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Quantitative vegetation analysis of Agoo Eco-park in Sta. Rita West Agoo, La, Union using grid-based mapping

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Key words: Agoo ecopark, Conservation status, Distribution status, Soil sampling, Vegetation analysis

Abstract

The quantitative vegetation analysis in Agoo Ecopark is assessed. This study is aimed to identify the plants present and classify them based on distribution, conservation status, and their ecological indices. This study also assessed the soil physicochemical composition. A quantitative and naturalistic observation was employed. Transect sample was used to obtain samples. There were 17 plants identified, 7 are native, 4 are naturalized, 3 exotics,1 cultivated, and 2 undocumented. Sonneratia alba recorded the highest Importance Value Index (IVI), the dominant plant family are the Fabaceae. Seven of the plants found are also native species and only two species are exotic. Moreover, this study shows that native species are dominant in the sampled area over exotic species. This study also shows that the soil conditions tolerable for the identified plants are extremely low Phosphorus, extremely high Potassium, normal pH range, which is acidic, and lightly textured due to the high presence of sand, and electrical conductivity which is non-saline. It is highly recommended that the Agoo Eco-park may be evaluated against other locations with the same ecosystem and a complete enumeration of vegetation may also be considered to create better results.

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Introduction

Biodiversity is important to most aspects of lives. People heavily rely on the various vegetation for resources in order to survive. Biodiversity, in general, has utilitarian and intrinsic values, complexity, diversity, spiritual significance, wildness, beauty and wonderness. Utilitarian values include the other basic needs humans receive from biodiversity such as food, fuel, shelter, and medicine. Among the richest in biodiversity globally has been the Philippine rainforest, which used to conceal about 90% of the country's land area. During the last decades, the forest cover has been minimized to less than 10% of the original, only a fraction of which is old-growth forest During the 1970 to 1990 period, the percentage of remaining rainforest in the country was drastically reduced from about 70% of what it was in the 1900s to less than 10% (Perez, 2020). Vegetation can even affect the weather conditions. It is of vital importance to maintain healthy forest ecosystems and provision of multiple services of ecosystem (Felipe-Lucia *et al.* 2018). Vegetation such as trees, bushes, wetlands, and wild grasslands naturally slow down water and help soil to absorb rainfall. Trees and other plants clean the air we breathe and help us tackle the global challenge of climate change by absorbing carbon dioxide.

In 2021, the Department of Environment and Natural Resources (DENR) started to reforest the place under its national greening program (NGP). The park is a part of the Agoo- Damortis Protected Landscape and Seascape (ADLPS), which covers 10,774.68 hectares as core zone and 135 hectares as buffer zone. Of this area, only 3 percent is land and rest is marine ecosystem. The Agoo Eco-Park, which was once identified as Agoo-Damortis Protected Landscape has been designated as a Protected Landscape and Seascape at national level in 2018 (DOPA, 2021). Agoo Eco-Park has been developed. Transects and quadrats are two ecological tools that permits quantifying the relative abundance, richness, diversity and evenness of species in an area. To track changes over time, it is important to be able to quantify changes in abundance. This method allows estimation of plant densities, frequency based on scattered points over a larger geographic area. This study utilized transects due to the vast extent of sampling sites. Measuring importance value can aid understanding the succession stages of a forest habitat. Importance values are one objective way of measuring this dominance. The three factors that are used to determine the importance value of a species are the density, dominance and frequency. The significance of this study is to analyze the vegetation Agoo Eco-Park in Sta. Rita West, Agoo, La Union.

