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RESEARCH ARTICLE

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Ecological Features of Semau Island, East Nusa Tenggara for Seaweed Culture *(Kappaphycus alvarezii)* During the West Season

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ABSTRACT

The development of seaweed culture in Semau Island depends upon the ecological features, especially during the rainy season, where wind and current are pretty critical. Selecting the appropriate location is crucial for the success of seaweed production. Land suitability analysis is an essential stage in the development of seaweed cultivation. The measured parameters were temperature, salinity, wave height, current velocity, nitrate, dissolved oxygen, pH, and chlorophyll. This research aims to identify potentially suitable areas, measure effective areas, and estimate production for seaweed cultivation in Semau Island, Kupang Regency. This research aims to identify potential areas suitable for seaweed culture in Semau Island, Kupang Regency, East Nusa Tenggara Timur. The survey method was used to determine the water conditions, and the Geographic Information System (GIS) was used to assess the potential seaweed area using a geospatial model approach. The research results showed that the suitability and potential of the waters around Semau Island for seaweed culture were classified as Less Suitable (LS), covering 11.08ha, Suitable (S), covering 2,295.74ha, and Highly Suitable (HS), covering 1,221.03ha. The potential area used for seaweed cultivation is around 20% of the total suitable area, which is 703.3ha with a potential total production of 70.33tons per cycle. It means that that area minimum could produce 281.32tons/year.

Keywords: Semau Island, Seaweed production, Area potential, Site selection.

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INTRODUCTION

Indonesia is one of the seaweed-producing countries in the world (FAO, 2022). In 2020, Indonesia exported 195,574tons of seaweed worth US$279.58millions (Arbit et al., 2024). Meanwhile, De Queiroz Andrade et al. (2020) stated that seaweed is a biological resource that generates millions of dollars for the world. The production of seaweed aquaculture in Indonesia amounts to 28,491,854tons (KKP, 2022). East Nusa Tenggara is one of the provinces that contributes to producing seaweed. The seaweed aquaculture production in the province of NTT amounts to 1,392,539.3tons (BPS NTT, 2023).

East Nusa Tenggara has sea waters suitable for seaweed cultivation, so it is known as a seaweed-producing province. The potential of the waters of East Nusa Tenggara covers an area of 68,630,107m^2 (KKP, 2022). Based on this potential, East Nusa Tenggara has the opportunity to be utilized in activities such as aquaculture and seaweed farming.

Seaweed is a primary commodity of East Nusa Tenggara Province. Seaweed cultivation, especially Kapppahycusalvarezii (trade names known as Eucheuma cottonii and Sakol), was developed in 1999 in Kupang Regency (DKP, 2018). Adhawati et al. (2024) noticed that the cultivation of this seaweed has economic value.

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The local government's dedication to supporting seaweed cultivation is important, as proved by the legislation of Governor Regulation Number 17/2014, which establishes the roadmap for the development and processing of the seaweed industry cluster based on Minapolitan in East Nusa Tenggara Province (DKP, 2018).

Kappaphycusalvarezii, a type of seaweed, has become a leading commodity in the province of East Nusa Tenggara. According to Bessie et al. (2023), seaweed is the main commodity of East Nusa Tenggara Province and has become a favorite of marine cultivation in coastal communities. In addition, the waters of East Nusa Tenggara are also suitable for cultivating the seaweed species Kappaphycusalvarezii. According to Tuwo et al. (2020), the location for seaweed cultivation must have favorable environmental parameters, such as water temperature, light intensity, salinity, water depth, waves, pH, and oxygen content. The suitable location for seaweed cultivation has several supporting environmental factors, as they all contribute to the growth, survival, and productivity of the seaweed.

Semau Island located in the Kupang Regency, to the west of TimorIsland, which is administratively divided into two sub-districts: Semau and South of Semau (BPS, 2023). The waters of Semau Island are particularly useful for producing seaweed. The development of seaweed provides advantages and economic significance for both direct and indirect uses, thereby supporting the needs of the Semau Island community. Darmawan et al. (2019) asserted that seaweed as a macroalga provides advantages for humans. The predominant source of income for the inhabitants of Semau Island is seaweed. Therefore, seaweed production on Semau Island must be developed by the water's potential conditions. Thus; the development of seaweed production on Semau Island must take into account the specific water conditions of the island, such as temperature, salinity, nutrient availability, and water movement, because these factors directly affect the growth and productivity of seaweed.

