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Land use changes and their influence in the conservation of plant diversity within a small Binaba watershed

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Abstract

Land uses are one of the prime causes in the loss or fragmentation of natural habitats and their species. In a small watershed in Agusan del Sur, the diversity of plant species were assessed using standard vegetation sampling technique developed by Hill (2005) as basis for the formulation of an integrated watershed management plan to reduce adverse cost of land use change on the remaining biodiversity. Results showed that the vegetation was composed of about 166 vascular plant species belonging to 134 genera and 64 families having an overall Shannon-Weiner diversity index (H') of 2.546 described to be moderately high. A number of ecologically sensitive species were encountered in the area such as the critically endangered *Shorea palosapis* and *Shorea contorta*. Relative to its area, the watershed has been subjected to diverse land-uses that directly affect richness of plant species either native or introduced in the area. Appropriate monitoring and area control therefore should be taken utmost consideration in the formulation of the management plan.

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Introduction

Fresh water comprises only a small portion of the total water on Earth and is expected to become the most limiting resource in the near future (Gleick, 2000; Postel, 1997; Postel *et al.*, 1996). With more people shifting to live in urban areas, expansion of urban areas changed natural landscapes into agricultural, residential, commercial, and industrial land uses.

The growing population increased imperviousness of some areas, and urban activities lead to increased runoff, decreased baseflow, reduced ground water recharge, and water quality reduction (O' Driscoll *et al.*, 2010; Chithra *et al.*, 2015). As more and more people dwell in urban areas, the demand for clean and potable water intensifies, driving too much pressure on our already critical watersheds. Watersheds were used in a variety of ways directly affecting streams and water provision. Plantations areas and shifting cultivation have important environmental impacts that either degrade or improve habitats for wildlife (Lawal, 2014). Monoculture areas as less diverse expose community to adverse consequences of pest and disease, among others. As one such impact, these land-uses pose significant changes to land and water and the overall ecological functioning of the watershed.

Degraded watersheds require immediate rehabilitation necessary to improve biological and habitat diversity. It is essential to increase commercial value for timber production, increase types and amount of non-timber products, improve forest functions such as water storage, water balance, sequestration of carbon, climate mitigation, and restore soil fertility and physical properties for protection against erosion (Kobayashi *et al.,* 2001). Conserving biodiversity in addition, is a key component to improved environmental performance and should always be embedded in every management plans. Sound management plans guarantee sustainable use of existing forests, thus appropriate knowledge on the resource is vital.

The biodiversity and the type of vegetative cover, the forests in particular are very crucial elements that influence erosion, runoff and climatic factors of the area. It provides food, fruit, fuel, fodder, forage, small timber and many more to the community. This study was conducted as a component for the formulation of developmental plans for a sustainable integrated watershed management of the local government unit. The main objective of this study is to 1) determine the current composition and species diversity of the existing terrestrial flora within the proposed Binaba watershed area, 2) provide information on the abundance and conservation status of the different vascular plant species and 3) determine the different existing land uses and their influence in biodiversity levels as part of the baseline information. The study aspires that showcasing the richness of species diversity in this unique watershed will kindle pride among the people of Prosperidad.

Materials and methods

Description of the Study area

The Binaba watershed was located within Brgy. New Maug and Brgy. Poblacion, in the Municipality of Prosperidad, Agusan del Sur. Geographically, it is situated at approximately 08°36'17" to 08°37'50" North and 125°54'55" to 125°56'23" East (Fig. 1). The watershed area is accessible by both land and water. Along the national highway, it is about an hour travel from the neighboring municipality of San Francisco, Agusan del Sur or about 2 hours from Butuan City, Agusan del Norte. It can also be reached via Gibong River from the bridge in Brgy. Poblacion using a boat or kayak.

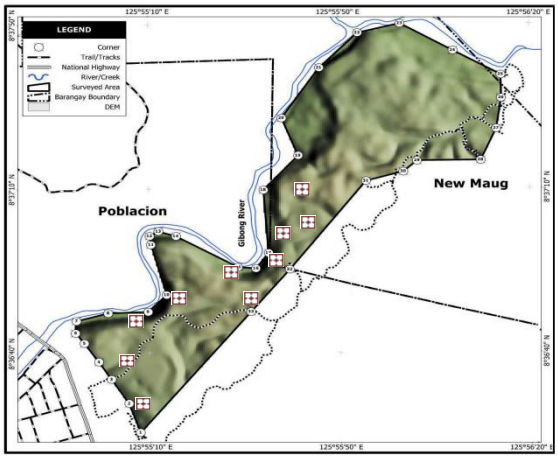

Fig. 1. Map showing the surveyed area of the proposed Binaba Watershed in the Municipality of Prosperidad. (Source: Prosperidad MENRO, 2018).

