Suitability of ecotourism in Tunda Island Serang Regency
Banten Province, Indonesia

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Abstract. The highest tourism frequency at Tunda Island is provided a positive effect on community livelihood, but the activities of tourism behaviour are not environmentally friendly which would affect nature and also can make habitat degradation in the coastal area. There was no specific research until now regarding the condition of suitable marine tourism in Tunda Islands as ecotourism areas. This research aims to analyze the suitability aquatic area to plan an ecotourism area in Tunda Island, Serang Regency. The research method used a purposive sampling method and it was conducted in July to September 2019. The results obtained showed that the highest suitability index on coastal tourism potentials (recreation) was 76.2% (very suitable), mangrove tracking was 12.8% (unsuitable), snorkeling tourism was 54.4% (suitable), and dolphin watching was 57.6% (suitable). Tunda Island has developed potential tourism that is promising, but it still needs some infrastructure procurement and facility improvement to support tourism activities. The ecotourism potential has a high sell point but its poor data is in dolphin watching. It would be temporal data with at least one-year sampling by carrying out the sampling for every month.

1. Introduction
Ecotourism is an economic activity based on the preservation of ecological functions and services as amenity services. [1] defined marine ecotourism as ecotourism that utilizes the character of coastal and marine resources. Marine ecotourism activities can be water-based, land-based, or a combination of them which includes observation of marine life, diving, snorkeling, seabed observation trips, also coastal and beach walks [2]. Utilization of coastal areas certainly requires a form of sustainable development and management in which efforts to develop a small island area as a marine ecotourism location require circumspection because of its unique nature. Planning and management require coordination and integration of some elements by referring to conditions concerning the ecological, suitability, carrying capacity, and socio-cultural aspects of the community [3].

Regarding Serang Regency from 2013-2033 (Regional Regulation of Serang Regency No. 2/2013; [4]) about zonation some areas and small islands, this research location is included one of marine tourism zone programs. Serang Regency has 17 small islands with one of the planned programs of the development of marine tourism. Several islands that are described in Regional Regulation of Serang Regency No. 2/2013 article 56, point i.2. include Pamujan Kecil Island, Pamujan Besar Island, Pisang Island, and Lima Island, Sangiang Island, Panjang Island, and Tunda Island, North Pulokali, and South Kalih Island as maritime tourism beaches (white sand beaches, diving, and snorkeling), fishing-sport, for families and special interests.

Tunda Island in administration is included in Wargasara Village, Serang District, it can see in Figure 1. Tunda Island is very unique because this island has only 1 village with its unique community characteristics and this area is physically almost surrounded by white sand and flat reefs which allow visitors to carry out marine activities, such as snorkeling, diving, fishing, sports, and relaxing or
recreation on the beach [5]. Geologically, the Tunda Island area is a volcanic island formed from frozen lava deposits. Based on the area of change in depth, the topography or depth in the waters of this island is included in the continental shelf, which is the sloping topography that is directly adjacent to the land which has a width of 50-70 km and a depth of not more than 200 m [6, 7]. The water seabed of Tunda Island has a fairly high slope. The slope is a measure of the slope of the seabed every time there is a change or size of the slope of the seabed cliffs in degrees. The morphological condition of the beach is sandy and there is mangrove vegetation in the eastern and southern parts of the island with a beach area of 7 kilometers.

Observing the various tourism activities on Tunda Island and considering that coastal and marine ecotourism activities usually have specific characteristics such as regarding their location which is not very wide and their unique various types of tourism activities, scientific information is needed to develop coastal and marine tourism activities on Tunda Island with the concept of ecotourism. This study was conducted to analyze the suitable aquatic area for the ecotourism area in Tunda Island, Serang Regency. The expected result is the resulting area suitability, carrying capacity, and stakeholder perceptions that are interesting to study for the sustainable use of Tunda Island’s resources. Carrying capacity is the area's ability to receive visitors who are present in a unit of time, so that is comfortable and safe and the area remains sustainable and protected [8]. The area is known to be able to maintain the sustainability of coral reef ecosystems without sustaining damage.

