



Important value index (IVI) and diversity of mangrove vegetation in Aceh Tamiang, Aceh Province

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ARTICLE INFO

Keywords:

Mangrove vegetation
Important value index
Density
Diversity
Aceh Tamiang

ABSTRACT

Mangrove ecosystem is one of the unique ecosystems that has high productivity and it grows along the coast of Aceh Province, Indonesia. The mangrove vegetation in Aceh Tamiang District was decreasing due to human exploitation i.e. stems of mangrove vegetation utilized by local communities become charcoal and firewood. These activities have a negative impact on live and growth of mangrove vegetation. Therefore, the purposes of the study are to analyses the important value index (IVI), mangrove species diversity, and to analyses the correlation between substrate characteristics with mangrove density. The research stations determined using the purposive sampling method and each station has three plots as replication. There were 4 research stations located in Seruway, Bandahara, Banda Mulia, and Banyak Paye sub districts. The study reported 12 species of mangrove in the tree's category, 9 species of saplings, and 8 species of seedlings. The 12 species of mangroves found were *Avicennia lanata*, *A. marina*, *A. officinalis*, *Bruguiera parviflora*, *B. sexangula*, *Ceriops decandra*, *C. tegal*, *Lumnitzera recamosa*, *Nypa fruticans*, *Rhizophora apiculata*, *R. stylosa*, and *Sonneratia alba*. The *R. apiculata* was species commonly found in each sampling location and it had highest IVI for the tree, sapling and seedling categories with the value of 207.24, 300, and 200, respectively. The average of diversity index was 1.56 categorized in the medium category. The moment Pearson correlation showed there was no significant correlation between the physical-chemical water parameters and substrate with the density of mangrove where $P_{sig} > 0.05$.

DOI: 10.13170/depik.12.2.31130

Introduction

Mangrove ecosystem is productive coastal forest that provide essential habitat for supporting aquatic organism (Kathiresan and Bingham, 2001; Goessens *et al.*, 2014), and many of the coastal people depend on their livelihoods in the mangrove ecosystem (Hoque *et al.*, 2015). Mangrove vegetation assessment is need as a way for understanding the vegetation structure for conservation and sustainable management purposes (Malik *et al.*, 2019; Rahim *et al.*, 2023). The community structure of the mangrove ecosystem is a tool arrangement of individual trees that has a significant effect on ecosystem function. Understanding the species composition and structure

of mangrove systems are also fundamental in assessing the maturity and sustainability of the forests, species conservation, and scientific management (Dislich and Pivello, 2002). Furthermore, the mangrove community structure alteration is impact to the distribution and abundance of economical aquatic organism (Cavalcanti *et al.*, 2009). Commonly, trees are a simple way of sample to count and identify, specifically for a taxonomic purpose (Sreelekshmi *et al.*, 2018).

Aceh Tamiang Regency has an area of ± 22.900 ha of mangroves forest (Muazzin and Tinianus, 2010). The preliminary observations showed many mangrove vegetation in Aceh Tamiang were used by

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local people for charcoal, firewood, and this was proven by some charcoal kitchens established in the mangrove forest area. According to Muazzin and Tinianus (2010), mangrove vegetations in Aceh Tamiang were exploited by communities for charcoal and it's been a long time. Those activities were very detrimental to the ecological side because there are many aquatic biotas depended on the existence of mangrove ecosystems such as fish, shrimp, crab, and sea tuntong (*Batagor borneoensis*) as endemic species in the research sites. Reducing the number of mangrove vegetation caused by human activities have impact disturbance and narrowing of mangrove land (Styawan et al., 2003). Moreover, plant overharvesting caused by human activities as fuel wood and charcoal are also contributing factors to the mangrove degradation (Boquiren et al., 2010; Uddin et al., 2014). The presence of mangrove ecosystem has a significant role towards the value of ecology, economy, and social coastal areas (Jachowski et al., 2013).