The watershed has an approximate total land area of 185 hectares. Based on the recent satellite images and site reconnaissance, the land use of the watershed ecosystem can be classified into the following: a) grasslands, b) coconut groves, c) secondary growth forest, d) agroforestry, and e) plantation areas. Currently, Binaba Watershed was the primary source of potable water utilized by the local water district. The focused watershed can be considered unique compared to other adjacent watersheds since majority of the water discharge emanates from cave springs at the drainage point and jumps into a small waterfall in Gibong River.

Vegetation Sampling

The sampling procedure used for the study was based on a belt transect method described by Hill (2005). A total of 10 sample quadrats with dimension 20m x 20m were laid out along the transect at varying intervals of 200 m to 500m depending on the terrain and density of the prevailing vegetation. A GPS receiver was used to determine the coordinates of the quadrats with the southern left corner used as reference. All plants inside quadrat with >5cm dbh were measured and recorded. All vascular plants encountered along the transect line were also enumerated to make up a near comprehensive list of plant species in the watershed. The sampling stations were pre-selected using maps provided by the Municipal Environment and Natural Resources Office (MENRO) and geo-referenced in Google Earth environment. Recent satellite images were also utilized to analyze land uses and determine areas containing vegetative cover.

Species Identification and Nomenclature

Identification of species was done on field with the help of literatures and taxonomic identification field guides. Some publications referring to the Philippine flora included Merrill (1912), Santos *et al.* (1986), Zamora and Co (1986), Madulid (2002) and online identification website PhytoImages (www.phytoimages.siu.edu) were also utilized to compare photographed species. Some unfamiliar species were posted online thru a social media group Co's Digital Flora of the Philippines (a public group of botanist, foresters, biologist and other plant enthusiasts) to confirm species identification. The scientific names and conservation status of species were crosschecked in the databases of The Plant List (www.theplantlist.org) and The IUCN Redlist of Threatened Species 2017 (www.iucnredlist.org), respectively. Since no gratuitous permit (GP) was secured for the study, collection of voucher specimens for identification was avoided.

Data Analysis

The data was encoded on a spreadsheet and analysed using the vegetational analysis formula of density, relative density, frequency, relative frequency, dominance, relative dominance and the species importance value (SIV). The SIV was computed as the sum of the relative frequency, relative density and relative dominance of a species in a community or forest (SIV = RFreq + RDom + RDen). An SIV provides a better index than density alone regarding the importance or function of a species in a habitat and also gives rank or order for a particular species within the community (Odum & Barret, 2005). Ecological parameters such as Simpson's Index of Diversity (1-D), Shannon-Wiener (H') diversity index, species richness and evenness on the other hand were computed using the PAST Statistical Software. To determine the levels of biodiversity, the Fernando scale was used.

Table 1. Biodiversity Scale (Fernando, 1998).

Relative Interpretation	Shannon's (H') Index	Evenness Index
Very High	>3.5	0.75-1.00
High	3.00 - 3.49	0.50-0.74
Moderate	2.50 - 2.99	0.25-0.49
Low	2.00 - 2.49	0.15-0.24
Very Low	<1.99	0.05-0.14

Result and discussion

Existing land use

The rapid floral assessment of Binaba watershed was conducted on May 19-20, 2018 with the assistance of personnel from the Municipal Environment and Natural Resource Office of the Municipality of Prosperidad, Agusan del Sur.

The watershed ecosystem can be generally described as a secondary growth limestone forest based on the prevailing soil and rock formation. As numerous large limestone boulders and coral rocks were observed in many parts of the ecosystem, it is believed that the entire watershed ecosystem may have been an underwater ecosystem in the long time ago and have surfaced by the combined actions of continental movements and other factors. It has as a unique assemblage of vascular and non-vascular flora from riparian areas to steep slopes and land surface in higher grounds. The land use types are generally categorized into the following: Riparian forest, agroforestry and open areas, grasslands, and some plantation areas. The riparian forest type can be found along the length of Gibong River and other water zones of the watershed. Based on recent satellite images and actual ground surveys, the forest forms a buffer from the easement at about 100-150 meters inward and extends its length from the bridge on the national highway towards the northern portion of the watershed (Fig. 2). Large trees such as *Pangium edule*, *Madhuca betis*, *Acacia mangium*, and other indigenous tree species were observed in the area. It has an average diameter of 37.1 ± 24.3cm at breast height and reaching an average of 21.7 ± 6.6 meters in total height.

Fig. 2. Satelite view of the riparian forest buffer of the Binaba watershed, Prosperidad, Agusan del Sur.

Some portions of the watershed were cleared for agriculture to raise cash crops such as Kamoteng kahoi (*Manihot esculenta*), Kamote (*Ipomea batatas*), Karlang (*Colocasia esculenta*) and Mani (*Arachis hypogaea*).