2. Material and methods
2.1. Time and location
This research activity was conducted from July to September 2019. The location of this research was on Tunda Island, Serang Regency, Banten Province (see Figure 1). Sample analysis and data processing were carried out at the Laboratory of the Research Center for Fish Resources Recovery in Purwakarta, West Java, and the Laboratory of Aquaculture (BDP), Sultan Ageng Tirtayasa University, Serang, Banten. The determination of stations to represent each area used a purposive sampling method. The measurement data obtained directly from the field (in-situ) were represented by aesthetic data in the form of photos and beach slopes. [9] explained that purposive sampling is a technique of taking a sample of data sources with certain considerations. This particular consideration is, for example, the person is considered to understand best about what we expect.

The types of data collected were primary and secondary data. The primary data were data obtained directly through surveys, observations, and direct interviews with village communities, tourists, and related stakeholders in the field. The secondary data were data obtained from literature review at related agencies or instances in Serang Regency, Banten Province, in the form of reports and publications, such as those collected from the Wargasara Village Government, the Tirtayasa District Office, Regency and Provincial Statistics Agency, and the Department of Marine and Fisheries. The type of data required, the method of data collection, the tools and materials used in this study are as shown in Table 1.
Table 1. Methods, tools, and materials for research observation

| Tourism Type        | Parameter          | Method    | Tools and Materials          |
|---------------------|--------------------|-----------|------------------------------|
| A. Coastal recreation| 1. Depth (m)       | In-situ   | Deep meter                   |
|                     | 2. Beach type      | In-situ   | Observation                  |
|                     | 3. Beach width (m) | In-situ   | Roll meter                   |
|                     | 4. Water base material | In-situ | Visual                       |
|                     | 5. Water current (m/second) | In-situ | Current meter                |
|                     | 6. Beach slope (°) | In-situ   | Laser distance meter         |
|                     | 7. Dangerous biota | In-situ   | Visual                       |
| B. Mangrove tourism | 1. Thickness (m)   | In-situ   | Laser distance meter         |
|                     | 2. Density (100 m²) | In-situ   | Transect at 10 x 10 m        |
|                     | 3. Composition     | In-situ   | Transect at 10 x 10 m        |
|                     | 4. Biota objects   | In-situ   | Transect at 10 x 10 m        |
| C. Snorkeling       | 1. Water depth (m) | In-situ   | Deep meter                   |
|                     | 2. Health status of coral reef | UVC     | Underwater Photo Transect    |
|                     | 3. Fish reef community structure | UVC     | Belt Transect at 250 m²      |

2.2. Data analysis

2.2.1. Analysis of the suitability index for coastal tourism in the recreation category

Suitability for coastal tourism in the recreation category considers several parameters, including water depth, beach type, beach width, water base material, current velocity, beach slope, water transparency, coastal land cover, hazardous biota, and availability of freshwater as shown in Table 2. The analysis of the suitability for coastal tourism in the recreation category used a formula that refers to [1] as follows:

\[
IKW = \sum \frac{N_i}{N_{\text{max}}} \times 100 \%
\]

Notes:
IKW = Tourism suitability index
\(N_i\) = i-parameter value (weight “x” score)
\(N_{\text{max}}\) = Maximum value of a tourism category
The percentage value of the suitability index is classified into three categories, consisting of very suitable (75% < IKW < 100%), suitable (50% < IKW < suitable 75%), and not suitable (IKW < 50%). The weights and scores obtained from the suitability matrix for coastal tourism in the recreation category can be seen in Table 2.

