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# Growth Characteristics of the Mangrove Forest at the Raised Coral Island of Marsegu, West Seram, Maluku

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**Abstract:- This study aims to determine the dynamics of mangrove growth on *Raised Coral Island*, particularly regarding structure and composition of mangrove vegetation, mangrove zonation patterns, and human intervention in the utilization of mangrove areas.**

**The vegetation data was collected using the line transect plot method. Research plots were made in the line transect. The area of the Seedlings plot was up to 1.5 meters high with a plot size of 2x2 m. Saplings with the height between 1.5 m - Ø <10 cm, plot size 10x10 m. Poles or small trees of Ø 10 - 19 cm, plot size 10x20 m and Trees Ø ≥ 20 cm, plot size 20x20 m.**

**Marsegu Island, with 240,20 ha, has 46,75% Mangrove Forest with a zonation pattern formed as follows: The Proximal Zone with an area of 32.12 ha, controlled by the *Rhizophora stylosa* and *Rhizophora mucronata* species. This zone is more dominated by the growth of pole stages, specifically the stem diameter between 10 to 20 cm with a crown height ranging from 3 to 5 meters. The Middle Zone with 39.00 ha is dominated respectively by *Bruguiera gymnorhiza, Rhizophora apiculata, Ceriops tagal,* and *Xylocarpus granatum* with tree heights reaching 5 to 15 meters. The opening of the canopy as a result of cutting trees provides an opportunity for seedling and sapling stages regeneration to grow from exposure to sunlight. The tree density in this zone is 105 ind/ha with diameters ranging from 20 to 40 cm, dominated by *Bruguiera gymnorhiza* species. The Distal Zone, with 41.17 ha, is dominated by *Bruguiera gymnorhiza, Ceriops tagal, Rhizophora apiculata*, and *Xylocarpus moluccensis* with larger tree diameters. The trees density in this zone is 300 ind/ha and has a diameter ranging from 30 to 60 cm; however, some reach 100 cm. Many old trees suffer a natural process of destruction and death.**

**The community carries out activities in the middle zone by cutting down the *Bruguiera gymnorhiza* species trees as construction materials. The middle part of the mangrove area is adjacent to the distal zone; there is a coconut plantation covering an area of 1.53 ha planted by the community.**

***Keywords:-*** *Mangrove Zonation Pattern, Raised Coral Island, Mangrove's Structure and Composition, Marsegu Island.*

## I. INTRODUCTION

*A. Background*

Mangrove ecosystems are natural resources located in coastal areas that contribute to the absorption of carbon emissions and other forest ecosystems (Hamilton & Friess 2018; Sharma, et al. 2020). The people who reside on the coast close to the ecosystem have had direct benefits from mangrove ecosystems (Huxham, et al 2017). Mangroves have been proven to reduce the impact of damage by the tsunami that hit several areas along the coast. The energy reduction depends on three main factors, particularly the mangrove structure, topography-bathymetry, and wave characteristics. Mangroves are vulnerable and resistant to various coastal disturbances, both natural and anthropogenic (Koh, et al. 2018; Lunghino, et al 2020).

Like trees that grow on land, the types of trees that grow in mangrove areas need a specific place to grow according to their growth needs; especially the growing area, which is closely associated with salinity, substrate, sea level, and the strength of the waves that hit (Van Chi. 2017).

Mangrove ecosystems are very complicated, given that many factors influence each other in their growth and development, both internal and external factors (Paembonan, 2020). To grow in this tidal zone, these plants must be able to adapt to high salt levels. Also, it has a modified root that provides opportunities for these plants to breathe in stagnant conditions.

Several researchers previously divided the mangrove growth area according to the degradation of altitude, which prompted differences in inundation duration into the ***proximal zone, middle zone,*** and ***distal zone*** (Dagar et al 1991; Mongia, et al 1993; Baskaran, et al 2012; Yuvaraj, et al 2017; Sivaperuman, et al 2018). To explain these zonations several terms are also used, such as: ***Fringing Zone, Intermediate Zone*** and ***Landward Zone*** (Sreelekshmi, et al 2018); ***Coastal Zone, Middle Zone*** and ***Inland Zone*** (Mansor, et al 2015; Nandi, et al. 2020); ***Seaward zone, Mid zone*** and ***Landward zone*** (Semeniuk, 1980; Ginantra, et al. 2020; Raganas, et al. 2020).

