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Low Species Diversity of Beach Forests among Coastal Barangays of Malita, Davao Occidental

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ABSTRACT

Beach forests play a crucial role in coastal stability, protecting against erosion, storms, and surges. The study focuses on the beach forest community in the coastal areas of Malita, Davao Occidental, which has a relatively understudied ecosystem. The study's objective was to describe the community structure of the beach forest qualitatively and quantitatively. The assessment involved using transects and quadrats to collect data on species composition, percent cover, stand basal area, importance value, diversity indices, and stems per hectare. The survey results revealed a total of 44 species belonging to 27 families. *Cocos nucifera* and *Terminalia catappa* were found in all sites, indicating their high occurrence. Stand basal area analysis showed that coconut trees had the highest basal area, suggesting their dominance. *T. catappa* and *Melanolepis multiglandulosa* also had significant values of importance, highlighting their ecological significance. The study found a positive correlation between tree height and diameter at breast height (DBH). Significant differences in DBH were observed among the recorded tree species in the barangays. The diversity indices and species evenness varied across barangays, although the values remained relatively low and exhibited minimal variation among the surveyed areas. The number of stems per hectare differed among the barangays, with Barangay Mana having the highest count. The findings emphasize the ecological importance of beach forest species, particularly coconut trees, *T. catappa*, and *M. multiglandulosa*. This information can be valuable for conservation and management efforts and future environmental projects in the region.

Keywords: Beach forest, biodiversity, community structure, Davao Occidental, Malita

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INTRODUCTION

Beach forest is not well studied in Malita, Davao Occidental, or the whole province, as reflected in the province's draft integrated coastal management plan 2016-2024. Only mangroves were recorded in the document. This may be because most of the publications on coastal ecosystem studies in the region focused on mangroves, such as studies of Uyanguren (2017), Cuenca-Ocay et al. (2019), and Yap et al. (2018). Dr. Resurrecion Sadaba of the University of the Philippines-Vizayas stated that the beach forest is a separate ecosystem with a "bio-shield" function, preventing coastal erosion, providing medicines, and possessing great potential for industrial applications. They can thrive along the coast and extend 200 km from the beach. Mangroves are absent in several areas of Davao Occidental. Only beach forests appear to be common in all coastal municipalities.

Around the world, beaches and foreshores provide a wide variety of products and services to the economies and communities on the shore (Blackwell, 2007). However, limited studies have been done on Philippines Island beach forest species (Romeroso et al., 2021). Primavera and Sadaba (2012) define beach forest as a mixed association of littoral creepers, shrubs, and trees above high tide level. They are called supratidal species that form a 'beach jungle' as referred by early explorers. They may also be called mangrove associates. The extension of beach forest usually does not exceed 50 m and there is no discernible distinct zonation. This is contrary to what Dr. Sadaba had stated that some species of beach forest can thrive in areas 200 kilometers away from the shoreline. The formation can be much more extensive on seashore cliffs. The beach forest is mostly a one-storage ecosystem with trees up to 25 meters in height. Typically, beach forests succeed landwards the growth of creepers dominated by the plant *Ipomoea pes-caprae* and therefore also called the *Pes-caprae* formation of beaches. Formation of Dipterocarpus - Shorea replaces the former further inland. *Pandanus dubius* (Fam. Pandanaceae) and *Barringtonia racemosa* (Fam. Lecythidaceae) are some of the tree species typical for beach forests that also do regularly occur in back-mangroves. Beach forests usually have low tree species diversity. Most of the beach forest trees are widespread within the Indo-Pacific Region and are easily recognized by their typical structure (Tobergte and Curtis, 2013).

Malita has 10 coastal barangays covering 32 km in length and a total coastal area of 27,732. The municipality is the capital of the province of Davao Occidental. The coastal and marine waters of Davao Occidental cover part of the Sarangani Straits, Celebes Sea, and Davao Gulf. The Island cluster of Sarangani, the South Cluster of Jose Abad Santos, and a portion of Don Marcelino lie within the Sarangani Straits and the Celebes Sea. The North, MBA, and South Clusters, i.e., Malita and a part of Don Marcelino, are part of the Davao Gulf. The coastal water of Davao Occidental is usually exposed to harsh environmental conditions almost all year round. The only protected areas are the embayment in Colongan and Basiawan of Sta. Narrow peninsulas and coves protect Maria and Tubalan of Malita and the other regions. Due to their early loss, since shorelines and riverbanks were among the first sites opened for human settlement, beach forests were not as well studied as other flora and, therefore, not familiar to the average Filipino. It should then be recommended that the province have baseline data on this for future rehabilitation activities along coastal areas. The study generally aimed to describe beach forest community structure qualitatively and quantitatively in a given area. Specifically, the study aimed to identify and classify beach forest species and evaluate the community structure regarding stand basal area stems per hectare, relative density, relative frequency, relative dominance, importance value, Shannon diversity index, seedling, and sapling density.

MATERIALS AND METHODS

The study was conducted in September 2022 along the shores of the 10 coastal barangays of Malita, namely Barangays Fishing Village, Poblacion, Culaman, Mana, New Argao, Tingolo, Lais, Lacaron, Tubalan, and Buhangin (Figure 1). Three (3) transect lines were established per barangay and laid perpendicular to the shore. Three (3) quadrats or plots of 10m x 10m were employed at 10m intervals within transects, depending on the density of the vegetation. Species outside transects were also noted to consider those that thrive several meters away from the shoreline.

During the data collection, a scoping/ reconnaissance activity to select the sampling sites was conducted in advance. Species were identified even during the scoping activity and verified further in the actual assessment.