### Table 2. The matrix of suitability for coastal tourism in the recreation category

| No. | Parameter                | Weight | Category                        | Score |
|-----|--------------------------|--------|---------------------------------|-------|
| 1.  | Water depth (m)          | 5      | 0 - 3                           | 3     |
|     |                          |        | > 3 - 6                         | 2     |
|     |                          |        | > 6 - 10                        | 1     |
|     |                          |        | > 10                            | 0     |
| 2.  | Beach type               | 5      | White sand                      | 3     |
|     |                          |        | White sand mixed little corals   | 2     |
|     |                          |        | Black sand, rocky, a little steep| 1     |
|     |                          |        | Muddy, rocky, steep             | 0     |
| 3.  | Beach width (m)          | 5      | > 15                            | 3     |
|     |                          |        | 10 - 15                         | 2     |
|     |                          |        | 3 < 10                          | 1     |
|     |                          |        | > 3                             | 0     |
| 4.  | Water base material      | 3      | Sandy                           | 3     |
|     |                          |        | Sandy coral                     | 2     |
|     |                          |        | Muddy sand                      | 1     |
|     |                          |        | Muddy                           | 0     |
| 5.  | Beach slope (°)          | 3      | < 10                            | 3     |
|     |                          |        | 10 - 25                         | 2     |
|     |                          |        | > 25 - 45                       | 1     |
|     |                          |        | > 45                            | 0     |
| 6.  | Water transparency (%)   | 1      | > 80                            | 3     |
|     |                          |        | > 50 - 80                       | 2     |
|     |                          |        | 20 - 50                         | 1     |
|     |                          |        | < 20                            | 0     |
| 7.  | Coastal land cover       | 1      | Coconut, open land              | 3     |
|     |                          |        | Shrub, scrub, low, savanna      | 2     |
|     |                          |        | High scrub                      | 1     |
|     |                          |        | Mangrove forests, settlements, ports| 0    |
| 8.  | Hazardous biota          | 1      | Not found                       | 3     |
|     |                          |        | Sea urchins                     | 2     |
|     |                          |        | Sea urchins, stingrays          | 1     |
|     |                          |        | Sea urchins, stingrays, lionfish, sharks| 0    |

Source: modified from [10].

Notes:
* Maximum score = 90
S1 = Very suitable, with an IKW of 75 - 100%
S2 = Suitable, with an IKW of 50 - 75%
TS = Not suitable, with an IKW of <50%

2.2.2. Analysis of the suitability index for mangrove tourism
Suitability in mangrove tourism considers several parameters, including mangrove thickness, mangrove density, mangrove composition, and biota objects which can be seen Table 3.
Table 3. Suitability matrix for mangrove tourism category

| No. | Parameter                            | Weight | Category     | Score |
|-----|--------------------------------------|--------|--------------|-------|
| 1.  | Mangrove thickness (m)               | 5      | > 500        | 3     |
|     |                                      |        | > 200 - 500  | 2     |
|     |                                      |        | 50 - 200     | 1     |
|     |                                      |        | < 50         | 0     |
| 2.  | Mangrove density (100 m²)            | 3      | > 15 - 20    | 3     |
|     |                                      |        | > 10 - 15; > 20 | 2  |
|     |                                      |        | 5 - 10       | 1     |
|     |                                      |        | < 5          | 0     |
| 3.  | Mangrove composition                 | 3      | > 5          | 3     |
|     |                                      |        | 3 - 5        | 2     |
|     |                                      |        | 2 - 1        | 1     |
|     |                                      |        | 0            | 0     |
| 4.  | Biota objects                        | 1      | Fish, shrimp, crab, molluscs, reptiles, birds | 3 |
|     |                                      |        | Fish, shrimp, crab, molluscs | 2 |
|     |                                      |        | Fish, molluscs | 1 |
|     |                                      |        | One of the aquatic biota | 0 |

Source: modified from [11].

Notes:
Maximum score = 39
Suitable = 75-100%
Suitable with conditions = 50-<75%
Not suitable = <50%

2.2.3. Analysis of the suitability index for marine tourism in the snorkeling category

The suitability for marine tourism in the snorkeling category considers several parameters, including water transparency, coral community cover, type of lifeform, reef fish species, current velocity, depth of coral reefs, and reef flat width shown in Table 4.

Table 4. The suitability matrix of the ecotourism area for the snorkeling category

