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ANALYSIS DIVERSITY MACROALGAE BASED ON SUBSTRATE IN TARAHAN ISLAND BANTEN

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ABSTRACT

Macroalgae play a crucial role in coastal and marine ecosystems as pollution indicators and providers of food resources and habitat, in addition to their economic value. This study was conducted on Tarahan Island, Serang Regency, Banten, from April 26 to May 15 2025, to analyze macroalgae diversity and evaluate water quality. An accidental sampling line transect method was employed for macroalgae data collection, while water quality parameters such as pH, salinity, Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), and Biological Oxygen Demand (BOD) were also measured. Identification results indicated the presence of seven macroalgae varieties from six families, comprising two species from Chlorophyta and five from Phaeophyta. The northern region of Tarahan Island exhibited the highest diversity with a Shannon-Wiener index (H′) of 1.499 (moderate category), supported by more favorable environmental conditions and substrates. Conversely, the western region showed a significant decrease in diversity, with only three pollution-tolerant species identified, attributed to its proximity to industrial pollution sources. Sargassum polycystum and Sargassum cinereum proved to be the most dominant and widespread species. However, a critical finding was the high TSS levels, reaching 400 mg/L in the north and 333.3 mg/L in the west, substantially exceeding the quality standard of 20 mg/L, indicating significant stress on Tarahan Island's waters from suspended solid concentrations.

INTRODUCTION

Macroalgae are algae that can be seen with the naked eye and live to grow by photosynthesizing in shallow waters that utilize sunlight. (Kasim, 2016; Asriyana et al., 2023). Macroalgae are a type of low-level plant that does not have a true structure like plants in general. Algae have chlorophyll pigments so they can photosynthesize. Macroalgae itself can grow in various types of substart such as sand, rubble, rock, and mud, and can thrive in various habitats such as coral reefs, muddy corals, dead corals, and mangroves (Ghazali et al. 2018; Dhargalkar et al., 2004). acts as a food source for some aquatic organisms and can be a shelter, besides that it can be a useful oxygen provider for other organisms. Besides its role in the ecosystem, macroalgae can also provide economic value for coastal communities, such as medicines, jelly, and other materials that are useful or have economic value.

Banten Province has macroalgae cover ranging from 50% - 80% and industries that use macroalgae raw materials as much as 36.5 tons in dry conditions (Lestari et al., 2015). seeing from the magnitude and role in the ecosystem and economy, it is necessary to understand more about the existence of macroalgae in Banten Province, especially Tarahan Island where data on the ecology and biodiversity of macroalgae on Tarahan Island are not yet available. Precisely on Tarahan Island has a moderate level of diversity and abundance, this is influenced by the geographical condition of Tarahan Island which is surrounded by industries located on the coast of Banten which can be a source of pollution for biodiversity, especially macroalgae. The characteristics of the aquatic environment, including the condition of muddy, sandy, and rocky substrates, along with the inherent potential of macroalgae, are the reasons for conducting this research. This study aims to understand the distribution of macroalgal diversity, identify potential pollution hindering macroalgal growth, and explore the utilization potential of macroalgae on Tarahan Island, Banten Province.

METHOD

This research was conducted in April 2025. Data sampling was conducted directly on the coast of Tarahan Island, Bojonegara District. Serang Regency, Banten (Figure 1). Data collection was carried out at 2 points west and north After data sampling, the entire identification process was carried out at the Marine Biotechnology Laboratory, Faculty of Agriculture, Sultan Ageng Tirtayasa University.

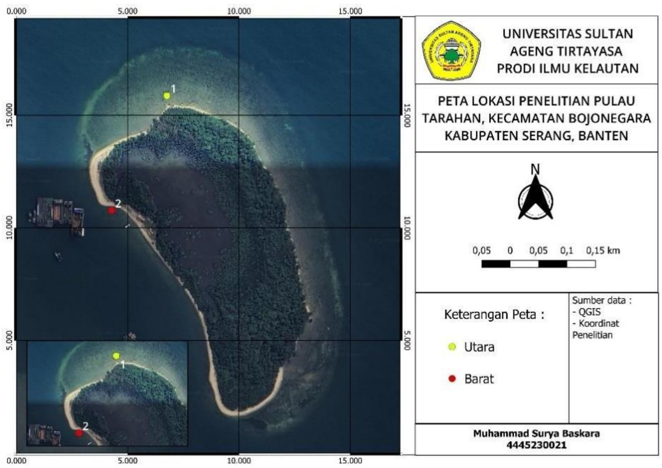

Figure 1. Research Location Map

Methods used in sampling data collection macroalgae using the

Accidental Sampling Non Probability method (Sugiyono, 2016). Samples were taken randomly according to the presence of macroalgae found in the Western and Northern stations. Samples were taken 5 times in each station spread across the western and northern parts of Tarahan Island. The water quality parameters were measured to support the analysis of the presence and distribution of macroalgae at the research site. These parameters include temperature, salinity, total suspended solids (TSS), pH, chemical oxygen demand (COD), and biological oxygen demand (BOD).

