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CALENDAR FOR PLANTING SEAWEED EUCHEUMA SP. IN MALLASORO BAY, JENEPONTO DISTRICT, BASED ON LANDSAT-8 IMAGES

Muhammad Anshar Amran[1]*, Andi Niartiningsih[1], Ahmad Faizal[1], Abdul Rasyid[1], Amir Hamzah Muhiddin[1], Isnaeni A[2]

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[1] Marine Science Department, Faculty of Marine Science and Fisheries, Hasanuddin University
[2] Student of Marine Science Department, Faculty of Marine Science and Fisheries, Hasanuddin University
Corresponding Author:
*Muhammad Anshar Amran
E-mail: anshar_btg@yahoo.co.id

ABSTRACT

Seaweed cultivation activities in Jeneponto Regency have been practised for a long time and have become the main livelihood for most of the Mallasoro Bay community. In cultivating seaweed, obstacles often arise in the form of failures experienced by seaweed farmers or poor-quality yields. This study was aimed to develop alternative planting calendars for *Eucheuma* sp. in Mallasoro Bay, Jeneponto Regency based on sea surface temperature and distribution of chlorophyll-a obtained from Landsat-8 imagery. Image Processing Sea Surface Temperature and Chlorophyll-a were processed using ENVI 4.8 AND 5.3 software, the satellite images used were clean and without cloud disturbance. In this study, data analysis was carried out descriptively. The water temperature that is good for seaweed growth is 27-30˚C, for Mallasoro Bay Sea Surface Temperature which is suitable for seaweed cultivation, namely April, May, June, July, August, September, October and November. While the classification is based on the criteria for chlorophyll-a trophic status in marine waters, namely the range < 1 mg/L is classified as Oligotrophic, ≥ 1–3 mg/L is classified as Mesotrophic, ≥ 3–5 mg/L is classified as Eutrophic, and > 5 mg/L is classified as Hypertrophic. , from the results of image analysis for the distribution of chlorophyll-a in Mallasoro Bay, it shows that Mallasoro Bay is at the Mesotrophic level throughout the year or the fertility level of the waters is quite fertile because it is in the range of ≥ 1–3 mg/L. so that a seaweed planting calendar can be obtained in Mallasoro Bay, namely in January, February and December, preparation of tools such as cleaning and repair of seaweed planting tools can be carried out, then at the end of March, the end of May, the end of July and the end of September, the procurement of seaweed seeds is carried out. , in early April, early June, early August, and early October, seaweed seeds can be spread, then in mid-May, mid-July, mid-September, and mid-November, harvesting can be carried out, so that seaweed cultivation can be carried out 4 times in one year. cycle.

Keywordsi: Planting Calendar of Seaweed, Ocean Surface Temperature, Chlorophyll-a, *Eucheuma* sp., Mallasoro Bay

INTRODUCTION

Indonesian waters are tropical waters which are very rich in fishery resources, including seaweed (WWF-Indonesia, 2014). Seaweed is a marine commodity that has high economic value. This is due to the content of agar and carageenan contained in seaweed which is highly needed in the pharmaceutical, cosmetic industry or as an ingredient in the production process (Istiqomawati, 2010). Mallasoro Bay was chosen as the research location because the area is in the form of a bay where the sea is surrounded by land and protected by a small island to the south of this bay, namely Libukang Island, this is what causes the waters in this bay to be nice and calm so that many seaweed farmers make the bay this as a location for seaweed cultivation (Ariny, 2016). Sea surface temperature can affect the life of aquatic organisms. Sahabuddin and Tangko (2008) said that temperature affects the metabolic activity and development of an organism. The suitable temperature for karogenophyte growth ranges from 25 – 30˚C, seaweed will die if the water temperature reaches 31˚C (Baracca, 1999). Chlorophyll-a is an active pigment that is very important in the process of photosynthesis and the formation of organic matter in waters. The content of chlorophyll-a in a water can be used as an indicator of the level of fertility of the waters, namely as an indication of the availability of nutrients in the waters (Marlian et al. 2015). Chlorophyll-a has been used as an indicator of water quality, because chlorophyll-a is an indicator of phytoplankton biomass, where its content thoroughly describes the effects of various factors that occur due to human activities (Linus et al. 2016). Along with the current development of satellite technology, which can already provide information on chlorophyll-a concentrations and sea surface temperature (Astrijaya, 2014). One of the remote sensing satellites equipped with sensors that can detect the content of chlorophyll-a in waters is the Landsat satellite. Landsat satellite imagery has been widely used to estimate the content of chlorophyll-a concentrations in waters (Hanintyo and Susilo 2016). In cultivating seaweed, obstacles often arise in the form of failures experienced by seaweed farmers or poor quality yields. This failure can cause quite high damage due to being attacked by pests and diseases because farmers sow seaweed without taking into account water conditions so that the results are often not as desired. This occurs because there is no planting calendar that can be used as a reference. The seaweed planting calendar can be used as a reference, a tool for seaweed farmers to determine the planting season. The planting calendar is compiled by using information on sea surface temperature and chlorophyll-a distribution obtained from Landsat-8 imagery and a questionnaire. This study compiled a grass planting calendar in Mallasoro Bay, Jeneponto Regency based on Landsat-8 imagery. which can later become a reference for planting seaweed farmers.

