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*Research Article*

# Biodiversity of Mangrove Vegetation in Rivers, Estuaries and Coastal Areas in Saronggi Subdistrict, Sumenep

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## ABSTRACT

Mangrove vegetation is the vegetation that makes up coastal ecosystems which are the largest ecosystems in Indonesia that provide ecosystem functions and services to marine-terrestrial biota and surrounding communities. Mangrove vegetation is a transitional ecosystem that is directly influenced by land and sea so that transitional areas such as river mouths and coasts. Rivers, estuaries and sea coasts are important components in optimizing the growth and development of mangroves. It is necessary to calculate the biodiversity of mangrove vegetation in rivers, estuaries and coasts in Saronggi District. The aim is to know the types and levels of mangrove vegetation biodiversity as well as studying the effect of environmental parameters on mangrove vegetation biodiversity in rivers, estuaries and coasts Saronggi District, Sumenep Regency. The method used is the quadratic transect combined with Stratified Random Sampling. The results of the mangrove diversity index value by dividing the area were obtained: the diversity index value in the coastal area was 1.379187 in the low category, the estuary area was 3.048782 in the high category, and the river area was 2.863279 in the medium category. The species diversity index in Saronggi District yielded 3.206173 in the high category. This indicates that Saronggi District has a high diversity of mangrove species/vegetation. Several factors became the basis for the existence of a high diversity index due to the large number of species found in Saronggi District, namely a total of 38 mangrove species with details of 22 true mangrove species and 16 associated mangrove species, dominated by Sonneratia alba, Rhizophora mucronata, Sonneratia caseolaris, Rizhophora stylosa and Nypa fruticans, with the highest important value index is Sonneratia alba with a value of 53.38%, Rhizophora mucronata (24,924%) and Nypa fruticans (20,71%).

**Keywords:** Biodiversity; Mangroves; Rivers; Estuarie; Coastal

## 1. INTRODUCTION

Mangrove is a general term to describe a variety of tropical coastal communities dominated by several distinctive plant species with the ability to grow in saltwater (Martuti, 2019). Mangroves grow on flat beaches along the sides of the island that are protected from wind and coral reefs off the coast (Nontji, 2002; Martuti; 2019) with typical tropical and subtropical forest formations in habitats on low and calm beaches, muddy, slightly sandy, and getting tides (Arif, 2003, Martuti; 2019). Indonesia is very fortunate because it has mangrove plants with high diversity and the largest area in the world. Among the factors related to geographical position, geological history and typology of the archipelago, as well as the distinctive oceanographic characteristics of Indonesia (Herison, 2020). Mangrove vegetation is directly influenced by land and ocean so that transition areas such as river estuaries and coasts are closely related to mangrove growth habitats. Rivers, estuaries and coasts are important components in optimizing the growth and development of mangroves (Edi, 2020). The flow of water in rivers that flow from upstream to downstream and empties into the sea (Ali, 2022) so that the influence of sea tides causes the flow of carbon-rich substrates to support plant growth (Aksornkoae, 1996; Bengen, 2002).

Saronggi District is one of the sub-districts in Sumenep Regency which is geographically located at 7° 4' 57.7" S 113° 49' 43.1" E. Based on the geographical situation, there are several villages in Saronggi District which are areas that are traversed by large rivers that flow into the coast and coast, namely Muangan Village, Saroka, West Dadap Garden, East Dadap Garden, Tanjung and Pagarbatu. The river in Saronggi is a large river with an area of 312.6 km2 and a length of 210 km with a flow that empties into the sea and directly reaches the coast (BPS Sumenep, 2021). The existence of a supporting side of geographical conditions shows the potential for varied and abundant mangrove vegetation. However, it can be found in some mangrove areas along the river to the coast of Saronggi there is illegal logging and accumulation of garbage that causes damage to mangrove vegetation. This problem causes the mangrove ecosystem to be damaged so that there can be a decrease in the function and uniqueness of mangrove vegetation (Edi, 2020). Vegetation damage will have an impact on decreasing productivity and marine wealth in Saronggi District (Siregar, 2002).

