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SENTINEL IMAGE APPLICATION FOR ASSESSMENT OF MACROALGAE CONDITIONS AT BONE MALAYA, MAKASSAR CITY 2015-2020

Mayang Nizhar Raj[1], Muh. Banda Selamat[2]*, Yayu A. La Nafie[2], Nurjannah Nurdin[2], Supriadi[2].

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[1]Undergraduate Student at Marine Science Study Program, Universitas Hasanuddin
[2]Departement of Marine Sciences, Faculty of Marine Science and Fisheris, Universitas Hasanuddin
Corresponding author:
*Muh. Banda Selamat
E-mail: mbandas2006@yahoo.com

ABSTRACT

This study was aimed to analyze and map the presence and percent cover of macroalgae in Bone Malalaya to determine the condition before and after the construction of the new port, as well as to analyze the distribution of suspended solids loads and environmental parameters and their relationship to changes in macroalgae cover in Bone Malalaya. The image used in this research is sentinel imagery 2A level 2A with the acquisition date of 28 October 2015, 14 July 2018 and 10 December 2020 which was processed using geographic information software to obtain a map of algae cover in Bone Malalaya. Sampling of water and physical parameters at the research location was carried out at 8 sampling stations, while algae sampling stations were carried out at 3 stations and 9 substations. There were no seagrass found in the research location, but algae species of *Sargassum* sp. With cover changes based on the calculation of image pixels, namely 36.49 Ha in 2015, 26.45 Ha in 2018 and 35.73 Ha in 2020. The highest Total Suspended Solid value at the study site was at station 8 with a value of 33.1 mg/L and the lowest value was at station 1 with a value of 16.3 mg/L. Seagrasses were not found at the research site due to unsupported physical parameters and port activities that interfere with seagrass life. The presence of macroalgae *Sargassum* sp at the research site is assumed because *Sargassum* sp has a high tolerance for physical parameters that exceed the quality standards set by the Ministry of Environment in 2004.

Keywords: *Sargassum* sp, Sentinel 2A imagery, Total Suspended Solid, Bone Malalaya.

INTRODUCTION

Algae is one of the marine biological natural resources that has economic value and has an ecological role as a high producer in the food chain and a spawning ground for marine biota (Bold and Wyne, 1985). *Sargassum* sp. is a brown alga that lives in coral habitats with a depth of 0.5-10 meters. Boney (1965) explained that the environment where *Sargassum* sp. especially in clear water areas that have a basic substrate of coral, dead coral, volcanic rocks and objects that are massive at the bottom of the waters. The depth for algae growth is from 0.5 to 10 m. *Sargassum* sp. belongs to the class Phaeophyceae, can thrive in the tropics, with a water temperature of 27.25 to 29.30 °C and a salinity of 32 to 33.5 ppt. The need for sunlight intensity of the genus *Sargassum* sp. higher than red algae. Macroalgae growth is influenced by several factors, including temperature, salinity, current velocity, depth, and brightness (Dahuri, 2001).

Remote sensing is the art and science of obtaining information about objects, areas or phenomena through the analysis of data obtained with a tool without direct contact with the object, area or phenomenon under study. Remote sensing is the science of obtaining, processing and interpreting recorded images that originated from the interaction between electromagnetic waves and an object (Sutanto, 1996).

Sakaruddin (2011) has conducted time series research to determine species composition, density, percent cover and changes in seagrass cover area by utilizing remote sensing methods. The results showed a decrease in seagrass area by 63.9% from 1990 to 2010. Research using Sentinel 2A imagery was also carried out by Zulkifli (2019) for mapping shallow waters on Bokori Island. The results of this study indicate that shallow water cover is spread in various places, by utilizing Sentinel 2A imagery to detect cover and classify shallow water cover.

The construction of the Makassar New Port in Makassar City began in June 2015 and has been operating in March 2019. The results of a study by Selamat et al., (2020) in Tallo Estuary and around the port showed that based on the Sentinel 2A image, there has been a value condition The suspended solids load exceeded the environmental quality book in January, September and October 2019. The distribution of TSS originating from the Tallo River Estuary spread to Bone Malalaya, so it was suspected that it would affect the condition of macroalgae or algae fields in the study location. Based on these circumstances, it is necessary to conduct research to determine the presence and condition of macroalgae in Bone Malaya after the construction of the port at that location.

