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Optimization of Seaweed Farming Areas in Sumba Island, East Nusa Tenggara Province

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ABSTRACT

Seaweed is the main commodity of East Nusa Tenggara Province and is the belle of marine aquaculture in coastal communities. In the last decade, seaweed farming has been an economic activity that is of great interest to the people of the coast of Sumba Island. The dominant types of seaweed farming there are *Kapppahycus alvarezii* and *Kappahycus striatum*. Sumba Island has the potential for seaweed farming of 17,752 Ha and only 42.86% has been utilized, with a production of 5,433,440.90 wet tons. Seaweed farming activities were chosen because of their advantages: a relatively short harvest period of 45 days, easy access to farming equipment, easy farming at low cost, and the availability of a market. Besides being easy to farm, the selling price is very good. These conditions have resulted in a large number of farming activities and their spread is poorly controlled and has even penetrated into conservation areas. This study aimed to examine the suitability of areas and the carrying capacity of waters in efforts to manage sustainable seaweed farming on the island of Sumba. Data collection methods used in this research were surveys and observation methods. The results showed that the suitability of seaweed farming areas in Sumba Island was categorized as Suitable and Very Suitable with a value range of 205 – 295, except for Pero Konda Waters which was categorized as Not Suitable so that it was not recommended for seaweed farming. The development of seaweed farming areas is still possible by taking into account the carrying capacity, with a maximum tolerance limit of 75% of the total area of suitable waters.

Key words: *Seaweed, Carrying capacity, Suitability areas, Sumba Island.*

Introduction

Seaweed is a leading commodity in East Nusa Tenggara Province (NTT) and is the belle of the sea cultivation business for coastal communities. The area of seaweed farming in NTT is 51,300 hectares, with a production potential of 15,800,000 wet tons. Seaweed production in 2020 reached 2,187,372.71 wet tons, with a utilization rate of only 12.5%. In Sumba Island, the area's potential for seaweed farming is 17,752 hectares and only 42.86% has been utilized, with a production of 5,433,440.90 wet tons. NTT Province is the second largest province contributing to seaweed production in Indonesia after South Sulawesi Province (Boro *et al.*, 2022).

Sumba Island in the Province of NTT consists of 4 districts, namely: East Sumba, Central Sumba, West Sumba, and Southwest Sumba. In the last de-

cade, seaweed farming has been an economic activity that is of great interest to the people of the coast of Sumba Island, especially in East Sumba and Southwest Sumba district. The dominant species of seaweed farmed are *Kapppahycus alvarezii* and *Kappahycus striatum*. Seaweed farming activities were chosen because of their advantages: a relatively short harvest period of 45 days, easy access to farming equipment, easy farming at low cost, and the availability of a market. Besides being easy to farm, the selling price is very good for *K. alvarezii* and *K. striatum*. In 2022 the highest selling price of dry *K. alvarezii* and *K. striatum* in Sumba Island was purchased by PT. Algae Sumba Timur Lestari reached IDR. 40,000/kg. This raises very high enthusiasm from the community for seaweed farming. These conditions have resulted in a large number of farming activities and their spread is poorly controlled, and have even penetrated into the conservation area (protection zone) of the Savu Sea Marine National Park. Seaweed has been planted along the coastline in several potential locations, without taking into account the suitability of the area and the ability of the waters to accommodate seaweed farming activities (carrying capacity).

In addition, even though most of the farming areas were experiencing biological disturbances due to the ice-ice disease, the community continued to farm in locations infected with the disease. If this continues and is not regulated properly, seaweed farming activities will experience a decrease in the quantity and quality of production, and the aquatic environment will experience disturbances both biologically and physically. Therefore, it is necessary to conduct a study regarding area suitability and carrying capacity in efforts to manage sustainable seaweed farming in Sumba Island, NTT Province.

Materials and Methods

Data collection methods used survey and observation methods. According to Singarimbun (1985), the survey method is a research method that explores data and information at the study location. In the context of this research, the survey method is to collect actual data related to seaweed farming activities, both biophysical measurements and aquatic ecology, as well as technology aspects in supporting the development of sustainable seaweed farming.

The Determination of the suitability of a farming location is an ecological condition that is carried out by observing the biophysical conditions of the farming location and comparing the results of quality standards or conditions for growing seaweed. Suitability class intervals were obtained based on the Equal Interval method (Prahasta, 2001) in order to divide the range of attribute values into sub-ranges of the same size. Class intervals and suitability scores were as follows:

225 – 300 = Very Suitable (S1)
171 – 224 = Fairly Suitable (S2)
0 – 170 = Not Suitable (N)

In this study, 13 parameters were used, including current speed, water brightness, salinity, dissolved oxygen (DO), nitrate, phosphate, temperature, water pH, water depth, exposure, pollution, substrate, and wild algae.

