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Vegetation Structure and Species Dominance of Mangrove Ecosystems in Kase Coastal Waters South Buru Regency Maluku, Indonesia

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ABSTRACT

Mangrove ecosystems play a crucial role in coastal protection, biodiversity support, and ecological stability, yet they are increasingly threatened by anthropogenic pressures, particularly in understudied regions such as eastern Indonesia. This study aims to analyze the vegetation structure of mangroves in the coastal waters of Kase Village, South Buru Regency. A quantitative descriptive approach was employed using line transect and plot methods to collect data on species composition, density, frequency, and ecological indices. Data were analyzed using vegetation analysis techniques, including density, frequency, dominance, Shannon-Wiener diversity index, and Importance Value Index (IVI). The results identified three dominant species, namely *Bruguiera gymnorhiza*, *Rhizophora apiculata*, and *Sonneratia alba*, with a total of 699 individuals across seedling, sapling, and tree stages. *B. gymnorhiza* dominated the seedling and sapling stages, while *R. apiculata* dominated the tree stage, indicating differences in regeneration and competitive strategies. The diversity index ranged from low to moderate, and the dominance index remained low, suggesting a relatively stable but low-diversity community. The IVI analysis confirmed the ecological importance of *B. gymnorhiza* and *R. apiculata* in shaping the community structure. This study contributes to the limited empirical data on mangrove ecosystems in Maluku and highlights the importance of species-specific strategies in mangrove management and restoration efforts.

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1. INTRODUCTION

The mangrove ecosystem is one of the coastal ecosystems that plays an important role ecologically, economically, and socially. Globally, mangroves function as natural protectors of shorelines from abrasion, barriers against seawater intrusion, and habitats for various marine organisms. In addition, mangroves serve as spawning grounds, nursery areas, and feeding sites for a wide range of aquatic biota. In Indonesia, mangroves are widely distributed across tropical coastal regions and represent one of the ecosystems with high biodiversity (Friess et al., 2019; Macreadie et al., 2019). However, the existence of mangrove ecosystems is currently facing various pressures due to human activities, such as land conversion into aquaculture ponds, settlements, and excessive resource exploitation. These conditions have led to degradation and a decline in mangrove area in many regions. At the local scale, similar conditions also occur in Kase Village, Leksula District, South Buru Regency, where community activities such as logging and the utilization of coastal resources have the potential to affect the structure of mangrove vegetation. Therefore, studies on mangrove vegetation structure are important to understand ecosystem conditions and to support sustainable management efforts (Goldberg et al., 2020; Romañach et al., 2018).

This study focuses on analyzing the structure of mangrove vegetation in the coastal waters of Kase Village. The scope of the study includes species composition, dominance patterns at each growth stage, and the ecological condition of the community as assessed through parameters such as density, frequency, diversity, and importance value index. Research on mangrove ecosystems indicates that vegetation structure is strongly influenced by environmental factors such as salinity, substrate type, and tidal dynamics. Various studies in tropical regions have reported that the genera *Rhizophora* and *Bruguiera* often dominate mangrove communities due to their high adaptability to coastal environmental conditions (Adame et al., 2021; Alongi, 2020). Furthermore, vegetation structure analysis using parameters such as density, frequency, and diversity indices has been widely applied to understand mangrove community dynamics. The diversity index is used to assess ecosystem stability, while the importance value index is employed to identify the relative role of each species within the community. Previous studies have shown that communities with low diversity tend to be dominated by a few key species that possess specific adaptations to environmental conditions (Basyuni et al., 2018; Kusmana & Hikmat, 2021).

However, most existing studies remain concentrated in well-researched regions such as Java, Sumatra, and Kalimantan. Research in eastern Indonesia, particularly in Maluku, is still relatively limited. In addition, comprehensive studies that integrate species composition, vegetation structure, and ecological indices within a single analytical framework are still scarce (Rahman et al., 2019). The research gap lies in the limited empirical data on mangrove vegetation structure in underexplored areas such as Kase Village. Moreover, many mangrove studies in Indonesia still primarily focus on carbon stock without integrating detailed vegetation structure and regeneration patterns (Arifanti et al., 2019). The lack of studies that combine regeneration patterns, species dominance, and ecological conditions further emphasizes the need for more comprehensive research. This study aims to analyze the structure of mangrove vegetation in the coastal waters of Kase Village based on species composition, density, frequency, as well as diversity index and importance value index. In addition, this study finds to identify patterns of species dominance and regeneration at each growth stage, which are essential indicators of ecosystem sustainability (Hidayat et al., 2020; Sulistiyowati et al., 2021).

