

Mapping the Marine Tourist Zone of Pasumpahan Island

Hendry Frananda^{1(*)}, Fitri Mudia Sari²

¹²Universitas Negeri Padang, Indonesia

*corresponding author: hendryfrananda@fis.unp.ac.id

Abstract. Pasumpahan island is located in Bungus Teluk Kabung district, which has various kinds of potential marine tourism, such as beach, snorkeling, and diving. It is one of the Regional Marine Conservation Areas in Padang which is very potential to be developed into a marine tourism area with due regard to the conservation concept. The objective of this study were are to knowing the percentage of coral cover, calculating the abundance of megabenthos and reef fish biota, and develop directives and strategies for managing marine tourism in island area. The method used in this research was an interpretation of remote sensing imagery, aerial photography, and field surveys. The base substrate on Pasumpahan Island consists of 36% live coral, 23% dead coral, and 41% abiotic. The number of reef fish species found there was 27.5 and 109.25 individuals. The beach tourism zone is in the southeast, the tourism zone which is quite suitable for snorkeling is on the east side to the west of the island, and the tourism zone which is very suitable for diving tourism is on the northwest side while the other parts are categorized as quite suitable for tourist sites.

Keywords: Mapping, marine, tourist zone, Pasumpahan island

1. Introduction

Pasumpahan island is one of the islets in Padang. The morphology of Pasumpahan Island is plain and partly hilly with white sandy beaches. Pasumpahan Island began to become one of the marine tourism destinations in Padang. Tourism activities not only provide economic benefits but also give a negative impact on the coral reef ecosystem [5]. Tourism activities such as snorkeling cause changes in the condition of coral reef ecosystems [8]. Some tourist behaviors have the potential to damage coral reefs such as kicking corals, holding corals, walking on corals, due to snorkeling at inappropriate depths.

The impact caused by tourist behavior on coral reefs is very small, but cumulatively these behaviors can put pressure on coral reefs and affect the percentage of coral cover to reduce tourist conditions on the island of the spilled islands [4]. If this continues, it can become a threat to environmental sustainability, this condition will harm and reduce the function of Pasumpahan Island as a marine conservation area. The purpose of this study was to determine the percentage of coral cover and the types of coral reefs, to know the abundance of megabenthos and reef fish biota, and to map land suitability for marine tourism, beach tourism, snorkeling tours and diving tours in Pasumpahan Island waters.

2. Method

The data used in this study are primary data and secondary data. Secondary data consists of Landsat 8 images in 2019, aerial photographs using Drones that are used to map more details for the phenomenon of coastlines, land cover and substrate base. The Bathymetry Map is used to find out the depth of the waters.

The sampling technique used was purposive sampling, which is sampling based on specific or deliberate considerations. The consideration in this study is based on the depth and appearance of the substrate. The selected depth is between 3-15 m, this depth is the appropriate depth for coral reefs. Watershed substrate is the most influential variable in marine conservation areas.

Data collection of corals and substrate waters using the Line Intercept Transect (LIT), Percentage of coral reefs cover that live in a certain area calculated [2][9].

$$C = \sum \frac{I_i}{I} \times 100\%$$

Where: I_i = Length of transect that goes through lifeform to-i
 I = length of the transect line

Fish data retrieval is similar to coral data retrieval, for observations of reef fish stretching roll meters along 70 meters, observations are carried out along the transect line with visibility as far as 2.5 meters on the right and left of the observation.

Seawater quality data is taken using the WQC-24 Standard Hand-held Water Quality Meter, which produces data in the form of temperature, salinity, pH, DO, and turbidity (turbidity). This water quality parameter is a common parameter that commonly used and also a major supporter in the development of ecotourism on Pasumpahan Island.

Table 1. Suitability matrix for beach tourism in the recreation category [10].

No.	Parameter	Weight	S1 Category	Score	S2 Category	Score	S3 Category	Score	N Category	Score
1	Water depth / Bathymetry (m)	5	0 - 3	3	>3-6	2	>6-10	1	>10	0
2	Beach type (modification)	5	White sand	3	white sand, there is trash	2	Black sand	1	mud, rocky, steep	0
3	Beach Width (m)	5	> 15	3	10-15	2	3-<10	1	<3	0
4	Underwater material	3	sand	3	sandy coral	2	muddy sand	1	mud	0
5	Water current speed (m/dt)	3	0-0,17	3	0,17-0,34	2	0,34-0,51	1	>0,51	0
6	Beach slope (°)	3	< 10	3	10-25	2	>25-45	1	>45	0
7	Water Brightness (m)	1	>80	3	50-80	2	20-<50	1	<20 (there is trash - high turbidity)	0
8	Coastal land cover	1	coconut, open land	3	scrub, low, savanna	2	high scrub	1	mangrove forests, settlements, port	0
9	Hazardous biota (modification)	1	none	3	sea urchin (1 species)	2	sea urchins, stingrays (2 species)	1	sea urchins, stingrays, lions, sharks (> 2 species)	0
10	Availability of freshwater (distance/km)	1	< 0,5 (km)	3	>0,5-1 (km)	2	>1-2	1	>2	0

