Carrying capacity studies of marine tourism during COVID-19 pandemic in Derawan Island, Berau, East Kalimantan

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Abstract. The COVID-19 pandemic has forced all sectors to adapt to new habits including the tourism sector. The research examines the carrying capacity of a particular area, especially marine tourism areas used for diving and snorkelling. Thus, the results can be used in the management of marine tourism in the new normal period. This research was conducted by survey and analyzed by the carrying capacity marine tourism formula. The research was carried out at six diving tourism and five snorkelling tourism sites scattered in the waters of Derawan Island. The carrying capacity of diving was 1,611 people/day with an area of 402,704.29 m² and the carrying capacity of snorkelling was 1,126 people/day with an area of 281,453.29 m². During the new normal period meaning the carrying capacity applied is 806 people/day for diving areas and 563 people/day for snorkelling areas. The utilization of marine tourism on Derawan Island is still sustainable because the number of tourist visits is smaller than the carrying capacity.

Keywords: carrying capacity; COVID-19; Derawan; diving; snorkelling

1. Introduction
The COVID-19 pandemic has forced all parties to adapt to new habits without exception in the tourism sector. Provisions for maintaining a distance of ±1 m, avoiding crowds and preserving the environment in the application of the COVID-19 health protocol [1], are in line with the concept of marine ecotourism. Restrictions on utilization with restrictions on activities, number of people, time, and space are listed in the concept of carrying capacity of the area in ecotourism development. The application of the carrying capacity of the area not only contributes to environmental sustainability but also creates comfort for visitors [2].

Ecotourism is not only limited to tourism that interacts with nature or the main service offered is the environment, but ecotourism is responsible travel to natural areas by preserving the environment, improving the welfare of local communities and providing educational value [3]. The application of marine ecotourism is not only enjoying environmental services but also paying attention to the carrying capacity of the area so that the resources used can be sustainable.
One of the marine tourism destinations affected by COVID-19 is Derawan Island [4], so it must immediately adapt to the new normal period, especially in terms of limiting the number of visitors [5]. Limiting the number of visitors can be seen from the study of the marine tourism carrying capacity. The study of the carrying capacity of the Derawan Island marine tourism area has never been carried out, so this study aims to determine the carrying capacity of the Derawan Island marine tourism area during COVID-19. The carrying capacity study conducted in this research is based on the availability of resources which are the potential for developing marine tourism on Derawan Island.

2. Methodology
2.1. Time and Location
The data used in the research of the carrying capacity of Derawan Island marine tourism is primary data and secondary data. Primary data collection was carried out in December 2020 in the waters of Derawan Island, while secondary data collection was carried out in December 2020-March 2021 at the relevant government office.

2.2. Data Collection and Analysis
Primary data was collected through field surveys, while secondary data was obtained from literature studies and personal communication with related office (East Kalimantan Provincial Department of Marine Affairs and Fisheries, East Kalimantan Provincial Departement of Tourism, and Berau Regency Departement of Tourism). The sites for the research were selected by purpose on the popular diving and snorkelling sites on Derawan Island.

The carrying capacity analysis is only carried out on tourist sites with a tourism suitability index in “suitable” to “very suitable” category [2]. The carrying capacity of diving tourism was analyzed from six sites (Bumphead Point, Coral Garden, Dharma Point, Jetty Bumi Manimbora Interbuana (BMI), Snapper Point, and Sibili Park), while the carrying capacity of snorkeling tourism was analyzed from

Figure 1. Distribution of data collection sites.

![Figure 1. Distribution of data collection sites.](image-url)
five sites (Coral Garden, Dharma Point, Jetty BMI, Jetty Derawan Café, and Kima Park). The entire site is spread over the waters of Derawan Island (see figure 1).

The carrying capacity analysis of diving and snorkelling tourism uses the Regional Carrying Capacity (DDK) concept, which is the maximum number of visitors that can be accommodated without causing disturbance to natural and human resources [2]. Directions for the development of the use of marine tourism are carried out using the ArcGIS 10 spatial analysis approach and refer to the Strategic Environmental Studies Zoning Plan for Coastal Zone and Small Islands (KLHS RZWP3K) East Kalimantan Province in 2019 – 2039 [6].

The carrying capacity analysis is carried out for the development of marine tourism based on natural resources in a sustainable manner. In this research, the analysis of the carrying capacity of the marine tourism area also considers the potential for utilization development in accordance with the availability of resources around the data collection site, while prioritizing nature's ability to tolerate visitors (ecological potential). The ecological potential of visitors (K) for diving tourism is two persons in a 2,000 m² area (Lt), while for snorkelling tours as much as one person in a 500 m² area (Lt); The predicted time required for diving tourism activities is 2 hours (Wp) with a total time of 8 hours/day (Wt), while snorkelling tours are 3 hours (Wp) with a total time of 6 hours/day (Wt) [2]. Regional carrying capacity (DDK) is calculated by the formula (1) [2]:

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DDK = K \times \frac{Lp \times Wt}{Lt \times Wp}
\]  

Information:
- DDK = Tourism area carrying capacity (people/day)
- K = Visitor ecological potential per unit area
- Lp = Area or length of usable area
- Lt = Unit area for certain categories
- Wt = Time provided by the area for tourist activities in one day
- Wp = Time spent visitors for each specific activity

3. Result and Discussion

The waters of Derawan Island are part of the Derawan archipelago, which is known to have the second-highest diversity of coral reefs in Indonesia after Raja Ampat [7]. The potential of aquatic resources such as the coral reefs and the diversity of reef fish species is in the moderate category [8]. The stretch of white sand and turtles on Derawan Island are additional attractions for tourists [9]. With this high biodiversity, Derawan Island has become one of the leading tourist destinations in East Kalimantan Province.