Mangroves often grow in groups of the same species, since these species can adapt to existing habitats (Snedaker, 1982; Satyanarayana, et al 2002; Sreelekshmi, et al 2018). The term Zonation is also applied to describe groups of mangrove species that grow together, such as the *Rhizophora Zone*, the *Bruguiera Zone*, the *Sonneratian Zone*, and the *Ceriops Zone*.

Mangrove forests are currently undergoing degradation and deforestation due to human activities such as constructing human settlements, constructing public facilities, and other activities (Walters, 2003; Hamilton & Casey, 2016; Deb & Ferreira, 2017; Puryono & Suryanti, 2019). For rehabilitation and restoration efforts, it is necessary to carefully study mangrove's characteristics in an area to identify the dominant factors that influence its growth, both internal and external. Apart from living in river estuaries and lagoons, mangroves are also found on small islands which have areas blocked from strong waves and winds (Moity, et al. 2019). However, small islands are limited in the supply of fresh water, because they have a small catchment area and the soil structure and texture do not support the process of storing groundwater (White & Falkland, 2010).

*B. Objectives*

Marsegu Island is one of the small islands in West Seram, Maluku Province, Indonesia, classified as a *raised coral island*. Marsegu Island is a protected forest area with 240.20 ha, while the sea area is a Marine Nature Tourism Conservation Area. Part of Marsegu Island is a mangrove area that grows in specific areas with relatively high salinity without river flow. This study aims to determine the dynamics of mangrove growth on *Raised Coral Island*, specifically regarding structure and composition of mangrove vegetation, mangrove zonation patterns, and human intervention in the utilization of mangrove areas.

## II. RESEARCH METHOD

*A. Research Time and Location*

The research location is the Marsegu Island Mangrove Forest, West Seram Regency, Maluku Province, Indonesia. Mangrove forest vegetation is located in the southern part of the island, while the north is a secondary forest area that grows on the reef. The type of tide in the Marsegu Island area is semi-diurnal (semi-daily tide), two times of high tide, and two times of low tide in one day. Field research was performed in March 2020.

*B. Research Implementation*

The tools used in this research were Compass, GPS Garmin V Personal Navigator, Meter Roll, Phi Band, Refractometer, Camera, and Writing Equipment. MS Excel software for tabulation and data analysis and Arcgis 10.3 for performing mangrove zonation maps.

The Vegetation data was collected using the line transect plot method. Research plots were made in the line transect. The plot areas for each growth stages are as follows:

- Seedlings plot was up to 1.5 meters high, plot size of 2x2 m,
- Saplings with the height between 1.5 m - Ø <10 cm, plot size 10x10 m,
- Poles or small trees of Ø 10 - 19 cm, plot size 10x20 m, and
- Trees Ø ≥ 20 cm, plot size 20x20 m.

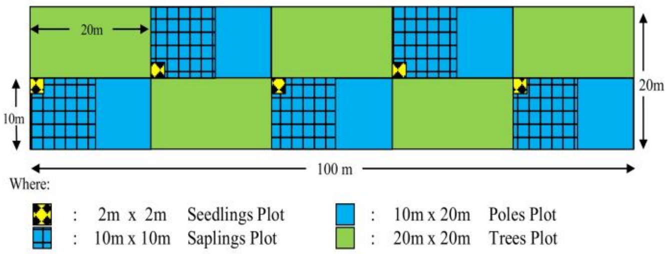



Fig.1:- Plots Size and Design

The data collected in the field were tree diameter at breast height (dbh), the total height of several trees to describe the crown strata formed in each mangrove zonation, and environmental factors such as salinity and canopy cover. The research line transect was made for each mangrove growth zonation with satellite imagery guidance and focusing on the dominant vegetation representation in the field. Each mangrove growth zonation was made a line transect with a size of 20 x 100 m with map coordinates as follows:

| Zonation | Map Coordinates Point | | Directions | Length | Salinity (‰) |
|---|---|---|---|---|---|
| | Lat | Long | | | |
| Proximal | -3,01585 | 128,05507 | 285° | 100 m | 30 |
| Middle | -3,01549 | 128,05360 | 285° | 100 m | 30 |
| Distal | -3,00682 | 128,05336 | 180° | 100 m | 30 |