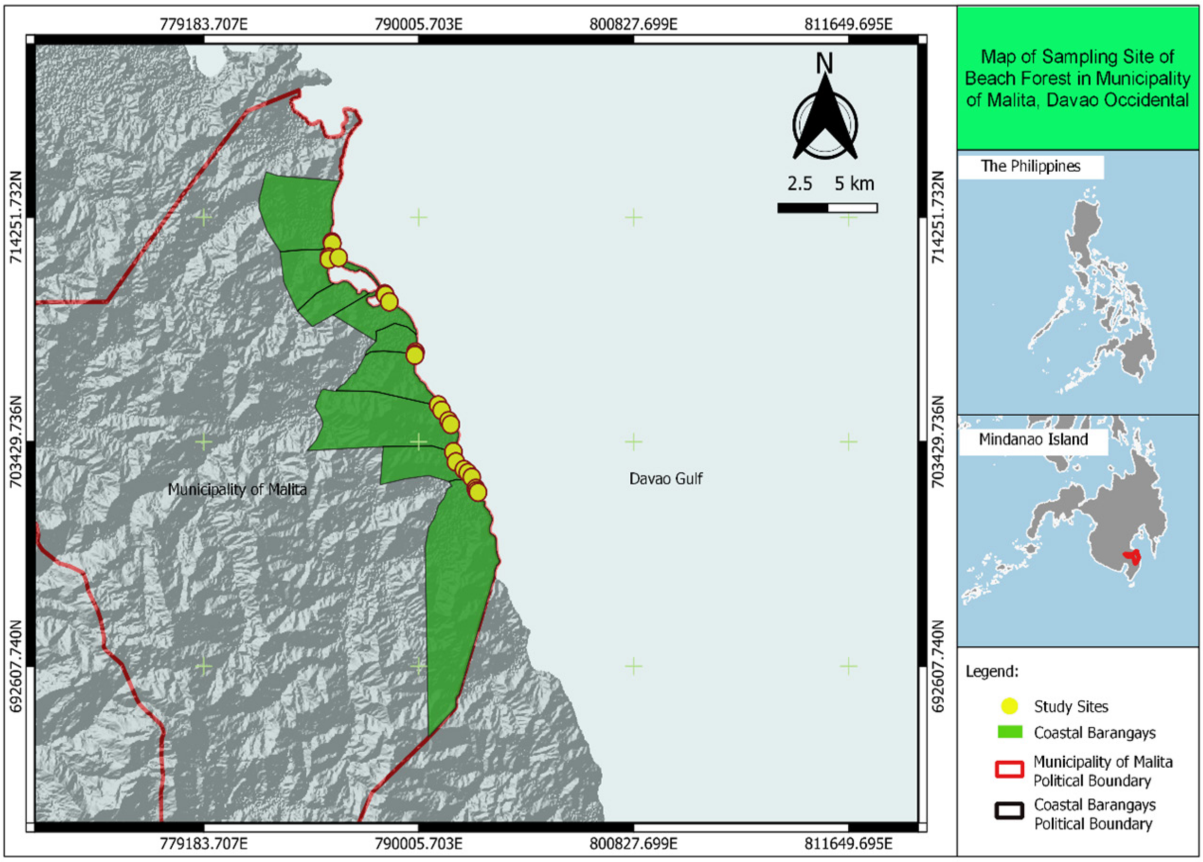


Figure 1. The map of the study sites in the 10 coastal barangays of Malita, Davao Occidental.

Sampling method

The transect length depended on the extent of the vegetation encountered. The distance between the transects was about 50m to 100m parallel, as Sadaba suggested in 2016. Transects were laid perpendicular to the shore. In the case of trees and shrubs, the quadrat or plot size was 10m x 10m, similar to the mangrove assessment adopted from English et al. (1997) methods.

Species composition and Percent cover

The species composition and percentage cover were measured within the quadrats placed at regular intervals along the length of each transect. The individual species were counted and identified. Trees inside were identified to species level, and diameter at breast height was measured using a tape measure.The beach forest community structure was calculated using the formulae adopted from English et al. (1997) and Odum and Barret (2005). Microsoft Excel program was used to facilitate computations using necessary formulae.

Identification of beach forest species

The book of Primavera and Sadaba (2012) used the primary references for species identification. Other reliable identification manuals were also utilized. Some samples were collected for herbarium specimens. Photographs were taken as part of the documentation.

Statistical analysis

To ascertain whether the data's distribution is normal, all data were put through Anderson-Darling Tests using R Studio version 4.2.1. Non-parametric tests would be employed if the data did not have a normal distribution or the variances were not equal. In these cases, Kruskal-Wallis will be utilized to determine whether there are any notable variations in DBH for the various species of mangroves among the barangays. One-way ANOVAs would be performed to determine whether there are any significant differences in DBH among the barangays for the species of mangroves, if the data have a normal distribution, or if the variances are equal. Correlation through Excel was also done for the height-DBH correlation of the tree species recorded.

RESULTS

The results of the survey were accomplished per barangay. A total of 44 species belonging to 27 families were documented in the whole municipality, in which Barangay Fishing Village has the highest number of species (23), followed by Barangays Lacaron (20), Mana, and New Argao (17). Barangay Buhangin had the lowest number recorded, with only 11 species.

Table 1. Occurrence of beach forest species per barangay.

Family	No. of species	Species	Lais	Tingolo	Tubalan	Buhangin	Lacaron	Culaman	Mana	New Argao	Poblacion	Fishing	No. of occurrence
Amaryllidaceae	1	*Crinum asiaticum*					1				1		2
Apocynaceae	2	*Rauvolfia viridis*							1				1
		Tabernaemontana pandacaqui	1	1	1	1	1			1	1		7
Arecaceae	2	*Cocos nucifera*	1	1	1	1	1	1	1	1	1	1	10
		Metroxylon sagu								1		1	2
Asteraceae	1	*Wedelia biflora*							1			1	2
Bignoniaceae	1	*Dolichandrone spathacea*			1	1		1		1		1	5
Boraginaceae	1	*Cordia subcordata*				1							1
Burseraceae	1	*Garuga floribunda (Bogo tree)*	1										1
Chrysobalanaceae	1	*Atuna racemosa*										1	1
Clusiaceae	1	*Cratoxylum sumatranum*										1	1
Combretaceae	1	*Terminalia catappa*	1	1	1	1	1	1	1	1	1	1	10
Convovulaceae	1	*Ipomoea pes-caprae*					1	1				1	3
Cycadaceae	1	*Cycas edentata*			1				1				2
Euphorbiaceae	4	*Breynia vitis-idaea*		1		1	1					1	4
		Jatropha gossypifolia							1	1	1	1	4
		Macaranga tanarius	1	1	1	1	1	1	1	1		1	9
		Melanolepis multiglandulosa	1	1	1	1		1	1	1	1	1	9
Fabaceae	6	*Guilandina bonduc L.*					1						1
		Derris trifoliata	1										1
		Milletia pinnata	1						1		1		3
		Prosopis juliflora	1				1	1			1	1	5
		Sophora tomentosa							1				1
		Vigna marina		1			1						2
Goodeniaceae	1	*Scaevola taccada*					1						1
Guttiferae	1	*Calophyllum inophyllum*		1	1					1			3
Lecythidaceae	1	*Barringtonia asiatica*					1		1		1	1	4
Malvaceae		*Kleinhovia hospita*			1								1