| No. | Parameter                | Weight | Category     | Score |
|-----|--------------------------|--------|--------------|-------|
| 1.  | Transparency (%)         | 5      | 100          | 3     |
|     |                          |        | 80 - < 100   | 2     |
|     |                          |        | 20 - < 80    | 1     |
|     |                          |        | < 20         | 0     |
| 2.  | Health of reef (%)       | 5      | > 75         | 3     |
|     |                          |        | > 50 - 75    | 2     |
|     |                          |        | 25 - 50      | 1     |
|     |                          |        | < 25         | 0     |
| 3.  | Type of lifeform         | 3      | > 12         | 3     |
|     |                          |        | < 7 - 12     | 2     |
|     |                          |        | 7 - 4        | 1     |
|     |                          |        | < 4          | 0     |
| 4.  | Reef fish species        | 3      | > 50         | 3     |
|     |                          |        | 30 - 50      | 2     |
|     |                          |        | 10 - < 30    | 1     |
|     |                          |        | < 10         | 0     |
| 5.  | Depth of reef area (m)   | 1      | > 3 - 6      | 3     |
|     |                          |        | > 1 - 3      | 2     |
| No. | Parameter                  | Weight | Category       | Score |
|-----|----------------------------|--------|----------------|-------|
| 6.  | Reef flat width (m)        | 1      | > 500          | 3     |
|     |                            |        | 100 - 500      | 2     |
|     |                            |        | 20 - 100       | 1     |
|     |                            |        | < 20           | 0     |

Source: modified from [11].
Notes:
* Maximum score = 57
S1  = Very suitable, with an IKW of 75 - 100%
S2  = Suitable, with an IKW of 50 - <75%
TS  = Not suitable, with an IKW of < 50%

### 2.2.4. Analysis of the carrying capacity of ecotourism

Carrying capacity analysis is carried out after the results of the suitability analysis are obtained as the basis for determining the carrying capacity. The carrying capacity analysis aims to determine the width and the capacity of a tourist area because it is easily damaged and has limited utilization space [24]. The formula used in the carrying capacity analysis refers to [1] and [11] as follows:

$$DDK = K \times \left( \frac{Lp}{Lt} \right) \times \left[ \frac{Wt}{Wp} \right]$$

Notes:
DDK  = Carrying capacity of the area
K  = Maximum ecological potential of visitors per unit area
Lp  = Area or length of the area that can be used
Lt  = Unit area for a certain category
Wt  = Time provided by an area for tourist activities in one day
Wp  = Time spent by visitors for any particular activity

The ecological potential of visitors is calculated based on the area used for activities and in which nature is still able to tolerate the presence of visitors. The ecological potential of visitors is determined by the condition of the resources and the types of activities carried out [6] as shown in Table 5.

| Type of Activity       | Σ visitors (K) | Unit Area (Lt) | Notes                                    |
|------------------------|----------------|----------------|------------------------------------------|
| A. Coastal Recreation  | 1              | 50 m           | 1 person for every 50 m of the coastline  |
| B. Mangrove Tourism    | 1              | 50 m           | Calculated by the track length, each person for every 50 m |
| C. Snorkeling-Diving   | 1              | 500 m          | Each person in 100 m x 5 m               |

Source: modified from [1] and [11]

The activity time of visitors (Wp) is calculated based on the duration of time spent by visitors to carry out tourism activities. The activity time of visitors is calculated with the time provided for the area (Wt) which is shown in Table 6. Area time is the length of time the area is opened in one day, and the average working time is around 8 hours (08.00-16.00).
Table 6. The ecological potential of visitors and time required

| Area   | Activity             | Time required Wp-(hour) | Total time of 1 Wt-day (hour) |
|--------|----------------------|-------------------------|------------------------------|
| 50 m   | Beach Recreation     | 3                       | 6                            |
| 50 m   | Mangrove Tourism     | 2                       | 8                            |
| 500 m  | Snorkeling-Diving    | 3                       | 6                            |

Source: modified from [1] and [11]

3. Results and Discussion

3.1. Suitability index for coastal recreational tourism

The analysis of the suitability of the Tunda Island beach which was intended for coastal tourism in the recreation category was measured based on parameters of water depth, beach type, beach width, water base material, current velocity, beach slope, water transparency, coastal land cover, hazardous biota, and water availability. The results of the measurement at the location were analyzed for suitability by weighting and scoring based on water quality and coastal area parameters. The water depth at the three stations ranged from 0.23-0.30 m (see Table 7). This depth was included in the most suitable coastal tourism suitability matrix. Depth is one of the factors that is considered important for visitors to do recreational activities and swimming because these activities are not only carried out by adults but also by children [10]. Beach type is an aspect that has an important value in coastal tourism because it can determine the comfort of visitors. The results of visual observations at the three stations showed that the beach type was white sandy with few corals, but this type of beach could still be tolerated by visitors for the convenience of tourism in the recreation category.