The novelty of this research lies in its analytical approach, which integrates multiple vegetation structure parameters and ecological indices into a single comprehensive framework. This study also provides contextual contributions regarding the condition of mangrove ecosystems in the Maluku region, which remains underrepresented in the scientific literature. This research is expected to contribute both theoretically and practically. From a theoretical perspective, the findings may enrich studies on the structure and dynamics of mangrove communities in tropical coastal regions. Insights related to species dominance and regeneration patterns can serve as references for the advancement of mangrove ecological studies. From a practical perspective, the results of this study can be used as a basis for the management and rehabilitation of mangrove

ecosystems in Kase Village and its surrounding areas. Information on species composition, vegetation structure, and environmental conditions can support the development of more effective conservation strategies. Furthermore, this study may also benefit local governments and communities.

2. MATERIALS AND METHOD

2.1 Research Design

This study employed a quantitative descriptive approach using a field survey method. This approach was selected to describe mangrove vegetation structure based on measurable ecological parameters, such as density, frequency, dominance, and diversity indices. Line transects and plot methods were applied to obtain representative data on the distribution and composition of mangrove vegetation at the study site. This approach enables a systematic analysis of mangrove community structure patterns based on growth stages (Azizah et al., 2021).

2.2 Location

The study was conducted in the mangrove area of the coastal waters of Kase Village, Leksula District, South Buru Regency, Indonesia. This location was selected due to its relatively understudied mangrove ecosystem and the presence of community activities that potentially influence mangrove vegetation conditions. The research object consisted of all mangrove vegetation present at the study site. Sampling was carried out using purposive sampling, considering the distribution of mangroves in the study area. The total observation area covered approximately ±0.07 km^2 of mangrove ecosystem. The unit of analysis in this study was individual mangroves classified into three categories: seedlings, saplings, and trees. The sample size was considered adequate as it included all individuals within the observation plots across each transect.

2.3 Data Collection Techniques

Data were collected through direct field observation using line transect and plot methods. A total of 20 transects were established with a distance of 50 meters between transects, and each transect contained 4 observation plots with a spacing of 10 meters between plots. Plot sizes were adjusted according to growth stages: 2×2 m for seedlings, 5×5 m for saplings, and 10×10 m for trees (Pratama et al., 2020). The data collected included species type, number of individuals at each growth stage, and measurements of environmental factors such as temperature, salinity, and pH. Species identification was conducted based on morphological characteristics using mangrove identification guides. To ensure data validity, systematic recording and field verification of species identification was carried out. Ethical considerations were observed by ensuring no environmental damage occurred during the observation process (Wicaksono et al., 2021).

2.4 Research Procedures

The study was conducted through several systematic stages. The initial stage involved determining the study location and establishing transect points based on mangrove vegetation distribution. This was followed by the placement of plots along each transect according to predetermined sizes (Sukardjo et al., 2019). The next stage involved data collection, including species identification, counting the number of individuals in each plot, and measuring environmental parameters. The collected data were then recorded and classified based on species and growth stages. After data collection, data processing and analysis were conducted to calculate vegetation structure parameters, including density, frequency, dominance, diversity index, and importance value index. All stages were carried out systematically to ensure that the data obtained were accurate and scientifically analysable (Putra et al., 2021).

2.5 Data Analysis Techniques

Data analysis was conducted quantitatively using a vegetation analysis approach. The calculated parameters included: (a) Species density and relative density to determine the number

of individuals per unit area; (b) Frequency and relative frequency to describe species distribution; (c) Dominance index (D) using the Simpson formula to determine the level of species dominance; (d) Diversity index (H') using the Shannon-Wiener index to assess community diversity levels; and (e) Importance Value Index (IVI) to determine the relative role of each species within the community.

3. RESULTS AND DISCUSSION

3.1 Location and Research Characteristics

Environmental conditions at the study site play a crucial role in supporting the growth and sustainability of mangrove vegetation. Table 1 presents the results of physical and chemical parameter measurements, including temperature, salinity, and pH, as indicators of habitat suitability.

Table 1. Characteristics of the study site in the coastal waters of Kase Village.