According to Kathiresan and Bingham (2001), there are 65 species of mangrove have been reported around the world, and divided into two categories namely true mangroves, and mangrove associates (Wan-Juliana et al., 2010). The study about mangrove diversity have been reported by several authors i.e. Sreelekshmi et al. (2018) reported 18 mangrove species in southwest cost of India; 14 mangrove species in Central Java Indonesia (Hidayat et al., 2010); and 7 species identified in Surabaya, East Java (Susanto et al., 2018). Sulistyorini et al. (2021) reported that the highest Important Values Index (IVI) of mangrove species in Kutai National Park, East Kalimantan were *Bruquiera sexangular*, *B. gymnorrhysa*, *Rhizophora mucronata*, and *R. apiculata*. However, the data and information about biodiversity of mangrove vegetation in Aceh Tamiang area is scanty and this data is needed by stakeholders as the basis for sustainable forest management.

Mangrove forests in Aceh Tamiang Regency are located in 4 subdistricts, namely Seruway, Banda Mulia, Bendahara, and Manyak Payed. Moreover, Seruway is one of conservation area in Aceh Tamiang due to the existence of sea tuntong (*Batagur borneoensis*). Mangrove ecosystem in Aceh Tamiang has higher number of species compare to other district in Aceh Province, and some subdistricts in the study areas were proposed as conservation area. The differences substrate and physical-chemical characteristics of the environment at the research location affect the mangrove vegetation grows, those are also interesting to be observed. Therefore, a study

is needed in order to identify and inventory of mangrove ecosystem in this area. The purposes of the study were to analyses the important value index (IVI) of mangrove, mangrove diversity, and correlation between mangrove density with environmental factors of mangrove ecosystem in Aceh Tamiang Regency, Aceh Province.

Materials and Methods

Location and time of research

The research was conducted in the mangrove ecosystem of Aceh Tamiang Regency, Aceh Province started from February until June 2019. Method applied for determining the sampling location was purposive sampling method. There were 4 (four) stations based on the presence of mangrove in 4 subdistricts, namely Seruway, Bandahara, Banda Mulia, and Manyak Panyet (Figure 1). Station 1, 2, 3, and 4 were located in 4°25'0.53"N and 98°16'40.07"E, 4°27'29.10"N and 98°13'53.80"E, 4°29'7.80"N and 98°10'44.43"E, and 4°29'55.92"N and 98°9'53.90"E, respectively. Mangrove vegetation samples that had been collected and not identified yet in the field would be brought to marine biology laboratory, Universitas Syiah Kuala. However, substrate sample was analyzed at soil chemistry laboratory, Agriculture Faculty, Universitas Syiah Kuala (USK).

Mangrove vegetation measurement

Measurement and identification of mangrove vegetation at each station done by using transect applied perpendicular from the sea to the land. Each station was divided into 3 plots as replication.

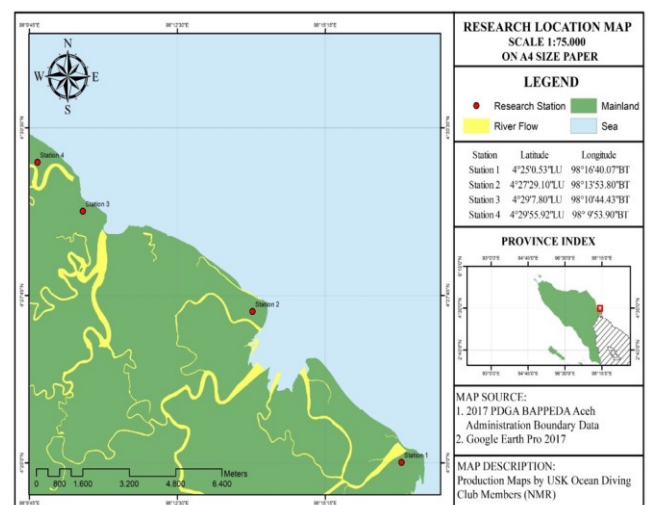


Figure 1. Map showed the sampling station (red dots)