The potential for seaweed cultivation on Semau Island presents a business opportunity for the community to enhance the economy for the welfare of the people. According to Aris et al. (2021), Kappaphycusalvarezii seaweed is one of the economically important commodities. Seaweed has become a main commodity in the seaweed market as it provides income for coastal communities. Furthermore, Kaya et al. (2023) stated that seaweed, as one of the fishery resources, is a cultivated commodity with high economic value. The people of Semau Island who live on the coast generally utilize the potential of marine resources as a source of livelihood, namely seaweed cultivation. Pulau Semau strongly supports the growth of seaweed, allowing the local community to develop seaweed farming businesses to meet their economic needs. This venture not only provides job opportunities for coastal communities but also becomes an important source of income, both for local consumption and for sale in the local market as well as in broader markets.

The cultivation of seaweed will continue to develop if the ecological conditions of the waters support its growth and sustainability. Yulianto et al. (2017) stated that the success of seaweed cultivation activities depends on environmental factors. Thus, they emphasised that the success of seaweed farming is determined by various environmental factors, such as water temperature, nutrient levels, salinity, and light intensity. The ecological aspects of water are one of the essential factors in the analysis of land or area suitability for the selection of seaweed cultivation locations. According to Sanchez-Jerez et al. (2015), the success of aquaculture greatly depends on site selection. For site selection, a spatial analysis of land suitability is conducted using Geographic Information Systems (GIS). Land suitability analysis is a complex stage that must consider several aspects, such as environmental aspects (physical, chemical, and biological), thus requiring spatial analysis using geographic information systems. Geographic information system (GIS) is technology that Nath et al. (2020) apply to clarify problems and generate solutions by addressing multiple spatial components simultaneously. Geographic Information System is powerful tool for identifying geographic problems and generating solutions by analyzing various spatial factors. Planning and management of both terrestrial and marine environments, including the suitability of locations for seaweed cultivation, can utilize this tool. Geographic Information System (GIS) is one of the technological analysis tools that can be used to obtain information on the potential suitability of land or areas for seaweed cultivation. According to Walinono (2018) and Ihsan et al. (2021), GIS technology is used to facilitate the determination of water suitability. This technology can assist in integrating field data, spatial analysis, and evaluating land or area suitability status.

This research aims to identify the potential suitability areas, measure the effective area, and estimate production for the development of seaweed cultivation in Semau Island, Kupang Regency. The objective of this research was to identify the potential suitability of areas based on environmental conditions suitable for seaweed growth, such as salinity, water temperature, water depth, brightness, nitrate, waves, and ocean currents. Geographic Information System (GIS) was used to analyze the potential suitability of ecological factors (physical, chemical, and biological) and to determine the extent of the area utilized for seaweed cultivation. Additionally, this research established the effective land area for seaweed cultivation. Furthermore, the effective land area served as the basis for an estimation of seaweed production. The seaweed cultivation activities in that area can achieve potential yields, as indicated by this production estimate.

MATERIALS & METHODS

This study was conducted in October and December 2023 in the waters of Semau Island, Kupang Regency. This research employed both primary and secondary data to collect ecological parameter data. Data collection was conducted at 35 observation stations based on points determined using a Garmin Montana 680 GPS (Fig. 1).