No	Environmental Parameter	Value	Unit	Description
1	Temperature	28.5	°C	Optimal condition for mangrove growth
2	Salinity	25–32	‰	Mangrove tolerance range
3	pH	6.8	-	Slightly acidic (normal for mangrove ecosystems)

The environmental conditions at the study site indicate characteristics that support the sustainability of the mangrove ecosystem. The measurement results presented in Table 1 show that the water temperature reaches 28.5 °C, salinity ranges from 25–32‰, and pH is 6.8. These values suggest that the aquatic environment in Kase Village falls within a suitable range for mangrove growth. Relatively stable temperatures and moderate salinity levels allow optimal physiological processes in plants. In addition, slightly acidic pH conditions are typical of mangrove ecosystems rich in organic matter. The measured environmental conditions indicate that the habitat at the study site is suitable for supporting mangrove vegetation growth. Temperature within the optimal range contributes to maintaining plant metabolic activities, including photosynthesis and respiration. Salinity levels ranging from 25–32‰ suggest that the environment remains tolerable for most mangrove species, although each species exhibits different tolerance levels.

A pH value of 6.8 indicates slightly acidic water conditions, generally influenced by the accumulation of organic matter such as mangrove leaf litter. This condition not only supports mangrove growth but also contributes to nutrient availability for other organisms within the ecosystem. Overall, relatively stable environmental parameters constitute an important factor in shaping the structure of the mangrove community at the study site. From a theoretical perspective, these findings confirm that environmental factors such as temperature, salinity, and pH are key components in determining mangrove distribution and growth. The suitability of environmental conditions influences the ability of species to adapt, grow, and compete within a community. Stable environments tend to support the formation of more balanced communities, although species diversity remains influenced by other factors such as habitat extent and external pressures.

As a practical perspective, this information is essential for supporting mangrove management and rehabilitation efforts. Environmental conditions that remain within optimal ranges indicate that this area has strong potential to be developed as a conservation or rehabilitation site. Furthermore, these data can serve as a reference for selecting suitable mangrove species for planting, thereby increasing the success rate of rehabilitation programs (Adame et al., 2021; Lee et al., 2019). The results of this study are consistent with previous research indicating that mangroves grow optimally within temperature ranges of approximately 28–32 °C and moderate salinity levels. The salinity values observed at the study site also fall within the general tolerance range of tropical mangroves, thereby supporting the presence of various species (Alongi, 2020; Krauss et al., 2021).

The slightly acidic pH conditions are also consistent with the characteristics of mangrove ecosystems in other coastal regions, which are generally influenced by high organic matter content. However, compared to several other locations that exhibit broader variations in environmental parameters, conditions in Kase Village tend to be more homogeneous. This may influence the level of species diversity present. The environmental conditions at the study site not only reflect habitat suitability for mangroves but also reinforce general findings regarding the characteristics of mangrove ecosystems in tropical regions (Macreadie et al., 2019). Table 2 presents the composition of mangrove species based on growth stages. These data are used to describe community structure and to examine patterns of dominance and regeneration for each species at the seedling, sapling, and tree stages.

Table 2. Composition of mangrove species by growth stage in Kase Village.

No	Species	Seedlings (ind.)	Saplings (ind.)	Trees (ind.)	Total (ind.)
1	*Bruguiera gymnorhiza*	277	74	65	416
2	*Rhizophora apiculata*	125	34	72	231
3	*Sonneratia alba*	17	8	27	52
	Total	419	116	164	699

The composition of mangrove species at the study site indicates that the community is dominated by three main species: *Bruguiera gymnorhiza*, *Rhizophora apiculata*, and *Sonneratia alba*. Based on Table 2, the total number of recorded individuals is 699, consisting of 419 seedlings, 116 saplings, and 164 trees. This distribution shows that the seedling stage has the highest proportion of individuals, indicating that natural regeneration is actively occurring in the area. At the seedling stage, *Bruguiera gymnorhiza* dominates significantly with 277 individuals, far exceeding *Rhizophora apiculata* (125 individuals) and *Sonneratia alba* (17 individuals). This dominance pattern continues at the sapling stage, where *Bruguiera gymnorhiza* remains the most abundant species with 74 individuals. However, at the tree stage, a shift in dominance occurs. *Rhizophora apiculata* becomes the most prevalent species with 72 individuals, followed by *Bruguiera gymnorhiza* with 65 individuals, while *Sonneratia alba* continues to exhibit relatively low abundance.