The results of the measurement of the beach width at the three stations were 7-9.5 m (see Table 7). This result indicated that it was not wide enough for coastal tourism because a wide coast will be suitable for coastal recreation so that visitors can relax. The water/substrate base material is one of the factors that can determine the water transparency. This visual observation showed the water base material which was sandy corals, which were quite suitable for coastal recreation tourism. The white water/substrate base material was very suitable for recreational tourism and swimming [11].

Table 7. Suitability index for coastal recreational tourism

| Parameters          | St 1     | St 2     | St 3     | Value | Score | Quality | Sum |
|---------------------|----------|----------|----------|-------|-------|---------|-----|
| Depth (m)           | 0.23     | 0.24     | 0.30     | 0.26  | 3     | 5       | 15  |
| Beach type          | White    | White    | White    |       |       |         |     |
|                     | sand     | sand     | sand     |       |       |         |     |
|                     | beaches, | beaches, | beaches, |       |       |         |     |
|                     | a few    | a few    | a few    |       |       |         |     |
|                     | coral    | coral    | coral    |       |       |         |     |
| Beach width (m)     | 7        | 9.5      | 7        | 7.83  | 1     | 5       | 5   |
| Substrate           |          |          |          |       |       |         |     |
| Coral and           | Coral    | Coral    | Coral    |       |       |         |     |
| rubble mixed with   | and      | and      | and      |       |       |         |     |
| sand                | rubble   | rubble   | rubble   |       |       |         |     |
| mixed with sand     | mixed    | mixed    | mixed    |       |       |         |     |
| Current (m/second)  | 0.13     | 0.15     | 0.17     | 0.15  | 3     | 3       | 9   |
| Beach slope(°)      | 8.2      | 7.2      | 11.95    | 9.12  | 3     | 3       | 9   |
| Water transparency  | 100      | 100      | 100      | 100   | 3     | 1       | 3   |
| Parameters                | St 1                      | St 2                      | St 3                      | Value                                      | Score | Quality | Sum |
|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------------------------|-------|---------|-----|
| Coastal Land Cover        | Waru, Ketapang            | Waru, Sea pandanus, coconut | Waru, Ketapang            | Waru, Ketapang, Sea pandanus, coconut,     |       |         |     |
| The dangerous organism    | Not Found                 | Not Found                 | Not Found                 | Not Found                                 |       |         |     |
| Availability of water     | >500 m                    | >500 m                    | >500 m                    | >500                                       | 2     | 1       | 2   |
| Total                     |                           |                           |                           |                                            |       |         | 64  |
| IKW                       |                           |                           |                           |                                            |       | 76.2%   |     |
| Suitable category         |                           |                           |                           |                                            |       | S1      |     |

The beach slope on Tunda Island is 9.12 degrees which are still in the suitable category because a beach slope of fewer than 10 degrees is considered the most suitable for coastal tourism, while a beach slope of more than 45 degrees is considered not suitable for coastal tourism because it is considered steep [5]. The water transparency measurement showed a result of 100%. Because of the shallow depth, the instrument for measuring the transparency could reach the bottom. Water transparency is a condition that indicates the ability of light to penetrate the water layer at a certain depth [13].

The coastal land cover of Tunda Island is Waru (*Hibiscus similis*), Ketapang (*Terminalia catappa*), sea pandanus, and coconut trees. Coastal land cover is a secondary factor in coastal tourism activities. Land cover that is included in the good category for tourism activities includes coconut trees and open land [14].

Observation of hazardous biota is important to determine the existence of biota that can endanger, disturb, and reduce the comfort of visitors. The results of visual observations on Tunda Island did not find any hazardous biota. The availability of freshwater is > 500 m from the beach location on Tunda Island so it is not suitable because coastal tourism requires that the freshwater source on the beach is sufficient and not far away, which is < 1 km [24]. The results of the suitability analysis at the three stations/observation areas showed that the suitability level was very good (very suitable/S1). The total weighting and scoring on each parameter from the three stations obtained the result of 64 or with the tourism suitability index (IKW) value of 76.2% (see Table 7).

