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Diversity and vegetation analysis in Delta Island, Lumbocan, Butuan city, Agusan Del Norte, Philippines

Chennie L. Solania*, Laurence B. Calagui

Department of Biology, Caraga State University, Ampayon, Butuan city, Agusan Del Norte, Philippines

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Key words: Vegetation Analysis, Delta, Importance value.

Abstract

Vegetation analysis is a way to study species composition and structure of a plant community. At the mouth of the Agusan River, two deltas was formed through the accumulation of silt, sand and mud over years. The main island "Isla Noah" is a densely vegetated delta. Four 50 meter transect lines with a width of 5 meters each were established in the Delta Island. A total of 17 species of plants belonging from 11 families were observed. The most encountered plant species in all transect lines includes: *Saccharum spontaneum, Paspalum conjugatum, Phragmites vulgaris, Ipomoea pescaprae* and an unidentified Fabaceae plant. In terms of plant habit, trees (4.5 ± 1.19) dominated the area while the least observed species was the graminoids (3.25 ± 0.5). The only threatened species observed in the area was the *Avicennia lanata*. Species dominance is low (0.20) and species evenness (0.58) is moderate. Overall species diversity is also low (2.03) because floral community were most likely to be similar in all transects. Overall grass cover ranges from rare to frequent. Using braycurtis similarity matrix, transect 2 and 3 had a 0.80 similarity. The most important species as calculated in the importance value was *Ipomoea pescaprae* (28%) followed by *Cocos nucifera* (9%) and *Terminalia catappa* (8%). These species were accordingly most important since they were abundant and frequently encountered. Since the area harbors a vulnerable species and provides habitat to many arthropods, insects, mammals, reptiles and birds, the area needs to be protected. Long-term sustainable plan for the stabilization of the banks is necessary to prevent the soil in cascading.

***Corresponding Author:** Chennie L. Solania ✉ 888cheny@gmail.com

Introduction

The high degree of endemism and species richness of the Philippines is because of the uniqueness of its flora correlated with pristine vegetation that is the reason; the country is regarded as a biodiversity hotspot (Langenberger, 2004). As the forest ecosystem is threatened with various environmental factors it must be conserved for these several reasons, diversity leads to ecosystem stability, underpinning for agriculture and forestry, medicinal resources, natural services, recreation and commercial values (Alberto, 2005).

The vegetation of an area is the primary source of production in an ecosystem and is an important bio-indicator of environmental changes (Burianek *et al.,* 2013). Vegetation has an immense importance in soil erosion and stabilization. It also protects and conserves water, hold stream banks to prevent washout, and other ecological roles (Wani and Mughai, 2012). Therefore the vegetation analysis provides a better index than density alone regarding the importance of a species in its habitat (Rotaquio *et al.,* 2007). Despite of the ecological uniqueness of the Philippine Flora, information on the vegetation and composition of plants in the Philippine forest is less documented (Langenberger, 2004). It might be that many endemic plant species be extinct in the future without even been discovered. This motivates the researcher to study on plant composition and vegetation analysis especially in an isolated delta which as observed harbors various plant species.

The river mouth delta is part of the Agusan River Basin (Miyazato, 2004). The island is composed of silt and mud which had slowly accumulated over the years.

The study generally aims to identify, classify and determine the conservation status of plants observed within Delta Island, determine the species richness, relative abundance, evenness, dominance and diversity and conduct vegetation analysis using cluster analysis, relative frequency, relative dominance and importance value.

The data gathered from the study served to provide baseline information on plants present in the area and could be a basis for crafting conservation measures not only for the plants but for the island as well.

Materials and methods

Study area and establishment of quadrats

The study was conducted at Delta Island, Lumbocan, Butuan City (Fig. 1) locally known as "Isla Noah" last February 1, 2016. 4-50m transect lines with a width of 5m were established, having a distance of 50m from each transect lines. The coordinates and elevation of each quadrat were collected to geographically describe the area.