Quantitatively, the area of mangroves in Indonesia every year always changes. It was recorded that in 1982, the area of mangrove forests in Indonesia, which was 5209543 ha and in 1993 it decreased to 2496185 ha (Nugroho, 2020). Then in 2017 the area of mangroves in Indonesia was recorded, which is 3489185 ha or about 23% of the area of mangroves in the world, which is 16530000. However, of the area of 3489185 ha, only 1,671,140.75 ha (±48%) are still in good condition while the remaining area, namely 1,817,999.93 or around ±52% is in poor condition (damaged) (Sari et. al., 2019; Syamsu et. al., 2018). Community activities in mangrove forest areas, such as mangrove logging and fishing and other biota (bivalves and gastropes), are feared to have a negative impact on changes in ecosystem function, composition and species diversity. Through the study of the diversity of a vegetation, quantitative information about the stability of mangrove vegetation biodiversity can be obtained to determine the diversity of mangrove species in Saronggi District.

## 2. RESEARCH METHOD

To study the biodiversity of mangroves in the area, the Transek-squared method was used in the data collection combined with Stratisfied Random Sampling (Dharmawan, 2020). This method is considered more effective in assessing vegetation conditions, especially in obtaining diversity information on a vegetation that has varying barriers to the research field (Poedjirahajoe et. al., 2017), this is because the research was carried out on 3 varied contours of the area, namely rivers, estuaries and coasts. A total of 21 transects were placed in the area of the research location, with the distance between the transects adjusted to the coordinates of the research location. In each transect there are 2-3 observation plots with a distance between plots of 10 m. The number of plotting is adjusted to the area of the mangrove area from the coast/river to the land. The determination of transect points and distances between transects as well as observation plots, is adjusted to the existence of mangroves and characteristics in the area where the research is located. The size of the observation plot is made in tiers, namely for the seedling level, which is 1 x 1 m, while for the seedling level, which is 5 x 5 m and for the tree level, which is 10 x 10 m.

The difference between these two methods only lies in the use of square plots, namely square plots which are square transrec methods and the use of random square plots which is a square transect method combined with Stratisfied Random Sampling. The data on the number of species and the number of individuals of each mangrove species found in each observation plot of each transect, were calculated and analyzed using the formula: 1) Important values were used to observe the dominance of plant species in life form groups and age groups at each site. Important values are obtained from the results of the sum of relative density, relative density, and relative frequency, which if summed up is 300 percent. The formula used to calculate the important value index based on Soegianto (1994) is: Important Value Index (INP) for trees, poles and stakes = KR + FR + DR. 2) species diversity index (H') according to Shannon-Wiener (Krebs 1972; Magurran 1991) applies the following formula: $H' = - \Sigma$ pi ln pi. Description: H'= Shannon-Wiener Type Diversity Index, pi= proportion of density of type i = (ni/N), ni= density of type I, N= density of all types, K = density. The level of species diversity uses the following criteria (Fachrul:2007). A) The value of $H' > 3$ shows that the species diversity is high. B) The value of $1 \leq H' \leq 3$ indicates that the type diversity is medium The value of $H' < 1$ indicates that the type diversity is low or little.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

The results of the research carried out showed that in Saronggi District, 38 mangrove species were found with details of 22 true mangrove species and 16 association mangrove species. The true mangroves found are the following: Rizhopora mucronata, Rizhophora stylosa, Rizhophora apiculata, Avicenia officionalis, Avicenia alba, Avicenia marina, Sonneratia alba, Sonneratia caseolaris, Nypa fruticans, Achantus ebratheatus, Acanthus illicifolius, Bruguiera cylindrical, Bruguiera gymnorriza, Xylocarpus granatum, Xylocarpus mulocensis, Ceriops tagal, Osbornia sp., Excoerecia agallotcha, Lumnitzera racemosa, Aegiceras carniculatum and Aegiceras floridum. While the associated mangroves found are as follows: Ipomoea pes-caprae, Ipomea obscura, Derris trifoliate, Hibiscus tiliaceus, Scirpus littoralis, Wedelia biflora, Stachytarpheta jamaicensis, Calotropis gigantean, Cryptocorine ciliate, Dolichadrone spathacea, Sesuvium portulacastrum, Terminalia catappa, Thypa angustifolia, Inocarpus fagifer, Abelmoschus moschatus and Pluchea indica. Based on the results of the acquisition, the mangroves found are included in 21 different families, namely Acanthaceae, Aizoaceae, Araceae, Arecaseae, Asclepiadaceae, Asteraceae, Bignoniaceae, Combretaceae, Convolvulaceae, Cyperaceae, Euphorbiaceae, Fabaceae, Lytheraceae, Malvaceae, Meliaceae, Myrsinaciae, Myrtaceae, Pteridaceae, Rhizophoraceae, Typhaceae and Verbenaceae.

