Study of biophysical status and resources support marine tourism area of mangrove in Indramayu Karangsong

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Abstract. Karangsong beach is located in the north of Indramayu district at Karangsong village. It has an area of approximately 25 Ha for mangrove forests conservation. This research had been conducted from April to June 2017 with a purpose of surveying mangrove's diversity and density, evaluating the status of mangrove ecosystems, and assessing the management of mangrove marine tourism area in Karangsong, Indramayu. We found out that throughout the whole ecotourism area, there are three types of mangrove: *Rhizophora mucronata*, *Rhizophora apiculata* and *Aviciena marina*. The biophysical status of mangrove ecosystem proves to be suitable for ecotourism, operations are well managed and could be accounted for its sustainability.

1. Introduction

One of the potentials possessed by coastal areas is marine tourism. Mangrove ecosystems have high ecological and economical values. Their roles as protectors of coastlines, can prevent sea water intrusions. They contain a wide range of biodiversity (habitats) where they function as feeding, nursery and spawning grounds for various aquatic biota. They also have economical functions that allow the production of household and industrial goods, and could be used as recreational areas for tourist attractions.

In 2017, mangrove forests in Indramayu Regency have sustained the worst damage in West Java province. Based on the analysis of satellite imagery data, in 2008, mangrove forests in Indramayu has an area of 1,103 Ha [2]. In the past 9 years, from 2008 until 2017, there should be an increase in its land area.

Mangrove management should consider methods that are not destructive neither directly nor indirectly, and their usage can be used as an additional source of income for people living around the area. Ecologically, mangrove ecosystems can protect the physical environment from anchoring waves, wind and are the habitat of a variety of wildlife such as monkeys, snakes, monitor lizards, birds, fish, and shellfish.

Karangsong beach is located in the north of Indramayu, a city where its village lies. Its coastal regions have approximately 25 Ha of mangrove forests' conservation areas. From 2008 till 2014, mangrove trees were being planted by State officials, Governor of Indramayu and Pertamina. These areas are then given access to public for tours.

Mangroves are usually damaged due to the lack of planning in formulating the management procedures and also due to the pressure resulting from economic necessities. Some of the main reasons that lead to the damages are: (1) a high number of populations, therefore the demand to convert mangroves to human goods increase; (2) planning and managing coastal resources in the past were very expensive; (3) low level of public awareness towards conservation and functions of mangrove forests; and (4) poverty of coastal communities.

With proper planning in conservation, mangrove ecosystems will be healthier, better and can affect the well-being of local communities. One of the plans that is currently being made is tourist sites. Marine tourism is of specific interest to which maritime-related activities, above sea level (marine) and under the sea surface (submarine), are conducted. This potential of coastal resources can be used for tours, hence it's referred to as marine tourism. Nowadays marine tourism is specially activity on tourism.

Ecotourism is a form of marine resource management from the development of sea and coastal conservation [4]. Its concepts are not emphasized on economic growth factor, but maintaining a balance between resource preservation and utilization [13]. Therefore, marine tourism is a concept which connects tourism with conservation. Ecotourism is a form of activity that involves tourists enjoying themselves and at the same time, being responsible towards the environment.

2. Materials and methods

The research was carried out in mangrove areas which are meant for tourists in Karangsong, Indramayu Regency. It started from February-July 2017. The source of data used are primary and secondary data. Data was obtained by objective random sampling.

Random sampling is done to obtain samples from each population. Based on the total area of mangrove tourism, this method is used to allow the same opportunity for each existing populations to be taken as samples. For density measurements and mangrove types, the data that were obtained are physical and chemical parameters of water, and biodiversity along with its associations. Purposive sampling was used to interview visitors and determine observation points based on specific objectives and the researchers' considerations, such as data collection of visitors (tourists), length measurement of the river, its depth and substrate. Secondary data are data from related services and research reports in advance.

2.1. Sampling Location

Sampling was done in 8 (eight) stations which represent all the characteristics of mangrove forests in Karangsong (Figure 1).