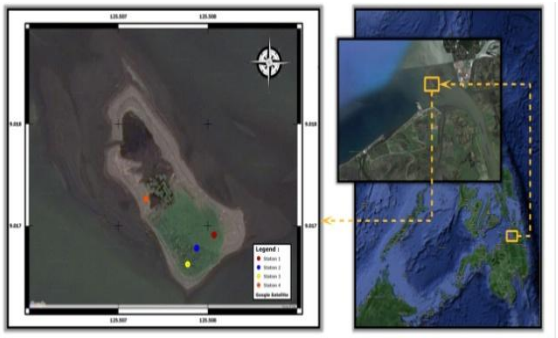

Fig. 1. Map showing Butuan Bay and the Sampling Stations at Delta Island, Barangay Lumbocan, Butuan City, Agusan Del Norte, Philippines.

Collection of taxonomic data and identification of plants

All plants observed within the transect were recorded. For grasses, sampling was done within a 1x1 quadrat inside each transect. Grasses were assessed using DAFOR wherein it utilizes percent cover. Cover is a size-based measure of the area covered by the above-ground parts of plants of all the species and sums to 100% (Sutherland, 2006). Field Information regarding the leaves, height of plant, manner of branching, color of flowers, local names and all other taxonomic characters considered vital in the identification process (Gomez-Roxas *et al.,* 2005) were recorded. Detailed photo documentation of each plant is collected since voucher specimens for herbarium purposes were not done. The weeds, herbaceous plants and grasses were identified using the book of Moody *et al.,* 1984.

Trees were identified using online keys and other reliable journals and online resources. Conservation status was of the observed plants was determined through IUCN Red List of Threatened Species, 2015.

Biodiversity indices, cluster analysis and vegetation analysis

Biodiversity indices (species richness, abundance, dominance, evenness and diversity), seriation analysis and cluster analysis were computed through Paleontological Statistics Software ver. 2.17c.

The most important species in the community can be determined by calculating the importance value of each species. For each species the following values were calculated: Abundance, Relative Abundance, Frequency, Relative Frequency, and Importance Value (Relative Abundance + Relative Frequency) (Schmidt, 2005).

Results and discussion

Species composition and abundance

A total of 17 species of plants, belonging from 11 families with three unidentified species (Table 6) were observed in all four transect lines laid in the sampling area at Delta Island, Lumbocan, Butuan City (Table 1).

There were five plant species observed in all transect lines as shown in Fig. 2. These include *Saccharum spontaeum, Paspalum conjugatum, Phragmites vulgaris, Ipomoea pescaprae* and a Fabaceae species (unidentified sp1). The first three were grasses, in which grasses were by nature cosmopolitan in distribution. *Paspalum conjugatum* is a predominant species in open habitats which is mostly glycophytic and mesophytic plant (Watson and Dallwitz, 1992). It has invasive properties and can grow in areas affected by periods of mild salinity (Ibemesim, 2010). *Saccharum spontaeum* is another wild species that grows on very well or less nutritious sandy soils (Balyan *et al.,* 1997). This adaptation explains the presence and abundance of these species in the area. Another species that were observed in all transect was *Ipomoea pescaprae*, a trailing vine that grows along coastal beaches forming large mats that stabilizes the sand (Umamaheshwari *et al.,* 2012). *Rhizopora stylosa* is only found in Transect 4 (facing the tides) where the substrate is muddy. According to Duke, 2006, these species were adapted to a wide range of intertidal wetland zone but grows best in fine mud sediments of downstream river estuaries.

Table 1. Species composition of plants at the Delta Island, Lumbocan, Butuan City, Agusan Del Norte, Philippines.

Family Name	Scientific Name	Common Name	Local Name
Arecacea	*Cocos nucifera*	Coconut	Lubi
Arecaceae	*Nypa fruiticans*	Nipa Palm	Nipa
Asteraceae	*Bidens pilosa*	Cobbler's pers	Pisau-pisau
Avicenniaceae	*Avicennia lanata*	Piyape	Piyape
Combretaceae	*Terminalia catappa*	Tropical Almond	Talisay
Convolvulacea	*Ipomoea pes-capreae*	Bayhops, Goat's Foot	Bagon-Bagon
Cyperaceae	*Actinoscirpus grossus*	Giant Bur Rush	Rush
Malvaceae	*Hibiscus tiliaceus*	Sea Rosemallow	Malabago
Musaceae	*Musa acuminata*	Banana	Saging
Poaceae	*Saccharum spontaeum*	Cane Sauvage	Bugang
Poaceae	*Phragmites vulgaris*	Common Reed	Tambo
Poaceae	*Paspalum conjugatum*	Carabao Grass	Kayat
Pontederiaceae	*Eichhornia crassipes*	Water Hyacinth	Water Hyacinth
Rhizophoraceae	*Rhizophora stylosa*	Red/Stilted Mangrove	Bakhaw
Fabaceae	Unidentified species 1		
	Unidentified species 2		
	Unidentified species 3		