Mangrove vegetation was measured in the transect as a plot of 10x10 m² for the tree category, 5x5 m² for sapling category, and 1x1m² for seedling category (Bengen, 2004). Tree, sapling, and seedling categories classified where the mangrove vegetation was >1.5 m in height and > 10 cm DBH (diameter at breast height); > 1.5 m in height and <10 cm DBH; <1.5 m high, respectively (Cintron and Novelli, 1984). Diameter, number of individual, and mangrove species identification was done in the field, identification of species based on mangrove identification book (Giesen et al., 2006; Noor et al., 2006). Some parameters measured in this study were included species abundance, species diversity and important value index (IVI) each species. Density is the amount of vegetation each species in an area unit as shown in the following formula (English et al., 1997):

$$D_i = \frac{N_i}{A}$$

Information: D_i is abundance of mangrove species in the- i^{th} (individual/m²), N_i is the number of individuals (ind), A is the area (m²)

Important value index (IVI) is an overview of the influence or role of particular mangrove species in the community. The IVI has been developed to express individual species' ecological development, the IVI for the species was determined as the sum of the relative frequency, relative density and relative dominance (Curtis, 1959; Razavi et al., 2012) and it has range between 0 until 300. The IVI value was calculated using the formula as follow:

$$\text{Relative density} = \frac{\text{No of individuals of a species}}{\text{Total No.of individuals of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{No of individuals of a species}}{\text{Sum of frequencies of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Basal area of a species}}{\text{Total basal area of all species}} \times 100$$

$$\text{IVI} = \text{Relative density} + \text{Relative frequency} + \text{Relative dominance}$$

The species diversity index (H') showed the vegetation stability level and to indicate the species diversity following the Shannon Wiener Index with the formula (Odum, 1971):

$$H' = \sum_{i=1}^s P_i \log_2 P_i$$

Information: H' is diversity index, P_i is the proportion of individuals in the- i^{th} species.

Physical-chemical of water and substrate characteristics measurement

The observation of physical and chemical parameters included temperature, salinity, and soil characteristics consisted of C-organic, N-total, P-available, and soil texture (percentage of sand, silt, and clay). Sampling physical and chemical parameter taken at each station were measured in situ with 3 replications. Furthermore, the soil samples were taken directly in the field using PVC pipe with a diameter of 5 cm at a predetermined point, at a depth of 30 cm with 3 replications (Indah et al., 2010). Soil were put into plastic and save in cool box before brought to the laboratory.

Data analysis

Pearson correlation analysis is used to analyze the relationship between the abundance of mangrove species with physical-chemical of water and substrate characteristic using PAWS (Predictive Analytics Software) statistics, SPSS. This analysis is important to determine the significance influence between 2 variable. Pearson correlation analysis used the dependent variable, namely tree species density, while the independent variable is physical-chemical of water and substrate characteristics.

Results

Mangrove vegetation in Aceh Tamiang was composed of 12 species from 5 families, namely Arecaceae (*Nypa fruticans*), Avicenniaceae (*Avicennia lanata*, *Avicennia marina*, *Avicennia officinalis*), Combretaceae (*Lumnitzera racemosa*), Rhizophoraceae (*Bruguiera sexangula*, *Bruguiera parviflora*, *Ceriops decandra*, *Ceriops tagal*, *Rhizophora apiculata*, *Rhizophora stylosa*), and Sonneratiaceae (*Sonneratia alba*). The highest number of species was found in Rhizophoraceae family. Figure 2 showed the total number of individuals in each species. *R. apiculata* had the highest number of species not only for tree category but also sapling and seedling category. There were 18, 64, and 23 individuals of *R. apiculata* trees, saplings, and seedlings category, respectively. Other species that have a high number of individuals were *N. fruticans* had 9 individuals of tree category, *B. sexangular* had 24 individuals of sapling, and *S. alba* had 11 individuals of seedling category.

