BIOTIK
Jurnal Ilmiah Biologi Teknologi dan Kependidikan
P-ISSN: 2337-9812, E-ISSN: 2549-1768
Vol.12, No.2, 2024. Page166-177

Analysis of Mangrove Vegetation in Mesjid Raya Sub-District, Aceh Besar District

[1]Rianda Pratama, [2*]Djufri Djufri, [2]Nazar Muhammad and [2]Vivera Ruselli Puspa

1. Undergraduate student, Universitas Syiah Kuala, Faculty of Teacher Training and Education Faculty, Department of Biology Education
2. Universitas Syiah Kuala, Faculty of Teacher Training and Education Faculty, Department of Biology Education

*Correspondence email: djufri_bio@usk.ac.id

Accepted : 29 Aug 2024
Published: 18 Sep 2024

Abstrak: Mangrove merupakan sebutan untuk kelompok tumbuhan yang tumbuh di kawasan tanah lumpur aluvial di daerah pantai dan muara sungai yang dipengaruhi pasang surut air laut. Analisis vegetasi adalah suatu cara mempelajari susunan atau komposisi vegetasi secara berstruktur dari spesies tumbuh-tumbuhan. Belum ada data yang komprehenshif terkait vegetasi mangrove di di Kecamatan Mesjid Raya. Penelitian ini bertujuan untuk mengetahui komposisi vegetasi mangrove dan tingkat keanekaragaman spesies mangrove di Kecamatan Mesjid Raya Kabupaten Aceh Besar. Penelitian ini menggunakan pendekatan kuantitatif dengan pengambilan sampel secara purposive sampling, yaitu dengan cara menentukan plot yang memiliki ukuran 10x10 m untuk kategori pohon yang tersebar di tiga stasiun yang memiliki perbedaan faktor fisik lingkungan, dengan jumlah total 90 plot. Hasil dari penelitian ini ditemukan 9 spesies dari 5 familia. Tingkat keanekaragaman (Ĥ) spesies tergolong rendah.
Kata kunci: Analisis vegetasi; tingkat keanekaragaman; mangrove.

Abstract: Mangrove ecosystems, characterized by their unique adaptation to intertidal zones along coastlines and river estuaries, play a crucial role in coastal ecology. There is no comprehensive data related to mangrove vegetation in the Mesjid Raya District. This study investigated the composition and diversity of mangrove vegetation in Mesjid Raya District, Aceh Besar Regency. Employing a quantitative approach with purposive sampling, nine plots measuring 10x10 meters were established across three stations with varying physical environmental conditions, totaling 90 plots. Vegetation analysis revealed the presence of nine mangrove species belonging to five families. The Shannon diversity index (Ĥ) indicated a low level of species diversity within the studied mangrove communities.
Keyword: Vegetation analysis; level of diversity; mangrove.

1. Introduction

Vegetation analysis comprehensively explains plant communities within a defined geographical area. Mangrove vegetation, a distinct plant community type, thrives in the intertidal zones along coastlines, strongly correlating with environmental factors [1]. Mangrove communities are typically characterized by three distinct components: major, minor, and associate. Major components uniquely adapt to mangrove ecosystems and are absent in terrestrial plant communities [2].

Mangroves play a critical ecological role, demonstrating a higher oxygen production rate than terrestrial plants. Their complex root systems contribute to coastal protection by mitigating abrasion and acting as a natural barrier against seawater intrusion. Furthermore, mangrove root systems filter and trap debris and pollutants originating from land-based sources [3].

Flourishing in muddy coastal landscapes, sheltered bays, deltas, and small islands, mangroves demonstrate a remarkable adaptability to challenging environments. Despite ongoing threats from deforestation and degradation, Indonesia maintains its status as the nation with the largest mangrove coverage globally [4][5].

Environmental factors significantly influence mangrove diversity, shaping the distinct zonation patterns observed within these ecosystems. Like other coastal regions, mangrove forest zonation in Aceh Besar Regency is strongly influenced by a complex interplay of factors, including substrate composition, salinity gradients, and tidal dynamics. The periodic influx of tides and currents carrying sedimentary material contributes to the heterogeneous nature of mangrove habitats, forming distinct zones [6].

