Spatial Analysis of Land Adjustment as a Rehabilitation Base of Mangrove in Indramayu Regency

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Abstract. Indramayu Regency is the area that has the largest mangrove in West Java. According to the environment and forestry ministry of Indramayu district will be targeted to be the central area of mangrove Indonesia. Mangroves in the regency from the 1990s have experienced a significant decline caused by the conversion of mangrove land into ponds and settlements. To stop the mangrove decline that continues to occur, it is necessary to rehabilitate mangroves in the area. The rehabilitation of mangrove should be in the area suitable for mangrove growth and what kind of vegetation analysis is appropriate to plant the area, so the purpose of this research is to analyze the suitability of land for mangrove in Indramayu Regency. This research uses geographic information system with overlay technique, while the data used in this research is tidal map of sea water, salintas map, land ph map, soil texture map, sea level rise map, land use map, community participation level map, and Map of organic soil. Then overlay and adjusted to matrix environmental parameters for mangrove growth. Based on the results of the analysis is known that in Indramayu District there are 5 types of mangroves that fit among others Bruguera, Soneratia, Nypah, Rhizophora, and Avicennia. The area of each area is Bruguera with an area of 6260 ha, 2958 ha, nypah 1756 ha, Rhizophora 936, and Avicennia 433 ha.

Keywords: Land, Mangrove, Rehabilitation

1. Introduction

Decline in the quality and quantity of mangrove forests can affect the economic life of coastal communities, such as decreased catches and reduced fishermen's income [1]. Indramayu district is one of the regencies located in West Java Province, this region has a coastal length of approximately 114.1 km and is very potential for the growth of mangrove and other coastal vegetation. Indramayu has a relatively wide forest potential of 43,027.41 ha. The types of commodities cultivated are for teak forests of 21,144.37 ha, brackish / mangrove forest (protected forest area) of 8,023.55 ha and eucalypt forests of

5,130.75 ha. The condition of mangrove forest in Indramayu Regency has been damaged due to changes in the surrounding environment and the direct and indirect pressure on the existence of the mangrove forest itself. Various rehabilitation efforts Have been conducted by the government and various NGOs to maintain the quality and quantity of mangrove forest in Indramayu district. Based on the research background, the formulation of the problem taken in this study is how the suitability of land for mangrove in Indramayu District, thus this study aims to see how the suitability of land for mangrove in Indramayu District [2,3].

2. Review of The Related Literature

2.1. Definition of Mangrove

Mangrove forests are typical forest types found along the coast or river estuaries, which are affected by tidal water, so often these forests are often called tidal forests, coastal forests, brackish forests, or mangrove forests. According to the Marine and Fishery Research Agency (2005), the characteristics of mangrove forest can be seen from various aspects such as floristic, climate, temperature, salinity, rainfall, geomorphology, hydrology, and drainage.
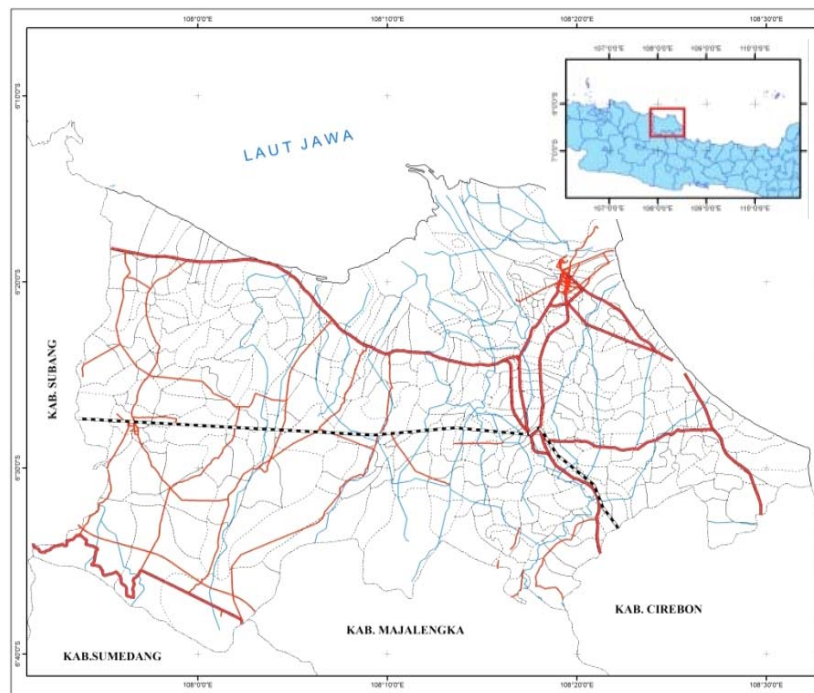
2.2. Evaluation of Land Suitability

