

Fitness Analysis Of Water Suitability For Seaeed Cultivation *Kappahycus Alvarezii* In South Buton Regency, Southeast Sulawesi

Fadhli Insani Ihsan^{1*}, Hasni Y. Azis², Muhammad Anshar Amran³

¹Magister program of Marine Sciences and Fisheries, Hasanuddin University, Indonesia

²Aquaculture Program, Hasanuddin University, Indonesia

³Marine Sciences, Hasanuddin University, Indonesia

*Corresponding author:

Email: hasniazis375@gmail.com

Abstract.

*Seaweed cultivation in Indonesia is more focused on the production of *Kappaphycus alvarezii* species as a carrageenan producer. Land suitability analysis is an important stage in the preparation of spatial planning for coastal areas. This study aims to determine the appropriate location of the waters based on physical and chemical parameters using GIS. The research method is survey methods to get actual data related to seaweed cultivation activities. The spatial analysis of land suitability was carried out with a geographic information system based on the results of the x-weight score. The results of the analysis show that the spatial distribution that can be used for seaweed cultivation in the Batauga sub-district is 280 ha (very suitable) and Sampolawa 519 ha (very suitable), 838 ha (suitable), 234 ha (unsuitable).*

KeyWords: *Seaweed, land suitability, spatial analysis.*

1. INTRODUCTION

Seaweed is an important commodity for Indonesian marine and fisheries. Seaweed cultivation in Indonesia is more focused on the production of the *Kappaphycus alvarezii* species as a carrageenan producer. Within a decade, seaweed cultivation production has increased with a value of <450 thousand tons in 2004 than in 2014 around 10 million tons and an increase of 11.6 million tons in 2016, world seaweed production is around 30 million tons almost 40% of the total seaweed production in the world comes from Indonesia [1].

In the development, the use of the area for seaweed cultivation is still very large, it is recorded as 1.1 million ha or 9% of the total area of the potential marine cultivation area which is 12,123,383 ha with a utilization rate of 25% [2]. The initial stage that needs to be done to utilize a potential area is a study of the suitability of waters by taking into account environmental conditions, water quality, socio-economy, infrastructure, and regional regulations.

Currently, seaweed cultivation in South Buton waters is the main source of livelihood for some coastal communities, especially in Batauga and Sampolawa

Districts, which are the center of seaweed cultivation activities, with details in Batauga Subdistrict as many as 12 business units and in Sampolawa Subdistrict, 7 business units out of a total of 34 cultivation business unit in South Buton Regency [3]. As with other problems in coastal areas in Indonesia, South Buton Regency at the beginning of the development of seaweed cultivation has not considered land suitability, so that the potential from seaweed cultivation activities can still be increased.

By utilizing spatial analysis using Geographical Information Systems (GIS) can determine the suitability of waters and provide a comprehensive explanation of land suitability analysis. Land suitability analysis is an important stage in the preparation of spatial planning for coastal areas so that there is synergy between activities that develop in coastal areas [4]. This study aims to determine the appropriate location of the waters based on physical and chemical parameters using GIS. The results are expected to provide information in the form of a map of the suitability of cultivation locations in the South Buton Regency.

II. METHODS

This research was conducted in July-August 2020 in Batauga and Sampolawa Districts, South Buton District, Southeast Sulawesi Province (Fig 1). The observation station consists of 15 stations that are determined randomly (purposive random sampling) by taking into account the characteristics and utilization of the coastal waters where there are seaweed cultivation activities.