#### Mangrove Important Value Index

The structure of a community in an ecosystem can be known by studying several aspects related to mangrove communities, including the process of proper identification and understanding of the diversity of species in a community. The structure of mangrove communities consists of an important value index (INP) and a diversity index on species along with the specifics of their growing areas. The Important Value Index for mangrove species in Saronggi District can be seen in the following **Table 1**.

**Table 1**. Significant Value Index (INP)

| No. | Spesies | INP |
|---|---|---|
| True Mangroves | | |
| 1 | Rizhopora mucronata | 24,924 |
| 2 | Rizhophora stylosa | 17,377 |
| 3 | Rizhophora apiculata | 7,259 |

| | | |
|---|---|---|
| 4 | Avicenia Officionalis | 7,008 |
| 5 | Avicenia alba | 0,611 |
| 6 | Avicenia marina | 10,981 |
| 7 | Sonneratia alba | 53,389 |
| 8 | Sonneratia caseolaris | 19,029 |
| 9 | Nypa fruticans | 20,712 |
| 10 | Achantus ebratheatus | 1,312 |
| 11 | Acanthus illicifolius | 8,527 |
| 12 | Bruguiera cylindrical | 4,860 |
| 13 | Bruguiera gymnorriza | 9,445 |
| 14 | Xylocarpus granatum | 11,460 |
| 15 | Xylocarpus mulocensis | 0,749 |
| 16 | Ceriops tagal | 3,250 |
| 17 | Osbornia sp | 0,741 |
| 18 | Excoerecia agallotcha | 13,416 |
| 19 | Lumnitzera racemosa | 9,981 |
| 20 | Aegiceras carniculatum | 1,375 |
| 21 | Aegiceras floridum | 1,637 |
| 22 | Acrostichum aureum | 1,443 |
| Mangrove Association | | |
| 23 | Ipomoea pes-caprae | 5,328 |
| 24 | Ipomea obscura | 4,431 |
| 25 | Derris trifoliate | 10,994 |
| 26 | Hibiscus tiliaceus | 1,927 |
| 27 | Scirpus littoralis | 10,692 |
| 28 | Wedelia biflora | 4,554 |
| 29 | Stachytarpheta jamaicensis | 3,280 |
| 30 | Calotropis gigantean | 3,347 |
| 31 | Cryptocorine ciliate | 3,751 |
| 32 | Dolichadrone spathacea | 0,651 |
| 33 | Sesuvium portulacastrum | 9,164 |
| 34 | Terminalia catappa | 3,969 |
| 35 | Thypa angustifolia | 4,567 |
| 36 | Inocarpus fagifer | 2,379 |
| 37 | Abelmoschus moschatus | 0,574 |
| 38 | Pluchea indica | 0,973 |

### River, Estuary and Coastal Mangrove Vegetation Diversity Index

The measurement of the Diversity Index is also based on the location that has an influence on the tides of sea water, namely rivers, estuaries and coasts. The diversity index based on the location affected by the tides is as follows.

**Table 2. Values of River, Estuary and Coastal Diversity Index**

| Stasiun | H' | Criterion |
|---|---|---|
| River | 2,863279 | Keep |
| Estuary | 3,048782 | Tall |
| Shore | 1,379187 | Low |

### Mangrove Vegetation Diversity Index of Saronggi District

The mangrove diversity index at all stations shows the overall diversity at the research location, namely in Saronggi District. The results obtained can be seen in the following table:

Table 3. Saronggi District Diversity Index Value

| Station | H' | Criterion |
|---|---|---|
| All Saronggi District Stations | 3,206173 | Tall |

## 3.2 Discussion

### Mangrove Species

The results of the research carried out showed that in Saronggi District, 38 mangrove species were found with details of 22 true mangrove species and 16 association mangrove species. The results show that the constituents of mangrove areas in Saroggi District have a varied diversity of vegetation with a large abundance of mangrove trees.