Land is part of the landscape that includes physical understanding including climate, topography / relief, hydrology, even vegetation conditions that potentially will affect land use [4]. Land suitability is the depiction of the level of suitability of a plot of land for a particular use. The conformity class of an area may differ depending on the type of land use under consideration. Land suitability is at the unit level. Land suitability at the unit level is the subdivision of sub-classes. All units within a subclass have the same level of conformity in the class and have the same type of constraint at the sub-class level. Units differ from each other in the additional properties or aspects of management that are necessary and often a detailed distinction of their constraints. Knowing the limits in detail will facilitate the planning interpretation at the farm level. Land suitability symbols at the unit level are distinguished by Arab numbers placed after sub-class symbols, eg S3t-2, S3t-3. There are no restrictions on the number of units in a sub-class.

2.3. Method of Research

2.3.1. Setting of Research

The study was conducted in Indramayu District which is astronomically located at 107 ° 52 ° - 108 ° 36 ° East Longitude and 6 ° 15 °- 6 ° 40 ° South latitude. The method used is quantitative method. Determining the location of the research is done "purposive", that is the determination of the location chosen directly or intentionally on the grounds that at that location there are mangrove forests whose condition is damaged and at this time rehabilitation efforts have been done. The location of research in the form of maps is shown in Figure 1.

Data collection methods for mangrove land suitability analysis consist of salinity, water pH, sediment organic matter, flow velocity, substrate, land use, puddle frequency, maximum inundation, wave height, Land subsidence, Sea level rise, erosion level, land interaction to current And ups and downs.

Figure 1. Map of District Administration Sukabumi

2.3.2. Analysis of the Availability and Suitability of Land for Mangrove Vegetation

The analysis of land availability for mangrove is done based on the matrix of mangrove land availability criteria as in Table 1.

Table 1. Matrix of Land Conformity Criteria for Mangroves

No	Parameter	Class	Value	Weight
1	Salinty ($^0/_{oo}$)	29 – 33	3	2
		25 - < 29 or > 33 – 37	2	
		< 25 or > 37	1	
2	Water pH	7 – 8,5	3	1
		6,5 - < 7 or > 8,5 –9,5	2	
		< 6,5 or > 9,5	1	
3	Organic sediment material (%)	> 10,1	3	1
		4,1 - 10	2	
		< 4	1	
4	Frequency of Inundation (D/W)	20	3	2
		10-19	2	
		<10 or >20	1	
5	The maximum puddle (m)	< 0,5	3	2
		0,5 – 1	2	
		> 1	1	
6	Water flow (cm/dt)	< 1	3	1
		1 – 10	2	
		> 10	1	
7	Wave (m)	< 0,5	3	2
		0,51 - 1	2	
		> 1	1	
8	Substrate	Sand or silt	3	2

No	Parameter	Class	Value	Weight
		clay	2	
		Gravel	1	
9	Land use	Mangrove, swamp forest	3	1
		Aquaculture	2	
		Residential, industry	1	
10	*Land Subsidence* (cm/year)	< 1	3	2
		1 - 4	2	
		> 4	1	
11	*Sea level rise* (mm/year)	< 4,99	3	2
		5 – 9,99	2	
		> 9,99	1	
12	Erosion (m/year)	0	3	2
		-0,1 – (-2)	2	
		> -2	1	
13	Land interaction with the flow And waves	Protected	3	2
		Somewhat protected	2	
		Open	1	

Source: Ministerial Decree no. 51 / MENKLH / 2004); Landon, (1991); Khazali, (1999); DKP, (2008); Mazda, et al. (2003); IUCN, (2006); Dewanto, 2007); Gornitz et al. 1992); Dahuri, (2003); Yulianda modification, (2007)

