

# Evaluating Ecotourism Development in Bontang : Water Quality, Compatibility and Carrying Capacity

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## Evaluating Ecotourism Development in Bontang: Water Quality, Compatibility, and Carrying Capacity

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**Abstract.** Marine and coastal tourism are both among the largest segments of the tourism industry and fastest growing local economic activities. However, tourism is also one of the main contributors to environmental depletion. This study aimed to evaluate the condition of the water quality, and the compatibility and the regional carrying capacity of the coastal area of Bontang City intended for marine tourism. Data were collected by purposive randomised sampling and used multicriteria analyses, based on the reference point methodology by adjusting parameters for each tourism category. The data were quantified using a matrix method then analysed descriptively. The results showed that the water quality qualified based on water quality standards with pollution index values of 0.72 and 0.80 for Kedindingan Island and Beras Basah Island, respectively. The tourist compatibility index for the mangrove tourism category was very suitable (80.7%), the snorkelling tourism category was appropriate (64.42%) and the beach tourism category also appropriate (78.6%). Furthermore, the regional carrying capacity was 392 people/day for the Beras Basah Island and 10,766 people/day for Kedindingan Island.

### 1. Introduction

For decades, tourism and its sustainability has been a concern of development agencies, policy makers, NGOs, environmental activists, and other stakeholders. The evolution of tourism development has described four platforms: advocacy, precautionary, adaptive, and knowledge-based [1]. Then, the sustainability and ethics have become additional platforms [2]. Ecotourism from its genesis and founding theories has set out to conserve and preserve the environment through sustainable operations that include surrounding communities in efforts to reduce their poverty levels [3]. The concept of ecotourism as a tourist activity is a form of tourism developed in a natural environment that includes tourism elements and rural culture. Ecotourism is seen as important because it can provide sustainable development as opposed to the negative impacts of uncontrolled development of mass tourism areas on the environment and local communities [4].

The development of tourism activities needs to pay particular attention, firstly, to the quality of the environment through measures aimed at its conservation and development [5]. Sustainability and the economic consequences of creating marine protected areas need to be addressed in a multispecies and multi-activity context [6]; furthermore, tourism and recreation could contribute significantly to the wellbeing of society. When the concept of sustainable development arose in relation to tourism in 1990s, sustainable development was seen as more closely related to the carrying capacity (CC) than anything else, because the idea of sustainability implies a limit and because both concepts share the



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1 same difficulties as far as the formulation of the ideas, practices, utility and diversity of types [7]. The carrying capacity of tourist areas is defined as the maximum number of people who can visit a tourist destination without causing physical, economic, or socio-cultural environment damage or an unacceptable decline in the quality of tourist satisfaction [16,10].

Maritime tourism, which includes coastal and marine tourism, is a segment of the tourism industry that has experienced rapid growth, including in Indonesia. Many people began to work on this type of tourism so that marine tourism became the fastest growing sector in the maritime sector [11]. The development of ecotourism can be considered the main opportunity offered by the current economic context since this form of tourism brings significant socio-economic benefits with minimal investment by using the natural tourism potential in a sustainable manner; furthermore, it can be a tool for nature conservation and sustainable local development [5]. In spite of significant economic benefits, ecotourism may have some negative impacts on the environment and population in the destination areas [12].

The tourism development program is one of the main city government programs in Bontang, East Kalimantan Province, Indonesia (e.g. decree of the mayor of the city of Bontang No.112/2011 about the reserve of a water conservation area in Bontang). So far, the economic structure of the city is highly dependent on the natural gas and fertilizer industries, with a contribution of 83.95%. However, economic growth was negative in 2016 and only grew 0.68% in 2017 [13]. Therefore, the government programmed the development of other more sustainable economic potentials such as tourism. For the tourism sector, Bontang has a coastline of approximately 24.4 km, directly facing the Makassar Strait, which is traversed by Indonesian archipelagic sea lane II and international shipping lines, between the Mahakam delta and Sangkulirang Bay [14]. The development of marine tourism in the coastal of Bontang continues to be developed along with other developments such as industry, land reclamation, ports and dredging channels [15].

