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Diversity of the riparian vegetation of lower agusan river towards establishing the sago-based eco belt for disaster risk reduction

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Abstract

The study describes the floristic diversity of Lower Agusan river as basis in enhancing riparian vegetation as buffer zone to reduce flash flood impacts. A survey was conducted in the 5-kilometer easement of the river to determine existing floristic composition and soil characteristics using transect and quadrat method. Results showed that the vegetation is composed of 105 species of vascular plants belonging to 85 genera and 42 families, with composite Shannon-Weiner diversity index (H') of 1.338 for the entire ecobelt. Despite low diversity index, a number of important floral species are present in the riverbanks wherein six species under threatened status were recorded. The vegetation structures differ in every site covered by the survey. In Pagatpatan, the palm *Nipa fruticans*is predominant although significant portions are also occupied by dense grass species. The lowest diversity of plant species was in the Banza site because it is already densely populated,. In species richness, the highest species count comprising 63% of the total identified species was recorded in Mahay site. This is followed by Pagatpatan and Banza at 61% and 50%, respectively. The stocking density of the ecobelt area was assessed to be very poor to function ecologically as a riparian buffer, having a mean density of 48 stems per hectare only. This indicated that all areas surveyed were classified to be of high risk, thus immediate rehabilitation is necessary to enhance vegetation cover especially those with low plant diversity status.

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Introduction

With the increasing vulnerability of human settlements and business ventures near the rivers due to increasing rain intensity and flooding episodes brought about by climate change, many governments invested in flood control systems to reduce calamities. Investments in restoring and enhancing streams, wetland and riparian areas have substantially increased in the last decade. Mostly, investments and associated ventures rely on engineering procedures like the construction of levees, dams, reservoirs, and flood ways. Such technologies are already proven effective. However, in the process of project implementation many biological organisms having ecological and scientific importance have been displaced. One effective method is "reforestation" of the degraded riparian ecosystems. This may be traditional, yet it is considered the most ecologically sensible and cost-effective method of reducing impacts of flooding that resulted from adverse effects of climate change.

In planning for enhancing the buffer zone by establishing the ecobelt of the Lower Agusan River, baseline information on species richness of the floristic composition is very important. With this information, planners and decision makers will be able to recommend appropriate species that match site requirements for effective rehabilitation, conservation and management of the ecobelt. Thus a survey was conducted to assess the soil quality and the existing vegetation to provide the basis for enrichment.

Materials and methods

Study area

The study was done in Butuan City, a growing metropolitan area located in the flood plains of the Lower Agusan River Basin. The central part of Butuan City has a geographical coordinates of 8°56′ 57″ North, 125°32′ 37″ East. Butuan has a total land area of about 820,000 square meters with population being 306,000 (6,300 households).

