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ARTICLE

Structure of Woody Plant Communities on Mudflats of Species to the Coast and Dykes Protection: As Case Study in Sea West of Kien Giang Province

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ABSTRACT

This study is proposed by Kien Giang University to the Ministry of Education and Training with the aim investigate species abundant in the Mekong Delta to develop land in Vietnam. Western Mekong Delta (WMD) alluvium sediments flows from upstream China to Vietnam. This sediments accumulated gradually elevation the new land. The coastal where mangrove forests with a rich ecosystem of plants and animals. Over time, these forests change, with different plant species succeeding each other. Biodiversity of tree species, and abundance communities, measured growth of the forest in this region. In 2023, a comprehensive survey was conducted. Investigate the situation of woody plant species in mangrove forests in sub-regions. The methods investigate is indentified the number of survey plots have done depend on the density of the forest, Base on the width of the forest range, the number of survey plots in sub region set up from 10 to 15 plots. In total, 68 plots have done established, plot is 100 square meters. Found the number of species in each ecological region and growth situation. The results of study are provided scientifically based information of the tree species composition, distribution, and community structures; this result had 16 species from 11 plant families is determined. Among these species have 6 dominant species. Main discovery is found two species grow on the best on new land were *Avicennia officinalis* and *Avicennia alba* can develope on the original new land. These adapted species can exploit food and medicinal herbs in biodiversity distribution abundance of these species. It can help Vietnam by mearsures using the species Aviecennia be discovered will promote sea reclamation faster instead of letting the natural

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law of sea reclamation follow. Conclusion there are 7 species in high land, 11 species medium land, 8 species low land 6 species lowest land, of which 2 species found that can planting in this area in target for land reclamation in this area.

Keywords: Structure of Mangrove Plant; Western Mekong Delta; Mangrove Forest Species; Expand Natural Land; Polder From Mangroves

1. Introduction

This region have the coastal length more than 500 kilometers from the Cambodia to Vietnam map. Along the the coast is the mangrove forest with the dike of forests is very thin [1-4]. In the world the mangroves forest are distributed along the coastlines of regions[5-7]. The species of the world are determined about 70 species from at 1.5 meters to 50 meters height [8, 9]. Mangroves are found in most tropical and subtropical countries, and they have the cover area about 11 to 18 million hectares of world [8]. In Vietnam 37 species of mangrove forest [6, 9]. The WMD is region high biodiversity [10, 11], so also have many species that developed in the mangrove forest [9]. The WMD was affected by two water sources: One of them is the saltwater from the Gulf of Thailand and second of them is the freshwater from Mekong rivers flowing from up stream to the WMD. These water resources mixed made in different environment with salt and brackish water along the coast of WMD. Besides, this coastal also was polluted by factors like the shrimp farming, residential areas, and seafood processing facilities. This coastal have given the alluvial from floodwaters carrying sediment and dissolved substances from upstream to the WMD. These substances accumulate at bottom mud and minerals, which can be useful for plants to grow so that the planted trees grow into forests and after it will be into the new lands for agriculture and other lands.

To understand for distribution and compossition of mangrove spescies in this region and also establish scientific basis with choosing suittable plant species for new alluvial soil land to sustainable development the mangrove forest in the WMD of Vietnam is necessary and urgent. This information is also help local governments make appropriate regulations and policies to forest protection and development quickly by mearsures on the basis of appling the rules of species and growth structure. Besides, results the rules of community structure show that it is posible to build mixed forest models with many species for each different region. Furthermore, results can be to found the law of the mangroves development through natural development can build an artifical on the new forest land and new lands by *Avicennia officinalis* and other *Avicennia sp.* species [12].

With 3 species in this region very important with foods and medicines *Avicennia officinalis*, *Avicennia alba*, *Sonneratia caseolaris* can exploited for human and animals, the species *Rhizophora apiculata* can exploit for wood and midicines.

There are studies on mangrove forest in this area, but most of them confirm the speices, compare the proportion of each species to found the richness and compare growth between species there is no topic mention about.

2. Methods

2.1. Ecological Zoning Method

Based on the ecological zoning method [13], ecological zone based on soil distribution, topography, water regime, plant communities and divides the ecologycal areas into different ecological sub-regions. Under the conditions of coastal WMD, it is divided into 4 ecological sub-regions.

2.2. Methods of Investigating Species

Number of sample plots (**Figure 1**):

Resource survey projects must be maintained [14, 15]. Depend on the purpose of the survey, accuracy is controlled differently. In forestry research, the specified reliability is usually 95% and the error is 10%. The number of sample plots was calculated the formula [14]:

$$n = \frac{4N(S\%)^2}{N(\Delta\%)^2 + 4a(S\%)^2}$$

(n: Number of cells to be investigated; N: Overall capacity (N=f/a); a: Area of sample plot; F: Area of investigation area; %: Given error (10%); S%: Coefficient of variation),

(an indicator that represents the relative average volatility of the observed value range) is calculated according to the formula:

$$S\% = \frac{S}{x} * 100$$

(In which: S: sample standard deviation; x: sample average)Identify species, diameter of the tree trunk at the height of 1.3 meter (D1,3) [15], measure height to the top (Ht), canopy diameter (Dc). Health of tree by 5 scales (1 died tree, 2 thin tree, 3 morderate growing tree, 4 well - growing tree, 5 strong growing tree) (He).