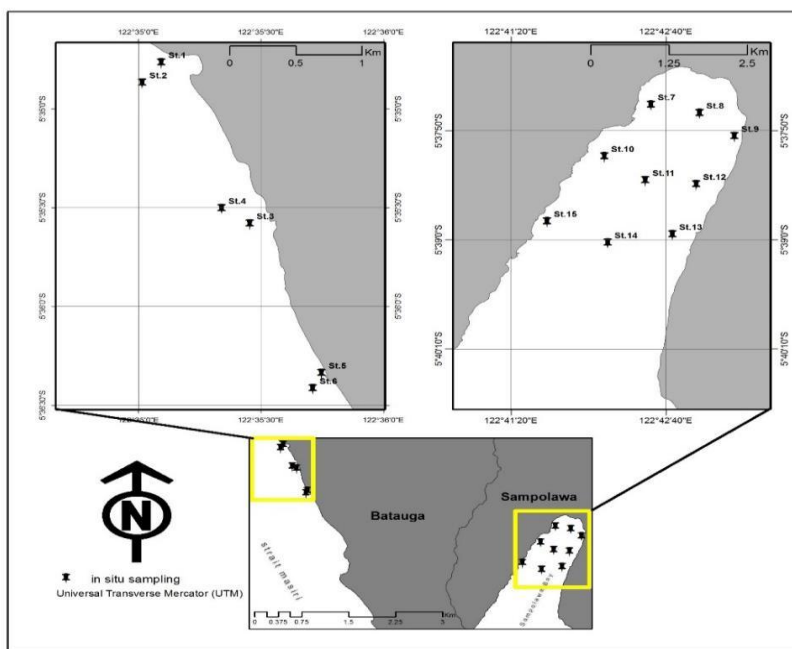


Fig 1. Site of research locations in South Buton Regency, Southeast Sulawesi Province

Water quality data collection is carried out directly (in situ) and observations in the laboratory (ex situ). In situ water quality measurements include salinity, temperature, and current velocity, whereas ex situ includes nitrate (NO₃⁻N), phosphate (PO₄⁻), ammonium (NH₄⁺N), TSS (Total Solid Suspended).

Analysis of the determination of suitability is carried out by means of the weighting or scoring method through the suitability matrix. Each parameter is given a weight (B), while the range value for each of these parameters is given a score (S) as shown in the Table of Criteria for the suitability of seaweed cultivation land (Table 1) and then calculated based on weight (B) and score (S), where the total value of land suitability for seaweed cultivation (NK) = $\sum B \times \sum S$ adopts [5]

Table. 1 Physical parameters of water for the suitability of seaweed cultivation land

No	Parameter	Weight (%)	Range	Score	References
1.	Salinity (‰)	15	32-34	3	[5]
			28-32	2	
			<28 atau >35	1	
2.	Temperature (°C)	15	28-30	3	[6]
			26 – 27 atau 33 - 35	2	
			<25 atau >35	1	
3.	Current velocity (cm/s)	15	21-30	3	[5]
			11-19 atau > 31-45	2	
			<11 atau >45	1	
4.	TSS (mg/L)	10	<25	3	[7]
			25 – 50	2	
			>50	1	
5.	Nitrate (mg/L)	10	0,9-3	3	[5]
			0,1 - < 0,9 atau 3 – 3,5	2	
			<0,1 atau >3,5	1	
6.	Amonium (mg/L)	10	0,1 – 2	3	[8]
			0,01 - <0,1 atau 2 – 2,5	2	
			<0,01 atau >2,5	1	
7.	Phosphate (mg/L)	10	0,02 – 1,0	3	[5]
			0,01-<0,02 atau 1,0 – 2,0	2	
			<0,01 atau >3,5	1	

The criteria for the suitability of seaweed cultivation land

Conformity Value

Value 85-142 (S3) = unsuitable

Value 142-198 (S2) = Suitable

Value 198-255 (S1) = Very suitable

Parameters that play an important role in the growth of seaweed are given the greatest weight, while the value of the most suitable parameter range is also given the highest score. Based on the NK value, land suitability is classified into three class

levels consisting of three categories, namely: S1 - very suitable, at intervals of 198 - 255, S2 – suitable, with intervals of 142 - 198, and N- unsuitable to intervals of 85 - 142. The value of each parameter listed in Table 1 is then mapped, then each thematic map is overlaid using spatial analysis, so that it becomes one final thematic map, namely the map of the suitability distribution of seaweed cultivation land in South Buton Regency.

III. RESULT AND DISCUSSION

Salinity

Salinity is the amount of salt dissolved in seawater. Salinity in a water can be influenced by several factors including water circulation patterns, evaporation, rainfall, and river flow. The salinity value from the measurement results in the field obtained values ranging from 26-34 ppt. The condition of the low salinity value is due to the influence of the freshwater content originating from the upstream of the river in Sampolawa District. *Kappaphycus alvarezii* can grow optimally in the range of salinity values 29 - 34 ppt [9], while according to [5], optimal growth is in the range of 32-35 ppt values. Therefore, in determining the location for cultivation, it is best to avoid locations that are close to river estuaries or other fresh water sources [10].

