Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 4 (1): 1-15, 2021

Beach Forest Communities of San Agustin, Romblon with Notes on Coastal Threats

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ABSTRACT

The coastal plains of the Philippines were among the first sites opened for human settlement. However, the sprouting of communities has displaced beach forests and mangrove swamps. The growing intensity and frequency of weather disturbances brought by changing global climate highlight beach forests' critical role as bio-shields for vulnerable coastal communities. Unfortunately, beach forests continue to disappear due mainly to conversion into human settlements and wanton harvesting for fuel wood and medicinal plant parts. Currently, no study has been conducted on the beach forest communities in San Agustin, Romblon; thus, this study was conceptualized. A survey was conducted in all barangays of San Agustin, and species identification was made. A total of 38 species of beach forest plants belonging to 21 families were identified. The municipality of San Agustin has a species richness of 3.99, Shannon diversity index of 2.53, Simpson dominance index of 8.73, and Evenness index of 0.70. Cabolutan had the highest species richness among the barangays, while Binonga-an had the highest diversity and dominance index. The relatively high abundance of *Cocos nucifera* denotes that these areas were subjected to anthropogenic activities. Erosion, garbage, seawall, road widening, and infrastructure developments for beach resorts and summer houses were the five major coastal threats recorded in the beach forest areas around San Agustin, Romblon. These data can serve as a reference for different conservation activities to protect and enhance the current status of the beach forest of San Agustin, Romblon.

Keywords: *coastal threats, distribution of beach forest, diversity of beach forest, mapping, species composition*

INTRODUCTION

The coastal forest plays a significant role in the social and economic development of both present and future generations, as coastal resources support critical economic and subsistence activities [Food and Agricultural Organization (FAO), 1998]. Coastal forest ecosystems provide many unpriced services (Cochard, 2017). Coastal forests form essential links with other terrestrial and marine coastal ecosystems. Such forest communities include mangroves, beach forests, and peat swamps.

A beach forest is a plant community growing along sandy shores up to a high tidal zone. These are critical ecological zones in many coastal regions. Plant species in these zones are adapted for growing in harsh environmental conditions, experiencing wide variations in temperature, salinity, and humidity which influence the composition of plant species (Cochard et al., 2008; Kongapai et al., 2016). They are also resilient to wind, rain, waves, and salt sprays from the ocean (Tanaka et al., 2007; Cochard et al., 2008; Kongapai et al., 2016).

Beach forests are essential in sustaining coastal ecosystems and local communities (Kongapai et al., 2016). For centuries, beach forests have provided shelter from strong typhoon winds. The beach forest and trees, to some extent, contribute significantly to preventing coastal erosion brought by fast tidal currents, wind, and wave activity (Prasetya, 2006). It reduces the impact forces, flow depths, and velocities, limiting the extent of flooding (Forbes & Broodhead, 2007). It also protects against damages caused by salt spray to human settlements or cultivation (Goltenboth et al., 2006; De Zoysa, 2008). Beach forests filter floodwaters of suspended soil particles before reaching the sea, thus protecting the coral reefs from coastal water sedimentation. (Victor et al., 2006). Adjacent sandy beaches are also important nesting sites for sea turtles (Kongapai et al., 2016). Thus, the increasing intensity

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Received 8 April 2022; Revised 01 July 2022; Accepted 4 July 2022

and frequency of weather disturbances brought by changing global climate highlight beach forests' critical role as bio-shields for vulnerable coastal communities and biodiversity.

Despite the significant roles of coastal forests, vegetation in these areas was the first to disappear, followed by mangroves and other forest types. Most Philippine beach forests have been lost to human development projects such as converting into human settlements and wanton harvesting for fuel wood and medicinal plant parts (Liao, 2014). Due to their early loss, beach forest is not well studied as other flora and, therefore, not familiar to the average Filipino (Primavera & Sadaba, 2014). Thus, studies assessing the beach forest communities of the country must be done to generate knowledge of what remains of these forests and formulate appropriate actions to protect them.

At present, no study has been conducted about the beach forest communities in the municipality of San Agustin, Romblon. Such information is needed to understand the ecology of beach forests and spatial changes over the long term. To address this knowledge gap, this study was conceptualized. This study is vital in determining the status of the beach forest of San Agustin, Romblon. This serves as baseline information for policymakers' decision-making in environmental awareness and resource management. Increased awareness of the total benefits of coastal forests is vital for its conservation and sustainable management aiming to increase and improve vegetation richness and diversity of disturbed beach forests, allowing them to thrive once again. Further, the study's results may also serve as a reference in initiating activities to build community awareness in protecting the beach forests, stressing its importance to the local communities. It may also serve as a reference and precedence for replicating other researchers of the same interest.

This study aimed to assess the beach forest of San Agustin, Romblon taking notes on coastal threats. Specifically, the study determined the species composition, distribution, and richness in the beach forest of San Agustin. Through this study, a map of the beach forest of San Agustin was generated, and threats to coastal areas of San Agustin were also identified.

METHODOLOGY

Locale of the Study

The sampling was conducted in the whole coastal area of San Agustin Romblon (Figure 1). It was conducted in the beach forest area of the coastal barangays, namely Cawayan, Long Beach, Sugod, Carmen, Cabolutan, Cagbo-aya, Dubduban, Doña Juana, Binonga-an, Lusong, Hinugusan, Buli, Camantaya, and Bachawan. A request letter was sent

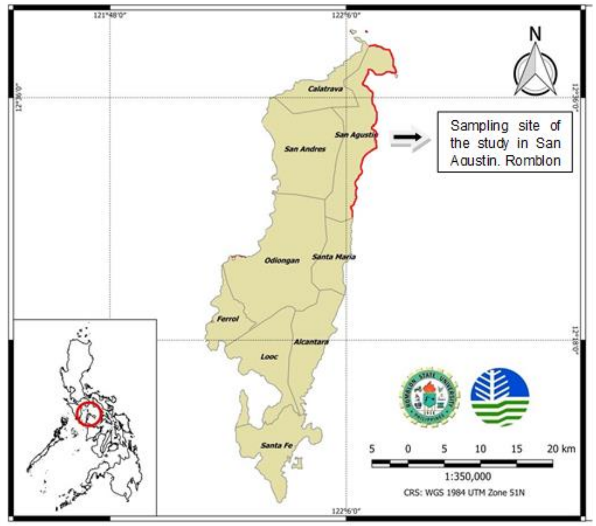


Figure 1. Location of sampling site (indicated by red line) in San Agustin, Romblon.

and approved by the Barangay Captain of each barangay before the start of the sampling. The sampling was conducted from December 2018 - February 2019.