### Mangrove Vegetation Important Value Index

The results of the analysis of the Important Value Index (INP) of mangrove forest vegetation in Saronggi District show that the forest area is dominated by Sonneratia alba, Rizhopora mucronata, Sonneratia caseolaris, Rizhophora stylosa and Nypa fruticans. The five types of mangrove plants almost dominate in all research stations. Based on (table 1) the mangrove plant species that have the highest important value index (INP) are Sonneratia alba with a value of 53.38%, Rizhopora mucronata

has an important value index (INP) of 24.924% and Nypa fruticans has an important value index of 20.71%. Meanwhile, the mangrove species that have the lowest important value index (INP) are Abelmoschus moschatus with an important value index of 0.574%, Avicenia alba with an important value index of 0.611% and Dolichadrone spathacea with an important value index of 0.651%. The important value index with the highest percentage of a species shows and describes the role of the existence of a species that is very influential in a mangrove community: Sonneratia alba, Rizhopora mucronata and Nypa fruticans.

Sonneratia alba has the highest INP of 53.38% because this plant is a pioneer type, intolerant to freshwater for a long period. Prefers soils mixed with mud and sand, sometimes on rocks and corals. It is often found in coastal locations that are protected from the blast of waves, as well as in estuaries and around offshore islands. On the coral coastal paths they are vegetatively dispersed. So that the compatibility of the place where this type grows with the optimal conditions can breed, causing this species to occupy the first position as a species that is very influential in river, estuary and coastal areas. Rizhopora mucronata has an INP of 24.924%. Compared to other types of rhizhopora, this species has a wider tolerance for adaptation, meaning that this species is more tolerant of several conditions, including in harder substrates and sand, this plant is able to grow better than other Rhizhopora species. It generally grows in groups, near or at the mouth of a tidal river and at the mouth of a river, rarely grows in areas far from the tide (Poedjirahajo, 2017). Optimal growth occurs in deeply flooded areas, as well as in humus-rich soils. It is one of the most important and most widespread types of mangrove plants in an area. Nypa fruticans has an important value index of 20.71%. The high INP in this species is due to one of the most defining characteristics is that this plant always requires a high annual freshwater input compared to most other types of mangroves, but it is rarely found outside the coastal zone. As we know, the characteristics of the research location are dominated by rivers and estuaries that have the characteristics of water flow originating from the upper reaches of the river so that the input of water with low salinity and freshness is very supportive to optimize the growth of this plant.

### River, Estuary and Coastal Mangrove Vegetation Diversity Index

The measurement of the Diversity Index is also based on the location that has an influence on the tides of sea water, namely rivers, estuaries and coasts. Based on the results of the research (table 2), the value of the mangrove diversity index obtained in the study varied. In the rivers located in Muangan Village and Saronggi Village have a diversity index of 2.863279 in the medium category, in the estuary which is carried out in the location of West Dadap Plantation Village and East Dadap Plantation Village, a diversity index of 3.048782 with a high category is obtained, in the coastal area with the implementation of research in Tanjung Village and Pagar Batu Village, a diversity index of 1.379187 is obtained with a low category.

The difference in the diversity index is due to several factors, namely the influence of sea tides, differences in salinity levels in each area/research location and the suitability of mangroves in each place. In some sources, it is mentioned that mangroves can grow in any place that is still affected by the tides, so we will find this plant and its community present in all of these places. In fact, this is not the case, where mangroves can only grow in certain places. In other places such as at the mouth of the river, mud deposits whose surface continues to rise are then overgrown with mangrove individuals who continue to develop to form a community (Poedjirahajo, 2017; Djamaludin, 2018). So for the river diversity index which is classified as moderate, it is because only a few mangrove communities can grow optimally and match the habitat, this is because rivers have several advantages in terms of abundant substrates, but have several disadvantages related to salinity compatibility which is the main factor in optimizing the growth of mangrove species. In estuarine areas that are classified as optimal zoning for mangrove growth, this is because there are several factors, namely salinity match, abundance of substrate content that supports fertility growth and tides that support the seedling process (Edi, 2020). The high level of variety and diversity of mangroves in the estuary is due to the process of collecting seeds/fruits/propagul that are collected simultaneously due to the presence of rivers connected to the estuary and the tidal flow of seawater that maximizes the growth of seeds/fruits that have a suitable texture in the estuary area which mostly has a muddy substrate.