1. Community Index Analysis

Ecological index analysis includes diversity, uniformity, and dominance indices. The diversity index is calculated using the Shannon Wiener diversity index (English *et al.,* 1997) using the following equation:

$$H' = -\sum \frac{ni}{N} \; In \frac{ni}{N}$$

Description:
H′= Diversity index
ni = Number of individuals in species i
N = Total of all individuals
H′<1= low
1≥ H′≤ 3= Medium
H′ > 3 = High

The uniformity index was calculated using the following equation (Krebs, 1985):

$$E = \frac{H'}{log^2 s}$$

Description:
E= Uniformity Index
H′= Diversity index
S = Number of species
E ~ 0= Species dominance exists
E ~ 1= The number of individuals of each species is equal

The Dominance Index was calculated using the following equation (Mangurran, 1982):

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Description:
C= Dominance index
ni = Number of individuals in species i
N = Total of all individuals 1
(C> 0.5)= Dominant
(C< 0.5)= Not Dominant

RESULT AND DISCUSSION

Based on the results of observations that have been made at the two research stations on the Tarahan Island Coast, 7 species were found, 6 families. The types of macroalgae found consist of the *Chloropyceae* Division totaling two species, *Phaeophyceae* totaling five species (Table 1). Macroalgae found in the West have less species richness than in the North, because the West is directly opposite the industrial area and downstream rivers, which affect the pollution of waters (Nalle *et al*., 2020). In the western part, only 3 species of macroalgae were found, of which the three macroalgae have a high level of tolerance to pollution. Direct water pollution of macroalgae is mainly caused by liquid waste from agricultural, household, and industrial activities. (Nalle *et al*, 2020) In the northern part, more macroalgae species diversity was found due to favorable water conditions and many types of substrates than in the western part (Astuti *et al*., 2019). This is in line with the findings of several studies showing that macroalgal communities in polluted environments tend to be dominated by opportunistic species that are able to survive under stressful conditions (Setiawan *et al*., 2017). In contrast, in the North, higher macroalgae species diversity indicates relatively better water conditions because it does not directly face the source of pollution (Astuti *et al*., 2019). This higher diversity reflects that despite indirect impacts, the environment in the North can support the presence of more sensitive macroalgae species compared to the West.

In the North, the percentage of all macroalgae found is mostly *Sargassum polycystum* which is still found up to 100 meters from the shoreline. *Sargassum polycystum* has the most percent cover of other species because *Sargassum polycystum* has a high level of resilience and *Sargassum polycystum* has a fastbreeding rate (Widyartini, 2017). Percent cover owned by sargassum polysectum at the western station is in the highest position, but only 3 types of macroalgae are found in this case influenced by the ecological conditions of waters and substrates at the western station. The high level of industrial activity at the western station also affected the percent cover and macroalgae diversity.

Table. 1 Percent Cover of Macroalgae Types

Type	West	North
Caulerpa racemosa	0	5%
Halimeda opuntia	0	5%
Dyctiopteris dicotoma	0	10%
Microzonia velutina	0	5%
Padina minor	5%	10%
Sargassum cinereum	10%	15%
Sargassum polycystum	85%	50%
Total	100%	

2. Environmental Conditions

The effect of macroalgae growth is strongly influenced by the condition of environmental parameters of a water body either physically or chemically.

Based on the research conducted, the results of several environmental parameters including pH, salinity, TSS, BOD (Table 2).

Table. 2 Environmental Parameters in Tarahan Island Waters.

Parameters	Tarahan Island		Quality Standard %
	Station North	Station West	
pH	8,4	7-8	7-8,5
Salinitas (‰)	27	27	33-34 (‰)
TSS	400 mg/L	333,3mg/L	± 20 mg/L
BOD	3,26 mg/L	3,26 mg/L	30 mg/L

In the results of measurements taken in the Tarahan Island Waters, a BOD value of 3.26 mg/L, a salinity of 27 ppt, a high TSS value at both stations (400 mg/L and 333.3 mg/L) and the pH value of the waters is 8.4 at the North station and 7 at the West station, where the pH value of 8.4 is categorized as a good pH and in accordance with the standard value of seawater pH quality standards. The pH value between 6-9 is a good pH and suitable for the growth and cultivation of macroalgae (Prasetyaningsih et al., 2016). The salinity of the tarahan island waters in the northern part is 27 ppt. In general, the salinity value of the Indonesian sea area ranges from 28 - 33 ‰ (Nontji, 2002). The salinity value of the tarahan island waters is below the average quality standard of seawater salinity. The existence of salinity values in its distribution in marine waters is strongly influenced by several factors, including the interaction of the entry of fresh water into marine waters through rivers, also influenced by evaporation and rainfall (Nurhayati, 2002).