Information:

- Maximum value = 84
- S1 = Very suitable, with a value of 75-100%
- S2 = Quite appropriate, with a value of 50- <75%
- S3 = Conditionally conditional, value 25- <50%
- N = Not suitable, with a value <25%

The suitability parameters of the beach tourism recreation category include water depth, beach type, beach width, bottom water material, current velocity, beach slope, coastal land cover, hazardous biota, and freshwater availability [10]. The land suitability matrix for beach tourism in the recreation category is presented in Table 1. Marine tourism consists of three categories, beach tourism, snorkeling tourism, and diving tourism [6].

Tabel 2. Suitability matrix for Snorkeling tourism.

No.	Parameter	Weight	S1 Category	Score	S2 Category	Score	S3 Category	Score	N Category	Score
1	Water Brightness (m) (modification)	5	>10	3	>5 - 10	2	3 - 5	1	<2	0
2	Coral community cover (%)	5	>75	3	>50 - 75	2	25 - 50	1	<25	0
3	Type of life form	3	>12	3	>7 - 12	2	4 - 7	1	<4	0
4	Types of reef fish	3	>100	3	50 - 100	2	20 - <50	1	<20	0
5	Water current speed (cm/dt)	1	0 - 15	3	>15 - 30	2	>30 - 50	1	>50	0
6	The depth of the coral reef (m)	1	6 - 15	3	>15 - 20 3 - <6	2	>20 - 30	1	>30 <3	0
7	Flat reef stretch (m)	1	>500	3	>100 - 500	2	20 - 100	1	<20	0

Table 3. Land suitability matrix for dive tourism

No.	Parameter	Weight	S1 Category	Score	S2 Category	Score	S3 Category	Score	N Category	Score
1	Water Brightness (m) (modification)	5	>10	3	>5 - 10	2	3 - 5	1	<2	0
2	Coral community cover (%)	5	>75	3	>50 - 75	2	25 - 50	1	<25	0
3	Type of life form	3	>12	3	>7 - 12	2	4 - 7	1	<4	0
4	Types of reef fish	3	>100	3	50 - 100	2	20 - <50	1	<20	0
5	Water current speed (cm/dt)	1	0 - 15	3	>15 - 30	2	>30 - 50	1	>50	0
6	The depth of the coral reef (m)	1	6 - 15	3	>15 - 20 3 - <6	2	>20 - 30	1	>30 <3	0

Information:

- Maximum value = 54
- S1 = Very suitable, with a value of 75-100%
- S2 = Quite appropriate, with a value of 50- <75%
- S3 = Conditionally conditional, value 25- <50%
- N = Not suitable, with a value <25%

3. Results and Discussion

Aquatic Quality

Pasumpahan Island is one of the islands included in the administrative area of Bungus Bay Kabung District with coordinates located at 01 ° 06'58" latitude-01 ° 07'14" latitude, and 100 ° 21'52" east-100 ° 22'12' east longitude, Pasumpahan Island has an area of 5 hectares.

The coastline around Pasumpahan Island has a slope ranging from 4.1 to 8.95 °. According to the USDA Natural Resources Conservation Service Soils, the slope criteria for sloping land have a value range of 1-8%, so that the coastline on Pasumpahan Island can be categorized as ramps. Pethick's [1] that a typical beach slope is between 0.01 (0.5 °) to 0.2 (11 °), which includes gentle sloping beaches, and ≥ 0.5 (26 °) which is included on a steep beach. Four observation stations were used to collect data on coral reef abundance and water quality.

Table 4. Field Observation Station Points

Station	Latitude	Longitude
Station 1	01°07'4.02"	100°22'17.6"
Station 2	01°07'8.85"	100°22'14.8"
Station 3	01°07'10.8"	100°21'59.6"
Station 4	01°07'6.86"	100°21'55.6"

Table 5. Results of water quality measurement around pasumpahan island

Sampling Point (coordinates)	pH	DO (mg/L)	Turbidity (NTU)	Temperature (°C)	Salinity (‰)	σ _T	Brightness (m)	Stream	
								Speed (cm/dt)	direction (°)
St 1 (100°22'17.6", 01°07'4.02")	8,93	7,15	0	30	32,5	19,8	> 6 m (depth only 6 m)	5,86	350
St 2 (100°22'14.8", 01°07'8.85")	9,01	8,13	0	30,2	33,5	20,5	10,37	8,96	180
St 3 (100°21'59.6", 01°07'10.8")	9,05	9,46	0	30,6	33,5	20,3	9,1	12,75	235
St 4 (100°21'55.6", 01°07'6.86")	9,01	9,25	0	30,5	33,6	20,5	> 4.5 m (depth only 4.5 m)	14,19	265
Quality standard [7]	7 – 8,5	> 5	5	Naturally, changes can occur <2 ° C	Naturally, changes can occur <5% seasonal mean salinity	-	> 6		

Source: 2019 field survey

The salinity value at the Pasumpahan Island displacement is 32.5-33.9 ‰, with an average of 33.4 ‰ presented in Table 2. From these results, the salinity value increases inconsistently and is highly variable which can increase the variety of seagoing salinity.

