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A GIS-Based Analysis for Mapping the Distribution of Seaweed Cultivation Area in East Lombok Southern Coastal Waters

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ABSTRACT

The analysis employed in geographic information systems is an analysis using GIS (Geographic Information Systems) software as in land mapping or the like. GIS-based analysis can provide information that the potential distribution of seaweed cultivation area owned by the local territory is assuredly propitious; and for that reason, it needs to be maintained wisely for the people welfare. The objectives of this study are to find out the distribution of the potential seaweed cultivation area and to obtain the database on the suitability of seaweed cultivation area in the south waters of East Lombok. This research employs survey approach since it utilizes the existing data for gaining the problem solution rather than hypothesis testing. The instruments deployed in the process of the research are some equipment such as ships, GPS, current kites, measuring signals, thermometer, geological compasses, stopwatch, secchi disk, basic diving equipment, salinometer, and a GIS-based analysis software. The data of the research are carefully collected through observation method, documentation, and experiments. The result of the study shows that the total area of 606.936 ha are classified into suitable category (S2) 47.27%, not suitable area (N) 46.37% and highly suitable area (S1) 6.36%.

Keywords: Analysis, Geographic Information Systems, distribution, database.

A. INTRDUCTION

The coastal community empowerment in West Nusa Tenggara is still ineffective due to the limited data and the lack of information about the feasibility of the natural resources in the coastal area. The detail data and information from the feasibility survey of potential distribution of seaweed cultivation area which is designed in the form of prospective maps. This research discusses the management and development of coastal and waters area by utilizing the Geographic Information Systems (GIS). GIS is chosen to portray the mapping of seaweed cultivation area distribution. A GIS-based analysis is used to identify the potential resources in the coastal area on a global scale which can be done effectively and accurately. The problem statement of this research is: the potential and the form of distribution of seaweed cultivation area in the southern waters of East Lombok.

The purpose of this study is to analyze the potential distribution of seaweed cultivation area and then create a map by utilizing Geographical

Information Systems (GIS). The GIS analysis is undertaken by referring the database about distribution of seaweed cultivation area in the southern waters of East Lombok. The database were obtained by survey and mapping. The result of study, therefore, is expected to contribute as the database for mapping the distribution of seaweed cultivation in the local coastal area to be used in the socio-economic empowerment for the local community. The database can be referred as a guide to develop the coastal and waters area in East Lombok.

According to Riyanto (2010), Geographic Information Systems (SIG) refers to a set of organized computer hardware, software, geographic data, method, and personnel which are designed efficiently to gain, store, update, manipulate, analyze, and display any forms of geographic-referenced information. The recent use of remote sensing image such as Landsat and Geographic Information Systems (SIG) can be highly essential for its affordable and comfortable procedure in providing data about coastal area and its dynamics. In GIS analysis, land classification can be done based on its designation. The classification of land capability can be referred as a guidance for the land use planning. Moreover, it is also useful as a strategic planning tool in responding the climate change issue (Brown et al., 2009). The physical mapping of a land can explain its suitability level while the economic mapping shows its feasibility level. Based on the result of qualitative land mapping (physical) followed by quantitative (economic) and supported by specific data of location, a land use direction is produced and then received by the local coastal community.

The utilization of coastal resources which have diverse characteristics can only be optimally and sustainably undertaken by the integrated and sustainable planning and management (Mukti Ali, 2015). By the support and encouragement of the central government with the concept of global maritime axis, the improvement capacity and productivity of coastal area and domestic waters towards marine products such as seaweed, fisheries and its processed products, sea transportation, marine tourism, and the other marine industries will be increasing. It is in line with Budiharsono's idea (2001; 16), he states that the opportunity of maritime sector development and its impact on the development of coastal and oceanic areas in the future is quite promising[4].