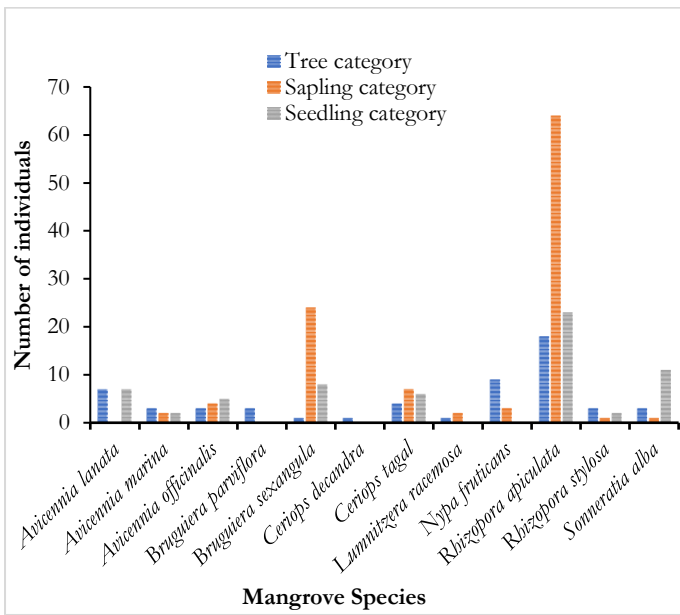


Figure 2. Number of individuals each mangrove species found in study area

Mangrove community in Aceh Tamiang was comprised of 12 trees species, 9 saplings species, and 8 seedlings species. Table 1, 2, and 3 showed the abundance, relative abundance, relative frequency, relative dominance, and important value index (IVI) of mangrove species for each category. In average, the species abundance for tree category was 448 individuals ha⁻¹, and station 2 had the higher density (560 individuals ha⁻¹) compared with station 1, 3, and 4. The highest important value index (IVI) was *R. apiculata* found at station 3, and 4 as many as 198.59 and 207.24 for tree category with relative density of them were 66.67 %, and 70 %. Otherwise, *A. lanata* had highest IVI in station 1 (134.40) and *N. fruticans* was the highest IVI at station 2 (73.39) (Table 1).

In the sapling category, the average of density was 3575 individuals ha⁻¹, and the highest density was in station 4 with 4500 individuals ha⁻¹. *R. apiculata* has the highest value of IVI as many as 300 followed by *B. sexangula* (235.71) at station 4 and 1, respectively. Furthermore, the highest IVI value in station 2 and 3 were *R. apiculata* with the value 102.15 and 216.46 (Table 2).

Table 1. Mangrove density and important value index (IVI) of trees in the research area

Station	Species	Di (ind ha ⁻¹)	RD _i (%)	RF _i (%)	RC _i (%)	IVI
1	<i>A. lanata</i>	200	41.18	2.86	50.37	134.40
	<i>B. sexangula</i>	30	5.88	4.29	3.40	23.57
	<i>N. fruticans</i>	200	35.29	8.57	23.09	86.95
	<i>S. alba</i>	100	17.65	4.29	23.15	55.08
Total		530	100	100	100	300
2	<i>A. marina</i>	100	18.75	20.00	16.12	54.87

	<i>A. officinalis</i>	100	18.75	20.00	14.41	53.16
	<i>B. parviflora</i>	100	12.50	10.00	7,10	29.60
	<i>C. decandra</i>	30	6.25	10.00	3,55	19.80
	<i>L. racemosa</i>	30	6.25	10.00	6,41	22.66
	<i>N. fruticans</i>	100	18.75	20.00	34,64	73.39
	<i>R. apiculata</i>	100	18.75	10.00	17,77	46.52
Total		560	100	100	100	300
3	<i>C. tagal</i>	100	33.33	40.00	28.08	101.41
	<i>R. apiculata</i>	300	66.67	60.00	71.92	198.59
Total		400	100	100	100	300
4	<i>R. apiculata</i>	200	70.00	75.00	62.24	207.24
	<i>R. stylosa</i>	100	30.00	25.00	37.76	92.76
Total		300	100	100	100	300

Table 2. Mangrove density and important value index (IVI) of saplings in the research area

