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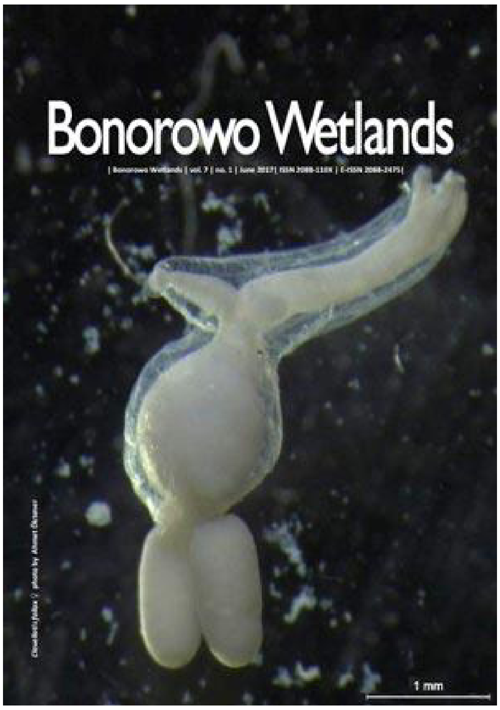

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The density, composition and mangrove forest habitat in coastal areas of Torosiaje Jaya Village, Gorontalo, Indonesia

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Abstract. *Rahim S, Baderan DWK, Hamidun MS. 2017. The density, composition and mangrove forest habitat in coastal areas of Torosiaje Jaya Village, Gorontalo, Indonesia. Bonorowo Wetlands 7: 38-42.* The ecosystem of mangrove is a quite good ecosystem which is located in Torosiaje Jaya Village of Popayato Subdistrict, Pohuwato District, Gorontalo Province, Indonesia. This because of the beach in the coastal of Torosiaje Jaya Village is a gently sloping beach. Further, this beach has deposited sediment and it is formed a promontory grave that causes that mangrove in that region grows large and relatively fertile. In addition, the mangrove which is located in Pohuwato has fairly high various species. One of them is found from Avicenniaceae family namely *Avicennia marina (*Forsk.) Vierh. This study aims to (i) obtain the information about the density of the mangrove; (ii) to determine the composition of mangrove species in coastal areas of Torosiaje Jaya Village; and (iii) to know the habitat of the species which is found in coastal areas Torosiaje Jaya Village. Besides, the data were collected by purposive sampling. Moreover, for the measurement of density, distribution type, diameter trees, and mangrove vegetation height use a distance method (*Point-Centered Quarter Method*). Further, the composition types of views are based on the number species are found, and to obtain the data of the habitat conditions of the species which has discovered is using a direct observation in the field by a tree and laboratory test sample originating from soil samples in the study sites. Moreover, the result of this study finds the four species of tree which dominates the mangrove in Torosiaje Jaya Village. They are *Bruguiera gymnorrhiza, Rhizophora mucronata*, *Rhizophora apiculata,* and *Rhizophora stylosa* with a density value of 51.55 trees/3 ha with an average distance of 581.94 m/tree. *B. gymnorrhiza* and *R. mucronata* are species that dominate in the region due to supply mud as suitable habitat with its growth, besides it is affected by the substrate of mangroves in the Torosiaje Jaya Village it is also affected by salinity and temperature. Further, the data which have obtained, they can be used in a management of mangrove forest which located in the coastal of Torosiaje Jaya Village and they can also be data in mangrove conservation efforts in order to reduce the effects of global warming.

Keywords: Composition, density, habitat, mangrove forests

INTRODUCTION

Mangrove forests have a role in mitigating climate change due to global warming because it can reduce CO_2 through the sequestration mechanism that carbon sequestration from the atmosphere and storage in several compartments such as vegetation, litter and soil organic matter (Hairiah and Rahayu 2007). Through the process of photosynthesis carbon dioxide which is from the atmosphere is absorbed by the mangrove plants and converted into organic carbon that will be distributed to all parts of the body and stored in the biomass plant. According to Nugraha (2011), it is about 50% of tree biomass is carbon.