Farm boundaries were planted with fruit trees such as Balimbing (*Averrhoa carambola*), Nangka (*Artocarus heterophyla*), Durian (*Durio zibethinus*) and many others. The mixture of agricultural plants together with fruit and timber producing trees is called "agroforestry". Coconut groves also were sporadically encountered in many parts of the watershed more particularly in flat terrains and adjacent agroforestry areas. The fringes of other vegetative zones are covered with grass-plant community type with Pakiling (*Ficus odorata*) wildlings dominating the landscape. Grasslands were observed on the different parts of the watershed either in the lowland or upland and lower or higher elevations. Where there are open areas, grasslands are present. The dominant species were Cogon (*Imperata cylindrica*) intermixed with marginal land shrubs such as Niog-niogan (*Ficus pseudopalma*) and Pakiling (*F. odorata*). Along trails, species composition gradually changed into dense community of fern species called Bayabang (*Nephropelis cordofolia*). The harsh environmental conditions of the area appear to favor the survival and growth of sturdy species.

Fig. 3. Some areas utilized for plantation species in the watershed. Top: Oil palm plantation; Bottom: Falacata plantation

A major portion of the watershed was cleared and planted with plantation species such as Moluccan sau (*Falcataria moluccana*), Big-leaf Mahogany (*Swietenia macrophylla*), Yemane (*Gmelina arborea*) and Para rubber (*Hevea brasiliensis*), while some was utilized for growing African oil palm (*Elaeis guineensis*) as shown in Fig. 3.

Plantations are monoculture areas raised with a single type of species for various management objectives such as timber, pulpwood, rubber and palm oil. The main disadvantage of raising plantations species in a watershed ecosystem is that these stands are usually cleared cut during harvest exposing the ecosystem to soil erosion, habitat loss and increased surface run-off.

Table 2. Summary of ecological parameters for flora diversity of the watershed.

Ecological Parameters	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Cumulative
Species Richness	7	6	10	7	7	5	4	7	17	11	52
Number of Individuals	15	15	14	9	11	18	9	15	26	27	159
Simpson Index of Diversity (1-D)	0.857	0.838	0.956	0.944	0.909	0.549	0.806	0.829	0.954	0.852	0.913
Shannon-Weiner Index (H')	1.767	1.640	2.243	1.889	1.846	1.051	1.311	1.714	2.682	2.021	2.546
Evenness Index (E_H)	0.908	0.915	0.974	0.971	0.949	0.653	0.946	0.881	0.947	0.843	0.644

Floristic diversity of the watershed

The sampling stations and transect walk revealed a diverse composition of vascular plants species. For this study, a total of 166 species belonging to 134 genera and 64 families were encountered and identified. The dominant families with the most number of species enumerated were Moraceae (16 species), followed by Euphorbiaceae (10), Fabaceae (9), Palmae (8) and Myrtaceae (with 7 species) while for the genera were *Ficus* (10 species), *Syzygium* (6) and *Artocarpus* with 4 species. The top ten families (Fig. 4) and the list of encountered species can be found in Annex A.

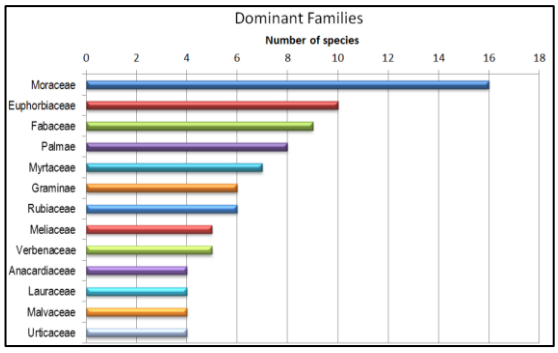

Fig. 4. Top ten families with the most number of species encountered and identified in the watershed area.

The most abundant species recorded in the sampling stations were *F. moluccana* with 18 individuals followed by *Ficus gigantifolia* (10), *Theobroma cacao* (8) and then *Cocos nucifera* and *G. arborea* with 7 individuals each. In terms of species importance value (SIV), the tree species that ranked among the top ten were as follows: Moluccan sau (*F. moluccana*) being the most dominant, followed by Balete (*Ficus balete*), and Kapadak (*Ficus gigantifolia*). Coconut (*C. nucifera*), Balakat (*Ziziphus talanai*) and Yemane (*G. arborea*) followed in the 4th, 5th and 6th ranks. The rest of the rankings could be found in the Annex B. The analysis of the different ecological parameters of the watershed is shown in Table 2. The species richness ranged from 4 (lowest) to 17 (highest), while the average for all plots is only 5.2 species, interpreted as "low". The computed Simpson's diversity index ranges from 0.549 – 0.956 (Plot 6 being the least and Plot 3 being the highest) with a composite diversity index of 0.913 for all plots indicating high species diversity. The same is true with Shannon-Weiner (H') index that ranges from 1.051–2.682 (Plot 6 being the least while Plot 9 being the highest). The watershed may have a composite diversity index (H') of 2.546 (moderately high), however, most of the assessed plots were classified to be "very low" (7/10 plots).

