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MANGROVE CONSERVATION IN HARAPAN JAYA BEACH, BEKASI, INDONESIA: ANALYSIS OF LAND SUITABLE FOR MANGROVE REHABILITATION USING GIS

IsniNurruhwati*, LantunParadhitaDewanti, RegaPermana, Herman Hamdani

Department of Fisheries, Faculty of Fisheries and Marine Sciences, UniversitasPadjadjaran, Indonesia.
E-mail: isni@unpad.ac.id

ABSTRACT

This study aims to analyze the suitability of mangrove rehabilitation land in MuaraGembong, Bekasi Regency. This research was conducted using the Geographic Information System (GIS) method and was supported by a survey at the Harapan Jaya Beach abrasion station. The parameters observed included temperature, salinity, substrate, land elevation and mangrove species. The land suitability level is divided into three classes, which are very suitable, quite suitable, and not appropriate. The results obtained indicate that Harapan Jaya Beach area is suitable to become a mangrove rehabilitation area.

KeyWords
Mangrove, MuaraGembong, Suitablity, Rehabilitation, GIS.

Introduction

Mangrove ecosystems are defined as the type of ecosystem that grows in tidal areas, flooded at high tide and free from flooding whose plant communities have tolerance to salt (Kusmana*et al*., 2013). Mangrove ecosystem functions are generally classified into three, namely physical function, ecological function and economic function(Liquete*et al*., 2016). The physical function of the mangrove ecosystem is to maintain the stability of the coastline and river bank from erosion or abrasion, accelerate the expansion of land with mud sediments carried by the current to the mangrove forest area, control the rate of sea water intrusion so that the well water around it becomes more fresh, protecting the area behind mangroves from waves, strong winds and tsunami hazards (Setiawan, 2013).

Mangrove ecosystems have experienced degradation. This degradation is caused by land conversion activities from mangrove ecosystems into residential areas and natural phenomena such as abrasion or coastal erosion (Kairo*et al*., 2001). MuaraGembongSubdistrict located in Bekasi Regency, Indonesia is one of the areas affected by abrasion. There are three villages that are threatened to be lost by abrasion, namely DesaBahagia, Mekar Beach and Bakti Beach. The abrasion that occurred in MuaraGembong was also caused by the conversion of mangrove ecosystems into ponds by nearby fishermen.

Potential hazards in MuaraGembongSubdistrict are not only from abrasion, but also run-off from upstream, because the area is the mouth of the Citarum River (Abdurrahmat, 2013). These things occur because of pressure due to utilization and management that does not pay attention to sustainability aspects. Based on this, FAO believes that mangrove rehabilitation is a conservative effort to restore the function of mangrove ecosystems that have experienced degradation and coastal erosion (Iskandar, 2008). Therefore, the land suitability analysis for mangrove rehabilitation areas in MuaraGembong District needs to be carried out in order

to determine the conditions and characteristics of the existing mangrove environment, so that mangrove management and rehabilitation can be carried out comprehensively and continuously.

Material and Methods

This research was conducted for two months from August to September 2017 in MuaraGembong Sub-District, Bekasi Regency, West Java, Indonesia. Data was collected at the Harapan Jaya Beach Abrasion Area, a station determined based on the existing mangrove rehabilitation activities (Figure 1).