Actually, Bontang is also a tourism destination. In the coastal area of Bontang there is an exotic Beras Basah Island for snorkelling to enjoy underwater beauty. In addition, there are also Segajah and Kedindingan islands that are equally beautiful. The existing tourism activities include beach tourism, snorkelling, diving and mangrove tourism. But, the impacts of massive tourism on water resources has received comparatively little attention from the scientific community, other than from a public health stand point. Furthermore, land-use planning in relation to water quality and point and non-point source pollutants, and to methods of managing eutrophic recreational waters, is frequently mentioned in literature concerning tourism and ecotourism [16–18]. However, there is a lack of quantification in the ecotourism of Bontang City. Most of the literature related to this kind of tourism are social and offer qualitative measures [13]. This situation is very crucial, because it is related to the planning of establishing this area as a part of the management of coastal areas and small islands according to law No.27/2007 and Act No. 1/2014. The lack of current environmental data collection and historical data in the Bontang coastal area necessitate reductionist approaches. This study aimed to assess the ecological aspects of the ecotourism industry and collect relevant information for studies on ecological compatibility and carrying capacity. Furthermore, the study aimed to provide base line data for policy makers in organizing strategic planning for coastal areas and small islands in Bontang City.

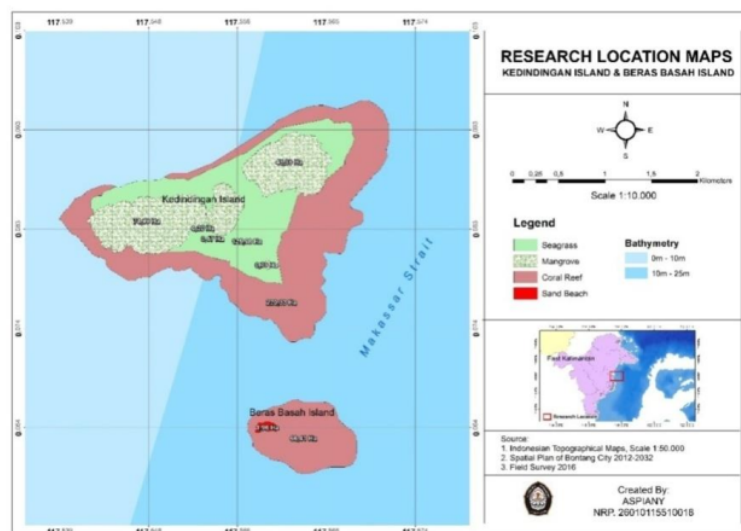
## 4 2. Materials and Methods

This research was carried out in the coastal area of Bontang City, comprising Kedinding Island and Beras Basah Island. The study site covers an area of 472.82 Ha which is located at coordinates 0° 5' 9.11" N, and 117 ° 33' 21.30" E (for Kedindingan Island) and 0° 3' 50.41" N and 117° 33' 21" E (for Beras Basah Island) (Figure 1).

### 2.1. Method of Collecting Data

The data collected included the average number of visitors and the characteristics of the tourism destination area including: water quality, characteristics of beaches, sea grasses, coral reefs, and mangrove forests. The data were then tabulated and analysed using a matrix scoring method to

determine the Tourism Compatibility Index and regional carrying capacity. Water quality was determined by the Pollution Index (PI) procedures and standards of water quality for marine tourism [19,20].



**Figure 1.** Map of the study area

## 2.2. Water Quality Analysis

The measured water quality parameters were compared with Quality Standards [20]. The parameters were: clarity, smell, total suspended solids (TSS), waste, temperature, oil and grease, pH, salinity, total ammonia ( $\text{NH}_3\text{-N}$ ), sulphide ( $\text{H}_2\text{S}$ ), phenol and detergents as MBAS. Water quality analysis is carried out by calculating the pollution index (IP), with the following classification:

**Table 1.** Classification of the pollution index

- |                               |  |
|-------------------------------|--|
| 1. If IP value < 1.0          | : Meets quality standards (good condition) |
| 2. If IP value = 1.0 - 5.0    | : Lightly polluted                         |
| 3. If IP value = 5.0 s/d 10.0 | : Moderate pollution                       |
| 4. If IP value > 10.0         | : Severe contamination                     |