The sampling station 6 has been consistently computed being the least in diversity values for Simpson's and Shannon-Weiner's indices despite the high number of individuals in the plot because the

plot was established near an ITP plantation area. About 67% of the plants recorded for the plot is composed only of a single species (*F. moluccana*) thus diversity is very low. In terms of evenness index for the 10 sampling plots, it has a composite value of 0.644 categorically fall under very high evenness indicating high similarity in composition of species between plots.

Forest Stand Structure

A total of 159 individuals with diameter at breast height >5 cm were recorded from the sampling stations. This number would account to a species density of only 398 trees ha^{-1} or an average of 16 trees per 20m x 20m sampling quadrat. This number suggests that the tree stocking of the watershed is very poor and therefore needs immediate rehabilitation such as reforestation and assisted natural regeneration. The computed density is very much lower as compared to the density of the 2-hectare permanent biodiversity plots in Mt. Makiling at 4,403 trees ha^{-1} (Malabrigo, 2016) and with the 16-hectare permanent forest plot in Palanan, Isabela at 4,999 trees ha^{-1} (Co *et al.,* 2006). Fig. 5 presents the classification of species according to growth habit. More than sixty-two percent (62%) of the identified species were classified as trees and arborescent species, 16% were accounted as herbaceous species both annuals and perennials, 9% were shrubs, 7% for vines both woody and non-woody, 4% were palms and palm like species, while the remaining 1% were identified as ferns and fern allies.

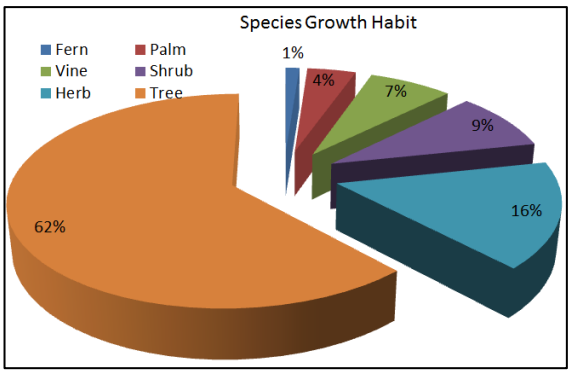

Fig. 5. Classification of species according to growth habit.

The average height of all trees inside sampling quadrats ranges from 6.6 ± 0.7m to 21.7 ± 6.6m. As observed, trees in the riparian buffer are much taller than trees on plains and higher grounds. Some large trees especially along trails were felled and severed as observed during the survey. The average diameter of all trees inside sampling plots is only 17.09 ± 2.25cm. Moreover, there is a big difference in the proportion of diameter classes of the trees as shown in Table 3. About 60% of the trees recorded fall under the category small trees while the medium-sized trees account only to 14% whilst large trees are only 2% of the trees inventoried. The remaining 25% is accounted for poles and saplings with DBH <10cm.

Table 3. Number of individuals per diameter class.

Diameter class	Diameter range	Number of individuals
Poles and Saplings	<10cm	39
Small trees	10cm to <30cm	95
Medium-size trees	30cm to <60cm	22
Larger trees	>60cm	3

Conservation Status and Ecologically Important

Specie of the 166 identified species, 139 (84% of total) are found to be indigenous (native) to the Philippines of which 19 are classified as endemic or are exclusively found only in the country. Twenty-seven (16% of total) of the enumerated species were classified as exotic or are introduced in the area either for rehabilitation, food and timber production, or ornamental purposes. Among the exotics trees recorded include *A. mangium*, *F. moluccana, H. brasiliensis* and *S. macrophylla*. Other introduced and considered invasive plant species that are widespread were Ipil-ipil (*Leucaena leucocephala*), Hagonoy (*Chromolaena odorata*), Buyo-buyo (*Piper aduncum*) and Trumpet tree (*Cecropia peltata*).

The watershed ecosystem has a number of ecologically sensitive species categorized as “Critically Endangered” based on IUCN Redlist of Threatened Species. In the watershed was encountered the critically endangered Mayapis (*Shorea palosapis*) and White Lauan (*Shorea contorta*). Vulnerable species include Ipil (*Intsia bijuga*), Hamindang (*Macaranga bicolor*), Narra (*Pterocarpus indicus*),

Betis (*Madhuca betis*) and Balakat (*Ziziphus talanai*) among others. The complete list of conservation classification can be found on Annex A.

General Observations

Most of the sites based on the established sampling stations and transect walks are observed to have been subjected to a variety of land use and were dominated with pioneer or nomadic miscellaneous species. Only very few are high premium species except along the riparian forest buffer. There were areas subjected to "*Kaingin*" or upland farms in the watershed area and planted to coconut, fruit trees, and industrial tree species like Falcata and Big-leaf Mahogany. These areas generally have lower diversity index compared to less disturbed areas (Table 2). Since most of the areas were already disturbed, therefore, the watershed's present condition is wanting of immediate improvement/rehabilitation effort.