Mangrove species exhibit specific ecological tolerances and preferences, resulting in distinct zonation patterns. The dynamic sedimentation and erosion processes further contribute to the spatial variability observed within mangrove ecosystems. Consequently, each zone can be characterized by the dominant mangrove species that comprise it [7].

DOI: 10.22373/biotik.v12i2.24846
Home page: www.jurnal.ar-raniry.ac.id/index.php/biotik/index

Aceh Besar Regency, with a coastal area encompassing 10% of its total area (2903.50 km^2), harbors a significant portion of Aceh's mangrove ecosystems. Mangroves cover approximately 130.66 km^2, representing 45% of the regency's coastal area. Among the sub-districts within Aceh Besar, Mesjid Raya Sub-district stands out as a significant site for mangrove conservation and research.

2. Research Method

This research adopts a quantitative approach, employing an exploratory survey design.

a. Time and Research Location

This study was conducted within the mangrove ecosystem of Mesjid Raya District, Aceh Besar Regency, spanning from September 2023 to November 2023.

b. Data Collection

This study will analyze various physical parameters within the mangrove ecosystem of Mesjid Raya District, Aceh Besar Regency. Data collection will focus on water quality, encompassing water pH, soil pH, and water salinity. Also, meteorological data will be recorded, including air temperature, water temperature, air humidity, and light intensity. Mangrove vegetation sampling will be conducted to assess species composition and distribution, considering availability.

Herbarium press, alcohol, hanging etiquette, thermometer, pH meter, Lux meter, Salinometer, soil meter tester, and a set of writing stationery. Data collection was conducted within the mangrove ecosystem of Mesjid Raya Sub-district, Aceh Besar District, encompassing a total study area of 9 hectares. Different stations were strategically selected, considering mangrove availability, hydrological conditions, and vegetation diversity. Thirty plots measuring 10 meters by 10 meters (10m x 10m) were established within each station using a purposive sampling approach. This method represented diverse mangrove communities and environmental conditions within the study area.

c. Data Analysis

The collected data were systematically organized and presented using tables and figures to facilitate comprehensive analysis. Quantitative methods were used to analyze the data, focusing on the diversity and abundance of mangrove species. The number of individuals per species was calculated to calculate Absolute and Relative Density. The frequency of occurrence was determined using Absolute Frequency and Relative Frequency. Dominance, a species' ecological importance measure, was evaluated using Absolute Dominance and Relative Dominance. Finally, the Importance Value Index was calculated to comprehensively assess each species overall ecological significance within the mangrove ecosystem [8].

Mangrove vegetation was identified primarily in situ. For those species requiring further examination, samples were collected and transported to the Biology Education Laboratory for identification using taxonomic keys, relevant literature, and journal articles. Field measurements of physical parameters, including water quality and meteorological variables, provided a comprehensive assessment of the prevailing environmental conditions within the mangrove study area.

A diversity index was calculated to assess the variation in plant species composition across the research stations. Species diversity indices provide a valuable metric for comparing communities and evaluating their stability. This study employed the Shannon-Wiener diversity index ($\hat{H}$) to quantify species diversity, utilizing the formula outlined [9].

$$\hat{H} = -\sum pi \ln pi$$

$$pi = ni/N$$

Where: $\hat{H}$ = Shannon-Wiener diversity index; pi= ni/N; ni= number of individuals to -i; N= the sum of important values of the whole species; ln= natural logaritma.

The Shannon-Wiener diversity index ($\hat{H}$) values were interpreted using the following criteria: $\hat{H} \leq 1$ (very low diversity), $1 < \hat{H} \leq 2$ (low diversity), $2 <$

$\hat{H} \leq 3$ (medium diversity), $3 < \hat{H} \leq 4$ (high diversity), and $\hat{H} > 4$ (very high diversity) [10].