Malvaceae	2	*Talipariti tilaceum*										1	1
Melastomataceae		*Melastoma*							1	1	1	1	4
	1	*malabathricum*	1										
Meliaceae		*Toona ciliata*											1
Moraceae	1	*Broussonetia luzonica*		1		1		1		1		1	5
	4	*(Bolbolan)*											
		Ficus microcarpa		1		1	1						3
		Ficus septica		1	1		1			1		1	5
		Ficus sp			1								1
Pandanaceae		*Pandanus sp*									1		1
	2	*Pandanus tectorius*					1			1		1	3
Pteridaceae		*Acrostichum sp*		1			1		1				3
Rubiaceae	1	*Morinda citrifolia*	1		1	1	1	1	1	1	1	1	9
Rutaceae	1	*Murraya*			1								1
Sterculiaceae	1	*Sterculia foetida*		1			1	1	1			1	5
Verbenaceae	1	*Premna odorata*	1	1	1		1	1	1	1	1	1	9
	3	*Vitex negundo*								1		1	2
		Vitex parviflora	1	1	1		1	1	1	1	1		8
Total Number of Species			13	15	15	11	20	12	17	17	14	23	157
Total Number of Families			9	10	12	8	15	10	13	11	11	17	

Family Fabaceae is the most represented family with six species (Table 1). Fabaceae was the most represented family in several beach forest communities in the Philippines, such as in San Agustin, Romblon (Gonzales et al., 2022), Kiamba Sarangani Province (Cañeda et al., 2022), Dinagat Island (Lillo et al., 2019), Surigao (Garcia et al., 2017), and in Claver, Surigao del Norte (Ocon et al., 2018).

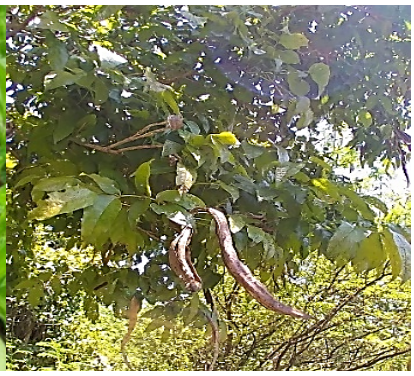
Family Name (FN): Amaryllidaceae
Scientific Name (SN): *Crinum asiaticum*
Local Name (LN): Bakong

FN: Apocynaceae
SN: *Tabernaemontana pandacaqui*
LN: NA

FN: Arecaceae
SN: *Cocos nucifera*
LN: Lubi

FN: Arecaceae
SN: *Metroxylon sagu*
LN: Sago

FN: Asteraceae
SN: *Wedelia biflora*
LN: NA



FN: Bignoniaceae
SN: *Dolichandrone spathacea*
LN: Tiwi

FN: Boraginaceae
SN: *Cordia subcordata*
LN: NA

FN: Combretaceae
SN: *Terminalia catappa*
LN: Talisay

FN: Convovulaceae
SN: *Ipomoea pes-caprae*
LN: Lambayong

FN: Cycadaceae
SN: *Cycas edentata*
LN: NA

FN: Euphorbiaceae
SN: *Breynia vitis-idaea*
LN: Matang-ulang

FN: Euphorbiaceae
SN: *Macaranga tanarius*
LN: Binunga

FN: Euphorbiaceae
SN: *Melanolepis multiglandulosa*
LN: Alim

FN: Fabaceae
SN: *Milletia pinnata*
LN: Bani

FN: Fabaceae
SN: *Caesalpina bonduc*
LN: Balogbog

FN: Fabaceae
SN: *Derris trifoliata*
LN: NA

FN: Fabaceae
SN: *Sophora tomentosa*
LN: NA

FN: Fabaceae
SN: *Prosopis juliflora*
LN: Aroma


FN: Fabaceae
SN: *Vigna marina*
LN: NA


FN: Goodeniaceae
SN: *Scaevola taccada*
LN: NA

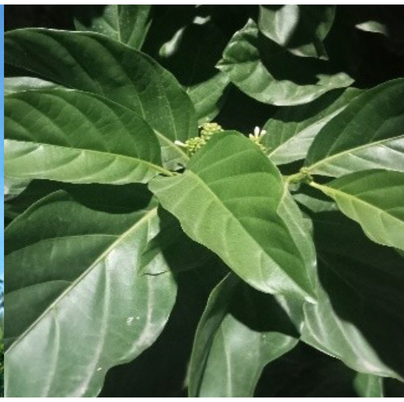

FN: Guttiferae
SN: *Calophyllum inophyllum*
LN: NA


FN: Lecythidaceae
SN: *Barringtonia asiatica*
LN: Bitoon


FN: Melastomataceae
SN: *Melastoma malabathricum*
LN: NA


FN: Moraceae
SN: *Ficus microcarpa*
LN: Balite


FN: Pteridaceae
SN: *Acrostichum* sp.
LN: Lagolo


FN: Rubiaceae
SN: *Morinda citrifolia*
LN: Bangkoro


FN: Sterculiaceae
SN: *Sterculia foetida*
LN: Kalumpang


FN: Verbenaceae
SN: *Premna odorata*
LN: Alagaw-dagat

Figure 2. Some important species of the beach forest plants of Malita, Davao Occidental.

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Frequency of occurrence of species across sites

Two species were found in all sites (100% occurrence): *Cocos nucifera* and *Terminalia catappa.* Another six species, namely *T. pandacaqui, M. tanarius, M. multiglandulosa, M. citrifolia, P. odorata,* and *V. parviflora,* were found to be very frequent across sites with >50% occurrence, as shown in Table 2.