Tunda Island has a seabed in shallow waters that are transverse with a vertical length or distance from the mainland to the edge or cliff, which varies widely from up to 75 m [15]. Tunda Island also has natural potential in the form of quite a wide sea and coastline with white sand, the beauty of underwater biota with various species of ornamental fish, coral reefs and seagrass, and there is a mangrove forest in the eastern part of the village which some of its potentials has not been introduced as ecotourism marine for tourists [16].

### 3.2. Suitability index for mangrove tourism

Tunda Island has mangrove forests that have the potential to be developed into mangrove tourism activities if the potential resources and environment in the mangrove forest area are optimized. Mangrove forests that will become tourist attractions must take into account ecology as a basis for consideration. Ecological assets completed with integrated planning with significant considerations can provide benefits in ecological, aesthetic, and economic forms [17]. The suitability index for mangrove tourism is the tourism suitability analysis used to determine whether the mangrove forest on Tunda Island can be used as a tourism place or not. The suitability of mangrove tourism considers five
parameters with four assessment classifications. The suitability parameters for mangrove tourism include mangrove thickness, mangrove density, mangrove composition, and biota objects.

Mangrove thickness is a parameter that weights 5 in the suitability level for mangrove tourism because it will have a major effect on visitor satisfaction. The thickness of the mangroves measured on Tunda Island from three stations ranged from 4.86-5.8 m. The results of the mangrove thickness are still far to be considered as suitable for mangrove tourism because they are included in the not suitable category. The mangrove forest on Tunda Island needs a replication effort in the mangrove ecotourism development area so that the mangrove thickness can meet the very suitable criteria for a good tourism area based on the tourism suitability index [18].

### Table 8. Suitability index for mangrove tourism

| Parameter                     | Explanation         | St 1  | St 2  | St 3  | Value | Score | Quality | Sum |
|-------------------------------|---------------------|-------|-------|-------|-------|-------|---------|------|
| Mangrove thickness (m)        |                     | 4.86  | 5.76  | 5.80  | 5.48  | 0     | 5       | 0    |
| Mangrove density (100 m²)     |                     | 0.10  | 0.12  | 0.14  | 0.12  | 0     | 3       | 0    |
| Mangrove composition          |                     | 1     | 1     | 1     | 1     | 1     | 3       | 3    |
| Organisms                     |                     | Fish, Crab, Molluscs | Fish and Crab, Molluscs | Fish, Crab, Molluscs | 2     | 1     | 2      |      |
| **Total**                     |                     |       |       |       |       |       | 5       |      |
| IKW                           |                     |       |       |       |       |       | 12.8%   | TS   |

The results of the analysis of mangrove density and mangrove composition obtained weight of 3 in the level of suitability, in which this parameter added to the beauty enjoyed by visitors. The measurement results showed that the mangrove density on Tunda Island was not very suitable because it obtained a score of 0.10-0.14 ind/100 m², which can be seen in Table 8. The number of mangrove composition found at the time of observation at three stations was only one species, which was Rhizophora mucronata which has branched roots and low thickness and density, so it is still not suitable for tourism. The value of species diversity that is above 2 in a mangrove ecosystem can be considered as a potential that can provide species diversity [19].

The suitability analysis for mangrove tourism on Tunda Island has a Tourism Suitability Index (IKW) value of 12.8% in not suitable category (TS). This category showed that the mangrove forest on Tunda Island was not suitable for tourism activities so that intensive action was needed for further management. This is in line with [27] that it is necessary to have mangrove nurseries and planting, as an approach to developing this area with a broad concept of sustainability in the utilization of coastal ecosystems and increasing the types of activities in mangrove tourism. Mangrove ecotourism development activities on Tunda Island are an effective alternative to tackling environmental problems and can open up economic opportunities for communities around the area [20].