## 2.3. Compatibility Analysis

Tourism compatibility was analysed by the following categories: mangrove tourism (Table 2); snorkelling tourism (Table 3) and beach tourism (Table 4). The mangrove tourism compatibility matrix used five parameters with a maximum value ( $N_{\text{max}}$ ) of 39. The Tourism Compatibility Index (TCI) using the following equation [21]:

$$TCI = \sum \left( \frac{N_i}{N_{\text{max}}} \right)$$

where: TCI is the Tourism Compatibility Index  
 $N_i$  is the  $i^{\text{th}}$  parameter value (Weight x Score)  
 $N_{\text{max}}$  is the maximum value of a tourist category

**Table 2.** Compatibility matrix for mangrove tourism [21].

No	Mangrove parameters	W	C (S1)	S	C (S2)	S	C (S3)	S	C (N)	S
1.	Area (m <sup>2</sup> )	5	> 500	3	>200 - 500	2	50-200	1	< 50	0
2.	Species	3	>5	3	3 - 5	2	0 - 1 - 2	1	0	0
3.	Density (trees/100 m <sup>2</sup> )	3	15 - 25	3	10 - 15	2	5 - 10	1	< 5	0
4.	Tides (m)	1	0 – 1	3	1 - 2	2	2 - 5	1	> 5	0
5.	Organisms	1	Fish, Shrimp, Crab, Mollusc, Reptile, Bird	3	Fish, Shrimp, Crab, Mollusc,	2	Fish, Mollusc	1	Only one organism	0

Notes: W (Weighing); C (Category); S (Score)

**Table 3.** Compatibility matrix for snorkelling tourism [21].

No	Parameter	W	C (S1)	S	N (w x s)
1	Water Transparency (%)	5	> 100 80 - 100 20 - 80 > 20	3 2 1 0	15 10 5 0
2	Coral Community Cover (%)	5	> 75 50 - 75 25 - 50 < 25	3 2 1 0	15 10 5 0
3	Types of coral	3	> 12 7 to 12 4 to 7 < 4	3 2 1 0	9 6 3 0
4	Types of reef fish	3	> 50 30 - 50 010 - 30 < 10	3 2 1 0	9 6 3 0
5	Current velocity (cm/s)	1	0 - 15 15 - 30 30 - 50 > 50	3 2 1 0	3 2 1 0
6	Coral depth (m)	1	1 - 3 3 - 6 6 - 10 > 10	3 2 1 0	3 2 1 0
7	Flat reef width (m)	1	> 500 100 - 500 20 - 100 < 20	3 2 1 0	3 2 1 0



**Table 4.** Compatibility matrix for beach tourism [21].

No	Parameter	W	C (S1)	S	C (S2)	S	C (S3)	S
1.	Water depth (m)	5	0-3	3	3 - 5	2	> 5	1
2.	Type of beach	5	White sand	3	White sand little coral	2	Black sand rock slightly steep	1
3.	Beach width (m)	5	> 30	3	10 - 30	2	3 - 10	1
4.	Sand base material	3	Sand	3	Sandy reef	2	Muddy sand	1
5.	Current velocity (m/d)	3	0 - 0.2	3	0.2 - 0.4	2	>0.4	1
6.	Beach slope (°)	3	> 10	3	10 - 25	2	> 25	1
7.	Clarity	1	> 5	3	3 - 10	2	< 3	1
8.	Coastal vegetation	1	open, coconut	3	Low shrub, grasslands	2	High thicket, settlement, port	1
9.	Hazardous organisms	1	No	3	One species	2	> 1 species	1
10.	Availability of fresh water (km)	1	< 0.5	3	0.5 - 1	2	1 - 2	1

Where: W (Weight); C (Category); S (Score)

The mangrove and beach tourist compatibility index classes are: **S1**: Very suitable, with a value of 83 – 100 %; **S2**: Suitable, with a value of 67 – < 83 %; **S3**: Conditionally suitable, with a value of 50 – <67%; **N**: Not suitable, with a value <50 %.