Seaweed commodity is one of biological resources found in the coastal

and ocean. According to Akmal (2008), the increasing productivity and quality of seaweed and optimizing the utilization of Indonesian marine could be the effective way to develop the seaweed cultivation. Seaweed becomes potential marine commodity to be developed in this recent days. Therefore, this research is carried out with consideration of the potential and feasibility of area to foster the local community welfare. The parameter of target seaweed cultivation area are as follows: 1) Flow Rate, 2) Wave, 3) Nitrate, 4) Phosphate, 5) Transparency, 6) Tides, 7) Temperature, 8) pH (Acidity), 9) DO (Dissolved Oxygen), 10) Depth.

Geographic Information Systems (GIS) analysis for mapping the distribution of seaweed cultivation areas in the southern waters of East Lombok will result in map and database. The result is expected to contribute for improving the socio-economic life towards the prosperous community.

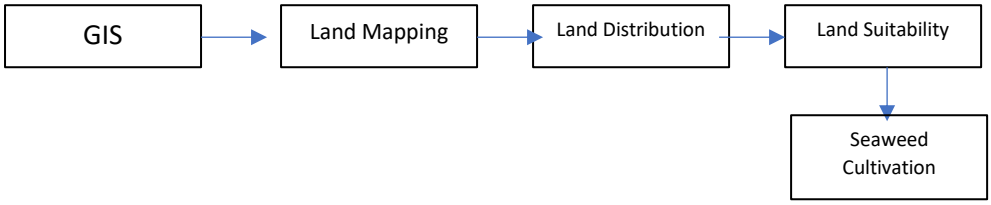

Figure 1. The Framework of the study

B. RESEARCH METHOD

Research method used in this research is survey method. The research design employed in this study is descriptive qualitative with survey approach. Riyanto (2010) defines descriptive research as research which is directed to provide symptoms, facts or events systematically and accurately, regarding the characteristics of particular population or area". Based on the expert opinion above, it can be summed up that the present study uses survey approach to find out the result of GIS analysis for seaweed cultivation area distribution that is presented in the form of maps and data about southern waters of East Lombok.

The location chosen by the researchers is the southern coastal waters in East Lombok including Ekas Bay, Seriwe Bay and Jukung Bay. The tourism site in the Ekas Bay beach is located at Pemongkong village, Jerowaru district, East Lombok. The research was carried out in April until May 2017. According to

Sugiyono, population is defined as generalized area consisting of: object/subject having particular quality and characteristics set by the researcher to be studied and then drawn conclusion from (Sugiyono, 2011). Based on these description, population in this research becomes the oceanographic parameter in the Ekas Bay, Seriwe bay, and Jukung bay in East Lombok. The total population is three points with the total area 606.936 ha while 10 samples taken from each point. The total number of the sample to be studied are 30 samples from a total three points with the total area 606.936 ha determined at the research location.

There are some methods used to obtain the data:

1. Observation, in which the researcher conduct the systematic observation and recording of the symptoms/phenomena investigated and analyzed by using Geographic Information Systems (GIS) application which is related to the distribution of seaweed cultivation area in the southern waters East Lombok in 2017
2. Documentation, is used to find out the satellite data and maps of the seaweed cultivation area. The results of the field observations are gained through chemical characteristic parameter and SIG application.
3. Experimentation, is used to explain the effect of parameter relationship determined on the suitability of the distribution of seaweed cultivation area which is analyzed using GIS application.

In this study, the type of data used is quantitative data. The data used in this research are primary sources obtained from the satellite data, observation and field documentation. In addition, the secondary sources are obtained from the supporting documents. The research consists of some phases (1) Preparation, is carried out by conducting literature review and doing initial data collection. (2) Field observationand determining the research object to get general overview of the research area. Furthermore, it can be determined the criteria to be the basis of this research. (3) Data collection covers two kinds of secondary data of research area and field survey data including

oceanographic chemical-physics data, as the following:

a. Current Direction and Speed Measurement by using the following formula:

V = s/t

Thus : V = current speed (m/second)
s = distance/ length of rope (meter)
t = time taken (second)

b. Depth measurement

c. Temperature measurement by using thermometer while the salinity is measured by utilizing handrefractometer

d. Wave directions and wave height measurement

To determine the wave data, it consists of significant wave height (H1/3), wave period (T), and significant wave period (T1/3) (Pratiko, 2006). Furthermore, it can be calculated with the mathematical formula as follows: Significant wave height (H1/3)

$$H_{\frac{1}{3}} = \frac{1}{3}\sum_{N=1}^{N}[H1 + H2 + ...H_N]$$

Thus : $H_{\frac{1}{3}}$ = Significant wave height (m)