Calculate canopy area and number tree:

Tree canopy area (Gp) calculate fomula:

$$Gp = \left(\frac{Dc}{2}\right) * \left(\frac{Dc}{2}\right) * \pi$$

Gp: Tree canopy area per plot (100 m^2)

Dc: Diameter of tree crown

$$\pi = 3.1416$$

Number of trees:

$$N/p = Ns1 + Ns2 \ldots.. Nsn$$

(Np: Number of tree per plot; Ns1: Number of tree total tree of species number one of plot; Nsn: Number of tree total of species number n of plot)

Species: Use statistical survey methods to determine the number of species[16], classify, collect samples, conduct collection and classification of families, genera, species, compare the mangrove statistical manual and format corresponding species in the measurement plot [11]. To identify species, technical staff are trained before field surveys and each group is sent a document pictures of trees, leaves, flowers and fruits to identificated them (**Figure 1**).

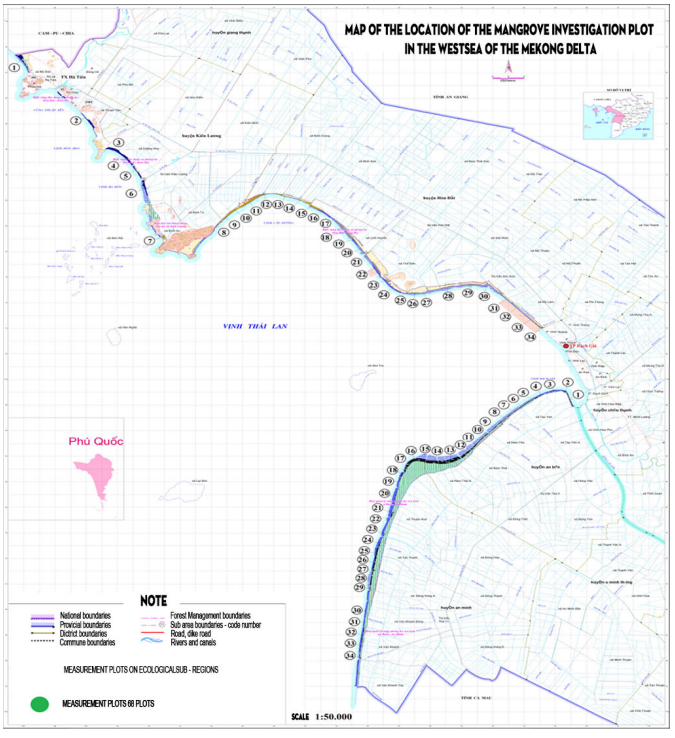

Figure 1. Map of mangrove measurement plot (GIZ Kien Giang, 2023).

2.3. Data Methods

Using Microsoft Excel software 16 to synthesize data.

Using of PRIMER 6 software to analyze similarities between species [17]. Variables are standardized using the Square root method, creating a similarity matrix according to the Bray-Curtis method and then drawing a branch diagram. Group average to consider similar levels.

Use SPSS statistical software to process data, use Anova analysis of variance method and Duncan test at 5% significance level to compare differences between study areas.

3. Results

3.1. Results of Dividing Sub Regions

Comments

Base on (**Figure 1, Figure 2, Table 1**) the soil properties, topography, and distribution of mangrove forest vegetation in the western sea of Mekong Delta, the mangrove forests in this region are divided into 4 sub-regions (**Figure 2**).

Sub-region 1: Mangrove forests on the litle mudflats and lot of sand depositted on the mountain teraces.

Sub-region 2: Mangrove forest on the average mudflats and average sand depositted on the mountain teracces

Sub-region 3: Mangrove forest on the lot of mudflats and alittle sand with clay.

Sub-region 4: Mangrove forest on the mudflats and loam soil .

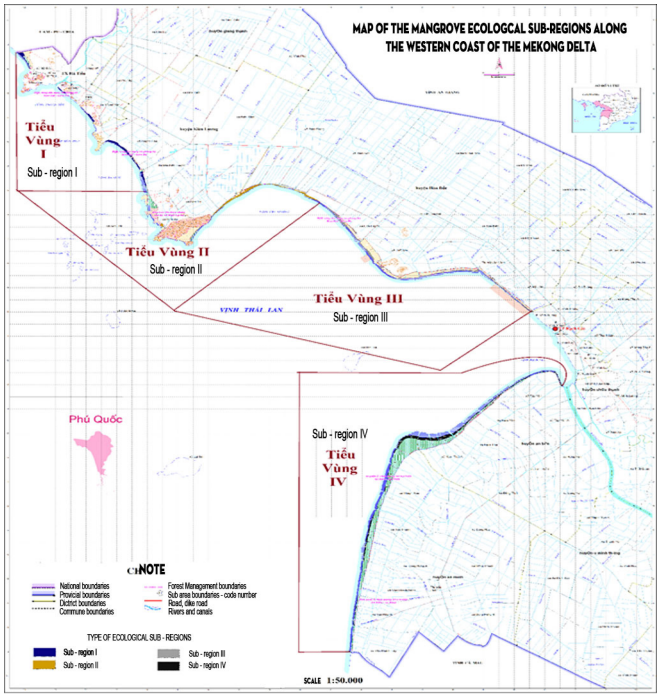

Figure 2. Map of 4 sub-regions.

Table 1. Scientific names of species.