The TSS value at the north station of 400 mg/L is far above the TSS seawater quality standard, indicating that the waters on Tarahan Island are in a depressed condition due to the high concentration of suspended solids. The TSS value at the west station also shows that the waters on Tarahan Island exceed the water quality standard, which is 333.3 mg/L, indicating that the waters on the west side of Tarahan Island are very turbid. High TSS can be caused by various factors such as domestic waste, industrial waste and others. Activities around the industry cause TSS that settles to the bottom to form mud that can disrupt water flow and cause siltation. This reinforces that domestic and industrial activities are sources of TSS input (Fitrianah, 2023).

3. Macroalgae Condition in Tarahan Island

Table 3. Number of Tarahan Island Macroalgae Spacies

Type of Macroalgae	Station	
	West	North
Caulerpa racemosa	0	4
Halimeda opuntia	0	4
Dyctiopteris dicotoma	0	7
Microzonia velutina	0	4

Padina minor	1	7
Sargassum cinereum	2	11
Sargassum polycystum	9	37
Total	12	74

Table 4. Ecological indices (Diversity, Uniformity, and Dominance) of Macroalgae in Tarahan Island

	Station			
	West	Info	North	Info
H'	0.849	(Low)	1.499	(Medium)
E	0.302	(Low)	0.534	(Medium)
C	0.597	(High)	0.299	(Low)

There are 7 species of 2 classes of macroalgae found in tarahan island (Table 3) with details of chlorophycae (*Caulerpa racemosa, Halimeda opuntia*), phaeophycae (*Dyctiopteris dicotoma, Microzonia velutina, Padina minor, Sargassum cinereum, Sargassum polycystum*). The most commonly found species are *Sargassum polycystum* and *Sargassum cinereum* which are cosmopolitan (widely distributed in various regions of the world). The macroalgae diversity index value on tarahan island is found at the north station with a value of 1.499, in the medium category. This condition is directly proportional to the amount of substrate in the North area compared to the West station (Tabel 4). Heterogeneous and varied substrates can support the growth of macroalgae.

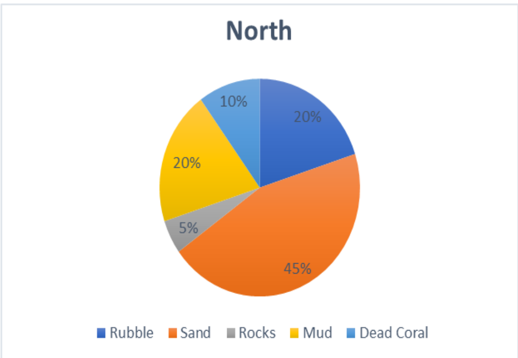

Figure. 3 Substrate Percentage in the North

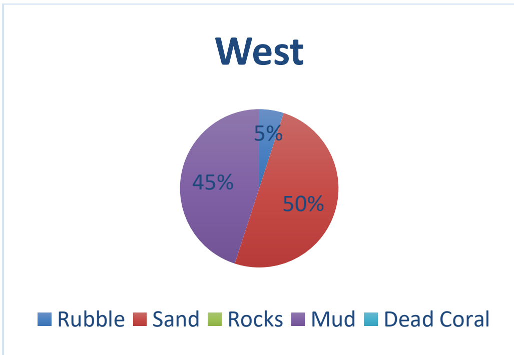

Figure. 4 Substrate Percentage in the West

From the results of the study, locations that have various types of substrates such as rubble, rocky, mud, dead coral and sand have a high diversity of macroalgae species. The basic substrate in the form of coral fragments allows more macroalgae to live on the rocks of coral fragments (Srimariana et al., 2020), because coral fragments which generally contain calcium carbonate compounds are very influential in the formation of the structure of several types of macroalgae, where the body is composed of lime substances such as Halimeda species. In addition to substrate conditions consisting of a mixture of sand and dead coral, nutrient levels and high water brightness determine high macroalgae diversity. Substrate conditions mixed with coral fragments allow a large variety of macroalgae that live in the area, hard substrates are needed by macroalgae to stick their bodies (Irwandi et al. 2017). Generally, macroalgae living on mixed substrates of sand and coral fragments have more diverse macroalgae than macroalgae in sandy substrates (Kadi, 2005). Judging from the percentage breakdown of substrates at the northern station (Figure 3) of this study showed 20% rubble, 5% cobble, 20% mud, 10% dead coral and 45% sand. It can be concluded that sand is the more dominant substrate in the North, accounting