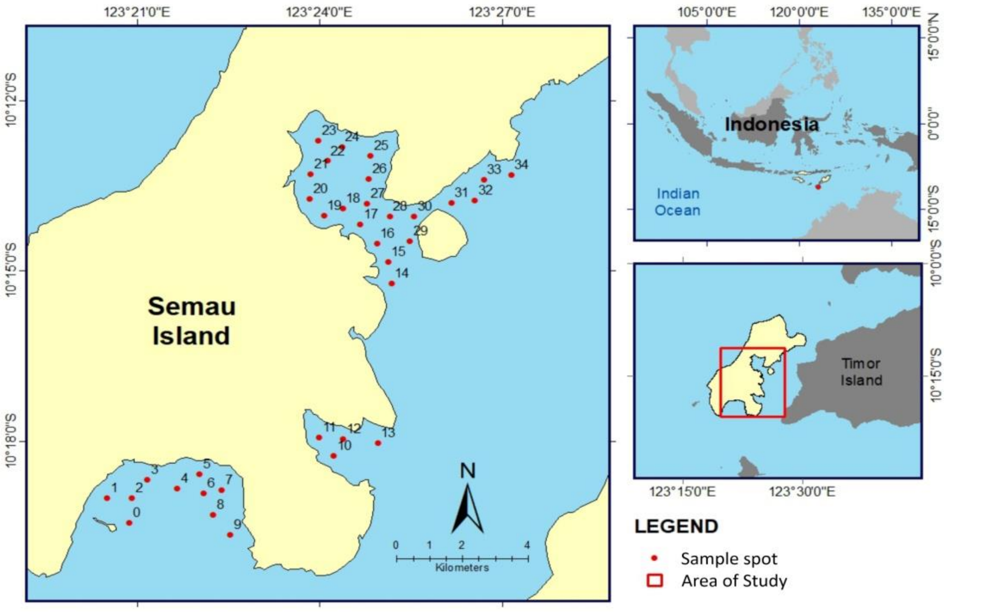

Fig. 1: Research Location in Semau Waters.

The primary data collection used includes physical oceanographic parameters (temperature, salinity, pH, water depth, and water clarity), chemical oceanographic parameters including dissolved oxygen (DO), nitrate, and biological parameters including chlorophyll-a (Yulianto et al., 2017). Meanwhile, the secondary data were originated from the Geospatial Information Agency, specifically Landsat-8 imagery from June 2024, wind data from Climate Copernicus, and bathymetry from the Geospatial Information Agency (BIG). The current and wave data were taken through 2D hydrodynamic modeling using DHI Mike 21 software (DHI, 2010). The survey method was employed to ascertain the water conditions and the GIS to pinpoint seaweed farming locations using a geospatial modeling approach.

Data Analysis

The two-dimensional (2D) hydrodynamic model simulates the current and wave conditions at the research location. The hydrodynamic model includes (a) Landsat 8 satellite imagery (https://earthexplorer.usgs.gov/); (b) bathymetric data from BATNAS (https://batnas.big.go.id/); (c) surface wind and wave data from the ERA-5 dataset every 6 hours with a 0.250 grid interval from October to December 2023 (https://cds.climate.copernicus.eu/); and (d) tidal data from October to December 2023 from Mike 21.

Current modelling is obtained from the continuity and the momentum equation at the average depth. The current model generates digital coastlines from Landsat 8 satellite imagery, bathymetry, wind dynamics, and tidal waves. The initial procedure involves creating a mesh and establishing the area boundaries using the continuity equation.

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=S$$

The equation for horizontal momentum in the X component is as follows (Sarjito et al., 2022):

$$\frac{\partial u}{\partial t}+\frac{\partial u^2}{\partial x}+\frac{\partial vu}{\partial y}+\frac{\partial wu}{\partial z}=fv-g\frac{\partial h}{\partial x}-\frac{1}{ro}\frac{\partial p_a}{\partial x}-\frac{g}{ro}\int_z^h\frac{\partial r}{\partial x}dz-\frac{1}{r_0 h}\left(\frac{\partial s_{xx}}{\partial x}+\frac{\partial s_{xy}}{\partial y}\right)+f_u+\frac{\partial}{\partial z}\left(v_t\frac{\partial u}{\partial z}\right)+u_s s$$

Meanwhile, the equation for horizontal momentum for the component is as follows (Sarjito et al., 2022):

$$\frac{\partial v}{\partial t}+\frac{\partial v^2}{\partial y}+\frac{\partial uv}{\partial x}+\frac{\partial wv}{\partial z}=fu-g\frac{\partial h}{\partial y}-\frac{1}{ro}\frac{\partial p_a}{\partial y}-\frac{g}{ro}\int_z^h\frac{\partial r}{\partial y}dz-\frac{1}{r_0 h}\left(\frac{\partial s_{yx}}{\partial x}+\frac{\partial s_{yy}}{\partial y}\right)+f_v+\frac{\partial}{\partial z}\left(v_t\frac{\partial v}{\partial z}\right)+v_s s$$

Note:

x, y, z = cartesiian coordinates in the x, y, z directions; u = velocity of water particles in the x direction; t = time; v = velocity of water particles in the y direction; d = ocean depth; w = velocity of waterr particles in the z direction; n = waters surface elevation; h = total ocean depth; f = coriolis parrameter (f = 2ω sinØ); Ω = Earth's revolution ratio; Ø = latitude coordinate; g = gravitational acceleration; sxx, sxy, syy = components of the radiation stress tensor; vt = vertical eddy viscosity; ρo = ocean density; pa = atmospheric pressure; s = discharge due to the source; us = particle velocity from the air source in the x direction; and vs = particle velocity from the air source in the y direction.

