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Suitability of Ecotourism and Carrying Capacity in Kapoposang Archipelago Marine Conservation Area

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A B S T R A C T

This study aims to analyze the suitability of tourism and carrying capacity in the Kapoposang Archipelago Conservation Area and its surrounding waters in Pangkep Regency. It was conducted over a period of two months, from January to February 2024. Primary data collection was carried out through field observations, including coral cover data acquisition using the Underwater Photo Transect (UPT) method. Coral fish species data were collected using direct counting techniques with the Underwater Visual Census (UVC) method. Interviews were conducted with respondents from government agencies, local communities, fishermen, and visitors. Respondents were selected using accidental sampling in accordance with the research objectives. Secondary data encompassed all supporting information related to the study. Data analysis in this research was performed through several stages, including the analysis of the tourism suitability index (TSI), the adaptive capacity of coral reef ecosystems, physical carrying capacity (PCC), and real carrying capacity (RCC). The results of the analysis indicate that 7 stations fall within the 'Suitable (S2)' category, while 2 stations, namely Station 5 and Station 14, fall within the 'Highly Suitable (S1)' category. According to the PCC analysis, the maximum capacity of divers per day at these locations is 2,194 divers per day and 800,810 divers per year. Meanwhile, the RCC analysis shows a range of 941 divers per day and 302,042 divers per year, with the highest diving point being Station 10 and the lowest being Station 8.

Keywords: Tourist suitability, support, marine tourism, conservation area, PCC, RCC, Kapoposang Islands,

1. Introduction:

Kapoposang Islands is one of the fascinating conservation areas in South Sulawesi. The richness of fish species, turtles, marine mammals, seagrass, and mollusks are unique features of the Kapoposang Islands Conservation Area. This underwater beauty makes the area an attractive destination for both local and international tourists. In the concept of sustainable tourism, sustainable tourism must prioritize environmental preservation to ensure sustainable tourism development and meet the needs of future generations. The development of sustainable marine tourism is carried out by considering the carrying capacity of the area and applying ecotourism principles (Riskiani, 2019). The utilization of natural resources for tourism must consider the suitability and carrying capacity of the tourism area (Hutabarat et al., 2009).

Philosophically, the establishment of conservation areas is based on the philosophy of generating ecological, economic, and social benefits for the community (Widada, 2008). However, the existence of conservation areas often leads to disputes between parties regarding the boundaries of their utilization. Managers are required to package the uniqueness and distinctiveness of the area into an attractive tourism product without neglecting the protective function of the area (Sekartjakrarini, 2009). Marine tourism, especially scuba diving, has become one of the main activities in the Kapoposang Islands. However, the development of diving tourism can put pressure on the sustainable management of the area. An increase in the number of divers can impact coral reef damage if not properly managed. Coral reefs have varying adaptive capacities depending on environmental conditions and the pressures they face (Graham et al., 2021).

In this context, it is important to understand the suitability of coastal tourism land, which refers to the degree of compatibility of a land area for natural tourism activities in coastal areas. This suitability assessment is based on the physical characteristics and ecological potential of the land. The results of this assessment serve as the foundation for sustainable coastal tourism planning and management, thereby preserving the environment and enhancing ecosystem quality (Purnomo, 2021). Additionally, environmental carrying capacity is a key factor in the success of coastal ecotourism. This concept refers to the limit of an ecosystem's ability to support human activities without experiencing damage (Harriot et al., 2001).

By integrating the concepts of tourism land suitability and environmental carrying capacity, the management of marine tourism areas, such as in the Kapoposang Islands, must ensure that tourism activities do not exceed the adaptive capacity of coral reefs and other ecosystems. If the carrying capacity is exceeded, environmental degradation will occur, negatively impacting the sustainability of ecotourism itself. Considering the unique characteristics of coastal ecosystems as public goods, effective management is crucial to ensuring a balance between economic interests and environmental conservation (Moberg et al., 1999).

This research is important because there is currently a lack of accurate and detailed visitor data in the Kapoposang Islands Conservation Area and its surrounding waters, especially for diving activities. The ambiguity regarding the number of visitors participating in diving activities makes it difficult for area managers to determine the ideal tourism carrying capacity. This affects the ability to design effective strategies to prevent environmental damage due to excessive tourism activities. Diving tourism, as one of the main activities in the Kapoposang Islands Conservation Area and its surrounding waters, has great potential to attract tourists. However, without adequate data, area managers cannot accurately measure the impact of the increasing number of divers on the coral reef ecosystem and the surrounding marine environment. Therefore, this research will make a significant contribution by providing the empirical data needed for sustainable management and protection of ecosystems in the Kapoposang Islands Conservation Area and its surrounding waters, ensuring that tourism activities can continue without damaging existing natural resources.

