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Unveiling coastal diversity: An inventory and conservation report of beach forest flora of Surigao del Sur, Philippines

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Abstract. *Ramos GB, Panduyos JB, Caray RE, Bacquial LS. 2024. Unveiling coastal diversity: An inventory and conservation report of beach forest flora of Surigao del Sur, Philippines. Biodiversitas 25: 421-430.* Coastal greenbelts, comprise mangroves and beach forest trees, are pivotal in disaster mitigation and climate change resilience. Despite the evident importance of these coastal ecosystems, they are often overlooked in research due to a lack of comprehensive data on species community structure and their broader ecological importance. Hence, this present study was conducted to document beach forests composition and conservation status in selected coastal municipalities of Surigao del Sur, Philippines. The study was conducted in five sampling locations, namely, La Paz, Bil-at, Balibadon, Poblacion Cagwait and Arangasa Island. At each sampling location, a 2 km transect line, parallel to the beach's shoreline, was established having a 100 square meter sampling plots spaced 50m apart. Beach species frequency counts, percentages, and diversity indices were quantified. The study documented 27 beach forest species belonging to 21 families and 25 genera with the dominant species being *Crinum asiaticum, Cocos nucifera, Millettia pinnata, Timonius compressicaulis,* and *Terminalia catappa.* Both Arangasa Island and La Paz beach forests have the highest species diversity (H' = 2.04); however, Cagwait has the highest species richness (Margalef = 2.34). This study has potential to significantly contribute in addressing existing data gap regarding beach forest species in the Philippines. With the looming threat of extinction due to infrastructural development and anthropogenic activities, the study's outcomes stand as an urgent call to action; thus, a collaborative endeavor of Local Government Units, academicians, and community for conservation and protection before these species succumb to the threat of extinction.

Keywords: Beach forests trees, climate change resilience, coastal greenbelts, disaster mitigation, Surigao del Sur

INTRODUCTION

The Philippines is located along the Pacific typhoon belt. Thus, the country experiences an average of 20 typhoons each year, of which at least five are destructive (ADRC 2019), claiming lives and properties. Among the most recently disastrous typhoons experienced within the country were Ondoy (2009), Sendong (2011), Pablo (2012), and Yolanda (2013), which impacted the agriculture and fishery sectors of the affected areas. One of the places in the Philippines that is always on the direct path of most typhoons in the country is the province of Surigao del Sur. This province is also often hit by floodings, making this area devastated by these natural disasters. Several strategies are therefore developed to mitigate the impacts of typhoons and floodings, one of which is by establishing coastal greenbelt. Coastal greenbelts act as a shield against natural disasters which can be in the form of mangroves and beach forest communities. Besides its role as natural barriers from typhoons and flooding, these vegetation communities are increasingly recognized to have a vital role in climate change mitigation by serving as important carbon storage. Mangroves and beach forests are also important habitat for various flora and fauna especially those adapted to unique transitional ecosystems.

Beach forests in particular, are a distinctive coastal ecosystem critical in protecting coastal environments and preserving biodiversity. These unique ecosystems are found in various coastal regions worldwide and are characterized by their proximity to the shoreline, often extending from the upper beach to the inland areas. Its biodiversity can alleviate coastal erosion (Göltenboth et al. 2006) due to the presence of littoral creepers, shrubs, and trees, which typically form a part of the supratidal vegetation that aids in mitigating the impact of powerful winds, coastal erosion, and wave actions resulting from typhoons, storms, and tropical cyclones (Romeroso et al. 2021). These forests stabilize soil, protect against erosion, and act as a bio-shield, safeguarding lives and properties from wind and wave energy causing storm surges. In addition, many plant species composing beach forests are characterized with water-resistant fruits and seeds which have undergone evolutionary adaptations, enabling them to be dispersed by sea currents (Göltenboth et al. 2006a).

While beach forests provide essential ecological functions and services, these ecosystems are increasingly threatened by environmental stressors such as climate change and coastal development. The biodiversity of beach forests is also confronted with imminent dangers caused by anthropogenic activities, and the possibility of species extinction is a significant concern. Since the coastal areas and riverbanks were among the initial areas made available for human tenancy, the flora and fauna of beach forests were among the most impacted by the collateral damage caused by such development (Primavera and Sadaba 2012).