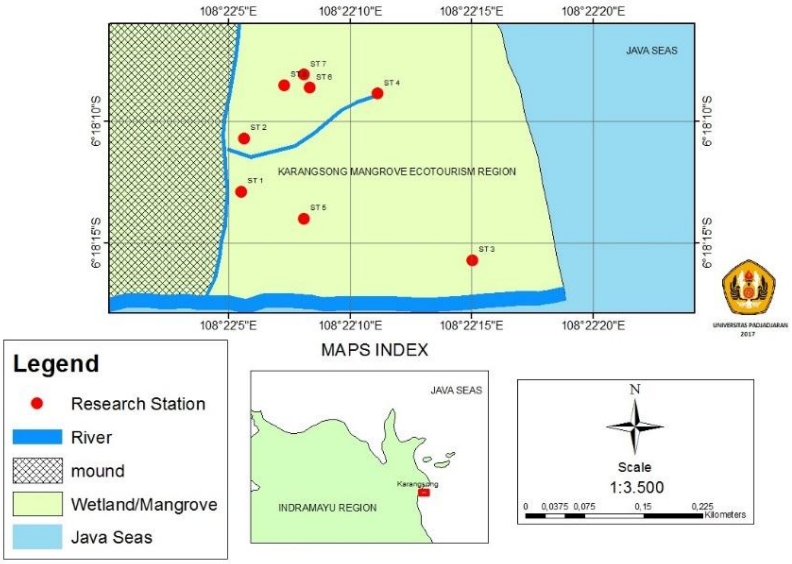

Figure 1. Map of Mangrove Research Station in Karangsong

2.2. Transect Sampling

To obtain transect sampling data, a line is drawn from a point located in the outermost area of mangrove trees, in the direction perpendicular to the coastline. The transect line is pulled as long as 50 m. Each line was made so that the observation plots are in accordance with its growth rate (Figure 2). The size of tree trunks and stakes are known by measuring the circumference of chest-high stalks (GBH), whereas the rate is only to log the type and number of stands.

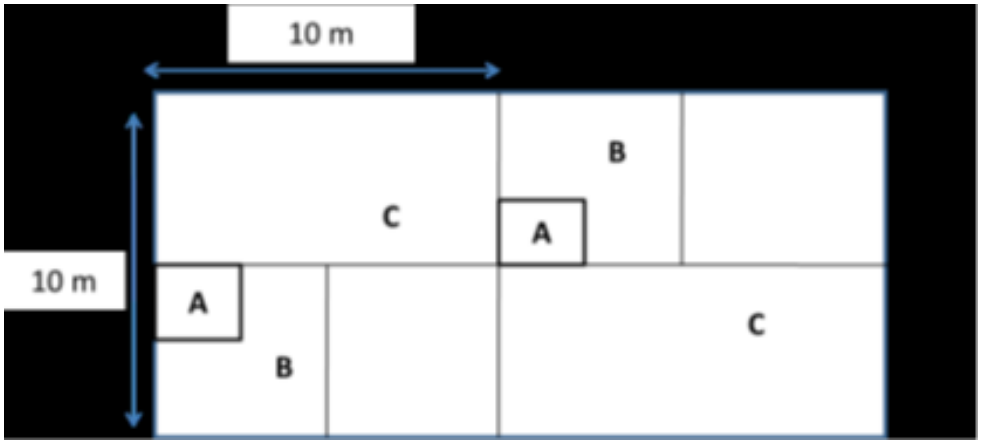

Figure 2. The observation design of vegetation in the field

Description:

A: Plots for observation (1 m x 1 m)
B: Plots for stake observation (5 m x 5 m)
C: Hiding plots for trees observation (10 m x 10 m)

2.3. Water Quality

The data required to study water quality has been obtained. It is used to study the physical and chemical parameters of the water, such as: temperature, salinity, dissolved oxygen (DO) and acidity (pH).

2.4. Biota Association

Biota data would be calculated and collected from direct observation and interviews with society/fishing in the surrounding area to get information they may not found or seen directly at the time. Observations were done to see objects that were not predetermined on biota criteria assessment which are based on object biota in the table according to the ecotourism suitability matrix [13]. Biota-object are observed in every research station. They found on photo and identification based on the macrozoobenthos book on mangroves.

2.5. Mangrove Substrate

Substrate and sediment samples were taken from stations that represent mangrove ecosystem areas in every location that has been defined and transected. The methods used for substrate analysis is sieve (Granulometry), using large scale grain Wentworth.