Research Design

A descriptive-quantitative research design was used in this study to determine the species composition, distribution, species richness, diversity, dominance, and evenness of beach forest plants. Direct observation and descriptive analysis were done to identify the threats on coastal areas and generate a map of the beach forest of San Agustin, Romblon.

Sampling Procedure

The survey method of English et al. (1997) was used to determine beach forest plants' distribution, richness, diversity, dominance, and evenness in San Agustin. A 100-meter transect was laid out five meters above the highest high tide in the beach forest area of each barangay. The transect was laid out parallel to the shore. All beach forest trees five meters below and five meters above the transect line were documented, counted, and recorded. Each transect was further replicated thrice in each barangay and had a 30 meters distance for short beach forest and at least 30 meters distance for long beach forest area. A total of 42 transects were established in the beach forest area of San Agustin.

Plant Identification and Beach Forest Mapping

A transect walk survey was used to inventory beach forest plants and map the beach forest areas in San Agustin. All plants such as trees, shrubs, ferns, palms, grass, and vines found in the beach forest were documented and identified using the work of Primavera and Montilijao (2017). Further verifications were done by sending documented pictures of beach forest plants to experts. The beach forest plants were marked, and the forest area was recorded by taking coordinates points using a handheld GPS Garmin metrics device. The coordinates were then plotted on Google Earth. Mapping of the beach forest of San Agustin was done using QGIS 3.22.

Coastal Threats Identification

The identification of coastal threats was made by a transect walk survey. All observed threats including erosion, an unwanted structure such as illegal settlements and concrete seawalls, root exposure, and other anthropogenic activities that caused coastal threats was recorded and captured.

Data Analysis

The descriptive statistics such as counts, percentages, and mean were computed using Microsoft Excel. The diversity, dominance, and evenness indexes were computed using the formula below. Data were analyzed using SPSS version 16.

For the Shannon Diversity Index, the following formula was used:

$$H = \sum_{i=1}^{S} -(\mathrm{Pi} * \mathrm{In\ Pi})$$

Where:

H = the Shannon Diversity Index
Pi = fraction of the entire population made up of species i
S = numbers of species encountered
$\sum$ = sum from species 1 to species S

Note: The power to which the base e (e=2.718281828) must be raised to obtain a number is called the number's natural logarithm (ln).

For Simpsons Dominance Index, the following formula was used:

$$\mathrm{D} = \sum_{i=1}^{S} (Pi^2)$$

Where:

D = Value of Simpsons diversity index
Pi = proportion of individuals in the ith species
S = # of species

For Evenness Index, the following formula was used:

$$e = H / \ln S$$

Where:

H = Shannon Diversity index
S = Total number of species in the sample

RESULTS AND DISCUSSION

Species Composition of Beach Forest Plant in San Agustin, Romblon

A total of 38 species of beach forest plants belonging to 21 families were identified in San Agustin, Romblon, Philippines (Table 1). Only one species was identified under each Amary: Two species were identified under families Arecaceae, Lamiaceae, Lecythidaceae, Malvaceae, and Rubiaceae. Three species were identified under each of the families Apocynaceae and Sterculiaceae. The family with the highest identified species is Fabaceae, with eight species. Meanwhile, there were two unidentified species of beach forest plant.

Distribution of Beach Forest Plants in San Agustin, Romblon

The distribution of beach forest plants in San Agustin, Romblon varied in every barangay (Table 2; Plate 1). A total of seven species were noted common in all barangays and these includes, *Terminalia catappa, Albizia procera, Morinda citrifolia, Ipomoea-pes caprae, Cocos nucifera, Millettia pinnata*, and *Vitex trifolia.* Cocos nucifera has the highest total number of 2,687 individuals among the seven common species.

Meanwhile, some beach forest plants showed restricted distribution, with some plants only found in specific barangays. This pattern indicates a restriction in the spatial distribution of beach forest trees of San Agustin, Romblon. The type of substrate present influenced the species composition in each area. It was observed that beach forest plants that showed restricted distribution were found in either the sand beach or rock beach substrate. Some beach forest plants were restricted to only two barangays, including *Caesalpinia bonduc, Cordia subcordata, Ficus microcarpa*, and *Heritiera littoralis,* which were only found in areas with a sandy substrate. On the other hand *Erythrina variegate* and Species 1 (unidentified) were found in areas with sandy and rocky substrates. Moreover, some plant species showed a very restricted distribution and are only found in the sandy substrate of a single barangay. These include *Alstonia macrophylla, Commersonia bartramia, Crinum asiaticum, Cydas edentate* and *Entada parviflora* in barangay Cagbo-aya, *Barringtonia acutangula, Cerbera manghas, Dolichandrone spathaceae,* and *Pterocarpus indicus* in barangay Cabolutan, and *bili* and *Guettarda speciosa* in barangay Sugod.

Species Richness, Diversity, Dominance, and Evenness of Beach Forest Communities in San Agustin Romblon

The municipality of San Agustin was found to have a species richness value of 3.99 with 38 recorded species of beach forest plant, diversity index of 2.53, the dominance index of 8.73, and an evenness index of 0.70. Among the barangays of San Agustin, barangay Cabolutan was found to have the highest species richness value of 3.79, with 27 recorded species of beach forest plant.

