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The diversity of plant species in a mangrove forest in the Coast of Metinaro, Timor-Leste

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The diversity of plant species in a mangrove forest in the Coast of Metinaro, Timor-Leste

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Abstract. The diversity of species in mangrove is the result of interaction between the biotic components and their abiotic environment for a long period of time. Mangrove ecosystem is located between land and sea, however, it gets many disturbances for human interest and consequently, it suffers degradation, area reduction and biodiversity decline. Therefore, it is important to study the diversity, abundance, morphology, and characteristics of various stages of the life of both plants and animals in mangrove communities. The objective of this research was to study the diversity of mangrove plant species in the coast of Metinaro, Timor-Leste. The results showed that nine plant species grew in mangrove forest, namely, *Rhizophora apiculata*, *Sonneratia alba*, *Avicennia alba*, *Ceriops decandra*, *Rhizophora mucronata*, *Lumnitzera racemosa* var. *racemosa*, *Amyema anisomeres*, *Ceriops tagal*, and *Bruguiera exaristata*. *Rhizophora apiculata* had the highest importance value index (IVI) for trees (IVI = 88.21%) and for saplings (77.53%), while *Avicennia alba* for seedlings (52.81%). The Shannon-Wiener diversity index (H′) was 3.25 for trees, categorized as high, 2.04 for saplings, categorized as medium and 1.57 for seedlings, also categorized as medium

1. Introduction

Mangrove forest is a specific and unique ecosystem type located in coasts or estuaries affected by the tide of the sea. Mangrove forests are a distinct and distinctive coastal ecosystem, with high carrying capacity for life [12]. Furthermore, therefore coastal areas become a very important part in development activities and the economy.

Mangrove usually grows in protected coast or in flat coast, protected from wind from the open sea, so that coastal communities have disturbed the growth of mangrove by converting the mangrove vegetation into ponds for fish, shrimp and crab, human settlement, and tree cutting for many purposes. Mangrove ecosystem is located between land and sea, so it gets many disturbances for human interest and consequently, it suffers degradation, area reduction and biodiversity decline [18]. Direct use of the mangrove ecosystem and surrounding land use significantly affects mangrove ecosystem sustainability [7, 6].

Metinaro Coast is located in the east of Dili with a distance of 28.3 km from downtown Dili. The duration of exposure to Metinaro Beach is caused by many uneven roads, most of which are tangled, and some other roads are damaged. As for the people of Metinaro, their livelihood as farmers and fishermen because in this region supported by mangrove forest which is fertile and wide. Metinaro Coast is mangrove forest and covers a large area of 425.6ha. It has been used by the majority of communities since 2006 as a source of livelihood by converting it into fish, shrimp and crab pond. The opening of land for ponds, both for Nila fish, shrimps, and crabs [9]. These activities have resulted in the reduction of mangrove vegetation area which in turn causes abrasion. In addition, the communities also throw solid inorganic waste to the coast and the garbage is trapped in mangrove vegetation. Observation results are known that this garbage closes the plants' lenticels so that oxygen uptake is impeded, reducing the function of the mangrove ecosystem. It is, therefore, necessary to have real action, involving all elements in the local communities to save the mangrove ecosystem, because the first time to do research on the diversity of mangrove vegetation associated with community activities around the mangrove forest on the coast of Metinaro.

What needs to be done in managing the mangrove ecosystem integrally using a zoning system, to maintain the sustainability and diversity of mangrove ecosystem. For this purpose, there is a need for data of vegetation structure, species composition, and other ecological data of Metinaro Coast. Therefore, this study was done with the purpose of studying the plant species diversity of mangrove forest in Metinaro coast, Timor-Leste.

2. Material and Methods

2.1. Location and time of study

This study was conducted in Metinaro Coast, Metinaro Subdistrict, Dili District, Timor-Leste from December 2014 to January 2015.