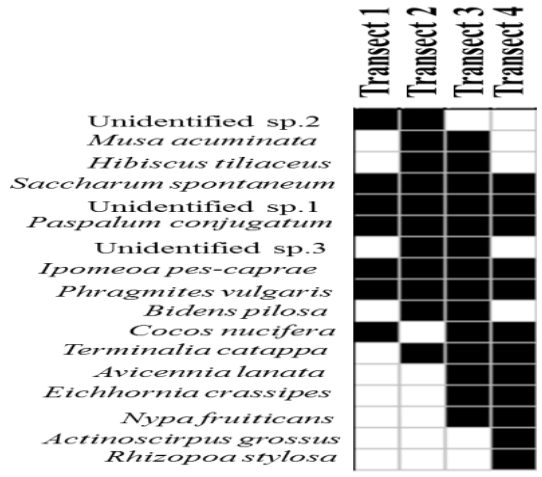

Fig. 2. Seriation Analysis of observed plant species in Delta Island, Lumbocan, Butuan City, Agusan Del Norte, Philippines.

In terms of plant groups, graphical presentation in Fig. 3 showed the number of monocot and dicot species, was equal living no plant group to be dominant with the other. In all transects surveyed, it was shown in Fig. 4 that tree with a mean value of 4.5 ± 1.190 is the most abundant plant habit. Trees in the area includes, *Cocos nucifera, Terminalia catappa, Avicennia lanata, Nypa fruiticans, Hibiscus tiliaceus, Rhizophora stylosa*and the Fabaceae species (unidentified sp.1) Herbs comprises only a mean of 3.5 ± 0.8660 in all transects. While the least abundant plant habit were the graminoids with a mean value of 3.25 ± 0.5000. There were only four species of grasses observed in the area, namely *Saccharum* sp *ontaeum, Paspalum conjugatum, Phragmites vulgaris* and *Actinoscirpus grossus* (Fig. 5).

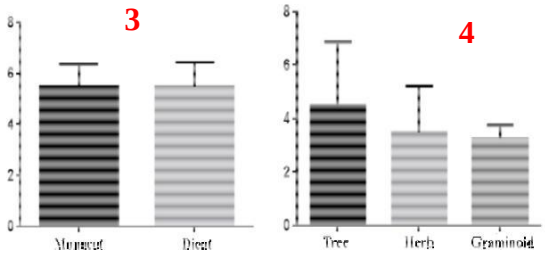

Fig. 3. Number of plant species in the different group. Error Bars represent standard error of the means.

Fig. 4. Graphical illustration of the number of plant species in terms of plant habit. Error Bars represent standard error of the means.

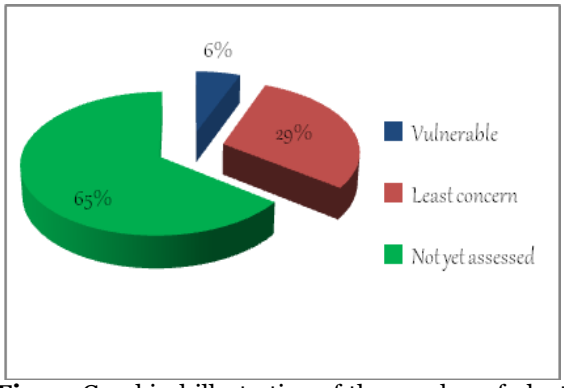

Fig. 5. Graphical illustration of the number of plant species in terms of plant habit. Error Bars represent standard error of the means.