MATERIALS AND METHODS

This research was conducted in April 2021–February 2022 in the Seaweed Cultivation Area in Mallasoro Bay, Bangkala District, Jeneponto Regency. The research was carried out at the Marine Remote Sensing Laboratory and in the field. The work process in the Laboratory includes image downloading, image processing, data analysis, water chlorophyll-a measurements taken on behalf of each station and preparation of the final report. Whereas in the field it includes determining coordinates, measuring temperature, and taking water samples at each station to measure chlorophyll-a in the laboratory as well as distributing questionnaires with seaweed farmers as image validation, while the map of the research location is presented in (figure 1). This research was conducted in the field and in the laboratory, through several stages.

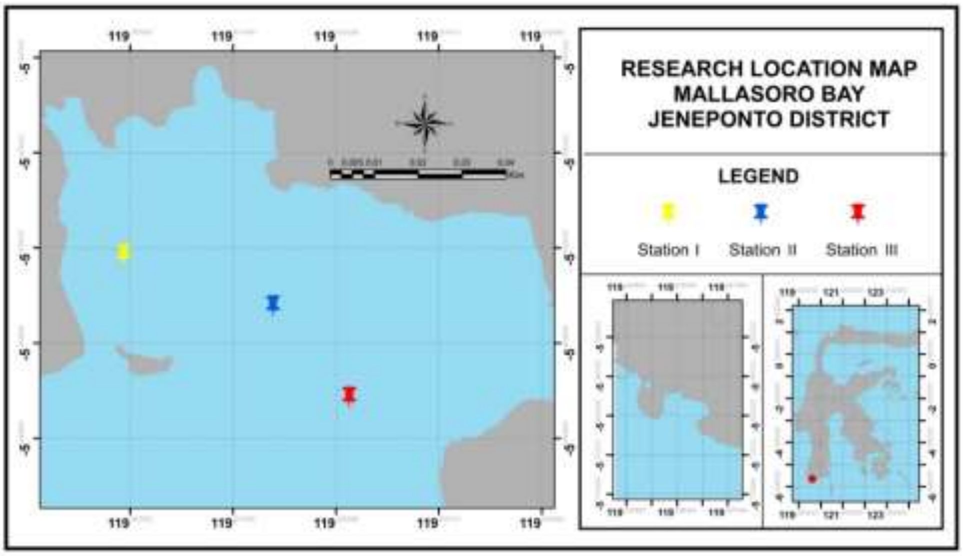

Figure 1. Map of research location

Landsat-8 imagery is obtained by downloading imagery at www.glovis.usgs.gov, at the address https://earthexplorer.usgs.gov/, by downloading Landsat 8 OLI/TIRS C1 Level-1 imagery. Furthermore, Landsat 8 image processing uses ENVI 4.8 and 5.3 software. The satellite image used must be in clean condition and there is no cloud disturbance at the research location so as to facilitate analysis. Satellite imagery data was obtained by taking recording data on (a) 25 January 2020, (b) 23 February 2019, (c) 13 March 2020, (d) 17 April 2021, (e) 3 May 2021, (f) 15 June 2019, (g) 19 July 2020, (h) 07 August 2021, (i) 08 September 2021, (j) 21 October 2019, (k) 6 November 2019, (l) 10 December 2020.