Station	Species	Di (ind ha ⁻¹)	RD _i (%)	RF _i (%)	RC _i (%)	IVI
1	<i>B. sexangula</i>	3200	92.31	60.00	83.40	235.71
	<i>N. fruticans</i>	100	3.86	20.00	14.81	38.67
	<i>S. alba</i>	100	3.86	20.00	1.79	25.66
Total		3400	100	100	100	300
2	<i>A. officinalis</i>	500	21.05	28.57	11.95	61.57
	<i>A. marina</i>	300	10.53	14.29	9.18	33.99
	<i>L. racemosa</i>	300	10.53	14.29	16.34	41.16
	<i>N. fruticans</i>	300	10.53	14.29	13.16	37.97
	<i>R. apiculata</i>	1100	42.11	14.29	45.75	102.15
	<i>R. stylosa</i>	100	5.26	14.29	3.63	23.18
Total		2600	100	100	100	300
3	<i>C. tagal</i>	900	24.13	40.00	19.40	83.53
	<i>R. apiculata</i>	2900	75.86	60.00	80.60	216.46
Total		3800	99.99	100	100	299.99
4	<i>R. apiculata</i>	4500	100	100	100	300
Total		4500	100	100	100	300

Table 3 showed the abundance and IVI of each seedling species, the total mangrove abundance was higher in station 1 (86.700 individuals ha⁻¹) compared with station 2, 3, and 4. The highest species abundance of mangrove was *S. alba* as many as 36.000 individuals ha⁻¹. However, the highest IVI of seedling was *R. apiculata* (200) at station 4 followed by *C. tagal* (90.00) at station 3.

The distribution of mangrove species each sampling station, the mangrove species that were often found were *R. apiculata*, this species was found in all station except in station 1. *S. alba*, *A. lanata*, and *B. sexangula* were found only in station 1, moreover *N. fruticans* was found in the station 1 and 2. The highest number of species was found in station 2 (7 species) followed by station 1 (4 species), and station 3, 4 (2 species) (Table 4).

Table 3. Mangrove density and important value index (IVI) of seedling in research area

Station	Species	Di (ind ha ⁻¹)	RD _i (%)	RF _i (%)	IVI
1	<i>A. lanata</i>	23.300	26.92	50	76.92
	<i>B. sexangula</i>	26.700	30.77	25	55.77
	<i>S. alba</i>	36.700	42.31	25	67.31
Total		86.700	100	100	200
2	<i>A. marina</i>	6700	11.77	25	36.77
	<i>A. officinalis</i>	16.700	29.41	25	54.41

	<i>R. apiculata</i>	27.700	47.06	25	72.06
	<i>R. stylosa</i>	6.700	11.77	25	36.77
Total		57.800	100	100	200
3	<i>C. tagal</i>	20.000	40	50	90.00
	<i>R. apiculata</i>	30.000	60	50	110
Total		50.000	100	100	200
4	<i>R. apiculata</i>	20.000	100	100	200
	Total	20.000	100	100	200

Table 4. The mangrove species distribution in each sampling station

Mangrove species	Station 1	Station 2	Station 3	Station 4
<i>A. lanata</i>	+	-	-	-
<i>A. marina</i>	-	+	-	-
<i>A. officinalis</i>	-	+	-	-
<i>B. parviflora</i>	-	+	-	-
<i>B. sexangula</i>	+	-	-	-
<i>C. decandra</i>	-	+	-	-
<i>C. tagal</i>	-	-	+	-
<i>L. recomosa</i>	-	+	-	-
<i>N. fruticans</i>	+	+	-	-
<i>R. apiculata</i>	-	+	+	+
<i>R. stylosa</i>	-	-	-	+
<i>S. alba</i>	+	-	-	-

Note: present (+), not present (-)