1.1 Need and Significance of the Study

The Conservation Area of the Kapoposang Islands and Surrounding Seas, with its stunning underwater beauty, has become a popular diving tourism destination. However, behind this beauty lie significant challenges in managing the area. One of the main obstacles is the lack of accurate data on diving tourism visits. Without solid data, we lack a clear picture of the number of divers visiting this area each year. The lack of data on diving tourism visits directly impacts the management efforts of the Conservation Area of the Kapoposang Islands and Surrounding Seas. Without knowing the exact number of visitors, it is difficult to determine the optimal environmental carrying capacity. As a result, the risk of coral reef damage due to excessive diving activities increases. Coral reefs, as highly sensitive ecosystems, require careful management. If the number of divers exceeds the carrying capacity, coral reef degradation will occur, potentially threatening marine biodiversity and the survival of various species. Therefore, the results of this research are expected to serve as a basis for developing more effective and sustainable management strategies.

1.2 The Research Questions

The research objectives of the study were delineated below:

1. What is the suitability index of marine tourism areas in the Kapoposang Islands Conservation Area and its surrounding seas?
2. What is the physical carrying capacity (PCC) and the real carrying capacity (RCC) of the coral reef ecosystem in the Kapoposang Islands Conservation Area and its surrounding seas?

2. The Review of Related Literature

Simanjuntak, S.W (2018). The research title is "Analysis of the Suitability and Carrying Capacity of Tourist Areas on Tidung Island and Its Surroundings." The results of the study indicate that the carrying capacity (CC) of Tidung Island, Payung Island, and Pari Island for beach tourism and snorkeling activities still meets the tourism carrying capacity standards, except during peak holiday seasons (Eid, Christmas, New Year, and other major holidays). The tourist areas in the study region can still be managed as ecotourism sites by implementing several strategies, including: preserving coral reef natural resources; enhancing tourism promotion in suitable and less-visited areas; limiting the number of visitors to avoid exceeding carrying capacity in specific areas during peak seasons; maximizing potential management by adding educational attractions or tour packages; avoiding mass tourism by establishing entry fees and ticketing for tourist sites; educating the community and tourists about coral reef conservation programs; improving infrastructure and adding supporting facilities; preparing local professional workforce through training; and undertaking efforts to prevent coral reef damage.

Papilaya, R L., P. Boli, V.P.H. Nikijuluw (2019). The research title is "Carrying Capacity of Diving Tourism in Dampier Strait Marine Conservation Area—District of Raja Ampat.". The results of the study indicate that the total potential number of divers at 15 dive sites over the course of a year in the Dampier Strait Marine Conservation Area is equivalent to 386,825 divers, with a physical carrying capacity (PCC) of 1,648 people and a real carrying capacity (RCC) of 1,104 people. The largest dive site is Melissa Garden, with a capacity of 120,600 people per year or 67 people per trip, whereas the Passage dive site has the smallest carrying capacity of 4,824 people per year or 3 people per trip. The attractions for divers include observing manta rays, enjoying panoramic views of coral reefs, and studying organisms associated with coral reefs. The Raja Ampat District Government could establish regulations on carrying capacity and tourism etiquette in the form of regional regulations to guide the implementation of sustainable tourism in the Raja Ampat Regency.

Sudiarta, I Ketut; Made; Komang, (2019). Title of the research: "Carrying Capacity Assessment of Dive Sites in Bali, Indonesia”. The findings of the study indicate that, from a managerial perspective, the carrying capacity of dive sites is not static; it depends on management capacity factors. Theoretically, the carrying capacity of dive sites can be enhanced through improvements in management capacity, both structurally (based on authority objectives) and non-structurally (by diving operators). Effective destination governance and quality service standards are crucial not only in the context of carrying capacity and controlling environmental impacts caused by diving activities but also in enhancing long-term competitiveness. Therefore, to achieve competitive and sustainable diving tourism goals, the implementation of carrying capacity concepts, synergies, and effective cooperation among stakeholders is required.