Frequency of occurrence across species

Table 2 also showed the frequency of species occurrence across all species documented in the 10 barangays. This revealed that 13 out of the total 44 species were found to be very frequent, with >3% occurrence. Expectedly, the two with the highest 6.4% occurrence are *C. nucifera and T. catappa.*

Table 2. Frequency of occurrence across sites and species.

Family	No. of species	Species	No. of occurrence	Overall Freq. of occurrence (%) across sites	Overall Freq. of occurrence (%) across species
Amaryllidaceae	1	*Crinum asiaticum*	2	20.0	1.3
Apocynaceae	2	*Rauvolfia viridis*	1	10.0	0.6
		Tabernaemontana pandacaqui	7	70.0	4.5
Arecaceae	2	*Cocos nucifera*	10	100.0	6.4
		Metroxylon sagu	2	20.0	1.3
Asteraceae	1	*Wedelia biflora*	2	20.0	1.3
Bignoniaceae	1	*Dolichandrone spathacea*	5	50.0	3.2
Boraginaceae	1	*Cordia subcordata*	1	10.0	0.6
Burseraceae	1	*Garuga floribunda* (Bogo tree)	1	10.0	0.6
Chrysobalanaceae	1	*Atuna racemosa*	1	10.0	0.6
Clusiaceae	1	*Cratoxylum sumatranum*	1	10.0	0.6
Combretaceae	1	*Terminalia catappa*	10	100.0	6.4
Convovulaceae	1	*Ipomoea pes-caprae*	3	30.0	1.9
Cycadaceae	1	*Cycas edentata*	2	20.0	1.3
Euphorbiaceae	4	*Breynia vitis-idaea*	4	40.0	2.5
		Jatropha gossypifolia	4	40.0	2.5
		Macaranga tanarius	9	90.0	5.7
		Melanolepis multiglandulosa	9	90.0	5.7
Fabaceae	6	*Caesalpina bonduc*	1	10.0	0.6
		Derris trifoliata	1	10.0	0.6
		Milletia pinnata	3	30.0	1.9
		Prosopis juliflora	5	50.0	3.2
		Sophora tomentosa	1	10.0	0.6
		Vigna marina	2	20.0	1.3
Goodeniaceae	1	*Scaevola taccada*	1	10.0	0.6
Guttiferae	1	*Calophyllum inophyllum*	3	30.0	1.9
Lecythidaceae	1	*Barringtonia asiatica*	4	40.0	2.5
Malvaceae	2	*Kleinhovia hospita*	1	10.0	0.6
Malvaceae		*Talipariti tilaceum*	1	10.0	0.6
Melastomataceae	1	*Melastoma malabathricum*	4	40.0	2.5
Meliaceae	1	*Toona ciliata*	1	10.0	0.6
Moraceae	4	*Broussonetia luzonica* (Bolbolan)	5	50.0	3.2
		Ficus microcarpa	3	30.0	1.9
		Ficus septica	5	50.0	3.2
		Ficus sp.	1	10.0	0.6

Pandanaceae		*Pandanus* sp.	1	10.0	0.6
	2	*Pandanus tectorius*	3	30.0	1.9
Pteridaceae		*Acrostichum* sp.	3	30.0	1.9
Rubiaceae	1	*Morinda citrifolia*	9	90.0	5.7
Rutaceae	1	*Murraya*	1	10.0	0.6
Sterculiaceae	1	*Sterculia foetida*	5	50.0	3.2
Verbenaceae	1	*Premna odorata*	9	90.0	5.7
	3	*Vitex negundo*	2	20.0	1.3
		Vitex parviflora	8	80.0	5.1
Total number of species			157		100.0

Stand basal area and importance value

Regarding the stand basal area, Figure 3 shows *C. nucifera* as the most commonly seen in the coastal regions and the highest, with an average of 24.30 m^2 ha^{-1}. Coconuts also have the highest importance value, with *T. catappa* as the second highest, followed by *M. multiglandulosa*, as shown in Figure 4. These three species are quite common on the whole coast of Malita.

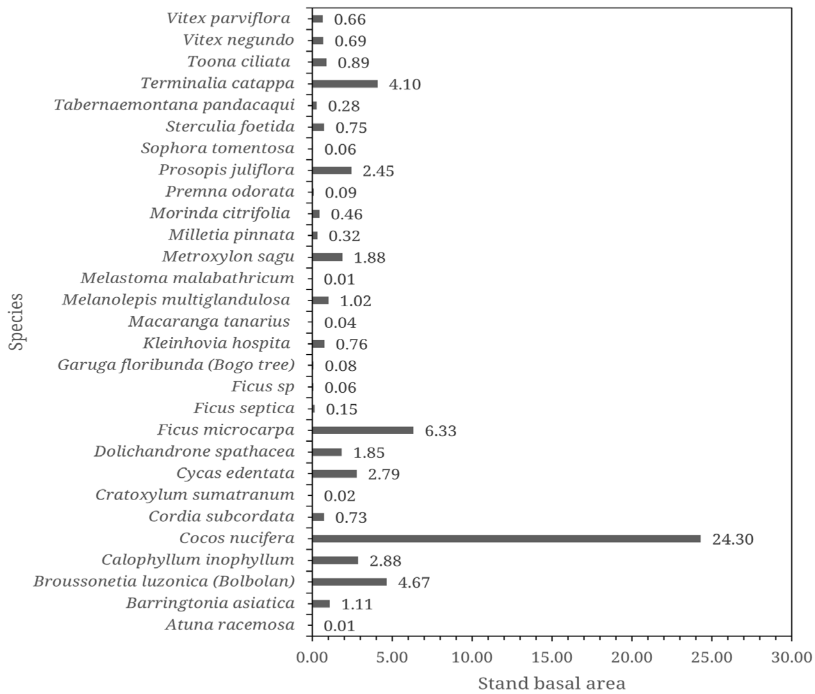

Figure 3. *Cocos nucifera* have the highest basal stand basal area, followed distantly by *Ficus microcarpa* and *Broussonetia luzonica.*