Marine tourism on Derawan Island relies on the potential of marine resources so that the most frequent tourist activities are diving and snorkelling. The concept of marine ecotourism running on Derawan Island is a tourist activity related to nature. One of the efforts to preserve the environment in tourism activities is to pay attention to the carrying capacity of the area for resource sustainability. The carrying capacity of the area considers two things: the ability of nature to tolerate disturbances from human activities and the authenticity of natural resources [2].

Tourism on Derawan Island develops by utilizing natural resources as its main attraction, one of which is coral reefs. The good condition of coral reefs and associated biota is an attraction for divers, especially the variety of colors and the uniqueness of the biota that can be seen by divers. The area of coral reefs that can be utilized is the area used in the research of carrying capacity. Based on the area that can be utilized, the diving tourism carrying capacity obtained is 1,611 people/day which can be spread over six sites, with an area of 402,704.29 m², while the snorkelling tourism carrying capacity
The number of tourist visits, both during normal conditions (before the COVID-19 pandemic) and during the occurrence of COVID-19, does not exceed the carrying capacity of the area. Utilization of potential for the development of marine tourism can be maintained at the level of sustainable use by considering the carrying capacity, carried out with an alternate trip system which is distributed on the available sites. The sites chosen for snorkeling and diving are adjusted to the abilities and experiences of tourists to minimize the risk of safety and damage to coral reefs. Based on the data pattern on the number of tourist visits presented in table 3, it can be estimated that under normal conditions (no COVID-19) there is an increase in tourist visits from year to year. The increase in visits can lead to increased pressure on natural resources that are utilized, especially the potential of coral reefs which are an attraction for marine tourism on Derawan Island. Recovery of coral reefs naturally can be done by reducing local pressure [10]. The carrying capacity of marine tourism, especially diving and snorkeling activities, can reduce pressure [2]. The quota system can reduce the impact of tourism [11]. Limiting diving and snorkeling tours period can reduce the pressure that can damage coral reefs [12].

COVID-19 has disrupted diving tourism worldwide [13], including Derawan Island as one of the marine tourism destinations in Indonesia. Based on the Indonesian Government's appeal, as an effort to

Table 1. Carrying capacity of the area for diving tourism.

| Sites            | Area (m²)   | CC (people/day) |
|------------------|-------------|-----------------|
| Bumphead Points  | 123,196.42  | 493             |
| Coral Garden     | 54,163.78   | 217             |
| Dharma Point     | 41,068.72   | 164             |
| Jetty BMI        | 33,498.61   | 134             |
| Snapper Point    | 94,774.58   | 379             |
| Sibili Park      | 56,002.18   | 224             |
| Total CC         |             | 1,611 people/day|
| Total New Normal CC |         | 806 people/day |
| Total CC in a year |           | 386,640 people/year |
| Total New Normal CC in a year | | 193,320 people/year |

Table 2. Carrying capacity of the area for snorkeling tourism.

| Sites            | Area (m²)   | CC (people/day) |
|------------------|-------------|-----------------|
| Coral Garden     | 138,211.80  | 553             |
| Dharma Point     | 15,692.34   | 63              |
| Jetty BMI        | 10,199.64   | 41              |
| Jetty Derawan Cafe | 13,075.78  | 52              |
| Kima Park        | 104,273.73  | 417             |
| Total CC         |             | 1,126 people/day|
| Total New Normal CC |         | 563 people/day |
| Total CC in a year |           | 337,800 people/year |
| Total New Normal CC in a year | | 168,900 people/year |
prevent the spread of COVID-19, the implementation of a maximum number of visitors is 50% of capacity under normal conditions [5]. Based on the appeal, the area's carrying capacity for the restoration of Derawan Island marine tourism in the new normal period is 806 people/day or 193,320 people/year for diving tourism; 563 people/day or 168,900 people/year for snorkelling tourism. In addition, it is important for tourism business actors to implement the CHSE (Cleanliness, Health, Safety, Environment Sustainability) protocol in the new normal period. Modification of the carrying capacity of the area using the government's appeal of 50% accompanied by the application of the CHSE protocol is highly recommended to be applied during the new normal period.

Limiting the number of visitors, limiting activities and limiting time can prevent the transmission of COVID-19, which can be easily transmitted through interacting with the people. Mass tourism leads to the travel of large numbers of tourists to a limited area with a high probability of causing pathogen transmission [14], so the application of ecotourism concept is highly recommended. It is important to manage visitor numbers to avoid overcrowding through careful spatial planning, introduce educational campaigns, especially targeting new visitor profiles, and promote sustainable tourism models, which do not rely on large visitor numbers [15].

4. Conclusion

The carrying capacity of diving tourism is 1,611 people/day and the carrying capacity of snorkelling tourism is 1,126 people/day. The carrying capacity during the new normal period for diving tourism is 806 people/day and 563 people/day for snorkelling tourism. The number of tourists is smaller than the carrying capacity of the area, so that the use of marine tourism on Derawan island is still in sustainable use.

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Table 3. Total tourist visits in Berau Regency before and during COVID-19 and carrying capacity.

| Years               | Foreign Tourist (people) | Domestic Tourist (people) | Total Visits (people) | Total Area Carrying Capacity (people/year) |
|---------------------|--------------------------|---------------------------|-----------------------|-------------------------------------------|
| 2018 (Before COVID-19) | 2,586                    | 283,294                   | 285,880               | 724,440                                   |
| 2019 (Before COVID-19) | 8,323                    | 292,692                   | 301,015               | 724,440                                   |
| 2020 (During COVID-19) | 220                      | 127,176                   | 127,396               | 724,440                                   |
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