TT	Families	Species	Local name
1	*Sonneratiaceae*	*Sonneratia caseolaris*	Ban chua
2	*Sonneratiaceae*	*Sonneratia ovate*	Ban oi
3	*Annonaceae*	*Annona reticulate*	Binh bat
4	*Combretaceae*	*Lumnitzera littorea*	Coc do
5	*Combretaceae*	*Lumnitzera racemosa*	Coc trang
6	*Rhizophoraceae*	*Rhizophora mucronata*	Dung
7	*Areecaceae*	*Nipa fruticans*	Dua nuoc
8	*Rhizophoraceae*	*Rhizophora apiculata*	Duoc
9	*Euphorbiaceae*	*Excoecaria agallocha*	Gia
10	*Avicenniaceae*	*Avicennia marina*	Mam bien
11	*Avicenniaceae*	*Avicennia officinalis*	Mam den
12	*Avicenniaceae*	*Avicennia alba*	Mam trang
13	*Rhizophoraceae*	*Bruguiera gymnorhiza*	Vet du
14	*Rhizophoraceae*	*Bruguiera cylindrical*	Vet tru
15	*Myrsinaceae*	*Aegiceras corniculatum*	Su
16	*Malvaceae*	*Hibiscus tiliaceus*	Tra

3.2. Species Structure

3.2.1. Species Structure in Sub-Region 1

Comments (Table 2)

+ Species structure:

There are 7 species, density is 6100 trees per hectare. species highest number of trees is *Avicennia officinalis* 2750 trees per hectarer, second species is *Rhizophora apiculata* 1983 trees per hectare, third species is *Sonneratia ovate* 717 tree per hectare. Species *Avicennia alba* is 300 trees per hectare, The other ones *Bruguiera gymnorhiza* only 183 trees per hectare, *Excoecaria agallocha* 117 trees per hectare and *Aegiceras corniculatum* 50 trees per hectare.

+ Ratio structure:

Species highest number of trees is *Avicennia officinalis* to 45% of total plot, second species 32.5% is *Rhizophora apiculata*, third species 11.75% is *Sonneratia ovate*. Species 4.9% is *Avicennia alba*; *Bruguiera gymnorhiza* 3% and *Excoecaria agallocha* 1.9%.

+ Height structure

Species *Sonneratia ovate* is highest 7.65 meters in estuaries where river and sea water, salinity is low. The species *Avicennia officinalis* the height is 5.80 meters and *Avicennia alba* is 5.54 meters are species are piooneer plants that live on mud; the species *Bruguiera gymnorhiza* height is 5.43 meters this species grows naturally on stable and hard soil. The other species with the height as *Excoecaria agallocha*. 4.86 meter *Aegiceras corniculatum* 3.38 meters and are the species grows naturally on stable hard ground.

+ Diameter structure

Species *Sonneratia ovate* diameter 1.3 meter is 11.90 centimeters in estuaries where river and sea water, salinity is low is highest diameter at 1.3 meters. Species *Avicennia officinalis* diameter at 1.3 meters are 6.63 centimeters and *Avicennia alba* is 6.32 centimeters are species are piooneer plants that live on mudflats. Species *Excoecaria agallocha* diameters is 6.34 centimeters this species grows naturally on stable and hard soil. The other species with the diameters as *Rhizophora apiculata*. 4.87 centimeters, *Bruguiera gymnorhiza* 4.83 centimeters and *Aegiceras corniculatum* 3.69 centimeters and are the species grows naturally on stable hard ground.

+ Canopy structure

Species *Avicennia officinalis* canopy 4013 square metters is the species highest canopy, the species *Rhizophora apiculata* 3667 square meters is species second canopy. Species *Sonneratia ovate* is 1347 square meters and *Avicennia alba* is 438 square metters; Species *Bruguiera gymnorhiza* is 410 square meters. Other species with the canopy *Excoecaria agallocha* 100 square meters and *Aegiceras corniculatum* 25 square meters .

+ Heath structure

Species *Bruguiera gymnorhiza*, *Rhizophora apiculata*, *Sonneratia ovate*, *Aegiceras corniculatum*, *Avicennia officinalis* heath from 3.5 to 4 per 5. Species heath indicators 3 per 5 are *Avicennia officinalis*, *Avicennia alba*, these species grows quickly but it develops many branches.

Table 2. Structure indicators

No.	Species	Density Structure (Tree)	Species Ratio (%)	Average Height (meter)	Average Diameter (centimeter)	Canopy Structure (Square Meter m2)	Heathy Structure (1 …5) 1: Bad 5: Best
1	*Sonneratia ovate*	717	11.75	7.65	11.19	1347	3.67
2	*Rhizophora apiculata*	1983	32.51	5.17	4.87	3667	3.9
3	*Excoecaria agallocha*	117	1.92	4.86	6.43	100	3.29
4	*Avicennia officinalis*	2750	45.08	5.8	6.63	4013	2.63
5	*Avicennia alba*	300	4.92	5.54	6.32	438	2.15
6	*Aegiceras corniculatum*	50	0.82	3.38	3.69	25	3.5
7	*Bruguiera gymnorhiza*	183	3	5.43	4.38	410	4
	Total*/Average**	6100*	100*	5.40**	6.27**	10000*	3.31**

3.2.2. Species Structure in Sub Region 2

Comments (Table 3)

+ Density structure

Species of this sub region have 11 species divided highest density is *Avicennia officinalis* 1190 trees per hectare, *Avicennia alba* is 820 trees per hectare, *Excoecaria agallocha* is 740 trees per hectare, *Rhizophora apiculata* is 540 trees per hectare. Species *Bruguiera gymnorhiza* density is 260 trees per hectare, *Lumnitzera racemosa* 110 trees per hectare. Species lower 100 trees per hectare are *Hibiscus tiliaceus*, *Aegiceras corniculatum*, *Lumnitzera littorea*, *Sonneratia caseolaris*, *Annona reticulate*.