Costa, D.D; Suharti,R.,R. Basuki (2020). The research title is "Analysis of the Carrying Capacity of Waters and Marine Ecotourism Potential in Atauro Island, Dili District, Atauro Sub-District, Timor-Leste." The results indicate that the average water quality at Atauro Island meets the quality standards. Live coral cover across all study sites has an average coverage of 54.80%, categorized as 'good'. Seagrass cover across all study sites has an average coverage of 82.08%, categorized as healthy or abundant. The fish species composition at Atauro Island includes a total of 704 fish, with an abundance of 28,160 individuals per hectare across all sites. The abundance of individuals in Beloi village is 11,840 individuals per hectare; Vila-Maumeta village has 8,200 individuals per hectare; and Biqueli village has 8,120 individuals per hectare. The analysis of the diving tourism suitability index in Beloi village is 75.93%, categorized as suitable; Vila-Maumeta village has 66.67% suitability; and Biqueli village has 61.11% suitability. The snorkeling tourism suitability index in Beloi village is 77.19% (suitable); Vila-Maumeta village has 78.95% suitability; and Biqueli village has 59.65% suitability. The seagrass ecotourism suitability index at each location ranges from 82.35% to 92.16%, categorized as very suitable.

3. Methodology of Study

The data used in this study comprises both primary and secondary data. Primary data pertains to coral reef cover conditions and biophysical parameters (depth, brightness, and current velocity). The parameters measured for dive categories are identical to those for dive categories, including brightness, coral cover, life form count, coral fish species, current velocity, and reef depth. Ecosystem capacity parameters for coral reefs include the Coral Reef Dimension Index. Coral cover data collection was conducted through observations using the Underwater Photo Transect (UPT) method. Coral fish species data were obtained through direct counting using the Underwater Visual Census (UVC) method. Secondary data were obtained through literature reviews and various reports issued by government agencies, which were used to describe the general state of the research area.

4. Analysis Data

4. 1. Tourism Suitability Index (TSI)

This analysis employs a series of indicators to assess the suitability of a location for specific tourism activities. The indicators typically include natural beauty, accessibility, supporting facilities, and ecosystem condition. The Tourism Suitability Index (IKW) aids in determining the most appropriate locations for specific types of tourism and identifying areas that require improvement or specialized management (Wilson, 2020).

The formula used to calculate the aquatic tourism suitability index is as follows:

$$TSI = \sum_{i=1}^{n} [\frac{Ni}{N\ max}]\ x\ 100\%$$

Explanation:

TSI : Tourism Suitability Index

n : Number of suitability parameters

Ni : Value of the i-th parameter (Weight x score)

N max : Maximum value of the tourism category

4.2. Physical Carrying Capacity (PCC)

PCC is the maximum number of tourists that can be physically accommodated by the space provided at a given time. The correction factors required in calculating PCC include the area available for diving activities, the area utilized by divers, and the number of rotations or repetitions of diving activities within a single day. PCC is calculated using the following formula:

{**PCC** = $(\frac{S}{SP})$ x NV}

Explanation:

PCC : Physical Carrying Capacity

S : Length of the Diving Route (meters)

SP : Maximum physical height of a person plus the distance required between divers during a single diving activity, measured (meters)

NV : Rotation factor or the number of repetitions of diving activities within one day

4.3. Real Carrying Capacity (RCC)

To obtain the RCC value, correction factors are essential and will inevitably vary across different dive sites. According to Kepdirjen PRL, 2023, the fundamental calculations for measuring factors are based on the following basic formula:

RCC = PCC X CFfrag x CFmort x CFwave x …

Explanation:

RCC : Real Carrying Capacity

CFfrag : Correlation factor of ecosystem vulnerability to charismatic species

CFmort : Correlation factor of ecosystem mortality rate

CFwave : Correlation factor of extreme wave events

Based on the correction factor values above, the estimation of the real carrying capacity (RCC) of a diving site can be determined. The RCC value indicates the maximum number of divers that can be accommodated at a single diving location within a specific period, taking into account "crowding/density effects," the local biophysical ecosystem, and diving accessibility (Ulya, 2022).

5. Result and Discussion

Based on research conducted at each observation station on Kapoposang Island, Tambakhulu Island, Pamanggangan Island, and Suranti Island, the score (weight x rating) for the suitability of marine diving tourism was determined across 15 observation stations. This study involved the meticulous and comprehensive collection of data from each observation station to evaluate various parameters affecting the suitability of the area as a diving tourism site. The parameters analyzed included water quality, the presence of coral reefs, the condition of the seabed substrate, and the biodiversity present at each location. Each parameter was then assigned a weight and rating based on its importance in supporting safe and appealing diving activities for tourists. The final score, derived from the combination of weight and rating, provides a clear depiction of the suitability of each observation station for marine diving tourism activities.