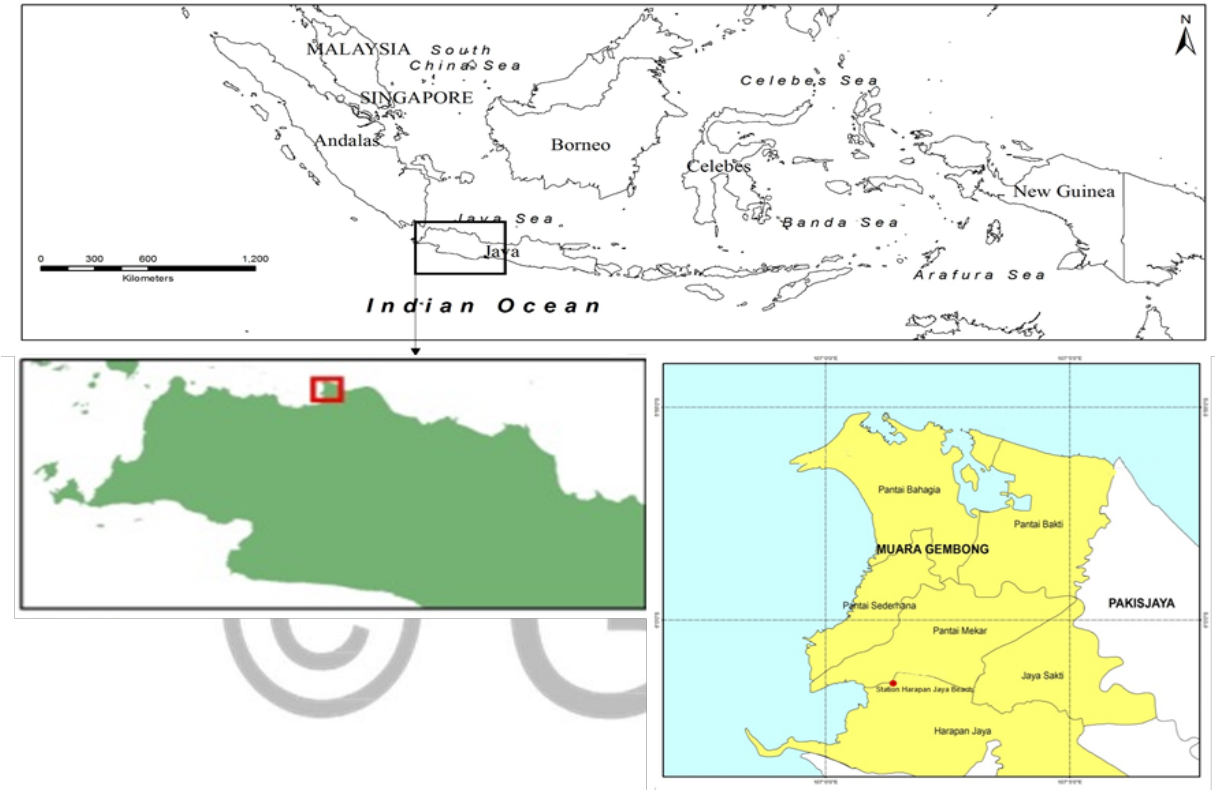

Figure 1. Map of the Research Station

The data used are primary and secondary data. Primary data is data on environmental parameters and water quality that affect mangroves. Secondary data is supporting data to conduct spatial analysis in the form of topographic data, land slope and substrate type as a comparison of primary data and administrative boundary data in MuaraGembongSubdistrict, especially in Harapan Jaya Beach area. The types and sources of data taken in this study are presented in Table 1.

Table 1. Types and Sources of Research Data

No.	Parameter	Unit	Tools	Measurement Method	References
1	Land Elevation	%	GPS	In Situ	BIG, 2003
2	Mangrove Types	-	-	In Situ	-
3	Substrate	type	Ekman Grab dan Scoop	Triangle Texture	PPPGL, 1997
4	Salinity	ppt	Refractometer	In Situ	APHA, 1995
5	Temperature	°C	Thermometer	In Situ	APHA, 1995

Land Suitability Analysis

Land suitability for mangrove rehabilitation is adjusted to environmental parameters and water quality that can support mangrove life. The suitability of the rehabilitation land is divided into four categories, namely very suitable (S1), suitable (S2), conditionally appropriate (S3) and not suitable (N). The eligibility criteria that are required refer to Table 2.

Table 2. Criteria for Suitability of Mangrove Land

No.	Parameter	Very Suitable (S1)	Suitable (S2)	Conditionally Appropriate (S3)	Not Suitable (N)	References
1	Land Elevation(m)	0-0,05	0,05-0,55	0,55-0,78	<0	Brown, 2006
2	Mangrove Types	>5	2-4	1	0	Dahuri, 2003
3	Substrate	Silt - Clay	Fine sand	Medium sand - coarse sand	Gravel	Barkey,1990
4	Salinity(ppt)	20-30	10-20	30-37	<9 ; >38	Kusamana, 1995
5	Temperature(°C)	26-28	21-26	18-20	<18 ; >28	Kusamana, 1995

Sumber:Iman, 2014

Parameters that can provide a stronger influence as a limiting factor for mangrove rehabilitation techniques are given higher weight. To get the weight value of each parameter used equation (Utojo, *et al*., 2004) like the equation below and the results of the weighting and score values can be seen in Table 3.

$$Wj = \frac{n-rj+1}{\sum (n-rp+1)}$$

Wj : Parameter Weight
N : Number of Parameters
rj : Ranking Position
rp : Parameters