+ Ratio structure

Species ratio highest is *Avicennia officinalis* 30.43% and *Avicennia alba* 20.97% . Species high ratio are *Excoecaria agallocha* 18.93%, *Rhizophora apiculata* 13.81%. Species low ratio are *Bruguiera gymnorhiza* 6.65%, *Lumnitzera racemosa* 2.81%, *Hibiscus tiliaceus* 2.3%, *Aegiceras corniculatum* 2.05%, *Lumnitzera littorea* 1.28%, *Sonneratia caseolaris* 0.51%, *Annona reticulate* 0.26%

+ Height structure

Species highest height in this sub region is *Sonneratia caseolaris*. Species average height are *Avicennia alba*, *Avicennia officinalis*, *Hibiscus tiliaceus*, *Rhizophora apiculata*, *Bruguiera gymnorhiza*. Species low height *Lumnitzera racemosa*, *Aegiceras corniculatum*, *Annona reticulate*, *Annona reticulate*.

+ Diameter structure

Diameter structure species *Sonneratia caseolaris* is highest. The second diemeter structure species *Avicennia officinalis*, *Avicennia alba*, *Annona reticulate*, *Hibiscus tiliaceus*. Third diameter structure species *Rhizophora apiculata*, *Bruguiera gymnorhiza*, *Excoecaria agallocha*, *Aegiceras corniculatum*, *Lumnitzera racemosa*, *Lumnitzera littorea.*

+ Canopy structure

Canopy structure highest is *Avicennia officinalis* 4773 m^2 per hectare, second canopy structure *Avicennia alba* 2759 m^2 per hectare. Canopy structure other species from 500 m^2 to 1000 m^2 by 5% to 10% of hectare are *Excoecaria agallocha*, *Rhizophora apiculata*, *Bruguiera gymnorhiza*. The canopy structure lower 5% of hectare are *Bruguiera gymnorhiza*, *Hibiscus tiliaceus*, *Aegiceras corniculatum*, *Sonneratia caseolaris*, *Lumnitzera racemosa*, *Annona reticulate* and *Lumnitzera littorea*.

+ Heath structure

Heath structure highest are *Aegiceras corniculatum*, *Rhizophora apiculata*, *Sonneratia caseolaris*, *Avicennia officinalis*, *Bruguiera gymnorhiza*, *Lumnitzera racemosa* from 3.0 to 4.3 per 5. Average health structure of species are *Avicennia alba*. Bad health structure species are *Hibiscus tiliaceus*, *Lumnitzera littorea*, *Annona reticulate*.

Table 3. Structure indicators

No.	Species	Density Structure (Tree)	Species Ratio (%)	Average Height (meter)	Average Diameter (centimeter)	Canopy Structure (Square meter m^2)	Heathy Structure (1 …5) 1: Bad 5: Best
1	*Sonneratia caseolaris*	20	0.51	10.5	25.54	155	4
2	*Annona reticulate*	10	0.26	3.5	11.78	24	2
3	*Lumnitzera littorea*	50	1.28	3.17	5.22	16	2.33
4	*Lumnitzera racemosa*	110	2.81	4.55	5.64	70	3.02
5	*Rhizophora apiculata*	540	13.81	5.72	8.17	581	4.04
6	*Excoecaria agallocha*	740	18.93	5.37	6.42	943	3.51
7	*Avicennia officinalis*	1190	30.43	5.99	13.91	4773	3.92
8	*Avicennia alba*	820	20.97	7.85	12.35	2759	2.98
9	*Hibiscus tiliaceus*	90	2.30	5.99	10.75	202	2.78
10	*Bruguiera gymnorhiza*	260	6.65	5.47	8.08	322	3.78
11	*Aegiceras corniculatum*	80	2.05	3.72	5.45	155	4.31
	Total* / Average**	3910*	100*	5.62**	10.30**	10000*	3.33**

3.2.3. Species Structure in Sub Region 3

Comments (Table 4)

+ Density species

Avicennia alba density the highest 1224 trees per hectare; *Nipa fruticans* is monocot species has density high to 800 tree per hectare. Species are good density *Avicennia marina*, *Rhizophora apiculata* with 628 trees and 522 trees per hectare. Low density *Bruguiera gymnorhiza* 339 trees per hactare, *Sonneratia caseolaris* 224 trees and *Rhizophora mucronata* 6 trees per hectare.

+ Ratio structure

Species *Avicennia alba* Ratio highest 31.37 %, second one is *Nipa fruticans*, the third *Avicennia marina* is 15.83 %, the four *Rhizophora apiculata* is 13.16 %. The species have the percent ratio low under 10% are *Bruguiera gymnorhiza*, *Sonneratia caseolaris*, *Excoecaria agallocha*, *Rhizophora mucronata*.

+ Height structure

Species highest height is *Sonneratia caseolaris* to 12.1 meters, height *Avicennia marina* is 8.18 meters, *Rhizophora mucronata* is 8.0 meters, *Avicennia alba* is 7.6 meters, *Rhizophora apiculata* 7.26 meters, *Excoecaria agallocha*. Lowest height is *Bruguiera gymnorhiza* 4.63 meters and *Nipa fruticans* 4.58 meters.

+ Diameter structure

Diameter biggest is *Sonneratia caseolaris* 25.22 centimeters. Species diameter bigger 10 centimeters is *Avicennia alba* 10.92 centimeters, *Avicennia marina* 11.52 centimeters. Species diameter bigger 5 to 10 centimeters are *Excoecaria agallocha* 8.6 centimeters, *Rhizophora apiculata* 7.68 centimeters.

+ Canopy structure

Canopy structure highest is *Avicennia alba* 2971 square meters, second species canopy is *Nipa fruticans* 2456 square meters, third species canopy is *Avicennia marina* 1876 square meters, four species canopy is *Sonneratia caseolaris*. Canopy species under 1000 square meters are *Rhizophora apiculat*, *Bruguiera gymnorhiza*.