MATERIALS AND METHODS

This research was conducted in October - December 2020 in Bone Malaya, Barrangcaddi Village, Sangkarang District, Makassar City. Water samples were collected from these locations were analyzed at the Chemical

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Oceanography Laboratory, Marine Science Department, Faculty of Marine Sciences and Fisheries, Universitas Hasanuddin, Makassar. The study locations and the distribution of sampling points is displayed in figure 1.

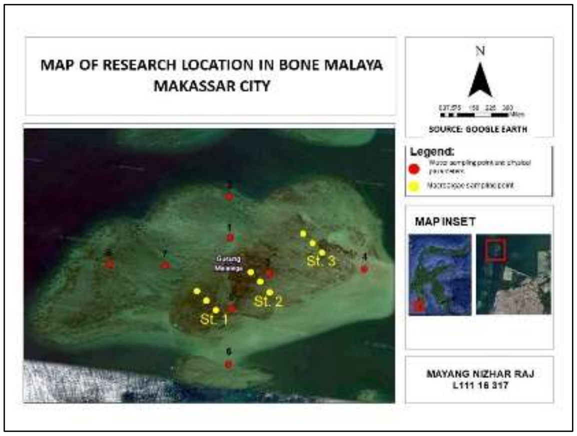


Figure 1. Map of Research Location

Field equipment used included a boat as a means of transportation for data collection, a 30m roll meter and a 50x50cm square for transects and macroalgae cover data collection, sample bottles and coolboxes to store water samples, current drifters to measure the direction and speed of currents, echosounders have been used. for depth mapping, GPS for recording the position of sampling points and tracking, secchi disk for measuring water brightness, and thermometer for measuring sea surface temperature, and underwater camera for documenting activities at the research location. Equipment and materials used in the laboratory include Whatman filter paper to filter suspended particles, a hand refractometer for measuring salinity and an oven to dry the sample.

Sampling locations of water samples and physical parameters were determined based on the division of the four cardinal directions, namely two points in each cardinal direction to obtain 8 sampling points for water samples with physical parameters. Sampling locations for macroalgae were determined by looking at the lowest depth of the bathymetric map that had been made based on tidal data from BIG, then divided into 3 stations and 9 substations. All sampling location points were entered into the GPS receiver for later use in the field. The related physical parameters measured were temperature, salinity, water clarity, current velocity and suspended solids charge (MPT). Image processing was done using Arcgis 10.4. The image used is a Sentinel 2A level 2A image that has been corrected atmospherically and geometrically, so that users are more focused on analyzing the study object. Image processing includes cropping the area according to the research location (cropping), shallow sea masking, making color composites using bands 4, 3, and 2. Next, the water column correction (Depth Invariant Index) is performed using the Lyzenga Algorithm, then classification of the image that has been obtained is carried out. corrected using the unsupervised classification. Class division in the classification process includes algae, sand, and rubble. Calculation of water column correction (Depth Invariant Index) using the formula:

$$a = \frac{(var\ Xi - VarXj)}{2cov.Xi.Xj}$$

Where:
var Xi = band i variance
Var Xj = band j variance
Cov = band I and i covariance

$$\frac{ki}{kj} = a - \sqrt{(a^2 + 1)}$$

Where:
$\frac{ki}{kj}$ = ratio of attenuasi correlation of compared bands

DII = log (xi) + [Ki/kj * log (xj)]

Where:
x_i = value of blue canal
x_j = value of green canal
K_i/k_j = attenuation coefficient

The accuracy calculation is done by making a matrix table that compares the class image classification results with 45 field photos (Congalton and Green, 2009; Lillesand and Kiefer, 1990).