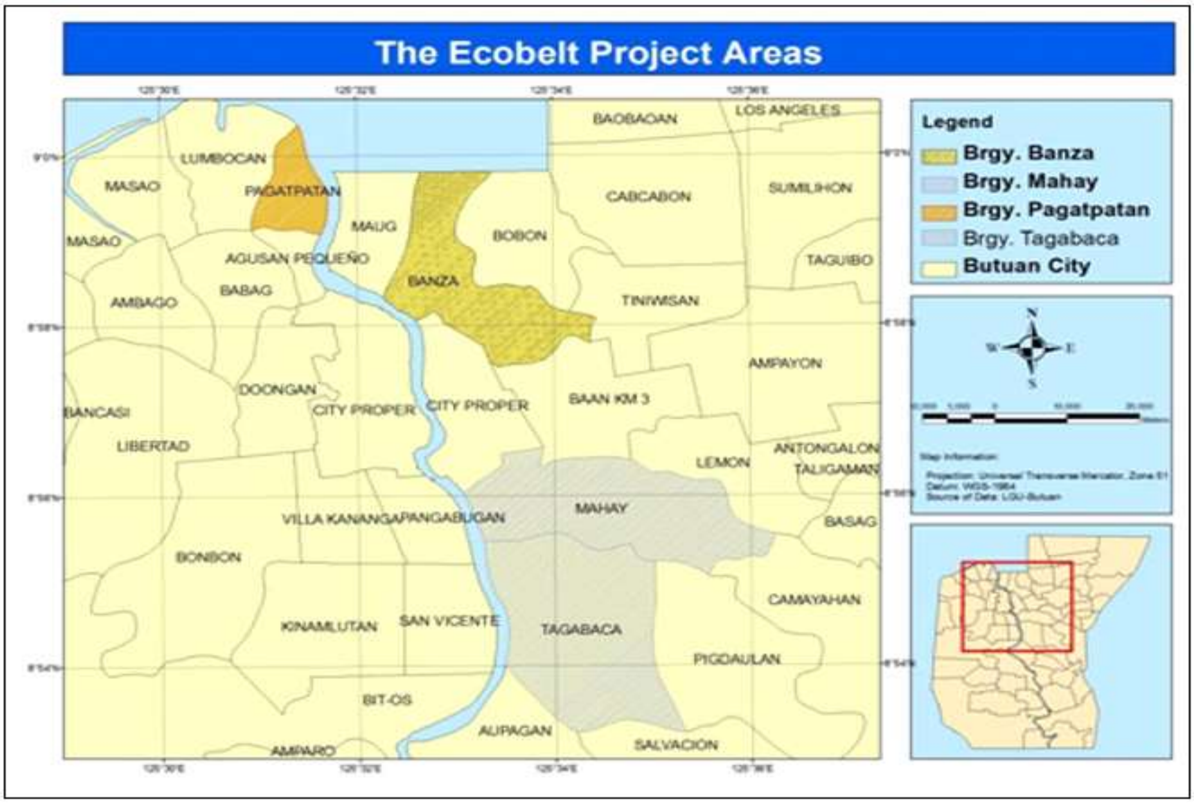

Fig. 1. Map showing the barangays of Butuan city identified as the pilot sites of the ecobelt project (Santillan, 2014).

The urban area is a delta created through years of sedimentation from silts carried by the Agusan River. The Agusan River is located in the eastern part of Mindanao. It is the third longest river in the Philippines with an estimated length of about 350 kilometers from its origin headwaters in Compostela Valley; traversing the central part of Butuan City and draining in Butuan Bay. In the eastern side of Agusan River, the floodplains irregularly undulate and incline in two directions. One direction points gently to the south-southwest direction (Mahay River and Aupagan Creek) and the other direction inclines gently to the north-northwest where Taguibo and Baan rivers flow.