Wave modeling using spectral wave modeling with input data in the form of a digital coastline from Landsat 8 satellite imagery, bathymetry, wind dynamics, tidal waves, and current modeling. The equilibrium wave energy equation in Cartesian coordinates is represented as follows (Sarjito et al., 2022).

$$\frac{\partial N}{\partial t}+\frac{\partial}{\partial \varphi}C\varphi N+\frac{\partial}{\partial \lambda}C\lambda N+\frac{\partial}{\partial \sigma}C\sigma N+\frac{\partial}{\partial \theta}C\theta N=\frac{S}{\sigma}$$

Energy source S shows the position of the function in various styles. (Sarjito et al., 2022)

$$S=S_{in}+S_{ni}+S_{ds}+S_{bot}+S_{surf}$$

Note:

Nx,σ,θ,t = power density; φλ = spherical coordinates; C = four-dimensional wave propagation speed; S = energy source; Sni = wind formation; Sin = non-linear energy transfer; Sds = wave energy caused by white capping; Sbot = wave energy due to bottom friction; Ssurf = dissipation caused by depth-induced cracking.

The maximum values of current speed and wave height during the research were recorded in the rainy season (October to December 2023). The 2D hydrodynamic modeling results, which were current velocity and wave height, were put together using the spline method and cell statistics were used to find the highest values of current velocity and wave height. Data processing used ArcGIS 10.8 software, with each parameter's data interpolated using the spline with barrier method.

Criteria for Suitability Seaweed Cultivation Area

The suitability location is determined based on the criteria of the water's physical, chemical, and biological parameters. After determining the distribution values of each parameter, weighting will be carried out by scoring each parameter. The score and weight of each parameter will vary based on their influence on the potential suitability of seaweed cultivation areas. The sum of the scores and weights is ranked according to the seaweed cultivation area suitability index.

The determination of suitability classes for seaweed cultivation is done using quantitative analysis, which is based on this equation:

$N = B_i \times S_n$

The range of suitability classes for seaweed cultivation locations based on the following equation:

$$I = \frac{(\sum \mathrm{Bi\ X\ Sn})\max - (\sum \mathrm{Bi\ X\ Sn})\min}{k}$$

Note:

N= Value; I= Suitability class interval, Bi= Weight of each parameter Sn= Suitability score; k= amount of suitability categories

The suitability classes are categorized into 4 categories: HS: highly suitable, S: suitable, LS: less suitable, and N: not suitable. The range of values falls into four categories: highly suitable (55.1–70.0), suitable (40.1–55.0), less suitable (25.1–40.0), and not suitable. (10.0–25.0). Each parameter in the suitability matrix was interpolated using the Spline with Barrier (SWB) interpolation method to produce a suitability map. The SWB method is used because it produces a distribution value that is smoother and more detailed, with interval values that are similar to the original data.

Spatial Modeling

Spatial modeling in this study used the intersect modeling tools in ArcGIS by integrating oceanographic data and water quality parameters classified by their suitability classification (Table 1) with modeling algorithms developed as follows:

$WS = (T_i \times 0.75) + (pH_i \times 0.5)+(DO_i \times 0.5)+(N_i \times 1.5)+(Br_i \times 1.5)+ (B_i \times 1.0) + (HS_i \times 1.0) + (CS_i \times 1.5) + (Ch_i \times 1.0) + (S_i \times 0.75)$

Note

WS=Water Suitability, CS_i= Current speed index map; T_i =temperature; pH=pH index map; N=Nitrate index map; DO=Disolved Oxygen map; S= salinity index map; Br=Brightnees index map; B_i=Bathymetry index map; HS_i=significant wave height index; Ch_i=Chlorophyl index map. The results of this modeling are subsequently used to determine the classification of suitability classes based on criteria (Table 1).

Production Estimate

The long-line method of seaweed cultivation yields a significant increase in seaweed production, both in terms of quantity and weight, over time. The total number of rafts is 703.3/ha with an estimated average production of 100kg per hectare in an effective location. Nashrullah et al. (2021) stated that the production quantity estimate is based on a raft size of 1 x 25meters within the effective land area.

RESULTS & DISCUSSION

Water Quality of Study Area

The waters of Semau Island as a seaweed cultivation location have varying water quality characteristics for each parameter presented in Fig. 3. The research results show that the range of water quality varies for each parameter but still falls within the limits that support seaweed life. According to Manurung et al. (2021), all water quality parameters positively contribute to the growth of seaweed, but the ones that contribute the most strongly to seaweed growth.