In this light, this study was a quantitative vegetation analysis of the Agoo Ecopark in Sta.Rita Agoo, La Union. The foci of the study were to identify the plants (family and genus) and its ecological importance; identify the conservation status of the plant species based on the International Union for the Conservation of Nature (IUCN) red list; identify the distribution status of the plant species based on Co's Digital Flora of the Philippines, (2011); and determine the physicochemical composition of the soil. The study is mainly focused on the vegetation analysis of floristic diversity in the forest areas of Ecopark Sta. Rita West, Agoo, La Union which was covered 10,648.94 hectares of coastal area, including mangrove swamps, stretches of fine black sand beaches, and seagrass beds. It was the first posted as a national park in 1965 and known as the Agoo–Damortis National Seashore Park. It covers approximately 30 kilometers of coastline of the Lingayen Gulf shared between the municipalities of Agoo, Santo Tomas and Rosario. In previous years the seascape has 10,197.61 hectares and 315.59 hectares landscape. The study area of Agoo Ecopark showing in Google Earth map where each line in the grid accounts 300 meters away from the seashore. It is evident that with the change in the seascape, there was also a change in the landscape. A lot of pioneer species are teeming in the Ecopark due to the expansion of land.

Materials and methods

Research Design

This study employed a naturalistic observation in which the methods require non-invasive sampling to

obtain quantitative data in order to evaluate and study the community of trees and underbrush species in the Eco-park, Agoo La Union. The sampling stations were generated randomly using Quantum Geographic Information System (QGIS) and the Global Positioning System (GPS). Transect method (100m) were set on the forest.

Plants were classified according to their distribution, conservation status, and taxonomy. The distribution was classified into four categories: native, naturalized, cultivated and exotic, whereas conservation status was classified according to the 7 levels from International Union for Conservation of Nature (IUCN) Red List, of Threatened species. In addition, the taxonomy of identified plants was subjected to the following: kingdom, subkingdom, infrakingdom, super division, division, class, superorder, order, family, genus, common name, scientific name, and description of the plants. To get the indices, the following were accounted for each plant: count, circumference, diameter at breast height (DBH), basal area, basal area per species, relative dominance, density, relative density, frequency, relative frequency, distribution and importance value. Aside from the plant features, a composite soil sample was characterized based on the nutrient content.

Data Gathered

The data were gathered from Barangay Sta. Rita West, Agoo, La Union using the Grid-based Mapping to study the area and they communicated with the government or Municipal Hall to allow them to survey the place. Data on locality ID, altitude, species composition and number and other pertinent information were noted. During the sampling the researchers gathered all identified and unidentified species in the transects. Each specimen was documented, numbered and placed in plastic bag for later identification and recorded including the location and distribution of each individual plant. The identification of plants was done in consultation with an expert from Jose Vera Santos Memorial Herbarium (PUH) Institute of Biology, Up Diliman. After the plants have been authenticated, identified plants were categorized according to conservation and distribution status. Data were tabulated as bases for the following calculations: basal area, density, relative dominance, relative density, frequency, relative frequency, importance value index, species richness and species evenness as variables of species diversity. The researchers also, collected composite soil to be sent to Department of Agriculture-Regional Field Office 1 (DA-R1), Integrated Laboratories Division, Regional Soils Laboratory for examination to distinguish their physicochemical composition. (Organic Matter (OM), Phosphorus (P), Potassium (K), electrical conductivity (EC), pH, moisture content and texture).

Data Analysis

For the vegetation analysis, data were used to calculate many factors of importance in biodiversity studies. The following were computed:

Relative Density = (no. of a species/total number of individuals) x 100%

Density = (Relative Density/100) x Average Density

Basal Area = Density x average Basal Area

Relative Basal Area = (Basal Area/Total Basal Area) x 100

Frequency = (no. of points at which species occurs/total no. of points sampled)

Relative Frequency = (Frequency/Total Frequency for all species) x 100.

Importance Value = Relative Density + Relative Frequency + Relative Basal Area

The diversity index and evenness index were also measured as. The Shannon-Wiener Index is measured using the formula:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

where *H'* is the species diversity index, *s* is the number of species, and *pi* is the proportion of individuals of each species belonging to the *i*th species of the total number of individuals. The higher the value of *H*, the higher the diversity of flora species in a particular community. The lower the value of *H*, the lower the diversity. The lower the value of *H*, the lower the diversity. A value of *H* = 0 indicates a

community that only has one species. The Shannon Equitability or Evenness Index is a measure of evenness of species in a community. The term evenness simply refers of the different species to how similar the abundances are in the community. Denoted as *EH*, this index is calculated as:

$$EH = H / \ln(S)$$

where *H* is the Shannon Diversity Index and *S* is the total number of unique species. This ranges value from 0 to 1 where 1 indicates complete evenness.