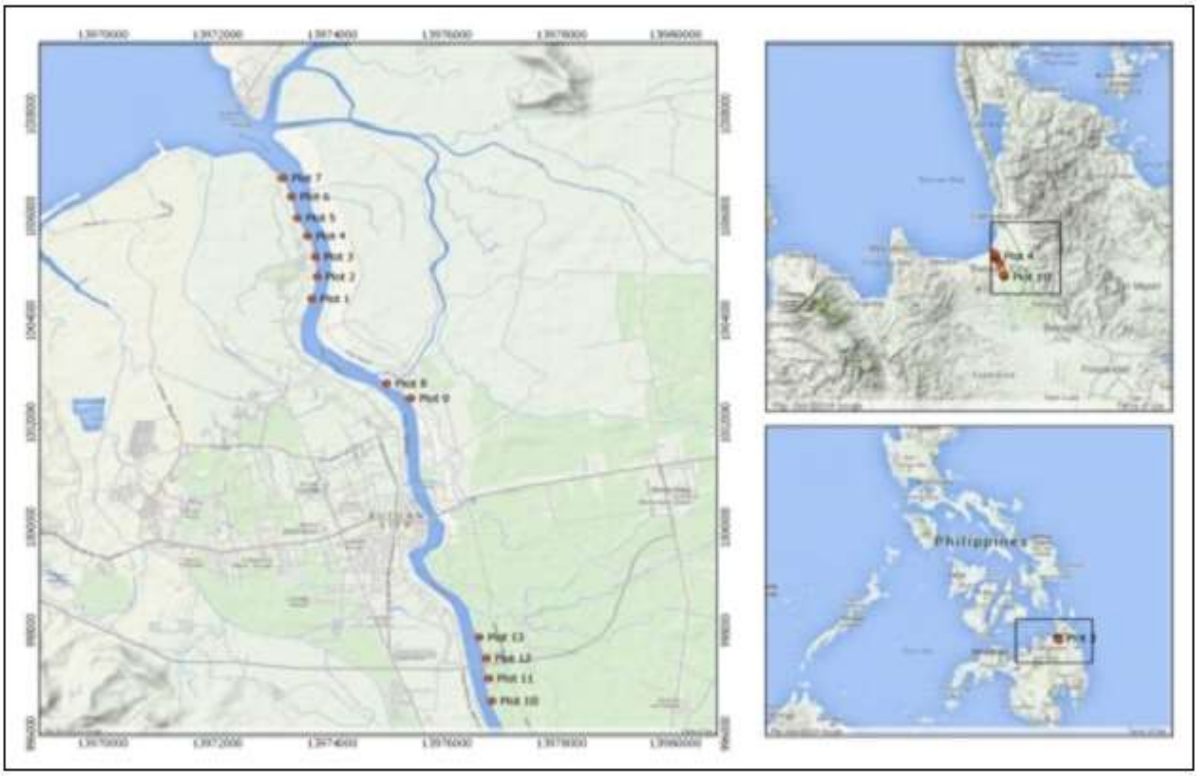

Fig. 2. Relative location of sampling plots along the proposed ecobelt in Pagatpatan, Banza, and Mahay in Butuan city.

In this side, the floodplain appears more dissected than that in the west with varying elevations reaching 5-18 meters above sea level (Banza and Mahay sites). Similar to the west-side, it is characteristically poorly drained and swampy. In the west-side of the Agusan River, the materials of the floodplain are abundantly humic and even peaty which is in contrast to the east-side where associations of humic and peaty materials are not very conspicuous. Instead there is an abundant admixture of a very course and gravelly basal sands.

Data collection

Prior to actual field survey, a pre-survey map interpretation was carried out to determine the extent and exact locations of the ecobelt. Field reconnaissance and transect walks were conducted to identify and describe vegetation types considering species richness, dominance, soil and other ecological parameters.

In the survey, the sampling procedure used was based on a belt transect method (Hill, 2005). Frame quadrats measuring 20 m x 20 m were laid out along the proposed ecobelt at an interval of 400 m from each other. A GPS was used to determine the coordinates of the quadrats. Within each quadrat, inventory and assessment of plants were conducted.

All plants (woody and non-woody) with dbh of >10 cm and height of >2.5 m were identified and recorded. Plants with dbh<10 cm are not included in the analysis but were identified and added to the species list. Taxonomic identification of the plant was done in the field for common species. For plant species that are not be readily identified in the field, photographs of the plant portraying all its salient characteristics were taken for later identification in the laboratory.

Plot establishment

Transects were established along the length of the riverbanks to identify and describe vegetation types considering species richness, dominance, and other ecological parameters. The relative location of plots per barangay is shown in Figure 2.Seven (7) quadrats were established along the riverbank of Pagatpatan for an estimated length of 2,525 m, two (2) quadrats established in Banza for an estimated length of 841 m, and four (4) quadrats were established in Mahay for an estimated length of 1,161m (Santillan, 2014). These quadrats are used for sampling of the various plant species.

Species identification

Identification of specimens was done on field using visual characteristics. For uncommon species, literatures and taxonomic identification keys were used.

References used in taxonomic identification include publications referring to the Philippine flora by de Guzman *et al.* (1986), Merrill (1912), Pancho (1983), Madulid (2001), Santos *et al.* (1986), and Zamora and Co (1986). Online identification guides such as PhytoImages (www.phytoimages.siu.edu) and Co's Digital Flora of the Philippines (www.philippineplants.org) were also utilized to compare and validate plant samples.

Data analysis

In the analysis of diversity indices, only plants with dbh>10 cm and height >2.5 meters anchored inside the quadrat were considered. Species richness, diversity index, evenness analysis were determined using a PAST Statistical software Version 2.14. Species importance value was computed using the equation SIV = RF + RDen + RDom.