Table 1. Checklist of Species Composition of Beach Forest Trees in San Agustin, Romblon

Family Name	**Scientific Name**	**Local Name**
Amaryllidaceae	*Crinum asiaticum* Linnaeus, 1753	Bakong
Apocynaceae	*Alstonia macrophylla* Wall. ex G.Don, 1837	Itang-itang
	A. scholaris (L.) R.Br. 1810	Dita
	Cerbera manghas Linnaeus, 1753	Buta-buta
Arecaceae	*Cocos nucifera* Linnaeus, 1753	Niyog
	Nypa fruticans Wurmb, 1779	Nipa
Bignoniaceae	*Dolichandrone spathacea* (L.fil.) K. Schum., 1889	Tiwi
Boraginaceae	*Cordia subcordata* Lam., 1792	Agut-ut
Capparidaceae	*Capparis micracantha* DC.,1824	Halubagat
Combretaceae	*Terminalia catappa* Linnaeus, 1767	Talisay
Convolvulaceae	*Ipomoea pes-caprae* (L.) R.Br., 1818	Palang-palang
Cycadaceae	*Cycas edentata* de Laub., 1998	Pitogo
Euphorbiaceae	*Macaranga tanarius* (L.) Müll.Arg., 1866	Binunga
Fabaceae	*Albizia procera* (Roxb.) Benth., 1844	San Pedro
	Caesalpinia bonduc Linnaeus, 1753	Dalugdug
	Entada parvifolia Merr., 1908	Bayakaw
	Erythrina variegata Linnaeus, 1754	Dapdap
	Gliricidia sepium (Jacq.) Kunth, 1842	Madre cacao
	Millettia pinnata Linnaeus, 1763	Bani
	Pterocarpus indicus Willd., 1802	Narra
	Vachellia aroma (Gillies ex Hook. & Arn.) Seigler & Ebinger, 2006	Aroma
Goodeniaceae	*Scaevola taccada* (Gaertn.) Roxb., 1814	Panabolong
Guttiferae	*Callophyllum inophyllum* Sieber ex C. Presl., 1828	Dangkalan
Lamiaceae	*Premna serratifolia* Linnaeus, 1771	Agdaw
	Vitex trifolia Linnaeus, 1753	Lagunding dagat
Lecythidaceae	*Barringtonia asiatica* (L.) Kurz, 1875	Bitoon
	B. acutangula (L.) Gaertn., 1791	Putat
Malvaceae	*Talipariti tiliaceum* (L.) Fryxell, 2001	Malabago
	Thespesia populnea (L.) Sol. ex Corrêa, 1807	Banago
Moraceae	*Ficus microcarpa* L.fil., 1781	Lunok
Pandanaceae	*Pandanus tectorius* Parkinson ex Du Roi, 1774	Pandan
Rubiaceae	*Guettarda speciosa* Linnaeus, 1753	Lambon
	Morinda citrifolia Linnaeus, 1753	Noni
Sapotaceae	*Planchonella obovata* (R.Br.) Pierre, 1890	Banasi
Sterculiaceae	*Commersonia bartramia* (L.) Merr., 1917	Mayamaga
	Sterculia ceramic R.Br., 1844	Banilad
	Heritiera littoralis Dryand. ex Aiton, 1789	Dungon late
		Bili
		Species 1 (Unidentified)

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 4 (1): 1-15, 2022

Table 2. Checklist of the distribution of beach forest plants in San Agustin, Romblon

Scientific Name	**Barangay**													
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**
Albizia procera	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Alstonia macrophylla						x								
Alstonia scholaris						x	x	x	x					
Barringtonia acutangula					x									
Barringtonia asiatica	x	x	x	x	x	x	x	x	x	x	x	x		x
Bili			x											
Caesalpinia bonduc			x		x									
Callophyllum inophyllum		x	x	x	x	x	x	x	x	x	x	x		x
Capparis micracantha		x		x	x				x					
Cerbera manghas					x									
Cocos nucifera	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Commersonia bartramia						x								
Cordia subcordata				x		x								
Crinum asiaticum						x								
Cydas edentate						x								
Dolichandrone spathacea					x									
Entada parviflora						x								
Erythrina variegate	x					x								
Ficus microcarpa			x					x						
Glericidia sepium		x	x	x	x	x	x	x	x			x		x
Guettarda speciosa			x											
Heritiera littoralis					x		x							
Ipomoea-pes-caprae	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Macaranga tanarius		x	x	x	x	x	x	x	x		x	x	x	x
Millettia pinnata	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Morinda citrifolia	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Nypa fruticans			x	x	x		x	x	x					
Pandanus tectorius	x	x	x	x	x	x	x	x	x	x	x	x		
Planchonella obovata	x	x	x	x	x	x	x	x	x			x	x	
Premna serratifolia		x	x	x	x	x	x	x	x		x	x		
Pterocarpus indicus					x									
Scaevola taccada	x		x	x	x	x		x	x	x	x			x
Species 1 (Unidentified)			x							x				
Sterculia ceramica		x	x	x	x		x	x			x			
Talipariti tiliaceum				x	x	x				x	x			x
Terminalia catappa	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Thespesia populnea		x		x	x	x				x	x		x	
Vachellia aroma		x	x	x	x	x	x	x	x					
Vitex trifolia	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TOTAL	**13**	**18**	**23**	**22**	**27**	**26**	**19**	**20**	**19**	**14**	**16**	**14**	**10**	**13**

Note: (**A**) Cawayan, (**B**) Long Beach, (**C**) Sugod, (**D**) Carmen, (**E**) Cabolutan, (**F**) Cagbo-aya, (**G**) Dubduban, (**H**) Doña Juana, (**I**) Binonga-an, (**J**) Lusong, (**K**) Hinugusan, (**L**) Buli, (**M**) Camantaya, and (**N**) Bachawan.