Image Proessing

Image processing begins with atmospheric correction. This correction serves to reduce or eliminate atmospheric disturbances when recording using the dark pixel subtraction method on band-1 to band-6 using the ENVI application. Image cropping is done to limit the area to the area to be studied, in this case image cropping is done in the Mallasoro Bay. Geometric correction is performed for image recovery (rotation) so that the image coordinates match the geographic coordinates. The main purpose of this radiometric calibration is to convert data in images which are (generally) stored in the form of a Digital Number (DN) into radiance and/or reflectance.

SPL image data processing

Furthermore, the ToA radian value must be converted to a Brightness Temperature value to obtain the effective temperature to be used for determining the SST. The equation is as follows (USGS, 2013).

$$T=(K_2)/(In((K_2)/L\lambda+1))$$

Processing of Chlorophyll-a Image data

The OC3 algorithm is used as a standard in processing Landsat-8 satellite imagery to obtain global water chlorophyll-a data.

The OC3 algorithm equation (O'Reilly et al. 2000)

$$\log_{10}\ (\text{cholor\_a}) = 0.1977 + \sum_{i=1}^{4} a_i \left(\log 10 \frac{\text{Rrs}\ (443 > 482)}{\text{Rrs}\ (561)} \right)^{i}$$

The field survey serves as image validation and is carried out in several stages, as follows:

Sea Surface Temperature

The measurement time is adjusted to the landsat-8 image recording. The surface temperature of the water is measured using a thermometer.

Chlorophyll-a

Sampling of water for measurement of chlorophyll-a content was analyzed in the laboratory. Calculation of chlorophyll-a levels in seawater samples uses the following formula (APHA, 1992):

$$Chlorophyll - a\ (\frac{mg}{l}) = \frac{(11{,}85\text{xE}664\ -\ 1{,}54\text{xE}647\ -\ 0{,}08\text{xE}630)\text{x Va}}{\text{Vxl}}$$

Distribution of questionnaires to seaweed farmers

Field data collection as supporting data was obtained through interview techniques with respondents, regarding the data to be obtained through the distribution of questionnaires to several seaweed farmers representing each station. Each station is represented by 5 seaweed farmers. The distribution of questionnaires was directly used so that researchers obtained field data related to pests and weeds, diseases, frequency of harvest, length of maintenance, and cultivation methods.

Data Validation

The data validation stage of Landsat 8 Satellite Imagery with data from field measurements, namely by comparing sea surface temperature values at each predetermined station with sea surface temperature data and Chlorophyll-a data, the results of Landsat 8 Satellite Image classification at coordinates and station points the same. Bani (2020) states that the RMSE (Root Mean Square Error) method can be used to find out the error values from field data and forecasting data.

$$RMSE = \sqrt{\frac{1}{n}\sum\nolimits_{i=1}^{n} e_i^2}$$

Where n is the amount of data and e_i^2 is the result of data processing minus the actual value which is the field data. Image validation also uses Aqua Modis image data in 2019, 2020 and 2021 by comparing the Landsat-8 image values that have been processed with the images obtained from Aqua Modis

Data Processing

In this study, data analysis was carried out descriptively in the table, from 12 months of images that were processed to see sea surface temperature and chlorophyll-a data, then combined images from January to December and supporting data, which matched the criteria from surface temperature data. sea and chlorophyll-a can be done seaweed cultivation**.** The water temperature that is good for seaweed growth is 27-30˚C (Duma, 2012), while the classification is based on the criteria for chlorophyll-a trophic status in marine waters, namely the range < 1 mg/L is classified as oligotrophic, ≥ 1–3 mg/L is classified as Mesotrophic, ≥ 3–5 mg/L classified as Eutrophic, and > 5 mg/L classified as Hypertrophic (Adani et al., 2013).