This shift in dominance across growth stages reflects dynamic changes in mangrove community structure. The dominance of *Bruguiera gymnorhiza* at the seedling and sapling stages indicates its strong regenerative capacity and its ability to optimally utilize environmental conditions during early growth phases (Kusmana & Hikmat, 2021; Sulistiyowati et al., 2021). This suggests that environmental factors such as substrate, salinity, and water conditions at the study site are particularly favorable for its germination and early development. In contrast, the dominance of *Rhizophora apiculata* at the tree stage indicates its advantage in long-term growth. Its persistence into the mature stage reflects strong adaptation to dynamic environmental conditions, including tolerance to inundation and spatial competition (Alongi, 2020; Krauss et al., 2021). Therefore, although *Bruguiera gymnorhiza* is dominant during early growth stages, *Rhizophora apiculata* demonstrates greater competitive ability in maintaining its presence at later stages.

The relatively low abundance of *Sonneratia alba* across all growth stages suggests limitations in its adaptability or competitive ability compared to more dominant species. This condition may be attributed to less optimal habitat suitability, such as specific substrate types or salinity levels that do not align with its ecological requirements. Additionally, competitive pressure from other species may further restrict its presence. From a theoretical perspective, these findings indicate that mangrove community structure is shaped by the interaction between regeneration processes and interspecific competition (Adame et al., 2021). Differences in dominance across growth stages confirm that mangrove ecosystems are dynamic and continuously undergoing structural changes. Species dominant in early stages are not necessarily able to maintain dominance at maturity due to natural selection influenced by environmental conditions and species interactions.

From a practical perspective, information on species composition has important implications for mangrove management and rehabilitation. *Bruguiera gymnorhiza* can be prioritized during early rehabilitation stages due to its high regenerative capacity and adaptability to local environmental conditions. Meanwhile, *Rhizophora apiculata* plays a crucial role in maintaining long-term ecosystem stability, particularly in strengthening vegetation structure at the mature stage. The low presence of *Sonneratia alba* should be considered in conservation efforts, as it may indicate environmental pressure or habitat limitations affecting this species. Appropriate conservation measures are necessary to maintain species diversity and overall ecosystem balance. These findings are consistent with previous studies indicating that *Bruguiera gymnorhiza* and *Rhizophora apiculata* commonly dominate mangrove ecosystems in tropical Indonesia (Arifanti et al., 2019; Basyuni et al., 2018). The dominance of *Bruguiera gymnorhiza* in early growth stages is often associated with its high regenerative capacity, whereas the dominance of *Rhizophora apiculata* at the tree stage is linked to its strong adaptation to tidal conditions and muddy substrates.

3.2 Vegetation Structure

Mangrove vegetation structure was analyzed using density and frequency parameters to describe patterns of species dominance and distribution at each growth stage. Species density values, which indicate the number of individuals per unit area, are presented in Table 3.

Table 3. Mangrove species density at each growth stage.

No	Species	Seedlings (ind./m^2)	Saplings (ind./m^2)	Trees (ind./m^2)
1	*Bruguiera gymnorhiza*	0.865	0.037	0.008
2	*Rhizophora apiculata*	0.390	0.017	0.009
3	*Sonneratia alba*	0.053	0.004	0.003
	Total	1.308	0.058	0.020

Based on Table 3, variations in density are observed across species and growth stages. Higher density values indicate a species' ability to utilize growing space more effectively. This pattern is further supported by species frequency analysis, which describes the level of species occurrence within the observation area. Frequency provides additional insight into species distribution patterns at the study site. The combination of density and frequency enables a more comprehensive interpretation of mangrove community structure, particularly in identifying dominant species and those with limited distribution.

The mangrove vegetation structure at the study site shows clear variation in density and frequency across species and growth stages. Based on Table 3, *Bruguiera gymnorhiza* exhibits the highest density at the seedling stage (0.865 ind./m^2) and sapling stage (0.037 ind./m^2), indicating its dominance during early growth phases. In contrast, at the tree stage, *Rhizophora apiculata* shows the highest density (0.009 ind./m^2), reflecting its success in reaching maturity. *Sonneratia alba* consistently exhibits the lowest density across all growth stages, with values of 0.053 ind./m^2 (seedlings), 0.004 ind./m^2 (saplings), and 0.003 ind./m^2 (trees). This suggests limitations in both regeneration and growth at the study site.

A similar pattern is observed in frequency values presented in Table 4. *Bruguiera gymnorhiza* shows the highest frequency at the seedling and sapling stages (0.350), indicating wide distribution during early growth phases. Meanwhile, *Rhizophora apiculata* records the highest frequency at the tree stage (0.475), suggesting dominance in mature phases. The lowest frequency values across all stages are again observed in *Sonneratia alba*, indicating restricted distribution. Differences in density and frequency among species reflect the dynamics of competition and adaptation within the mangrove community. The high density and frequency of *Bruguiera gymnorhiza* at early growth stages indicate strong regenerative capacity and high tolerance to environmental conditions during initial development. This enables the species to colonize available space more rapidly than others.