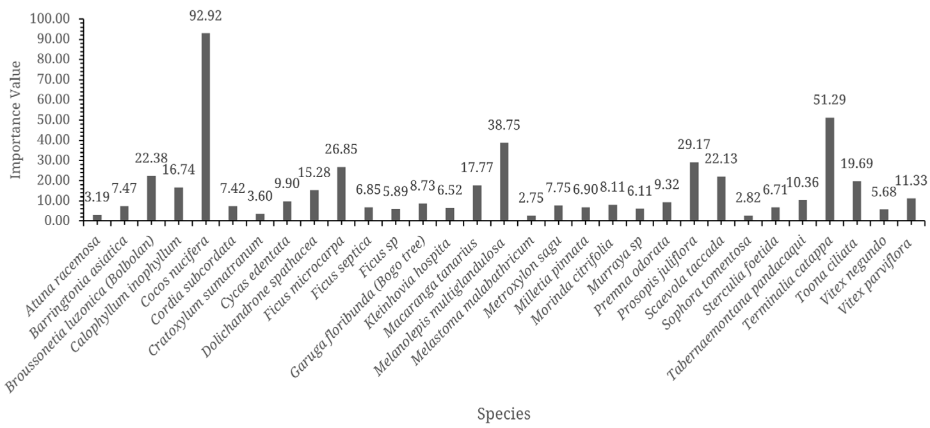

Figure 4. *Cocos nucifera* have the highest importance value among all species documented.

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It is also proven in this study that the taller most trees grow, the wider their trunks (DBH) become. There is a positive correlation between the tree heights and DBH in this survey, as shown in the graph (Figure 5).

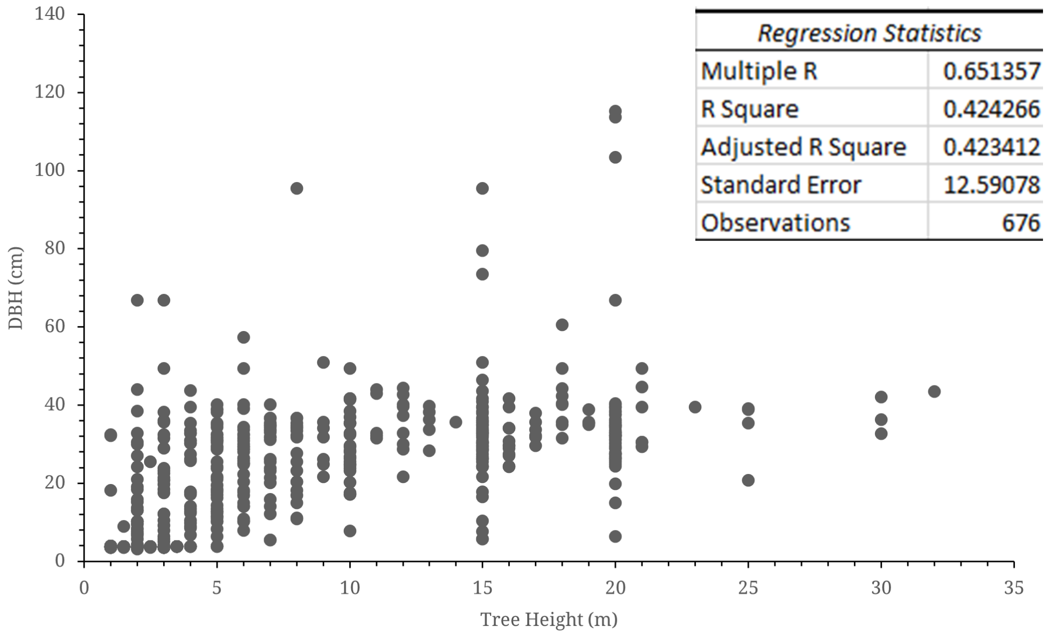

Figure 5. With an *r* coefficient of 0.65, the diameter at breast height (DBH) and tree height relationship is positively correlated. While the general trend (as shown by the dense cluster of points in the graph) indicates that taller trees tend to have larger diameters, variability, and outliers suggest that other factors may also significantly influence DBH, such as species, age, and growing conditions.

There is also a significant difference in the diameters at the breast height of all trees recorded in the ten (10) barangays. Kruskal-Wallis rank sum test and one-way ANOVA were used to obtain this. Also, the significant differences per mean of the species species DBH among the barangays where they were found were tested (Table 3). The results of the test were as follows:

Table 3. Significant difference (bold) test results of the mean of each beach forest tree species' diameter at breast height (DBH) among the assessed barangays.

Species	*p*-value
Barringtonia asiatica	0.765
Broussonetia luzonica	0.154
Callophylum inophyllum	**5.04×10^{-7}**
Cocos nucifera	**0.0003**
Dolichandrone spathaceae	0.418
Ficus sp.	**0.010**
Ficus septica	0.061
Macaranga tanarius	0.082
Melanolepis multiglandulosa	**9.53×10^{-8}**
Milletia pinnata	**0.0001**
Morinda citrifolia	**0.003**
Premna odorata	0.085
Prosopis sp.	**0.009**
Steculia foetida	0.147
Terminalia cattapa	0.197
Tabernaemontana pandacaqui	0.431
Vitex parviflora	**0.005**

Diversity Index and Species Evenness

Regarding species diversity, Barangay Tubalan had the highest diversity index of 0.95, but this was almost equal to the other two barangays, New Argao and Culaman, which had 0.92 and 0.91 indices. The least diverse was in Barangay Poblacion (0.71), as shown in Figure 6. This further showed that beach forest diversity in Malita was low since the typical values of the Shannon index were generally between 1.5 and 3.5 (Magurran, 2004).