Results

The identified vegetation was found in Agoo Eco-park where there are three categories as follows: tree species, underbrush species, and vine species (Figure 2). There were 17 species, 16 genera, and 12 families recorded from the sampling sites. Overall, a total of *17 individuals* were identified as certified by the Jose Vera Santos Memorial Herbarium (PUH), Institute of Biology, University of the Philippines Diliman. Most of the species are from the family Fabaceae with four (4) representative species followed by Cucurbitaceae with two (2) species, Acanthaceae with two (2) species. The families Convolvulaceae, Poaceae, Asteraceae, Lythraceae, Casuarinaceae, Combretaceae, Oleaceae, Rhizophoraceae, and Araceae were equally represented with one (1) species.

Table 1. Distribution and conservation status of identified vegetation in Agoo Eco-park.

Local/ Common name	Scientific name	Conservation Status	Distribution Status
I. Tree Species			
Mangrove pagatpat	*Sonneratia alba*	Least concern	Native
Acacia	*Acacia confusa*	Least concern	Native
Aroo	*Casuarina equisetifolia*	Undocumented	Native
Shoofly	*Caesalpinia decapetala*	Least concern	Undocumented
Mangrove api api	*Avicennia officinalis*	Least concern	Undocumented
Madre de cacao	*Gliricidia sepium*	Least concern	Naturalized
Talisay	*Terminalia catappa* L.	Least concern	Native
Bakawan lalaki	*Rhizophora acipulate*	Least concern	Native
II. Underbrush Species			
Pipinong-gubat	*Melothria scabra*	Undocumented	Naturalized
Bagaswa	*Ipomoea pes-caprae* (L.)	Least concern	Native
Putok-putok	*Ruellia tuberosa*	Undocumented	Naturalized
Kawad-kawaran	*Cynodon dactylon*	Undocumented	Native
Hagonoy	*Chromolaena odorata* (L.)	Undocumented	Exotic
Mani	*Arachis hypogaea*	Undocumented	Naturalized
Pipinong-gubat	*Melothria pendula* L.	Undocumented	Exotic
Sampaguita	*Jasminum sambac*	Undocumented	Cultivated
II. Vine Species			
Arrowhead plant	*Syngonium podophylum*	Undocumented	Exotic

Table 2. Computed importance value index (IVI).

Scientific Name	BA per species	RDo	De	RDe	F	Rf	IVI
Sonneratia alba	805.66	50.21	5	4.17	2	5	59.38
Acacia confusa	38.40	2.39	33	27.50	8	20	49.89
Casuarina equisetifolia	75.26	4.68	29	24.17	5	12.5	41.36
Cynodon dactylon	157.54	9.81	7	5.83	3	7.5	23.16
Rhizophora acipulate	200	12.47	4	3.33	2	5	20.82
Ipomoea pes-caprae (L.) R.Br.	156.40	9.74	2	1.67	3	7.5	18.92
Chromolaena odorata	99.68	5.91	13	10.83	3	7.5	18.42
Terminalia catappa L.	2.33	0.14	4	3.33	3	7.5	10.98
Ruellia tuberosa	5.91	0.37	8	6.67	1	2	9.54
Avicennia officinalis	16.48	1.02	4	3.33	2	5	9.37
Arachis hypogaea	37.93	2.37	1	0.83	2	5	8.19
Melothria pendula L.	0.65	0.04	3	2.50	1	2.5	5.05
Gliricidia sepium	1.56	0.09	2	1.67	1	2.5	4.26
Melothria scabra	0.34	0.03	2	1.67	1	2.5	4.18
Jasminum sambac	5.31	0.34	1	0.83	1	2.5	3.67
Syngonium podophyllum Schott	0.80	0.04	1	0.83	1	2.5	3.39
Caesalpinia decapetala	0.12	0.007	1	0.83	1	2.5	3.35
Total	1604	100	12	100	40	100	

*Note: (BA) Basal Area, (RDO) Relative Dominance, (De) Density, (RDe) Relative Density, (F) Frequency, (Rf) Relative Frequency, (IVI) Importance Value Index.