3. Results and Discussion

The three stations exhibited distinct substrate characteristics. Station 1 was characterized by a predominantly solid sandy substrate interspersed with patches of wet mud. Station 2 featured a greater prevalence of mud puddles and a predominantly wet mud substrate. In contrast, Station 3 consisted primarily of solid land with a minor presence of mud, exhibiting a dense substrate composed of sand and mud. Across all three stations, 9 mangrove species representing 5 families were identified. The density of each species at each station is presented in Table 1 below.

Table 1. Mangrove Species Density in Mesjid Raya Sub-district, Aceh Besar District

No	Local Name	Species Name	Familia	Stations			Total (Individual)	
				1	2	3	AD	RD (%)
1	Bakau Minyak	*Rhizopora apiculata* Blume	Rhizoporaceae	114	74	77	265	44,9
2	Api-Api	*Avicennia germinans* (L.)	Avicenniaceae	40	0	15	55	9,3
3	Bakau Hitam	*Rhizopora mucronata* Lam.	Rhizoporaceae	17	38	0	55	9,3
4	Api-Api Putih	*Avicennia marina* (Forssk.) Vierh.	Avicenniaceae	62	43	46	151	25,6
5	Teruntum Putih	*Lumnitzera racemosa* Wild.	Combretaceae	0	7	0	7	1,2
6	Nipah	*Nypa fructicans* Wurmb.	Arecaceae	0	8	0	8	1,4
7	Buta-Buta	*Excoecaria agallocha* L.	Euphorbiaceae	0	20	0	20	3,4
8	Lindur	*Bruguiera gymnorhiza* Lam.	Rhizophoraceae	0	16	0	16	2,7
9	Perepat	*Sonneratia alba* Sm.	Sonneratiaceae	0	0	13	13	2,2
	Total						**590**	**100**

*AD : Absolute Density
*RD : Relative Density

As evident in Table 1, *Rhizopora apiculata* was the dominant mangrove species, observed across all stations with 265 individuals, comprising 44.9% of the total mangrove population. In contrast, *Lumnitzera racemosa* exhibited the lowest abundance, represented by only 7 individuals (1.2%) and restricted to Station 2. The prevalence of *R. apiculata*, a member of the Rhizophoraceae

family, suggests a preference for silty clay loam substrates, consistent with previous research.

Soil substrate and physical factors, including pH, temperature, salinity, light intensity, and humidity, are crucial in shaping mangrove species distribution and abundance. Each species exhibits a specific tolerance range for these environmental variables, influencing its ability to thrive in a particular habitat. *R. apiculata*, known for its high environmental tolerance, was widely distributed across all research stations, likely due to its adaptability to various substrates and physical conditions. The diversity of mangrove species documented in Mesjid Raya District, Aceh Besar Regency, is visually represented in Figure 1.