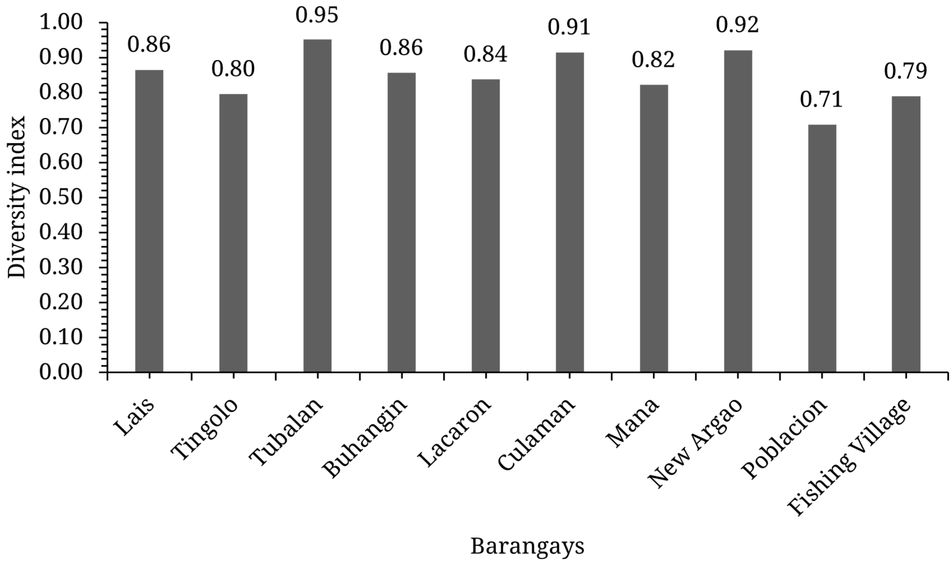

Figure 6. Barangay Tubalan had the highest species diversity index among the 10 barangays assessed, and Poblacion showed the least diversity. (It should be noted here that these values of diversity were low).

This agreed with the species evenness computed in all the 10 barangays assessed. The aforementioned three barangays had the highest species evenness indices, but Culaman had the highest among the three (0.88). Barangay Fishing Village showed the least species evenness of 0.69, as shown in Figure 7.

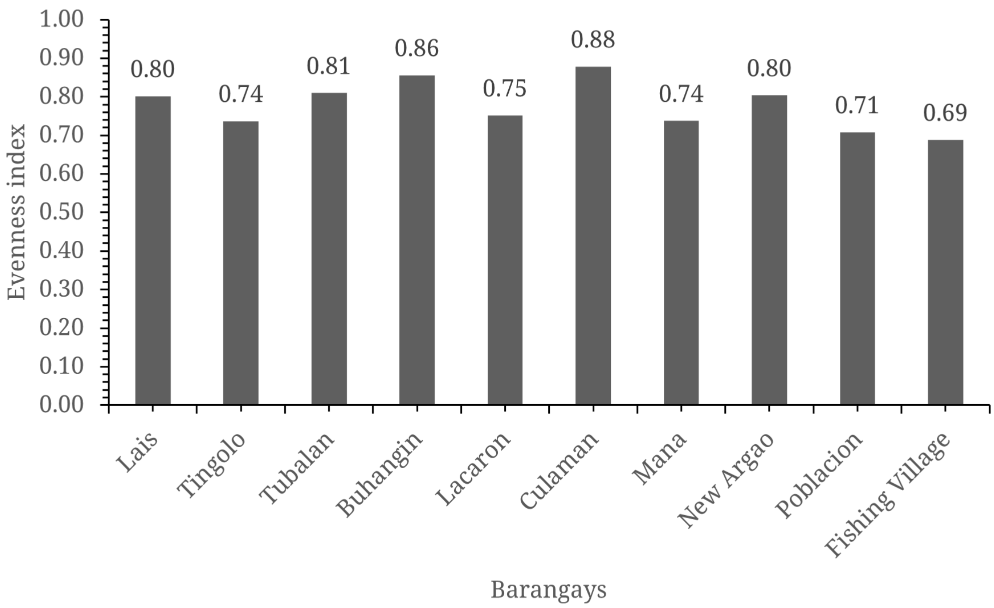

Figure 7. The species' evenness was similar to the results of the diversity index, with Barangay Culaman having the highest evenness, and Barangay Fishing Village showing the lowest evenness index.

Stems per hectare

Figure 8 shows that the coastal areas of Malita were observed to have few beach forest trees, especially in the heavily inhabited areas, where coconuts and a few stands of *T. catappa* were a common sight. Fishing Village had the most significant trees of the ten barangays, while Culaman had the least. Tubalan had the highest number of saplings. Barangay Mana is notable for its high number of seedlings compared to the other barangays. This resulted in Mana showing the highest number of stems per hectare, with 4,889, and Barangay Tingolo had the lowest, with only 1,356 stems per hectare.

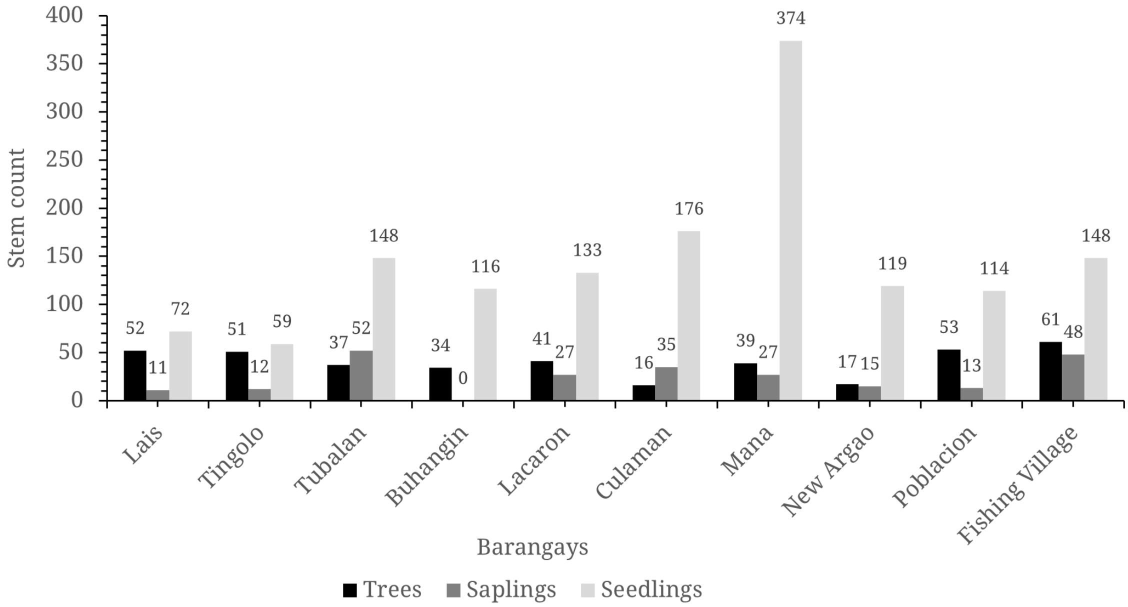

Figure 8. Malita coastal areas have only few trees as compared to the number of seedlings recorded.