Results and discussion

Species composition and diversity

Field inventory along the riverbanks of the pilot sites revealed a total of 105 vascular plant species representing 42 families (Table 1).

Table 1. Inventory of species encountered in the proposed ecobelt

#	Scientific Name	Family Name	Common Name	Area Present			Status
				P	B	M	
1	*Cynometra ramiflora*	Anacardiaceae	Balitbitan	√			NA
2	Mangifera caesia	Anacardiaceae	Baluno			√	LC
3	*Mangifera indica*	Anacardiaceae	Manga		√	√	DD
4	*Mangifera philippinensis*	Anacardiaceae	Paho		√		NA
5	*Spondias pinnata*	Anacardiaceae	Libas			√	NA
6	*Annona muricata*	Annonaceae	Guyabano	√	√	√	NA
7	*Polyalthia longifolia*	Annonaceae	Indian tree			√	NA
8	*Allamanda cathartica*	Apocynaceae	Yellow bell vine	√			NA
9	*Polyscias nodosa*	Araliaceae	Malapapaya			√	NA
10	*Schefflera insularum*	Araliaceae	Galamay-amo	√			NA
11	*Dolichandrone spathacea*	Bignoniaceae	Tui	√			LC
12	*Oroxylum indicum*	Bignoniaceae	Pinkapinkahan			√	NA
13	*Spathodea campanulata*	Bignoniaceae	African tulip			√	NA
14	*Bixa orellana*	Bixaceae	Achuete			√	NA
15	*Ceiba pentandra*	Bombacaceae	Kapok	√		√	NA
16	*Intsia bijuga*	Caesalpiniaceae	Ipil	√			ES
17	*Tamarindus indica*	Caesalpiniaceae	Sampalok	√			NA
18	*Carica papaya*	Caricaceae	Papaya		√	√	DD
19	*Terminalia catappa*	Combretaceae	Talisai	√	√		NA
20	*Muntingia calabura*	Elaeocarpaceae	Datiles	√	√		NA