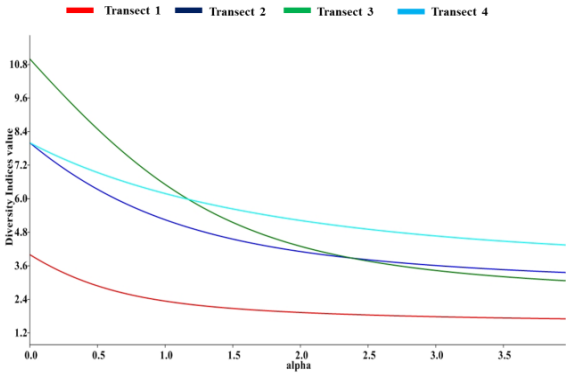

Fig. 6. Conservation Status of surveyed plants in Delta Island, Lumbocan, Butuan City, Agusan Del Norte, Philippines.

Conservation status

It was shown in Fig. 5 that most of the surveyed plant species were not yet assessed by the International Union for the Conservation of Nature due to its abundance in the field. There were five species that were regarded as least concern, these includes, *Paspalum conjugatum, Saccharum spontaneum, Phragmites vulgaris, Actinoscirpus grossus* and *Rhizophora stylosa*. The only vulnerable species was *Avicen nialanata* (IUCN, 2015). It is regarded as vulnerable because it is considered to be facing a high risk of extinction in the wild.

According to Jayatissa *et al.,* 2002, if there are rare and threatened species present in an area it requires very specific management practices. Therefore the presence of a vulnerable species (*Avicennia lanata*) requires a strict management in order for this plant to boost in number.

Biodiversity Indices and Cluster Analysis

Table 2 shows the computed Biodiversity indices with a total abundance of 319. It is noticeable that the total species richness is only 13 because the researcher excludes the grasses in the computation since; grasses observed in the area were scored in percent cover interpreted through DAFOR (table 2 and 4).

Overall Species Dominance is low (0.2142) implicating that there was no species dominating in abundance in the area sample. These results coincided with the overall evenness (0.5833) which is interpreted as moderate, meaning there was an even distribution of species across transects.

Table 2. Diversity Indices of observed plants excluding graminoids in the Delta Island, Lumbocan, Butuan City, Agusan Del Norte, Philippines.

Diversity Indices	Transect 1	Transect 2	Transect 3	Transect 4	Total
Species richness	4	8	11	8	13
Abundance	60	78	116	65	319
Dominance	0.5178	0.2433	0.2326	0.1915	0.2142
Simpson	0.4822	0.7567	0.7674	0.8085	0.7858
Shannon	0.8495	1.658	1.873	1.822	2.026
Evenness	0.5846	0.6561	0.5919	0.7733	0.5833

Table 3. Percent cover (%) of graminoids observed in the sampling area.

Species Name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Average
Paspalum conjugatum	50	20	35	20	31.25
Saccharum spontaneum	25	75	50	25	43.75
Phragmites vulgaris	25	5	15	25	17.5
Actinoscirpus grossus	0	0	0	30	7.5

Table 4. Interpretation of plant percent cover using DAFOR*.

	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Overall
Paspalum conjugatum	A	O	F	O	F
Saccharum spontaneum	O	D	F	O	F
Phragmites vulgaris	O	R	O	O	O
Actinoscirpu sgrossus	R	R	R	O	R

*D-Dominant (>75% cover), A-Abundant (51-75%), F-Frequent (26-50%), O-Occasional (11-25%) and R-Rare (<11%cover).

Simpson's Diversity is the measure of dominance that gives the probability that any two individuals drawn at random infinity large community belongs to different species. The total Simpson's diversity is high, meaning there is a high probability of species occurring in all sites. This probability was also reflected in the seriation analysis in Fig. 2, wherein almost all species can be seen in all transects laid.

According to Fernando and Rajaraman, 1998, the overall Shannon diversity (2.026) in table 2 means low. It might also be speculated that since floral communities were most likely to be similar in all transects in the area, it can lead to the low diversity.

Seasonal Flooding and ocean currents also deplete the soil in the Delta Island and might also be the reason for the low diversity. According to locals, long before the Island is still lush of beach forest plants but as years pass by, the ocean currents and seasonal flooding from the Agusan River flushed out the land leaving what is now seen today.

It was shown in Fig. 6 that transect 3 has the highest diversity profile among all transect studied because it has the highest variety of beach forest plants observed. Ten species of plants (trees and herbs) and three species of grasses were observed in Transect 3.

While Transect 1 was the least diverse in all transects. Transect 1 was an open area habitat and the only species observed in the site were the grasses and herbs.