Recommendations and conclusions

Recommendations

1. In vacant lots and kaingin areas, rehabilitation species must be indigenous or native species to include premium species that are found thriving in the area.
2. Encourage the farmers to plant fruit trees but not rubber trees. Acid substances added to latex to coagulate may find its way to the water bodies through surface run-off during rainfall events.
3. The rampant hillside farming in several parts of the watershed uses fire to clear the planting area resulting to denudation and massive soil erosion, thus should be minimized.

Conclusions

Results of the intensive study revealed that the vegetation of the forests over limestone environment of Binaba Watershed, Brgy. Poblacion, Prosperidad, Agusan del Sur holds a remarkable diversity of trees and other vascular plants species. The overall floral diversity of the watershed with H' value of 2.546 was classified as moderately high. Though the landscape of the watershed is highly fragmented, there are pockets of vegetation that harbor endemic and endangered species.

The information developed in this research can help provide significant knowledge on the dynamics of the plant species in a forest ecosystem subjected into different anthropological activities such as shifting cultivation, fuelwood gathering and timber harvesting. This study as well gives critical importance for the future research activities in the area and can be a principal venue for current and planned efforts of the LGU Prosperidad thru its Municipal Environment and Natural Resources Office (MENRO) towards attaining better conservation and rehabilitation programs for the production of clean and quality water. The information on the ecological status of the biodiversity should be disseminated to advocate conservation. It is not enough to protect and conserve these habitats but also to manage the landscape so as to protect the habitats and the species therein.

Acknowledgements

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Annexes

A. List of vascular species encountered in the study area.

No.	Local Name	Scientific Name	Family Name	IUCN Status
Ferns and fern allies				
1	Anotong	*Cyathea microchlamys*	Cyatheaceae	VU
2	Bayabang	*Nephrolepis cordofolia*	Davalliaceae	NA
3	Pakpak lawin	*Asplenium nidus*	Polypodiaceae	NA
Herb and other herbaceous species				
1	Karlang	*Colocasia esculenta*	Araceae	LC
2	Wild fortune plant	*Dracaena angustifolia*	Asparagaceae	NA
3	Papaya	*Carica papaya*	Caricaceae	DD
4	Kamaria	*Artemisia vulgaris*	Compositae	NA
5	Kamote	*Ipomoea batatas*	Convolvolaceae	NA
6	Tubang-usa	*Costus speciosus*	Costaceae	NA
7	Kalabasa	*Cucurbita maxima*	Cucurbitaceae	NA
8	Kamoteng kahoi	*Manihot esculenta*	Euphorbiaceae	NA
9	Calopo	*Calopogonium mucunoides*	Fabaceae	NA
10	Mani	*Arachis hypogaea*	Fabaceae	NA
11	Mani-mani	*Arachis pintoi*	Fabaceae	NA
12	Hantatamsi	*Cyrtandra villosissima*	Gesneriaceae	NA
13	Amorseko	*Andropogon aciculatus*	Graminae	NA
14	Buho	*Schizostachyum lumampao*	Graminae	NA
15	Cogon	*Imperata cylindrica*	Graminae	NA
16	Hagonoy	*Chromolaena odorata**	Graminae	NA
17	Mais	*Zea mays*	Graminae	NA
18	Lobster's claw	*Heliconia humilis*	Heliconiaceae	NA