$N = \frac{1}{3}$ Total of measured waves

1. Wave Period ($\overline{T}$)

$$T = \frac{t}{T}$$

Thus : T = the obtained wave period (sec)

t= observation time (sec)

N = total numbers of waves

2. Significant wave period ($T_{\frac{1}{3}}$)

$$T_{\frac{1}{3}} = 1{,}1 \times T$$

Thus ; T= Wave period (sec)

$T_{\frac{1}{3}}$ = Significant period (sec)

e. Transparency measurement is undertaken by using secchi disk. Besides, secondary data are gained from the related research report conducted in the same location. The data also come from the relevant organizations. The secondary data are:
   1. Physical Oceanography Data
   2. Tidal Data
   3. Chemical Data/Waters Quality

The researchers then conduct data analysis using GIS analysis based on spatial data analysis and descriptive/tabular data analysis aiming for determining the potential of marine resources management. The analysis is carried out to input the data from survey in the basic map through data overlay system in each variable. Then, it will produce a suitability map and a marine resources prospective management.

Table 2. Suitability Matrix for Seaweed Cultivation

No	Parameter	Score (S)			
		Not Suitable (N)	Suitable (S2)	Highly Suiable (S1)	Weight
		1	3	5	(B)
1	Current (cm/sec)	<10atau>40	10-20 atau 30-40	20-30	15
2	Transparency (cm)	<3	3-5	>5	10
3	Acidity level (pH)	<6,5 dan >8,5	6,8 - 8,5	6,8 - 8,5	10
4	Temperature (°C)	<20 atau >30	20-24	24-28	5
5	Depth (m)	<2atau>15	1 -2	2- 15	5
6	Wave height (cm)	>30	10-30	<10	5
7	Salinity (ppt)	<28 atau >37	34-37	28-34	5
8	DO (mg/1)	<4 atau>7	6,1-7	4- 6	5
9	Nitrate (mg/1)	<0,01 atau > 1,0	0,8-1,0	0,01-0,07	5
10	Phosphate (mg/1)	<0,01 atau > 0,30	0,21-0,30	0,10-0,20	5
11	Tidals (m)	A>4	2 <A>4	A < 2	5

Source: Modified from Aslan (2008:75), Mappadjantji, A, 2001. and Ditjenkanbud (2005).