The data in Fig. 3 show a DO distribution value >5mg/L, which falls into the highly suitable (HS) category for seaweed cultivation. KLH, (2004) states that the dissolved oxygen level for aquatic organisms is >5mg/L. Dissolved oxygen is essential in water bodies as it can affect the survival of organisms, including seaweed. According to Afandi & Musadat (2018), seaweed needs oxygen to grow during the metabolism process. Furthermore, Maradhy et al. (2021) stated that dissolved oxygen is a basic necessity for plants and animals' lives. Meanwhile, Nabila et al. (2022) asserted that all living organisms require oxygen for respiration, metabolism, and growth. The research results demonstrate that the temperature, depth, pH and nitrate distribution in the waters of Semau are both suitable and highly suitable for seaweed culture. The distribution of suitable and highly suitable temperatures in the waters of Semau indicates that the temperature conditions remain within the tolerance limits for seaweed life. Arbit et al. (2024) research confirms that the temperature range in Majene's waters is

Table 1: Criteria for Seaweed Cultivation Suitability *(Kappaphycus alvarezii)*

Variables	Weight (Unit?)	Values				Sources
		Not Suitable (NS)	Less Suitable (LS)	Suitable (S)	High Suitable (HS)	
		1	3	5	7	
Current speed (cm/sec)	1.5	<10 or >40	10-15 or 35-40	15-20 or 30-35	20 – 30	Modification of SNI (2010)
Nitrate (mg/L)	1.5	<0.008 or>3.5	0.008-0.01	0.01-0.1	0.1 – 3.5	Modification of KLH (2004); Radiarta et al. (2014)
Brightness (m)	1.5	<2	2-4	4-5	>5	Modification of Kamlasi (2008)
Wave Height (cm)	1.0	<20 or >40	35-40	30-35	20-30	Modification of Hardiana et al. (2023)
Chlorophyl (mg/L)	1.0	<0.16 or >1.84	0.16-0.44	0.45-0.61	0.62 – 1.84	Modification of Widiaratih et al. (2022)
Depth (m)	1.0	<2 or >20	2-3	3-5	5-20.	Modification of SNI (2010), Madina et al. (2022)
Temperature (^{0}C)	7.5	<25 or >35	32-35	30-32	25-30	Modification of Kamlasi (2008); Tuwo et al. (2020)
Salinity (psu)	7.5	<25 or >36	25-26 or 35-36	26-28 or 34-35	28 – 34	Modification of SNI (2010)
DO (ppm)	0.5	<1	1-3	3-5	>5	Modification of KLH (2004); Radiarta et al. (2014)
pH	0.5	<2 or >11	2-4 or 10-11	4-7 or 8.5-10	7 – 8.5	Modification of Radiarta et al. (2014)