19	Sibuyas	*Allium cepa*	Liliaceae	NA
20	Saging saba	*Musa sapientum var. compressa*	Musaceae	NA
21	Philippine ground orhid	*Spathoglottis tomentosa*	Orchidaceae	NA
22	Bariu	*Pandanus copelandii*	Pandanaceae	NA
23	Karagumoi	*Pandanus simplex*	Pandanaceae	NA
24	Pandan-baging	*Freycinetia maxima*	Pandanaceae	NA
25	Talong-talungan	*Solanum torvum*	Solanaceae	NA
26	Lipang-aso	*Laportea interrupta*	Urticaceae	NA
Palms				
1	African oil palm	*Elaeis guineensis**	Palmae	LC
2	Balatbat-bilog	*Licuala grandis**	Palmae	NA
3	Betel nut	*Areca catechu*	Palmae	NA
4	Kaong	*Arenga pinnata*	Palmae	NA
5	Mc Arthur's Palm	*Ptychosperma macarthurii*	Palmae	NA
6	Niog	*Cocos nucifera**	Palmae	NA
7	Pugahan	*Caryota cumingii*	Palmae	NA
8	Sagisi	*Heterospathe elata*	Palmae	NA
Shrubs				
1	Castor oil plant	*Ricinus communis*	Euphorbiaceae	NA
2	San Francisco	*Codiaem variegatum*	Euphorbiaceae	NA
3	Tuba-tuba	*Jathropa curcas*	Euphorbiaceae	NA
4	Flemingia	*Flemingia macrophylla*	Fabaceae	NA
5	Kakawate	*Gliricidia sepium**	Fabaceae	NA
6	Gapas	*Gossypium hirsutum*	Malvaceae	NA
7	Gumamela	*Hibiscus rosasinensis**	Malvaceae	NA
8	Red Lip	*Syzygium campanulatum*	Myrtaceae	NA
9	Buyo-buyo	*Piper aduncum*	Piperaceae	NA
10	Arabian coffee	*Coffea arabica**	Rubiaceae	NA
11	Kahoi-dalaga	*Mussaenda philippica*	Rubiaceae	NA
10	Santan	*Ixora coccinea*	Rubiaceae	NA
12	Limon-cito	*Triphasia trifolla**	Rutaceae	NA
13	Sili	*Capsicum annuum*	Solanaceae	NA
14	Handamay	*Pipturus arborescens*	Urticaceae	NA
15	Kandi-kandilaan	*Stachytarpheta jamaicensis*	Verbenaceae	NA
Trees and arborescent species				
1	Apali	*Mangifera longipes*	Anacardiaceae	NA
2	Balinghasai	*Buchanania arborescens*	Anacardiaceae	NA
3	Mangga	*Mangifera indica*	Anacardiaceae	DD
4	Mangga paho	*Mangifera monandra*	Anacardiaceae	NA
5	Guyabano	*Annona muricata**	Annonaceae	NA
6	Ilang-ilang	*Cananga odorata*	Annonaceae	NA
7	Takulau	*Miliusa vidalii*	Annonaceae	NA
8	Bayag-usa	*Voacanga globosa*	Apocynaceae	NA
9	Malapapaya	*Polyscias nodosa*	Araliaceae	NA
10	African Tulip	*Spathodea campanulata**	Bignoniaceae	LC
11	Durian	*Durio zibethinus*	Bombacaceae	NA
12	Kapok	*Ceiba pentandra**	Bombacaceae	LC
13	Anonang	*Cordia dichotoma*	Boraginaceae	NA
14	Antsoan-dilau	*Senna spectabilis**	Caesalpiniaceae	NA
15	Ipil	*Intsia bijuga*	Caesalpiniaceae	VU
16	Mountain agoho	*Gymnostoma rumphianum*	Casuarinaceae	NA
17	Abuab	*Lophopetalum toxicum*	Celastraceae	NA
18	Laiusin	*Kostermanthus heteropetalus*	Chrysobalanaceae	NA
19	Sakat	*Terminalia nitens*	Combretaceae	VU
20	Talisay	*Terminalia catappa*	Combretaceae	NA
21	Lima-lima	*Dioscorea pentaphylla*	Dioscoreaceae	NA
22	Manggasinoro	*Shorea assamica forma philippinensis*	Dipterocarpaceae	NA
23	Mayapis	*Shorea palosapis*	Dipterocarpaceae	CR
24	White lauan	*Shorea contorta*	Dipterocarpaceae	CR
25	Anislag	*Securinega flexuosa*	Euphorbiaceae	VU
26	Balanti	*Homalanthus populneus*	Euphorbiaceae	NA
27	Banato	*Mallotus philippensis*	Euphorbiaceae	NA
28	Hamindang	*Macaranga bicolor*	Euphorbiaceae	VU
29	Lagapak	*Macaranga hispida*	Euphorbiaceae	NA
30	Para rubber	*Hevea brasiliensis**	Euphorbiaceae	NA