RESULTS AND DISCUSSION

Image Processing

The image chosen for processing in this study is an image that is free from clouds, which is an image in 2019 – 2021 due to the presence of a large number of cloud covers that can interfere with the image processing process, resulting in the months being obtained not sequentially every year, but complementing each other in 2019. different, the processed images are as many as 12 images, including recording January 25 2020, February 23 2019, March 13 2020, April 17 2021, May 03 2021, June 15 2019, July 19 2020, August 7 2021, September 08 2021, 21 October 2019, 06 November 2019, 10 December 2021. The verification phase of Landsat 8 Satellite Imagery data with data from field measurements, namely by comparing sea surface temperature values at each predetermined station with sea surface temperature data and Chlorophyll-a data, the results of Landsat 8 Satellite Image classification at coordinates and station points the same. The validated image is the recorded image of September 8, 2021 with three station points, the first station is located at coordinates 119.627104, -5.653189, the second station is located at coordinates 119.616843, -5.64094, and the third station is located at coordinates 119.596788, -5.634057, respectively station validation of sea surface temperature and water sampling for chlorophyll-a calculations were carried out 3 times. From the results of image processing data and field data, it shows that there is a difference in the values of sea surface temperature and chlorophyll at each station, this indicates an error at each station.

The verification results of field collection data with image data have an average value of error or Root Mean Squared Error (RMSE), while the RMSE value of Sea Surface Temperature is 0.481 and the RMSE Chlorophyll-a value is 0.29394. This value indicates that the accuracy obtained is good as mentioned by Parmadi and Sukajo (2016) which states that if the results of the RMSE calculation ≤ 1, the accuracy is getting better. Validation of Aquamoditas images, using level 3B data and taking data on sea surface temperature and chlorophyll-a in Mallasoro Bay then using seaDAS software to process images in 2019, 2020 and 2021, with the aim of seeing a comparison of Sea Surface Temperature and Chlorophyll values -a in the Aqua Modis image with Sea Surface Temperature and Chlorophyll-a values in the Landsat-8 imagery, but there are several images that have no value because the image is covered by clouds, from these results it

is found that there is no very significant difference in three years the. In January, February, March, and December the value of sea surface temperature in the Aqua Modis image still shows numbers above 30 ˚C as is the case with Landsat-8 imagery, then in the processing of Chlorophyll-a using the Aqua Modis image it shows that Mallasoro Bay is located throughout the year. at the Mesotrophic level in the range of ≥ 1-3 mg/L as is the case with Landsat-8 image processing

Table 1. Field data validation with Landsat-8 imagery

Parameter	Station	Coordinate		Image	Field	Deviation
		X	Y			
SST (˚C)	1	119.627104	-5.653189	29.5	29.2	0.3
	2	119.616843	-5.64094	27.5	28.1	0.6
	3	119.596788	-5.634057	27.5	28	0.5
Chlorophyll-a (mg/l)	1	119.627104	-5.653189	3.5	2.61795	0.8820
	2	119.616843	-5.64094	1.5	1.88424	0.3842
	3	119.596788	-5.634057	1.5	1.68346	0.1835

Table 2. Validation of the sea surface temperature of Aqua Modis imagery with Landsat-8 imagery

Months	Sea Surface Temperature					
	Aqua Modis			Landsat-8		
	2019	2020	2021	2019	2020	2021
January	31.2	31.11	0	0	30.447	0
February	30.745	0	30.26	31.725	0	0
March	31.28	30.905	30.83	0	33.358	0
April	29.635	29.265	29.349	0	0	28.31
May	29.725	28.605	28.985	0	0	29.126
June	27.165	28.885	29.51	28.374	0	0
July	26.26	27.215	28.23	0	29.624	0
August	26.465	26.965	27.31	0	0	29.354
September	26.905	27.53	28.62	0	0	29.702
October	27.15	28.625	28.23	29.211	0	0
November	29.355	29.835	29.855	29.936	0	0
December	31.27	0	0	0	33.5	0

Table 3. Validation of chlorophyll a Aqua Modis Imagery with Landsat-8 Imagery

Months	Chlorophyll-a					
	Aqua Modis			Landsat-8		
	2019	2020	2021	2019	2020	2021
January	1.27175	1.3265	1.56048	0	1.5	0
February	1.43795	0		1.5	0	0
March	1.09099	1.23266	1.2085	0	1.14078	0
April	1.54668	1.55492	1.5293	0	0	1.59591
May	1.56965	1.52776	1.56955	0	0	1.67293
June	2.95741	2.64433	2.98689	3.00585	0	0
July	1.97901	1.8901	1.97294	0	2.08738	0
August	2.14301	1.94621	1.98109	0	0	2.1828
September	2.37724	2.25756	2.30628	0	0	2.38409
October	1.31491	1.38746	1.46703	1.57361	0	0
November	2.214	1.99455	0	2.44331	0	0
December	2.3724	0	0	0	2.4643	0