FN: AMARYLLIDACEAE
SN: *Crinum asiaticum*
LN: Bakong

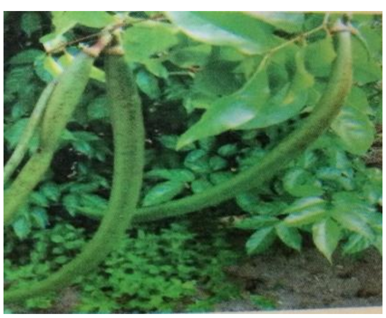
FN: ARECACEAE
SN: *Cocos nucifera*
LN: Niyog

FN: ARECACEAE
SN: *Nypa fruticans*
LN: Nipa

FN: APOCYNACEAE
SN: *Alstonia macrophyll*a
LN: Itang-itang

FN: APOCYNACEAE
SN: *A. scholaris*
LN: Dita

FN: APOCYNACEAE
SN: *Cerbera manghas*
LN: Buta-buta



FN: BIGNONIACEAE
SN: *Dolichandrone spathaceae*
LN: Tiwi

SN: **BORAGINACEAE**
SN: *Cordia subcordata*
LN: Agut-ut

FN: CAPPARIDACEAE
SN: *Capparis micracantha*
LN: Halubagat

Plate 1. The beach forest plants of San Agustin, Romblon, Philippines

Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
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FN: COMBRETACEAE
SN: *Terminalia catappa*
LN: Talisay

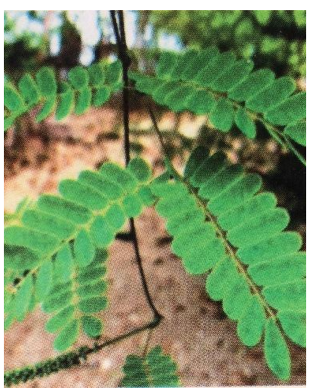
FN: CONVOLVULACEAE
SN: Ipomoea-pes caprae
LN: Palang-palang

FN: CYCADACEAE
SN: *Cydas edentate*
LN: Pitogo

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

FN: FABACEAE
SN: *Erythrina variegate*
LN: Dapdap

FN: FABACEAE
SN: *Caesalpinia bonduc*
LN: Dalugdug



FN: FABACEAE
SN: *Entada parviflora*
LN: Bayakaw

FN: FABACEAE
SN: *Albizia procera*
LN: San Pedro

FN: FABACEAE
SN: *Glericidia sepium*
LN: Madre cacao

Plate 1. The beach forest plants of San Agustin, Romblon, Philippines (cont.).

FN: FABACEAE
SN: *Millettia pinnata*
LN: Bani

FN: FABACEAE
SN: *Pterocarpus indicus*
LN: Narra

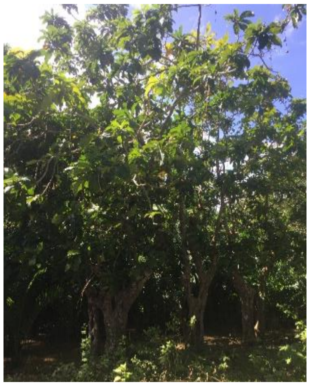
FN: FABACEAE
SN: *Vachellia aroma*
LN: Aroma

FN: GOODENIACEAE
SN: *Scaevola taccada*
LN: Panabolong

FN: GUTTIFEREAE
SN: *Callophyllum inophyllum*
LN: Dangkalan

FN: **LAMIACEAE**
SN: *Vitex trifolia*
LN: Lagunding dagat

FN: LECYTHIDACEAE
SN: *Barringtonia asatica*
LN: Bitoon



FN: LECYTHIDACEAE
SN: *B. acutangula*
LN: Putat

FN: MALVACEAE
SN: *Talipariti tiliaceum*
LN: Malabago

Plate 1. The beach forest plants of San Agustin, Romblon, Philippines (cont.).

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FN: MALVACEAE
SN: *Thespesia populnea*
LN: Banago

FN: MORACEAE
SN*: Ficus microcarpa*
LN: Lunok

FN: PANDANACEAE
SN: *Pandanus tectorius*
LN: Pandan

FN: RUBIACEAE
SN: *Guettarda speciose*
LN: Lambon

FN: LAMIACEAE
SN: *Morinda citrifolia*
LN: Noni

FN: LAMIACEAE
SN: *Premna serratifolia*
LN: Agdaw

FN: SAPOTACEAE
SN: *Planchonella obovata*
LN: Banasi

FN: STERCULIACEAE
SN: *Commersonia bartramia*
LN: Mayamaga

FN: STERCULIACEAE
SN: *Sterculia ceramica*
LN: Banilad

FN: STERCULIACEAE
SN: *Heritiera littoralis*
LN: Dungon late

Species 1 (Unidentified)

LN: Bili

Plate 1. The beach forest plants of San Agustin, Romblon, Philippines (end.).

It was then followed by Cagbo-aya with 3.50 (26 species), Sugod with 3.02 (23 species), Dubduban with 2.88 (19 species), Carmen with 2.81 (22 species), Binonga-an with 2.68 (19 species), Long Beach with 2.64 (18 species), Dona Juana with 2.60 (20 species), Hinugusan with 2.42 (16 species), Cawayan with 2.38 (13 species), Buli with 2.25 (14 species), Lusong with 2.22 (14 species), Bachawan with 2.04 (13 species) and lastly, Camantaya with 1.80 (10 species) (Figure 2).

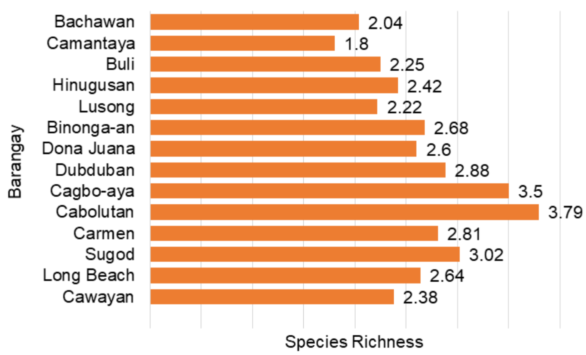

Figure 2. Total species richness of beach forest of San Agustin, Romblon.

Regarding diversity, the beach forest of barangay Binonga-an housed the most diverse species of plants with an index of 2.47. It was then followed by Cagbo-aya with 2.45, Cabolutan and Dona Juana with 2.42, Sugod with 2.31, Carmen with 2.21, Dubduban with 2.19, Cawayan with 2.15, Buli with 2.13, Long Beach with 2.08, Bachawan with 1.93, Camantaya with 1.92, Lusong with 1.84, and Hinugusan with 1.74, respectively (Figure 3).