One of the mangrove areas in Indonesia is in the coastal region of Gorontalo Province, Torosiaje Jaya Village of Pohuwato region. Pohuwato is known as a famous green belt of mangrove and coastal ecosystems where the mangrove as broad enough to stretch from the District of Paguat until Popayato District of West. Mangrove areas have contained in Pohuwato fairly high species diversity. One of the mangrove species found, among others, from family Avicenniaceae namely *Avicennia marina* (Forsk.) Vierh. According to Dharmawan and Siregar (2008), *A. marina* is as one of the mangrove species that can absorb and store carbon is greater, because of habitat that is characteristic of wetlands with muddy soil types.

Based on the results of interpretation of *Landsa*t imagery which is reported Damanik (2012), that the mangrove area Pohuwato has undergone significant changes, which in 1988 reached the mangrove area of 13243.33 hectares and in 2010 the remaining 7420.73 ha. The damage to the mangrove forests in the coastal Torosiaje Jaya Village has an impact on other Tomini bay ecosystem conditions such as Togean Islands National Park in Tojo Una-Una, Central Sulawesi Province. By reducing area of coastal mangrove in Torosiaje Jaya Village cause of carbon in the atmosphere cannot be absorbed and stored in plant biomass optimally. This further confirms the need for a precautionary measure in order to damage that occurred in the coastal mangrove Torosiaje Jaya Village need to be immediately addressed through the information on the density, composition, and habitat, of mangrove forests. Findings of this research may serve as a database for mangrove forest conservation management purposes in

Torosiaje and other regions as well as for addressing global warming and climate change issues.

MATERIALS AND METHODS

Study area

The study area is located in the coastal areas of mangrove forest Torosiaje Jaya Village, Popayato Subdistrict, Pohuwato District, Gorontalo Province, Indonesia (N 0º 28’ 45”E, 121º26’ 15”). The geographical position of the study area is presented on the map (Figure 1).

Methods

The method used in this research is using the quadrant method or P-CQM (Point Centered Quarter Method). Each plant is contained in the quadrant, recorded the name of the species (as seen by recognition by the research team and mangrove identification books (Tomlinson 1986; Giesen et al. 2006). Measured the diameter of the tree is calculated based on diameter at breast height (dbh) of 1.3 m above the ground or above the buttresses, while the total tree height is calculated from the above buttress without counting the canopy.

The stages will be undertaken in this study are: (i) The preparation phase, covering: observation, setting up data collection methods, prepare the equipment that will be used for data collection in the field. (ii) The data collection stage, include the determination of the density of vegetation.

To determine the density of the vegetation at the study site, created transect lines perpendicular from the shoreline landward by determining the point of observation or sampling point along the transect. At every point of measurement is made abscissa and ordinate imaginary line, so that at each measurement point there are four quadrants: I, II, III and IV. Select one of the trees in each quadrant are located closest to the point of a benchmark tree and measure the distance from each tree to tree point benchmark.

Each plant is contained in the quadrant, recorded the name of the species. Measured the diameter of the tree is calculated based on diameter at breast height (dbh) of 1.3 m above the ground or above the buttresses, while the total tree height is calculated from the above buttress without counting the canopy. Furthermore, in calculating the density of the wood. Mangrove species that cannot be identified in the field, that it was taken instance leaves, fruits, and flowers to be made herbarium and further identified in the Laboratory of Botany, Universitas Negeri Gorontalo, Indonesia. In addition to data mangrove species, also measured the temperature, salinity, soil pH, and moisture.