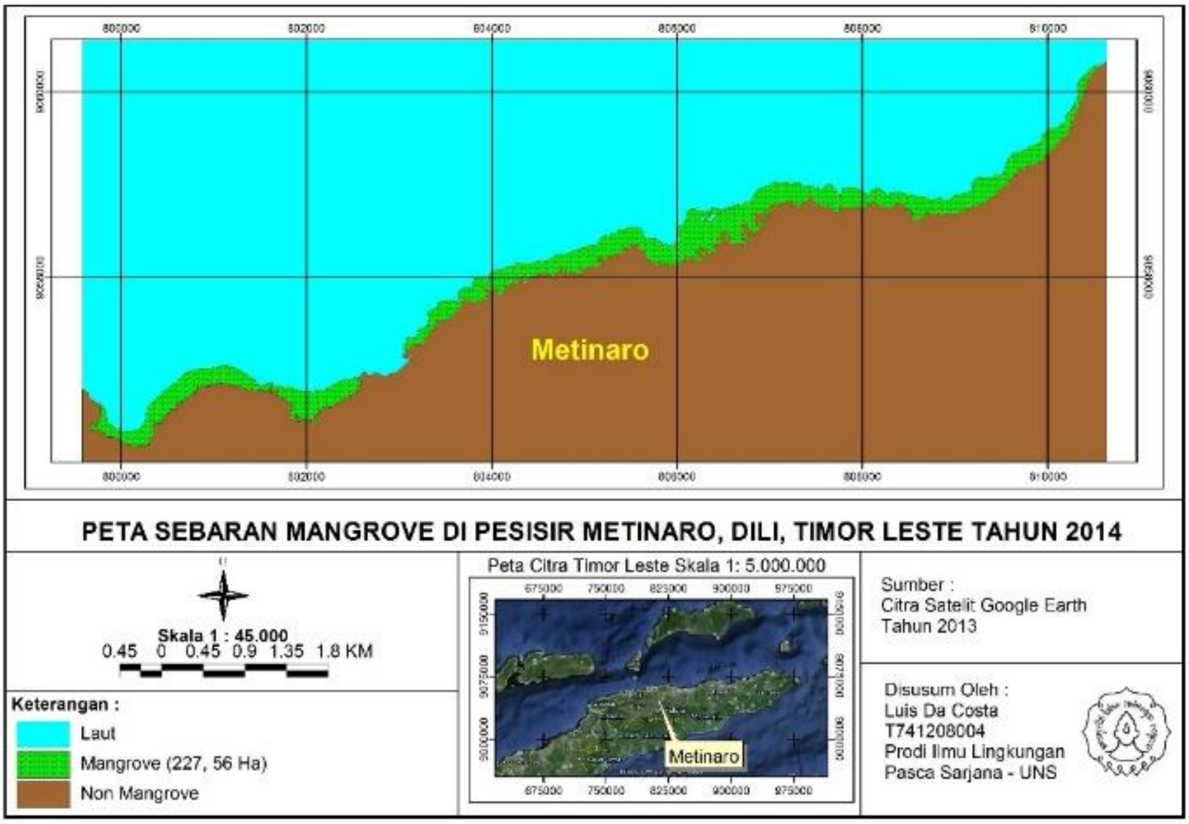

Figure 1. Map of research sites and distribution of mangrove forests on the coast of Metinaro, Timor-Leste.

2.2. Tools and materials
Tools and materials used in the study were GPS, compass, Measuring tape, clinometers, rope (50-100 m), wooden poles, Plastic bags, notebooks, pens, labeling paper, and forest area map

2.3. Procedures
This descriptive and quantitative study used plots to collect vegetation data which were then analyzed quantitatively using diversity index and importance value index. Data of mangrove plant in Metinaro Coast were conducted using 107 plots. Furthermore, the plot size for each stand level is as follows :(a) seedlings: 2 x 2 m,(b) saplings: 5 x 5 m, and (c) trees: 10 x 10 m [4]. The coverage area of research site is 320,06 ha. Plots were placed from the site of the furthest low tide to the site of the high tide, so they covered all environmental conditions.

2.4. Data analysis
The data were analyzed to determine the diversity index and the importance value index.

2.4.1. Diversity index
To know the extent of plant species diversity, the data were analyzed using the Shannon-Wiener Index [5]:

$$H = -\sum_{i=1}^{s}(pi)(\ln pi) \quad (1)$$

Where: H′ = Shannon–Wiener diversity index
pi = ni/N
N = total individuals in the community
ni = total individuals of a given species
Ln = natural logarithm

The criteria used to interpret the diversity index were:
$H' < 1$: low diversity
$1 < H' < 3$: medium diversity
$H' > 3$: high diversity [8].