For almost half of the whole. rubble and mud substrates have the same percentage, while rocky substrates and dead corals are the least found in the area. This North area has high diversity compared to the West station is characterized by the discovery of 7 species of macroalgae namely, *Caulerpa racemosa, Halimeda opuntia, Dyctiopteris dicotoma, Microzonia velutina, Padina minor, Sargassum cinereum, Sargassum polycystum.* That substrate heterogeneity in tidal areas can affect the level of macroalgae species diversity in the area (Nurkiama et al. 2015). Of the seven species found, Sargassum polycystum and Sargassum cinereum dominated. This is because sargassum (phaeophycae) has a strong holdfast or root-like structure to survive in sandy substrates compared to other types of macroalgae. The percentage of substrate at the West station (Figure 4) shows that there are 50% sandy substrate, 45% muddy substrate and 5% Rubble. Rivers carry sediment from land to the sea, and in the downstream area of the river, these particles will settle due to reduced current velocity, thus enriching the sand and mud content at the bottom of the water (Wardhani et al., 2019). The waters of the research site in the western part of Tarahan Island are dominated by sand and mud substrates as shown in (Figure 4), where at this location 85% of the substrate is dominated by the macroalgae species Sargassum polycystum.

West of Tarahan Island, sandy and muddy substrates dominate because the area has calm currents, and the western part of Tarahan Island is also directly facing the downstream of the river. Sandy and muddy substrates dominate the western area because the area is relatively calm or has low currents (Kismoyo *et al*., 2017). The calm current conditions allow the deposition of fine sediment particles such as sand and mud, forming a stable substrate (Effendi *et al*., 2020). The sandy substrate starts from the shoreline to a distance of 7 meters with a depth of 1.5 meters and then continues with a muddy substrate. The abundant presence of *Sargassum polycystum* on sand and mud substrates indicates that this species has good adaptability to these conditions (Susanto *et al*., 2016). *Sargassum polycystum* is known as a macroalga that is often found in shallow waters with stable sandy or muddy bottoms, as these substrates provide good attachment sites for their holdfasts (Haryanti *et al*., 2021). In addition, calm water conditions and proximity to river mouths often provide sufficient nutrients for algal growth (Fitri *et al*., 2017).

CONCLUSION

The study on Tarahan Island, Banten revealed that macroalgae diversity is significantly influenced by environmental conditions and substrate. The northern part of the island showed moderate diversity with a Shannon-Wiener index (H′) of 1.499, supported by more varied substrates and relatively better water conditions. Conversely, the western part exhibited low diversity with only three pollution-tolerant species found, primarily due to its proximity to industrial areas and river influence. Although Sargassum polycystum and Sargassum cinereum were the most dominant species at both stations, with Sargassum polycystum showing the highest percentage cover due to its resilience, the waters of Tarahan Island are generally under significant stress from high suspended solid concentrations (TSS), with values of 400 mg/L in the north and 333.3 mg/L in the west , far exceeding the quality standard of 20 mg/L. These findings underscore the importance of managing domestic and industrial waste to maintain the health of the macroalgae ecosystem in the region.

REFERENCES

Asriyana, Jumiati, Ardyati, D., P., I. (2023). Identification of Macroalgae Species Found in the Intertidal Zone of Tanjung Buaya Beach, Lasoro Village, East Mawasangka District. Journal of Biology and Education Research. Vol 2 (1).

Astuti, L. P., Irawan, A., & Pratiwi, D. (2019). Diversity and Abundance of Macroalgae in Pari Island Waters, Thousand Islands. Journal of Marine Science and Fisheries, 29(1), 1-10.

Dhargalkar, V.K. and K. Devanand. 2004. Seaweed: A Field Manual, National Institute of Oceanography, Dona Paula, Goa, 403004.

Draisma SGA, van Reine WF, Herandarudewi SMC, Hoeksema BW. (2018). Macroalgal diversity along an inshore-offshore environmental gradient in the Jakarta Bay-Thousand Islands reef complex, Indonesia. Estuarine, Coastal and Shelf Science. 200: 258-269.

Effendi, E., Suryono, S., & Hartati, R. (2020). Bed Sediment Distribution and its Relationship with Water Conditions in the Serayu River Estuary, Cilacap. Journal of Marine Science, 25(2), 107-116.

