and seagrass ecotourism with an area of 28.44 hectares. With the value of the area's carrying capacity of 113 people / day with a good response from the community as a provider of tourism activities.

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