Where:

Y = Final Value

Ai = Weight factor

Xn = Value of land suitability

The land suitability class is obtained based on the Equal Interval method [5,6] (Prahasta, 2002) to divide the range of attribute values into sub-ranges of the same size. The calculations are as follows:

$$I = \frac{(\Sigma\ ai.Xn) - (\Sigma\ ai.Xn)_{min}}{k}$$

Where:
I = Interval of land suitability class
K = Number of classes of land suitability desired
Based on the above formula and calculation obtained class interval and value (score) of land suitability as follows:
S1: Very Match, with value 55-66
S2: Quite Accordance, with a value of 44-54
S3: Appropriate Marginal with a value of 33-43
N1: Not Current, with a value of 22-32
N2: Not Permanent <22

After knowing the availability of land for mangroves, then the appropriate vegetation analysis in planting in the area begins with arranging the matrix of conformity criterion as shown in Table 2 as reference in analyzing the existing parameters so as to be able to make arrangements to the land suitability classes for growth Mangroves. Land suitability analysis for mangrove growth using weighted overlay method where each parameter is given the same weight then the result shows the suitability of area or area for mangrove growth.

Table 2. Matrix Selection of Mangrove Species on Suitable Land

Tidal Type/Inundation Class Watsin (1928)	Inundation Class (Salinity and Tidal Frequency) de Haan (1931)	Soil Texture Type	Dominantly *Mangrove* Type
All High tides	Brackish to salt, Salinity 10-20 ppt, Always flooded (1-2 times / day, minimum 20hari / month)	Coral, sandy, sandy clay	*Avicennia, spp* *Sonneratia, spp* *Rhizophora,spp*
	Brackish to salt, salinitas20-30ppt, always stagnant (1-2kali / hari, minimum 20 days / month)		
	Brackish to salt, salinity> 30ppt, always stagnant (1-2kali / hari, minimum 20 days / month)		
Medium high tides	10-19 days / month, salinity 10-20ppt	Dusty to dusty clay	*Bruguera gymnorrhiza*
	10-19 days / month, salinity 20-20ppt		
	10-19 days / month, salinity> 30ppt		
Normal high tides	9 days / month, salinity 10-20ppt	Dusty, clay dusty to clay	*Xylocarpus, spp* *Scyphiphora, spp* *Lumnitzera,spp*
	9 days / month, salinity 20-30ppt		
	9 days / month, salinity> 30ppt		
Spring tides only	A few days / month, salinity 0 ppt	Sandy until dusty clay	The marginal types in the environment such as *Xylocarpus moluccensis, Intsia bijuga, Nypa fruticans, Ficus retusa, Glochidion littorale.*
Storm highes tides only	A few days / month, salinity 0 ppt (Rarely stagnant pairs)	Sandy until dusty clay	*Oncosperma* spp, *Cerbera* spp.

Source: Kusmana et al. (2005)

3. Result and Description

3.1. General Condition of Research Area

Geographically, Indramayu Regency is located in 1070 52 '- 1080 36' East Longitude and 60 15 '- 60 40' South Latitude. Indramayu Regency has an area of 209,942 ha with 114.1 km long coastline stretching along the north coast between Cirebon and Subang regencies. Indramayu district has an average temperature between 22.9 ° - 30 ° Celsius, while the average rainfall during 2014 is 2,104 mm with the number of rainy days 103 days. The highest rainfall occurred in District Lohbener approximately 2,756 mm with the number of rainy days recorded 125 days, while the lowest rainfall occurred in District Terisi approximately 666 mm with the number of raindays recorded 52 days.

The soil type in the dominant study area is Inceptisol and Entisol, ie Typic Epiaquepts, Typic Endoaquepts, Aquic Dystrudepts and Typic Endoaquepts, Aquic Eutrudepts, Typic Udorthents. Ups and downs in Indramayu District are based on estimation data from two stations (Tanjung Priok and Cirebon), tidal types in the North Coast region of West Java, including in Indramayu Regency belonging to the mixed tidal type leading to semi-diurnal (multiple mix).