Among these plants are eight (8) trees species, eight (8) underbrush species, and one (1) vine. These species are *Avicennia officinalis* (Mangrove api api), *Casuarina equisetifolia* (Aroo), *Terminalia catappa* L. (Talisay), *Acacia confusa* (Acacia), *Caesalpinia decapetala* (Shoofly), *Terminalia catappa* L. (Madre de cacao), *Gliricidia sepium* (Mangrove pagatpat), *Sonneratia alba* (Bakawan lalaki), *Ruellia tuberosa* (Putok putok), *Chromolaena odorata* (L) R.M. King & H. Rob (Hagonoy), *Ipomoea pes-caprae* (L.) R.Br. (Bagaswa), *Melothria scabra* (*Pipinong gubat*), *Melothria pendula* L. (Pipinong gubat), *Arachis hyogaea* (Mani), *Jasminumsambac* (Sampaguita), *Cynodon dactylon* (Kawad-kawaran) and *Syngonium podophyllum* Schott. (Arrowhead plant).

Table 3. Computed Shannon-Weiner Diversity Index and Shannon Evenness Index.

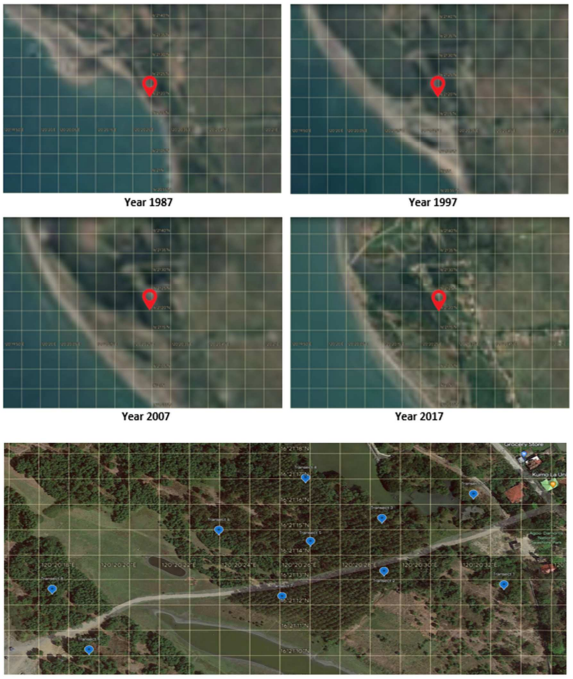
No. of Species (Density)	Shannon-Weiner Diversity Index	Shannon Evenness Index
33 29 13 8 7 5 4 4 4 3 2 2 2 1 1 1 1	0.28	0.48

Table 4. Soil analysis data.

Description	OM (%)	P (ppm)	P (ppm)	T	MC (%)	pH	EC (mS/c)
Dominated by Aroo	0.15	1.67	140.88	Light	0.44	6.54	1.17
Dominated by Acacia	0.75	8.42	263.20	Light	0.55	6.62	0.17
Dominated by Mangrove	0.35	1.93	347.81	Light	0.79	6.12	0.08
Mean	0.42	4.00	250.63	N/A	0.59	6.43	0.47
Descriptive Value	Very low	Very low	Extremely high	Sandy	Very low	Acidicnormal	

*Note: (OM) Organic Matter, (P) Phosphorus, (K) Potassium, (T) texture, (MC) Moisture Content, (EC) Electrical Conductivity.

Despite the area being developed, and the Aroo trees being the main attraction, there are still a variety of tree species identified. A great amount of underbrush species is also present in the area even with the number of tourists visiting the Agoo Eco-Park that threatens the quantity of these species.



Year 2018-present

Fig. 1. Study area of Agoo Eco-Park at Sta. Rita as viewed in Google Earth 1987 to 2018 data.