User accuracy is calculated by the formula:

$$User's\ Accuracy = \frac{X_{kk}}{X_{+k}} \times 100\%$$

The manufacturer's accuracy is calculated by the formula:

$$Producer's\ Accuracy = \frac{X_{kk}}{X_{k+}} \times 100\%$$

The overall accuracy is calculated by the formula:

$$Overall\ Accuracy = \sum \frac{X_{kk}}{X_{+k}} \times 100\%$$

Where:
X_{kk} = Diagonal value of the contingency matrix i and column i
X_{+k} = Total Number of the row i
X_{k+} = Total Number of i column
N = Total Number of samples

RESULTS AND DISCUSSION

Tides and Bathimetry

The results of tidal observations for 39 hours obtained a temporary mid-seat value of 1.52 meters. The highest tide in this period or called High Water (AT) reached 1.86

meters and the lowest tide or Low Water (AR) was 0.69 meter

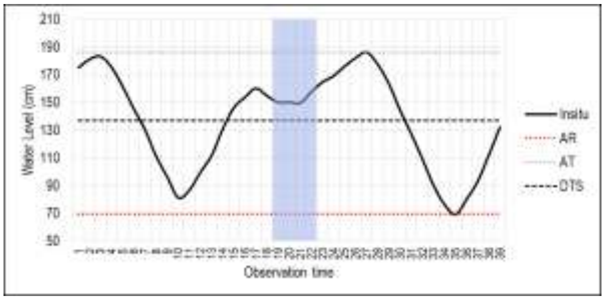


Figure 2. Observation of tides in 39 hours

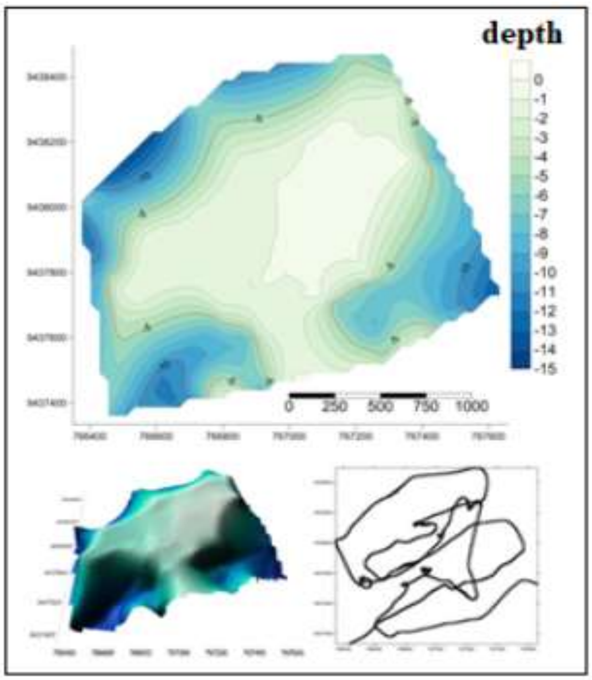


Figure 3. Bathymetry map of Bone Malalaya

From the results of tidal data analysis, it can be seen that the depth in the study area is very diverse. The minimum depth is 0.69 m and the maximum depth reaches 15 m. The use of depth measurement is to see the depth and its relationship with the ecosystem at the bottom, as it is known that macroalgae need good light penetration in order to photosynthesise to survive. Meanwhile, in the research location, the difference between shallow and deep-water areas is very much different. According to Echosounder data, there are only a few areas with a depth of 1-3 m or shallow water. The deeper a water is, the less macroalgae will survive because of the lack of light penetration for macroalgae growth.

Relationship between the Presence of Macroalgae and Environmental Parameters

The presence of macroalgae Sargassum sp. influenced by several factors, such as season and environmental parameters. This study has measured environmental parameters such as temperature, salinity, water clarity, current velocity and suspended solids charge as well as bathymetry at the research site to get an overview of the physical condition of the waters at the study site. Sea Surface Temperature

The measurement of sea surface temperature gets the highest temperature values at stations 3, 6, and 8 which are around 33˚C, while the lowest temperature values are at station 4 worth 31.5˚C (figure 4a). The average value of water temperature from all sample points is 32.5˚C. According to Dahuri (2001), the optimal temperature for algae growth is 15-30˚C, if it exceeds or is less than this value, the living conditions of the algae will decrease drastically as well. Meanwhile, according to KEPMEN-LH 2004, the standard for sea water quality for biota is 28-30˚C. The results showed that the sea surface temperature exceeded the standard temperature for macroalgae life, but with this temperature change, macroalgae were still found in the waters of Bone Malaya. This shows that Sargassum sp macroalgae can still live with not drastic temperature changes.