C. RESULT AND DISCUSSION

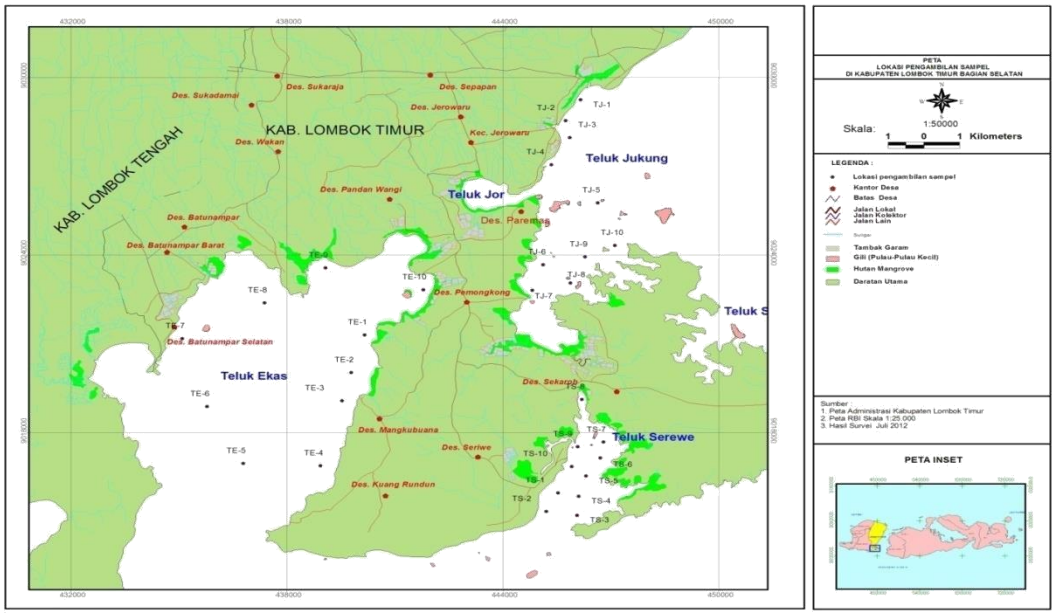

Figure 2. Map of Sampling Location

Development agenda in the coastal area will be successful by considering some crucial factors. One of them is the selection of seaweed cultivation location. Environmental factors will be highly determining the success of the cultivation since they are directly related to physical and chemical parameter. Those parameters are:

a. Temperature. The temperature at Ekas Bay is in the range of 25 – 28^{o} C to be suitable (S2). Serewe Bay is in the range 25 - 27 ^{o} C belongs to suitable category (S2). Jukung Bay 26 – 28 ^{o} C classified into suitable category (S2).

b. Salinity. The salinity level of Ekas Bay is on 33 – 40 ppt, so it belongs to suitable (S2) and some are dispersed in not suitable (N). Serewe Bay salinity is at 36 -37 ppt showing the suitable level (S2). Besides, the salinity 35 – 38 ppt for Jukung Bay meaning that suitable (S2) but more dominantly to not suitable (N).

c. Transparency. The transparency of Ekas bay is seen at 0.30 – 7.00 meter, meaning that it is highly suitable (S1) to the level of suitable (S2). Serewe Bay belongs to highly suitable (S1) and some parts are suitable (S2) with 0.5 – 4.00 meter. With the range of 0.5 – 5.00 meter, Jukung Bay is categorized into highly suitable (S1) and some suitable (S2).

d. Acidity Level (pH). Ekas Bay with the salinity level 7.2 – 8.2 is categorized into highly **suitable** (S1) to suitable (S2). Serewe Bay with 7.3 salinity belongs to suitable (S2) and Jukung Bay is at 7.3 – 7.4 included to be suitable (S2).

e. Dissolved Oxygen (O_2). Ekas Bay is at 6.00 – 6.60 ppm dominated by suitable category (S2) and some are highly suitable (S1). Serewe Bay DO is 5.7 – 6.60 ppm categorized into highly suitable (S1) to the suitable (S2), and Jukung Bay is at 5.3 – 5.6 ppm meaning highly suitable (S1).

f. Phosphate (PO_4). Phosphate condition at Ekas Bay is 0.06 – 038 ppm, showing suitable (S2) to not suitable (N). Serewe Bay with Phosphate (PO_4) of 0.07 -0.15 ppm belongs to suitable category (S2), while Jukung Bay phosphate (PO_4) is at 0.44 – 2.33 ppm to be not suitable category (N).

g. Nitrate (NO_3). The nitrate (NO_3) in Ekas Bay is 1.80 – 2.10 ppm to be not suitable level (N). Serewe Bay nitrate (NO_3) is 0.80 – 2.90 ppm showing suitable (S2) to not suitable category (N). Jukung Bay at 1.40 – 1.90 ppm which is categorized as not apropriate (N).

h. Depth. Ekas Bay at the depth of 0.50 – 37.20 meter dominated by highly suitable category (S1) to the not suitable (N). Serewe Bay with the depth at 1.00 – 11.00 meter indicates the highly suitable level (S1) and Jukung Bay at the depth 0.50 – 5.00 meter is classified into highly suitable (S1).

i. Current Speed (V). Ekas Bay with the current speed at 0.003 – 0.349 m/second is categorized as suitable (S2) and some are highly suitable (S1). There are some not suitable areas (N) located in the area of river mouth which tends to have low current speed. Serewe Bay at 0.105 – 0.353 m/second belongs to suitable (S2) up to the highly suitable (S1). For Jukung Bay, the sped is 0.019 – 0.054 m/second which dominated by not suitable category (N), so it requires great effort to develop seaweed.