21	*Breynia rhamnoides*	Euphorbiaceae	Matanghipon	√	√	√	NA
22	*Codiaeum variegatum*	Euphorbiaceae	San Francisco		√	√	NA
23	*Jatropha curcas*	Euphorbiaceae	Tuba tuba	√			NA
24	*Macaranga tanarius*	Euphorbiaceae	Binunga	√	√	√	NA
25	*Manihot esculenta*	Euphorbiaceae	Cassava		√	√	NA
26	*Securinega flexuosa*	Euphorbiaceae	Anislag			√	VS
27	*Derris cumingii*	Fabaceae	Tublingkahoy	√			NA
28	*Derris trifoliate*	Fabaceae	Tubli-tubli	√			NA
29	*Diospyros blancoi*	Fabaceae	Kamagong	√	√		CES
30	*Gliricidia sepium*	Fabaceae	Kakawate	√	√		NA
31	*Inocarpus fagifer*	Fabaceae	Kayam	√			NA
32	*Pongamia pinnata*	Fabaceae	Bani	√		√	LC
33	*Pterocarpus indicus*	Fabaceae	Smooth Narra	√		√	CES
34	*Flacourtia jangomas*	Flacourtiaceae	Governor's Plum			√	NA
35	*Arundo donax*	Graminae	Tambo	√			LC
36	*Bambusa spinosa*	Graminae	Kawayantinik	√	√	√	NA
37	*Bambusa vulgaris*	Graminae	Kawayandilau		√		NA
38	*Chromolaena odorata*	Graminae	Hagonoy	√	√		NA
39	*Dendrocalamus merrilianus*	Graminae	Bayog	√			NA
40	*Imperata cylindrical*	Graminae	Cogon	√	√	√	NA
41	*Saccharum spontaneum*	Graminae	Talahib	√			LC
42	*Lantana camara*	Lamiaceae	Lantana		√		NA
43	*Persea americana*	Lauraceae	Avocado	√	√	√	NA
44	*Barringtonia acutangula*	Lecythidaceae	Saku	√	√		NA
45	*Barringtonia racemosa*	Lecythidaceae	Potat	√	√	√	NA
46	*Dracaena fragrans*	Liliaceae	Fortune Plant			√	NA
47	*Durio zibethinus*	Malvaceae	Durian		√	√	NA
48	*Hibiscus rosa-sinensis*	Malvaceae	Gumamela	√			NA
49	*Hibiscus tiliaceus*	Malvaceae	Malubago	√	√	√	NA
50	*Kleinhovia hospita*	Malvaceae	Bitan-ag	√	√	√	NA
51	*Theobroma cacao*	Malvaceae	Cacao			√	NA
52	*Azadirachta indica*	Meliaceae	Neem	√	√		NA
53	*Lansium domesticum*	Meliaceae	Lanzones			√	NA
54	*Sandoricum koetjape*	Meliaceae	Santol	√	√	√	NA
55	*Swietenia macrophylla*	Meliaceae	LL Mahogany	√	√		VS
56	*Acacia confuse*	Mimosaceae	Ayangile			√	NA
57	*Leucaena leucocephala*	Mimosaceae	Ipil-ipil	√	√	√	NA
58	*Paraserianthes falcataria*	Mimosaceae	Falcata		√	√	NA
59	*Saman easaman*	Mimosaceae	Rain tree	√	√	√	NA
60	*Artocarpus blancoi*	Moraceae	Antipolo		√	√	VS
61	*Artocarpus communis*	Moraceae	Kamansi		√	√	NA
62	*Artocarpus heterophylla*	Moraceae	Nangka	√	√	√	NA
63	*Artocarpus odoratissimus*	Moraceae	Marangbanguhan	√		√	NA
64	*Ficus balete*	Moraceae	Balete	√	√	√	NA
65	*Ficus congesta*	Moraceae	Malatibig		√	√	NA
66	*Ficus nota*	Moraceae	Tibig	√		√	NA
67	*Ficus pubinervis*	Moraceae	Niog-niogan	√		√	NA
68	*Ficus septica*	Moraceae	Hawili	√	√	√	NA
69	*Ficus variegate*	Moraceae	Tangisangbayawak	√	√	√	NA
70	*Moringa oleifera*	Moringaceae	Malunggai		√	√	NA
71	*Musa sapientum*	Musaceae	Saging	√	√	√	NA
72	*Psidium guajava*	Myrtaceae	Guava	√	√	√	NA
73	*Syzygium aqueum*	Myrtaceae	Tambis	√			NA
74	*Syzygium cumini*	Myrtaceae	Duhat	√			NA
75	*Syzygium ellipticum*	Myrtaceae	Lambog	√			NA
76	*Syzygium samarangense*	Myrtaceae	Makopa	√		√	NA
77	*Nuclea orientalis*	Naucleaceae	Bangkal		√		NA
78	*Averrhoa carambola*	Oxalidaceae	Balimbing			√	NA
79	*Arenga pinnata*	Palmae	Kaong			√	NA
80	*Chrysalidocarpus lutescens*	Palmae	Palmera	√	√		NT
81	*Cocos nucifera*	Palmae	Coconut	√	√	√	NA
82	*Metroxylon sagu*	Palmae	Sagu	√			NA
83	*Nipa fruticans*	Palmae	Nipa	√			NA
84	*Veitchia merrillii*	Palmae	Manila palm			√	LR
85	*Acrostichum aureum*	Polypodiaceae	Lagolo	√			LC
86	*Bruguiera parviflora*	Rhizophoraceae	Langarai	√			LC
87	*Bruguiera sexangula*	Rhizophoraceae	Pototan	√			LC