2.6. Suitability of Ecotourism Area

Based on the suitability calculations, the data obtained are as follows (table 1):
Maximum value = 88
S1 = Very fit, with a value of 80 - 100%
S2 = Fit, with a value of 60 - < 80%
S3 = Corresponding conditional, with a value of 35 - < 60%

N = no match, with a value of < 35%

IKW = Σ (Ni/Nmax) x 100%
IKW = index of suitability for mangrove ecosystems

Great fit/ really suitable : 80 - 100%,
Suitably fits : 60 - 80%,
Corresponding Conditional : 35 - < 60% ,
Not suitable : < 35 %).
NI = the value of the parameter to-i (Weight x Score).
Nmax = the maximum value of category of mangrove tour

Table 1. Matrix of Suitability For Mangrove Ecosystem Areas

No.	Criteria	Density	Score 4	Score 3	Score 2	Score 1
1	Density (trees/100 m^2)	3	>15-25/100 m^2	>10-15/100 m^2	5-10/100 m^2	<5/100 m^2
2	Mangrove type	5	>5	3-5	1-2	0
3	Thickness (m)	3	>500 m	>200-500 m	50-200 m	<50 m
4	Biota Association	5	4	3	2	1
5	River's Length (km)	1	>3 km	3 km	2 km	1 km
6	River's Width (km)	1	>500 m	201-500 m	4-200 m	<4 m
7	River's depth (m)	3	>3-5m	>2-3m	1-2m	<1m
8	Substrate	1	Rough, a little rough and soft sand	Rough and a little rough sand	Soft sand	Sand

3. Results

This research identified 3 types of mangroves in Karangsong, namely *Avicennia marina*, *Rhizophora mucronata* and *Rhizophora stylosa*.

3.1. Water Quality and Substrate

Water quality in mangrove ecosystems are divided into 4 physical and chemical parameters, including temperature, salinity, dissolved oxygen (DO) and power of hydrogen (pH). The testing was done in 8 stations in Karangsong and the results are represented by mangroves (table 2).

Table 2. The results of water quality and substrate measurements

Parameter	**Station**							
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
Temperature (°C)	30,33	29,5	30,5	30	30	29	30	30
Salinity (%)	28	27	29	28	29	28	29	29
DO (mg/L)	6,4	5,2	5.8	5,3	5,3	5,4	5,3	5,3
Water pH	7,5	7,4	7,33	7,5	7,4	7,5	7,4	7,5
Substrate type	Soft sand (mud)	Sand			Sand		Sand	

3.1.1. Temperature

The results of the measurements done on each station show that the temperature range in mangroves of Karangsong are : Station I 30.33 ° C, Station II 29.5 ° C, Station III 30.5 ° C, Station IV 30 °C, Station V 30 °C, Station VII 30 °C and Station VIII 30 °C. Generally, the temperature in each station is not much different from the temperature range of observation stations. This condition supports life biodiversity like mangrove crabs (*Scylla* sp) and violin crabs (*Uca* sp.). These temperatures are also suitable for mangroves to survive. The difference in time when measurements were taken in each station is related to the intensity of sunlight received by water bodies, weather conditions, and shade (closure) by plants.

3.1.2. Salinity

The results of the measurements done on each station show that the salinity range in water bodies of Karangsong are 28 ppt in Station I, IV & VI, 27 ppt in Station II, and 29 ppt in Station III, V, VII & VIII. Generally, the salinity on each station is not much different from the salinity range of observation stations. This condition supports the survival of violin crabs (*Uca* sp.). The results are in accordance with Kepmen LH No. 51 Year 2004 which states that the salinity suitable to support life for mangrove crabs (*Scylla* sp) and violin crabs (*Uca* sp) are up to 34 ppt. The salinity range in observation sites still shows corresponding values for mangroves' lives. The optimum salinity for the growth of mangroves ranges between 10-30 ppt [10].

3.1.3. Dissolved Oxygen (DO)

Based on the results of dissolved oxygen (DO) measured from each station, the data obtained are : Station I 6.4 ppm, Station II 5.2 ppm, Station III 5.8 ppm, Station VI 5.4 ppm and 5.3 ppm for Station IV, V, VIII & VIII. These are good conditions for the life of mangroves. Mangroves can live in waters with oxygen levels > 4 mg/l [10]. The amount of dissolved oxygen in water is affected by the process of aeration, photosynthesis, respiration, and oxidation of organic materials [9]. There is a relationship between oxygen levels with temperature which is : an increase in temperature reduces the solubility of oxygen. DO is indispensable for the survival of aquatic organisms, including mangrove [9].