j. Tidal (A). Based measurement results in Ekas Bay, Serewe Bay, and Jukung Bay, the overall condition of tidal is shown in the range of 3 meters. It can be said that it belongs to the highly suitable category (S1).

k. Wave Height (H1/3). Ekas Bay with the wave height 0 – 0.178 meter is categorized as suitable (S2). Serewe Bay at 0.105 meter indicates that it

belongs to suitable category (S2) and Jukung Bay has wave height at the range of 0.100 – 0.247 meter categorized as suitable (S2). Based on spatial analysis, it can be used for determining the level of land suitability as seen in Figure 3.

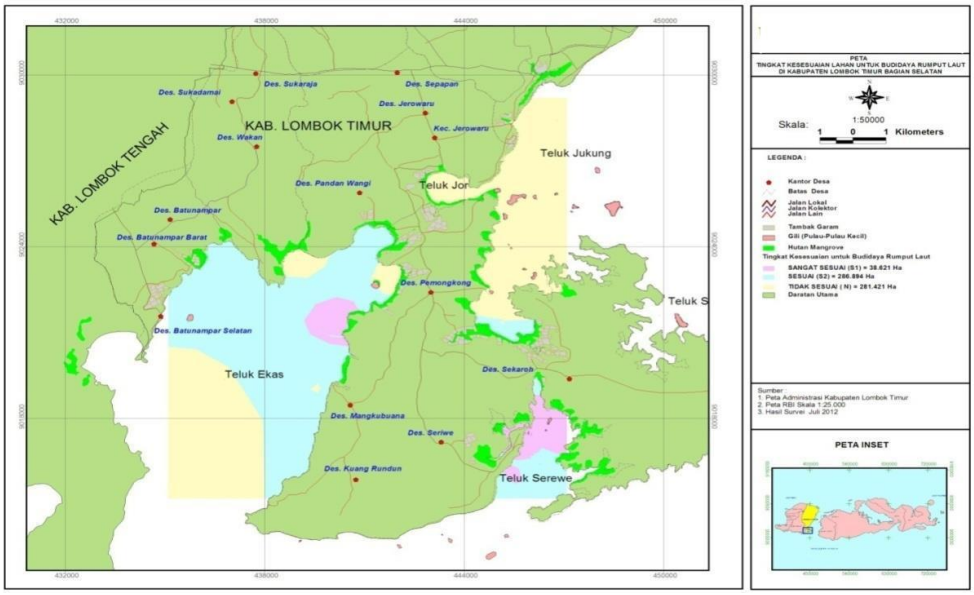

Figure 3. Land Suitability Map for Seaweed Cultivation

Based on the results of land suitability analysis for seaweed cultivation, the research setting covers 606.936 ha areas. Most of the areas are categorized as suitable level (S2) with 47.27% or 286.894 ha. There are 46.37% or 281.421 ha area classified into not suitable (N). Furthermore, 6.36% or 38.621 ha area are highly suitable category (S1).

D. Conclusion and Recommendation

1. Conclusion

From the results of GIS analysis, it can be concluded that the southern coastal area in East Lombok has area distribution for seaweed cultivation. The potential areas could trigger the welfare improvement for the local community. In this research context, mapping and utilization of coastal areas are closely related to the GIS application. GIS application provides great advantages in the process of regional planning and development based on the land suitability parameters both physical and chemical. Total area of this research is 606.936 ha, classified into suitable 286.894 ha (S2) (47.27%), not suitable (N) 281.421 ha (46.37%) and highly suitable (S1) 38.621 ha (6.36%).

2. Recommendation

To the government, the policy making related to the land use should consider the distribution of land capability in accordance to its designation. In order to improve the productivity, the environmental factors should be carefully taken into account since it influences the seaweed growth. Moreover, it is expected that the government will take further action to follow up the result of this study, so that the spatial planning in southern coastal East Lombok will be appropriate with the condition of land. Hopefully, this research will positively contribute and support the coastal community development program to be more on target so that the natural resources can be utilized optimally for local welfare.

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