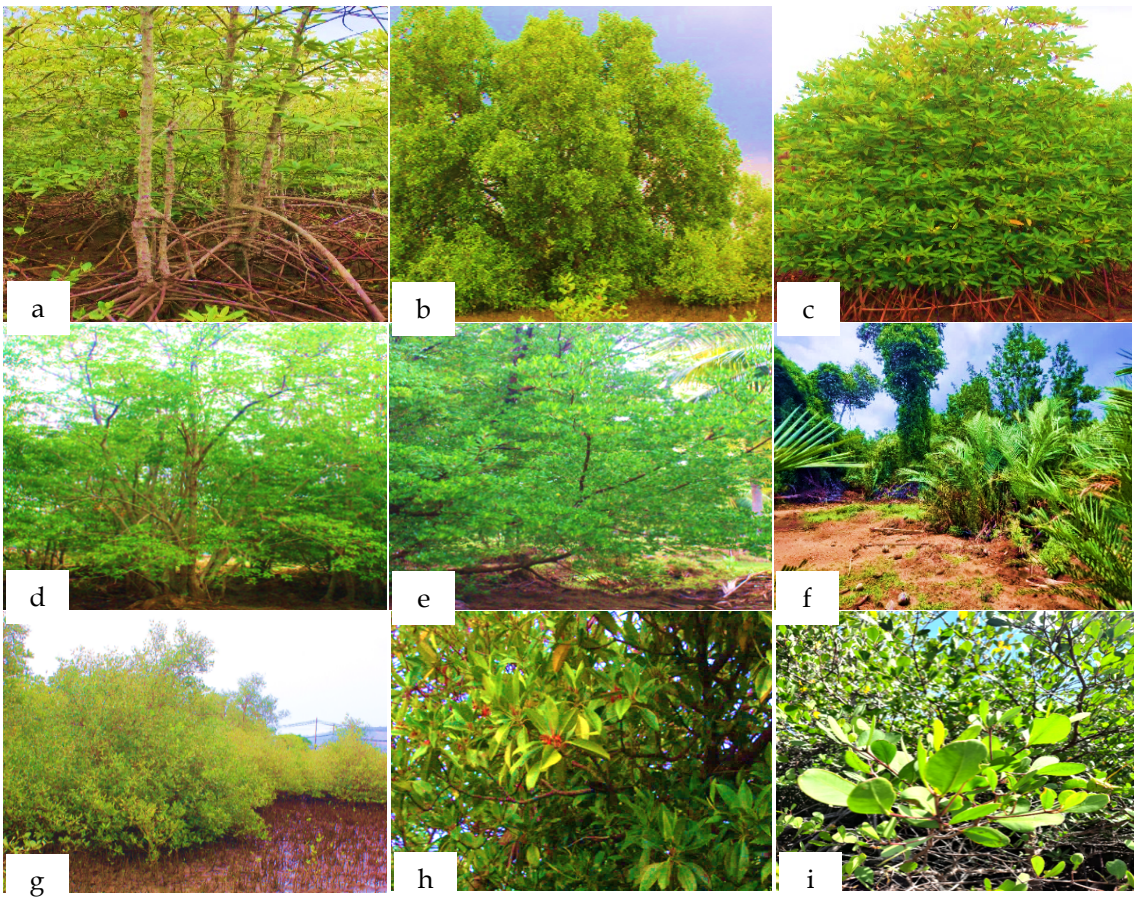

Figure 1. Mangrove Species at the Research Site. (a) *Rhizopora apiculata* Blume; (b) *Avicennia germinans* (L); (c) *Rhizopora mucronata* Lam.; (d) *Excoecaria agallocha* L.; (e) *Lumnitzera racemosa* Wild.; (f) *Nypa fructicans* Wurmb.; (g) *Avicennia marina* Forskk.; (h) *Brugueira gymnorhiza* L.; and (i) *Sonneratia alba* Sm.

Figure 1 illustrates that the mangrove community within the study site is predominantly composed of major mangrove species. This major component encompasses five families and nine genera: *Avicennia, Bruguira, Ceriops, Kandelia, Languncularia, Lumnitzera, Nypa, Rhizopora,* and *Sonneratia*. While minor mangrove species are present, they are less conspicuous and typically occupy peripheral areas of the mangrove habitat, rarely forming monospecific stands [3].

Complex interplay of environmental factors, including pH, temperature, salinity, light intensity, humidity, and distance from the shoreline, influences mangrove species' distribution and zonation patterns. These factors form distinct mangrove zones, each characterized by specific species assemblages adapted to the prevailing environmental conditions. The frequency and distribution of mangrove species across all study stations are presented in Table 2.

Table 2. Frequency of Mangrove Species in Mesjid Raya District, Aceh Besar District

Local Name	Species Name	Familia	Stations			Total (Individual)	
			1	2	3	AF	RF (%)
Bakau Minyak	*Rhizopora apiculata* Blume	Rhizoporaceae	21	21	20	62	33,2
Api-Api	*Avicennia germinans* (L.)	Avicenniaceae	16	0	9	25	13,4
Bakau Hitam	*Rhizopora mucronata* Lam.	Rhizoporaceae	7	13	0	20	10,7
Api-Api Putih	*Avicennia marina* (Forssk.) Vierh.	Avicenniaceae	22	14	16	52	27,8
Teruntum Putih	*Lumnitzera racemosa* Wild.	Combretaceae	0	4	0	4	2,1
Nipah	*Nypa fructicans* Wurmb.	Arecaceae	0	5	0	5	2,7
Buta-Buta	*Excoecaria agallocha* L.	Euphorbiaceae	0	8	0	8	4,3
Lindur	*Bruguiera gymnorhiza* Lam.	Rhizophoraceae	0	4	0	4	2,1
Perepat	*Sonneratia alba* Sm.	Sonneratiaceae	0	0	7	7	3,7
Total						**187**	**100**