Fig. 2. Identified floral species in Agoo Eco-park. from left to right labeled a-q categorized as trees: a. *Avicenia officinalis*, b. *Casuarina equesetifolia,* c. *Terminalia catappa* L., d. *Acacia confusa,* e. *Caesalpinia decapetala,* f. *Gliricidia sepium,* g. *Sonneratia alba,* h. *Rhizophora acipulate*, underbrush: i. *Ruellia tuberosa,* j. *Chromolaena Odorata,* k. *Melothria scabra,* L. *Melothria pendula* L., m. *Ipomoea pes-caprae*, n. *Arachis hypogaea*, o. *Cynodon dactylon*, p. *Jasminum sambac* and vine: q. *Syngonium podophylum*.

Discussion

Distribution Status

The plants were authenticated, and the identified plants were categorized according to conservation and distribution status (Table 1). The distribution status was based on Co's Digital Flora of the Philippines (2011). From the literature, it was found that seven (7) species out of 17 species were native, these are as follows*: Ipomoea pes-caprae* (L.) R. Br. (Bagaswa), *Cynodon dactylon* (Kawad-kawaran*), Sonneratia alba*, (Mangrove pagatpat), *Acacia confusa* (Acacia), *Casuarina equisetifolia* (Aroo), *Terminalia catappa* L. (Talisay), *Rhizophora acipulate* (Bakawan lalaki). On the other hand, four (4) species are naturalized namely*, Melothria scabra* (Pipinong-gubat), *Ruellia tuberosa* (Putok putok), *Arachis hypogaea* (Mani) and *Gliricidia sepium* (Madre de cacao). The *Jasminum sambac* (Sampaguita) is considered cultivated. Two (2) species were undocumented and had no records *Caesalpinia decapetala* (shoofly) and *Avicennia officinalis* (Mangrove api-api). Unfortunately, the vegetation sample revealed that there are three (3) exotic species namely *Chromolaena odorata* (L.) R.M.King & H.Rob. (Hagonoy), *Melothria pendula* L. (Pipinong-gubat) and *Syngonium podophylum* Schott. (Arrowhead plant).

Conservation Status

Conservation statuses were lifted from International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (The IUCN Red List of Threatened Species, n.d.). There was no available data from regional and local evaluations and the data presented on (Table 1) is from the Global Red List Assessments. Based on the Global Red List Assessments, there is a total of nine (9) species categorized with Least Concern (LC): *Ipomoea pes-caprae* (L.) R.Br. (Bagaswa), *Sonneratia alba*, (Mangrove pagatpat), *Acacia confusa* (Acacia), *Caesalpinia decapetala* (Shoofly), *Avicennia officinalis* (Mangrove api api), *Gliricidia sepium* (Madre de cacao), *Terminalia catappa* L. (Talisay*), Rhizophora acipulate* (Bakawan lalaki). Other species are categorized as undocumented since they are not found on the database of the IUCN.

Dominance

The number of species, frequency, height, and diameter at breast height of each plant species were determined together with the Importance Value Index (IVI) that is the standard measure used to determine the species-rank relationship in ecology (Table 2). High Importance Values were obtained from the following species: *Sonneratia alba* having the highest IVI of (59.38), followed by *Acacia confusa* (49.89), and *Casuarina equisetifolia* (41.36). These three (3) species are considered as dominant plant species and are likely to influence the growth and survival of other species in the area. For example, *Acacia confusa* tends to fall eight (8) times to the transects, *Casuarina equisetifolia* five (5) times from the transect, and *Rhizophora acipulate* two (2) times from the transect. It is possible these species were able to develop specific adaptations.

Species with the least IVI are *Caesalpinia decapetala*, *Syngonium podophyllum* Schott., and *Jasminum sambac* with the following respective indices (3.35), (3.39), and (3.67). These species which have recorded low importance values also have the least frequencies. The basal area is a measurement of the tree density in a specific area of a land, determined by looking at a cross-sectional surface of land at a breast height of 4.5 feet from the ground having the highest basal area per species were obtained from the following species, *Sonneratia alba* (805.66), *Acacia confusa* (38.40*), Casuarina equisetifolia* (75.26). Species having the highest basal area means that they have a wider trunk base and that are capable of absorbing and trapping more carbon dioxide. The carbon collected is used by plants during the process of photosynthesis. Density is the number of individuals of a given species that occurs within a given sample unit or study area. Having the highest density are the following species, *Acacia confusa* (33*), Casuarina equisetifolia* (29) and *Chromolaena odorata* (L.) R.M. King & H. Rob. (13). which are these species being more in the study area and other species is least density.