Meanwhile, in terms of dominance, the beach forest of barangay Binonga-an has the most dominant plant species, with an index value of 9.15. It was then followed by Cagbo-aya with 8.72, Dona Juana with 8.48, Cabolutan with 8.13, Sugod with 6.84, Carmen with 6.73, Dubduban with 6.40, Cawayan with 6.30, Buli with 5.93, Longbeach with 5.63, Camantaya with 5.51, followed by Bachawan with 5.30, Lusong with 4.03, and Hinugusan with 3.46, respectively (Figure 4).

Moreover, barangay Binonga-an and Cawayan were found to have the highest evenness index of 0.84. It was then followed by Camantaya with 0.83, Buli and Dona Juana with 0.81, Cagbo-aya and Bachawan with 0.75, Dubduban with 0.74, Sugod with 0.74, Cabolutan with 0.73, Carmen and Longbeach with 0.72, Lusong with 0.70, and Hinugusan with 0.63 (Figure 5).

Furthermore, after subjecting to statistical analysis, results showed no significant difference in species richness, diversity index, dominance index, and evenness index among the beach forests of all the barangay in the municipality of San Agustin, Romblon.

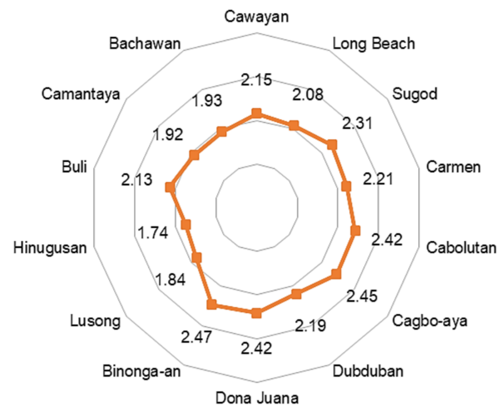

Figure 3. Shannon diversity index of beach forest of San Agustin, Romblon.

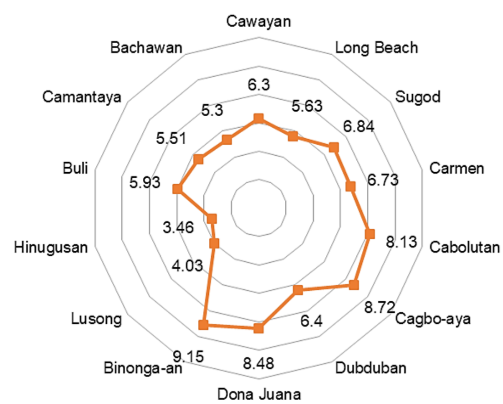

Figure 4. Simpson dominance index of beach forest of San Agustin, Romblon.

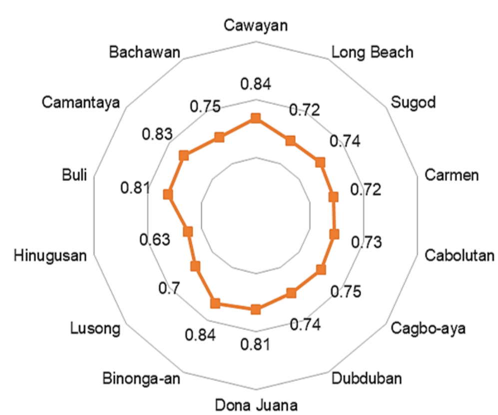

Figure 5. Evenness index of beach forest of San Agustin, Romblon.

This indicates that the beach forest around the municipality of San Agustin has an even distribution of beach forest plants.

Results showed that the beach forest of San Agustin holds about 38 species out of 96 species of beach forest plants in the country. The number of beach forest plants in San Agustin, Romblon was relatively higher than in other beach forests in the Philippines and other countries (Table 4). For instance, only 16 species were found on Dinagat Island (Lillo et al., 2019), 21 species were found on Sicogon Island (Pedregosa et al., 2006), and 24 species were found in Pang Nga, Thailand (Kongapai et al., 2016). On the other hand, the results of the present study were lower compared to the study of Sabulao et al. (2020) in Guiuan Eastern Samar with 39 species, a study by Garcia et al. (2017) in Surigao, the Philippines, with 55 species, study of Nini and Tatil (2017) in Surigao del Norte with 57 species and the study of Neamsuvan et al. (2012) in Songkhla province, Thailand with 69 species.

Some beach forest plant species recorded from the study have high economic value, such as *Pterocarpus indicus* and *Callophyllum inophyllum* for their timber, *Cocos nucifera* for its fruit, and *Ipomoea-pes caprae* and *C. inophyllum* for their medicinal uses (Neamsuvan et al., 2012). Some species also serve as food for the coastal area animals and play key roles in the ecosystem.

Among the 21 families present, Fabaceae has the highest recorded species of beach forest plants. This family is known to fix nitrogen and is relatively common in beach forests (Goltenboth et al., 2006; Lillo et al., 2019). However, in the present study, four species under this family were only found in a few barangays. *P. indicus*, a species of beach forests tree which provides valuable timber was only found in the sandy beach of only one barangay. Another beach forest tree that provides timber widely distributed in the municipality is *C. inophyllum.*

Moreover, seven beach forest plant species were found common in all barangays. These include *Terminalia catappa, Albizia procera, Morinda citrifolia, Ipomoea-pes caprae, C. nucifera, Millettia pinnata, Vitex trifolia.* These species were also noted to be the dominant beach forest plant in the study of Lillo et al. (2019). Among these *C. nucifera* was found dominant. The relatively high abundance of *C. nucifera* denotes that these areas were subjected to anthropogenic activities that have altered the species composition since palms are not natural vegetation in these ecosystems (Goltenboth et al., 2006). It was reported that the agriculture sector of the municipality has initiated the plantation of these trees for agricultural purposes.