Tabel 6. The Pearson correlation

Analysis/Parameter	Temperature	Salinity	Organic carbon	N-total	P-available	Sand	Silt	Clay
Average	26.75	32.25	3.87	0.08	27.32	74.25	12.25	13.50
Mangrove abundance Pearson Correlation	-0.25	-0.56	0.58	0.69	0.51	-0.80	0.79	0.82
P-Sig	0.74	0.43	0.41	0.30	0.48	0.19	0.20	0.17

Shannon–Weiner diversity index (H') of tree, sapling, and seedling in Aceh Tamiang Coast were ranged from 0.88 to 2.69, from 0.10 to 2.25, and from 0.10 to 1.76, respectively. The highest mangrove diversity was in station 2, not only for tree category but also sapling and seedling category. The highest diversity index of tree, sapling, and seedling category were 2.69, 2.25, and 1.76, respectively. The value was categorized as medium diversity. There were 7 species of trees, 6 and 4 species of saplings and seedlings. Otherwise, the lowest species diversity was found at station 4 for all categories (Table 5).

Tabel 5. Shannon-Weiner Diversity index (H') of mangrove ecosystem in research location

Station	H' tree	category	H' Sapling	category	H' Seedling	category
1	1.74	Medium	0.47	Low	1.56	Medium
2	2.69	Medium	2.25	Medium	1.76	Medium
3	0.92	Low	0.80	Low	0.92	Low
4	0.88	Low	0.10	Low	0.10	Low
Average	1.56	Medium	0.88	Low	1.06	Medium

Pearson correlation was used to analyze the correlation between the abundance of mangrove species with physical, chemical and substrate parameters using IBM SPSS Statistics software or commonly called PAWS (*Predictive Analytics Software*). The results of the analysis can be seen in Table 6. The value shows no significant correlation between abundance of mangrove with physical-chemical of water and substrate parameters ($P_{sig} < 0.05$).

Discussion

There are 5 true mangrove families have been recorded in study area namely Arecaceae, Avicenniaceae, Combretaceae, Rhizophoraceae and Sonneratiaceae. Rhizophoraceae is one of mangrove families that has the highest number of species in the study area followed by Avicenniaceae as well as Canizares et al. (2016) reported 5 species of Rhizophoraceae and the highest family mangrove composition in Dinaga Island, Philippines. Rhizophoraceae is true mangrove category that has widely distribution and commonly found (Nebula et al., 2013).

Sulistiyowati (2009) reported 3 families in Pulau Sempu, Indonesia they were Rhizophoraceae, Aviceniaceae, and Sonneratiaceae. There were 12 species that have been identified, they were *Avicennia lanata*, *A. marina*, *A. officinalis*, *B. sexangular*, *B. parviflora*, *C. decandra*, *C. tagal*, *L. recomosa*, *N. fruticans*, *R. apiculata*, *R. stylosa*, and *S. alba*. Sreelekshmi (2018) reported 18 true mangrove species found in southwest coast of India. Furthermore, nine mangrove tree species recorded at Sibuti, Sarawak (Shah et al., 2016), 15 species of true mangrove reported in Pulau Rimau, Indonesia (Yuliana et al., 2019), and 19 species of mangrove found in Segara Anakan, Cilacap Regency-Indonesia (Ismail et al., 2021). The number of species is different in each region because of climate characteristics, environmental parameters, nutrients, and substrate characteristics. The species of *R. apiculata* has the highest abundance in tree and sapling categorized, however *S. alba* was the highest species abundance in seedling. *R. apiculata* is commonly species found throughout coastal of Banda Aceh and Aceh Besar (Deviyanti, 2005). The mangrove distribution is in line with Wan Juliana et al., (2016) who mentioned

that *R. apiculata* is species that have distribution widely and dominant in Serawak, Malaysia.