+ Health structure

Heath highest structure are *Rhizophora apiculata* 4.29 per 5, *Bruguiera gymnorhiza* 3.78 per 5; Species quite good stem shapes. All of species heath level from 3 to 3.3 per 5.

Table 4. The structure indicators

No.	Species	Density Structure (Tree)	Species Ratio (%)	Average Height (meter)	Average Diameter (centimeter)	Canopy Structure (square meter m^2)	Heathy Structure (1 …5) 1: Bad 5: Best
1	*Sonneratia caseolaris*	244	6.15	12.1	25.22	1292	3.34
2	*Nipa fruticans*	800	20.17	4.58	Monocot	2456	3.28
3	*Rhizophora mucronata*	6	0.15	8	6.68	6	3
4	*Rhizophora apiculata*	522	13.16	7.26	7.68	687	4.29
5	*Excoecaria agallocha*	183	4.61	6.83	8.6	190	3.33
6	*Avicennia marina*	628	15.83	8.18	11.52	1876	3.15
7	*Avicennia alba*	1244	31.37	7.6	10.92	2971	3.15
8	*Bruguiera gymnorhiza*	339	8.55	4.63	6.42	522	3.78
	Total* / Average**	3966*	100*	7.40**	10.16**	10000*	3.41**

3.2.4. Species Struscture in Sub Region 4

Comments (Table 5)

+ Density structure

Density structure highest is *Avicennia officinalis* 1200 trees per hectare, second species is *Avicennia alba* 665 trees per hectare, third species is *Rhizophora apiculata* 376 trees per hectare. Other species *Excoecaria agallocha* 141 trees per hectare, *Bruguiera gymnorhiza* 21 trees per hectare, *Sonneratia ovate* 17 trees per hectare, *Lumnitzera racemosa* 15 tree per hectare, *Avicennia marina* and *Bruguiera cylindrica* 6 tree per hectare and *Sonneratia caseolaris* 3 tree per hectare.

+ Ratio structure

Species highest ratio is *Avicennia officinalis* is

48.98%, *Avicennia alba* 27.14 %, *Rhizophora apiculata* 15.35 %. Species small ratio is *Excoecaria agallocha* 5.75 %, species ratio under 1% is *Bruguiera gymnorhiza* 0.86 %, *Sonneratia ovate* 0.69 %, *Lumnitzera racemosa* 0.61%, *Avicennia marina* 0.24 %, *Avicennia marina* 0.24%, *Sonneratia caseolaris* 0.12 %.

+ Height sturcture

Height highest is *Avicennia marina* this species is adapts on the alluvial mudflats, second height species is *Sonneratia ovate* this species is grows fast in this region, third height is *Lumnitzera racemosa* this species live on the land stabilized. On the mixed alluvial soft and hard height *Rhizophora apiculata*, *Avicennia officinalis*, *Bruguiera gymnorhiza*, *Excoecaria agallocha*, *Avicennia alba*, *Sonneratia caseolaris*, *Excoecaria agallocha*, *Bruguiera cylindrica*,

+ Diameter structure

Diameter biggest is *Sonneratia ovate* is 14.08 centimeters, second *Avicennia marina* is 13.77 centimeters, third species *Lumnitzera racemosa* is 11.04 centimeters, oher species higher 9 centimeters are *Avicennia officinalis* 9.57 centimeters, *Rhizophora apiculata* 9.52 centimeters, *Avicennia alba* 9.43 centimeters, species bigger 8 centimeters are species *Excoecaria agallocha* 8.72 centimeters, *Bruguiera gymnorhiza* 8.56 centimetrs, *Sonneratia caseolaris* 7 centimeters, *Bruguiera cylindrica* 4.93 centimeters.

+ Canopy structure

Biggest canopy is *Avicennia officinalis* 5054 square meters, second canopy is *Avicennia alba* 2727 square meters, third canopy is *Rhizophora apiculata* 1518 square meters. Canopy structure from 100 to 300 square meters are *Excoecaria agallocha* 363 square meters, *Bruguiera gymnorhiza* 109 square meters, *Sonneratia ovate* 104 square meters. The species under 100 meters are *Lumnitzera racemosa* 84 square meters, *Avicennia marina* 22 square meters, *Sonneratia caseolaris* 10 square meters, *Bruguiera cylindrica* 9 square meters

+ Heath structure

Heath structure biggest are *Sonneratia caseolari*, *Sonneratia ovate*, *Lumnitzera racemosa* heath level 4 per 5, the species heath level higher 3.5 are *Rhizophora apiculata* 3.82, *Excoecaria agallocha* 3.76, *Bruguiera gymnorhiza* 3.75, species 3.5/5 are *Avicennia alba* 3.52, *Avicennia marina* 3.5, *Bruguiera cylindrica* 3.5 per 5.

Table 5. The structure indicators.