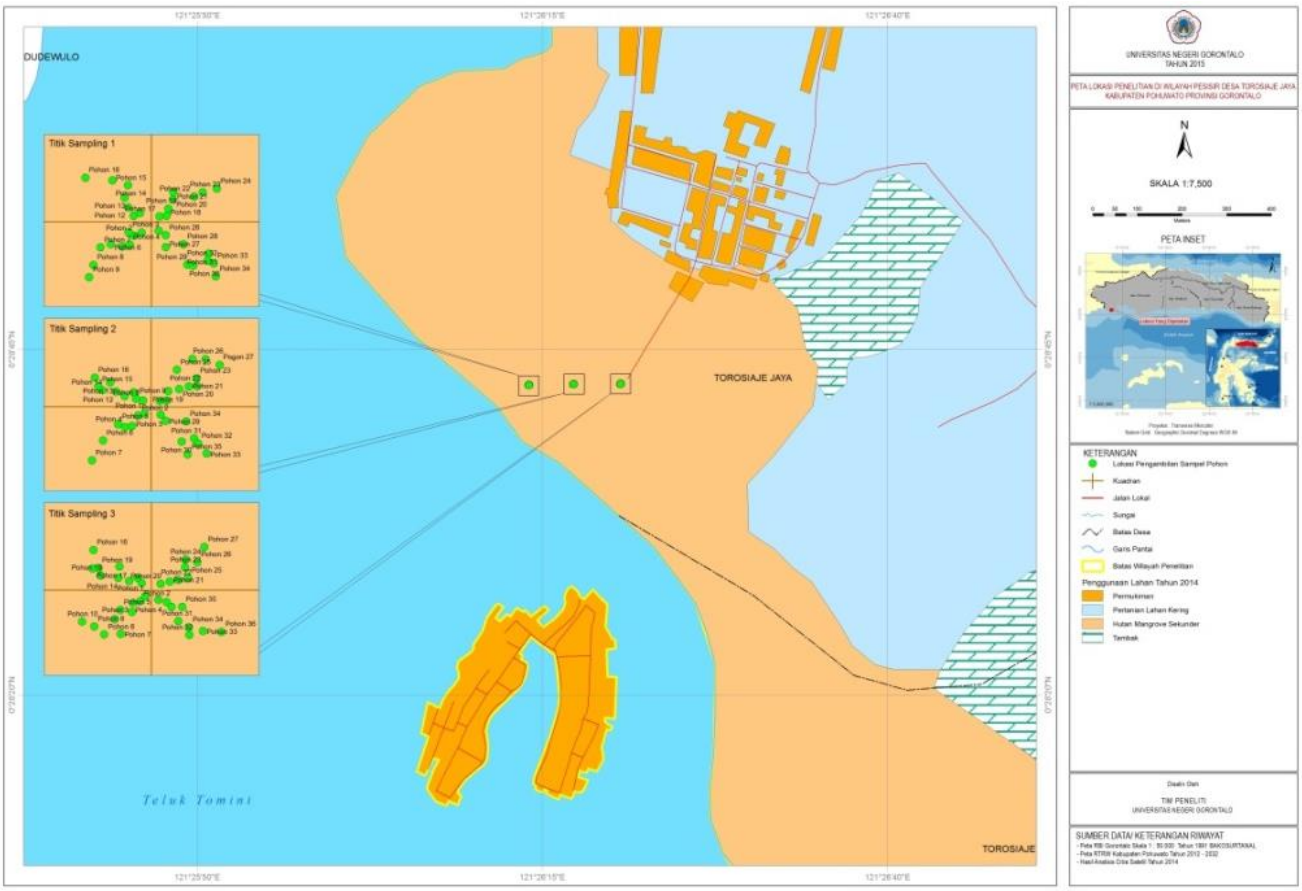

Figure 1. The study site in the coastal region of Torosiaje Jaya Village, Gorontalo, Indonesia

Data analysis

Density

To calculate the density, calculated the average distance of each individual tree with the following formula (Indriyanto 2010):

The distance the average individual tree to tree point benchmark (d):

$$d = \frac{d1+d2+d3+\cdots+dn}{n} \quad (1)$$

Where:

d1, d2, d3, ..., dn = distance of each tree to the point of measurement

n = number of trees

d = average distance of individual trees to the measuring point

Density all species per hectare (K)

To calculate the density of all types of trees used the following formula (Indriyanto 2010):

$$k = \frac{\text{Area}}{(average\ distance\ of\ tree)^2} \quad (2)$$

Volume of trees

Volume of trees is a content or the magnitude of a sample obtained from the width and height of the sample. Tree volume calculated using the formula Brown (1997):

$$V = ¼.\pi.d^2.t.f \quad (3)$$

Where:

V = volume of trees (m^3)

π = constant (3.14)

d = diameter of tree height chest (cm)

t = total height (m), and

f = figures tree form (0.6)

Composition type

Composition kind is calculated based on the number of mangrove species are found.

Habitat

The research used descriptive analysis towards the habitat analysis obtained from the soil sample analysis done in the laboratory. The laboratory examination included examining soil texture (sand, silt, and clay). In addition, the examination also covered temperature, humidity and salinity aspects, which are significant factors in the development of mangrove.