Temperature

Seawater temperature parameters are very important environmental factors for the growth of seaweed. Based on the results of measurements in the field, it was obtained water temperature data ranging from 27.8 - 28.2°C. According to [11], the temperature values range 25-31°C has a role to increase the level of seaweed consumption so as to provide a smooth metabolic process. Change in temperature are influenced by meteorological conditions such as rainfall, evaporation, air humidity, wind speed, and sunlight intensity. Meanwhile, [12] stated that the temperature is good for the growth of seaweed *Eucheima cottonii* is 24-31°C and the results of studies conducted by [13] both on a laboratory and field scale indicate that *E. cottoni* has a maximum photosynthetic rate at 30°C and experiences photosynthetic resistance in the range of values 35-40°C.

Total Solid Suspended (TSS)

The turbidity parameter is very important because it will affect the level of light penetration that enters the water column and as a material for photosynthesis for algae. Based on the results of the analysis, the TSS values ranged from 31.76 to 48.58 mg/L. The high TSS can affect the life of organisms, namely the inhibition of light penetration into the water column which causes disruption the photosynthesis process so that it can interfere with the growth of seaweed. [14] states that the TSS concentration in waters generally consists of phytoplankton, zooplankton, human activity waste, sludge, and industrial waste. Suspended solid material in natural waters is not toxic, however, if the amount is excessive, it can increase the turbidity value which further inhibits the penetration of sunlight into the water column. In the [15]

concerning Sea Water Quality for Marine Cultivation the desired TSS value is <25 mg/L and is still allowed at the level of 80 mg/L. The turbidity value that is too high will prevent the penetration of sunlight into the water body.

Current velocity

Current movement is an important factor affecting the growth of seaweed. Based on the results of measurements in the field, it is obtained current velocity data in the range of 10 - 51 cm/s, with a maximum current speed of 51 cm/s and a minimum of 10 cm/s. Based on [5] stated that plant growth is not disturbed by the movement of water (current) which is quite fast because it can clean plants from fine grains of sediment and epiphytes in the thallus, and can present new nutrients, get rid of metabolic waste, stimulate plant growth through force or the hydraulic strength of water movement, and preventing large fluctuations in water temperature. According to [16], a good current velocity for the cultivation of *Eucheima cottonii* is 33–66 cm/s. [17] states that the optimum growth of *E. cottonii* seaweed occurs at a current velocity of ± 20 cm/s.

Nitrate (NO_3^-N)

The element of nitrate in a water is very important because nitrate shows the fertility level of a water. Based on the analysis, the nitrate concentration is around 0.05 - 0.21mg/L. [18] states that if the condition of the nitrate content is below 0.1 or above 4.5 mg/L, then nitrate becomes a growth limiting factor. Based on the Decree of the State Minister for the Environment number 51 of 2004 concerning quality standards, the maximum concentration of nitrate is 0.008 mg/L, and or 0.06 mg/L [19].

Ammonium (NH_4^-N)

Ammonium is a nitrogen source that influences the growth process of seaweed [20]. Based on the results of the analysis, the ammonium values ranged from 1.04 to 2.77 mg/L with an average of 1.48 mg/L. The highest value for ammonium parameters was 2.78 mg/L and the lowest was 1.04 mg/L. According to [21], the high ammonium absorbed by seaweed causes high levels of carrageenan in the seaweed.

Phosphate (PO_4^-)

Phosphate is an essential element for higher plants and algae, so this element can be a limiting factor for aquatic plants and algae, and greatly affects the level of aquatic productivity both temporally and spatially [22]. Based on the analysis result, the phosphate values range from 0.01 to 0.03 mg/L.

According to [23], the phosphate content in the waters for seaweed cultivation is 0.1 - 0.2 mg/L. If in seawater there is a minimum of 0.01 mg/L phosphate, then the growth rate of most aquatic biota will not experience any obstacles. However, if the phosphate level falls below this critical level, the cell growth rate will decrease further [24].