88	*Morinda citrifolia*	Rubiaceae	Noni	√			NA
89	*Citrus grandis*	Rutaceae	Pomelo		√	√	NA
90	*Citrus microcarpa*	Rutaceae	Kalamansi	√	√	√	NA
91	*Nephelium nappaceum*	Sapindaceae	Rambotan			√	NA
92	*Chrysophyllum cainito*	Sapotaceae	Caimito	√	√	√	NA
93	*Capsicum frutescens*	Solanaceae	Sili			√	NA
94	*Solanum melongena*	Solanaceae	Talong			√	NA
95	*Solanum toryum*	Solanaceae	Talong-talungan		√	√	NA
96	*Sonneratia alba*	Sonneratiaceae	Pagatpat	√			LC
97	*Octomeles sumatrana*	Tetrameliaceae	Binuang		√		LR
98	*Wikstroemia lanceolata*	Thymeliaceae	Salagongsibat		√		NA
99	*Trema orientalis*	Ulmaceae	Anabiong			√	NA
100	*Boehmeria nivea*	Urticaceae	Ramie	√	√	√	NA
101	*Cecropia peltata*	Urticaceae	Trumpet tree			√	NA
102	*Leucosyke capitellata*	Urticaceae	Alagasi			√	NA
103	*Gmelina arborea*	Verbenaceae	Gmelina	√	√	√	NA
104	*Premna odorata*	Verbenaceae	Alagao	√	√	√	NA
105	*Vitex negundo*	Verbenaceae	Lagundi		√	√	NA

* Conservation Status: NA-Not Assessed, DD-Data Deficient, LC-Least Concern, NT-Near Threatened, LR-Lower Risk, CES-Critically Endangered Species, ES-Endangered Species, VS-Vulnerable Species, OTS-Other Threatened Species.

The Moraceae family had the highest species representation with 10 species followed by families Fabaceae and Graminae with 7 species each. A number of important species grow in the riverbanks, namely: *Kleinhovia hospita* L. (Sterculiaceae), *Mangifera caesia* Jack. (Anacardiaceae), *Spondias pinnata* (L. fil.) Kurz (Anacardiaceae), *Oroxylum indicum* (L.) Kurz (Bignoniaceae), *Flacourtia jangomas* (Lour.) Raeusch (Flacourtiaceae), *Syzygium ellipticum* K. Schum. & Lauterb. (Myrtaceae), and *Octomeles sumatrana* Miq. (Tetrameliaceae). About 6 species were classified as threatened species based on the Philippine Red List of Threatened Species (Fernando *et al.*, 2008) which established the national list of threatened plants and their categories and the IUCN Red List of Threatened Species (2016). The species *Diospyrus blancoi* A. DC. and *Pterocarpus indicus* Willd. *Forma indicus* were catergorized under critically endangered species. *Securinega flexuosa* Meull. Arg. recorded in Mahay and *Intsia bijuga* (Colebr.) Kuntze in Pagatpatan were also categorized under vulnerable and endangered status, respectively under the same red list. Another species recorded is *Swietenia macrophylla* King. which is an introduced species in the Philippines.

Table 2. Similarity indices to compare the vegetation of the three sites along the Agusan river using Dice's coefficient

Sites	Pagatpatan	Banza	Mahay
Pagatpatan	1.00	-	-
Banza	0.13	1.00	-
Mahay	0.52	0.22	1.00

Though it is not listed under any status based on the Philippine Red List, the species was considered vulnerable internationally based on the IUCN Red List.

Out of the 105 identified species, sixty-four (64) species were in Pagatpatan, fifty-two (52) species in Banza, and sixty-six (66) species were recorded in Mahay. Of the three pilot sites, Mahay has the most number of species with a species richness comprising 63% of the total identified species.

It is followed by Pagatpatan with 61%, and Banza with only 50% of the total species identified. A substantial portion of Pagatpatan riverbank had been cleared and planted with coconut, cassava, and banana. Areas near the residential site also served as backyard gardens. While some areas were covered with grasses and sedges, there were open patches used as building sites for boats and an abandoned fishpond. According to some old residents, Pagatpatan was named after "Pagatpat" (*Sonneratia alba* Sm.), a dominant mangrove species in the area. However in the recent study conducted, Pagatpat is seldom encountered in the area. The loss of the species can be attributed to the indiscriminate cutting for use as firewood.