2.4.2. Importance value index
The potential of forest can be determined qualitatively using importance value index [11]. The importance value index for each species was calculated using this formula:
IVI = Relative Density + Relative Frequency + Relative Dominance

3. Result and Discussion
3.1. Plant diversity of mangrove forest in the coast of Metinaro
The zoning of mangrove is related to the species' response to environmental condition and a characteristic affected by substrate, salinity, and tides of sea water. The environmental condition of each zone is different, limiting the distribution of certain species in certain zones, but species having high adaptation may live in a large area [15]. In general, the characteristics of mangrove trees in the coast of Metinaro are the followings:

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Figure 2. *Flowers of Bruguiera exaristata.*

Bruguiera exaristata: trunk: straight; leaf: simple, opposite, green, shiny, thicker than the leaf of *Bruguiera palvifora*; bark: black; root: knee roots; seed type: viviparous with the height of the tree reaching 9-11 meters. Habitat: silty soil, moderately dry wet-land

Figure 3. Flowers of *Ceriops decandra*

Ceriops decandra: trunk: straight; leaf: dark green, rather thick, obovate, apex rounded, margin entire; seed type: viviparous. Habitat: wet soil, usually in moderately dry wet soil. Trees or small shrubs up to 15 meters high.

Figure 4. Fruits of *Ceriops tagal*

Ceriops tagal: trunk: straight; leaf: obovate, light green, apex rounded, thick, upper side green, shiny, clumped at the end of twigs, and free of brown spots; root: knee roots; seed type: viviparous. Habitat: moderately dry wet soil, only a few grow in silty and dry soil. Small trees with altitudes between 18 - 25 meters.

Figure 5. *Fruits of Rhizophora mucronata.*

Rhizophora mucronata: trunk: straight, short, profusely branched; leaf: thick, broadly elliptic, light green, having brown spots at the lower side, clumped at the end of twigs, venation pinnate, midrib white, young leaves white; root: stilt roots; seed type: viviparous. Habitat: silty, brownish black soil. This species includes a common type of mangrove with a height of between 15-30 meters.

Figure 6. *Flowers of Lumnitzera racemosa*

Lumnitzera racemosa: trunk: slightly branched; height: 4-9 m; bark: peeled; leaf: opposite, slightly hairy, lower side white, upper side green, shiny, thick, apex acute, clumped at the end of twigs; root: no pneumatophore; flower: small, yellowish green. Habitat: dry soil (high tide), grayish soil. Habitus of this plant species is a shrub or small tree with a height of between 6 to 8 meters and has no breath root.

Figure 7. Fruits of *Sonneratia alba.*

Sonneratia alba: Large and tall tree; trunk: straight; Leaf: Thick, obovate, green, apex obtuse, simple, opposite, clumped at the end of twigs, venation pinnate, margin entire. Habitat: Yellowish white sandy soil always inundated by sea water. Habitus tree with a height of between 15 - 29 meters, pencil-shaped pneumatophora and larger than *Avicennia* pneumatophora.

Figure 8. *Roots of Amyema anisomeres.*

Amyema anisomeres: trunk: branched from the base; bark: moderately smooth and peeled; leaf: opposite, apex acute, upper side brightly green, a lower side having fine white hair. Habitat: dry soil, grey clay soil. Trees with a height of between 4 and 7 meters, smooth trunk surfaces and hard stems, have strong roots and grow more towards the ground.

Figure 9. Roots of *Rhizophora apiculata.*

Rhizophora apiculata: large and tall tree; bark: blackish brown; leaf: thick, dark green, apex apiculate, large and wide, young leaf whitish, alternate, clumped at the end of twigs; root: knee roots; fruit: long. Habitat: brownish black wet silty soil. This plant species is 15 to 32 meters tall and has a typical rooting of up to 3 - 5 meters and occasionally this type of branch takes out the air roots, the bark is dark gray tanned.

Figure 10. Flowers of *Avicennia alba.*

Avicennia alba: not a very tall tree; leaf: opposite, folding backward; flower: yellow when blooming, clumped at the end of pedicels (capitulary). Habitat: living side by side with *Sonneratia spp*. sometimes in silty, moderately sandy soil. This tree can grow well up to 20 meters and the surface of the stems are smooth and gray-black, pencil-shaped pneumatophora with a height of 19 cm and covered by lenticels.