No.	Species	Density Structure (Tree)	Species Ratio (%)	Average Height (meter)	Average Diameter (centimeter)	Canopy Structure (square meter m^2)	Heathy Structure (1 …5) 1: Bad 5: Best
1	*Sonneratia caseolaris*	3	0.12	7.5	7	10	4
2	*Sonneratia ovate*	17	0.69	10.72	14.08	104	4
3	*Lumnitzera racemosa*	15	0.61	10.45	11.04	84	4
4	*Rhizophora apiculata*	376	15.35	9.07	9.52	1518	3.82
5	*Excoecaria agallocha*	141	5.75	6.9	8.72	363	3.76
6	*Avicennia marina*	6	0.24	10.85	13.77	22	3.5
7	*Avicennia officinalis*	1200	48.98	8.05	9.57	5054	3.47
8	*Avicennia alba*	665	27.14	7.6	9.43	2727	3.52
9	*Bruguiera gymnorhiza*	21	0.86	8.93	8.56	109	3.75
10	*Bruguiera cylindrica*	6	0.24	6.8	4.93	9	3.5
	Total* / Average**	2450*	100*	8.69*	9.66**	10000*	3.73**

3.2.5. Species Structure in Total Region WMD

Comments (Table 6)

+ Density structure of species in total in the WMD The WMD after survey and anlysis have 16 species in 11 families, total trees/per hectare is 4401; *Sonneratia caseolaris* 91 trees per hectare, *Sonneratia ovate* 110 trees pé hectare, *Annona reticulate* 2 trees per hectare, *Lumnitzera littorea* 10 trees per hectare, *Lumnitzera racemosa* 32 trees per hectare, *Nipa fruticans* 128 tree

per hectare, *Rhizophora mucronata* 2 tree per hectare, *Rhizophora apiculata* 1165 trees per hectare, *Excoecaria agallocha* 325 trees per hectare, *Avicennia marina* 195 trees per hectare, *Avicennia officinalis* 1006 trees per hectare, *Avicennia alba* 1116 trees per hectare, *Bruguiera gymnorhiza* 39 tree per hectare, *Bruguiera cylindrica*l 140 trees per hectare, *Aegiceras corniculatum* 22 trees per hectare, *Hibiscus tiliaceus* 18 trees per hectare.

+ Ratio structure in total the WMD

Highest ratio of species is *Rhizophora apiculata* is 26.47 %, second high is *Avicennia alba* 26.36 %, third is *Avicennia officinalis* 22.86 %, Group from 4 to 7 % are *Avicennia marina* 4.43 %, *Excoecaria agallocha* 7.38 %. Group from 2 % to 3% are *Bruguiera cylindrica*l 3.18 %, *Bruguiera cylindrica*l 2.91%, *Sonneratia ovate* 2.50%, *Sonneratia caseolaris* 2.07 %. Group ratio under 1% are *Bruguiera gymnorhiza* 0.87 %, *Lumnitzera racemosa* 0.73 %, *Aegiceras corniculatum* 0.5 %, *Hibiscus tiliaceus* 0.41%, *Rhizophora mucronata* 0.05 %, *Annona reticulate* 0.05 %. Results three species ratio high are *Annona reticulate*, *Avicennia alba*, and *Avicennia officinalis*.

+ Height structure in WMD

Height structure in WMD: First is the highest *Sonneratia ovate* 10.72 meters, Second species height is *Avicennia marina* 9.52 meters, third species *Sonneratia caseolaris* is 9.44 meters. Height structure from 7 - 8 meters are *Rhizophora mucronata* is 8 meters, *Lumnitzera racemosa* 7.5 meters, *Avicennia alba* is 7.15 meters. Species from 6 - 7 meters are *Rhizophora apiculata* 6.81 meters, *Bruguiera gymnorhiza* is 6.33 meter, *Bruguiera gymnorhiza* is 6.61 meters. Species from 5 - 6 metesr are *Hibiscus tiliaceus* is 5.99 meters, *Excoecaria agallocha* is 5.99 meters. Species from 3 - 5 meters are *Nipa fruticans* is 4.55 meters, *Aegiceras corniculatum* is 3.5 meters, *Annona reticulate* is 3.5 meters, *Lumnitzera littorea* is 3.17 meters.

+ Diameter Structure in WMD

Diameter structure biggish is *Sonneratia caseolaris* 17.24 centimeters, second diameter is *Sonneratia ovate* 14.08 centimeters. Species structure from 11 to 12 centimeters are *Avicennia marina* is 12.64 centimeters, *Annona reticulate* is 11.78 centimeters. Species from 10 - 11 centimeters are *Hibiscus tiliaceus* 10.75 centimeters, *Avicennia officinalis* is 10.04 centimeters. Species structure from 9 - 10 centimeters are *Avicennia alba* 9.75 centimeters. Species structure from 8 - 9 centimeters are *Lumnitzera racemosa* 8.34 centimeters. Species structure from 7-8 centimeters are *Rhizophora mucronata* 7.56 centimeters, *Excoecaria agallocha* 7.52 centimeters. Species stucture from 6 to 7 centimeters are *Rhizophora mucronata* 6.68 centimeters, *Bruguiera gymnorhiza* 6.60 centimeters. Species structure from 4 to 6 centimeter are *Lumnitzera littorea* 5.22 centimeters, *Bruguiera cylindrica*l 4.93 centimeters, *Aegiceras corniculatum* 4.57 centimeters, *Nipa fruticans* 4.21 centimeters.

+ Canopy structure in WMD

Canopy structure biggesh is *Avicennia alba* 2955 square meters, second canopy is *Rhizophora apiculata* 1809 square meters. The species canopy from 300 to 600 square meters are *Avicennia marina* is 546 square meters, *Sonneratia caseolaris* is 541 square meters, Nipa fruitica is 526 suare meters, *Excoecaria agallocha* is 348 square meters, *Sonneratia ovate* is 304 square meters. Species canopy structure under 100 square meters are *Bruguiera cylindrica*l is 76 square meters, *Bruguiera gymnorhiza* is 70 square meters, *Aegiceras corniculatum* is 51 square meters, *Hibiscus tiliaceus* is 48 square meters. Species under 10 square meters are *Annona reticulate* is 6 square meters, *Lumnitzera littorea* is 4 square meters, *Rhizophora mucronata* is 3 aquare meters.