Table 3. Species diversity indices of the three sites in Butuan city

Index	Pagatpatan	Banza	Mahay
Shannon's Diversity (H')	0.780	0.859	1.332
Simpson's Diversity (D)	0.336	0.521	0.506
Total for all sites	1.338		

Banzais the site near the urbanized area of Butuan thus this becomes a human settlement site. About 50 species are encountered in the area; however, most of the species are purposely planted for household use. Based on the map generated by Santillan (2014), Banza riverbank has an estimated length of about 841 meters. Unfortunately, large portions of the riverbank are already privately owned and utilized as mango plantations and sawmill sites for wood processing industries. Only a small portion can be used for ecobelt purposes, however, the same area was protected as a historic site of the old church ruins.

Table 4. Computed importance value of species encountered on the proposed ecobelt

Number of Plots Sampled:	13 Plots			Number of Species:			20
Area per Plot:	400 sq.m.			Total Number of Individuals:			507
Total Area :	0.52 ha						
Species	Freq	Den	Dom	RelFreq	Rel Den	Rel Dom	SIV
Nipa fruticans	0.308	582.692	54.873	9.091	60.359	72.485	141.934
Musa sapientum	0.308	240.385	9.800	9.091	24.900	12.946	46.937
Cocos nucifera	0.615	40.385	3.735	18.182	4.183	4.933	27.299
Sandoricum koetjape	0.231	9.615	0.735	6.818	0.996	0.970	8.784
Klehoviahospita	0.231	3.846	0.829	6.818	0.398	1.094	8.311
Swietenia macrophylla	0.154	23.077	0.747	4.545	2.390	0.987	7.923
Samaneasaman	0.154	5.769	0.999	4.545	0.598	1.319	6.462
Terminalia cattapa	0.154	9.615	0.521	4.545	0.996	0.688	6.230
Artocarpus heterophylla	0.154	7.692	0.283	4.545	0.797	0.374	5.716
Tamarindus indica	0.154	3.846	0.269	4.545	0.398	0.355	5.299
Citrus grandis	0.154	3.846	0.168	4.545	0.398	0.222	5.165
Artocarpus odoratissimus	0.154	3.846	0.025	4.545	0.398	0.034	4.977
Annona muricata	0.077	3.846	1.309	2.273	0.398	1.729	4.400
Paraserianthes falcataria	0.077	7.692	0.501	2.273	0.797	0.662	3.731
Mangifera indica	0.077	3.846	0.570	2.273	0.398	0.753	3.425
Inocarpus fagifer	0.077	5.769	0.137	2.273	0.598	0.181	3.051
Barringtonia acutangula	0.077	3.846	0.042	2.273	0.398	0.055	2.726
Pongamia pinnata	0.077	1.923	0.090	2.273	0.199	0.118	2.590
Theobroma cacao	0.077	1.923	0.045	2.273	0.199	0.059	2.531
Bixa orellana	0.077	1.923	0.026	2.273	0.199	0.034	2.506
Total	3.385	965.385	75.702	100.000	100.000	100.000	300.000

Mahay has the most number of naturally growing species recorded. Large trees with diameter ranging from 80 to 120 cm and a height to 30 meters such as *Saman easaman* (Jacq.) Merr., *M. caesia*, *S. pinnata*, *Artocarpus communis* J. R. & G. Forst and *S. macrophylla* are found in the area. The riverbank is more elevated compared with the other two sites. However, severe erosion due to stream velocity and flooding was observable. Some trees near the river have been uprooted while some are already leaning towards the river due to slowly disintegrating soil cover on the cliff of the riverside.

The floristic species composition of each site was compared using Dice's similarity index (Table 2). High values suggest that two sites have a higher degree of similarity in terms of species composition. The similarity index was highest (0.52) for Pagatpatan and Mahay.

Although disturbance and topography are completely different for both sites, the vegetation is relatively similar except for the more even distribution of Mahay's vegetation. Banza has the lowest similarity when paired with the other two sites because Banzais already urbanized thus the floristic species have been intentionally planted such as *Paraserianthes falcataria* (L.) I.C. Nielsen, and *S. macrophylla*. In the other two sites, naturally growing species are more prevalent.

Fig. 3. Dominant vegetation encountered in the study site. (Left) Dense clumps of *N. fruticans* and (Right) *M. sapientum* plantation converted areas along the River.