RESULTS AND DISCUSSION

Result

Density, density of all species per hectare, and tree volume

Based on the density of trees in the Torosiaje Jaya Village indicates a density value of 51.55 trees/3 ha with an average distance of 581.94 m/tree. All species density value are presented in (Table 1)

Composition type

In Table 2, it can be argued that in the mangrove forest Torosiaje Jaya Village number of species found little that four types i.e. *Bruguiera gymnorrhiza, Rhizophora mucronata*, *Rhizophora apiculata*, dan *Rhizophora stylosa*, of trees 36 individual per 300 m^2 with an average distance of 581,94 (trees/3 ha). Number of trees in sampling points 300 m^2 in the village of Mangrove Forests Torosiaje Jaya, Gorontalo, Indonesia is presented in Table 2 below.

Habitat for mangrove species

Texture, detritus and pH are the dominant factors that affect the development of mangrove. Mangrove soil is alluvial, which is brought and sedimented by the river and the seawater. Alluvial can be classified as sand, silt and clay. It is these three components which form soil in different composition. Mud is composed by silt and clay which are rich in detritus.

The analysis conducted at the Laboratory of PG Tolangohula and the site investigation revealed that the habitat of the species found in Torosiaje for Sampling Point 1, *Bruguiera gymnorrhiza* is in the habitat which contains sand (0%), silt (61.0-62.1%), and clay (38.9-39.0%). Sampling Point 2, *Rhizophora mucronata* contains sand (0%), silt (62.5-69.7%), and clay (30.8-37.5%). Sampling Point 3, the habitat of *Rhizophora stylosa* contains sand (0%), silt (52.0%), and clay (47.0%). The habitat of *Rhizophora apiculate* contains sand (0%), silt (33.4%), and clay (67.0%). The temperature at the Sampling Point 1 for *Bruguiera gymnorrhiza* ranges between 31.5-31.8^{0}C, its salinity is between 21.6 ppt – 22.1 ppt, and its humidity level is between 84.8-85%. At the Sampling Point 2, the temperature for *Rhizophora mucronata* ranges between 31-31.5^{0}C, its salinity is between 21.8-22.1 ppt, and its humidity level is between 85-86%. At the Sampling Point 3, the temperature for *Rhizophora apiculate* ranges between 30-30.5^{0}C, its salinity is between 21.2-21.8 ppt, and its humidity level is between 86.5-87%; the temperature for *Bruguiera gymnorrhiza* is 30^{0}C, its salinity is 20.5 ppt, and its humidity level is 87%; the temperature for *Rhizophora stylosa* is 30.5^{0}C, its salinity is 201 ppt, and its humidity level is 86.5%; and the temperature for *Rhizophora mucronata* is between 30-30.2^{0}C, its salinity is between 20-20.5 ppt, and its humidity is 87%.

Discussion

Based on the results of data density of trees in the village of Torosiaje Jaya indicate that at the sampling point 3, 2, and 1 has the highest density. This is evidenced, with 36 trees found at sampling points 3, *Bruguiera gymnorrhiza is* the dominant species, 35 trees for sampling point 2 with dominant species *Rhizophora mucronata*, and found 34 trees for one sampling point with the dominant species *Rhizophora stylosa*. These species were classified as dominant as they are the dominant species found at the research site and had the widest distribution over the site.

Table 1. Density value, density of all species per hectare, and tree volume at the research site