+ Health structure in WMD

Species heath structure the best trunk are *Aegiceras corniculatum* 4.31/5, *Rhizophora apiculata* 4.01/5, *Bruguiera cylindrica*l is 3.83/5, the good health structure are *Sonneratia caseolaris* is 3.78/5, *Sonneratia ovate*is 3.65/5, group 3 *Lumnitzera racemosa* is 3.51/5, *Bruguiera cylindrica*l is 3.5/5. *Avicennia officinalis* is 3.34/5, *Avicennia marina* is 3.32/5, Nipa fruiticans is 3.28/5. Group 4 *Avicennia alba* is 2.95/5, *Hibiscus tiliaceus* is 2.78/5, Anona reticulate 2/5.

Table 6. The indicators of species in total region WMD.

No.	Species	Density Structure (Tree)	Species Ratio (%)	Average Height (meter)	Average Diameter (centimeter)	Canopy Structure (square meter m^2)	Heathy Structure (1 …5) 1: Bad 5: Best
1	*Sonneratia caseolaris*	91	2.07	9.44	17.24	541	3.78
2	*Sonneratia ovate*	110	2.50	10.72	14.08	304	3.65

Table 6. *Cont*.

No.	Species	Density Structure (Tree)	Species Ratio (%)	Average Height (meter)	Average Diameter (centimeter)	Canopy Structure (square meter m^2)	Heathy Structure (1 …5) 1: Bad 5: Best
3	*Annona reticulate*	2	0.05	3.5	11.78	6	2
4	*Lumnitzera littorea*	10	0.23	3.17	5.22	4	2.33
5	*Lumnitzera racemosa*	32	0.73	7.5	8.34	51	3.51
6	*Nipa fruticans*	128	2.91	4.58	4.21	526	3.28
7	*Rhizophora mucronata*	2	0.05	8.00	6.68	3	3
8	*Rhizophora apiculata*	1165	26.47	6.81	7.56	1809	4.01
9	*Excoecaria agallocha*	325	7.38	5.99	7.52	384	3.47
10	*Avicennia marina*	195	4.43	9.52	12.64	546	3.32
11	*Avicennia officinalis*	1006	22.86	6.61	10.04	2626	3.34
12	*Avicennia alba*	1116	25.36	7.15	9.75	2955	2.95
13	*Bruguiera gymnorhiza*	39	0.87	6.33	6.60	70	3.83
14	*Bruguiera cylindrica*l	140	3.18	6.8	4.93	76	3.5
15	*Aegiceras corniculatum*	22	0.50	3.55	4.57	51	4.31
16	*Hibiscus tiliaceus*	18	0.41	5.99	10.75	48	2.78
	Total* / Average**	4401	100	6.87	9.04	10000*	3.28

3.2.6. Apply for Local Government

Comment (Table 7)

After training for staff of Department of Agriculture and Rural development of Kien Giang province, the local government set up plan to development forestry by planting by *Avicennia officinalis* and *Avicennia alba* depends on the results of this conclusion (**Table 7**). In study of mangrove forest [27] 36 years mangrove forest lost 50 percent by change land use and cover land in the Vietnam southern coastal region, 1998 – 2011 reduce 46.79%. mangrove deforestation rate reduce 50% from 2011 – 2023 by protection and natural regeneration. Total area change to shrimp farming 38.91%, other purpose 5.82%, dike 3.34%. In other study [28] the Western Irrawaddy River Delta (WIDR), which is part of Myanmar's largest delta in Southeast Asia, reduction in area by 45.35% over the past 35 years, Estuarine barriers situated in the WIRD act as buffers, dissipating wave energy and facilitating seaward growth. of mangrove forests. Along the coast of Tien Yen, Quang Ninh province Vietnam with an overall accuracy of over 90.5% in 2022 by protection Mangrove forest[29]. The largest mangrove forest in 2023 is still in Ujung Pangkah District, with an area of 1261.50 hectares or 64.26%[30]. For ten years (from 2012 to 2023), Gresik Regency's mangrove forests increased by 590.41 hectares, the most significant increase in Ujung Pangkah District (increased by 458; 76 hectares). In Kien Giang by conservation and natural regeneration encrease 17.91%. Kien Giang province reforestation 509.88 ha from 2015–2020.

Table 7. The area for planting by *Avicennia officinalis* and *Avicennia alba* of local government.

TT	Species	Sub - Region	Area (Hectare)
1	*Avicennia officinalis*	1	115.5
2	*Avicennia offcinalis*	2	35
3	*Avicennia officinalis*	3	50
4	*Avicennia alba*	4	309.38
	Total		509.88

4. Discussions

4.1. Discussions for Food

The Physico-chemical characteristic of four species of Indonesian mangroves fruits, namely Avicennia sp., Bruguiera sp., Rhizophora sp., and Sonneratia sp, and its respective starches. Mangrove fruits of Avicennia sp., and Sonneratia sp., are safe for direct consumption or further processing. Meanwhile, Rhizophora sp. and Bruguiera sp. are not recommended for direct consumption because they contain cyanide [18]. The biscuits product were measured of the proximate, crude fiber, glycemic index and glycemic load on wistar rats. The best treatment was 20% of pedada flour with 80% of taro starch which produced biscuit with 76.24% of yield, 2.58% of protein, 15.55% of fat, 2.72% of crude fiber, 48.83 of glycemic index and 7.39 of glycemic load [19]. Knowledge of the biological activities and chemical constituents of mangrove is desirable, not only for the discovery of new therapeutic agents, but also in disclosing new sources of already known biologically active compounds. For the said reason Mangrove leaves are used as base in feed formulation. Other ingredients used are of high nutritive value. The feed is well accepted and easily consumed by herbivorous fishes [20]. According to lactose 20%,pregelatinized starch 20%,mannitol 20%,xylitol 23%,citric acid 1%,vitamin C 1%,eucalyptus phthalate extract 15% soft material,mixed evenly,24 mesh sieve,drying at 70℃for 2 h,adding 0.5% magnesium stearate and 0.5% [21]. The results showed that the best results were brownies made from pedada fruit flour because they had higher fiber and lowered calories with test scores for calorie content, crude fiber, air content, fat content, protein content, ash content, carbohydrate content respectively. 401. 87 kcal each; 16.49%; 18.32%; 21.7%; 4.03%; 1.44%; and 54.64% [22]. he parameters measured were the content of protein, vitamin C, fat, water, ash, and carbohydrates. The chemical characteristics of mangrove chocolate for 100g with 40% Sonneratia alba fruit composition contains 7.65% protein, 12.30% vitamin C, 14.6% fat, 12.5% water, 0.7% ash content, and 52.25% carbohydrat [23].