Salinity

Nurzahraeni (2014) in his research stated that all species of macroalgae have different tolerances to salinity, but most have a wide range of salinity between 10-40 ppt. The optimum value of tolerance to salinity in seawater is 35 ppt. Rahman et al (2013) conducted a study to see the effect of oceanographic parameters on the growth of macroalgae. The results of the study stated that the range of salinity values of 27.20 ppt can still be said to be good if there is a supply of fresh water from the river. This is in accordance with the results of research in Bone Malalaya because the research location is still influenced by the supply of fresh water from the Tallo River estuary with a salinity value of 14-24 ppt (Farhan, 2020), while Ristanti (2018) measures the salinity value at the Tallo River estuary in the range of 16 -25 ppt.

The results showed that the salinity value of the waters in Bone Malalaya ranged from 30-31 ppt (figure 4b). According to the biota quality standard set by KEPMEN-LH 2004 this value does not exceed the quality standard limit of 33-34 ppt for macroalgae, so it can be said that salinity is not a factor that causes reduction or damage to the macroalgae ecosystem in Bone Malaya, and is a parameter that optimal for the life of macroalgae *Sargassum* sp.

Water Clarity

Nainggolan (2011) states that in natural waters, brightness is very important because it is closely related to the photosynthesis process. The higher the brightness value, the higher the level of light penetration into the water column. Sunlight penetration or brightness is very important for macroalgae plants. This can be seen from the distribution of macroalgae which is limited to areas that still receive sunlight. The TSS value can be said to be inversely proportional to the brightness value. The higher the TSS value in a waters, the lower the brightness value. The value of the brightness of the waters at the study site is in the range of 0.7-1.6 m with an average of 1.15 m (figure 4c), which is very far below the macroalgae quality standard of >3 m. This indicates that the waters are in a cloudy state, which is closely related to the high TSS value, and is very influential on the life of macroalgae because light cannot penetrate the waters with a brightness value of 0.7-1.6 m. This value also proves that the waters of Bone Malalaya is relatively cloudy, causing a decrease in macroalgae density.

Current Velocity

The results of the research conducted by Rahman et al (2013) showed that the current velocity values in the two research locations ranged from 0.017-0.025 m/s, stating that this value is below the quality standard but is still in the category that is suitable for life and supports the growth of macroalgae.

The average value of the current at the study site is 0.08 m/s (figure 4d). When compared with the research results of Rahman et al (2013), the current value in Bone Malaya can be categorized as supportive for macroalgae life. Currents that are too weak can make macroalgae leaves filled with sand or mud particles which will inhibit the growth of macroalgae.

Load of Suspended Solids (Total Suspended Solid)

Several studies stated that the higher the TSS value, the lower the macroalgae density value. The high average value of TSS in a waters will cause TSS deposition in the leaves of macroalgae and directly affect the photosynthesis process and inhibit the growth of macroalgae. Research conducted by Ristanti (2018)