Analysis of the carrying capacity of the waters for the development of seaweed farming was carried out using the farming area approach based on the method applied. The stages of analysis based on the capacity approach of seaweed farming using the Long Line and Off Bottom methods with the formula from Rauf, 2008, included:

- Determination of the suitable area in m^2;
- Determination of seaweed water capacity;
- Determination of the carrying capacity of seaweed based on water capacity;
- Determination of unit area of seaweed farming;
- Determination of the number of seaweed farming units;

Results

Suitability of Seaweed Farming Areas

Ketepatan pemilihan lokasi adalah salah satu faktor yang menentukan keberhasilan usaha budidaya. Berdasarkan informasi dari masyarakat pembudidaya dan pemerintah setempat, pemanfaatan areal budidaya perairan laut yang dilakukan selama ini umumnya tanpa diawali dengan analisa kesesuaian lahan dan kondisi daya dukung perairan serta status lokasi. Dengan demikian para pembudidaya dihadapkan pada berbagai kondisi yang tidak diprediksikan sebelumnya yang dapat mempengaruhi usaha budidaya yang dilakukan. Oleh karena itu dilakukan analisis kesesuaian lahan/perairan budidaya rumput laut di Pulau Sumba. Hasil analisis ditampilkan pada Tabel 1.

The location selection accuracy is one of the fac-

tors that determine the success of farming activities. Based on information from farmers and local government, the utilization of farming areas that have been carried out so far has generally not started with an analysis of suitability and carrying capacity, as well as the status of the location. Thus, farmers are faced with various conditions that are not predicted in advance which can affect the farming activities being carried out. Therefore, an analysis of the suitability areas for seaweed farming in Sumba Island was carried out. The results of the analysis are shown in Table 1.

Based on Table 1, the level of suitability area for seaweed farming in almost all sampling locations is categorized as Suitable and Very Suitable (inside and outside the farming areas), except for Pero Konda Waters in Southwest Sumba Regency, both inside and outside the farming areas categorized as Not Suitable. This means that sampling locations that represent seaweed farming activities and projected locations for seaweed farming development on Sumba Island have limiting physical-chemical factors that can be tolerated. The identified limiting factors are current speed, temperature, water brightness, salinity, pH, substrate, and exposure. The process of determining the suitability area was done by comparing the prerequisite parameters with the measured water conditions. The results of this analysis showed that Sumba Waters (except Pero Konda Waters, Southwest Sumba Regency) were very suitable for farming activities both inside and outside the existing seaweed farming areas, but Bessie et al. (2022) stated that farming activities still pay attention to the carrying capacity of the area in an effort to develop sustainable seaweed and also for optimal production results.

Very suitable area (S1) is characterized by not having serious barriers (inhibitors) to determine the treatment given or only having obstacles (limiters) that are not significant or have a significant effect on their use and will not increase the input/level of treatment given. Several limiting factors in this area were natural and apply to almost all seaweed farming areas, including (a) the location was in the area that has conditions of current and wave movement which in the second west/second transition season were extreme so that during that season seaweed farming cannot be carried out (but in the eastern part of Sumba Island there was a safe area for nurseries), (b) ice-ice disease which continues to infect/

Table 1. Analysis of Suitability Area for Seaweed Farming in Sumba Island

Study Location	Land Suitability Value in Cultivation Areas			Land Suitability Value outside the Cultivation Area		
	Very Suitable	Fairly Suitable	Not Suitable	Very Suitable	Fairly Suitable	Not Suitable
Benda Waters, East Sumba Regency	285			290		
Laipori Waters, East Sumba Regency	240				220	
Laiwila Waters, East Sumba Regency	280			280		
Maudolung Waters, East Sumba Regency	265				205	
Londa Lima Waters, East Sumba Regency	265				215	
Palanggay Waters, East Sumba Regency	280			290		
Kapihak Mondu Waters, East Sumba Regency	275			250		
Warajangga Tapil Waters, East Sumba Regency	280			260		
West Kaliuda Waters, East Sumba Regency	265			265		
Larawali Napu Waters, East Sumba Regency	270			295		
West Waide Tana Mbanas Waters, Central Sumba Regency	260			275		
Tana Mbanas East Waters, Central Sumba Regency	275			285		
Bina Natu Tana Righu Waters, West Sumba Regency	285			290		
Mananga Waters, West Sumba Regency	260			260		
Karuni Waters, Southwest Sumba Regency	290			280		
Letekonda Waters, Southwest Sumba Regency	285			285		
Wanyapu Waters, Southwest Sumba Regency	230			190		
Pero Konda Waters, Southwest Sumba Regency			170			170
Pero Batang waters, Southwest Sumba Regency	240			255		

Source: Primary data processed, 2023

spread within the farming locations even though the attack intensity was small (suspected the quality of the seeds and water quality such as temperature, salinity, and current speed at a certain time), (c) the location is quite far from transportation facilities so that it requires additional costs for transportation.

For the development of environmentally friendly and sustainable seaweed farming activities, it is necessary to arrange/provide areas for transportation routes so that fishing boats can still sail to catch fish.