Furthermore, the coastal area actually has a very low diversity index, namely 1.379187. Based on references, it is stated that the success of the growth of vegetation in coastal areas is inseparable from the environmental factors where the vegetation grows (Martuti, 2019; Edi, 2020). Based on the zoning, generally on the border of the sea area is dominated by pioneer mangrove species Avicennia spp. and Sonneratia spp. on the outskirts or banks of river estuaries, Rhizopora spp. which occupies. At the back of this zone is a mixed zone of mangrove species such as Rhizopora spp., Sonneratia spp., Bruguiera spp., and tree species associated with mangroves such as tingi (Ceriops sp,) and roasted (Excoecaria sp.). Along the river at the mouth of the river, nipah trees (Nypa fruticans) are usually found (Irwanto, 2006; Poedjirahajo, 2017). In the first location in the coastal area, namely in Tanjung Village, there is still a lot of diversity of mangrove plants, this indicates that this area is very suitable and good for mangrove growth, but at the research location in Pagar Batu Village, the number of mangroves and species diversity is very small so this is the main factor in the lack of diversity in the coastal area. Several problems were also found, including the logging of mangroves around the research site and the substrate contained in this location is coral rocks that cause suboptimal growth of mangroves. Thus, the influence of zoning adjusted to the area affected by the tides of sea water illustrates that the growth of species is dynamic caused by the influence of the rate of deposition or erosion of substrates that affect each other (Edi, 2020). The ability or adaptability of a mangrove species to the conditions where it grows is able to determine the composition of the species found in each location. The farther from the sea, one species will replace another, then this process can occur to estuaries or transitional areas, namely bordering swamp, freshwater, and inland forests that have high diversity (Rahim, 2017).

### River, Estuary and Coastal Mangrove Vegetation Diversity Index

The diversity of mangroves at all stations observed showed the total Diversity Index at the research location, namely in Saronggi District. Based on (table 3) the value of the mangrove diversity index in Saronggi District was obtained with a diversity index of 3.206173 with a high category. This indicates that Saronggi District has a high diversity of mangrove

species/vegetation. Some of the factors that are the basis for the high diversity index are due to the many species found in Saronggi District, namely a total of 38 mangrove species with details of 22 true mangrove species and 16 association mangrove species. This has been classified as a very high diversity in the scope of the research area with a total of 7 sampling stations with 49 sample points. And the number of plants was found to be 1790 plants. Several factors that support this diversity are due to the existence of river, estuary and coastal channels that are connected in one unit that still maintains the growth and development of mangroves. According to Djamaluddin (2018), the effectiveness and abundance of mangrove growth comes from the process of growth and production of mangrove seeds that takes place well and naturally. Floating seeds are able to survive for a few days to months for certain species. Furthermore, there is the fact that in some mangrove species, seeds that are carried by sea currents and moored in a certain location, turn out to still have the ability to refloat and stay alive until they arrive somewhere else where the conditions support the seeds to grow (Edi, 2020; Djamaluddin, 2018). Therefore, the availability of natural seeds can increase and maximize the development of mangrove communities. Especially in places where natural mangrove communities still exist and continue to produce healthy natural seeds can support mangrove diversity in an area/region (Rahim, 2017).

## 4. CONCLUSION

Based on the classification of species found in the implementation of the research, true mangrove plants consisted of 22 species and association mangroves consisted of 17 species. The results of the analysis of the Important Value Index (INP) of mangrove forest vegetation in Sarongi District showed that the forest area was dominated by *Sonneratia alba, Rizhophora mucronata, Sonneratia caseolaris, Rizhophora stylosa* and *Nypa fruticans*, with the highest important value index (INP) being *Sonneratia alba* with a value of 53.38%, *Rizhophora mucronata* having an important value index (INP) of 24.924% and *Nypa fruticans* has an important value index of 20.71%. Meanwhile, the mangrove species that have the lowest important value index (INP) are *Abelmoschus moschatus* with an important value index of 0.574%, *Avicenia alba* with an important value index of 0.611% and *Dolichadrone spathacea* with an important value index of 0,651%. The important value index with the highest percentage of a species shows and describes the role of the existence of a species that is very influential in a mangrove community: *Sonneratia alba*, *Rizhopora mucronata* and *Nypa fruticans.* The value of the mangrove diversity index with the division of areas was obtained as follows: the value of the diversity index in coastal areas was 1.379187 with the low category, the estuary area was 3.048782 with the high category, and the river area was 2.863279 with the medium category. The species diversity index in Saronggi District was obtained with a result of 3.206173 with a high category. This indicates that Saronggi District has a high diversity of mangrove species/vegetation. Some of the factors that are the basis for the high diversity index are due to the many species found in Saronggi District, namely a total of 38 mangrove species with details of 22 true mangrove species and 16 association mangrove species.

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