The measured pH of seawater in the waters around Pasumpahan Island is 8.93-9.05, with an average of 9.00. The value of DO dissolved oxygen waters in Pasumpahan Island ranged from 7.15 to 9.46 mg / L with an average of

8.42 mg/L. This value is very good, both for marine life and the development of marine tourism around the island.

While the measured brightness varies, >> 4.5-10.37 m, values > 4.5 m are measured with the condition that the depth of the measurement location is only 4.5 m, so it is not possible for the measurement tool to be measured. This brightness value is quite supportive in the development of marine tourism because it is included in the category S1 (very suitable) and S2 (sufficient categories). The current conditions in the waters of Pasumpahan Island are quite small, ranging between 5.86 - 16.85 cm/sec, supporting the development of marine tourism, including the S1 (very suitable) and S2 (Quite appropriate) categories.

Image analysis

In this study used two types of images, namely Landsat 8 images 2019 recording and aerial photography using drones (DJI Phantom 3 pro), the use of 2 types of images is done so that the accuracy of the mapping results is high [3]. The results of image analysis obtained a map of land cover in the land area of the spill island and also the primary substrate for marine waters.



Figure 1. Image of Pasumpahan island region and sample station

Coral reefs

Table 6. Attributes of the table of substrate basics waters of pasumpahan island

Substrate	Land area m ²	%
Dead coral	75.600	30,54
Sand	108.000	43,63
Live coral	63.900	25,81
Total	247.500	

Source: Results of Landsat 8 satellite image processing and field data, 2019

In the waters of Pasumpahan Island, sandy coral material is the essential water compiler. However, at depths of 0 to 2 meters, the substrate of the bottom waters is fine sand. At a depth of 2 - 10 meters, the substrate of water in the form of coral stretch both live and dead coral that is almost found on each side of Pasumpahan island with a percentage of living coral 25.81% and the percentage of dead coral 30.54%.

Coral fish

Observation of reef fish is done visually around the coral measurement area. The types of fish observed were divided into 3, namely indicator fish, target fish, and major fish.

Fish indicator

The results showed fish species indicators were found in waters Pasumpahan, namely Chaetodon Benetti, Chaetodon collare, Chaetodon kleinii, Chaetodon lunula, Chaetodon oxycephalus, Chaetodon rafflesii, Chaetodon Triangulum, Chaetodon trifasciatus, Chaetodon vagabundus, Heniochus acuminatus, Heniochus pleurotaenia, and Heniochus singular.

Indicator fish species that are often found are at station 1 (the northwestern part), which is nine species, but only 15 individuals are identified. Whereas the observation site to the south of the island, only five species were observed with 22 individuals identified.

The diversity of indicator fish in the west location is higher than that in the south, which is 2.06, meaning that the indicator fish in the west are quite numerous and varied while the diversity of indicator fish in the southern part of the island is 1.40.

Target fish

The families of Acanthuridae and Caesionidae dominate the target fish group. The existence of target fish on coral reefs is not only dependent on the condition of the coral cover, but it is very much determined by the condition of the reef structure both as a shelter and as a hiding place from other predators. On average, in the condition of the excellent structure of the coral reefs, there will be many target fish groups. At the observation site, the highest abundance of target fish was found in the northwestern part of the waters of Pasumpahan Island.

Major fish

Major fish groups are types of fish that are not consumed and on average, are small in size. Some species are included in the types of ornamental fish with a high economic value. On average, these target fish groups are almost dominated by the Pomacentridae family. The diversity of major fish species in the northwestern part of the island is 1.12, higher than the diversity in the south of the island of 0.61.

Suitability of ecotourism

In general, marine ecotourism is very suitable to be developed in the area of small islands, as well as Pasumpahan Island. The coast of the island is quite extensive and has white sand, good natural scenery, and there is an excellent coral reef ecosystem, which will be an attraction for tourists to visit the island.