Sea Surface Temperature

One of the most important oceanographic parameters is Sea Surface Temperature (SST), every living thing has a different tolerance for temperature changes, according to (Duma et al, 2012) The water temperature that is good for seaweed growth is 27-30˚C , seaweed will die when the water temperature reaches 31˚C. changes in sea surface temperature are caused by currents, waves, wind and water turbidity (Rochmady, 2008). Image processing in April, June, and October displays varied images because they are influenced by changes in the transitional season as research (Badraeni, 2020) impacts of seasonal changes is the occurrence of sea water circulation due to the meeting of two water masses that have different characteristics, both temperature and salinity. The results of sea surface temperature image processing show varying SST values, spatially it can be seen that the SST distribution pattern in Mallasoro Bay in December - February (West Season) shows relatively high temperatures in the range of 30.4˚C - 33.5˚ C. This relatively high temperature range is still visible in the early March period (transition season I) because in March it is still influenced by the western monsoon, entering April - May there are signs of a decrease in sea surface temperature in Mallasoro Bay, this decrease also more visible in June - August (east season), in August - November (transition season II) the SST distribution shows an increase in the SST value in Mallasoro Bay when compared to the previous season period, namely the east season. The results of image processing of sea surface temperatures ranged from 28.37˚C - 33.49˚C (table 2). The results of analysis of satellite imagery for sea surface temperatures in January were 30.4˚C, in February 31.7˚C, in March 33.3˚C, in April 28.3˚C, in May 29.1˚C, in June 28.4˚C, in July 29.6˚C, in August 29, 3˚C, in September 29.7˚C, in October 29.2˚C, in November 29.9˚C, and in December 33.5˚C, so that the sea surface temperature is appropriate or in the range 27˚C - 30˚C for the optimal temperature for seaweed growth in April, May, June, July, August, September, October, and November as the results of Baracca's research, (1999) The suitable temperature for seaweed growth ranges from 25 – 30˚C, seaweed will die when the water temperature reaches 31˚C. Chlorophyll-a is a pigment from phytoplankton that used as a parameter of aquatic productivity (Susanto et al., 2001). Water fertility is usually related to the concentration of nutrients in water bodies. The high or low content of chlorophyll-a is closely related to the supply of nutrients originating from land through rivers that enter water bodies (Linus et al. 2016). Chlorophyll-a is a parameter that greatly determines the primary productivity of the oceans. The distribution and high and low concentrations of chlorophyll-a are directly related to the oceanographic conditions of the waters themselves (Nuriya et al., 2010). Sihombing et al., (2013)

In general, seaweed cultivation locations must have good water quality. According to Sihombing et al., (2013) one of the parameters that greatly determines the level of water fertility is chlorophyll-a. Oceanographic conditions of a body of water are closely related to the distribution and level of chlorophyll-a concentrations. If the chlorophyll-a of water is high, then the fertility level of the water will be high and vice versa, if the chlorophyll-a of a water is low, then the fertility level of the water will be low. The distribution of sea surface temperature images is presented in the following figure:

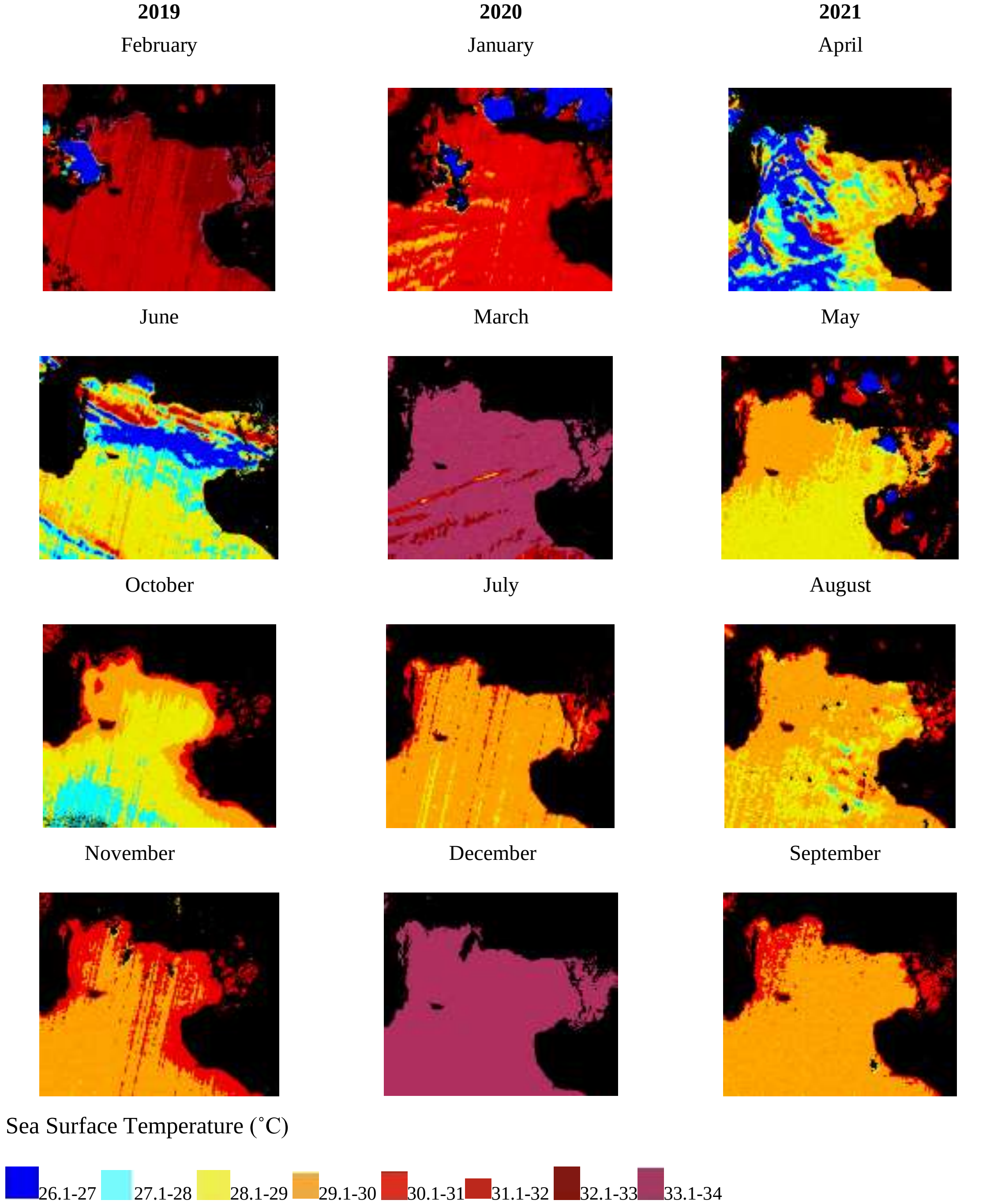

Figure 2 Mallasoro Bay sea surface temperature distribution map

Chlorophyll-a

Spatially, the level of chlorophyll-a concentration does not look too different in each season. However, in the western monsoon from January to February, the average concentration of Chlorophyll-a in Malalsoro Bay is lower compared to other seasons. However, a relatively high level of concentration is found in coastal areas, the chlorophyll-a content in coastal areas has a higher chlorophyll-a value compared to chlorophyll-a in the middle of the bay, this is due to the influence of nutrient input from the mainland, Wirasatriya (2011) said The distribution pattern shows a gradient of high chlorophyll-a concentration values in coastal areas, especially river estuaries and lower towards the open sea, because coastal areas and rivers are places for accumulation of nutrients originating from the mainland so that they empty into these waters. The distribution of Chlorophyll-a images is presented in the following figure:

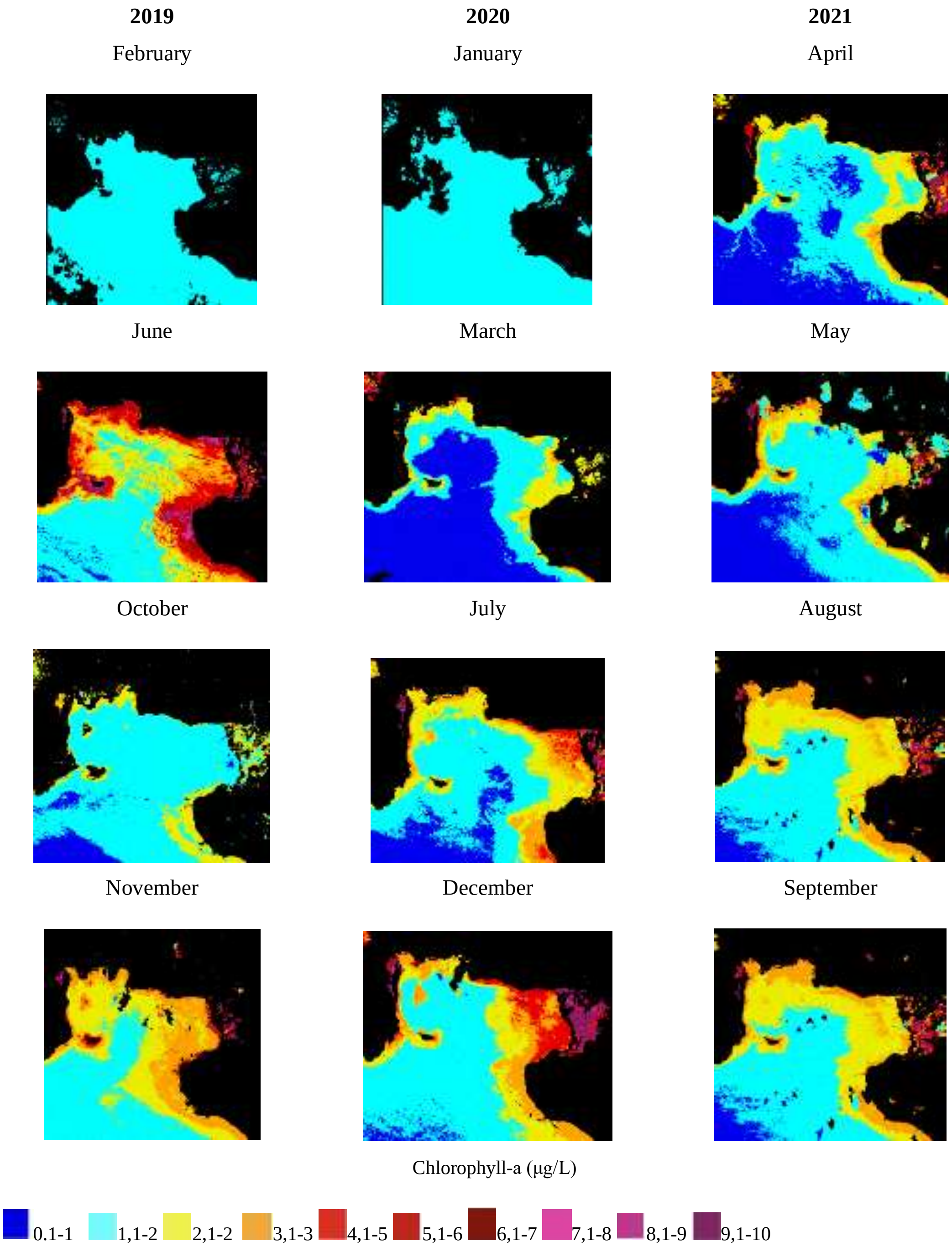

Figure 3 Map of distribution of chlorophyll-a in Mallasoro Bay

From the results of image analysis for the distribution of chlorophyll-a in Mallasoro Bay in January, the value was 1.5 (mg/l), in February 1.5 (mg/l), in March 1.14 (mg/l), in in April 1.60 (mg/l), in May 1.68 (mg/l), in June 3.00 (mg/l), in July 2.08 (mg/l), in August 2.18 (mg/l), in September 2.38 (mg/l), in October 1.57 (mg/l), in November 2.44 (mg/l), and in December 2 .46 (mg/l). according to Adani et al (2013), the level of water fertility is classified into 4, namely: the range < 1 mg/L is classified as Oligotrophic, ≥ 1–3 mg/L is classified as Mesotrophic, ≥ 3–5 mg/L is classified as Eutrophic, and > 5 mg/L L is classified as hypertrophic. This shows that Mallasoro Bay is at the Mesotrophic level throughout the year or the fertility level of the waters is quite fertile because it is in the range ≥ 1–3 mg/L, according to (Pauwah et al 2020) even though the level of water fertility is sufficient, it still provides optimum growth. , so it is still within the range to support seaweed growth.