Table 3. Matrix of Land Suitability for Mangrove Rehabilitation

No.	Parameter	Weight	Category	Criteria	Scale	Nilaiskor
1	ElevasiLahan (m)	0,33	0-0,05	Very Suitable	4	1,32
			0,05-0,55	Suitable	3	0,99
			0,55-0,78	Conditionally Appropriate	2	0,66
			<0 ; >0,78	Not Suitable	1	0,33
2	JumlahJenis Mangrove	0,27	>5	Very Suitable	4	1,08
			2-4	Suitable	3	0,81
			1	Conditionally Appropriate	2	0,54
			0	Not Suitable	1	0,27
3	Substrat	0,2	Silt-Clay	Very Suitable	4	0,8
			Fine Sand	Suitable	3	0,6
			Medium-Coarse Sand	Conditionally Appropriate	2	0,4
			Gravel	Not Suitable	1	0,2
4	Salinitas	0,13	20-30	Very Suitable	4	0,52
			10-22	Suitable	3	0,39
			30-37	Conditionally Appropriate	2	0,26
			<10 ; >38	Not Suitable	1	0,13
5	Suhu	0,07	26-28	Very Suitable	4	0,28
			21-26	Suitable	3	0,21
			18-20	Conditionally Appropriate	2	0,14
			<18 ; >28	Not Suitable	1	0,07

Assessment to determine the suitability of mangrove rehabilitation land based on the score of each parameter is calculated using the following equation (Utojo, *et al*., 2004):

$$\text{Value of Evaluation Results} = \frac{\text{Total score at the location}}{\text{Highest score}} \times 100\%$$

so that the determination of categories is based on the percentage of land suitability intervals as shown in Table 4.

Table 4. Class of Land Suitability for Mangrove Rehabilitation

No.	Classification	% Interval Classification
1	S1 (Very Suitable)	75-100
2	S2 (Suitable)	50-75
3	S3 (Conditionally Appropriate)	25-50
4	N (Not Suitable)	0-25

Spatial Analysis

Spatial analysis in determining the suitability of aquatic land is divided into three stages, namely the interpolation stage, the reclassification stage and the overlay stage. Spatial analysis is done after land suitability analysis. The interpolation stage is the stage of estimating the value of environmental parameters based on sample data measured at the designated station, with the Inverse Distance Weight (IDW) interpolation technique. The IDW method is more appropriate for interpolating the physical data of coastal areas because it does not produce values beyond the data sampled (Pramono*et al*., 2005). This method assumes that each input point has a local effect so that it gives great weight to cells closest to the point compared to cells that are far from the point. The next stage is to overlay. Methods that can be used in research include overlay methods between administrative maps and interpolation maps of water parameter data, whether physical, biological or chemical factors. Next, a matching method is carried out between the characteristics of these waters with the suitability requirements on the land (Djaenudin*et al*., 2003).

Resultsand Discussion

Suitability Parameters

The parameters of the suitability of mangrove rehabilitation are environmental conditions and water quality in MuaraGembong District water can show land suitability in general. The value of each parameter falls into four categories, which are very suitable (S1), suitable (S2), conditionally appropriate (S3) and not suitable (N). The results of measurements of environmental parameters and water quality are presented in Table 5.

Table 5. Average Values of the Suitability of Mangrove Rehabilitation Land in MuaraGembong District

No.	Parameter	StasiunHarapan Jaya Beach	Classification
1	Land Elevation (m)	2,7	N
2	Mangrove Types	1	S3
3	Substrate	Lanau	S1
4	Salinity (ppt)	34	S3
5	Temperature(°C)	29,5	S2

The height of a land greatly affects the type of mangrove vegetation. At the study site, the mangrove rehabilitation area had an average height of 40 m with a maximum height of 200 m (Farhana*et al*., 2016). Based on the measurement results in the field the height range of mangrove rehabilitation areas is 0.3 m. At this station is a mangrove planting area, only one type of mangrove is found, *Rhizophoramucronata*. According to Saenger (2002) mangroves from the genus Rhizophora are the most widely planted mangroves during rehabilitation, because they are easy to breed and adapt well to the environment.

The type of substrate is one of the determining factors for the success of a mangrove rehabilitation effort. According to Noor *et al*., (1999) most mangrove species grow well in muddy soils rather than sandy or rocky soils. At the research location, the substrate found was sandy loam and silt. Clay and silt are fine substrate fractions that can form mud. The types of mangroves used for planting activities in the MuaraGembong District area are *Rhizophoramucronata*. According to Kelana et al., (2015) *Rhizophoramucronata* mangrove species. Often found in areas with muddy substrates and rich in nutrients. Based on the research results obtained, this parameter is included in the category of very appropriate and quite appropriate.

Salinity is one of the factors that determine the development of mangroves, therefore, the zonation of each mangrove habitat is always different according to local environmental conditions. Salinity at the study site was 34 ppt. According to Jesus (2012) Mangroves can survive in the range of 31-34 ppt if they are in a zone directly facing the sea. Prominent habitat characteristics in the area of mangrove ecosystems, forming mangrove zoning, mangroves can survive from the front zone near the sea to the zone far from the sea with a range of salinity in water that wet the zone between 2-22 ppt (Nursal*et al*., 2005). Based on this, in general the research station is in the very appropriate category to suit the conditional.