*AF : Absolute Frequency
*RF : Relative Frequency

Table 2 reveals that *R. apiculata* exhibited the highest frequency of occurrence, observed at all stations, with a total of 62 occurrences, representing 33.2% of the total. Conversely, *L. racemosa* and *Bruguiera gymnorhyza* displayed the lowest frequency, each with 4 occurrences (2.1%) and restricted to Station 2. The widespread distribution of *Rhizophora apiculata* can be attributed to its

effective seed dispersal mechanisms, enabling its establishment across various zones within the study area. Furthermore, *R. apiculata* exhibits a higher tolerance to environmental stressors than other mangrove species, contributing to its dominance. The favorable physical conditions prevailing in the study area likely further support the growth and proliferation of this species.

The limited presence of *L. racemosa* and *B. gymnorhyza* suggests lower adaptability to the specific environmental conditions of the study area. Factors such as substrate preferences, salinity tolerance, and competitive interactions with other species may contribute to their restricted distribution.

Dominance, calculated based on canopy cover, provides insights into the competitive ability and influence of each mangrove species within the community. Canopy cover directly impacts light penetration, influencing understory conditions and the photosynthetic capacity of individual trees. The dominance of mangrove species at the research site is presented in Table 3.

Table 3. Mangrove Species Dominance in Mesjid Raya Sub-district, Aceh Besar District

Local Name	Species Name	Familia	Stations			Total (Individual)			
			1	2	3	AD	RD (%)	ADM (m2)	RD M (%)
Bakau Minyak	*Rhizopora apiculata* Blume	Rhizoporaceae	114	74	77	265	44,9	1347,5	44,9
Api-Api	*Avicennia germinans* (L.)	Avicenniaceae	40	0	15	55	9,3	279,7	9,3
Bakau Hitam	*Rhizopora mucronata* Lam.	Rhizoporaceae	17	38	0	55	9,3	279,7	9,3
Api-Api Putih	*Avicennia marina* (Forssk.) Vierh.	Avicenniaceae	62	43	46	151	25,6	767,8	25,6
Teruntum Putih	*Lumnitzera racemosa* Wild.	Combretaceae	0	7	0	7	1,2	35,6	1,2
Nipah	*Nypa fructicans* Wurmb.	Arecaceae	0	8	0	8	1,4	40,7	1,4
Buta-Buta	*Excoecaria agallocha* L.	Euphorbiaceae	0	20	0	20	3,4	101,7	3,4
Lindur	*Bruguiera gymnorhiza* Lam.	Rhizophoraceae	0	16	0	16	2,7	81,4	2,7
Perepat	*Sonneratia alba* Sm.	Sonneratiaceae	0	0	13	13	2,2	66,1	2,2
Total						**590**	**100**	**3000**	**100**

*AD : Absolute Dominance
*RD : Relative Dominance
*ADM : Absolute Dominance
*RDM : Relative Dominance

Table 3 demonstrates that *R. apiculata* exhibited the highest dominance across all stations, occupying 1347.5 m², constituting 44.9% of the total station area of 3000 m². Conversely, *L. racemosa* displayed the lowest dominance, covering only 35.6 m² or 1.2% of the total station area. The competitive superiority of *R. apiculata* in resource acquisition, particularly nutrients, likely contributes to its greater dominance. Its extensive root system and rapid growth rate may provide advantages in nutrient uptake compared to other mangrove species. The low dominance of *L. racemosa* suggests a lower competitive ability, potentially influenced by its adaptability to the prevailing physical conditions and substrate characteristics of the study area.