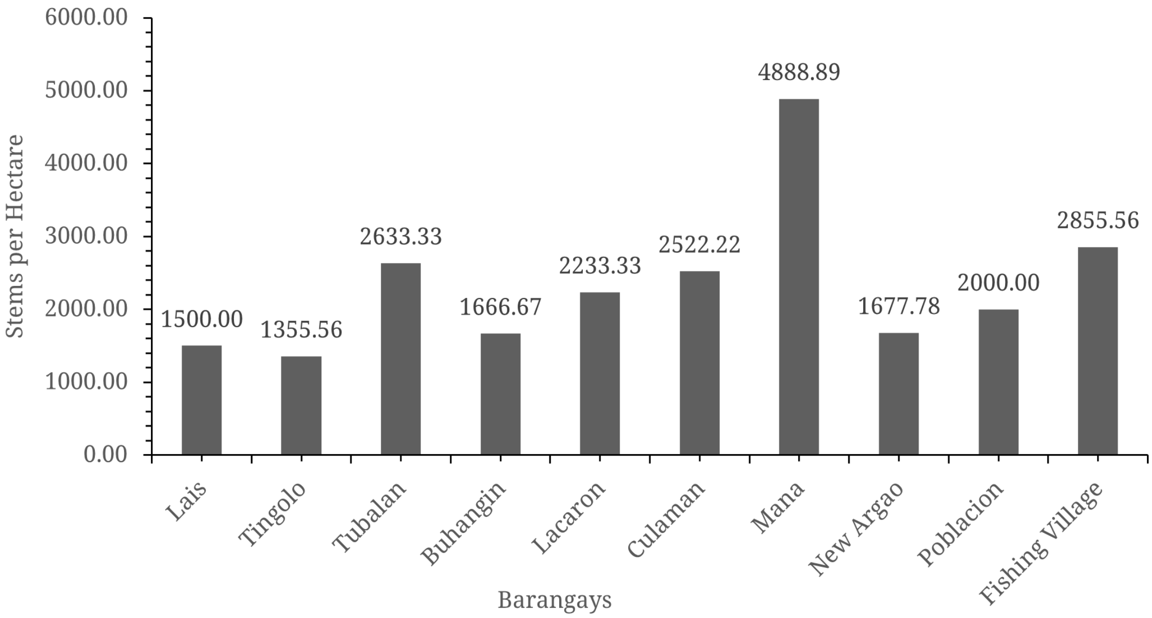

Figure 9. With notably high number of seedlings observed, Barangay Mana had the highest number of stems per hectare.

DISCUSSION

Ecological dominance

The data confirms the ecological dominance and importance of *C. nucifera* and *T. catappa*, typical coastal species with high frequency and basal area. Coconuts are regarded as indicators of areas subjected to anthropogenic activities that have altered the species composition since palms are not natural vegetation in these ecosystems (Goltenboth et al., 2006). This is notablebecause Malita, as mentioned in their draft integrated coastal management plan, has a soil type classified as "alluvium washed mainly from the uplands underlying with igneous rocks," which is utilized mainly for coconut, lowland rice and adaptable to most crops (Davao del Sur Integrated Coastal Management Plan 2016-2024).

It should be noted here also that there are species that are found only in one or two barangays such as *Crinum asiaticum, Metroxylon sagu, Wedelia biflora, Cordia subcordata, Atuna racemosa, Cratoxylum sumatranum, Cycas edentata, Caesalpina bonduc, Derris trifoliata, Sophora tomentosa, Vigna marina, Scaevola taccada, Kleinhovia hospita, Talipariti tilaceum*, and *Vitex negundo.*

C. asiaticum is known to thrive on sandy shores (Pelser et al., 2011), which aligns with the fact that Barangays Lacaron and Poblacion mostly have sandy substrate on their shores. Similarly, *S. taccada* exhibits this characteristic as this was only found in Lacaron. *M. sagu* is recorded to be naturalized in riparian habitats, which describes the type found in Barangay Fishing Village, where freshwater and saltwater are mixed along the shore. This could explain the presence of *T. tiliaceum in this area. C. subcordata* was only recorded in Barangay Tubalan, in its mangrove area, along its landward edges. This species is observed to be common in this kind of habitat (Primavera & Sadaba, 2012). The native *C. edentata* is listed as Endangered by the IUCN (IUCN 2023) and locally listed as vulnerable by DENR Administrative Order (DAO) 2017. This was still present in Malita and recorded only in Barangays Tubalan and Mana, where rocks and pebbles are the usual substrate within residential houses. The dry lands of Barangay Lacaron offer a home for *C. bonduc*, which is known to thrive in dry areas close to the beach. The vast shores of Barangay Lais are bounded by a river on the side of Poblacion, and this contributes to the muddy type of substrate in some parts of the Barangay where *D. trifoliata*, a species known to thrive in muddy shores and along tidal streams (Primavera and Sadaba, 2012), was recorded during the survey. The high importance of *T. catappa* and *M. multiglandulosa* also suggests that these species are significant components of the local ecosystem and should be considered when making management decisions (Figure 3).

T. catappa Linn., locally known as talisay, is indigenous to Southeast Asia and a big, tropical or subtropical climate-adapted tree (Anand et al., 2015). This species is quite common in several coastal areas in the country as reflected in the abovementioned studies of floristic diversity in coastal areas. *T. catappa,* commonly called tropical almond, is well adapted to subtropical and tropical climates where rainfall is usually in the range of 1000-3500 mm per annum, distributed relatively uniformly throughout the year or with a summer maximum (Thomson and Evans 2006), and this quite fit the description of the province of Davao Occidental in terms of climate. The province has a favorable climate characterized by more or less evenly distributed rainfall throughout the year and a Type IV climate. The province's annual rainfall, based on the rainfall data from the Sugar Regulatory Administration in Guihing, Hagonoy, ranges from 1046 millimeters to 1082 millimeters (Davao del Sur Integrated Coastal Management Plan 2016-2024).