The mangrove ecosystem in the coast of Metinaro has the following characteristics: (i) The mangrove ecosystem is affected by the tide of seawater; it is inundated during high tide and uninundated during low tide. (ii) It grows parallel with shoreline, forming mangrove belt, on an anaerobic substrate of firm clay soil, peat, sandy soil, and coral soil. (ii) It has one stratum of the canopy, and has several species. (iv) The tree species differ from one place to another, depending on soil conditions, the intensity of inundation, and salinity. (v) The zones of mangrove are: The species found at the zone closest to sea are *Avicennia* spp. and *Sonneratia* spp. which grow on the moderately deep silty sandy substrate in organic matter. The middle zone (behind *Avicennia* spp. and *Sonneratia* spp.) is generally *Rhizophora* spp. while the zone furthest from the sea (behind *Rhizophora* spp.) is dominated by *Brugiera* spp., *Ceriops* spp., and *Amyema anisomeres.*

3.2. Composition and structure of mangrove vegetation

A coverage area of research site is 320,06 ha consists of 1059 trees, 516 saplings and 520 seedlings of nine species belonging to five families (Table 1). Based on the number of individuals, *Rhizophora apiculata* was the most dominant species for trees with 365 individuals (34.37%), *Sonneratia alba* for saplings with 132 individuals (12.7%), and *Avicennia alba* for seedlings with 82 individuals (7.74%). In the research sites, the average number of individuals in each plot is not the same, it is influenced by the presence frequency corresponding to the growth zone of each type so that sometimes in 1 plot only found 1 type or 2 species only with quite a small amount. The absence of other types in each plot is due to the destruction of mangrove forests so the pattern is not evenly distributed, even often in the plot there are 1-2 species only.

Table 1.Family, species, and total individuals of mangrove trees in the coast of Metinaro.

No.	**Family**	**Species**	**Total individuals/ha and %**		
			Trees /ha (%)	Saplings/ha (%)	Seedlings/ha (%)
1.	Avicenniaceae	*Avicennia alba*Blume	149 (14.07)	77 (7.27)	82 (7.74)
2.	Combretaceae	*Lumnitzera racemosa* Willd.var.racemosa	68 (6.42)	36 (3.40)	74 (6.99)
3.	Loranthaceae	*Amyema anisomeres* Dans	32 (3.02)	37 (3.48)	49 (4.63)
4.	Rhizophoraceae	*Rhizophora apiculata*Blume	365 (34.37)	89 (8.40)	64 (6.04)
		Ceriops decandra (Griff.) Ding Hou	83 (7.84)	51 (4.82)	57 (5.38)
		Rhizophora mucronata Lmk.	81 (7.65)	58 (5.48)	63 (5.95)
		Ceriops tagal (Perr.) C. B. Rob	23 (2.17)	32 (3.02)	45 (4.25)
		Bruguiera exaristata Ding Hou	15 (1.41)	4 (0.38)	8 (0.76)
5.	Sonneratiaceae	*Sonneratia alba* J.E Smith	243 (22.95)	132 (12.7)	78 (7.37)
	∑ 5	∑ 9	1059	516 (48.73)	520 (49.10)

3.2.1. Importance value index (IVI)

Among the trees found in the mangrove forest in the coast of Metinaro, *S. alb*a had the highest importance value index or IVI (88.21%), followed by *R. apiculata* (80.53%) and *A. alba* 36.57% (Table 2). The rank in IVI was the same for saplings, with *S.alba*has the highest IVI (77.53%), followed by *R.apiculata* (58.52%) and *A.alba* (39.63%) (Table 3). The rank of IVI seedling was different, *A.alba*isbeing the highest IVI (52.81%), followed by *R.apiculata* (50.57%) and *S.alba* (44%) (Table 4).

Table 2.Importance value index of each species of tree in mangrove vegetation in Metinaro coast.

No.	Species	Relative Density (%)	Relative Frequency (%)	Relative Dominance (%)	Importance value index (%)
1.	*Rhizophora apiculata* Blume	34.46	20.47	25.60	80.53
2.	*Sonneratia alba* J.E Smith	22.95	18.13	47.13	88.21
3.	*Avicennia alba*Blume	14.07	10.53	12,27	36.87
4.	*Ceriops decandra*(Griff.) Ding Hou	7.84	9.94	4.96	22.74
5.	*Rhizophora mucronata* Lmk.	7.65	16.96	3.51	28.12
6.	*Lumnitzera racemosa* Willd.var. racemosa	6.42	11.69	2.61	20.72
7.	*Amyema anisomeres* Dans	3.02	7.02	2.09	12.13
8.	*Ceriops tagal* (Perr.) C. B. Rob	2.17	2.92	1.14	6.23
9.	*Bruguiera exaristata* Ding Hou	1.42	2.34	0.69	4.45

Table 3.Importance value index for each species of a sapling in a mangrove ecosystem in Metinaro coast.