The temperature range at each research station in Muara District is in accordance with the existing mangrove habitat conditions. The temperature range depends on the density and cover of the mangrove canopy at the observation station (Jesus, 2012). At the observation station, the temperature is 29.5 ^{o}C, due to the density and good cover of the mangrove canopy so that it can prevent sunlight from directly penetrating the body of water.

Conformity of Mangrove Rehabilitation Land

The value of each parameter is then assessed based on the land suitability matrix that has been made. The results of the assessment and percentage of suitability indicate that Harapan Jaya Beach is in the quite appropriate category (S2) with a presentation of 50% for mangrove rehabilitation land.

Analysis of Spatial Mangrove Rehabilitation

Based on the suitability value of each of the above parameters and based on the results of the overlay that has been done, a water suitability map is obtained (Figure 2). Spatial analysis results show that Harapan Jaya Beach area has a land suitability category for mangrove rehabilitation that is quite appropriate (s2). The quite appropriate category has a land area of 12,2Ha. Unsuitable water area is around 9,268 ha.

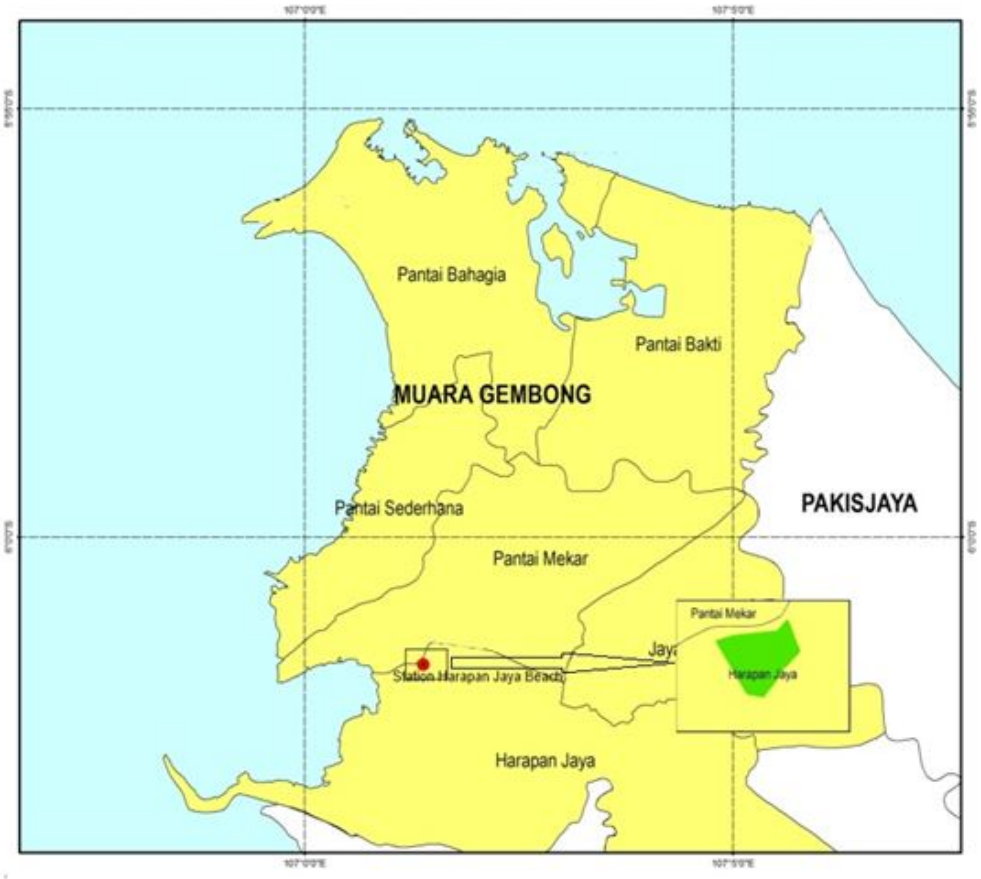

Figure 2. Map of Land Suitability for Mangrove Rehabilitation

Conclusion

MuaraGembongSubdistrict is an area that experiences very severe abrasion. To anticipate the impact of abrasion which is getting worse, it is necessary to rehabilitate mangroves. The results of the analysis show the extent of mangrove rehabilitation in the Bahari Jaya beach area including the appropriate category (S2) with an area of 12.02 Ha.

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