Table. 1:- Azimuth Point and Direction of the Research Line Transect

C. Data Analysis

The collected vegetation data is then analyzed to determine species density, relative density, species dominance, relative dominance, species frequency and relative frequency as well as the Importance Value Index using the Mueller-Dombois and Ellenberg (1974) formula as follows:

$$\text{Density} = \frac{\text{Number of Species}}{\text{Plot Area Measured}}$$

$$\text{Relative Density} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

$$\text{Dominance} = \frac{\text{Number of the basal area}}{\text{Plot Area Measured}}$$

$$\text{Relative Dominance} = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \times 100\%$$

$$\text{Frequency} = \frac{\text{Number of plot found in a species}}{\text{Number of all plot}}$$

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Number Frequency of all species}} \times 100\%$$

Importance Value (I.V) =
Relative Density + Relative Dominance + Relative Frequency

The Importance value is the sum of the relative density, relative frequency and relative dominance, which ranges between 0 and 300 (Mueller-Dombois and Ellenberg, 1974). The regeneration stages, namely saplings and seedlings, is the sum of the relative density and relative frequency, so that the maximum importance value is 200.

Species diversity and community stability of each area is explained by the Shannon-Wiener index (Ludwig & Reynold, 1988):

$$H^1 = \sum_{i=1}^{s} (pi) \text{ LN } pi$$

Where :
H' = Diversity Index Shannon-Wiener
pi = ni/N
ni = Importance value of species i
N = Number Importance value of all species

The greater the H' index of a community, the more stable the community is. The value of H' = 0 occurs when there is only one species in one line transect of research and H' is maximal when all species have the same number of individuals and this indicates a perfectly distributed abundance.

## III. RESULTS AND DISCUSSION

A. Raised Coral Island of Marsegu

*Raised Coral Island* is an island formed by coral reefs raised above sea level due to uplift and subsidence from the seabed due to geological processes. When the seafloor is near the surface (less than 40 m), coral reefs have the opportunity to grow and develop on the rising seafloor. Once above sea level, the coral will die and omit a reef. If this process continues, coral islands will form. In general, the coral that rises to the sea's surface is terraces shaped like rice fields in the mountains. This process can occur on volcanic or non-volcanic islands (Bengen et al. 2012). These emerging coral islands are often found in eastern Indonesian waters, such as the Seram, Sulu, and Banda Sea (Molengraaff, 1929).

Marsegu Island is located in Kotania Bay, West Seram Regency, Maluku Province. Kotania Bay is astronomically located at -2,96667 to -3,10000 S and 128.00000 to 128.1333 E with 5 (five) small islands, i.e., Marsegu Island, Osi Island, Burung Island, Buntal Island, and Tatumbu Island. The inhabited islands are Osi Island and Buntal Island, where the form of settlement is dominated by stilt houses built on an area of seagrass and coral reef flats. Several families once occupied this inhabited Marsegu island; however, now they have moved to Seram Island. This area has three coastal ecosystems, particularly coral reefs, mangroves, and seagrass beds. In general, the waters of Kotania Bay constitute a reef area, especially the fringing reef type, which is attached to the mainland of Seram Island (Arfah, et al. 2014).

The term "Marsegu" comes from the local language, which means bats since this island was discovered in many bats. The population of Seram Bats on this island is estimated to be 14 individuals/ha; thus, the total number is 647 individuals in the mangrove area. The activity of the Seram Bat is mostly found to be the location of the mangrove species of *Rhizophora* (Serumena, 2013). However, during research in March 2020, the number of bats was found in the thousands that rummage for food after the sunset, leaving Marsegu Island to Seram Island.


Fig 2:- *Pteropus ocularis* above the crown of *Rhizophora apiculata*

The Seram bat is a large bat known as the *Ceram Flying Fox* (*Pteropus ocularis*), which during the day makes the crown on *Rhizophora apiculata* on Marsegu Island a resting habitat. The large trees of *Rhizophora apiculata* that reach a height of 20 meters in the distal zone are used to dangle as many as 20-30 bats per tree. The *Ceram Flying Fox* flock after sunset to Seram Island to obtain food in the broader area. Then in the early morning, these animals returned to Marsegu Island.