Table 4. Mangrove species frequency at each growth stage.

No	Species	Seedlings	Saplings	Trees
1	*Bruguiera gymnorhiza*	0.350	0.350	0.412
2	*Rhizophora apiculata*	0.312	0.237	0.475
3	*Sonneratia alba*	0.087	0.087	0.200
	Total	0.749	0.674	1.087

Conversely, the dominance of *Rhizophora apiculata* at the tree stage indicates a more effective long-term growth strategy, as its persistence into maturity reflects strong adaptation to environmental conditions, including tolerance to inundation and spatial competition (Alongi, 2020; Krauss et al., 2021). The low density and frequency of *Sonneratia alba* indicate limited adaptability or competitive disadvantage relative to other species. Environmental factors such as substrate type, salinity level, and inundation intensity may influence its growth and survival. Overall, the combination of density and frequency provides a comprehensive understanding of mangrove community structure, where dominant species are characterized not only by high abundance but also by broad distribution.

From a theoretical perspective, these findings reinforce the concept that mangrove vegetation structure is shaped by the interaction between environmental factors and species adaptation strategies. Differences in dominance across growth stages indicate that mangrove communities are dynamic and subject to temporal changes, reflecting natural selection processes (Adame et al., 2021). From a practical perspective, information on density and frequency is essential for mangrove ecosystem management planning. Species with high density and wide distribution, such as *Bruguiera gymnorhiza*, can be prioritized for early-stage rehabilitation due to their strong adaptive capacity, while *Rhizophora apiculata* can be utilized to strengthen long-term ecosystem structure. Furthermore, the relatively low presence of *Sonneratia alba* should be considered in conservation efforts, particularly if the species plays specific ecological roles, such as sediment stabilization or habitat provision.

These findings are consistent with previous studies indicating that *Rhizophora apiculata* often dominates at the tree stage due to its strong root system and high adaptability to tidal conditions, while *Bruguiera gymnorhiza* is known for its high regenerative capacity at early growth stages (Gunawan et al., 2025; Kusmana & Hikmat, 2021). The low density and frequency of *Sonneratia alba* are also consistent with other studies showing that this species tends to have a more limited distribution and depends on specific habitat conditions. The mangrove vegetation structure at the study site not only reflects local conditions but also follows general patterns observed in tropical mangrove ecosystems.

3.3 Ecological Indices and Importance Value Index (IVI)

Ecological index analysis was conducted to understand the level of species diversity and dominance within the mangrove community. The values of diversity and dominance indices at each growth stage are presented in Table 5.

Table 5. Mangrove Diversity Index (H') and Dominance Index (D).

No.	Criteria	Diversity Index (H')	Category	Dominance Index (D)	Category
1	Seedlings	0.764	Low	0.526	Low
2	Saplings	0.829	Low	0.498	Low
3	Trees	1.024	Moderate	0.377	Low

Based on Table 5, the diversity and dominance indices reflect the structural condition of the community at each growth stage. Variations in these values provide insights into ecosystem stability and the tendency of certain species to dominate the mangrove community. To further understand the relative role of each species, the analysis was extended to include the importance value index. The importance value index represents the ecological contribution of each species

within the mangrove community. By combining parameters of density, frequency, and dominance, this index helps identify key species as well as those with relatively minor influence at each growth stage.

The ecological index analysis reveals variation in diversity and dominance values across mangrove growth stages. Based on Table 5, the diversity index (H') at the seedling and sapling stages is categorized as low, with values of 0.764 and 0.829, respectively, whereas the tree stage shows a higher value of 1.024, classified as moderate. This indicates that species richness and distribution at early growth stages are still limited, while greater structural variation occurs at the tree stage. The dominance index (D) across all growth stages is categorized as low, with values of 0.526 (seedlings), 0.498 (saplings), and 0.377 (trees). This suggests that no single species overwhelmingly dominates the community, although differences in species contributions are evident.

Table 6. Mangrove Importance Value Index (IVI).