The results of this analysis indicate that there is variation in the suitability levels across different observation stations, reflecting the differing environmental conditions at each location. For instance, several observation stations on Kapoposang Island exhibit high scores, indicating that these areas are highly suitable for diving activities due to their well-preserved coral reefs and clear waters. Conversely, some stations on Tambakhulu Island may have lower scores due to factors such as coral reef damage or suboptimal water quality. These findings are crucial for the sustainable management planning of dive tourism areas, as they allow managers to focus on conservation efforts and environmental improvements at less suitable observation stations. Therefore, the information presented in the following table provides a solid foundation for decision-making in marine tourism management in this region, ensuring that dive activities can proceed safely, attractively, and sustainably for the future of marine conservation in the Kapoposang Archipelago and its surroundings. This can be seen in Table 1.

Table 1 - Matrix of Suitability for Marine Tourism Areas in the Kapoposang Seas

Parameter	**Weight**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**
Water clarity (%)	0,25	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Coral reef cove (%)	0,25	34,1	48,6	12	35,8	54,4	52	10,2	70	41,5	26,9	14,6	28,2	6,6	60,5	34
Diversity of living coral genera	0,15	26	31	16	27	33	30	20	15	30	29	23	16	32	32	12
Reef fish species	0,15	143	98	52	23	154	87	32	61	67	60	67	54	30	65	21
Current speed (m/d)	0,10	0,17	0,17	0,046	0,14	0,15	0,3	0,17	0,13	0,13	0,13	0,14	0,16	0,2	0,07	0,14
Coral reef depth (m)	0,10	6	6	6	6	6	6	6	6	7	7	10	7	4	7	8
Tourism Suitability Index (TSI) (%)		70	80	54	68	86	74	58	67	78	68	65	58	56	84	56
Category TSI		S2	S2	N	S2	S1	S2	N	S2	S2	S2	N	N	N	S1	N

Suitability Criteria:

< 66% = Not Suitable (N)

66-80% = Suitable (S2)

≥ 80% = Highly Suitable (S1)

The analysis of the suitability of 15 research stations indicates a significant level of diversity. Among all the stations, 7 are categorized as 'Suitable (S2)' and 2 are categorized as 'Highly Suitable (S1)', namely Station 5 with a score of 86% and Station 14 with a score of 84%. This suggests that these two locations have the most favorable physical and environmental characteristics for the planned research activities. Optimal physical conditions, such as water clarity, the presence of healthy coral reefs, and high biodiversity, are key factors that make Stations 5 and 14 ideal for diving activities and further marine research.

According to Dahuri et al. (2022), the placement of development in bio-physically suitable locations is crucial. They emphasize that the success of development should not only be measured from an economic perspective but also consider ecosystem balance to ensure environmental sustainability. In this context, highly suitable locations such as Stations 5 and 14 offer optimal opportunities for developing sustainable diving tourism without compromising marine ecosystem conservation. The application of ecological principles in tourism planning and management can help prevent environmental degradation and maintain habitat quality that supports marine life.

Additionally, the dynamics of the carrying capacity of a tourism area are significantly influenced by environmental quality and external factors that may occur at the tourism site. Zelenka and Kacetl (2014) emphasize that the determination of tourist numbers is not the sole factor in managing tourism areas. More critical variables include the distribution of tourists within the area, the types of activities conducted, tourist behavior, ecosystem conditions, and the social and tourism infrastructure systems. Therefore, the determination of tourism carrying capacity must be periodically verified to ensure that all these aspects have been considered and managed properly.

Accurate determination of tourism carrying capacity requires a holistic approach that considers various factors contributing to ecosystem sustainability and the tourist experience. Even the distribution of tourists can prevent overcapacity at specific locations, which often leads to environmental damage. Furthermore, tourist behavior and the types of activities conducted should be regulated to minimize negative impacts on ecosystems. For example, diving and snorkeling activities should be closely monitored to prevent coral reef damage. Adequate tourism infrastructure must also be provided to support tourism activities and minimize environmental impacts (Kusuma, 2020). Thus, sustainable management based on scientific research, such as in the Kapoposang Islands Conservation Area and its surrounding seas, can be an effective model for the development of sustainable maritime tourism in Indonesia.