Despite its great ecological importance Primavera (2018), beach forests are often overlooked politically and economically. In 2015, the Philippine government took the initiative as part of its mandate towards the environment, allocated an initial Php 400M to the Department of Environment and Natural Resources (DENR) through the Department of Budget and Management (DBM) as part of the National Greening Program (NGP) for the development of mangrove and beach forests to uphold the crucial functions of these ecosystems (DENR 2019). Such development requires baseline information regarding the state and characteristics of beach forests as a reference for decision making and management. Unlike other ecosystem types, the beach forests of the Philippines have not been extensively researched (Primavera and Sadaba 2012). Among the studies that have been carried out in beach forests were in Dinagat Island, Guiuan, Eastern Samar, San Jose, Antique, and Kiamba, Sarangani Province (Lillo et al. 2019; Sabulao et al. 2020; Cañeda et al. 2022; Millamena et al. 2022); hence there is still a need for additional floristic inventories that is necessary to address the limited availability of data on beach forests and prevent the extinction of native species due to environmental threats and infrastructural developments. Consequently, minimal information on the beach flora species also resulted in data scarcity in the country. Besides, no extant published scientific reports on the beach forests' diversity and community structure in the province of Surigao del Sur were noted; thus, the dearth of information was the motivation to undertake this endeavor. Hence, this study aims to provide an overview of the beach forests in the selected municipalities of Surigao del Sur, shedding light on their ecological significance, current status, and the challenges they face. These findings can be utilized for crafting contextual policy for conservation and sustainable management of natural resources.

MATERIALS AND METHODS

Study area

Surigao del Sur is situated along the northeastern coastline of Mindanao, facing the Philippine Sea, between the longitudes of 125°40' to 126°20' East and the latitudes of 7°55' and 9°20' North. It is bordered to the northwest by the province of Surigao del Norte, to the southwest by Davao Oriental, and the west and southwest by Agusan del Norte and Agusan del Sur (Province of Surigao del Sur 2023). The province is classified as having a Type II climate, characterized by rainfall that is evenly distributed throughout the year, although a distinct rainy season usually begins in November and ends in March. Regardless, in recent years, there have been variations in the climatic behavior of the province, with the onset of the rainy season occurring at different times than usual. The months with low rainfall are from July to October, with September as the driest month. On the other hand, the wettest months are from November to June, with January experiencing the highest amount of rainfall (Surigao del Sur 2023). The sampling was conducted in five locations of beach forest of the coastal barangays of Bayabas: La Paz (9° 00' 50" N, 126° 14' 24" E) and Bil-at (8° 57' 56" N, 126°17' 42" E); Cortes: Balibadon (9° 08' 46" N, 126° 10' 21" E); Cagwait: Poblacion (8° 54' 57" N, 126° 18' 38" E) and Arangasa Island (8° 52' 46" N, 126° 20' 24" E) (Figure 1).

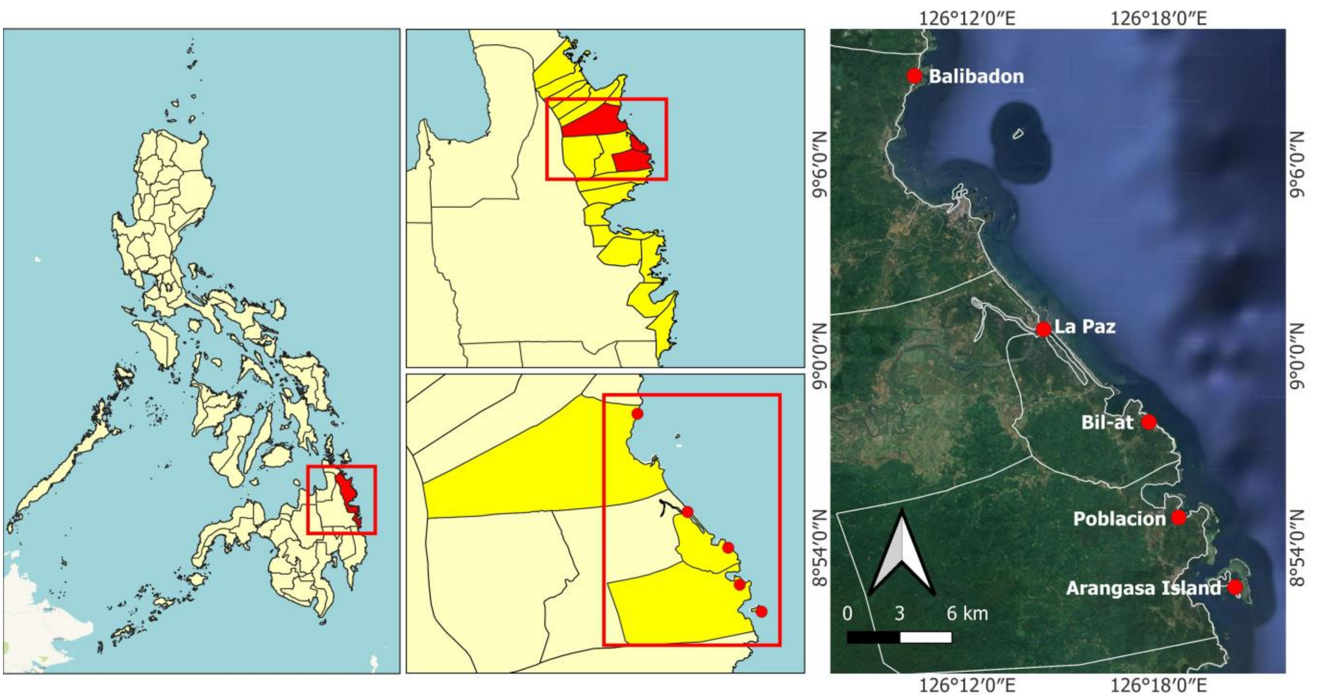

Figure 1. Location of sampling sites in Surigao del Sur, Philippines

Table 1. Rating ranges and values for ecological indices evaluation (diversity, richness, and evenness)