3.1.4. pH

Based on the results of pH measured from each station, the data obtained are : 7.55 for Station I, 7.4 for Station II, III & IV, 7.33 for Station 3, and 7.5 for Station IV, VI & VIII. In general, there is a slight difference in pH. The pH of the water in mangrove observation sites were assessed according to mangrove plants. Generally, mangroves are still able to grow at a pH range of 5 – 8.5 which is in compliance with Quality Raw on Kepmen LH No. 51 Year 2004 which stated that the ideal pH water for mangroves is 7 – 8.5.

3.1.5. Substrate

Based on the identification results of substrate samples conducted in the laboratories of marine science and technology, the data obtained can be seen in table 3.

Table 3. Results of Mangrove Forest's Substrate in Karangsong

Station	Mud Texture			
	Gravel (%)	Sand (%)	(%)	Texture class
1	0,1	74,3	25,6	Muddy sand
2	0	82,9	17,1	sand
3	0	96	4	Sand
4	0	93,6	6,4	Sand
5	0	96	4	Sand
6	0	93,5	6,5	Sand

7	0	95	5	Sand
8	0	95	5	Sand

The substrate observation results from each station are : Station I consists of 0.1% gravel, 25.6% muddy sand, and 74.3% sand, Station II consists of 0% gravel, 17.1% muddy sand and 82.9% sand, Station III consists of 0% gravel, 4% muddy sand and 96% sand, Station IV consists of 0% gravel, 6.4% muddy sand and 93.5% sand, Station V consists of 0% gravel, 4% muddy sand and 96% sand, Station VI consists of 0% gravel, 6.5% muddy sand, 93.6% sand, Station VII consists of 0% gravel, 5% muddy sand and 95% sand, and Station VIII consists of 0% gravel, 5% muddy sand and 95 % sand. The station has a pad sand. Sand is classified as little stones/ pebbles. The presence of different types of sediment in each station is probably due to the source of sediments. Coarse-sized particles generally are deposited in a location not far from their source, whereas finer particles will be further transported by currents and waves, and deposited even further from the source.

Mangroves in Karangsong are the result of rehabilitation by the villagers which started in 1998. Data observations from 8 stations showed that mangroves at criteria are rarely included in Karangsong (broken) with density (trees/ha) presented at < 1000 and only station 1, 5, and 6 are the ones that have medium damage; see table 4.

Table 4. The Measurement Results of Mangrove Density

Station	Density (trees/ha)
1	1040
2	380
3	560
4	620
5	1160
6	1060
7	860
8	920

Based on the decision of Kepmen LH number 201 year 2004 about raw damage, mangroves in station I-VIII have damaged ecosystem conditions with sparse density. The data are presented in table 5.

Tabel 5. Raw Damage Criteria for Mangroves

Criteria	Density (trees/ha)
Solid	>1500
Medium	>1000 - <1500
Rare (damage)	<1000

Source: Decree of the State Minister of Environment No. 201 Year 2004

Station I and II are located in the mangrove forest, near Jetty boats which ferry tourists. According to Kepmen LH No. 21 Year 2004, a density of 1040 trees/Ha are dominated by *Avicennia* sp mangroves. Station II has 380 trees/Ha and are dominated by *Rhizopora* types, while Station III station has 560 trees/Ha which is located close to the beach and is dominated by *Avicennia* species. Station IV has 620 trees/Ha and is conveniently located near a pond which is dominated by *Rhizopora* sp. Station V to VIII has 860 – 1160 trees/Ha and are dominated by *Rhizophora* sp.

Station V contains the highest, most valuable density of mangroves (1160 ind/ha) and Station II has the lowest density (380 ind/ha). The mangroves in Karangsong are still largely in the stake phase. The

low density vegetation and the amount of mangrove species in the territorial waters may diminish even further due to the threat caused by the plans of converting the area into fishponds, logging and settlements. The criteria for raw damage of mangroves have changed from medium to rare.