No.	Species	Relative Density (%)	Relative Frequency (%)	Relative Dominance (%)	Importance value index (%)
1.	*Rhizophora apiculata*Blume	17.25	20.47	20.80	58.52
2.	*Sonneratia alba* J.E Smith	25.58	18.13	33.82	77.53
3.	*Avicennia alba*Blume	14.92	10.53	14.18	39.63
4.	*Ceriops decandra*(Griff.) Ding Hou	9.88	9.94	8.76	28.58
5.	*Rhizophora mucronata* Lmk.	11.24	16.96	10.07	38.27
6.	*Lumnitzera racemosa* Willd.var. racemosa	6.98	11.69	5.22	23.98
7.	*Amyema anisomeres* Dans	7.17	7.02	4.41	18.6
8.	*Ceriops tagal* (Perr.) C. B. Rob	6.20	2.92	2.33	11.45
9.	*Bruguiera exaristata* Ding Hou	0.78	2.34	0.41	3.53

Table 4.Importance value index for each species of seedling in a mangrove ecosystem in Metinaro coast.

No.	Species	Relative Density (%)	Relative Frequency (%)	Relative Dominance (%)	Importance value index (%)
1.	*Rhizophora apiculata*Blume	12.31	18.22	20.04	50.57
2.	*Sonneratia alba*J.E Smith	14.99	16.15	12.86	44
3.	*Avicennia alba*Blume	15.77	12.5	24.54	52.81
4.	*Ceriops decandra*(Griff.) Ding Hou	10.96	8.86	13.16	32.98
5.	*Rhizophora mucronata* Lmk.	12.12	17.71	6.21	36.04
6.	*Lumnitzera racemosa* Willd.var. racemosa	14.23	13.02	13.84	41.09
7.	*Amyema anisomeres* Dans	9.42	8.86	5,60	23.88
8.	*Ceriops tagal* (Perr.) C. B. Rob	8.66	2.60	3.47	14.73
9.	*Bruguiera exaristata* Ding Hou	1.54	2.08	0.28	3.9

Field observations show that the high IVI value of a mangrove species indicates that the species can adapt well to the environment when the soil is rich with organic matter and has enough salinity. The adaptation of plant during the sapling stage is relatively moderate, but the adaptation ability increases with the increasing age of plants. According to Barkey in [10], *Avicennia* spp. and *Sonneratia* spp. generally grow well in fine-textured soil, rich in organic matter and highly saline. *Rhizophora* spp. grow well in soil coarser in texture than *Avicennia* spp., but generally, the soil is still categorized as fine-texture. In the coast of Metinaro, *Rhizophora* spp. and *Avicennia* spp. grow well in silty clay soil. According to [10], *Rhizophora* spp. develop on relatively coarser soils compared to *Avicennia* spp. but in general, can still be classified on fine-textured soil. State that *S. alba* is a pioneer species, intolerant to fresh water for a long period of water, preferring sandy silt soil, and occasionally, it is found on rocks and corals [13].

The mangrove ecosystem in Metinaro coast has been extensively affected by human activities, such as land conversion into fish ponds, shrimp, and crabs as well as the felling of mangrove trees to serve as firewood and building materials by the community, so that it is hard to determine the zones. However, the zoning of mangrove is also affected by high sedimentation and habitat changes. This is related to the extreme condition of mangrove. For example, the new silty substrate in mangrove will be dominated by plants whose propagules arrive in that location [16].

The most areas of the mangrove ecosystem in the coast of Metinaro have been converted into the fish pond which jeopardizes the sustainability of the mangrove because the cutting of trees is not followed by tree planting. The human settlements near the coast of Metinaro throw a lot of solid waste to the sea and this garbage is trapped in the roots of *S. alba*, *Avicennia* spp., and *Rhizophora* spp. Those activities caused the tree lenticels closed and reducing the uptake of oxygen for active transport in the roots (Figure 11).