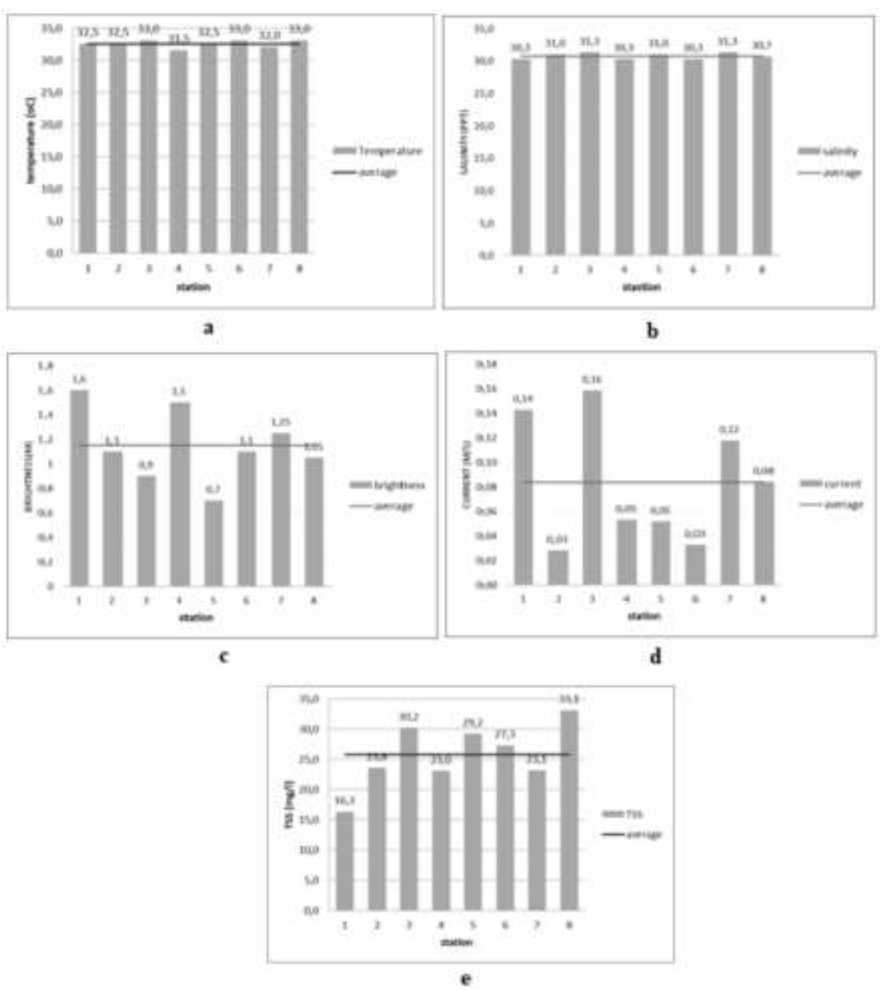


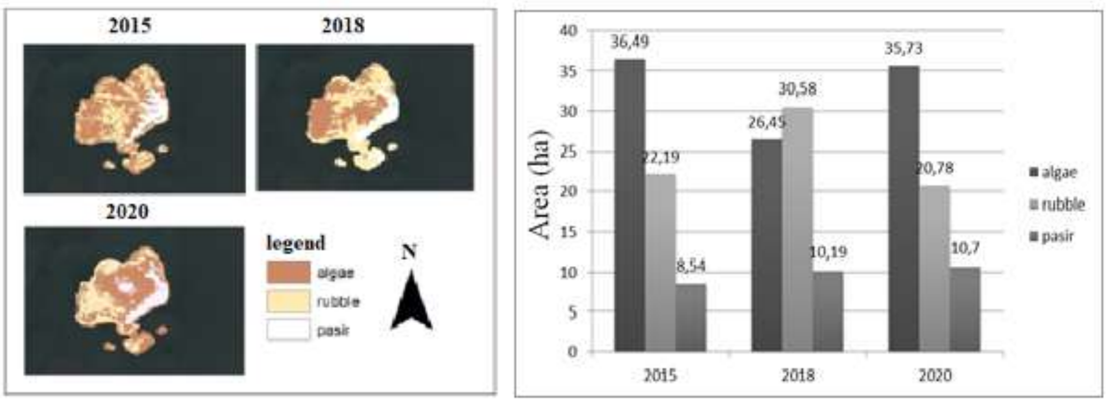
Figure 4. The results of the measurement of environmental parameters in Bone Malalaya: a) Temperature, b) Salinity, c) Brightness, d) Current, and e) TSS

states that the TSS value at the mouth of the Tallo River ranges from 22.9-79.6 mg/L. Farhan (2020) in his research stated that the TSS value at the mouth of the Tallo River ranged from 32-80 mg/L. The results of research conducted by Selamat et.al (2020) revealed that the highest TSS value at the Tallo River estuary in 2019 occurred in January with a TSS value of 600 mg/L and decreased in February with a TSS value of 54 mg/L and a TSS value of 54 mg/L. lowest in April with a TSS value of 32 mg/L. This value is categorized as high and is far above the quality standard set by the Ministry of Environment and Forestry in 2004.