Mangrove forests have been largely influenced by human activities, therefore high sedimentation and habitat changes can affect mangrove zoning. Availability of propagule are allegedly more influential in the reproduction process [8]. If the environmental conditions are suitable or appropriate, the mangroves will reproduce. This is related to the adaptation of mangrove resources against extreme conditions, for example, shoals of mud will be dominated by the propagule up at the venue.

3.2. Biota Association

There are 5 objects of biota which are associated with mangrove forests in Karangsong, Indramayu. In these five objects, there are 14 types of biota (table 6).

Table 6. The Observation Results Of Biota Association

No.	Object Biota	Type of Biota
1	Fish	Gelodok fish (*Periopthalamus sp*)
		Mullet fish (*Mugil dosumieri*)
2	*Crustacea*	Mangrove crab (*Scylla serrata*)
		Violin crab (Uca sp)
3	Mollusc	Conus shell (Conus sp)
		Cassidula aurisfelis
		Cerithidea cingulate
		Cerithidea Pomacea
		Telescopium sp
		Mangrove shell (*Polymesoda bengalensis*)
4	Reptile	Monitor lizard (*Varanus salvator*)
		Mangrove snake (*Chryosopolea sp.*)
		Lizard (*Emoia crotostata*)
5	Bird	White Heron (*Bubulcus ibis kuntul*)

The mangrove biota's diversity such as fish, crabs, molluscs, reptiles (monitor lizards and snakes), monkeys and birds add appealing values in mangrove habitats. Terrestrial fauna does not have any special adaptations to live in mangrove forests, like insects, snakes, birds and primates. Aquatic fauna consists of two types : (a) fauna living in water column, particularly various types of fish and shrimps; and (b) the ones that occupy substrates especially crabs, shells and various types of invertebrate [7]. Mangrove communities have an important role for growth, reproduction, feeding and spawning, source of nutrients for fauna which is generally a commodity economy for human communities around the beach. Fish biota include: fish, shrimp, crab, mussels, other fisheries biodiversity and non-commercial use [1].

Biota living in mangrove areas need to be preserved. The most appropriate management for biota to be able to live is to involve local communities and district managers to be more peaceful and helpful - they can live and breed. As for the benefits for public and tourists, they receive a lot of information which are derived from the existence of biodiversity in mangrove areas, like how the plants and animals live, their way of living and breeding, how their habitats are, their beauty and forms. All of this can create a feeling of happiness.

Mangrove is an organism that has numerous functions from various aspects of biology, physics and chemistry. One of them is ecotourism. To support the biophysical components for marine ecotourism, land needs to be provided [11]. The biophysical relation with mangrove ecotourism can be described using the suitability matrix with these parameters: density, type, thickness, width and length of the associated river, and substrate [13]. These parameters will produce values based on the biophysical

parameters of suitability. Mangrove ecotourism itself can be used as an alternative way to use mangroves in a positive manner besides using them just to produce wood [10]. This activity can also be used as a means of surveillance against the utilization of mangrove woods so as to preserve and maintain the natural vegetation (See Table 7).

Table 7. The Result of Suitability Matrix For Mangrove Ecosystem

No	Parameters	Density	Result	Score	Density X Score
1	Density (trees/100m^2)	3	8.25	3	9
2	Mangrove type	5	3 types	3	15
3	Thickness of the mangrove (m)	3	>500m	4	12
4	Biota Association	5	5 types of biota (fish, *Crustacea*, Mollusc, Reptile, Bird)	4	20
5	Substrate	1	Rough, medium and soft sand	4	4
6	River's Width (km)	1	4-200m	2	2
7	River's Length (km)	1	2 km	2	2
8	River's Depth (m)	3	>2-3m	3	9
Total = 73 IKW = Σ (73/88) x 100%					
IKW=Σ(Ni/Nmax) x 100%		82.95%			
Karangsong mangrove areas are really suitable for Tourism					

IKW = index of suitability for mangrove ecosystems

Mangrove tourism is a very suitable activity to gather tourists. The activities include walking, seeing birds, going to the beach, biota sightseeing and boat riding. Tourism activities that are developed should be tailored to the potential resources and allocation. Each activity requires resources and appropriate environmental attractions which should be developed [12]. Ecotourism is a form of marine resource management from the development of sea and coastal conservation [3]. A form of tourism that is based

on environmental sustainability and socio-culture can also be referred to as marine ecotourism. In term on this research marine ecotourism is mangrove tourism.