Seaweed Cultivation Suitability Map

Based on the results of spatial analysis (overlay) the suitability of waters for seaweed cultivation based on determinants of seaweed growth shows the spatial

distribution that can be used for seaweed cultivation. Based on Figure 2, the water area is included in the S1 class category (very suitable) with the area in Batauga Subdistrict 280 ha and Sampolawa Subdistrict with an area of 519 ha, class S2 (Suitable) with an area of 838 ha in Sampolawa Subdistrict, and class S3 (unsuitable) covering an area of 234 ha in Sampolawa Subdistrict.

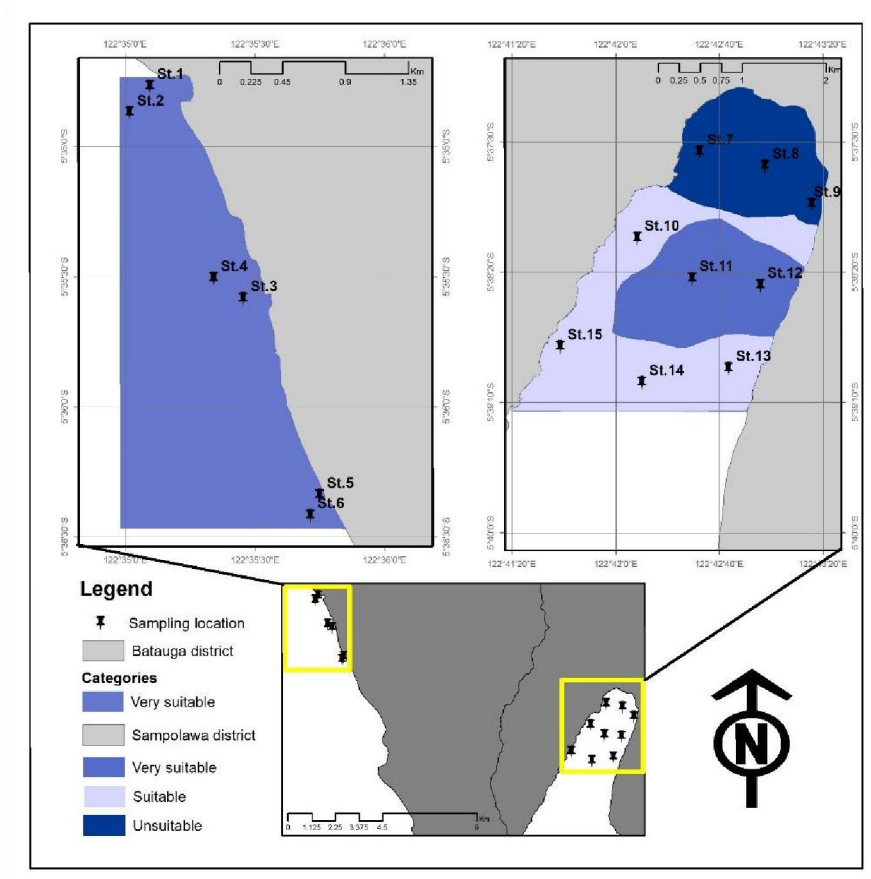


Fig 2. Suitability Map for Seaweed Cultivation

Batauga sub-district has a large enough potential for the development of seaweed cultivation. This is because the conditions of the waters based on the scoring results fall into the very suitable category, this is because almost all of the water quality parameters required for optimum growth of seaweed meet the suitability value. Meanwhile, Sampolawa Subdistrict based on the scoring results is classified into the unsuitable, suitable, and very suitable category. 3 stations are classified into the unsuitable category, this is because several water quality parameters required for optimum growth of seaweed do not meet the conformity values, namely nitrate, phosphate, ammonium, and TSS. The nutrient response plays a very important role in the growth of seaweed, especially the nitrogen and phosphate content. *Kappaphycus*

alvarezii growth rate is positively correlated with the increase in nitrogen content in the plant and the environment of the cultivation location [25].

IV. CONCLUSION

1. Based on the results of the analysis, there were 3 unsuitable stations because 4 parameters did not meet the requirements, namely nitrate, phosphate, ammonium, and TSS.
2. The area of water suitability for seaweed cultivation in South Buton Regency is 1,267 ha, each in the Batauga sub-district is 280 ha and Sampolawa is 987 ha.

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