Fitri, M., Suryono, S., & Wijaya, I. P. G. (2017). Species Composition and Abundance of Macroalgae in the Coastal Waters of Awur Bay, Jepara. Journal of Marine Research, 6(2), 164-171.

Fitrianah, L. (2023). Analysis of Water Quality in Banjarkemantren River Industrial Area Using Pollution Index Method. G-Tech: Journal of Applied Technology, 7(3), 2915-2921.

Ghazali M., Husna H., Sukiman (2018), Diversity and Characteristics of Red Algae (Rhodophyta) on Mangrove Roots in Serewe Bay, East Lombok Regency,

Haryanti, E., Subarjo, M., & Rochman, A. (2021). Abundance and Diversity of Macroalgae in Seagrass Ecosystem of Pasir Putih Beach, Situbondo. Scientific Journal of Fisheries and Marine, 13(2), 105-112.

Irwandi, Salwiyah, Nurgayah WA. 2017. Macroalgae community structure in Different substrates in the waters of Tanjung Tiram Village, North Moramo Subdistrict, South Konawe Regency, Province Journal of Tropical Biology, 18(1), 80-90.

Kadi A. 2005. Some Notes on the Presence of the Sargassum Clan in Indonesian Waters. Oseana. 30(4): 19-29.

Kasim, M.R. 2016. Macro algae. Jakarta: Penebar Swadaya.

Kismoyo, A. N., Sulisetiono, A., & Purnomo, K. (2017). Characteristics of Bottom Sediments in Kondang Merak Beach, Malang. Journal of Marine Science: Indonesian Journal of Marine Science and Technology, 10(3), 205-212.

Lestari D. F., Kawaroe M., Salundik. (2015). Biogas production from red macroalgae (*Gracilaria verrucosa*) in batch system. Journal of Fisheries and Marine Technology. Vol 6(2).

Marianingsih, P., Amelia, E., & Suroto, T. (2013). Inventory and Identification of Macroalgae in the Waters of Untung Java Island. Proceedings of Semirata FMIPA University of Lampung. Vol 1(1).

Nontji, A. 2002. The Archipelago Sea. Djambatan Publisher. Jakarta: 59-67.

Nurhayati. 2002. Hydrographic and Current Characteristics in the Malacca Strait Waters. Indonesian Waters Oceanography, Biology and Environment. Oceanography Research Center of LIPI. Jakarta: 1 - 8

Poncomulyo, T., M. Herti and K. Lusi. 2006. Seaweed Cultivation and Processing.
PT AgroMedia Pustaka, Jakarta.

Prasetyaningsih, A. and Rahardjo, D. (2016). Diversity and Bioactivity of Active Compounds of Macroalgae of Wediombo Beach, Gunung Kidul Regency. Journal of Agrisains, 17(1), 107-115.

Rasyid, A. 2003. Brown Algae (Phaeophyta) as a Source of Alginate. 28 (1): 34.

Setiawan, A., Supriadi, B., & Cahyadi, D. (2017). Macroalgal Communities in Polluted Waters: A Case Study in Jakarta Bay. Oceanology and Limnology in Indonesia, 43(3), 209-220.

Srimariana, E. S., Kewaroe, M., Nugraha, A. H., (2020). Diversity and Potential Utilization of Macroalgae on the Coast of Tunda Island. Vol 25(1): 138-144.

Sugiyono. (2016). Quantitative, Qualitative and R&D Research Methods. Bandung: PT Alfabet. Susanto, B., Suryono, S., & Supriharyono, S. (2016). Macroalgae Community Structure in
Panjang Island Waters, Jepara. Journal of Marine Research, 5(2), 105-113.

Tjitrosoepomo, G. 2001. Plant Taxonomy: Schizophyta, Thallophyta, Bryophyta and Pteridophyta. Gadjah Mada University Press, Yogyakarta.

Wardhani, I. N., Sulisetiono, A., & Suryono, S. (2019). Influence of Current and Tide Tidal Impacts on the Distribution of Bottom Sediments in the Estuary Waters of the West Flood Canal River, Semarang. Journal of Oceanography, 8(1), 89-97.

Watung P.M.M, R.C. Kepel and L.J.L. Lumigas, 2016. Journal of Macroalgae Inventory in the Coastal Waters of Mantehage Island, Wori District, North Minahasa Regency, North Sulawesi Province vol 4 (2).

Widyartini, D. S., Widodo, P., & Susanto, A. B. (2017). Thallus variation of Sargassum polycystum from Central Java, Indonesia. Biodiversitas, 18(3), 1004-1011.