Shannon-Wiener Diversity Index		Margalef Richness Index		Pielou Evenness Index	
Range	**0-5**		**0-5**		**0-1**
High status	>4-5	Integrated	>5	Balanced	>0. 8-0.9
Good status	>3-4	Semi disturbed	>2.05-5	Semi- balanced	>0.5-0.8
Moderate status	>2-3	Disturbed	≤2.05	Unbalanced	≤ 0.5
Poor status	>1-2				
Bad status	0-1				

Sampling procedure and community structure analysis

Prior to sampling, reconnaissance surveys were undertaken in the different coastal municipalities of Surigao del Sur to obtain a comprehensive understanding of the geographical setting and coast's condition, ascertain the presence of indigenous species, quantify the extent of beach forest coverage, and designate the appropriate location for establishing transects. Moreover, human settlements and activities within the beach forest ecosystems were also noted. The field samplings were done from August to October, 2020 during the dry or low rainfall season.

At each sampling location, a 2 km transect line, parallel to the beach's shoreline, was established having a 100 square meter sampling plots with an interval of 50m. The number of subplots per sampling area were varied depending on the length of the coastline. Beach forests species were identified in-situ utilizing the book "Beach Forest Species and Mangrove Associates in the Philippines" (Primavera and Sadaba 2012) and field guide by Primavera and Montilijao (2017). Herbaria specimens were photographed in situ for proper identification and deposited in North Eastern Mindanao State University- Tandag Campus.

Species identified on each site were accounted for beach forest plants' distribution, richness, diversity, dominance, and evenness. The rating of ecological indices levels used in this study was adapted from Jorgensen et al. (2005) which was modified by Hussain et al. (2012) to suit the ranges of ecological indices in their research in the southern marshes of Iraq (Table 1). The number of families and species' relative frequency distributions were also counted to identify the most prevalent groups and genera.

Data analysis

Microsoft Excel (Microsoft Corporation 2018) was used to compute descriptive statistics such as counts, percentages, and mean. On the other hand, Paleontological Statistics (PAST) 4.10v (Hammer et al. 2001) was used to evaluate the species diversity indices and cluster analysis using the Bray-Curtis similarity index.

RESULTS AND DISCUSSION

Beach forests flora composition and distribution

A total of 27 species of beach forest flora belonging to 21 families and 25 genera were recorded in the selected municipalities of Surigao del Sur. Table 2 depicts that the beach forest flora in the present study exhibited a relatively similar abundance to other beach forests within the Philippines and other countries based on recorded families. However, in terms of species, it is lower than most of the study sites. The variation of plant diversity among locations is likely influenced by climatic conditions, soil, topography and level of human disturbances as well as the number and extent of sampling plots.

In terms of family composition, data in figure 2 revealed that Fabaceae recorded the highest number of species with three species, while two species within the families of Arecaceae, Combretaceae, Lecythidaceae, Malvaceae, and Rubiaceae (Table 3). The beach forests were dominated by species *Crinum asiaticum* Linn., *Cocos nucifera* Linn., *Millettia pinnata* Linn., *Timonius compressicaulis* Wall. ex G. Don, *Terminalia catappa* Linn., *Premna serratifolia* Linn., *Calophyllum inophyllum* Linn., *Morinda citrifolia* Linn., and *Talipariti tiliaceum* (Linn.) Fryxell (Figure 2). Notably, *C. nucifera* and *T. catappa* were observed to be widely distributed in the transect lines across all sites.

The observed high abundance and wide distribution of beach forest species within family Fabaceae indicate that it is known for its wide range adaptability, making it one of the most prolific botanical families (Chase et al. 2016). According to Christenhusz and Byng (2016), it is the third largest plant family in species numbers after the Asteraceae and Orchidaceae. Fabaceae has around 770 genera and 19,500 species (Christenhusz and Byng 2016; Azani et al. 2017). In addition, Arfin Khan et al. (2014) reported that their ability to thrive in barren soil conditions enables their successful establishment in inhospitable environments, and the facilitating effect of Fabaceae is more distinct in conditions of extreme climate (Baptista et al. 2020).