#### 2.4. Tourism Carrying Capacity Analysis

Estimating the carrying capacity of tourism activities for the use of conservation areas referred to Government Regulation No. 18/1994 concerning exploitation of natural tourism in the utilization zone of national parks, forest parks, and natural tourism parks. Tourism should not exceed 10% of the total utilization zone of the national park. The carrying capacity equation used was as follows:

$$CC = 0.1 \left[ K \frac{L_p W_t}{L_t W_p} \right]$$

Where: CC is the carrying capacity of the area (person/day)  
 K is the maximum number of visitors per unit area (Table 5)  
 Lp is the area that can be utilized  
 Wt is the time available for each tourist activity per day (Table 5)  
 Lt is the unit area for each tourist category (Table 5)  
 Wp is the time visitors spend on each tourist activity (Table 5)

**Table 5.** Table of values for K, Lt, Wp, and Wt [21–23].

No	Tourism Category	K (ΣVisitor) (people)	Unit Area (Lt) (m <sup>2</sup> )	Visit Time (Wp) (hour)	Time reserved (Wt) (hour)
1.	Snorkelling	1	500	3	6
2.	Coastal Recreation	1	50	3	6
3.	Mangrove Tourism	1	50	2	8

### 3. Results and Discussion

#### 3.1. Water Quality

The Pollution Index (PI) was 0.72 for Kedindingan Island and 0.80 for Beras Basah Island (Table 6). These IP values are in the suitable category according to water quality standard criteria in Decree of the Minister of the Environment Number 115/2003 concerning Guidelines for Determining Water Quality. Only ammonia was higher than the water quality standard in Minister of the Environment Decree Number 51/2004 concerning water quality standards for the use of marine tourism.

**Table 6.** Analysis of pollution Index on the water quality in Kedinding and Beras Basah Islands

No.	Parameters	Unit	Measurement Results (C <sub>i</sub> )		Quality Standards (L <sub>ij</sub> )	C <sub>i</sub> /L <sub>ij</sub>	
			1	2		1	2
1	Turbidity	mg/L	2.6	2.65	>3	0.87	0.88
2	Smells		0	0	none	0.00	0.00
3	TSS	mg/L	33	47	80	0.41	0.01
4	Waste		0	0	none	0.00	0.00
5	Temperature	°C	29	28.2	± 3	0.97	0.03
6	Oil Layer		0	0	none	0.00	0.00
7	pH	-	7.8	7.83	6.5-8.5	0.26	0.33
8	Salinity	17	33	33	35	0.94	0.03
10	Total Ammonia(NH <sub>3</sub> -N)	mg/L	0.1	0.6	<0.3	0.33	1.11
11	Sulphides (H <sub>2</sub> S)	mg/L	0	0	<0.05	0.00	0.00
12	Phenol	mg/L	0.1	0.11	<0.002	0.00	0.00
13	Detergents as MBAS	μg/L	0	0	<0.01	0.00	0.00
Sum						3.79	2.39
Average (C <sub>i</sub> /L <sub>ij</sub> )R						0.32	0.20
Max value (C <sub>i</sub> /L <sub>ij</sub> )M						0.97	1.11
Pollution Index (IP)						0.72	0.80

Remarks: 1. Kedindingan Island; 2. Beras Basah Island

Ammonia can accumulate in water because aquatic organisms continuously excrete ammonia and are part of the nitrogen cycle. Three main pollutant types are nutrients, sediments and pesticides. Pollutant loads can be usefully disaggregated [24]. Kedindingan island has a mangrove ecosystem characterised by muddy substrate which is nutrient-rich from organic matter decomposition. Conversely, Beras Basah island has no mangroves at all and is dominated by beach and coral reef ecosystems. Nutrients are generally deemed detrimental to mangroves because of synergistic effects occurring with other pollutants during intense discharge events [22]. Coral reef ecosystems are particularly sensitive to turbidity. Suspended sediments reduce light availability for coral symbionts (zooxanthellae), which may result in coral bleaching and death [23]. Suspended sediments also disturb the coral reproductive cycle.