#### 3.3. Suitability index for snorkeling tourism

The suitability for snorkeling tourism is influenced by the condition of the coral and fish communities that are associated in one ecosystem. Visitors who do snorkeling activities expect that the location to be seen promises an interesting and memorable underwater view. The level of suitability of tourism on Tunda Island for marine tourism in the snorkeling category is measured based on parameters of water transparency, coral community cover, type of lifeform, reef fish species, current velocity, depth of coral reef, and reef flat width. The measurement results from the six stations will be analyzed for suitability by weighting and scoring regarded on some importance parameters.
Parameters of water transparency and coral community cover had a weight value of 5 on the suitability level for snorkeling tourism. The results of measuring the water transparency at the six stations obtained a percentage of 100%, indicating that the transparency is very suitable for snorkeling tourism. The percentage of coral community cover obtained ranged from 8.3-44.9%. This percentage indicated that the coral community cover was not suitable for snorkeling due to the small cover of the coral community at each measurement station. Differences in coral reef cover can be caused because a location is protected from currents and waves [21].

The types of lifeforms and reef fish species are important because they attract visitors. Parameters for the type of lifeform and reef fish species had a weight value of 3. The observation at the locations showed that there were 2-3 types of lifeforms available. Based on these data, the coral ecosystem on Tunda Island showed that it was not suitable for snorkeling tourism because various types of lifeform are needed as they can be enjoyed under the sea [4]. The results of the suitability analysis of coral growth (lifeform) for diving tourism in the eastern area of Kunyit Island were included in the quite suitable (S2) category with a percentage of 100%. This is due to the number of coral lifeforms at all station points for diving tourism ranged from 9 to 11 of coral lifeforms [22].

The type of coral lifeform is also important to determine in marine tourism. This is in line with the statement from [23] who explained that the type of coral lifeform in marine tourism is needed as a variation that can be enjoyed under the sea. Several types of corals have a function as a home for fish and other biotas, becoming a special attraction for visitors who do snorkeling activities. Based on observations, the reef fish species in the location showed that there was a range of 9-13 species. This showed that they were still not suitable because of the suitability level of the number of reef fish species for tourism activities (see Table 9). The more diverse reef fish species from the indicator group, the higher the level of coral fertility [24].

| Parameters                          | I    | II   | III  | IV   | V    | VI   | Score | Score | Weight | Sum |
|-------------------------------------|------|------|------|------|------|------|-------|-------|--------|-----|
| Water transparency (%)              | 100  | 100  | 100  | 100  | 100  | 100  | 3     | 5     | 5      | 15  |
| Health coral reef (%)*              | 21.9 | 8.3  | 10.4 | 16.9 | 16.3 | 44.9 | 20    | 0     | 5      | 0   |
| Lifeform                            | 3    | 3    | 2    | 2    | 3    | 2    | 3     | 0     | 3      | 0   |
| Reef fish                           | 13   | 9    | 12   | 12   | 12   | 12   | 1     | 3     | 3      | 9   |
| Current (cm/dt)                     | 0.1  | 0.1  | 0.1  | 0.1  | 0.1  | 0.1  | 0     | 3     | 3      | 9   |
| Depth of coral reef (m)             | 5.6  | 5.1  | 5.4  | 9.7  | 4.5  | 5.2  | 6     | 2     | 1      | 2   |
| Reef flat width (m)                 | 208  | 129  | 161  | 368  | 281  | 199  | 239   | 2     | 1      | 2   |
| Total                               |      |      |      |      |      |      |       |       |        | 31  |
| IKW                                 |      |      |      |      |      |      |       |       | 54.4%  |     |

*): The analysis average results of data from [4]

Current velocity and depth of coral reefs are parameters that also influence the level of suitability of the snorkeling tourism category which has a weight value of 1. The fast current speed will disturb the comfort of visitors, and the very deep depth of coral reefs will disturb the visibility of coral reefs by visitors. The results of measuring the current velocity at each station were 0.1 cm/second, which showed that the current speed for snorkeling activities was very suitable so that it obtained a score of 3. The water area which has a relatively weak current velocity is ideal to be used as a marine tourism area because it gives comfort and safety for tourists [25].

The waters on Tunda Island have a sloping topography with the cliff conditions surrounding the island. The reef flat width parameter obtained a weight value of 1, in which the value of this parameter
will affect visitor satisfaction during snorkeling. Measurement of the reef flat width on Tunda Island obtained a width ranging from 129-368 m so that the reef flat width on Tunda Island was included in the suitable category. The results of the measurement of the depth of coral reefs at each station obtained a depth ranging from 4.5-9.7 m. The depth of the coral reef that is more than 2 m is suitable for snorkeling because it will reduce the impact of coral damage and is interesting to see, such as a good stretch of the coral reef ecosystem, so that the depth of coral reefs on Tunda Island is quite suitable [26]. The results of the suitability analysis at the six stations/areas showed that the tourism suitability index (IKW) for snorkeling obtained 54.4%, which means that it was suitable (S2). These results were obtained from the total weighting and scoring of each parameter of each station.