Diversity

Species diversity determines the distribution of individuals among the species in a particular habitat.

Diversity of the sampling areas was analyzed using Shannon-Weiner Diversity Index (Table 3) and Shannon Evennes Index. The calculated Shannon-Wiener index is equal to 2.28. Typically, Shannon-Wiener Index values generally range from 1.5 to 3.5 in most ecological studies (Ifo *et al.*, 2016). Based on the ecological values, the computed value in the area has low diversity (Table 3). This may be due to the limited number of species and level of disturbance experienced by the species and, shortage of soil nutrients and absence of mycorrhizal fungi species. For the heterogeneity of the vegetation, the Shannon was used to measure richness and evenness. Richness is a measurement of the abundance of land cover classes, and evenness is a measure of the relative area of land cover classes (Gauthier and Derome, 2021). Richness is the total number of land cover classes in the selected area. A homogeneous area would have a Richness of one (1). Evenness is a measure of the relative abundance of pixels in the area selected and has a value between >0 and 1. For a given number of classes (Richness), an Evenness = 1 is reached when all classes have the same area. The value computed in this study revealed that using the sample vegetation, the evenness index is only recorded at 0.47, a value near 0. This indicates that nearly every sampled area in the vegetation sampled is the same.

Soil Analysis

Based on the general findings, the soil in Agoo Eco-park (Table 4) was considered light. Soil is the loose surface material that covers most land. This consists of two organic and inorganic matters. Also, soil provides structural support to plants and their source of water and nutrients. Soils vary greatly in their chemical and physical properties.

Based on the results of the soil analysis, the soil collected from the composite were grouped due to their location exactly on the Aroo Park, the transect 1 (16.35407, 120.34151), transect2 (16.35427, 120.34149), transect 3 (16.35395, 120.34157) and transect 4 (16.35479, 120.34067). Here, the Organic Matter (0.15%), available Phosphorus (1.67) ppm, available Potassium (140.88 ppm), Texture is light, Moisture Content (0.44%), pH (0.44%), and Electrical Conductivity (1.17mS/cm).

The site is dominated by the acacia park. This site covered three transects transect 5 (16.35423, 120.34125), transect 6 (16.35402, 120.34126), transect 7 (16.35378, 120.33984). The recorded organic matter is 0.75%, available phosphorus (8.42ppm), available potassium (263.20ppm), texture is light, moisture content (0.55%), pH (6.62%), and electrical conductivity (0.17mS/cm). The third site was grouped near the mangrove part of the park. Transect 8 (16.35310, 120.33875), transect 9 (16.35356, 120.34276), and transect 10 (16.35436, 120.34259). Organic matter (0.35%), available phosphorus (1.93ppm), available potassium (347.81ppm), texture is light, moisture content (0.79%), pH (6.12%), and electrical conductivity (0.08mS/cm)

Conclusions

There were 17 plants identified. The ecological indices of these identified plants show that based on the (i) importance value index (IVI), *Sonneratia alba, Acacia confuse* and *Casuarina equisetifolia* recorded the highest values, (ii) according to the diversity index, the Agoo Eco-Park has low diversity, and (iii) according to the evenness index, the distribution of species among the area is slightly uneven. On a global scale, there was no problem in terms of the conservation status of species in Agoo Eco-Park as eight (8) out of all species are of least concern and the rest, which are the majority of under brushes, are undocumented.

Seven (7) of the plants found are also native species and only three (3) species are exotic. Moreover, this study also shows that native species are dominant in the sampled area over exotic species. The physicochemical parameters show the conditions which are tolerable for the species identified: low percent organic matter, extremely low Phosphorus, extremely high Potassium, normal pH range, which is slightly acidic, and lightly textured due to the high presence of sand.

Recommendations

Based on the findings and conclusions in this study, it is recommended that the Agoo Eco-park may be evaluated against other locations with the same ecosystem. A complete enumeration of vegetation may also be considered to create better results.

Declaration of competing interest

The authors declare no competing interest

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