### 3.2. Mangrove Tourism Compatibility

Kedindingan Island is actually a kind of muddy sandbar overgrown with mangroves. This sandbar inhibits the flow of currents and slows the ocean waves that lead to the coast so that it increases the sedimentation process in the surrounding area and has slowly formed a dry and submerged island periodically submerged by high tides. The survey results on the condition of the mangrove forests on Kedindingan Island gave an S1 category (score 3) for mangrove parameters, tidal conditions, and the presence of fauna as tourism objects.

**Table 7.** Mangrove tourism compatibility for Kedindingan island

No	Parameter	S	W	S	Nmax	N <sub>i</sub>
1.	Area of mangrove (m <sup>2</sup> )	1174200	5	3	15	15
2.	Types of mangrove	4	5	2	15	10
3.	Mangrove density (100 m <sup>2</sup> )	6	3	1	9	3
4.	Tides (m)	0.18	3	3	9	9
5.	Objects (fauna)	Fish, Shrimp, Crabs, Molluscs, Reptiles, Birds	3	3	9	9
Amount (ΣN)					57	46
Compatibility Index						80.7%



The analysis of mangrove tourism compatibility obtained a value of 80.7%. This index value is in the very appropriate category (range of 83-100%). The high tourist compatibility of mangroves on Kedindingan Island is certainly influenced by the extent of 117.4200 m<sup>2</sup> with good tidal conditions (0.18 m) and a wide variety of fauna. The only parameters with low scores were mangrove species and density, with only 6 types of mangroves present in relatively low densities. Mangroves on Kedindingan Island included *Rhizophora mucronata*, *Avicennia mucronata*, and *Sonneratia sp.* These mangroves are common types that grow in coastal areas with salinity up to 32 ppt. This mangrove forest is a nursery for various types of marine life, including nekton, crustaceans and molluscs. The types of fish found included; *Abudefduf sexfasciatus*, *Chromistern atensis*, *Ctenchaetus striatus*, *Caesio teres* and *Thalassoma lutescens*. The mangrove ecosystem of Kedindingan Island is also a habitat of the little egret (*Egretta garzetta*) which is a protected species of bird in Indonesia [20,25]. In addition, there are also reptiles such as monitor lizards and crocodiles which are sometimes seen around the mangroves on Kedindingan Island.

### 3.3. Snorkelling Tourism Compatibility

For coral reef tourism the main zone is around Beras Basah Island. Although there are also coral reefs around Kedindingan Island, the area is small and the diversity low. The snorkelling tourism compatibility matrix (Table 8) obtained a value of 68.42%, in the Suitable category S2 (50%-80%). For snorkelling, water clarity is very important. Around Beras Basah Island, water clarity had a score of 3 (the highest category) with 100% visibility. The other parameters had scores of 2, but no parameters scored 1 or 0.

In addition, the diversity and beauty of corals and reef fish in the coral reef ecosystem is certainly a major attraction for tourists. The corals around Beras Basah Island were diverse with stable categories and stable fish communities. The types of fish found in Beras Basah waters included: *Pterapogon kauderni*, *Chaetodon octofasciatus*, *Thalassoma lutescens*, *Abudefduf sexfasciatus*, *Chromis ternatensis*, *Neoglyphidodon nigrifrons* and *Pomacentrus alexanderae* while the types of coral found included the genera *Echinopora*, *Pachyseris*, *Porites*, *Pectinia*, and *Acropora*.

**Table 8.** Suitability matrix for snorkelling tourism on Beras Basah island and Kedindingan island

No	Parameter	Weight	Score	Nmax	N
1.	Water clarity (%)	5	3	15	15
2.	Coral community cover (%)	5	2	15	10
3.	Number of coral type	3	1	9	3
4.	Types of reef fish	3	2	9	6
5.	Current speed (cm/s)	1	2	3	2
6.	Depth of coral reef (m)	1	1	3	1
7.	Flat stretch of reef (m)	1	2	3	2
<b>Amount</b>				<b>57</b>	<b>39</b>
<b>Compatibility Index</b>					<b>68.42%</b>

### 3.4. Beach Tourism Compatibility

Beras Basah Island is also prioritized for coastal tourism. The presence of white sand that stretches around the island attracts tourists to visit the island, especially on weekend holidays and at peak season. The compatibility matrix (Table 9) shows this site as suitable based on the classification in [21].