3.4. The carrying capacity of the area (DDK) on Tunda Island
The results of the analysis of the carrying capacity of the area (DDK) on Tunda Island showed that ecotourism for the coastal recreation category was 124 people/day, ecotourism for the snorkeling tourism category was 24 people/day, ecotourism for the mangrove tourism category was 3 people/day, and ecotourism for the seagrass tourism category was 5 people/day. The results of the study by [27] explained that the carrying capacity of the area on Tanjung Pasir Beach for the coastal recreation category was 156 people/day and the carrying capacity of the area on Untung Jawa Island for the snorkeling category was 20 people/day.

Analysis of the carrying capacity of the area to be used as ecotourism has benefits for the future in the area. The carrying capacity of ecotourism is very important to maintain an environment in a sustainable manner for an ecotourism activity [11]. The development of marine ecotourism in small islands influences coastal and marine ecosystems. Efforts to balance natural resources as objects of marine ecotourism need to consider the carrying capacity of the area [28]. The time required for each activity on Tunda Island in considering the carrying capacity can be seen in Table 10.

| No. | Type of activities | Time required Wp- (hours) | Total time of 1 Wt-day (hour) |
|-----|-------------------|--------------------------|------------------------------|
| 1.  | Coastal recreation| 3                        | 6                            |
| 2.  | Mangrove tourism  | 2                        | 8                            |
| 3.  | Snorkeling        | 3                        | 6                            |

Table 11. Calculated of carrying capacity

| No. | The Types   | Area      | DDK      |
|-----|-------------|-----------|----------|
| 1.  | Coastal recreation | 3,102 m²  | 124      |
| 2.  | Mangrove tourism  | 1,000 m²  | 3        |
| 3.  | Snorkeling        | 300 m²    | 24       |
| Total|              |           | 151 people/day |

Tunda Island has an area of 2,575.00 m² (257.50 Ha). Ecotourism activities that can be carried out on Tunda Island are coastal recreation, mangrove area for tourism, seagrass area, and also snorkeling. The area of Tunda Island that can be used in marine ecotourism activities and the results of the calculation of the carrying capacity of the area on Tunda Island can be seen in Table 11. Carrying capacity is the limit of an area to accommodate visitors at a time to maintain the preservation of the ecosystem and the comfort of visitors. Carrying capacity is a way to apply the concept with limitations to utilize existing resources, such as coral reef ecosystem resources, to conserve coral reef ecosystem resources without causing damage in a sustainable manner [26].

Various recreational activities are currently carried out by people, by travelling out of their place of residence or area to a new place. Generally, tourists are interested in the climatic, cultural, and natural conditions of the destination. Ecotourism activities are nature tourism that includes some aspects like...
education, interpretation and cultural environment of the community with ecological sustainability management [29]. According to Tuwo [30], coastal and marine ecotourism will not encounter market saturation because ecotourism does not sell goals and objects, but rather sells philosophy and taste. Exploring the potential and diversity of flora and fauna is the main capital in the development of ecotourism. The more potential natural tourist attractions that exist in an area, the more tourists will be attracted to visit the area [31].

4. Conclusions
The coastal tourism potential on Tunda Island area is white sand beaches, coral and rubble mixed sand, mangroves, and coral reefs. The value of the Tourism Suitability Index (IKW) for coastal recreation tourism is 76.2% (very suitable/S1). The value for mangrove tourism activities is 12.8% (not suitable/TS), the value of snorkeling and diving tourism activities is 54.4% (suitable/S2), and the value for other tourism activities is 41.2% (not suitable/TS). The other tourism activities include the development of dolphin watching tourism, but the data of dolphin sighting is not well recorded, so it is fortunate if the tourists can enjoy the dolphin sighting. Values of carrying capacity on Tunda Island for some tourism activities is around 151 people per day (55,115 people/year).

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