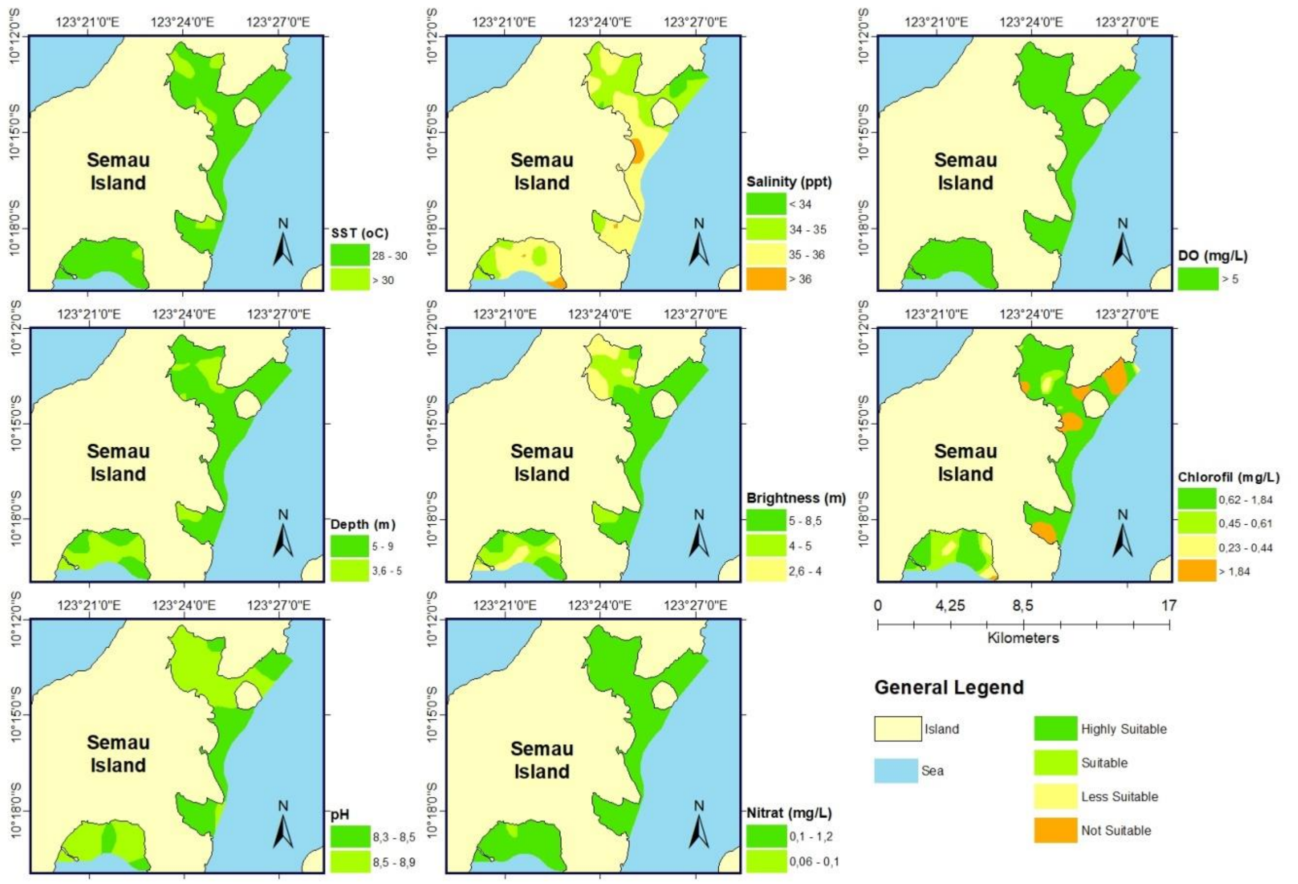

Fig. 3: Distribution of physical, chemical and biological parameters in all waters; a) Temperature b) Salinity c) DO d) Depth e) Brightness f) pH; g) Nitrate and h) Chlorophyll.

28.9-31.1°C, an ideal range for seaweed cultivation. The results of the observation of the distribution of seawater temperature in the suitable category indicate that the seawater temperature is still within the range that supports seaweed growth, while the very suitable category (28-30°C) indicates that the seawater temperature very much supports seaweed growth.

The classification of nitrates in Semau's waters as either suitable or highly suitable indicates their suitability for seaweed cultivation. Risnawati et al. (2019) found that a nitrate concentration >0.2mg/L will stimulate the rapid growth of algae and aquatic plants. Seaweed requires nitrate, a nitrogen-containing compound in water, for its growth process. According to Sarjito et al. (2022), nitrate is a limiting factor and one of the nutrients needed for the growth of seaweed. The pH distribution values fall into both the suitable and highly suitable categories, indicating that they remain within the tolerance limits for seaweed. The Ministry of Forestry and Environment degree no. 51/2024 stated that the pH value for marine biota is between 7 and 8.5. The study by Arbit et al. (2024) found the pH value in the waters of Majene to be between 5.81 and 8.7. The results of the pH range during the study between 8.3 and 8.9 indicate that this pH range varies and is alkaline but still supports seaweed growth. This shows that seaweed is able to grow and survive in pH changes that occur in its environment. According to Ya'la (2022), water pH greatly affects the growth of cultivated seaweed, and water conditions with a neutral or slightly alkaline pH are ideal for the growth of marine organisms.

Similarly, the water depth falls into the suitable and highly suitable categories. According to SNI (2010), the location for seaweed cultivation must meet the minimum requirement of 2m at the lowest tide. Furthermore, Madina et al. (2022) stated that the optimal depth range for cultivating E. cottonii seaweed is 2-10m. The depth of a body of water depends on the topography of the aquatic area, but length is an important factor in seaweed cultivation because the depth of the water affects ecological conditions such as light, temperature, and currents, which play a role in seaweed growth. The distribution of water transparency levels spans from unsuitable to suitable to highly suitable. There are 3 areas near the beach that have less suitable brightness values due to shallow waterbed sediments, resulting in turbidity. According to Hardiana et al. (2023), the presence of suspended substances in the water body could cause low transparency, which in turn could result in lower light penetration for seaweed assimilation. The transparency distribution indicated there were activities and weather, as well as organic materials around the water, interferes with the incoming light. According to Soejarwo & Maryanto (2020), the brightness value of a body of water depends on the intensity of the incoming light. In the most suitable category, the clear water condition occurs in an area where light can penetrate deep into the water pond. According to Nashrullah et al. (2021), the penetration of light into the water closely correlates with brightness, as the photosynthesis mechanism of seaweed necessitates light.