On the other hand, the Arecaceae (palms), a well-known botanical family found in tropical and subtropical regions (Dransfield et al. 2008), holds great cultural and economic significance, comprising about 181 genera and 2,600 species (Yao et al. 2023). Besides this, the diversity and habitat range of these ancient angiosperms are essential (Martins et al. 2014). Furthermore, extensive research has been conducted on their pharmacological properties, revealing their potential use in various industries like food, cosmetics, biodiesel, etc. (Lima et al. 2015; Armenta-Méndez et al. 2019; de Souza et al. 2020). This family is further associated with biological activities such as antioxidant, antimicrobial, and anti-inflammatory effects, which can be attributed to the presence of specific chemical compounds (da Silva et al. 2021). Additionally, palm invasions have been proven to create new ecosystems, although the exact ecological impacts are not fully understood. Despite this, urbanization and global warming are expected to further propagate palm species and facilitate the establishment of non-native palms in new ecosystems (Fehr et al. 2020).

Combretaceae consists of two main genera, *Combretum* and *Terminalia*, and numerous species are widely distributed in tropical and subtropical regions globally (Rahate et al. 2019). The *Combretum-Terminalia* vegetation plays a crucial role in addressing climate change in dryland ecosystems. Additionally, research suggests that this woodland ecosystem in Ethiopia and other tropical regions stores a significant amount of carbon, surpassing other dryland vegetation (Tesfaye and Negash 2018). Moreover, studies have demonstrated the phytochemical and pharmacological properties of these two genera (Anand et al. 2015; Cock and Van Vuuren 2015; Salih et al. 2017a, b; Terças et al. 2017; Salih et al. 2018). Similarly, the family Lecythidaceae is found in tropical regions of Central and South America, Southeast Asia, Africa, and Madagascar (Mori 2004), with approximately 25 genera and 400 species identified (de França Ferreira et al. 2021). One of its subfamilies, Planchonioideae, consists of six genera, with *Barringtonia* being the most prominent. *Barringtonia asiatica* is known as the "fish killer tree" due to its ability to induce piscicidal activity (Drijfhout and Morgan 2010). Furthermore, various plant species in this family have been found to possess a diverse range of bioactivities (anti-arthritic, anti-inflammatory, antileishmanial, antibacterial, and antifungal effects), attributed to the presence of bioactive compounds (de França Ferreira et al. 2021). *Barringtonia asiatica* is commonly used worldwide for the treatment of liver disorders, diarrheal diseases, eye diseases, antifungal and antibacterial conditions, chest pains, and heart problems (Umaru et al. 2018).

Another beach forest tree family observed in the coastal areas of Surigao del Sur is the Malvaceae family. This is an extensive family of angiosperms with approximately 244 genera and 4,225 species found in tropical and subtropical regions (Christenhusz and Byng 2016). It includes important species like cotton and okra (Alzahrani et al. 2021). *Talipariti tiliaceum*, a member of this family, is a shrub or tree found in coastal areas and associated with mangrove vegetation. It is also known by other names as *Hibiscus tiliaceus* Linn., and its variations (Vélez-Gavilán 2022). A study suggests that *T. tiliaceum* is suitable for a bioretention tree system in tropical regions due to its growth rate, root infiltration capabilities, and nitrogen absorption (Lim et al. 2021). Rubiaceae is another widespread family of angiosperms with approximately 637 genera and 13,000 species (Mongrand et al. 2005; Pereira and Meireles 2010). There is a high diversity of Rubiaceae in the Philippines (Banag et al. 2017), with 83% endemic species (Davis et al. 2009). Also, Batuyong et al. (2021) mentioned that according to Alejandro (2007), the Philippines has a significant proportion (12.1%) of the worldwide Rubiaceae. On the other hand, secondary metabolites in different genera of Rubiaceae show a chemotaxonomic correlation (Martins and Nunez 2015). *M. citrifolia*, also known as noni, is a tree or shrub in the Rubiaceae family with a pantropical distribution (Nelson 2003), which is abundant in the coastline of the province; and has found various beneficial effects due to its phytochemicals (Abou Assi et al. 2017; Almeida et al. 2019). Noni extracts have shown anticancer properties (Kumar et al. 2022) and are not toxic or mutagenic, and have potential use in phytotherapeutic or nutritional contexts (de Matos Lima et al. 2022).

Meanwhile, most beach forest flora in the present study has a Least Concern Status (i.e. having a stable population trend) according to the International Union for Conservation of Nature Red List. However, some species were currently not evaluated. Notably, *Cycas edentata* de Laub., locally known as pitogo, was listed as Near Threatened due to its decreasing population trend (IUCN 2023). This beach forest species was not observed to be widely distributed and abundant in the sampling sites.