Species names	TS	Quadrant	NP	JP (m)	DP (cm)	VP (m^3)
B.gymnorrhiza	1	I	1	8	82	2,566.68
B.gymnorrhiza			2	12	86	2,826.5
B.gymnorrhiza			3	14	92	3,638.98
B.gymnorrhiza			4	18	102	4,473.06
B.gymnorrhiza			5	21	82	2,248.47
B.gymnorrhiza			6	26	108	4,457.58
B.gymnorrhiza			7	33	83	1,974.55
B.gymnorrhiza			8	42	85	2,416
B.gymnorrhiza			9	49	74	1,831.15
B.gymnorrhiza		II	10	8	72	1,485.86
B.gymnorrhiza			11	10	68	1,104.46
B.gymnorrhiza			12	16	82	1,927.26
B.gymnorrhiza			13	21	86	2,826.5
B.gymnorrhiza			14	26	72	1,485.86
B.gymnorrhiza			15	35	92	2,830.32
B.gymnorrhiza			16	47	68	1,104.46
B.gymnorrhiza		III	17	5	72	1,485.86
B.gymnorrhiza			18	7	82	2,248.47
B.gymnorrhiza			19	12	85	2,761.15
B.gymnorrhiza			20	18	65	1,009.16
B.gymnorrhiza			21	22	82	2,248.47
B.gymnorrhiza			22	29	93	3,305.35
B.gymnorrhiza			23	35	100	3,821.66
B.gymnorrhiza			24	44	120	6,191.08
B.gymnorrhiza		IV	25	6	75	1,612.26
B.gymnorrhiza			26	11	72	1,485.86
B.gymnorrhiza			27	17	82	2,248.47
B.gymnorrhiza			28	23	65	1,009.16
B.gymnorrhiza			29	32	83	2,303.65
B.gymnorrhiza			30	34	68	1,104.46
B.gymnorrhiza			31	37	72	1,485.86
B.gymnorrhiza			32	40	64	978.34
B.gymnorrhiza			33	43	89	2,648.74
B.gymnorrhiza			34	49	93	3,305.35
R. mucronata	2	I	1	5	68	1,104.46
R. mucronata			2	8	84	2,022.42
R. mucronata			3	16	82	1,927.26
R. mucronata			4	19	65	1,009.16
R. mucronata			5	21	98	3,670.32
R. mucronata			6	35	74	1,569.55
R. mucronata			7	48	95	3,880.18
R. mucronata		II	8	6	68	1,325.35
R. mucronata			9	9	75	1,880.97
R. mucronata			10	12	81	2,193.96
R. mucronata			11	17	72	1,485.86
R. mucronata			12	22	103	4,054.39
R. mucronata			13	28	102	4,473.06
R. mucronata			14	30	82	1,927.26
R. mucronata			15	33	96	3,081.78
R. mucronata			16	37	99	3,277.4
R. mucronata		III	17	5	68	1,104.46
R. mucronata			18	9	69	1,137.18
R. mucronata			19	13	74	1,569.55
R. mucronata			20	19	78	1,743.82
R. mucronata			21	24	68	1,104.46
R. mucronata			22	28	75	1,612.26
R. mucronata			23	31	82	1,927.26
R. mucronata			24	42	86	2,119.87
R. mucronata			25	26	96	3,522.04
R. mucronata			26	37	106	3,757.26
R. mucronata			27	45	116	5.785.22
R. mucronata		IV	28	7	98	3,211.53
R. mucronata			29	11	64	978.34
R. mucronata			30	26	102	3,976.05
R. mucronata			31	30	68	1,104.46
R. mucronata			32	33	76	1,655.54
R. mucronata			33	42	69	1,364.62
R. mucronata			34	22	74	1,569.55
R. mucronata			35	35	82	1,927.26
R. mucronata	3	I	1	5	69	1,364.62
R. mucronata			2	9	69	1,137.18
R. mucronata			3	13	72	1,485.86
R. mucronata			4	17	74	1,569.55
R. mucronata			5	22	86	2,473.18
B.gymnorrhiza			6	28	88	2,589.55
B.gymnorrhiza			7	32	65	1,210.99
R. apiculata			8	38	66	1,040.45
R. apiculata			9	40	74	1,569.55
R. apiculata			10	45	96	3,522.04
R. stylosa		II	11	7	64	978.34
R. stylosa			12	11	85	2,070.86
R. stylosa			13	13	96	3,522.04
R. stylosa			14	20	103	4,054.39
R. stylosa			15	23	112	5,393.12
R. stylosa			16	42	96	3,522.04
R. mucronata			17	37	92	2,830.32
R. mucronata			18	31	88	2,219.62
R. mucronata			19	34	102	4,473.06
R. apiculata		III	20	5	72	1,485.86
R. apiculata			21	11	68	1,104.46
R. apiculata			22	18	66	1,248.54
R. apiculata			23	24	89	3,027.13
R. apiculata			24	26	102	4,473.06
R. stylosa			25	21	115	5,.685.91
R. stylosa			26	31	92	3,234.65
R. stylosa			27	39	96	3,522.04
B.gymnorrhiza		IV	28	6	65	1,009.16
B.gymnorrhiza			29	10	86	2,119.87
B.gymnorrhiza			30	15	72	1,485.86
R. stylosa			31	24	68	1,325.35
R. stylosa			32	34	72	1,485.86
R. stylosa			33	38	86	2,119.87
R. mucronata			34	30	102	4,473.06
R. mucronata			35	21	64	978.34
R. mucronata			36	48	121	8.392.93
The mean distance of tree (m^2)					581,94	
The density of all species/ha					51,55	

Notes: TS: Sampling Point, Np: Tree Number, Jp: Tree Distance, Dp: Tree Distance, Vp: Tree Volume

Table 2. Number of trees in sampling points 300 m^2 in the village of Mangrove Forests Torosiaje Jaya, Gorontalo, Indonesia.