31	Falcata	*Falcataria moluccana**	Fabaceae	NA
32	Narra prickly	*Pterocarpus indicus forma echinatus*	Fabaceae	VU
33	Narra smooth	*Pterocarpus indicus forma indicus*	Fabaceae	VU
34	Ulaian	*Lithocarpus celebicus*	Fagaceae	NA
35	Pangi	*Pangium edule*	Flacourtiaceae	NA
36	Binukau	*Garcinia binucao*	Guttiferae	NA
37	Paguringon	*Cratoxylum sumatranum*	Guttiferae	NA
38	Buntan	*Engelhardia rigida*	Ixonanthaceae	NA
39	Avocado	*Persea americana**	Lauraceae	NA
40	Marang	*Litsea perrottetii*	Lauraceae	NA
41	Mindanao cinnamon	*Cinnamomum mindanaense*	Lauraceae	NA
42	Tirukan	*Beilschmiedia glomerata*	Lauraceae	NA
43	Cannonball	*Couroupita guianensis*	Lecythidaceae	LC
44	Putat	*Barringtonia racemosa*	Lecythidaceae	NA
45	Toog	*Petersianthus quadrialatus*	Lecythidaceae	NA
46	Kaliantan	*Leea philippinensis*	Leeaceae	NA
47	Batitinan	*Lagerstroemia piriformis*	Lythraceae	NA
48	Aratiles	*Muntingia calabura*	Malvaceae	NA
49	Cacao	*Theobroma cacao*	Malvaceae	NA
50	Igyo	*Dysoxylum gaudichaudianum*	Meliaceae	NA
51	Kangko	*Aphanamixis polystachya*	Meliaceae	LC
52	Lansones	*Lansium domesticum*	Meliaceae	NA
53	Large leafed Mahogany	*Swietenia macrophylla**	Meliaceae	VU
54	Santol	*Sandoricum kaetjape*	Meliaceae	NA
55	Ipil-ipil	*Leucaena leucocephala**	Mimosaceae	NA
56	Mangium	*Acacia mangium**	Mimosaceae	NA
57	Agus-us	*Trophis philippinensis*	Moraceae	NA
58	Alangas	*Ficus heteropoda*	Moraceae	NA
59	Antipolo	*Artocarpus blancoi*	Moraceae	VU
60	Balete	*Ficus balete*	Moraceae	NA
61	Gumihan	*Artocarpus sericicarpus*	Moraceae	NA
62	Hagimit	*Ficus minahassae*	Moraceae	NA
63	Hauili	*Ficus septica*	Moraceae	NA
64	Kapadak	*Ficus gigantifolia*	Moraceae	NA
65	Malatibig	*Ficus congesta*	Moraceae	NA
66	Marang banguhan	*Artocarpus odoratissimus*	Moraceae	NA
67	Nangka	*Artocarpus heterophyllus**	Moraceae	NA
68	Niog-niogan	*Ficus pseudopalma*	Moraceae	NA
69	Pakiling	*Ficus odorata*	Moraceae	NA
70	Tangisang bayawak	*Ficus variegata*	Moraceae	NA
71	Tibig	*Ficus nota*	Moraceae	NA
72	Trumpet tree	*Cecropia peltata**	Moraceae	NA
73	Bagotambis	*Syzygium leytense*	Myrtaceae	NA
74	Bayabas	*Psidium guajava**	Myrtaceae	NA
75	Lumboy	*Syzygium cumini*	Myrtaceae	NA
76	Makopa	*Syzygium samarangense**	Myrtaceae	NA
77	Malatambis	*Syzygium hutchinsonii*	Myrtaceae	NA
78	Sambulawan	*Syzygium albayense*	Myrtaceae	NA
79	Balimbing	*Averrhoa carambola**	Oxalidaceae	NA
80	Kamias	*Averrhoa bilimbi**	Oxalidaceae	NA
81	Balakat	*Ziziphus talanai*	Rhamnaceae	VU
82	Balanigan	*Gardenia longiflora*	Rubiaceae	NA
83	Lisak	*Neonauclea bartlingii*	Rubiaceae	NA
84	Wisak	*Neonauclea kentia*	Rubiaceae	NA
85	Bugauak	*Evodia confuse*	Rutaceae	NA
86	Pomelo	*Citrus grandis**	Rutaceae	NA
87	Malugai	*Pometia pinnata*	Sapindaceae	NA
88	Rambutan	*Nephelium ramboutan-ake*	Sapindaceae	NA
89	Betis	*Madhuca betis*	Sapotaceae	VU
90	Caimito	*Chrysophyllum cainito**	Sapotaceae	NA
91	Tagatoi	*Palaquium foxworthyi*	Sapotaceae	NA
92	Bayok	*Pterospermum diversifolium*	Sterculiaceae	NA
93	Bitan-ag	*Kleinhovia hospita*	Sterculiaceae	NA
94	Agosip	*Symplocos ahernii*	Symplocaceae	NA

95	Balobo	*Diplodiscus paniculatus*	Tiliaceae	DD
96	Malaikmo	*Celtis philippensis*	Tiliaceae	LC
97	Lipang-kalabaw	*Dendrocnide meyeniana*	Urticaceae	NA
98	Ramie	*Boehmeria nivea*	Urticaceae	NA
99	Alagau	*Premna odorata*	Verbenaceae	NA
100	Lagundi	*Vitex negundo*	Verbenaceae	NA
101	Lingo-lingo	*Vitex turczaninowii*	Verbenaceae	NA
102	Yemane	*Gmelina arborea**	Verbenaceae	NA
Vines and other scandent species				
1	Amolong	*Epipremnum pinnatum*	Araceae	NA
2	Limuran	*Calamus ornatus*	Arecaceae	NA
3	Burakan	*Merremia peltate*	Convolvolaceae	NA
4	Ubi	*Dioscorea alata*	Dioscoreaceae	NA
5	Sampinit	*Caesalpinia latisiliqua*	Fabaceae	NA
6	Baling-uai	*Flagellaria indica*	Flagellariaceae	NA
7	Bikal baboi	*Schizostachyum felsianum*	Graminae	NA
8	Ligtang	*Anamirta cocculus*	Menispermaceae	NA
9	Buyo	*Piper betle*	Piperaceae	NA
10	Balloon vine	*Cardiospermum halicacabum*	Sapindaceae	NA
11	Nitong puti	*Lygodium ciricinnatum*	Schizaeaceae	NA

*Introduced species in the Philippines.