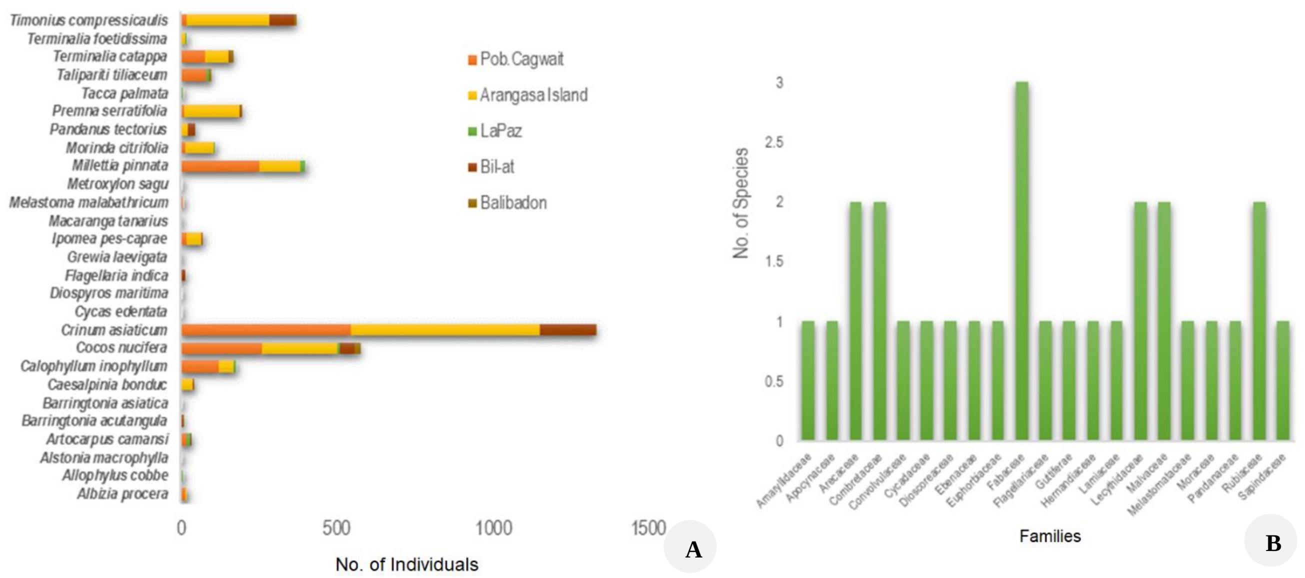

Figure 2. Illustrations of: A. The relative abundance of beach forest flora, and B. The species richness per family of beach forest flora in Surigao del Sur, Philippines

Beach forests flora community structure

The diversity indices for each site were computed in this study. Species richness represents the number of species in each site, while the Shannon diversity index accounts for species abundance and evenness. Figure 3A shows that beach forests of Arangasa Island and La Paz have the highest species diversity (H' = 2.04), while Bil-at has the lowest diversity value (H' = 1.45). The cluster can be used to show the correlation between sites and their ecological indices (Figure 3B); however, these sites are still categorized as having poor status (Table 1). The less favorable climatic and soil conditions as claimed by Atchadé et al. (2023) and the implemented ecological development policies implemented by the Local Government Units (LGUs) may contribute to this. However, this aspect was not explored in the present study. Furthermore, species richness varies among sites, with Poblacion Cagwait having the highest Margalef richness index of 2.34 and Bil-at having the lowest (1.70) (Figure 3A). The dominance of a native species and perennial bulbous herb, *C. asiaticum*, in Bil-at, Cagwait and Arangasa Island show almost the same prominence in all sites. It is well-documented in other countries for its medicinal value (Mahomoodally et al. 2021), nevertheless it is not exploited in the Philippines hence it is abundant in the wild. It has ethnomedicinal value and various studied properties such as antioxidant, analgesic, anti-inflammatory, anti-plasmodial, cytotoxicity, anticancer and antimicrobial effects (Mahomoodally et al. 2021). The ethanol extract of *C. asiaticum* seeds has potential as an anti-Alzheimer's drug due to its neuroprotective activity and anti-neuroinflammatory effects (Lim et al. 2020).

The Evenness index trends show a limited number of species in all sites with La Paz and Balibadon having a homogeneous distribution among sites. The cause maybe attributed with rapid land conversion, human settlements and the recent conversion of beaches to resorts/tourist spots, similarly observed by Millamena et al. (2022). These urban anthropogenic pressures impact biodiversity and ecosystem services (McDonald et al. 2013; Semeraro et al. 2022). Yet, developing urban vegetation can enhance resilience to climate hazards by offering urban ecosystem services, potential ecological infrastructure foundations, and urban nature-based solutions (Atchadé et al. 2023).