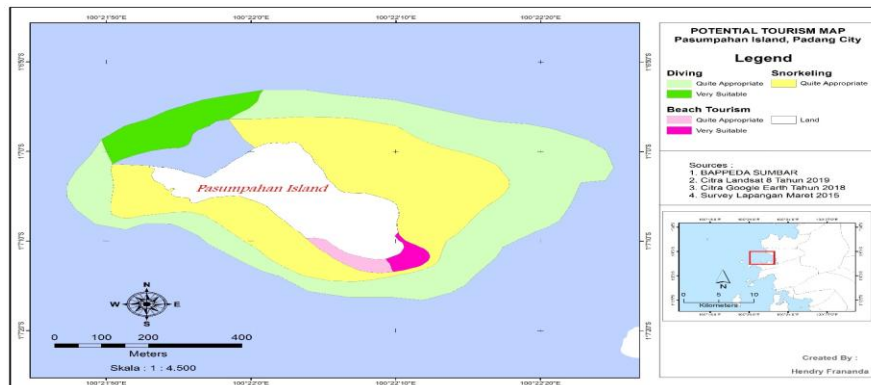


Figure 2. Potential tourism map for marine ecotourism

Beach tourism

The beach tourism zone is only in the southeast because only this section has a wide enough beach and is dominated by sand. While the eastern part of the island is a cliff (steep) and the west side is mangrove vegetation, the east side is rocky coast. The area of beach tourism with sufficient category is 0.7 ha, while the area of beach tourism category is very suitable is 0.6 ha.

Snorkeling tourism

Pasumpahan Island coastline is very suitable to be used as a beach tourism location. The marine ecotourism for the snorkeling category on Pasumpahan Island is quite suitable to be developed to be better presented in Figure 2. The depth limit of the waters used as a snorkeling tour location is about 5 m, which can still be performed underwater scenery in the form of coral, fish corals, and coupled with some underwater vegetation and other marine life. The snorkeling tourism zone is a quite suitable category starting from the east side to the west part of Pasumpahan Island with a total area of 18.7 ha.

Dive tourism

Overall, Pasumpahan Island is an area suitable for diving tourism activities, for diving tourism zones a very suitable area is located on the northwest side with an area of 3.3 ha, while other parts are included in the category sufficiently under the area of 20 6 ha.

4. Conclusion

Marine ecotourism is potential enough to be developed on Pasumpahan Island. The beach tourism zone is in the southeast, while the zone that is quite suitable for snorkeling tourism is on the east side to the west of the island, the zone that is very suitable for diving tourism is on the northwest side while the other parts are quite suitable.

5. References

- [1] Cahyanto, N. Priyo., H. Setiyono dan E. Indrayanti. (2014). *Studi Profil Pantai di Pulau Parang Kepulauan Karimunjawa Jepara*. Jurnal Oseanografi UNDIP. 3(2).
- [2] English, S., C. Wilkinson, dan V. Baker. 1994. Survey manual for tropical marine resources. Australian Institut of Marine Science. Townsville.
- [3] Frananda H 2015, Komparasi Indeks Vegetasi Untuk Estimasi Stok Karbon Hutan Mangrove Kawasan Segoro Anak Pada Kawasan Taman Nasional Alas Purwo Banyuwangi, Jawa Timur. *Majalah Ilmiah Globe* 17 (2), 113-123 vol: issue : 2015.
- [4] Hawkins, J.P. and C.M. Robert. 1992. Effect of recreational scuba diving on reef slope communities of coral reef. *Biological Conservation*, 30(1):25-30.
- [5] Hughes, T.P., A.H. Baird, D.R. Bellwood, M. Card, S.R. Conolly, C. Folke, R. Grosberg, O. Hoegh-Guldberg, J.B.C. Jackson, J. Kleypas, J.M. Lough, P. Marshall, M. Nystrom, S.R. Palumbi, J.M. Pandolfi, B. Rosen, and R. Roughgarden. 2003. Climate change, human impacts, and the resilience of coral reefs. *Science*, 301: 929-933.
- [6] Johan, Yar. 2016 Analisis kesesuaian dan daya dukung ekowisata bahari Pulau Sebesi, Provisi Lampung.
- [7] Kementerian Lingkungan Hidup. (2004). *Surat Keputusan Menteri Negara Lingkungan Hidup Nomor: 51 Tahun 2004 tentang Baku Mutu Air Laut untuk Wisata Bahari dan Biota Laut*. Jakarta.
- [8] Liew, HC., Y.S. Chua, and E.H. Chan. 2001. The Impact on coral reefs by leisure divers in Redang. National Sympo-sium on Marine Park and Island in Trengganu. 7p.
- [9] LIPI. 2014. *Panduan Monitoring Kesehatan Terumbu Karang*. Bogor. PT. Sarana Komunikasi Utama.
- [10] Yulianda F 2019. *Ekowisata Perairan: Suatu Konsep Kesesuaian dan Daya Dukung Wisata Bahari dan Wisata Air Tawar*, IPB Press.