The relationship between stem size and dominance is well-established in mangrove ecosystems. Larger stem volumes generally correlate with greater canopy spread and resource capture, leading to higher dominance. *R. apiculata*, with its characteristically large stems and expansive canopies, effectively outcompetes other species for light and nutrients, contributing to its dominance within the study area [12]. Factors such as soil type, wave exposure, and tidal inundation regimes significantly shape mangrove species diversity. The diversity of mangrove species observed at the study site is presented in Table 4.

Table 4. Diversity of Mangrove Species in Mesjid Raya Sub-district, Aceh Besar District

No	Stations	Important Value Index	Diversity (Ĥ)
1	1	300	1,25
2	2	300	1,71
3	3	300	1,21
	Average		**1,39**

As shown in Table 4, the average diversity index (Ĥ) across all stations was 1.39, indicating low mangrove species diversity. Species diversity within ecosystems is influenced by many environmental factors, including but not limited to temperature, humidity, and light intensity. These abiotic factors can significantly impact plant growth rates, distribution patterns, and species diversity. Only those species with suitable adaptations for the prevailing environmental conditions can successfully establish themselves and compete for resources within a given habitat.

A complex interplay of biotic and abiotic environmental factors governs the occurrence and distribution of plant species within a given area. These factors include climate, soil moisture, topography, and interactions with other organisms. While similar environmental conditions may support similar species, it is crucial to recognize that abiotic factors do not solely determine species composition. Biotic interactions, such as competition and facilitation, also play a significant role in shaping plant communities. Therefore, even in environments with comparable physical characteristics, variations in species composition can arise due to differences in biotic interactions and historical factors. The observed similarity in species composition at the research location suggests a relatively homogeneous set of environmental conditions and biotic interactions [13].

Air temperatures within the study area ranged from 29.0°C to 31.3°C, while water temperatures ranged from 28.1°C to 30.5°C. These temperature ranges fall within the optimal range for mangrove growth and development. Soil temperatures, ranging from 31.2°C to 32.73°C, further support the suitability of the study area for mangrove establishment [14]. The pH levels measured in the research area ranged from 5.8 to 6.2, indicating slightly acidic conditions. This range falls well within the tolerance limits for mangrove growth, as mangroves generally tolerate a wide pH range (5.0-8.5) [15]. Salinity measurements within the study area ranged from 22.6 ppt to 26.6 ppt, falling within the typical salinity range (10 ppt - 30 ppt) of estuarine environments where mangroves thrive.

However, it is important to acknowledge that salinity can fluctuate spatially within an estuary, and higher salinity levels can negatively impact mangrove growth and species composition. As salinity increases, particularly in areas farther from the water's edge, mangroves may exhibit stunted growth, reduced canopy cover, and shifts in species composition [16].

4. Conclusion

The mangrove ecosystem of Mesjid Raya Sub-district, Aceh Besar District, was found to harbor nine species representing five families. The mangrove species diversity across all observation stations was determined to be low, with an average Shannon diversity index (Ĥ) of 1.39. The findings of this mangrove vegetation analysis in Mesjid Raya Sub-district, Aceh Besar District, provide a valuable foundation for future research and management efforts. Specifically, this study can inform further investigations into mangrove degradation along the coast of Mesjid Raya Sub-district, utilizing remote sensing techniques such as the Normalized Difference Vegetation Index (NDVI) for analysis. The preservation of plant biodiversity within Mesjid Raya Sub-district, Aceh Besar District's coastal region necessitates focused attention and conservation efforts from governmental agencies and relevant stakeholders involved in flora conservation.

5. Reference

[1] Nurjaman, D., Kusmoro, J., & Santoso, P. (2017). Perbandingan Struktur dan Komposisi Vegetasi Kawasan Rajamantri dan Batumeja Cagar Alam Pananjung Pangandaran, Jawa Barat. *Jurnal Biodjati*. 2(2): 167-179.