Based on the Shannon diversity index, the beach forest of San Agustin, Romblon, has a diversity index value of 2.53. This result indicates that the municipality has higher species diversity when compared to Dinagat Island with a 1.45 index (Lillo et al., 2019) and the beach forest trail of Puerto Princesa Subterranean River National Park, Palawan with a 1.85 index (Alcantara et al., 2014), but lower when compared to Brgy. Sta Cruz, Surigao del Norte with 3.27 index (Nini and Tatil, 2017). Moreover, San Agustin, Romblon's Simpson dominance index and Evenness index were 8.73 and 0.70, respectively. These high index values indicate a uniform distribution of various species of beach forest plant in the whole municipality and are are interpreted as about 70 % of the species in the sampling sites are like each other. This value is higher than the recorded evenness index in Brgy. Sta Cruz, Surigao del Norte with 0.66 (Nini and Tatil, 2017), but lower than the recorded evenness index in Dinagat Island of 0.956 (Lillo et al., 2019)

Among the barangays of the municipality, the beach forest with relatively high species composition was found in Cabolutan. In contrast, the highest diversity, dominance, and even distribution of the different plant species were found in barangay Binonga-an. Other barangays with high indexes also include barangay Cagboaya, Doña Juana and Cawayan. This result can be attributed to the situation and structure of the coastal communities in these barangays. It was observed that the communities' houses were not close to the seacoast, giving an area for the beach forests plant to flourish. Another factor can be due to the topographical features of each barangay. Due to the steeper topography of some barangay, the community was forced to build their houses near the shore, occupying the areas for possible beach forests. Furthermore, the low indexes obtained from the beach forests of barangay Hinugusan and barangay Lusong must have been affected by the shorter coastal zones in these barangays.

Map of the Beach Forest of San Agustin, Romblon

The coastal area of the San Agustin, Romblon was characterized by a long range of beach forests where diverse species of beach forest plants can be found (Figure 6). The northern part of the municipality, specifically in the coastal areas of barangay Cawayan and barangay Long Beach, was characterized by karst forest, rock, and boulders. Mangroves and beaches also characterized the coastal area. Meanwhile, piles of garbage and coastal erosion were also observed in some areas and in the artificial infrastructure of seawalls and bridges.

Coastal Threats in the Beach Forest Communities of San Agustin, Romblon

Five major coastal threats were recorded along the beach forest areas of San Agustin, Romblon (Table

3; Plate 2). The most common threat in all the barangay was the garbage that was possibly dumped or washed by waves to the beach forest areas. Locals also built seawalls as barriers against strong waves or typhoons. Meanwhile, the beach forest area of some barangay was also replaced by beach houses and resorts for tourism purposes. Coastal erosion, which caused escarpment and exposure of roots of beach forest trees, was also observed. Lastly, the cutting of beach trees in the beach forest was observed in two barangays.

Table 3. Checklist of coastal threats in beach forest communities of San Agustin, Romblon.

Barangay	Erosion	Seawall	Garbage	Infrastructure	Cutting of beach trees
Cawayan					
Longbeach			x	x	
Sugod	x		x		
Carmen		x	x	x	x
Cabolutan	x		x	x	
Cagbo-aya	x		x	x	
Dubduban			x		
Dona Juana	x	x	x		x
Binonga-an		x	x		
Lusong			x		
Hinugusan		x	x	x	
Buli		x	x	x	
Camantaya		x	x	x	
Bachawan		x	x	x	

Plate 2. Captured threats in beach forest of San Agustin, Romblon which includes houses and seawall (a), exposed roots of trees (b), port (c), washed out garbage (d), beach resort (e), and cut trees (f).

Table 4. Comparison of beach forest in different parts of the world.

Location	No. of species	Author
San Agustin, Romblon	38	This study 2019
Surigao, Philippines	55	Garcia et al., 2017
Dinagat Island, Philippines	16	Lillio et al., 2019
Surigao del Norte, Philippines	57	Nini and Tatil, 2017
Guiuan Eastern Samar, Philippines	39	Sabulao et al., 2020
Philippines	96	Primavera and Montilijao, 2017
Sicogon Island, Antique, Philippines	21	Pedregosa et al., 2006
Pang Nga, Thailand	24	Kongapai et al., 2016
Songkhla province, Thailand	69	Neamsuvan et al., 2012

Beach forests are plant communities growing along sandy shores and up to the high tidal zone. The vegetation is found on dunes, sometimes on sand, gravel, or rock, and are composed of dense grasses, shrubs, and herbs, grove, or forest with a closed canopy (Neamsuvan et al., 2012). Plants present in this area can tolerate salt spray (halophytes), strong wind, and drought (Rueangphanich, 2005). The beach forest and trees play a significant role in protecting the shoreline from the erosion caused by wave action, wind, and fast tidal currents (Prasetya, 2006).