Shannon-Weiner's (H') and Simpson's (D) index of diversity were computed to compare plant communities (Table 3). Results showed that H' was highest in Mahay with (1.332) followed by Banza (0.859) and Pagatpatan (0.780). Banza has a higher index compared with Pagatpatan even though Pagatpatan has higher number of species recorded. It should be noted that the Shannon's diversity index takes into consideration not only the number of species but also the number of individuals per species and the evenness of distribution of individuals per species (Gomez-Roxas *et al.*, 2005). A closer analysis of the data showed that most of the species inhabiting the riparian areas of Banza were randomly distributed. In Pagatpatan, while there are many species of plants present, each species was represented by just a few individuals with one species completely dominating almost the entire area.

Hence, diversity index was higher in Banza than in Pagatpatan. The composite H' value of the entire ecobelt was computed to be 1.338 which is considered very low.

On the other hand, Simpson's diversity (D) is highest in Pagatpatan (0.663) compared with the other areas. Simpson's index is influenced by the percentage equitability of species and its species richness. For a particular community, as species becomes more equitable, D is expected to decrease as the case of Banza, wherein no single species is dominant.

Species Frequency, Density and Dominance

As observed, the proposed ecobelt site is dominated by *Nipa fruticans* Wurmb. This species is the most abundant species with 303 individual clumps and a species density of 583 individuals per hectare (Table 4). This palm is native to the coastlines and estuarine habitats in the Pacific and the only palm considered adapted to the mangrove biome. Four out of thirteen quadrats are occupied with dense clumps of Nipa, inhibiting growth of other wetland species due to its dense and wide canopy growth pattern.

Banana (*Musa sapientum* L.) and coconut (*Cocos nucifera* L.) are also found to have high species density with 240 and 40 individuals per hectare, respectively. This is because some plots fall on a banana plantation with no other species present, while coconut is commonly found and intentionally planted in the area. The mean density for all species was 48 individuals per hectare which can be classified as "very poor stocking". For a riparian stand to effectively function as buffer, ideal stocking should have a mean density of at least 930 stems per hectare including sapling, sab-canopy and overstory vegetation (Baird and Wetmore, 2004).*C. nuciferais* also the most frequently occurring species in the ecobelt site at 0.615 (8 out of 13 quadrats). *N. fruticans* and *M. sapientum* followed with 0.308 (4 out of 13 quadrats).

These three species had the highest SIV values and, therefore, considered to be the most dominant species in the pilot areas.

Pagatpatan and Banzaare located at the outlet of Agusan river where most waters from the upstream drain. The soil is generally soft and muddy and classified as sandy clay loam, which is suitable for the growth of the predominant species. Some portions of Pagatpatan and Mahay riverbanks support dense grass species such as *Arundo donax* L., *Imperata cylindrica* (L.) P. Beauv. and *Saccarum spontaneum* L. (Quadrat 6 and 10). Grasses are characterized to grow long and fibrous root systems that are good for erosion control and soil stabilization. *A. donax* is an aggressive species with an ability to reproduce quickly, outcompeting native plant species and becoming as one of the primary threats to native riparian habitats altering ecological and successional processes. *A. donax* and *I. cylindrica* are both listed in the top 100 world's worst invasive alien species (Lowe *et al.*, 2000). These grasses are good soil stabilizers; however, these are also serious weeds not only in crops but also in natural areas, causing serious economic and environmental damage.

Conclusion

The proposed ecobelts in Pagatpatan, Banza, and Mahay in Butuan City housed 105 floral species under 85 genera and 42 families. Pagatpatan is dominated by *N. fruticans* while the majority of Banza areas are planted to *M. indica*. Of the sites, Mahay has the highest species diversity and classified as slightly disturbed. A number of naturally growing species and large diameter trees are present. Species richness, abundance, and diversity indices indicated low values as some areas were left open or converted into agriculture. An average density of only 48 individuals per hectare is an indication of low vegetation stocking. However, some noteworthy species existing in the area can be considered for enrichment planting since these species are represented only with just one or two individuals. The present population needs to be enhanced to prevent local extinction of these species.

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