The distribution of chlorophyll and salinity parameter suitability values ranges from unsuitable to highly suitable. Five areas in the chlorophyll distribution are deemed unsuitable due to their chlorophyll content values exceeding 1.84mg/L. This can lead to increased algal growth or eutrophication, which can disrupt aquatic organisms. According to Widiaratih et al. (2022), high concentrations of chlorophyll-A can affect the fertility of a water body. In less suitable areas, chlorophyll levels are still low but do not affect other aquatic organisms. Research results indicate that there are areas that are suitable and higly suitable because the distribution of chlorophyll in those areas is sufficient, categorizing them as fertile waters. Abigail et al. (2015) asserted that the chlorophyll-a concentration, as a component of primary productivity in aquatic environments, can indicate the fertility level of the water. Chlorophyll in each region varies depending on the weather, geological conditions, and water conditions. Furthermore, Firdaus et al. (2024) asserted that factors such as temperature, salinity, geographical location, and season influence the chlorophyll distribution.

The distribution of high salinity values during measurement renders areas unsuitable for salinity distribution. According to Aris et al. (2021), high salinity levels will affect the osmoregulation process in cells, resulting in suboptimal seaweed growth. For areas categorised as less suitable, suitable, and very suitable, they describe the salinity fluctuation conditions that are appropriate for seaweed cultivation. According to Sulistiawati et al. (2020), salinity plays a role in supporting the life of aquatic biota. Salinity plays an important role in influencing the ecological balance in aquatic environments to adapt to different salinity levels. Furthermore, a low or high salinity range can disrupt the growth of seaweed. Aris et al. (2021) found that variations in salinity influence the growth rate of *K. alvarezii* seaweed explants, achieving optimal growth at a salinity of 31ppt and the lowest growth value at 34ppt. The distribution of current and wave parameters is crucial in seaweed culture (Fig. 4). The research results for wave height at the research location (Fig. 4a) have yielded four categories: not suitable, less suitable, suitable, and higly suitable. In the unsuitable category, certain points in the bay area, situated in front of Kambing Island, function as wave barriers. Meanwhile, the southern part of the bay, situated in the Puku Afu Strait, falls into the suitable and higly suitable categories, with wave values ranging from 0.2 to 0.4m. According to Lanuru et al. (2023), the wave height on Meosbekwan Island at the time of the study was around 0.1–0.3m.

Based on the research results, the current velocity and wave height at the research location (Fig. 4b) indicate that some areas are unsuitable due to their sheltered nature, while other areas range from less suitable to highly suitable. Topographically, the research location sits in a bay and strait with a coral reef base, thereby mitigating strong waves and currents. The study by Imamshadiqin et al. (2024) found that the current speed around Simeulue Island is between 10-60cm/second. Furthermore, Salim et al. (2019) reported that the current velocity in the waters of South Halmahera ranges from 10 to 40cm/s. According to SNI (2010), the location requirements for seaweed cultivation include water movement or current velocity between 20–40cm/second. According to Indriyani et al. (2019), the current speed in the waters of Sembilan Island ranges from 5 to 30cm/second. Although the current ranges in each area differ depending on the topographical conditions of the location, they are within the tolerance limits for seaweed life because seaweed requires current speed for nutrient circulation

Potentially Suitable Sites for Seaweed Cultivation

Based on the physical, chemical, and biological characteristics of the waters, we divide location suitability into four classes: not suitable (NS), less suitable (LS), suitable (S), and highly suitable (HS). However, the overlay results do not show any areas that are Not Suitable (NS) (Fig. 5).

The analysis results for each criterion are as follows: Less Suitable (LS) area is 11.08ha (0.31%), Suitable (S) area is 2,295.74ha (65.07%), and Highly Suitable (HS) area is 1,221.03ha (34.61%). A combination of suitable and very suitable locations yields a potential seaweed cultivation area of 3,516.77ha (Fig. 6). According to Tasnim et al. (2024), habitat suitability maps are spatial representations or models that integrate environmental parameters with occurrence data to identify ideal habitats used for cultivation.