[2] Rusydi, Ihwan, & Suaedin. (2015). Struktur dan Kepadatan Vegetasi Mangrove di Teluk Kupang. *Jurnal Segara*. 11(1): 147-157.

[3] Tomlinson. (1994). *The Botany of Mangroves. Cambridge University Press, Cambridge*.

[4] Tumangger, B. S. (2019). Identifikasi Dan Karateristik Jenis Akar Mangrove Berdasarkan Kondisi Tanah Dan Salinitas Air Laut Di Kuala Langsa. *Biologica Samudra*. 1(1): 9-16.

[5] Rahardian, A., Prasetyo, L. B., Setiawan, Y., Wikantika, K. (2019). Tinjauan historis data dan informasi luas mangrove Indonesia. *Jurnal Media Konservasi*. 24(2): 163-178.

[6] Chandra, I.A., G. Seca, A.M.K. Hena, (2011). Aboveground biomass production of Rhizophora apiculata Blume in Sarawak Mangrove Forest. *Agricultural and Biological Sciences*. 6(4): 469-474.

[7] Poedjirahajoe, E. (2007). Dendrogram Zonasi Pertumbuhan Mangrove Berdasarkan Habitatnya di Kawasan Rehabilitasi Pantai Utara Jawa Tengah Bagian Barat. *Jurnal Ilmu Kehutanan*. 1(2): 10-21.

[8] Cahyanto, T., Chairunnisa, D., & Sudjarwo, T. (2014). Analisis Vegetasi Pohon Hutan Alam Gunung Manglayang Kabupaten Bandung. *Jurnal Istek*. 8(2): 145-161.

[9] Djufri., Wardiah, ZA Muchlisin. (2016). Plants diversity of the deforested peat-swamp forest of Tripa, Indonesia. *Biodiversitas Journal of Biological Diversity*.7(1). 372- 376.

[10] Djufri. (2011). Pengaruh Tegakan Akasia (*Acacia nilotica* (L.) Willd Ex. Del. Terhadap Komposisi dan Keanekaragaman Tumbuhan Bawah di Savana Balanan Taman Nasional Baluran Jawa Timur. *Biologi Edukasi: Jurnal Ilmiah Pendidikan Biologi*. 3(2): 38-50.

[11] Rambu, L.P., Ferawati, R., Frida A.L. (2019). Keragaman dan Distribusi Mangrove Berdasarkan Tipe Substrat di Pesisir Pantai Kampung Syoribo Distrik Numfor Timur Kabupaten Biak Numfor Provinsi Papua. *Jurnal Sumberdaya Akuatik Indopasifik*,3(1), 31-44.

[12] Simamora, H. P., Khairijon, K., & Isda, M. N. (2014). Analisis Vegetasi Mangrove Di Ekosistem Mangrove Desa Tapian Nauli Kecamatan Tapian Nauli Kabupaten Tapanuli Tengah Provinsi Sumatera Utara (*Doctoral dissertation*, Riau University)

[13] Nahdi, M, S., Marsono, D., Djohan, T, S. & Baequni, M. (2014). Struktur Komunitas Tumbuhan dan Faktor Lingkungan di Lahan Kritis, Imogiri Yogyakarta. *Jurnal Manusia dan Lingkungan.* 21(1): 67-74.

[14] Susilo. 2017. Analisis Vegetasi Mangrove (*Rhizophora*) di Pesisir Pantai Pulau Menjangan Besar Karimunjawa. *Jurnal BIOMEDIKA*, 10(2), 1-4.

[15] Kuncoro, Iwan. (2019). Analisis Vegetasi Mangrove di Muara Sungai Peniti, Kabupaten Mempawa. *Jurnal Laut Khatulistiwa*, 2(1): 32-38.

[16] Wantasen, A. S. (2013). Kondisi Kualitas Perairan Dan Substrat Dasar Sebagai Faktor Pendukung Aktivitas Pertumbuhan Mangrove Di Pantai Pesisir Desa Basaan I, Kabupaten Minahasa Tenggara. *Jurnal Ilmiah Platax*. 1(4): 204-209.