Certain species (*C. nucifera, T. catappa, T. tiliaceum, C. inophyllum, P. serratifolia,* and *M. pinnata*) with a diameter ranging from 12m to 62cm, with total height ranging from 5m to 12m, dominate the province's beach forest trees (Figure 4). Such findings could be an indication of a close to mature forests. As mentioned by Snedaker et al (1984), higher stand basal areas, diameters and lower densities are an indication of a more mature forests. A mature beach forest, characterized by well-established and fully developed vegetation, holds significant ecological importance within coastal ecosystems. The ecological significance of a mature beach forest is multifaceted, impacting both the terrestrial and marine environments. They can provide biodiversity support, erosion control, nutrient cycling, climate regulation, recreation and aesthetic value and storm protection (Göltenboth et al. 2006b).

Table 2. List of published studies on beach forests in different parts of the world with notes on the recorded number of species and families

Author/s	Location	Number of species	Number of families
This study (2023)	Surigao del Sur, Philippines	27	21
Cañeda et al. (2022)	Kiamba, Sarangani, Philippines	39	23
Millamena, et al. (2022)	San Jose, Antique, Philippines	16	12
Gonzalez et al. (2022)	San Agustin, Romblon, Philippines	38	21
Sabulao et al. (2019)	Guiuan, Eastern Samar, Philippines	39	
Lillio et al. (2019)	Dinagat Island, Philippines	16	15
Primavera and Montilijao (2017)	Entire Philippines	96	
Atchadé et al. (2023)	Cotonou City, West Africa	62	27
Kongapai et al. (2016)	Pang Nga, Thailand	24	
Neamsuvan et al. (2012)	Songkhla Province, Thailand	69	

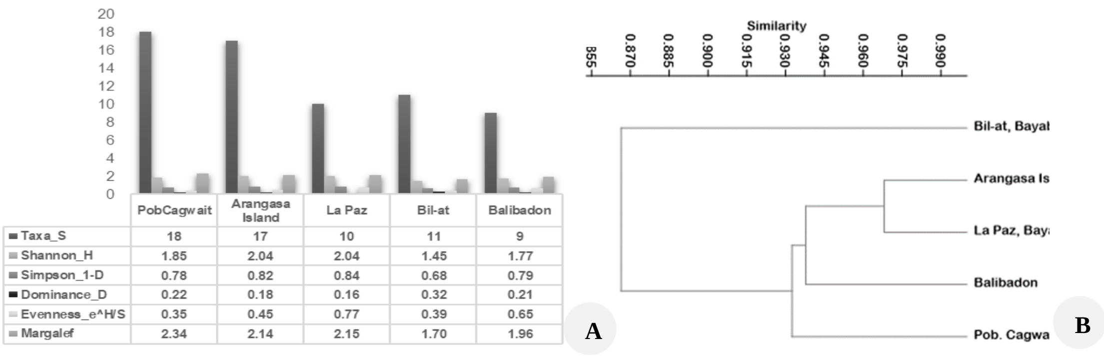

Figure 3. Illustrations of: A. Ecological indices values of beach forest flora across sites, and B. Bray-Curtis similarity dendrogram of sampling sites

Table 3. Checklist of species composition and distribution of beach forest flora in Surigao del Sur

Family name	Scientific name	Local name	Distribution per site					Freq. of occurrence across sites	Conservation status (IUCN)
			AI	PC	LP	BT	BN		
Amaryllidaceae	*Crinum asiaticum* Linn.	Bakong	*	*		*	*	80%	NE
Apocynaceae	*Alstonia macrophylla* Wall. ex G.Don	Itang-itang	*					20%	LC
Arecaceae	*Cocos nucifera* Linn.	Lubi, niyog	*	*	*	*	*	100%	NE
	Metroxylon sagu Rottb.	Sago		*				20%	LC (stable)
Combretaceae	*Terminalia catappa* Linn.	Talisay	*	*	*	*	*	100%	LC (stable)
	Terminalia foetidissima Griff.	Magtalisay	*		*			40%	LC (stable)
Convolvulaceae	*Ipomoea pes-caprae* (Linn.) R. Br.	Mambago	*	*		*		60%	LC (stable)
Cycadaceae	*Cycas edentata* de Laub.	Pitogo		*				20%	NT (decreasing)
Dioscoreaceae	*Tacca palmata* Blume	Payung-payungan		*	*			40%	NE
Ebenaceae	*Diospyros maritima* Blume	Kanomai		*				20%	LC (stable)
Euphorbiaceae	*Macaranga tanarius* (Linn.) Müll.Arg.	Binunga					*	20%	LC (stable)
Fabaceae	*Albizia procera* (Roxb.) Benth	Payhod	*	*				40%	LC (stable)
	Caesalpinia bonduc (Linn.)Roxb	Dalugdug	*			*		40%	LC (stable)
	Millettia pinnata Linn.	Bani	*	*	*			60%	LC (stable)
Flagellariaceae	*Flagellaria indica* Linn.	Huak				*		20%	NE
Guttiferae	*Callophyllum inophyllum* Linn.	Bitaog	*	*	*			60%	NE
Hernandiaceae	*Hernandia nymphaeifolia* (C. Presl) Kubitzki	Koron-koron		*				20%	LC
Lamiaceae	*Premna serratifolia* Linn.	Agdaw	*	*		*	*	80%	LC (stable)
Lecythidaceae	*Barringtonia asiatica* (Linn.) Kurtz	Bitoon	*					20%	LC (decreasing)
	Barringtonia acutangular (Linn.) Gaertn.	Himbabalod	*			*	*	60%	LC
Malvaceae	*Talipariti tiliaceum* (Linn.) Fryxell.	Malabago		*	*		*	60%	LC
	Grewia laevigata Vahl	Alagat					*	20%	LC (stable)
Melastomataceae	*Melastoma malabathricum* (L.) Smith	Malatungaw		*				20%	NE
Moraceae	*Artocarpus camansi* Blanco	Kamansi	*	*	*	*		80%	NE
Pandanaceae	*Pandanus tectorius* Parkinson ex Zucc.	Pandan	*			*		40%	LC
Rubiaceae	*Morinda citrifolia* Linn.	Noni	*	*	*			60%	NE
	Timonius compressicaulis (Wall. ex G.Don) Hook.f.	Magamwa	*	*		*	*	80%	NE
Sapindaceae	*Allophylus cobbe* (Linn.) Reausch.	Dagumay			*			20%	NE
		Total	17	18	10	11	9		