Table 2 - ***Physical Carrying Capacity*** **(PCC)**

TitikSelam	**S (meter)**	**SP (meter)**	**Hv (menit)**	**Tv (menit)**	**Nv (Rotation)**	**PCC divers/day**	**PCC divers/year**
Station 1	320	4	480	120	4	320	116800
Station 2	217	4	480	120	4	217	79205
Station 4	231	4	480	120	4	231	84315
Station 5	262	4	480	120	4	262	95630
Station 6	217	4	480	120	4	217	79205
Station 8	200	4	480	120	4	200	73000
Station 9	282	4	480	120	4	282	102930
Station10	200	4	480	120	4	200	73000
Station14	265	4	480	120	4	265	96725
Total PCC in the Conservation Area of the Kapoposang Islands and the surrounding seas						2194	800810

Based on the data presented in Table 2, there are 9 stations deemed suitable for diving tourism locations. The dive paths range in distance from 200 to 320 meters, with the longest dive path located at Station 1 and the shortest dive paths found at Stations 8 and 9. Further analysis reveals that the maximum number of tourists that can be physically accommodated at these nine stations ranges from 200 to 320 divers per day. Station 10, characterized by a short dive path, has the lowest capacity of 200 divers per day, whereas Station 1, with the longest dive path, can accommodate up to 320 divers per day. The analysis indicates that the total PCC value at the research stations is 2,194 divers per day and 800,810 divers per year.

The maximum diver capacity per day is also a critical factor to consider in dive tourism management. Stations with higher capacities, such as Station 1, must ensure that their infrastructure and environmental management can support a high number of divers without damaging the marine ecosystem. According to Harriott et al. (2001), effective management of diver capacity is crucial for minimizing negative impacts on coral reefs and the marine environment as a whole.

The number of dive activities that can be conducted in one day at a single dive site is determined based on the duration of diving that can be performed at that site. Diving activities are assumed to occur only between morning and evening (from 08:00 to 16:00) for safety reasons. This time period was selected due to optimal natural lighting conditions and generally stable weather, which supports diver safety. Thus, the duration of diving activities in one day is eight hours. However, this duration may vary depending on accessibility to the dive location. The farther and more difficult the location is to reach, the more time is required for travel, thereby reducing the effective diving time available.

A limiting factor for the duration of a single dive is the time required to consume a tank of air, which averages between 40 and 60 minutes. This implies that divers can be underwater for a limited period before needing to surface to replace or refill their air tanks. Additionally, there are several additional factors to consider when calculating the total time required for each dive session. First, the time needed for the ascent and descent of divers to and from the boat must be accounted for. This process involves boarding the boat, donning or removing equipment, and ensuring all divers are safe and prepared for the subsequent dive.

Next, the time required for the dive guide to provide instructions before commencing the dive must also be considered. These instructions include a briefing on the conditions of the dive site, safety procedures, and protocols to be followed during the dive. The guide will also provide information on the flora and fauna that may be encountered during the dive, as well as other relevant details to enhance the diver's experience. This is crucial to ensuring that all participants have a clear understanding of what to expect and how to behave while underwater, ensuring the safety and comfort of all involved.

Additionally, the time needed for divers to acclimate before entering the water surface should also be accounted for. This adjustment period includes a final check of equipment, ensuring there are no technical issues, and allowing time for divers to calm themselves and mentally prepare before entering the water. This factor is important as it helps to reduce the risk of anxiety or technical problems that could disrupt the diving experience.

Overall, if all these factors are combined, the total duration of a single dive can reach approximately 120 minutes. This includes the effective underwater dive time, the time for ascending and descending from the vessel, as well as the time for briefing and preparation. Therefore, in a single day, divers can conduct multiple dives, depending on efficient time management and site conditions. If the duration of a single dive session is about two hours, then within an eight-hour day, divers can perform up to four dives, assuming travel and preparation times can be optimized. However, this number of dives may decrease if the dive site is difficult to access or if weather and sea conditions are less favorable.

Effective time management implementation is crucial to ensuring a safe and enjoyable diving experience. With proper planning, dive operators can optimize the number of dives conducted in a single day without compromising safety or the quality of the diver's experience. According to a study by Davis et al. (2019), effective planning and good time management are key to successful dive tourism operations, which not only enhance customer satisfaction but also support the sustainability of healthy marine environments.