Figure 11. Garbage disposal and land conversion into fish, shrimp and crab ponds

3.2.2. Species diversity index

The species diversity index (H′) in a mangrove ecosystem in Metinaro coast was 3.25 for trees (Table 5), 2.04 for saplings (Table 6) and 1.57 for seedlings (Table 7). The diversity index for trees, saplings, and seedlings were not the same because of natural and anthropogenic factors [3]. Furthermore, Anthropogenic factors contribute greatly to the destruction of secondary forest habitat through forest clearing, logging, forest burning, shifting cultivation, and physical development. The criteria for categorizing diversity index are as follows: low: H' < 1; medium: 1<H′< 3 = medium, and high: H′ > 3 [8]. The plant density in this location was high, and this location was dominated by trees with pneumatophores, stilt roots and knee roots. Another reason was that the location was far from land and mangrove plants usually grow better from the middle zone toward the sea.

The species diversity of saplings (2.04) was considered medium. The saplings in the coast of Metinaro grew between the middle zone toward the sea as well the land, so people had a chance to cut the saplings for firewood and construction, causing the decline in diversity. The species diversity of seedlings was lower (1.57) than saplings, but it was still categorized as a medium. There had been degradation of mangrove at seedling stage due to natural and anthropogenic factors.

According to [17], the low diversity of an ecosystem indicates that the ecosystem is stressful or its environmental condition has deteriorated. The high intensity of exploitation, unsuitable habitat, and species interaction may cause the low presence of a mangrove species in certain locations [2]. This situation can happen because mangrove plants live in the extreme environment due to high salinity and the presence of silty substrate, so species surviving mangrove environment must have been naturally selected and must possess specific adaptation to the natural environment, and to the anthropogenically affected environment [17]. The low species diversity at the seedling stage may jeopardize the sustainability of mangrove ecosystem in the coast of Metinaro.

Table 5.The Shannon–Wiener diversity index of trees

No.	Species	Trees			
		∑ individuals	pi	pi Ln pi	H′
1	*Rhizophora apiculata*Blume	365	0.34	-0.46	
2	*Sonneratia alba* J.E Smith	243	0.23	-0.64	
3	*Avicennia alba* Blume	149	0.14	-0.85	
4	*Ceriops decandra* (Griff.) Ding Hou	83	0.08	-1.11	
5	*Rhizophora mucronata* Lmk.	81	0.08	-1.12	3.25
6	*Lumnitzera racemosa* Willd.var.racemosa	68	0.06	-1.19	
7	*Amyema anisomeres* Dans	32	0.03	-1.52	
8	*Ceriops tagal* (Perr.) C. B. Rob	23	0.02	-1.66	
9	*Bruguiera exaristata* Ding Hou	15	0.01	-1.85	
	Total	1059			

Note: pi = ni/N,Ln = natural logarithm, H’ = Shannon–Wiener diversity index

Table 6.The Shannon–Wiener diversity index of saplings

No.	Species	Saplings			
		∑ Individuals	pi	Pi Ln pi	H′
1	*Rhizophora apiculata*Blume	89	0.17	-0.76	
2	*Sonneratia alba* J.E Smith	132	0.26	-0.59	
3	*Avicennia alba*Blume	77	0.15	-0.83	
4	*Ceriops decandra* (Griff.) Ding Hou	51	0.10	-1.01	
5	*Rhizophora mucronata* Lmk.	58	0.11	-0.95	2.04
6	*Lumnitzera racemosa* Willd. var. racemosa	36	0.07	-1.16	
7	*Amyema anisomeres* Dans	37	0.07	-1.14	
8	*Ceriops tagal* (Perr.) C. B. Rob	32	0.06	-1.21	
9	*Bruguiera exaristata* Ding Hou	4	0.01	-2.11	
	Total	516			

Note: pi = ni/N, Ln = natural logarithm, H' = Shannon–Wiener diversity index

Table 7.The Shannon–Wiener species diversity index of seedlings.

No.	Species	Seedlings			
		∑ individuals	pi	pi Ln pi	H′
1	*Rhizophora apiculata* BI	64	0.12	-0.91	
2	*Sonneratia alba* J.E Smith	78	0.15	-0.82	
3	*Avicennia alba* BI	82	0.16	-0.80	
4	*Ceriops decandra* (Griff.) Ding Hou	57	0.11	-0.96	
5	*Rhizophora mucronata* Lmk.	63	0.12	-0.92	1.57
6	*Lumnitzera racemosa* Willd.var. racemosa	74	0.14	-0.85	
7	*Amyema anisomeres* Dans	49	0.09	-1.03	
8	*Ceriops tagal* (Perr.) C. B. Rob	45	0.09	-1.06	
9	*Bruguiera exaristata* Ding Hou	8	0.01	-1.81	
	Total	520			1.57