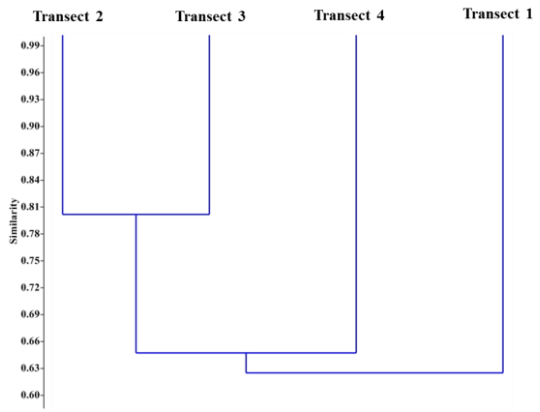

Fig. 7. Diversity Profile of plant species in the sampling area.

Grasses were scored using percentage cover inside each 1x1 quadrat to have an ease in counting shown in table 3. *Saccharum spontaneum* is the most abundant grass with an average of 43.75% while the least abundant was the *Actinoscirpus grossus* found only in transect 4 and which only had an average abundance of 7.5%. *A. grossus* is a naturalized weed which occurs in swappy and inundated places spreading by stolons. In some part of the USA, *A. grossus* poses a significant threat to the tropical plants since it dominates the place (WSSA, 2012). But in the area, *A. grossus* is not dominant in the area paving no competition to other native species.

The average results for both *S. spontaeum*and *P. conjugatum* were Frequent with *P. vulgaris* as Occasional and *A. grossus* as Rare according to the interpretation tool-DAFOR (Table 5-6). Grasses on both sides of the beaches was common but progressing towards the center was least. Because by nature grasses like areas which were well-lighted, in Quadrat 2 (midpart of the island) grasses were not that common because of dense canopy cover from the trees with the exception of *S. spontaneum* locally known as "Bugang" as this species tends to grow taller than other species of grass.

Table 5. Plant Groups and Plant Habit of each plant observed in the Delta Island, Lumbocan, Agusan Del Norte, Philippines.

Species Name	Habit	Plant Group
Ipomoea pes-caprae	Herb	Dicot
Cocosn ucifera	Tree	Monocot
Terminalia catappa	Tree	Dicot
Avicennia lanata	Tree	Dicot
Nypa fruiticans	Tree	Monocot
Hibiscus tiliaceus	Tree	Dicot
Musa acuminate	Herb	Monocot
Eichhornia crassipes	Herb	Monocot
Rhizopora stylosa	Tree	Dicot
Bidens pilosa	Herb	Dicot
Paspalum conjugatum	Grass	Monocot
Saccharum spontaneum	Grass	Monocot
Phragmites vulgaris	Grass	Monocot
Actinoscirpus grossus	Grass	Monocot
Unidentified sp 1	Tree	Dicot
Unidentified sp 2	Herb	Dicot
Unidentified sp 3	Herb	Dicot

Table 6. Species composition and Abundance of each plant observed in the Delta Island, Lumbocan, Butuan City, Agusan Del Norte, Philippines.

Species Name	T1	T2	T3	T4	Total
Ipomoea pes-caprae	40	30	50	15	135
Cocos nucifera	16	0	3	6	25
Terminalia catappa	0	10	4	5	19
Avicennia lanata	0	0	5	20	25
Nypa fruiticans	0	0	8	7	15
Hibiscus tiliaceus	0	5	10	0	15
Musa acuminata	0	5	3	0	8
Eichhornia crassipes	0	0	15	8	23
Rhizopora stylosa	0	0	0	3	3
Bidens pilosa	0	5	13	0	18
Unidentified sp 1	2	1	2	1	6
Unidentified sp 2	2	2	0	0	4
Unidentified sp 3	0	20	3	0	23

The cluster analysis on the four transects in Fig. 7 revealed two groups. The first group was composed of Transect 1 alone and the second group was composed of Transect 4 and the group of Transect 2 and 3 with a 0.65 similarity. Transect 2 and 3 (with a 0.80 similarity) had the highest similarity. The result was in full agreement to the species composition and abundance of these two transects because of they share almost similar species compared to other transects. According to the seriation analysis in Fig. 2, species that can only be found in Transect 2 and 3 and can nowhere found elsewhere in other transect includes: *Musa acuminata* "Saging", *Hibiscus tiliaceus* "Malabago", *Bidenspilosa* and unidentified sp.3. Transect 1 stands alone with a 0.62 similarity to other transects because of least species observed and these species were also abundant in other transects.