In study area, the total abundance of trees, saplings, and seedlings were 1790 trees ha⁻¹, 14300 saplings ha⁻¹, and 214.500 seedlings ha⁻¹, respectively. The saplings, and seedlings density value was high in study area comparable with the mangrove forest in Sarawak-Malaysia where [Shah et al. \(2016\)](#) reported 1938.46 trees ha⁻¹, 1722.22 saplings ha⁻¹, and 6222.22 seedlings ha⁻¹. Species abundance and diversity was influenced by soil characteristics, soil is one of environmental parameters can affect the mangrove existence and growth. Mangrove grown land is generally in a fine textured soil and mud which is silt and clay combination ([Spalding et al., 2010](#)). Mangrove forests well grow in coastal areas that contained mud and sand substrate ([Windusari et al., 2014](#)). In the study area, station 1, 3, and 4 located next to the sea that brought sand from the sea due to tidal action and made those station have sandy clay for substrate texture.

The abundance of trees was highest in station 2, this assumed due to sandy loam substrate texture in this station where the percentage of sand, silt and clay fraction were 44%, 32%, and 24%, respectively. [Andrade et al. \(2018\)](#) mentioned that the result of tidal activity would be result the soil content was sand>silt>clay, moreover [Spalding et al. \(2010\)](#) stated that commonly mangrove soil is known as mud, which is combination of silt and clay. *S. alba* was species that had the highest density for seedling category, it was presumed due to substrate texture and *S. alba* have been planted in this station. [Noor et al. \(1999\)](#) explained that *S. alba* growth well in sandy beach. Station 1 had the highest seedling density presumed because of the substrate texture. Soil fraction in station 1 contained by highest sand fraction (81%) and followed by silt, and clay fraction were 7%, and 12%, respectively, and formed the substrate texture in this station was sandy clay.

The importance value index (IVI) of mangrove vegetation can be obtained from the sum of the relative frequency, relative density, and relative dominance of a vegetation. The IVI provides an overview of the influence or role of a mangrove plant species in the mangrove community, the higher the IVI value of certain species means the more important its role in the community ([Matatula et al., 2021](#)). The highest IVI value of *R. apiculata* was in station 3, and 4 were 198.59 and 207.24 for tree category with relative density of them were 66.67 %, and 70.00 %. Otherwise, *A. lanata* and *N. fruticans* have highest IVI in station 1 and 2. The high INP of *R. apiculata* species because this species has a wide

distribution area and cosmopolite characteristic so it can develop well as long as it is still have supplied with salt water. [Shah et al. \(2015\)](#) obtained the highest IVI in mangrove forest, Serawak-Malaysia was *R. apiculata* (202.24) followed by *Xylocopus granatum* (63.85). Previous research in Idi Rayeuk, East Aceh was also found a *R. apiculata* which had the highest relative density of 100% ([Parmadi, 2016](#)). At saplings level, *R. apiculata* has the highest IVI (300) followed by *B. sexangular* (235.71) at station 4 and 1, respectively. The difference of mangrove vegetation IVI value might be caused by competition of each mangrove species for nutrient, space, and sunlight. Apart from nutrient and sunlight penetration, other factors that cause differences in the density, frequency, and dominant of mangrove vegetation are the type of substrate, tide of sea water, and land suitability ([Yanti et al., 2021](#)). Furthermore, high IVI value describes that the certain species are able to compete in their environment as well as with other species ([Renta et al., 2016](#)), and indicate the role and dominance of species ([Pamoengkas, 2017](#)). Species that has high IVI describes that species having greater cumulative control value to their environment, preponderant in exploiting resources, and more able to adapt well in their habitat ([Raymond et al., 2010](#); [Haileab et al., 2011](#))

In average, the diversity index of mangrove ecosystem in Aceh Tamiang Regency was medium category for tree and seedling, but low category for sapling according to the Shannon-Wiener Diversity Index. The criteria for categorizing diversity index are low ($H' < 1$), medium ($1 < H' < 3$), and high ($H' > 3$). Shannon's index is a commonly tool to seek out species diversity ([Vijayan et al., 2015](#)). The highest diversity index in the study area for tree, sapling, and seedling categories were 2.69, 2.25, and 1.76, and found at station 2. The similar result was reported by [Asuk et al. \(2018\)](#) in Mangrove swamp forest Nigeria, the H' ranged from 1.61 to 2.12 (medium category). The result similar to [Nugroho \(2002\)](#) found the diversity index of mangrove in Ajkwa and Kamora, Mimika Regency ranged from 1.01 to 2.5 (medium category), and in Sebatik Island, East Kalimantan of 1.30 as a medium category ([Ardiansyah, 2012](#)). High diversity index indicated that the ecosystem in a mature condition ([Odum, 1971](#)).