Note: pi = ni/N, Ln = natural logarithm, H' = Shannon–Wiener diversity index

3.3. Environmental parameters

The environmental parameters in the study site which might affect the mangrove vegetation are given in Table 8. The range of relative humidity in the study site was 31.9-34.5%, and the salinity was 0.65‰–2.17‰, suitable for the growth of mangrove, and does not cause degradation. The temperature was 29-34.5°C, which was within the normal range for the growth of mangrove because mangrove is a typical vegetation in the tropics which flourish at the temperature 19-40°C with temperature fluctuation no less than 10°C [20].

Based on field observation, the soil pH was 5.8–6.8, moderately acidic because there had been pollution from feces and urine of the community's animals, such as cows, goats, and horses. There was pollution from the waste of fish feed with a trademark of FF-999. While this feed may improve the stamina of fish, reducing death due to stress, and enhance early growth of fish, it contains chemicals affecting the pH, but the pH in the study site was still in the normal range for the growth of mangrove, which is 5.0–8.5 [21]. According to [1], the pH of water is one of the factors affecting the water productivity, and water with pH of 6.5-7.5 is a productive one, while the water with pH > 8.5 is categorized unproductive.

Soil texture is also an environmental parameter affecting the growth of mangrove. In some plots of the research site, the soil textures were sandy loam, clay loam, and sandy. Therefore, *Rhizophora* spp., *Sonneratia alba,* and *Avicennia* spp. dominated that zone, because these species grow well in silty soil and can tolerate sandy silt soil. In some other plots, the soil textures were clay loam, moderately sandy and silty. *Rhizophora* spp, *Avicennia alba,* and *Ceriops tagal* dominated this zone because this zone had sufficient essential elements. Generally, the soil in the mangrove ecosystem is silty and sandy, which causes this ecosystem rich in germplasm [14].

The wind speed in the study site was 0.3m/s-17m/s (Table 9), which was still in normal range for the growth of mangrove and does not cause any damage to the ecosystem. The primary data source of research results 2014-2015 with the measurement of environmental data is done based on each research plot.

Table 8. The physical and chemical parameters in a mangrove ecosystem in the coast of Metinaro.

Environmental parameters	Total number of plots
Relative humidity (%)	31.9 – 34.5
Salinity (‰)	0.65 – 2.17
Temperature (^{0}C)	29 – 34.5
pH	5.8 – 6.8
Soil texture	Silty loam, Clay loam, sandy

Table 9.The results of wind measurement in a mangrove ecosystem in the coast of Metinaro.

Wind direction	Wind speed (m/s)		
	Morning	Noon	Afternoon
	05.00	12.00	17.00
North	1.2 – 17	1.8 – 2.3	0.8 – 2.2
West	0.7 – 0.8	0.8 – 1.3	0.9 – 2.2
South	0.3 – 2.2	1.6 – 1.9	0.5 – 1.1
East	1.2 – 1.3	1.1 – 1.6	0.6 – 1.5

4. Conclusions

Based on vegetation analysis, mangrove ecosystem in the coast of Metinaro, Dili District, consists of nine species, i.e.: y *Rhizophora apiculata*, *Sonneratia alba*, *Avicennia alba*, *Ceriops decandra*, *Rhizophora mucronata*, *Lumnitzera racemosa*, *Amyema anisomeres*, *Ceriops tagal*, and *Bruguiera exaristata*. The most dominant species was *Rhizophora apiculata* (365 individuals = 34.37%) for trees, *Sonneratia alba*(132 individuals = 12.47%) for saplings, and *Avicennia alba* (82 individuals = 7.74%) for seedlings. The highest importance value index (IVI) was presented by *Sonneratia alba* (IVI =88,21%) for trees, *Sonneratia alba* (IVI=77,53%) for saplings and *Avicennia alba* (52,81%) for seedlings. The Shannon-Wiener species diversity (H′) was 3.25 (categorized as high) for trees, 2.04 (medium) for saplings and 1.57 (medium) for seedlings. In general, the coast of Metinaro has been degraded due to community activities and natural factors which affected the diversity of mangrove vegetation, but the results of the analysis indicate that the high diversity of trees due to the presence of adequate nutrients for growth and the obstruction of the root, hanging roots, and knee root making it difficult for people to destroy mangrove trees.

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