The Ceram Flying Fox is a large bat species in the Pteropodidae family. This species is endemic to the forests and mountains of the islands of Buru and Seram. This bat was once found near Ambon Island, yet probably it is not anymore. Their habitat area is less than 20.000 $km^2$ and continues to decline as a result of logging. Due to decreased numbers and hunting by residents, this species has been listed as "Vulnerable" by the IUCN since 1996 (iNaturalist, 2019).

Marsegu Island has a flat to slightly wavy topography and is slightly steep in rocky areas, a maximum height of 35 m above sea level, an island length of 2.75 km, and a width of 1 km. Marsegu Island is a rocky area with no river flow, only two wells made by Osi Island people as a source of drinking water, bathing, and washing.

Marsegu Island Protected Forest Area has an area of 240.20 ha and a long coastline of 6.698,50 m. Marsegu Island has a mangrove area of 112.29 ha or 46.75% of the island's area with details as follows: proximal zone 32.12 ha, middle zone 39.00 ha, and distal zone 41.17 ha.

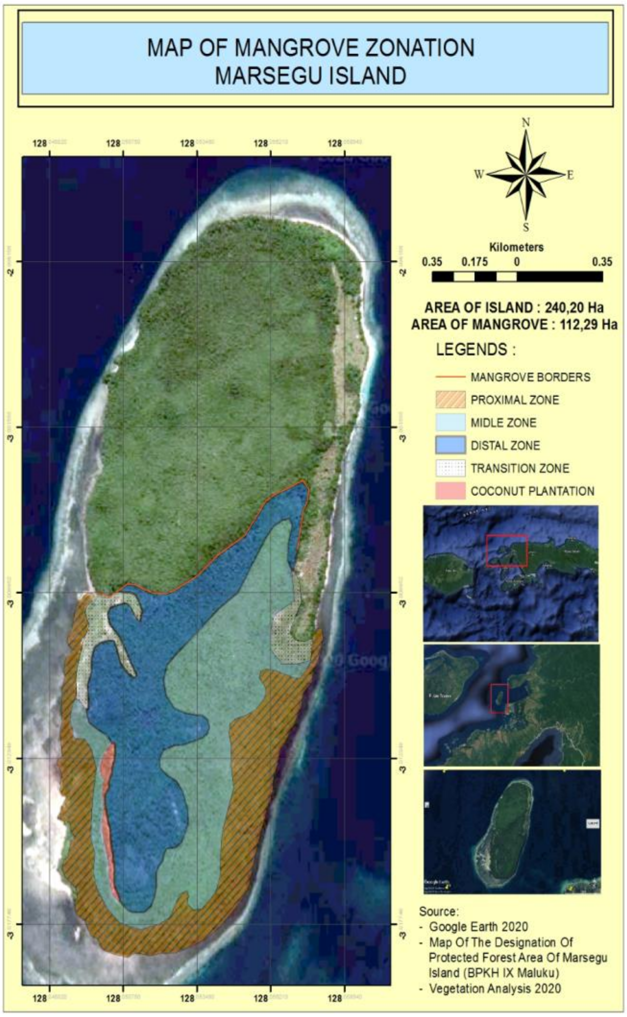



Fig 3:- Map Of Mangrove Zonation on Marsegu Island

B. Composition and Species Abundance

The results of the study on the presence of species for each growth stage at the three zone observations are presented in Table 2.

| No | Mangrove Species | Family |
|---|---|---|
| 1 | *Bruguiera gymnorhiza (L.) Lam.* | Rhizophoraceae |
| 2 | *Ceriops tagal (Perr.) C.B.Rob.* | Rhizophoraceae |
| 3 | *Rhizophora apiculata Blume* | Rhizophoraceae |
| 4 | *Rhizophora mucronata Lam.* | Rhizophoraceae |
| 5 | *Rhizophora stylosa Griff.* | Rhizophoraceae |
| 6 | *Xylocarpus granatum J. Koenig* | Meliaceae |
| 7 | *Xylocarpus moluccensis (Lam.) M.Roem.* | Meliaceae |

Table 2:- Number of Species and Families

The presence of mangrove species in the research line transect was seven species classified into two families, specifically *Rhizophoraceae* and *Meliaceae*. When compared to various growth stages, there were only three species of seedlings. The evenly distributed species were *Bruguiera gymnorhiza*, spread over various growth stages and all mangrove zonation. The types of mangrove composers based on the Importance Value Index (I.V) of various growth stages in each zonation can be seen in the following Table 3.