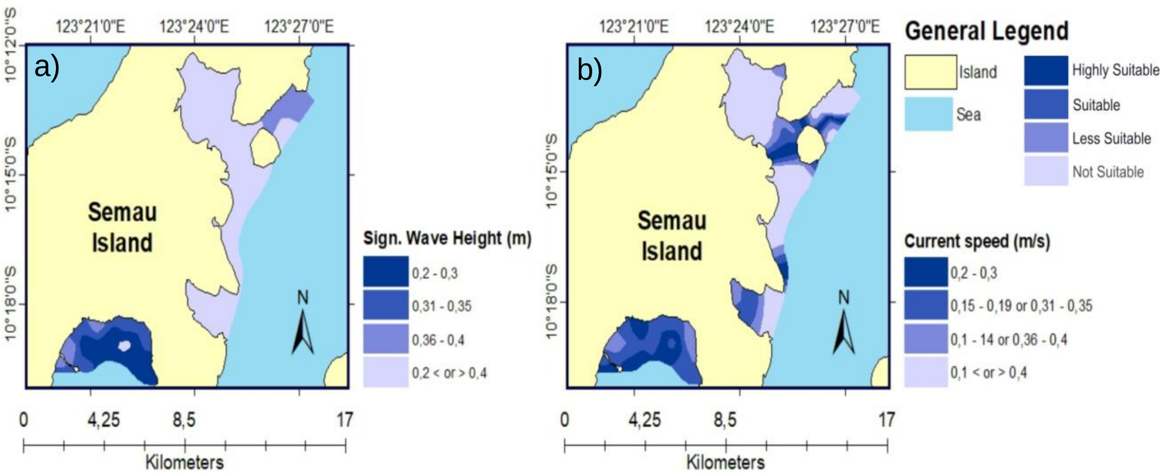

Fig. 4: a) Wave height and b) Current speed.

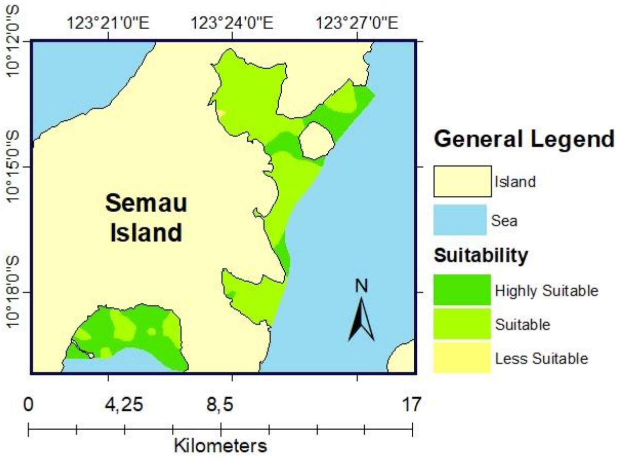

Fig. 5: Distribution of Suitability of Seaweed Cultivation Areas.

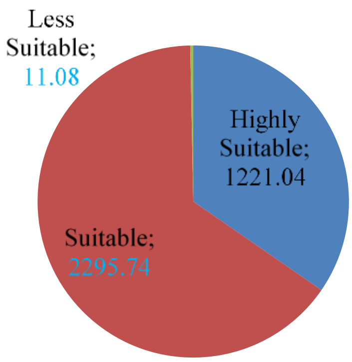

Fig. 6: Potential Seaweed Cultivation Areas.

The combined results of the effective locations were used to calculate production estimates to determine the production output over the effective area. According to Nashrullah et al. (2021), the estimated seaweed production in the waters of Nusa Lembongan uses a distance of 15-25m and a width of 1m (25m²). To Fig. out how much seaweed is grown in the water around Semau Island, a calculation using a 25m rope, a 1meter rope distance, and a point distance of 20 to 25cm shows that there are a total of 281.342 rafts in the effective locations (20%) of the suitable and very suitable locations. The production estimate uses 20% of the area because it does not generate waste and provides access space for other activities, such as fishermen's transport routes, tourism activities, and other cultivation. Therefore, the potential effective water area of 703.3ha is expected to yield a total output of 70.33metric tonnes per harvest cycle. It means that those areas could produce 281.32tonnes/year.

Conclusion

The research concluded that Semau Island has potential as a seaweed aquaculture center. The ecological analysis demonstrated that 2,295.74ha (65.07%) and 1,221.03ha (34.61%) were suitable (S) and highly suitable (HS) for seaweed aquaculture, respectively. Cultivating 20% of the potential area could yield 70.33tonnes of seaweed per cycle. This implies that the minimum area could yield 281.32tonnes of seaweed annually.

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