Carrying Capacity

Every development activity requires space, but the space/area to support development activities is increasingly limited considering the intensity of the growth rate in the use of space is getting higher. In an effort to overcome conflicts over the use of space, it is necessary to carry out spatial planning that prioritizes the carrying capacity of the area. Of course, this is supported by the availability of data on the physical, ecological, and socio-economic conditions of the existing natural resources. Clark (1992), stated that the carrying capacity of the environment or area is defined as the capacity possessed by an area where the use of various resources continues (development activities). In an integrated manner, the meaning of carrying capacity is the level of utilization of natural resources or ecosystems in a sustainable manner without causing damage to resources and the environment. In more detail, the carrying capacity of the waters and the number of farming units that can be developed for seaweed farming on Sumba Island are presented in Table 2.

Utilization area activities for seaweed farming in Sumba Island Waters (especially East Sumba and Southwest Sumba Regencies) have increased over the last decade. The increase in areas used is due to the regional government's program to build a seaweed industry (factory) in East Sumba Regency, the Ministry of Maritime Affairs and Fisheries through

Table 2. Area of Carrying Capacity and Number of Ris Ropes that can be developed for Seaweed Farming on Sumba Island

No.	Study Location	Suitable Area (ha)	Waters Carrying Capacity (ha)	Number of Stretches Ropes (units)	Farming Costs per Unit (seeds, ropes, buoys, etc.) (IDR)	Production Period (month)
East Sumba Regency						
1.	Benda Waters	5,55	4,16	520	91.054.688	10
2.	Laipori Waters	3,47	2,60	325	56.929.688	10
3.	Laiwila Waters	10,56	7,92	990	173.250.000	10
4.	Maudolung Waters	8,10	6,08	759	132.890.625	10
5.	Londa Lima Waters	2,77	2,08	260	45.445.313	10
6.	Palanggai Waters	3,30	2,48	309	54.140.625	10
7.	Kapihak Mondu Waters	0,62	0,47	58	10.171.875	10
8.	Warjangga Tapil Waters	2,81	2,11	263	46.101.563	10
9.	West Kaliuda Waters	3,20	2,40	300	52.500.000	10
10.	Larawali Napu Waters	13,25	9,94	1.242	217.382.813	10
Central Sumba Regency						
11.	Waide Tana Waters	2,00	1,50	188	32.812.500	10
12.	Lenang Waters	2,34	1,76	219	38.390.625	10
West Sumba Regency						
13.	Bina Natu Waters	16,47	12,35	1.544	270.210.938	10
14.	Lakori Waters	4,29	3,22	402	70.382.813	10
15.	Karuni Waters	8,27	6,20	775	135.679.688	10
Southwest Sumba Regency						
15.	Letekonda Waters	17,14	12,86	1.607	281.203.125	10
17.	Wainyapu Waters	1,62	1,22	152	26.578.125	7
18.	Pero Batang Waters	3,80	2,85	356	62.343.750	7
19.	Pero Konda Waters	0,00	0,00	0	0	0
	Jumlah	**109,56**	**82,20**	**10.262**	**1.797.468.754**	

Source: Primary data processed, 2023

the Integrated Marine and Fisheries Center Program which focuses on seaweed development, and the Seaweed Farming Village Program, and the private sector. such as Non-Governmental Organizations and seaweed entrepreneurs with seaweed farming area development programs. For this reason, the determination of the carrying capacity of the seaweed area is very important. In this study, the determination of the carrying capacity of areas for seaweed farming was carried out using a water capacity approach based on the appropriate water area (Highly Suitable category). Besides that, the determination of the carrying capacity was adjusted to the farming method applied by the farmers at the research location, namely the long line and off-bottom methods.

Based on the results of the analysis of the carrying capacity of the areas for seaweed farming activities based on determining the area that was Very Suitable (Table 2), the areas that can be supported for managing seaweed farming is 82.20 Ha with a total of 10,262 units of stretch rope. Meanwhile, the budget/capital requirement to support the total stretch/ropes in the four regency on Sumba Island (19 locations) is IDR. 1,797,468,754, with a production period of 7-10 months

The concept of carrying capacity developed in seaweed farming on Sumba Island is the concept of ecological carrying capacity while taking into account other dimensions. The determination of the carrying capacity of the areas ecologically still takes into account the utilization status, whereas, in the suitability analysis of the waters, one can calculate the area and number of farming units by taking into account the technological dimension by adjusting to the farming methods used on Sumba Island (off bottom and long-line methods), taking into account the social dimension - culture and economy such as shipping lanes, fishing/fishing areas, water tourism, port areas, and other uses. With the intention that seaweed farming does not interfere with shipping lanes and access for fishermen going and returning to sea and other users so as to avoid conflicts of interest among fellow stakeholders.

The carrying capacity of the areas greatly determined the sustainability of the seaweed farming activities. If farming activities exceed the carrying capacity of the area, there will be degradation of the quality of the area which in the end will no longer be able to meet the needs of seaweed for growth.

Conclusion

The suitability analysis of seaweed farming areas on Sumba Island was categorized as Suitable and Very Suitable with a value range of 205 – 295, except for Pero Konda Waters which was categorized as Not Suitable so it was not recommended for seaweed farming. The development of aquatic areas for seaweed farming was still possible by taking into account the carrying capacity, with a maximum tolerance limit of 75% of the total area of suitable areas

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