Note: AI: Arangasa Island, PC: Poblacion Cagwait, LP: La Paz, BT: Bil-at, BN: Balibadon, LC: Least Concern, NT: Near Threatened, NE: Not Evaluated

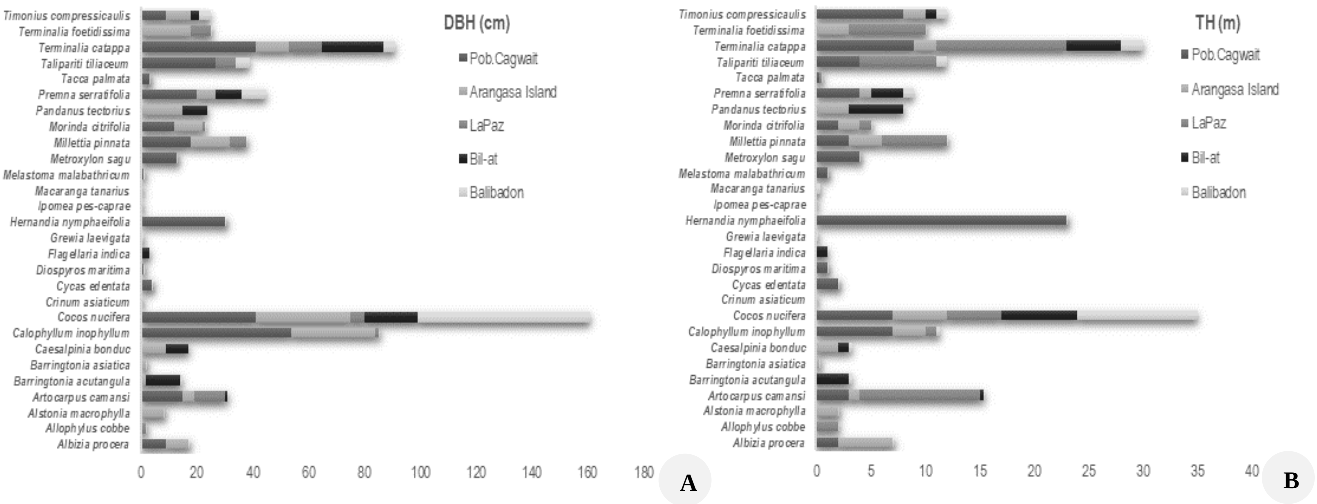

Figure 4. Illustrations of: A. Beach forests flora' Diameter at Breast Height (DBH) and B. Species' Tree Heights (TH) in all sampling sites

Similarly, *T. catappa, C. nucifera, T. tiliaceum, A. procera, M. citrifolia, Ipomoea-pes caprae* and *M. pinnata* were also found prevalent in other studies as well (Lillo et al. 2019; Cañeda et al. 2022; Gonzalez et al. 2022). *Cocos nucifera* is a primary agricultural commodity in Surigao del Sur, hence it is observed with high prevalence. Its origin is uncertain, but it is believed to be native to Southeast Asia (Lima et al. 2015; Harries et al. 2020). *Cocos nucifera* is notably important in tropical regions and produces various income-generating products (Prades et al. 2016). New developments in biodiesel production and extraction of coconut fibers from husks have been documented (Rasyid et al. 2018; Universiti Malaysia Sarawak 2019; Rao et al. 2020; Ben University of Applied Sciences 2021; Ignacio and Miguel 2021). These developments are increasingly used in agriculture, civil engineering, and eco-green cities construction (Prades et al. 2016; Rao et al. 2020).