**Table 9.** Beach tourism compatibility matrix on Beras Basah island

No	Parameter	S	W	S	Nmax	N
1.	Water depth (m)	1	5	3	15	15
2.	Beach type	White sand	5	3	15	15
3.	Beach width (m)	5	5	1	15	5
4.	Basic material waters	Sandy	3	2	9	6
5.	Current velocity (m/d)	0.16	3	3	9	9
6.	The slope of beach (°)	4	3	3	9	9
7.	Brightness of waters	3	1	2	3	2
8.	Closure of coastal land	open, coconut	1	3	3	3
9.	Biota dangerous	3	1	1	3	1
10.	Availability of fresh water (km)	5.6	1	1	3	1
<b>Amount</b>					<b>84</b>	<b>66</b>
<b>Compatibility Index</b>						<b>78.6%</b>

Beras Basah Island is only 2.5 Ha and categorised as a small island. This island has white sand beach with a slope  $<10^\circ$  fringed by coconut trees. These characteristics suitable for marine tourism. However, the absence of fresh water sources is an obstacle to the development of coastal tourism on this Island.

### 3.5. Regional Carrying Capacity

The carrying capacity analysis for Beras Basah Island and Kedindingan Island is shown in Table 10.

**Table 10.** Carrying capacity of Beras Basah and Kedindingan island

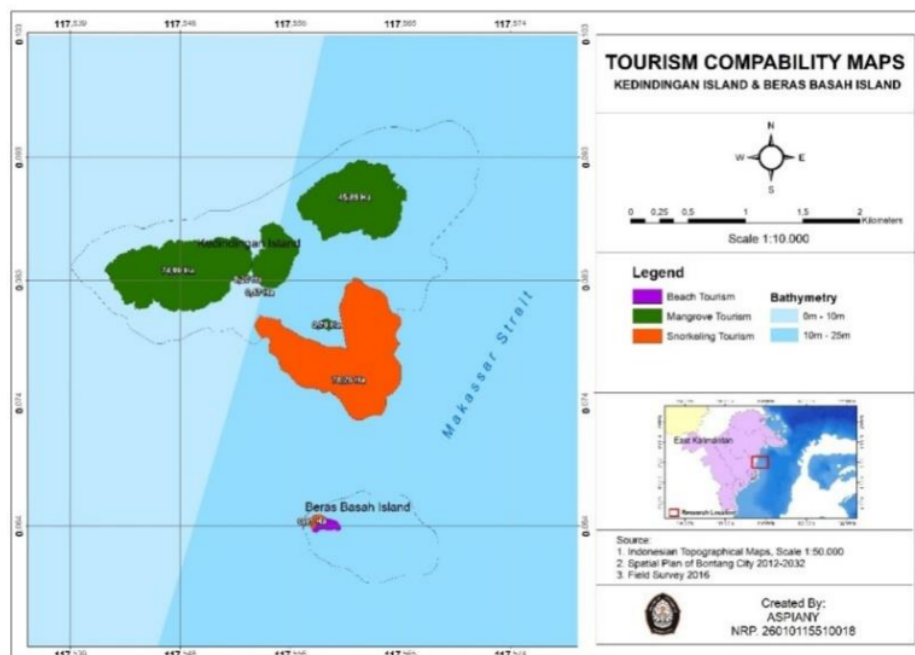
No.	Type of Activity	K	$L_t$ ( $m^2$ )	$W_p$ (hour)	$W_t$ (hour)	$L_p$ ( $m^2$ )	DDK (people/day)	Actual Visits
A. Beras Basah Island								
1.	Snorkelling	1	500	3	6	722000	289	4
2.	Beach Recreation	1	50	3	6	25800	103	81
Sub Total							392	85
B. Kedindingan Island								
1.	Snorkelling	1	500	3	6	3431700	1373	4
2.	Mangrove Tourism	1	50	2	8	1174200	9394	4
Sub Total							10,766	8
Total							11,158	93