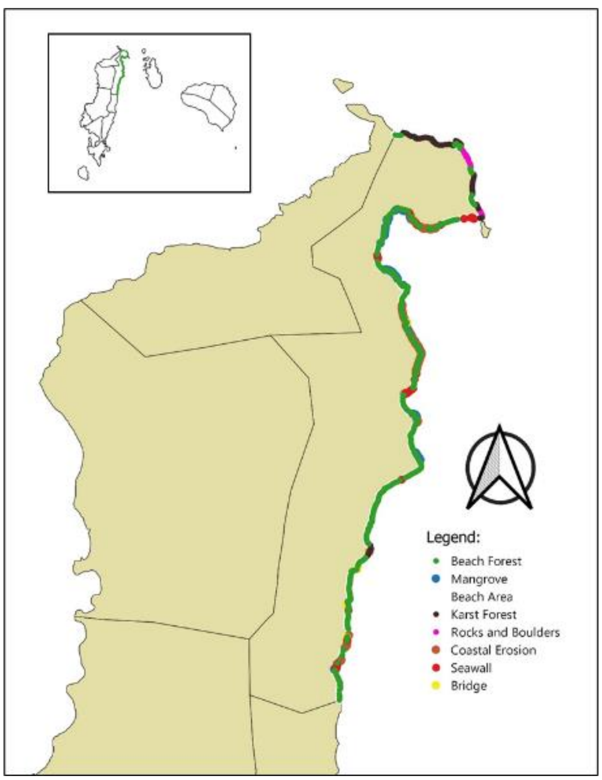

Figure 6. Beach Forest Mapping of San Agustin, Romblon

However, these coastal ecosystems were threatened by different natural changes like sea-level rise, high-intensity storms and anthropogenic activity such as excessive resource exploitation and coastal development (Barbier et al., 2011; Frosini et al., 2012). These areas also serve as hotspots of plastic accumulation (Ceccarini et al., 2018; Rangel-Buitrago et al., 2018). These plastics were washed to shore by floods from the coastal communities or brought into the beaches by the strong action of waves and winds from the sea. Tons of household garbage, industrial wastes, and sewage are produced every year. Mismanagement of these often results in major environmental problems. Plastic bags are one of the most problematic garbage that threatens the ecosystem. During rainfall events, the additives from these plastic bags leach out into dunes and absorbed by the seeds and roots of plants (Menicagli et al., 2019). Accordingly, plastic pollution creates several adverse impacts combined with ecological and socio-economic effects (Thushari & Senevirathna, 2020). Significant ecological effects that threaten biodiversity and trophic relationships include entanglement, toxicological effects from ingesting plastics, suffocation, starvation, dispersal and rafting of organisms, provision of new habitats, and introduction of invasive species (Thushari & Senevirathna, 2020).

Moreover, the increasing coastal population has dramatically disturbed the forests, converting these areas to residential zones where houses and beach resorts were built along with seawalls protecting them from strong waves and high tides. Although these structures support economic and social activities that can contribute to positive or negative effects on the coastal environments (Sevilla et al., 2018), coastal development, such as residential houses and beach resorts, not only replaced the beach forests and the ecosystem services it provides but may also produce pollutants which affect near-by ecosystems such as coral reefs (Bozec et al., 2008).

Furthermore, beach forest trees were cut in the coastal areas. Trees were cut and harvested for charcoal production and house construction, similar to what had happened to other beach forest areas in the Philippines (Buitre et al., 2019). These human activities significantly contribute to the loss of coastal ecosystems such as beach forests. These anthropogenic activities might have also resulted in further natural threats such as coastal erosion.

Nowadays, more extensive beach forest areas only occur in more remote parts of the country. The beach forests in more populated areas have declined drastically, and the destruction went almost unnoticed by the community. As the population of the province increases and pressures are put along the coastal areas where the community settles near the shore due to fishing, their primary source of income, activities for the conservation and protection of the beach forests must come to action.

CONCLUSION

Beach forests play an essential role as a component of coastal ecosystems that links with other terrestrial and marine coastal ecosystems. However, only a few studies were conducted on the beach forests in the country. In the municipality of San Agustin, a total of 38 species of beach forest plants belonging to 21 families were identified and recorded. Seven (7) species were noted common in all barangays, such as *Terminalia catappa*, *Albizia procera*, *Morinda citrifolia*, *Ipomoea-pes caprae*, *Cocos nucifera*, *Millettia pinnata*, and *Vitex trifolia*. The relatively high abundance of *C. nucifera* among these species was due to the plantation activity of the agriculture sector of the local government unit. The spatial situation and structure of coastal communities in barangay Cabolutan and Binonga-an affected the beach forest plants population. Moreover, the mapping revealed a long range of beach forests along with the coastal areas of San Agustin, which are now being threatened by different factors that anthropogenic activities cause. Due to the lack of data, the researchers could not assess how much has been lost in the beach forest of the municipality. However, these data serve as a reference for different conservation activities to protect and enhance the status of the beach forest of San Agustin, Romblon.

ACKNOWLEDGMENT

The authors would like to thank Ms. Antonette M. Monsales and Mr. Cris M. Magracia for their time and effort in extending help during the conduct of the survey in the beach forest of San Agustin.

AUTHORS' CONTRIBUTION

Mr. Gonzalez and Ms. Mangao participated on the conceptualization and data collection. Mr. Gonzalez and Ms. Mazo carried out the data processing and data interpretation. All authors helped in the manuscript write-up. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Alcantara, M. J., Bolintiam, J. G., & Lapuz, R. S., (2014). Tree diversity assessment of the beach forest trail of Puerto Princesa subterranean river national park, Palawan, Philippines. *Philippine Journal of Health Research and Development*, *18*(1), 1-15.

Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C. & Silliman, B. (2011). The value of estuarine and coastal ecosystem services. *Ecological Monographs, 81*(2), 169–193.

Bozec, Y. M., Acosta-Gonzá, G., Nunez, E. & Arias, E. (2008). Impacts of coastal development on ecosystem structure and function of Yucatan coral reefs, Mexico. *Proceedings of the 11th International Coral Reef Symposium*, Ft. Lauderdale, Florida.

Buitre, M. J., Zhang, H. & Lin, H. (2019). The mangrove forests change and impacts from tropical cyclones in the Philippines using time, series satellite imagery. *Remote Sensing*, *11*(6), 1-15.

Ceccarini, A., Corti, A., Erba, F., Modugno, F., La Nasa, J., Bianchi, S. & Castelvetro, V. (2018). The hidden microplastics: new insights and figures from the thorough separation and characterization of microplastics and of their degradation by-products in coastal sediments. *Environmental Science Technol*ology, *52*(10), 5634–5643.

Cochard, R., Ranamukhaarachchi, S. L., Shivakoti, G. P., Shipin, O. V., Edwards, P. J. & Seeland K. T. (2008). The 2004 tsunami in Aceh and Southern Thailand: A review on coastal ecosystems, wave hazards and vulnerability. *Perspectives in Plant Ecology, Evolution and Systematics*, *10*(1), 3–40.

Cochard, R. (2017). Coastal Water Pollution and Its Potential Mitigation by Vegetated Wetlands: An Overview of Issues in Southeast Asia. *Redefining Diversity and Dynamics of Natural Resources Management in Asia*, *1*, 189-230.