Millettia, belonging to the Fabaceae family, consists of about 200 species thriving in tropical and subtropical regions (Chen et al. 2018). *Millettia pinnata* is found endemic in Asia and its seeds are widely used for biodiesel production (Madhu et al. 2016; Mohankumara et al. 2020), however the yield of essential oils and plant extracts is insufficient. *Millettia* trees have nitrogen-fixing capability, and can withstand adverse conditions. They are commonly used for soil erosion control and dune binding (Singh et al. 2021a). *Millettia* species are also used in traditional medicine for various ailments (Jena et al. 2020). Along with other common plants, *M. pinnata* is prevalent on the coasts of Surigao del Sur. Another tree, *C. inophyllum*, is found in Polynesia (Léguillier et al. 2015) and has numerous health benefits like anticancer, anti-HIV, antiviral, antitumor, anti-inflammatory, antimicrobial, antimalarial, anticoagulant, antifeedant, analgesic, photoprotective, molluscicidal, and piscicidal agents (Febrilliant et al. 2020). In addition, the wound healing and antimicrobial properties of *C. inophyllum* oils have been extensively studied by Léguillier et al. (2015). The seed oil of *C. inophyllum* also has low cytotoxicity and can be used as a natural screening agent (Ku et al. 2021). The seeds too are suitable for green energy production (Fadhlullah et al. 2015). *Calophyllum inophyllum* has a high fruit production rate and can adapt to different climate conditions (Jahirul et al. 2013). Pure stands of this tree can still be found along the coastlines of Surigao del Sur.

Terminalia catappa has wide application in traditional medicine (to treat dysentery and hepatitis), food, and industries (dos Santos et al. 2016). Bioactive compounds from *T. catappa* have antimicrobial potential according to Sowmya and Raveesha (2021). Their results also highlight the polyphenol-rich fraction's significant inhibition of multidrug-resistant bacterial strains and fungi; further, it reported the potential use of the identified compounds for antimicrobial use, which could lower the implication of multidrug resistance. *Premna serratifolia* on the other hand, is native to tropical and subtropical regions (Simamora et al. 2020), which has various medicinal uses (Dianita and Jantan 2017) and pharmacological properties such as tumor cell suppression, cytotoxic, anti-inflammatory, and anticancer activities (Habtemariam and Varghese 2015; Mali 2016). *Premna serratifolia* leaves also have antidiabetic and antioxidant properties (Timotius et al. 2018). It can also protect against the toxicity caused by various xenobiotics (Singh et al. 2021b). Its roots have anti-inflammatory and immunomodulatory effects (Azad et al. 2018). Meanwhile, it was documented that *Hernandia nymphaeifolia, Artocarpus camansi, C. inophyllum, M. pinnata, C. nucifera,* and *T. catappa* are some observed centuries-old trees in the province’s coastal areas. Taller and bigger beach forest trees suggest a more developed and matured forest, which can only be achieved over time. Likewise, the presence of *I. pes-caprae* is very evident as vines and creepers are also copious in the sampling sites, creating beds throughout the coastline.

In conclusion, the present study's findings suggest that the beach forests of Arangasa Island, Cagwait, and La Paz, Bayabas hold a substantial capacity for developing beach forest parks as tourism Eco Parks. The diversity and maturity of the beach forest trees and the reasonably high diversity and species richness/evenness indicate that the ecosystems are in good health and possess the necessary conditions for sustainable development. However, the challenges facing these beach forests are considerable. Human activities such as urbanization, infrastructure development, and recreational use of coastal areas often encroach on these ecosystems; hence, the degree of these impacts can be attributed to human exploitation of natural resources, lack of information dissemination, lack of community preparedness and resiliency, and numerous laws and programs that are not strictly implemented. In addition, climate change-related phenomena, such as sea-level rise and more frequent and severe storms, further exacerbate the vulnerabilities of these beach forests. Invasive species, pollution, and altered hydrological regimes also threaten the integrity of these unique habitats. Furthermore, Surigao del Sur’s coastline is home to rich beach forest flora that can be utilized for their valuable ethnomedicinal and ethnopharmacological components and for climate change mitigation that should be explored and exploited.

Understanding the beach forests' socioeconomic, cultural, climate change and disaster risk mitigation importance to coastal communities is crucial for developing sustainable management strategies to ensure their continued ecological significance; hence, conservation and rehabilitation efforts are recommended. This research hopefully will contribute to the broader goals of coastal conservation and the sustainable management of beach forests in the face of a changing world. The study provides valuable information for policy-making, conservation strategies, management, and action plans for the beach forests of Surigao del Sur to protect and preserve this unique yet understudied ecosystem.

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