Based on several previous studies, it showed that the TSS value at the mouth of the Tallo River is quite high. The distance between the mouth of the Tallo River and the research location causes the TSS from the mouth of the Tallo River to spread and affects the TSS value and causes turbidity in Bone Malaya. The average value of TSS in the waters of Bone Malalaya is 25.72 mg/L (figure 4e) which exceeds the quality standard set by KEPMENLH No. 51 of 2004 concerning the sea water quality standard, which is 20 mg/L. The highest TSS was found at station 3 of 49.58 mg/L, and the highest average TSS value was at station 8 of 33.08 mg/L. The lowest TSS value was at station 1 with a TSS value of 14.88 mg/L.

The high average value of TSS at certain points, and the average value of TSS at the study site that exceeds the quality standards are one of the factors for the decline in macroalgae density in Bone Malalaya

Macroalgae Distribution Classification Image



(a) (b)

Figure 5. a) Changes in the spatial distribution of algae 2015-2020 in Bone Malaya; b) changes in the area of each image class 2015-2020

Image analysis in this study includes masking, cropping, water column correction using the Lyzenga method, and unsupervised classification. Shallow sea masking is carried out in the Bone Malaya area because the entire area is a water area. Cropping is done to narrow the area and make classification easier. The method used is the Lyzenga algorithm to correct the water column. The water column correction produces a specific basic index value for each type of substrate (Selamat, 2012). Calculation of macroalgae cover area by counting the number of pixels then multiplied by the resolution of the image used, namely the Sentinel 2A level 2A image with a resolution of 10x10m. From the map of changes in the distribution of macroalgae from 2015-2020 (figure 5a) it can be seen that there was a change in distribution from 2015-2020, where in 2015 macroalgae spread in the waters of Bone Malaya with an area of 36.49 Ha. In 2018 the macroalgae growth area changed and condensed in the western and southern parts of Bone Malaya and there was a decrease in density to 26.45 Ha. In 2020 macroalgae condensed and centered in the middle of Bone Malalaya and there was an increase in macroalgae density to 35.73 Ha.

The highest TSS values are at stations 3 and 8. Based on the image analysis and data collection point maps, station 3 is in the shallow area and station 8 is in the deeper water area. Due to the increase in area at the station, it can be said that the TSS in Bone Malalaya did not significantly affect the growth of *Sargassum* sp in that location even though the TSS value exceeded the quality standard. The highest temperature values were at stations 3, 6 and 8, but at these stations there was an increase in cover, as well as brightness, the highest values were at stations 1 and 4 but in that areas there was also an increase in area. This means that the TSS, temperature, and brightness values at that location can still be tolerated by *Sargassum* sp.

Thematic Accuracy Test

The Accuracy Test is an attempt to calculate the level of correctness of interpretation and mapping results, and aims to determine the level of confidence in the data or mapping of remote sensing interpretation (Sutanto, 2013). Accuracy test is carried out to assess the quality of the resulting classified image map. The minimum acceptable accuracy for shallow sea bottom habitat mapping based on SNI 7716.2011 concerning shallow marine bottom habitat mapping is 60%. The thematic accuracy test resulted from this research is 71.1%, which means that the accuracy between field reference and image classification is quite strong. In terms of user accuracy, the highest accuracy is algae with a value of 85.7% and the lowest accuracy is rubble and sand with a value of 58.3%. In terms of producer accuracy, the highest accuracy value is sand with an accuracy of 77.8% and the lowest accuracy value is rubble with a value of 63.6% (Table 1).

Table 1. Thematic Accuracy TestTable 1. Thematic Accuracy Test

		Field reference			Number of rows	User accuracy (%)
		macroalgae	rubble	sand		
Image class	macroalgae	18	1	2	21	85,7
	rubble	5	7	0	12	58,3
	sand	2	3	7	12	58,3
Number pf columns		25	11	9	45	
Producer accuracy (%)		72	63,6	77,8		
Overall accuracy(%)		71,1				

CONCLUSION

The image detects that the algae cover area changed from 2018 and 2020, during the port construction period. This indication is reinforced by the TSS value which tends to exceed the quality standard. The high TSS value is estimated to come from the activities of dredging and sediment redeposition as a result of reclamation around the study site. The concentration of TSS in Bone Malalaya is high, i.e., 25.72 mg/L, while according to quality standards, the concentration of TSS is 20 mg/L. The temperature value of 32.5˚C tends to be higher than the quality standard. Meanwhile, other parameters such as salinity and current are still within the range of optimal values for algae life

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