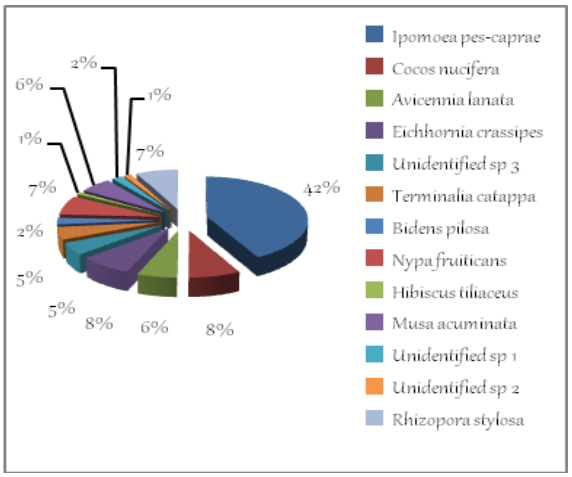

Fig. 8. Cluster Analysis of similarity of species composition and abundance at four transect lines laid at Delta Island, Lumbocan, Butuan City analyzed using Bray-Curtis Similarity Matrix.

Vegetation Analysis

Fig. 8 shows the result of vegetation analysis wherein *Ipomoea pes-caprae* (42%) had the highest relative abundance. It is a mangrove associate and abundant along shoreline and is an obligate out-crosser due to its self-incompatibility. It is an important component of the beach forest since it stabilizes the estuarine banks and shorelines (Solomon Raju *et al.,* 2014). This species was observed and abundant in all transects.

The least abundant species was the mangrove *Rhizopora stylosa* (1%), it was only found in Transect 4 with only 3 individuals. These type of mangrove should be propagated because of its massive tangled, arching roots which can protect the mainland from ocean current speed, reduce wave energy, traps sediments, reduce siltation and remove and recycle agricultural chemicals (Downing *et al.,* 2013), especially those run-off chemicals from the Agusan River. The species with highest relative frequency value were the *Ipomoea pes-caprae* and unidentified Fabaceae sp. 1 (13%) and *Cocos nucifera* and *Avicennia lanata* (10%) shown in Fig. 9.

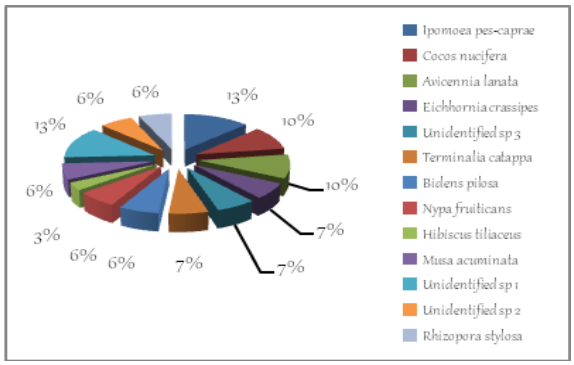

Fig. 9. Graphical illustration of computed relative abundance.

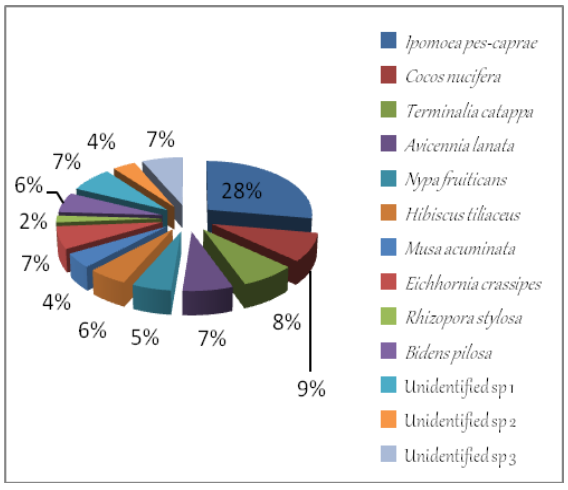

Fig. 10. Graphical illustration of computed relative frequency.