The concept of regional carrying capacity provides a useful strategy for achieving goals that can be applied in the context of tourism management [26]. For every ecotourism activity, visitors need a wide enough space to carry out activities such as diving and snorkelling in order to enjoy the beauty of the underwater world, so it is necessary to predict the time needed for each tourism activity [27]. Every ecological potential is determined by the condition of the resources and the types of activities that will be developed. The results of the analysis show that the carrying capacity of the tourism area on Beras Basah Island is 392 people/day and 10,766 people/day for Kedindingan Island using the same ratio for both islands, where snorkelling > seagrass tourism > beach recreation. Meanwhile, field data shows the number of tourists was 85 people/day for Beras Basah Island and 13 people/day for Kedindingan Island. This number only reached 21.57% and 0.07% of the carrying capacity of the area available on the two islands.

The maximum number of visitor track areas ( $L_t$ ) provided for each tourist category strongly determines the carrying capacity index of the tourist area. The greater the area that is needed for each visitor, the lower the carrying capacity. The percentage of the area set at 10% is in accordance with the

stipulation in Government Regulation No. 18 of 1994 concerning exploitation of natural tourism in the utilization zone of national parks, major forest parks, and natural tourism parks.

In general, the number of visitors in the main tourism zone area is still very low, below 50% of the total area carrying capacity. This condition is certainly considered to be very good in terms of conservation, because it is assumed that it will not be able to have a significant impact in terms of damage to the natural environment. Kedindingan Island has a higher carrying capacity (10766 people/day) compared to Beras Basah Island (392 people/day). The difference is certainly influenced by the area of the island. Kedindingan Island does not have coastal tourism potential, but has the advantage of 117,4200 m<sup>2</sup> of mangrove forest. Meanwhile, Beras Basah Island does not have mangrove forests, but has a beach tourism with white sand covering an area of 25800 m<sup>2</sup>. However, the two islands have seagrass and snorkelling potential (coral reefs). The shortage of tourist categories on Beras Basah Island is complemented by Kedindingan Island and vice versa. So that it forms an integrated tourism main zone that is attractive to visitors and has the potential to be developed as marine tourism (Figure 2).



**Figure 2.** Map of tourism compatibility. Purple = beach tourism; green = mangrove tourism; orange = snorkelling tourism

Overall, the carrying capacity of the main coastal zone of Bontang City is 11,158 people/day. This value is higher than the carrying capacity of ecotourism in Lantebung, Makassar City [25], which reportedly has a carrying capacity of 274 people/day. However, it is lower than the carrying capacity of Panjang Beach, Bengkulu [28] which has a carrying capacity of 42,045 people/day and Baluran, NTB with a carrying capacity in the ecotourism area of 3288 people/day [29].

The balance between the number of visitors and the condition of the resource and the type of activity developed certainly needs to take into account the area used which is compared with the ability of nature to tolerate visitor activities so that sustainability is maintained [21]. An increase in

visitor numbers must have an impact, and can have both positive and negative influences, especially on the condition of the natural resources of a coastal region [29]. In the blue economy concept, it is vital to ensure that development is not merely oriented towards generating economic growth but must also be able to ensure social and ecological sustainability. Blue economy principles include national natural resource efficiency, free of waste, social inclusiveness, production system cycles, and unlimited adaptation and innovation [11].

#### 4. Conclusion.

Kedindingan Island and Beras Basah Island are in the main zone for development of marine tourism in coastal areas and small islands in Bontang City. Therefore, the analysis of the water quality, compatibility and carrying capacity of the region is very important for policy makers in developing the strategic plan for the area. The two small islands in Bontang are suitable for ecotourism activities. The water quality on Beras Basah Island and Kedindingan Island fulfilled quality standards based on the pollution index values. Kedindingan Island is very suitable (S1 category) for mangrove tourism, while for beach tourism and snorkelling tourism Beras Basah Island is classified as suitable (S2 category). The carrying capacity for ecotourism in the Bontang coastal and marine protected area was estimated at 11,158 people/day. Currently, tourist arrivals in this region are below 20% of the estimated carrying capacity.

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