| No | Mangrove Species | Trees | | | Poles | | |
|---|---|---|---|---|---|---|---|
| | | A | B | C | A | B | C |
| 1 | *Bruguiera gymnorhiza* | 36,43 | 181,93 | 147,33 | 33,84 | 198,07 | 101,61 |
| 2 | *Ceriops tagal* | - | 46,61 | 62,90 | - | 32,98 | 118,87 |
| 3 | *Rhizophora apiculata* | 34,64 | 54,67 | 45,40 | - | 50,98 | - |
| 4 | *Rhizophora mucronata* | 99,80 | - | - | 158,89 | - | - |
| 5 | *Rhizophora stylosa* | 129,14 | - | - | 107,28 | - | - |
| 6 | *Xylocarpus granatum* | - | 16,78 | - | - | - | - |
| 7 | *Xylocarpus moluccensis* | - | - | 44,36 | - | 17,97 | 79,52 |
| | Jumlah | 300,00 | 300,00 | 300,00 | 300,00 | 300,00 | 300,00 |
| **No** | **Mangrove Species** | **Saplings** | | | **Seedlings** | | |
| | | **A** | **B** | **C** | **A** | **B** | **C** |
| 1 | *Bruguiera gymnorhiza* | 78,98 | 134,50 | 102,80 | 133,33 | 175,45 | 200,00 |
| 2 | *Ceriops tagal* | 9,48 | 54,36 | 44,22 | - | 24,55 | - |
| 3 | *Rhizophora apiculata* | 24,31 | 11,15 | 15,62 | - | - | - |
| 4 | *Rhizophora mucronata* | 61,13 | - | - | - | - | - |
| 5 | *Rhizophora stylosa* | 26,10 | - | - | 66,67 | - | - |
| 6 | *Xylocarpus granatum* | - | - | 37,35 | - | - | - |
| 7 | *Xylocarpus moluccensis* | - | - | - | - | - | - |
| | Jumlah | 200,00 | 200,00 | 200,00 | 200,00 | 200,00 | 200,00 |

Table. 3:- The Important Value of Mangrove Species on Marsegu Island

Where : A = Proximal Zone, B = Middle Zone, C = Distal Zone

C. Density of Growth Stages

The comparison of the density of each growth stage per zone can be seen in Figure 3. In this graph, the dominant density for each growth can be compared.

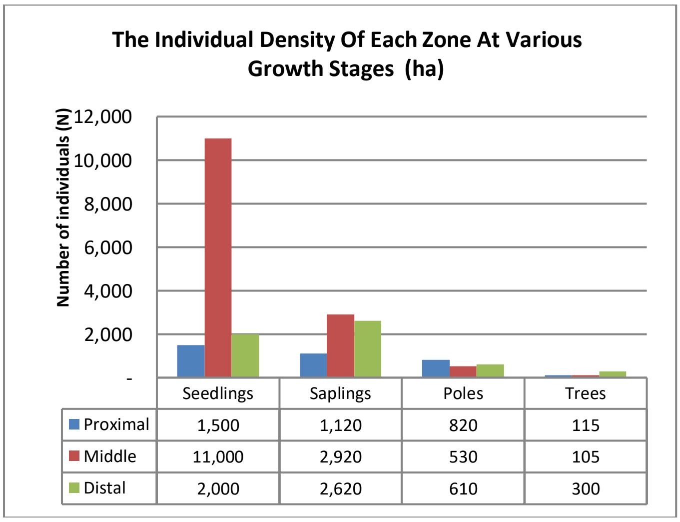



Fig. 3. The individual density of each zone at various growth stages (ha)

Based on Figure 3, it is identified that the most massive tree density is 300 trees per hectare in the Distal zone. These tree-level constituents' highest density is the *Bruguiera gymnorhiza* species in the middle and distal zones and *Rhizophora stylosa* in the proximal zone. At the same time, the smallest density is 105 trees per hectare in the middle zone. The highest pole stage density is 820 poles per hectare in the proximal zone; the lowest is in the middle zone at 530 poles per hectare. The highest sapling density is 2.920 sapling per hectare in the middle zone.