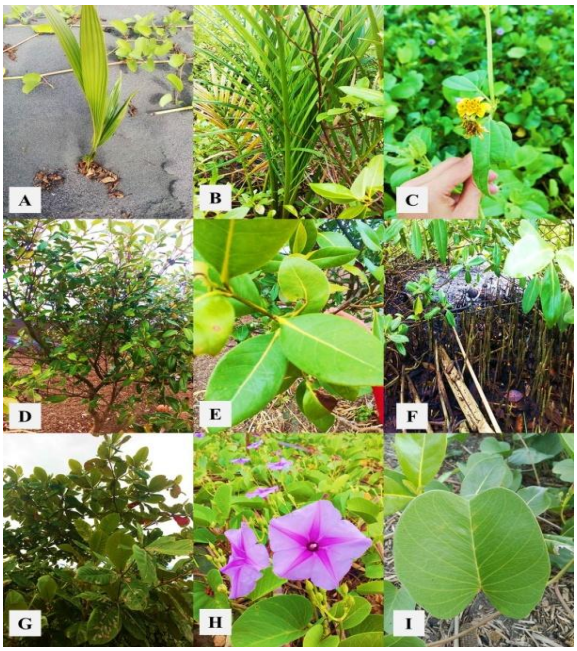

Fig. 11. Observed flora in Delta Island, Lumbocan Butuan City. (A) *Cocos nucifera,* (B) *Nypa fruiticans* (C) *Bidens pilosa* (D-F) *Avicennialanata*, whole plant, leaves and pneumatophores (G) *Terminalia catappa* and (H-I) *Ipomoea pes-caprae*, flowers and leaves.

Fig. 12. Observed flora in Delta Island, Lumbocan, Butuan City. (A) *Actinoscirpus grossus* (B) *Hibiscus tiliaceus* (C) *Musa acuminata* (D) *Saccharum spontaneum* (E) *Phragmites vulgaris* (F-G) *Paspalum conjugatum* and (H-I) *Eichhornia crassipes*, leaves and stem.

Species Important Value is used to explain the most important species in the community. It utilizes relative abundance and relative frequency (Schmidt, 2005).

It is evident in Fig. 10 that the three highest importance value surveyed was *Ipomoea pes-caprae, Cocos nucifera* (9%) and *Terminalia catappa* (8%).

Fig. 13. Observed flora in Delta Island, Lumbocan, Butuan City. (A-B) *Rhizophora stylosa*, whole plant and leaves (C-D) Unidentified fabaceae species, whole plant and leaves (E) Unidentified sp.2 and (F) Unidentified sp.3.

These species were the most abundant and frequently encountered in the area reflecting its importance value in the Delta Island. *Cocos nucifera* requires a hot, moist climate, thriving especially near the seaboard. It is tolerant to soil variations but its natural preference is for sandy, well-aerated and well drained soils.

The coconut is an important tropical tree, its products include: the fruit, fodder, apiculture, fuel, fiber, timber, lipids, alcohol and many other services (Orwa *et al.,* 2009). *Terminalia catappa* locally known as "Talisay" was another important mangrove associate species. The tree is tolerant of strong winds, salt spray, grows on moderately high salinity root zone and sandy soils.

It plays a vital role in coastline stabilization. It provides a wide range of non-wood products and services. This tree also display a characteristic pagoda form and monopodial horizontal branching which provides shades for many insects, arthropods, mammals and reptiles (Thomson and Evans, 2006).

Conclusion

The study provides information regarding the floral composition of Delta Island, Lumbocan, Butuan City. A total of 17 plant species were observed in the area with trees being the most dominant plant habit. One vulnerable species was observed (*Avicennia lanata*) implicating the conservation importance of the area, five least concern species and the rest were not yet assessed by the IUCN. Species diversity was low (2.03) because floral community were most likely to be similar in all transects.

The most diverse and abundant Transect was Transect 3. There were four species of grass observed, DAFOR interpretation revealed a rare to frequent grass population in the quadrat observed. The most important species as computed by the importance value was *Ipomoea pes-caprae* (28%), because it is abundant and found in all transects laid.

Correlation of the Physico-chemical parameters to the observed species is recommended to best explain the richness and abundance of species, and stabilization of the banks is necessary to prevent the soil in cascading.

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