Questionnaire

Questionnaires were distributed to 3 cultivation locations namely Biringkassi Village, Kassi Kebo Village, and Kalumpang Village which were represented by 5 seaweed farmers each. Questionnaire data were taken using the open questionnaire method, namely a questionnaire containing questions by giving respondents the opportunity to write opinion regarding the questions asked. The questions that the researchers asked in the questionnaire included pests and weeds, diseases, harvest frequency, length of maintenance, cultivation method, month of planting and month of harvesting of seaweed in Mallasoro Bay. The results obtained are that the people of Mallasoro Bay have been working as seaweed farmers for more than 10 years, the stretches that are installed in one cultivation are 100-400 stretches, the seaweed is maintained for approximately 40-50 days before being harvested. The obstacles that are often encountered when cultivating seaweed are weather, disease (white and yellow spots), weeds (moss) and pests that often occur at the beginning of the year. According to research (Badraeni, 2020) the impact of changes in water quality affects the quality and quantity of seaweed, such as production, carrageenan content, epiphytes, and ice-ice disease, (Akmal et al., 2017). Several studies have found changes in water temperature have an impact on increasing epiphytes and ice-ice disease, besides that there are some weeds that are perennial or their presence is based on the season. Even though there are obstacles in January-February, if farmers have the capital, they still spread seaweed seeds, this often results in crop failure.

Seaweed Calendar

Based on the results of data processing of sea surface temperature, chlorophyll-a and questionnaires, we obtained the seaweed planting calendar in Mallasoro Bay, Jeneponto district (Table 5). In January, February and December you can prepare tools and materials such as cleaning and repairing planting tools because in those months it is not possible to do planting because sea surface temperature conditions in those months are not optimal for seaweed growth, this is in accordance with research (Badraeni, 2020) that during the rainy season which coincides with December to March there is no seaweed planting at the research site, due to constraints with environmental factors. During this season it is not possible to carry out cultivation activities, due to big waves, high rainfall which can damage seaweed and stretch ropes break easily carried away by strong currents. Then, based on the results of the questionnaire, information was obtained that in that month there were obstacles experienced by seaweed farmers, namely the presence of pests and diseases that attack seaweed which is characterized by the presence of white and yellow spots and causes the seaweed to break easily, according to (Maryanus, 2018) with weeds and efophytes, infection with ice-ice disease on seaweed which is characterized by a change in the color of the thallus to pale yellow and finally turns white and breaks off easily. Seaweed production fluctuates based on the season, in general the productive growing season is from April to October, while the less productive growing season is in January, November and December (Arisandi et a., 2013). So that in one year, 4 cultivation cycles can be carried out, namely in the first cycle carried out at the end of March (procurement of seeds), early April (stocking of seeds), and end of May (harvest). Then cycle 2 at the end of May (seed procurement), early June (seed stocking), and mid-July (harvest), then cycle 3 at the end of July (seed procurement), early August (seed stocking), and end of September (harvest). and finally cycle 4 at the end of September (seed procurement), early October (seed stocking), and mid-November (harvest). Seaweed cultivation at each cultivation location in various regions generally only lasts three to four months in one year which is the peak season for seaweed production and the rest is a transitional season where seaweed production is relatively lower than the peak season (Badreani, 2020). From the results of image and field data processing can be presented in the following table:

Table 4. Value of image data processing and field data

Parameter	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
SST	30.4	31.7	33.4	28.3	29.1	28.4	29.6	29.4	29.7	29.2	29.9	33.5
Chlorophyll-a	1.5	1.5	1.14	1.6	1.67	3.01	2.09	2.18	2.38	1.57	2.44	2.46
Questionnaire												

= not eligible

Table 5. Seaweed planting calendar

Process	Months																																		
	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Equipment Preparation																																				
Procurement of seeds																																				
Seed Spreading																																				
Maintenance																																				
Harvest																																				

CONCLUSION

Based on the results of the study, it was found that the seaweed planting calendar in Mallasoro Bay, namely in January, February and December, can be carried out with the preparation of tools such as cleaning and repairing seaweed planting tools, then at the end of March, the end of May, the end of July and the end of September, the procurement of seeds is carried out. seaweed, in early April, early June, early August, and early October can be stocked with seaweed seeds, then in mid-May, mid-July, mid-September, and mid-November, harvesting is carried out, so that seaweed cultivation in one year can be done as much as 4 cycles.

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