Species diversity depends on the distribution of individuals in each species and the diversity of species in a community is considered low if the distribution is uneven. Station 2 had higher mangrove diversity than other station, it is presumed by soil characteristics i.e. soil texture, and nutrient content. The results of the soil fraction at the station 2 were

44% of sand, 32% of dust, and 24% of clay categorized as sandy loam soil. Station 2 contained higher Organic carbon (OC), N-total, and P-available of mangrove soil than other station. The OC, N-total, and P-available at station 2 were 7.49%, 0.16%, and 30.5%, respectively. The value of soil nutrient indicated that OC in the station 2 was high, Fitriana (2006) was classified OC into very low if the carbon content is <1.00%; low (1-2.00%); moderate (2.01-3.00%); and high (> 5.00%). The OC, N-total, and P-available in station 1; 3; and 4 were 1.38%, 0.05%, 24.6%; 4.06%, 0.08%, 29.9%; and 2.57%; 0.06%; 24.3%. The OC in Mangrove ecosystem, Aceh Tamiang higher compared with OC in the mangrove ecosystem Aceh Besar and Banda Aceh were categorized moderate, low, and very low (Dewiyanti et al., 2021). The high OC was caused by high contribution of mangrove component i.e. leaves, fruits, and branches dead and fall into ecosystem. Moreover, high OC related to lower sand and higher clay percentage in station 2 compared with other station. Clay content has positive correlation with organic matter (Andrade et al., 2018).

The correlation between mangrove species density with physical-chemical of water, and substrate characteristic based on the Pearson Correlation showed there is a no significant correlation between abundance of mangrove with physical-chemical of water and substrate ($P_{sig} > 0.05$), and the correlation explained that there were a negative (inverse) correlation between temperature (-0.25), salinity (-0.56), and sand (-0.80) with mangrove density. The negative correlation indicated higher the temperature, salinity, and sand percentage would reduce mangrove species abundance. Khairijon et al. (2015) reported there is a negative correlation between mangrove abundance with sand. However, Organic Carbon, N-total, P-available, silt and clay have a positive correlation to the mangrove density, meaning that increasing those variables will be increasing mangrove abundance. The highest correlation was the mangrove density with clay, and the correlation value was 0.82 categorized high even though it was not significantly correlate based on Pearson correlation ($P_{sig} > 0.05$).

Conclusion

Total number of mangrove species identified in mangrove ecosystem, Aceh Tamiang were 12 species from 4 families namely, *Avicennia lanata*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera parviflora*, *Bruguiera sexangula*, *Ceriops decandra*, *Ceriops tegal*, *Lumnitzera recomosa*, *Nyssa fruticans*, *Rhizophora apiculata*, *Rhizophora stylosa*, and *Sonneratia alba*. The *R. apiculata* was species

that commonly found in each sampling station and it had the highest Important Value Index (IVI) for the tree, sapling and seedling categories. The species abundance was highest in *R. apiculata* for tree and sapling, however for seedling category *Sonneratia alba* was the highest species abundance. The average of diversity index (H') was categorized in the medium category. There was no significant correlation between the physical-chemical water parameters and substrate with the abundance of mangrove.

Acknowledgments

We would like to express our thanks to Nanda, and Muntazir for their assistance during field work and data analysis. Our deepest thanks to Ocean Diving Club (ODC) team and local people in study area for their supporting and very good cooperation.

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How to cite this paper:

Dewiyanti, I., M. Rifki, C. Octavina, M. Ulfa, A. Damora, N. Nurfadillah. Important value index (IVI) and diversity of mangrove vegetation in Aceh Tamiang, Aceh Province. Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan, 12(2): 190-197.