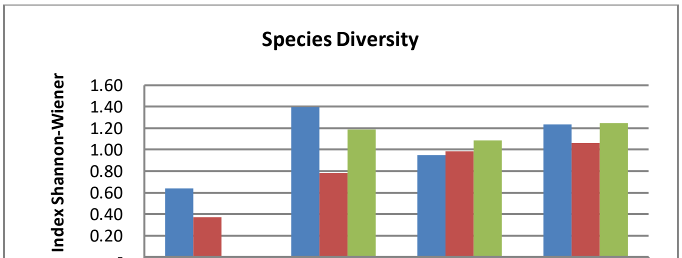
In comparison, the smallest density is 1.120 sapling per hectare in the proximal zone. For seedling density, the highest level is 11.000 seedlings per hectare in the middle zone. In contrast, the smallest density is 2.000 seedlings per hectare in the proximal zone.

Based on the analysis results, it can be observed that the abundance of each growth stage in each zone can describe the growth process of the Marsegu Island mangrove forest. The dominant level of trees is in the distal zone, with very striking differences from other zones. The number of trees in the distal zone is 2-3 times more than the middle and proximal zone. For the regeneration level, specifically seedlings and saplings, the highest density is in the middle zone; when more canopy gaps were created due to cutting trees by the community. With the gaps of the canopy from the cutting down, sunlight reaches the forest floor. The seeds that fall on the forest floor have a chance to germinate and grow (Ngakan, et. al. 2006).

The proximal zone has fewer individual seedlings and saplings than the other zones. Regeneration in the proximal zone is hampered due to the tight crush of Rhizophora roots, making it difficult for seedlings and saplings to grow. This proximal zone is dominated by *Rhizophora stylosa* and *Rhizophora mucronata*. In addition to inhibited regeneration growth in the proximal zone, this also occurs in the distal zone. Seedlings and saplings in the distal zone cannot grow and develop properly because they are covered by canopy of large trees reaching 25 meters high, as a result, very little sunlight penetrates the forest floor.

D. Species Diversity

The existence of species in a forest community can be measured by a species diversity index to observe the community's species stability. Species diversity is influenced by the number and distribution of species in each research transect. According to Shannon-Wiener, the results of the analysis of the species diversity index can be observed in Figure 4.




| | Seedling | Sapling | Pole | Tree |
|---|---|---|---|---|
| Proximal | 0.64 | 1.40 | 0.95 | 1.23 |
| Middle | 0.37 | 0.78 | 0.99 | 1.06 |
| Distal | 0.00 | 1.19 | 1.09 | 1.25 |

Fig. 4. Index of Species Diversity

The highest species diversity index for seedlings was discovered in the proximal zone of 0.64. The lowest was in the distal zone at 0.00; this is because there is only one species of seedling stage, particularly *Bruguiera gymnorhiza*, in that zone. The highest species diversity index at tree stage is found in the distal zone of 1.25, while the lowest is in the middle zone of 1.06.

The diversity of species in mangrove forests is low due to the plants that live in this area have to adapt to standing seawater and high salinity. This type of mangrove vegetation has a special shape that allows them to live in shallow waters, particularly having surface roots, spreading widely with specific support roots growing from stems or branches. Shallow roots often extend called *pneumatophores* to the substrate's surface, which allows them to acquire oxygen in anoxic sludge. Several types of mangrove plants have salt glands that help maintain osmotic balance by removing salt (Nybakken, 1997).

E. Marsegu Island Mangrove Forest Zonation Pattern

Mangroves often show species zones from wetlands to drier lands. When Rhizophora grows and develops in the lagoon, a succession occurs, since the tree's supporting roots begin to capture mud particles and dead plants. This situation prompts the build-up of litter material, elevating the soil surface when old Rhizophora plants die. Their places are often replaced by the more common terrestrial plants typical for the lagoon's environmental area (Ewusie, 1980).

Marsegu Island's mangrove forests can be divided into three zones; the foremost part is close to the sea, namely the proximal zone, the middle part is the middle zone, and the back zone or the deepest part is called the distal zone.