To increase the suitability index for mangrove ecotourism, reforestation needs to be done to increase the mangrove's density and thickness. To use mangrove forests in a friendly and environmentally manner, ecotourisms need community involvement to protect, maintain and manage mangrove ecosystems; that is in itself a concept of ecotourism. In addition, these activities are expected to support the livelihood of communities.

4. Conclusions

There are 3 types of mangroves found, namely *Avicennia marina, Rhizophora apiculata* and *Rhizophora stylosa*. The parameters and quality of the existing mangrove environment are still within the appropriate raw quality of Kepmen LH. We found 14 biota which are associated with mangroves in Karangsong, Indramayu.

The associated biota found in mangrove forests are Gelodok fish (Periopthalamus sp), mullet fish (*Mugil dosumieri*), mangrove crabs (*Scylla serrata*), mangrove oysters (*Polymesoda bengalensis*), mangrove snake (*Chrysopelea* sp), monitor lizard (*Varanus salvator*), lizards (*Emoia acrotostata*) and White Heron (*Bubulcus ibis*, herons). The substrate composition on Princess Island is fine sand, medium sand and silt.

The suitability index for Mangrove Tourism is 82.95%, which proves that it really is suitable for ecotourism. This shows that the mangrove ecosystem's biophysical components are worthy and have the potential for mangrove ecotourism. This fact is based on biophysical analysis.

Further research needs to be done to learn more about tourists' carrying capacity and create new tourism activities.

References

[1] Direktorat Jendral Rehabilitasi Lahan dan Perhutanan Sosial 2008 Inventarisasi dan Identifiksi Pemanfaatan Sumberdaya Hutan Mangrove
[2] BPLHD Prov. Jawa Barat 2008 *Laporan Kajian Status Mutu Laut* Bandung
[3] Ketjulan R 2011 Daya Dukung Perairan Pulau Hari sebagai Obyek Ekowisata Bahari *Jurnal Aqua Hayati* **7** (3): 183-188
[4] Ketjulan Romy, Arip Bayu and Ahmad Mustafa 2013 Kajian Potensi dan Kesesuaian Ekosistem Terumbu Karang di Pulau Lura Untuk Pengembangan Ekowisata Bahari *Jurnal Mina Laut Indonesia* Vol. **01** No. 01: 49-60
[5] Keputusan Menteri Negara Lingkungan Hidup No. 51 Tahun 2004 tentang Baku Mutu Air Laut
[6] Keputusan Menteri Negara Lingkungan Hidup No. 201 Tahun 2004 Tentang Kriteria Baku Dan Pedoman Penentuan Kerusakan Mangrove
[7] Mulya M B 2000 *Kelimpahan dan Distribusi Kepiting Bakau (Scylla sp.) serta Keterkaitannya dengan Karakteristik Biofisik Hutan Mangrove di Suaka Margasatwa Karang Gading di Langkat Timur laut, Provinsi Sumatra Utara* Thesis Institut Pertanian Bogor Bogor
[8] Onrizal and C Kusmana 2005 *Ekologi dan manajemen mangrove Indonesia* Buku Ajar Departemen Kehutanan FP USU Medan
[9] RSNI 2001 *Survey dan Pemetaan Mangrove* RSNI
[10] Saparinto C 2007 *Pendayagunaan Ekosistem Mangrove* PT. Dahara Prize Semarang
[11] Safri, Chandra Joei and Andi Zulfikar 2015 Analisis Biofisik Ekosistem Mangrove Untuk Kawasan Ekowisata Mangrove Sungai Kawal *Jurnal FIKP UMRAH*
[12] Shiddieqy Ash, Falmi Yandri and Arief Pratomo 2014 Kelayakan Ekowisata Mangrove Arungan Sungai Di Sungai Carang Berdasarkan Pada Biofisik Mangrove *Jurnal FIKP UMRAH*
[13] Yulianda F 2007 *Ekowisata Bahari Sebagai Alternatif Pemanfaatan Sumberdaya Pesisir Berbasis Konservasi.* Bogor: Institut Pertanian Bogor