B. Summary of computed species importance value of plants in sampling stations.

Species	Freq	Den	Dom	R Freq	R Den	R Dom	SIV
Falcataria moluccana	0.50	45.00	0.22	6.17	11.32	3.50	20.99
Ficus balete	0.10	2.50	1.13	1.23	0.63	17.60	19.47
Ficus gigantifolia	0.50	25.00	0.19	6.17	6.29	2.97	15.43
Cocos nucifera	0.30	17.50	0.46	3.70	4.40	7.13	15.24
Ziziphus talanai	0.40	17.50	0.28	4.94	4.40	4.36	13.70
Gmelina arborea	0.10	17.50	0.45	1.23	4.40	6.97	12.61
Macaranga bicolor	0.40	12.50	0.27	4.94	3.14	4.22	12.30
Swietenia macrophylla	0.20	10.00	0.47	2.47	2.52	7.25	12.23
Pangium edule	0.20	10.00	0.31	2.47	2.52	4.77	9.75
Intsia bijuga	0.10	2.50	0.50	1.23	0.63	7.82	9.69
Theobroma cacao	0.10	20.00	0.15	1.23	5.03	2.40	8.67
Cananga odorata	0.30	10.00	0.15	3.70	2.52	2.39	8.61
Mallotus philippeninses	0.20	15.00	0.14	2.47	3.77	2.22	8.46
Pterosepermum diversifolium	0.20	5.00	0.27	2.47	1.26	4.19	7.92
Ficus nota	0.20	15.00	0.06	2.47	3.77	0.87	7.11
Polyscias nodosa	0.20	7.50	0.13	2.47	1.89	1.95	6.30
Ficus septica	0.20	10.00	0.08	2.47	2.52	1.24	6.22
Homalanthus populneus	0.20	12.50	0.03	2.47	3.14	0.54	6.15
Annona muricata	0.10	12.50	0.06	1.23	3.14	0.91	5.29
Lansium domesticum	0.10	12.50	0.04	1.23	3.14	0.70	5.08
Heterospathe elata	0.20	7.50	0.04	2.47	1.89	0.69	5.05
Vitex turczaninowii	0.10	5.00	0.14	1.23	1.26	2.20	4.69
Evodia confusa	0.20	7.50	0.01	2.47	1.89	0.13	4.49
Pometia pinnata	0.10	5.00	0.11	1.23	1.26	1.74	4.23
Shorea contorta	0.20	5.00	0.03	2.47	1.26	0.46	4.18
Pandanus copelandii	0.10	7.50	0.04	1.23	1.89	0.59	3.71
Lithocarpus celebicus	0.10	5.00	0.08	1.23	1.26	1.18	3.67
Terminalia nitens	0.10	5.00	0.05	1.23	1.26	0.71	3.20
Engelhardia rigida	0.10	5.00	0.04	1.23	1.26	0.67	3.16
Kleinhovia hospital	0.10	2.50	0.08	1.23	0.63	1.17	3.04
Hevea brasiliensis	0.10	5.00	0.02	1.23	1.26	0.38	2.88
Neonauclea bartlingii	0.10	5.00	0.02	1.23	1.26	0.32	2.82
Madhuca betis	0.10	2.50	0.05	1.23	0.63	0.83	2.69
Arenga pinnata	0.10	2.50	0.05	1.23	0.63	0.83	2.69
Ficus heteropoda	0.10	2.50	0.05	1.23	0.63	0.76	2.63
Cyrtandra villosissima	0.10	5.00	0.01	1.23	1.26	0.11	2.60
Boehmeria nivea	0.10	2.50	0.03	1.23	0.63	0.54	2.40
Artocarpus sericicarpus	0.10	2.50	0.03	1.23	0.63	0.49	2.35
Leucaena leucocephala	0.10	2.50	0.03	1.23	0.63	0.49	2.35
Syzygium cumini	0.10	2.50	0.03	1.23	0.63	0.49	2.35
Lophopetalum toxicum	0.10	2.50	0.02	1.23	0.63	0.24	2.10

Areca catechu	0.10	2.50	0.01	1.23	0.63	0.21	2.07
Pterocarpus indicus	0.10	2.50	0.01	1.23	0.63	0.18	2.04
Syzygium campanulatum	0.10	2.50	0.01	1.23	0.63	0.18	2.04
Muntingia calabura	0.10	2.50	0.01	1.23	0.63	0.12	1.99
Syzygium samarangense	0.10	2.50	0.01	1.23	0.63	0.08	1.94
Ficus nota	0.10	2.50	0.00	1.23	0.63	0.06	1.92
Lagerstroemia pyriformis	0.10	2.50	0.00	1.23	0.63	0.04	1.91
Buchanania arborescens	0.10	2.50	0.00	1.23	0.63	0.03	1.89
Leea philippinensis	0.10	2.50	0.00	1.23	0.63	0.03	1.89
Coffea arabica	0.10	2.50	0.00	1.23	0.63	0.03	1.89
Macaranga hispida	0.10	2.50	0.00	1.23	0.63	0.03	1.89
Totals	8.10	397.50	6.42	100.00	100.00	100.00	300.00