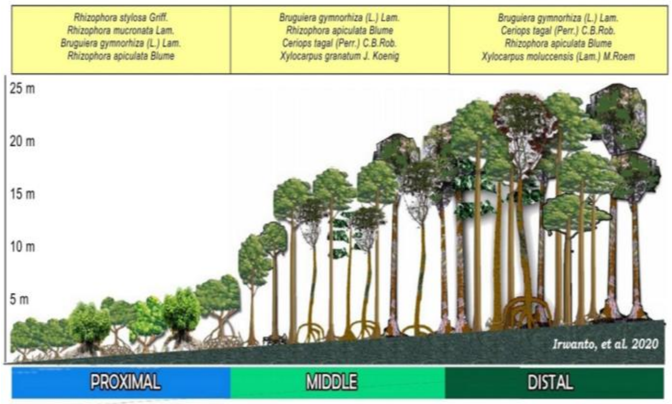



Fig. 5:- Sketch of Mangrove Forest Zonation on Marsegu Island

The proximal zone of mangrove is controlled by the *Rhizophora stylosa* and *Rhizophora mucronata* species. This zone is more controlled by the pole stage's growth, particularly the stem diameter between 10 to 20 cm with a crown height ranging from 3 to 5 meters. When entering the proximal zone deeper towards the center, about 40-50 meters, *Bruguiera gymnorhiza* and *Rhizophora apiculata* can be discovered.

The Middle zone of mangrove was dominated by *Bruguiera gymnorhiza, Rhizophora apiculata, Ceriops tagal*, and *Xylocarpus granatum*, heights reaching 5 to 15 meters yet some trees reaching 20 meters in limited numbers. The tree density in this zone is 105 ind/ha with diameters ranging from 20 to 40 cm, dominated by *Bruguiera gymnorhiza* species, which have a presence frequency of up to 50%. There are several open spots due to logging performed by communities around Marsegu Island. The canopy opening provides an opportunity for seedlings and saplings to sprout from the sun. The density of seedlings and saplings in this zone is 11.000 ind/ha and 2.920 ind/ha higher than the other zones.

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The distal zone is dominated by *Bruguiera gymnorhiza*, *Ceriops tagal*, *Rhizophora apiculata*, and *Xylocarpus moluccensis* with larger tree diameters. The tree density in this zone is 300 ind/ha and has a diameter ranging from 30 to 60 cm, although some reach 100 cm. Many old trees suffer a natural process of destruction and death. The tree canopy is denser and less light penetrates the forest floor; thus, there is less regeneration (Ngakan, et. al. 2006).


Fig. 6:- Vegetation Forms in Various Mangrove Zones

Mangrove vegetation in the distal zone has reached the climax phase of mangrove forests with larger tree sizes and different types. Large trees that reach old age die naturally and then rot to become litter and humus. If the accumulation of litter and humus continues, and the process of lifting from below is added, an area that is no longer inundated will become coastal forest vegetation.

The results of water salinity testing in mangrove forests using a refractometer show that the water in the proximal zone has the same salinity as water is obtained from the middle and distal zones of the mangrove forest, which is 30 ‰; this means that the Marsegu Island mangrove forest community is formed with high salinity, there is no freshwater (river) flowing into the sea. This factor can be seen clearly that the mangrove area of Marsegu Island does not have Nypa fruticans, a type that usually grows at lower salinity at riverbanks (Siddiqi, 1995).

F. Community Activities on Marsegu Island

People from other islands around Marsegu Island often have activities on this island while on vacation to enjoy the 1,720-meter long white sand beach atmosphere. This location is located in the northeastern part of Marsegu Island, which has coastal vegetation dominated by *Pongamia pinnata* and *Terminalia catappa*. Community activities such as swimming, fishing, and boating are carried out in small numbers or groups. However, there is no management of tourism activities, either from related agencies or the local community. The local community or outside the area is still free to travel in this area free of charge. The western part of Marsegu Island has diving spots with various coral reefs, which are an attraction for divers (Irwanto, 2017).

Fishers often take advantage of Marsegu Island to hunt for fish and other marine products. Some even stay a few days to meet their catch target when big waves and strong winds occur, the fishermen set in Marsegu Island as a place of shelter and rest.

Community activities in the mangrove area of Marsegu Island are still being carried out to utilize marine products and those on land. The deposition of sludge, accumulation of litter and humus, and uplift from below creates a dry area. The community uses these dry areas to plant coconut trees, which are considered economical and commercial. The middle part of the mangrove area is adjacent to the distal zone; there is a coconut plantation covering an area of 1.53 ha. The community made breakthroughs in the dense proximal zone with *Rhizophora stylosa* and *Rhizophora mucronata* to penetrate the mangrove's middle area.