Table 3 - *Reel Carrying Capacity* (RCC)

Dive Point	**PCC**	**Ecosystem vulnerability factors**		**Mortality rate adjustment factors**		**Extreme wave/weather correction factors**		**RCC divers/ day**	**RCC divers/ year**
		composition of coral fragile (%)	**CFfrag**	**Coral mortality index**	**CFmort**	**Cwave**	**CFwave**		
Stasiun 1	320	6.20	0.9	0.59	0.40	44	0.99	122	39043
Stasiun 2	217	15.00	0.9	0.39	0.60	44	0.99	112	35894
Stasiun 4	231	5.27	0.9	0.44	0.55	44	0.99	121	38919
Stasiun 5	262	11.4	0.9	0.70	0.29	44	0.99	68	21952
Stasiun 6	217	16	0.8	0.30	0.70	44	0.99	128	40945
Stasiun 8	200	63.87	0.4	0.19	0.80	44	0.99	58	18644
Stasiun 9	282	27	0.7	0.47	0.52	44	0.99	108	34758
Stasiun10	200	13.4	0.9	0.19	0.80	44	0.99	139	44688
Stasiun14	265	49.8	0.9	0.36	0.64	44	0.99	85	27199
Total RCC in the Kapoposang Archipelago Conservation Area and Its Surrounding Seas								941	302042

Based on the analysis of the correction factor values that have been conducted, the real carrying capacity (RCC) estimate for each dive site or location can be determined. The RCC value represents the maximum number of dives that can be accommodated at a single site over a specified period, taking into account various crucial factors such as "crowding effects" or visitor density, the biophysical conditions of the local ecosystem, and the accessibility of the dive site.

The analysis results indicate that the total RCC value at the research station is 941 divers per day and 302,042 divers per year. The dive site with the highest capacity is Station 10, which can accommodate up to 139 divers per day, whereas the site with the lowest capacity is Station 8, with a lower RCC value of 58 divers per day. This variation reflects differences in environmental conditions and infrastructure at each location.

The RCC value is crucial for ensuring that diving activities do not exceed the acceptable environmental capacity, which could lead to negative impacts on marine ecosystems. The "crowding effect," or visitor density, becomes a key factor in determining RCC, as high density can affect both the quality of the diving experience and the health of marine ecosystems. Additionally, biophysical factors such as water quality, coral reef conditions, and biodiversity also influence the RCC value. Locations with better environmental conditions can support a higher number of divers without compromising ecosystem health (Syarif, 2022).

However, it is important to consider that RCC values may vary depending on the primary attraction of the site. If the main attraction is marine biota, such as specific fish species or corals, the ecosystem's vulnerability factors should be adjusted based on the occurrence and composition of these biota. For example, if a location serves as a habitat for rare or threatened species, the carrying capacity should be reduced to protect these species from damage caused by excessive diving activities (Burke, 2011).

Furthermore, the mortality correction factor, which represents the potential impact on marine biota, needs to be adjusted to become an index of mortality or disturbances specific to the biota itself (Cesar, 2003). In this way, the estimation of the actual carrying capacity will more accurately reflect the potential impacts on marine ecosystems and assist in the planning of more sustainable dive tourism management (Hoegh-Guldberg, 2017).

Overall, a thorough understanding of RCC (Reef Check Condition) and adjustments based on the specific conditions of the location are crucial for maintaining a balance between the utilization of tourism resources and environmental protection. The implementation of appropriate management methods will support the sustainability of diving tourism and help ensure that marine ecosystems remain healthy and accessible for future generations (Mooberg et al., 1999).

6. Conclusion

The conclusions of this study indicate a significant variation in the suitability of 15 research stations, with 7 stations categorized as ‘Suitable (S2)’ and 2 stations, namely Station 5 and Station 14, categorized as ‘Highly Suitable (S1)’. Stations 5 and 14 possess optimal environmental characteristics for diving and research activities, such as water clarity and high biodiversity. Data also reveal that nine stations are deemed suitable for dive tourism, with a physical carrying capacity of 2,194 divers per day and 800,810 divers per year. However, the real carrying capacity, considering the correction factor for physical support capacity, allows for only 941 divers per day and 302,042 divers per year. The differences in RCC values among these locations reflect variations in environmental conditions and infrastructure. For effective management, priority should be given to stations categorized as ‘Highly Suitable’ by implementing strategies to limit the number of divers and enforcing strict monitoring to maintain environmental sustainability. At locations with large carrying capacities, such as Station 10, adequate infrastructure and control systems must be developed to prevent environmental damage. Management strategies should include stringent monitoring, appropriate infrastructure development, and the scheduling of visits and dive routes to balance resource utilization with the sustainable preservation of marine ecosystems.

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