Whereas, *M. multiglandulosa* (Reinw. ex Blume) of the family Euphorbiaceae, locally known in the Philippines as alim, is found in many parts of East Asia (Apostol et al., 2016). This species thrives in often poorly drained and/or temporarily inundated soil, alluvial sand, clay, volcanic soil, coralline sand, and andesite bedrock (Welzen et al., 1999). The types of soil that Malita is described to have, alluvium washed mainly from the uplands underlying with igneous rocks.

Biodiversity

The diversity and evenness indices reveal that while some barangays like Tubalan and

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Culaman support more diverse and balanced plant communities, others like Fishing Village may be dominated by a few species, affecting resilience and stability. This echoes the findings by Morris et al. (2014) and Mori et al. (2013) on the ecological importance of evenness. However, the indices are not significantly different, indicating fairly similar diversity values among the barangays in Malita. This could be attributed to the fact that all coastal barangays are consistently encroached with coastal settlements and development, typical of coastal municipalities in the country, which uniformly affect the coastal ecosystem diversity. No surveyed area is uninhabited and untouched by development. The significant result that suggests some reason for possible negative impacts of coastal development is the lowest diversity and evenness indices of Barangays Poblacion and Fishing Village. These barangays of the municipality are heavily inhabited (PhilAtlas, 2025), and their coastal areas are artificially protected with complex stabilization structures, such as seawalls, compared with the rest of the coastal barangays. Seawalls are common in these parts and are a way for the local government unit to protect the households and establishments nearshore from storms and surges. A study in Albania in the Central Mediterranean Sea showed that 15 years of coastal development could result in a loss of structurally and functionally crucial habitats that provide essential goods and services for local human communities and recreation (Fraschetti et al., 2011).

The high diversity indices of Barangay Tubalan, New Argao, and Culaman indicate that these areas have a higher number of different species. At the same time, the low evenness of Barangay Fishing Village suggests a high degree of variation in the abundance of other species in this area.

The high evenness indices of Barangay Tubalan, New Argao, and Culaman suggest that the individuals of different species are evenly distributed in these areas, which indicates a more stable and balanced ecosystem. The higher evenness index of Culaman compared to the other two barangays suggests a more equal distribution of individuals among species in this area (Morris et al., 2014).

Understanding the patterns of species diversity and evenness in different barangays can provide important information for conservation and management efforts, as areas with high diversity and evenness are generally considered more resilient to environmental disturbances and have greater ecological stability (Mori et al., 2013).

Sampling and tree regeneration

The significant height-DBH relationship aligns with findings from Dey et al. (2021), suggesting consistent growth patterns in coastal forest species. Variation in DBH across barangays reflects both natural ecological gradients and methodological biases or environmental heterogeneity: Variability in the tree data most likely results from the survey's instructions, the surveyor's preferences and bias, and ecological and environmental various spatial scales of variability. These sources may impact the choice of sample trees, species identification, size, and sample distance, which may affect the environment. Variability in the data could also be caused by the heterogeneity of environmental conditions and plant communities at both broad and fine spatial scales. (Liu et al., 2011).

The high stem density in Barangay Mana, mainly due to seedlings, suggests potential for forest regeneration. Conversely, areas like Culaman may require intervention due to low tree density. These patterns have important implications for conservation planning, reforestation efforts, and community-based forest management.

Areas with many stems per hectare may have more resources available for local communities. In contrast, areas with few stems may require management strategies to improve tree growth and promote forest regeneration.

Implications to human impacts

Beach forests have also been important in future coastal landscape planning, rehabilitation, and resource management. One study revealed that mangroves such as *Rhizophora apiculata, Rhizophora mucronata,* and *Pandanus odoratissimus*, a representative tree that grows in beach sand, were found to be especially effective in protecting from tsunami damage due to their complex aerial root structure. A horizontal structure of trees with small and large diameter vegetation and layers of vertical vegetation structure with *P. odoratissimus* and *Casuarina equisetifolia* were also essential for increasing drag and trapping objects, broken branches or driftwoods, houses, and people. The vertical vegetation structure also provided an effective soft landing for people washed up by the tsunami or escaping when the tsunami hit (Tanaka et al., 2007).

Overall, the observations suggest differences, despite their low values of diversity, in tree composition, growth, and density among the different barangays in the coastal areas of Malita. Understanding these patterns can provide important information for conservation and management efforts, as well as for supporting the livelihoods of local communities.

CONCLUSION

Coconuts (*Cocos nucifera*) are the most common tree species in heavily inhabited areas, with *T. catappa* and *M. multiglandulosa* also present. Second, species diversity and evenness varied across regions, but it is important to note that the municipality showed a low diversity index among the barangays surveyed. Third, the number of trees, saplings, and seedlings varied across the different barangays, with Barangay Fishing Village having the most significant number of trees and Barangay Mana having the highest number of seedlings.

Baseline information is essential to forecast future needs and make better and more informed decisions for resource managers. It is apparent in the findings that the coastal forests of Malita are changing due to human activities and other environmental factors. Management and conservation efforts may be necessary to preserve the remaining forests, promote forest regeneration and diversity, and ensure that the forests continue to provide significant ecological, economic, and social benefits to local communities. Further research and monitoring may also be needed, such as a study on abiotic components like beach topography, grain type, size analysis, and tidal profile, to understand the current state of the forests better and to guide future decision-making.

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CONFLICT OF INTEREST

Authors have declared that no competing interests exist.

AUTHOR CONTRIBUTIONS

Conceptualization: J. R. P. and J. D. C.; data analysis and curation: J. D. C.; investigation/ field survey, all authors; writing—original draft preparation: J. D. C.; writing—review and editing, all authors; supervision: J. R. P. and J. D. C.; project administration: J. R. P. and J. D. C.; funding acquisition: J. R. P. and J. D. C. All authors have read and agreed to the published version of the manuscript.

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