The community carries out activities in the middle zone by cutting down the *Bruguiera gymnorhiza* species trees as construction materials. If cutting trees activities continue, the Marsegu Island mangrove forests will be damaged, and will lose their economic and ecological value as an excellent carbon storage area. Marsegu Island has been designated as a protected forest area since 2002; according to the prevailing regulations, the community can still use non-timber forest products. However, they are not allowed to cut the trees to utilize the wood.

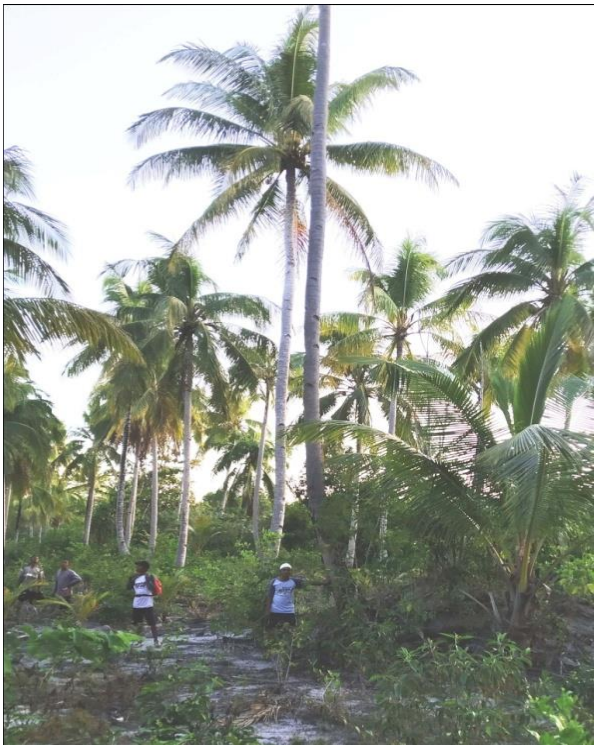

Fig. 7. Coconut plantation in the middle of the Mangrove area

## IV. CONCLUSION

1. Marsegu Island, with an area of 240.20 ha, has 46.75% mangrove forest with the following zonation patterns :
   - The proximal zone is controlled by the species *Rhizophora stylosa* and *Rhizophora mucronata*. This zone is more controlled by the pole stage growth, particularly the stem diameter between 10 to 20 cm with a crown height ranging from 3 to 5 meters.
   - The middle zone is dominated by *Bruguiera gymnorhiza*, *Rhizophora apiculata*, *Ceriops tagal*, and *Xylocarpus granatum* with tree heights reaching 5 to 15 meters, although some trees are reaching 20 meters in limited numbers. The tree density in this zone is 105 ind/ha with diameters ranging from 20 to 40 cm. There are gaps in the canopy due to cutting trees carried out by communities around Marsegu Island.
   - The distal zone is dominated by *Bruguiera gymnorhiza*, *Ceriops tagal*, *Rhizophora apiculata*, and *Xylocarpus moluccensis* with larger tree diameters. The tree density in this zone is 300 ind/ha and has a diameter ranging from 30 to 60 cm, although some reach 100 cm. Many old trees suffer a natural process of destruction and death.
2. Marsegu Island mangrove forest is formed with a high salinity of 30 ‰; there is no fresh water (river) flowing. Marsegu Island's mangroves do not contain *Nypa fruticans*, which usually grow at lower salinity at river basins.
3. The deposition of sludge, accumulation of litter and topsoil, and uplift from below creates a dry area. The community uses these dry areas to plant coconut trees, which are considered economical and commercial. The middle part of the mangrove area is adjacent to the distal zone; there is a coconut plantation covering an area of 1.53 ha.
4. The community carries out activities in the middle zone by cutting down the *Bruguiera gymnorhiza* species trees as construction materials. If cutting trees activities continue, the Marsegu Island mangrove forests will be damaged, and will lose their economic and ecological value.

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- The Head of KPH (Kesatuan Pengelolaan Hutan) West Seram Maluku Province gave a research permit.
- The Head of BKSDA (Balai Konservasi Sumber Daya Alam) Maluku Province gave the research permit.
- Drs. Mat Elly Turukay and La Ode Hasanudin, S.Hut as assistants in the field.

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