Location	Number of species	Number of trees
Side point 1	1	34
Side point 2	1	35
Side point 3	4	36

Data showed that the dominant species found in each Sampling Point possessed the highest skills of adaptation towards their habitats for survival purposes. The species composition of coastal mangrove forests Torosiaje Jaya Village found four species of *Bruguiera gymnorrhiza* namely, *Rhizophora mucronata*, *Rhizophora apiculata, Rhizophora stylosa*.

Salinity, substrate, and temperature affect mangrove density and species composition. Salinity affects the growth and density of mangrove, which is based on the results of further research towards the sea, the salinity or salt content of the higher places. Mangrove is not a plant that needed salt but mangrove is a plant that is tolerant of salt. This is in line with the opinions by Hutahaean et al. (1999), which examined the mineral elements needed for the growth of mangrove plants are the macro elements such as N, P, S, K, Ca and Mg and micro elements consisting of Zn, Mn, and Cu. Based on these results the elements Na and Cl are not needed for the growth of mangrove plants. If the salt content on the site is too high then the growth will be stunted mangrove. According Hutahaean et al. (1999) that the range of salinity for *Rhizophora mucronata* is 12-30 ppt. based on the results of research that salinity in coastal areas Torosiaje Jaya Village for 21.5 to 22 ppt of *Rhizophora mucronata.* species, a species that is from 21.5 to 22 ppt of *Bruguiera gymnorrhiza*, *Rhizophora stylosa* species are 20 to 21.5 ppt. Therefore, The coastal of Torosiaje Jaya Village is a coastal region that can support the growth of three species of mangrove dominant.

Various types of mangroves overcome salinity levels in different ways. Rhizophora, for instance, secretes excess salt through the glands under its leaves to overcome high salinity. The absorbed water has almost become fresh water, with 90-97% of salt content in seawater were unable to pass through this root filter. Salt from the plant body was accumulated in the old leaves and wasted along with fall leaves. Mangrove vegetation should seek to maintain water because of the difficulty in obtaining fresh water.

In addition to salinity, density substrate also affects the mangroves. The substrate is generally composed of sand, clay, and dust. Based on the results of laboratory analysis, soil dominant mangrove species *Bruguiera gymnorrhiza* is a land that has a <5% sand, dust from 61.1 to 75.3%, and 17.1 to 47.9% clay. According to Indah et al. (2008), this ground including clayey loam soil which is dominated by a blend of silt and clay that causes the formation of good texture. That is why the substrate in this region is classified as good and supports the growth of various mangrove species found in the research site.

Based on observations of air temperature that is at the study site ranged from 30-31.8ºC. At the point of observation that high temperature caused by sunlight is still hindered by the mangrove canopy cover so that the temperature becomes lower. Temperatures in the coastal mangrove forests Torosiaje Jaya Village is the range of temperature that supports the growth of mangrove. This is confirmed by Kusmana (2010) states that if the temperature is higher than 35ºC, it will give unfavorable influence on the process of photosynthesis so that the process of mangrove growth will be hampered.

In conclusion, the value density types of mangrove forests in the coastal regions of Torosiaje Jaya Village for the entire species is 51.55 trees/ha with an average distance of 581.94 m/tree. The species composition of coastal mangrove forests of Torosiaje Jaya Village found four species namely *Bruguiera gymnorrhiza*, *Rhizophora mucronata*, *Rhizophora apiculata*, and *Rhizophora stylosa*. Mangrove density and species composition in an area influenced by several factors among which salinity, substrate, and temperature. Habitat that affects the growth of mangrove species on the coast of Torosiaje village is mangrove soil which contained sand (<5%), dust (61.1-75.3%), and clay (17.1-47.9%). The soil includes clay because of the combination of dust and clay that forms a good texture. Therefore, the substrate found in this coast is classified as good and can support the growth of various mangrove species found in the research site.

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