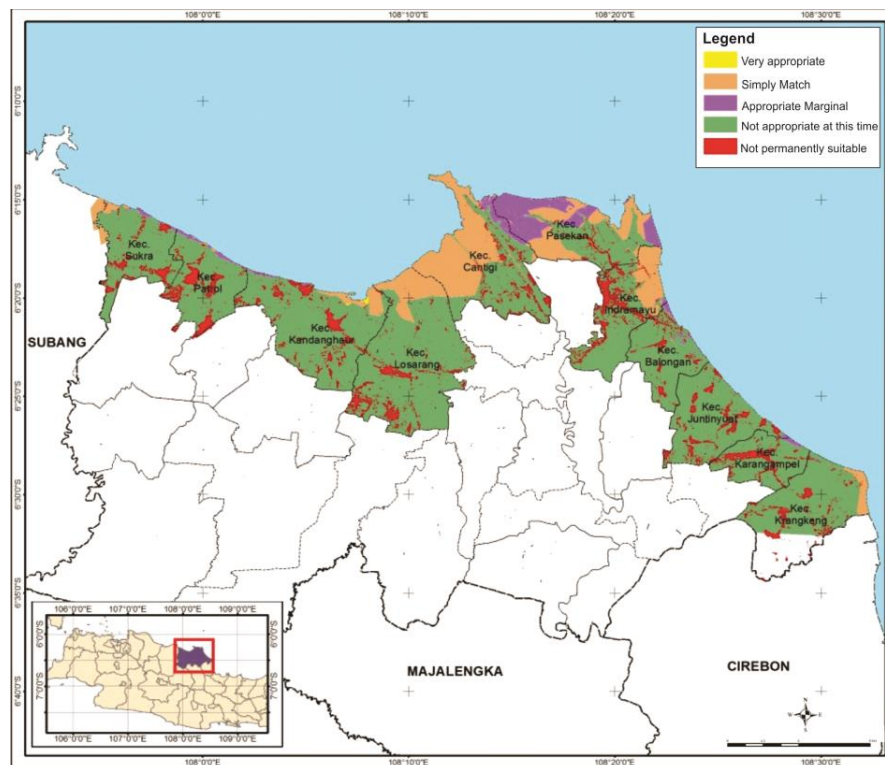*3.2. Analysis of Land Suitability for Mangrove in Indramayu District*

Based on the result of overlay some parameters of land suitability for mangrove (salinity map, pH, sediment organic matter, puddle frequency, maximum inundation, velocity, wave, substrate, land use, land subsidence, sea level rise, coastal erosion / abrasion, Current) obtained several land suitability criteria such as land criteria according to 1, according to 2, suitable 3, not current, and not permanently appropriate. Land suitability for mangrove spatially as presented in Figure 2.

Based on Figure 2 it can be seen that the land suitability for mangroves in Indramayu Regency is very complex from very suitable to non-permanent in Indramayu District. The area of each class of land suitability as shown in Table 3.

Table 3. Land Suitability Area For mangroves in Indramayu District

District	Area (ha)				
	Very appropriate	Simply Match	Appropriate Marginal	Not appropriate at this time	Not permanently suitable
Sukra	0	103.06	132.26	4143.4	498.98
Patrol	0	25.00	92.98	3102.6	726.03
Kandanghaur	29.64	505.17	56.17	7179.5	808.39
Losarang	0	1298.46	0	9092.97	859.41
Cantigi	0	3958.6	348.91	3552.8	538.55
Pasekan	0	2040.93	2140.48	2449.67	233.275
Indramayu	0	1210.0	28.18	3151.7	837.65
Balongan	0	48.13	103.66	3359.9	330.152
Juntinyuat	0	7.08	22.50	4775.6	653.39
Karangampel	0	2.10	49.42	2598.2	456.39
Krangkeng	0	371.3	5.46	4740.82	518.44
Amount	29.64	9.569.83	2.980.02	48.147.16	6.460.65

Based on Table 3, it is seen that the area of land which has a very suitable category is 29.64 ha, it is quite appropriate that is 9,569.83 ha, according to the marginal is 2,980.02 ha, not according to the current of 48147.16 ha, and the non permanent suit 6,460,657 Ha. It can be concluded that the majority of Indramayu Regency owns the land with sufficient criteria suitable for mangrove. Based on the distribution of land that has the criteria according to one is only available in Kandanghaur District of 29.64 ha, whereas for other criteria almost spread in all subdistricts that become research area.