Criteria	Species	IVI (%)
Seedlings	*Bruguiera gymnorhiza*	112.85
	Rhizophora apiculata	71.46
	Sonneratia alba	15.66
Saplings	*Bruguiera gymnorhiza*	115.71
	Rhizophora apiculata	64.47
	Sonneratia alba	19.79
Trees	*Bruguiera gymnorhiza*	130.96
	Rhizophora apiculata	186.92
	Sonneratia alba	52.43

Further analysis using the importance value index in Table 6 shows that *Bruguiera gymnorhiza* has the highest IVI at the seedling (112.85) and sapling (115.71) stages. In contrast, at the tree stage, *Rhizophora apiculata* exhibits the highest IVI at 186.92. Meanwhile, *Sonneratia alba* consistently shows the lowest IVI across all growth stages. The low diversity index values at the seedling and sapling stages indicate that early-stage mangrove communities are dominated by a limited number of species with uneven distribution. This reflects a regeneration process that is still compositionally restricted, despite a relatively high number of individuals. The increase in diversity at the tree stage suggests the occurrence of natural selection processes that allow certain species to persist and develop, leading to a more varied community structure.

The consistently low dominance index across all growth stages indicates that no species completely controls the community. This condition reflects a relatively balanced interaction among species, despite quantitative differences in dominance. The high IVI values of *Bruguiera gymnorhiza* at the seedling and sapling stages reinforce its important role in regeneration processes. Meanwhile, the high IVI of *Rhizophora apiculata* at the tree stage indicates its dominant ecological contribution in mature phases. The low IVI of *Sonneratia alba* suggests a relatively minor ecological role within the mangrove community at the study site. From a theoretical perspective, these findings demonstrate that mangrove community structure is influenced by a combination of species diversity, dominance levels, and the relative roles of individual species. Low diversity coupled with low dominance indicates a simple yet relatively stable community structure, although with limited ecological complexity.

From a practical perspective, information on diversity indices and IVI is essential for mangrove ecosystem management. Species with high IVI values, such as *Bruguiera gymnorhiza* and *Rhizophora apiculata*, can be prioritized as key species in rehabilitation and conservation programs due to their significant roles in maintaining ecosystem structure and function (Kusmana & Hikmat, 2021; Sulistiyowati et al., 2021). Furthermore, the low diversity values indicate the need for efforts to enhance species variation, for example through the introduction or planting of additional suitable species. This approach aims to improve ecosystem stability and resilience to external disturbances (Adame et al., 2021).

These findings are consistent with previous studies indicating that mangrove ecosystems with limited species composition tend to exhibit low diversity values. Such conditions are commonly observed in mangrove areas with relatively small spatial extent or those experiencing environmental pressures (Alongi, 2020). The low dominance values are also consistent with other studies showing that mangrove communities are rarely dominated by a single species to an extreme degree, but rather exhibit relatively balanced distributions among major species. The dominance of *Bruguiera gymnorhiza* at early stages and *Rhizophora apiculata* at mature stages has also been widely reported, reflecting differences in species adaptation strategies (Basyuni et al., 2018). Meanwhile, the low contribution of *Sonneratia alba* aligns with findings that this species tends to have a more limited distribution and depends on specific habitat conditions.

4. CONCLUSION

This study demonstrates that the mangrove vegetation structure in the coastal waters of Kase Village is dominated by three main species: *Bruguiera gymnorhiza*, *Rhizophora apiculata*, and *Sonneratia alba*. The species distribution pattern reveals differences in dominance across growth stages, where *Bruguiera gymnorhiza* dominates at the seedling and sapling stages, while *Rhizophora apiculata* dominates at the tree stage. This indicates the presence of regeneration dynamics and interspecific competition within the mangrove community.

Vegetation structure analysis shows that the highest density and frequency at early growth stages are attributed to *Bruguiera gymnorhiza*, whereas the mature stage is dominated by *Rhizophora apiculata*. The diversity index values, ranging from low to moderate, along with consistently low dominance values, suggest that the mangrove community is relatively stable despite having limited species diversity. The importance value index further reinforces the dominant roles of these two species in shaping community structure.

From a scientific perspective, this study confirms that mangrove community structure is influenced by the interaction between environmental factors and species adaptation strategies. From a practical perspective, the findings provide a basis for mangrove management and rehabilitation by prioritizing dominant species. Further research is recommended to examine environmental factors in greater depth and to investigate long-term dynamics of mangrove ecosystem changes.

AUTHORS CONTRIBUTION

VS and DW designed and conducted the research, ES provided valuable inputs in tables, and all authors conceptualized and finalized the draft.

CONFLICT OF INTEREST

The authors declare no conflicts of interest and take full responsibility for the content of the article, including any implications of AI-generated art.

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