4.2. Discussions for Medicine:

As a result [24], the starch obtained from R. mucronata propagule can be used as a carbohydrate source after removing the tannin content. In the health sector, various parts of this plant organ are traditionally used to remedy diarrhea, hepatitis, ulcers, etc. Further research shows that extraction with multiple solvents across multiple plant organs can be an antioxidant, anticancer, anti-inflammatory, anti-diabetic, antimicrobial (antiviral, antifungal, antibacterial). Suggest that ethanol leaf and bark extracts of *Avicennia officinalis* were efective in inhibiting α-amylase and α-glucosidase and also have antioxidant, antimicrobial potentials [25]. Within the mangrove fruit, the levels of primary metabolites such as carbohydrates, protein, and fat are acceptable for daily intake. The mangrove fruits, seeds, and endophytic fungi are rich in phenolic compounds, limonoids, and their derivatives as the compounds present a multitude of bioactivities such as antimicrobial, anticancer, and antioxidant [26]. Phytochemical studies have revealed that *Rhizophora apiculata* leaf and root extract contains saponins, tannins, flavonoids, steroids, and terpenoids. The extract stopped the pathogenic bacteria from growing larger [31]. The structures of all phytosterol compounds are clearly elucidated by the spectroscopic data. All phytosterols were examined for their cytotoxicity against three cancer cell lines: HeLa, MCF-7, and A549. Among these isolates, phytosterols with alkene units (C-22 and C-23) and 24-ethylsterol showed increased cytotoxicity in cancer cells, demonstrating the importance of the aliphatic sterol moiety [32] The elevated total cholesterol, triglyceride, liver toxicity makers (SGOT and SGPT) and urea level were found to be ameliorated. The in vitro bioactivity-guided assay of AOEB led to isolation of a bioactive compound that inhibits the carbohydrate metabolizing enzymes (α-amylase and α-glucosidase) and also scavenging the DPPH, ABTS and superoxide radicals [33]. The results suggest that ethanol leaf and bark extracts of A. officinalis were effective in inhibiting α-amylase and α-glucosidase and also have antioxidant, antimicrobial potentials which justify the ethnobotanical use of this plant [34].

5. Conclusions

In the Sub region 1 next to the mountain high land with 7 species determined and 6 indicators (density, ratio,

height, diameter, canopy, heathy of species) are *Avicennia officinalis*, *Rhizophora apiculata*, Sonnertia ovate have been adapted with Mangrove soil Western Mekong Dleta Vietnam. In the region 2 with 11 species determined and 6 indicators are *Avicennia officinalis* and *Avicennia alba* are adapted with Mangrove soil on the area haft mountain and delta along the coast. In the sub region three with 8 species determined and 6 indicators are Avicenia alba, monocot plant Nipa fruiticans and *Avicennia marina* adapt in the haft mountain and delta. In the Sub region 4 with 10 species and 6 indicators are *Avicennia officinalis* and *Avicennia alba* very adapts on the alluvial delta open biggest of Mekong Delta Vietnam.

In the total region of mangroves in Western Mekong Delta determined have 16 species of Mangroves, investigate system showed *Avicennia officinalis* and *Avicennia alba* are natural forest grows on the mudflats with alluvial. *Rhizophora apiculata* adapts on the alluvial has stabbilitized normally plantation. The area next to of end river occurred *Sonneratia caseolaris* and *Sonneratia ovate*. The high land alittel salinity occurred *Hibiscus tiliaceus*, Annona reliculate.

The references of *Avicennia officinalis*, *Avicennia alba*, Sonneratia caceolaris, *Sonneratia ovate*, *Rhizophora apiculata* and other sepcies from leaves and fruits can use partly replacing starch for food processing livestock and poulty feed and raising aquatic species from renweable bioenergy on mangroves is huge.

Author Contributions

M.D. conceptulization, validation, formal anlysis, investigation, data curation, writing – origional, draft preparation, writing review and edting, visaalization, project administration, funding asquisition; LT.T. conceptulization, methodology, validation, formal anlysis, investigation, data curation, writing – origional, draft preparation, writing review and edting conceptulization, methodology, validation, formal anlysis, investigation, data curation, writing – origional, draft preparation, writing review and edting; B.M.N.N. conceptulization, validation, formal anlysis, investigation, data curation, writing – origional, draft preparation, writing review and edting, visaalization, suppervision, project administration, funding asquisition. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statemnent

This study does not invol human and animals.

Informed Consent Statement

All studies only study plant and soil. It is not related to human only help community and government to develop economic.

Data Availability Statement

These database are by ourseft. Thus we using to study and for our article, Published in Journal can share by authors group, Journal.

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Conflicts of Interest

The authors declare no conflict of interest.

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