Figure 2. Map of Land Suitability for Mangroves in Indramayu District

3.3. *Referral Type of Mangrove Vegetation suitable for Rehabilitation in Indramayu District*

In conducting mangrove rehabilitation, feasibility analysis of land suitable for mangrove is needed, as this affects the growth of mangrove itself. In addition to the need for land suitability for mangroves, also the appropriate matching of mangrove vegetation species appropriate to plant in the area by taking into account and analyze the environmental factors that affect mangrove growth.

Based on the result of overlay analysis which has been done with criterion of environmental factors affecting mangrove growth sourced from matrix of land suitability for various types of mangrove resulted that in Regency of Indramayu there are five type which suitable to be made as type choice for rehabilitation, for example Avicennia, Bruguera Nypah, Rhizophora, and Soneratia. The spatial picture can be seen in Figure 3.
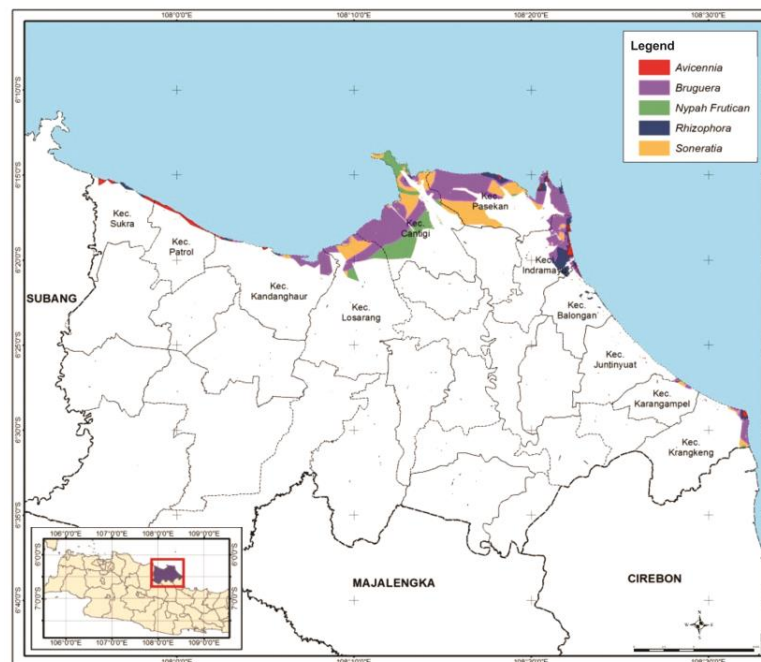
Figure 3. Map of mangrove type suitable for rehabilitation in Indramayu District

Table 4. Wide range of mangrove rehabilitation directions based on the type of vegetation

The appropriate type of mangrove	Area (ha)	%
Avicennia sp,	433	3.51
Bruguiera sp.	6,260	50.7
Nypa fruticans	1,756	14.2
Rhizophora sp.	936	7.58
Sonneratia sp.	2,958	24

Based on Table 4 it can be seen that the most suitable type of mangrove rehabilitation is the type of Bruguera which has an area of 6260 ha, then the second type is Soneratia area of 2958 ha, Nypah 1756 ha, Rhizophora 936, and Avicennia 433 ha. It shows that in Kabupaten Indramayu the type suitable for majority rehabilitation is suitable for Bruguera type.

4. Conclusion

4.1. Conclusion

The result of land suitability analysis for mangrove in Indramayu Regency obtained five categories of land suitability level that is land criteria according to 1, according to 2, according to 3, not suitable at present, and not permanent fit. The majority have land in Indramyu Regency has a suitable land criterion 2 for mangroves.

4.2. Recommendation

Local governments need to allocate programs related to increasing community participation in rehabilitation and conservation of mangrove forests. In addition, PERHUTANI needs to oblige people

who have tenure in the forest area to apply silvofishery system to their ponds so that the mangrove area in Indramayu Regency will increase and have an effect on the environmental balance in the area.

5. References

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