De Zoysa, M. (2008). Casuarina coastal forest shelterbelts in Hambantota City, Sri Lanka: assessment of impacts. *Small Scale Forest*, *7*(1), 17–27.

English, S., Wilkinson, C., & Baker, V. (1997). *Survey manual for tropical marine resources*. Australian Institute of Marine Science, Townsville Mail Centre, Australia.

Food and Agriculture Organization. (1998). In Scialabba, N. (Eds), *Integrated coastal area management and agriculture, forestry and fisheries, FAO Guidelines.* Environment and Natural Resources Service, FAO, Rome.

Forbes, K. & Broodhead, J. (2007). *The Role of Coastal forests in the Mitigation of tsunami impacts*. RAP Publication 2007/1, FAO United Nations, Regional Office for Asia and the Pacific, Bangkok, Thailand.

Frosini, S., Lardicci, C., & Balestri, E. (2012). Global change and response of coastal dune plants to the combined effects of increased sand accretion (burial) and nutrient availability. *PLoS One, 7(10)*, e47561.

Garcia, C., Asube, L.C, Varela, R., & Garcia, G.A. (2017). Floristic composition in Kinalablaban River delta interconnected with the nickel mines in Surigao, Philippines. *Journal of Biodiversity and Environmental Sciences*, *10*(1), 97-104.

Goltenboth, F., Langenberger, G. & Widmann, P. (2006). Beach forests. In: Goltenboth, F., Timotius, K.H., Milan, P.P. & Margraf, J. (Eds.), *Ecology of Insular Southeast Asia: The Indonesian Archipelago (*pp 281–95). Elsevier, Amsterdam.

Kongapai, P., Sompongchaiyakul, P., Jitpraphai, S., & Plumley, F.G. (2016). Beach forest changes (2003–2013) in the tsunami-affected area of Phang Nga, Thailand from multi-temporal satellite data. *Science Asia*, *42*(1), 159-170.

Liao L. (2014). Book Review: Beach Forest Species and Mangrove Associates in the Philippines by Primavera, J.H and Sadaba, R.B. (2012). SEAFDEC Aquaculture Department, Tigbauan, Iloilo. *Tropical Natural History*, *14*(1), 43-44.

Lillo, E. P, Fernando, E. S. & Lillo, M. J. (2019). Plant diversity and structure of forest habitat types on Dinagat Island, Philippines. *Journal of Asia-Pacific Biodiversity*, *12*(1), 83-105.

Menicagli, V., Balestri, E. & Lardicci, C. (2019). Exposure of coastal dune vegetation to plastic bag leachates: A neglected impact of plastic litter. *Science of The Total Environment*, *683*(1), 737–748.

Neamsuvan, O., Singdam, P., Yingcharoen, K. & Sengnon, N. (2012). A survey of medicinal plants in mangrove and beach forests from Sating Phra Peninsula, Songkhla Province, Thailand. *Journal of Medicinal Plants Research*, *6*(12), 2421-2437.

Nini, J.M.S. & Tatil, W.T. (2017). Beach forest characterization in two coastal barangays in Socorro, Bucas Grande Island, Surigao del Norte, Philippines. *Proceedings of the 22nd International Forestry and Environment Symposium*. University of Sri Jayewardenepura, Sri Lanka.

Pedregosa, M., Paguntalan, L., Jakosalem, P. G., Lillo, E., Rico, E., De Alban, J. D., Lorica, R., Lastica-Ternura, E., & Enricoso, F. (2006). *An assessment of the native flora and fauna of Sicogon Island, Panay, Philippines: A consolidated report*. 10.13140/RG.2.1.4720.4244.

Prasetya, G. S. (2006). The role of coastal forest in combating coastal erosion. *Regional Technical Workshop*. Khaolak, Thailand.

Primavera, J. H., & Sadaba, R. B. (2014). Beach forest species and mangrove associates in the Philippines. *Tropical Natural History*, *14*(1), 43-44.

Primavera, J. H. & Montilijao, C. L. (2017). *Field Guide to Philippine Beach Forest Species*. Zoological Society of London-Philippines. Iloilo City, Philippines.

Rangel-Buitrago, N., Castro-Barros, J. D., Gracia, A., Villadiego, J.D. & Williams, A.T. (2018). Litter impacts on beach/dune systems along the Atlantico Department, the Caribbean coastline of Colombia. *Marine Pollution* Bulletin, *137*(1), 35–44.

Rueangphanich, N. (2005). *Forest and forestry in Thailand.* Academic Promoting Center: Bangkok.

Sabulao, J. B., Magtolis, J. M., Capanang, C. A., Ingente, D. E., Paa, M. W., Hitosis Jr., R. C., Mabag, J. A. & Raga, C. C. (2020). Preliminary survey of beach forest species in Guiuan Eastern Samar, Philippines: An ethnobotanical study. *Indian Journal of Science and Technology***,** *13*(9), 1098-1106.

Sevilla, N. P., Adeath, I. A., Le Bail, M. & Ruiz, A. Z. (2018). Coastal Development: Construction of a Public Policy for the Shores and Seas of Mexico. In Krishnamurthy, R. R., Jonathan M. P., Srinivasalu, *S. &* Glaeser, B. (Eds.), *Coastal Management, Global Challenges, and Innovations* (pp. 21-38). Elsevier Inc. https://www.sciencedirect.com/science/article/pii/B9780128104736000030

Tanaka, N., Sasaki., Y., Mowjood, M. I., Jinadasa K. B. & Homchuen, S. (2007). Coastal vegetation structures and their functions in tsunami protection: Experience of the recent Indian Ocean tsunami. *Landscape and Ecological Engineering*, *3*(1), 33-45.

Thushari, G. G. N. & Senevirathna, J. D. M. (2020). Plastic pollution in the marine environment. *Heliyon*, *6*(8), e04709.

Victor, S., Neth, L,. Golbuu, Y., Wolanski, E. & Richmond, R. (2006). Sedimentation in mangroves and coral reefs in a wet tropical island, Pohnpei, Micronesia. *Estuarine Coastal and Shelf Science, 66*(3), 409-416.