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Assessment of Physical Characteristics of Bugang River Watershed in Pandan, Antique, Philippines

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Abstract

Sustainable and appropriate watershed management strategies require the determination of biophysical information which includes the floral characteristics of the watershed. This study was conducted to characterize the floral composition of the Bugang River watershed. Data gathering was done by conducting an inventory for trees, palms, and bamboos with Quadrant Sampling using a stratified random sampling method in the forested area of the watershed with 50 m × 20 m sampling plots. Floral species were identified and classified through local experts, published books, journals, the internet, and available references. A total of 60 species belonging to 31 families and 52 genera were found using this method. Gogo (*Entada phaseoloides*) had the highest number of species with 222 or 14% of the total species. Trees with dbh 10 cm and above have a total estimated volume of 102.31 m^3. The average diameter and average height of species decrease as the elevation increases. The result showed that the Bugang River watershed has a diverse floral composition, with vertical stratification and a dense canopy. The advocacy and awareness campaign should be done and strengthen the protection and conservation efforts of concerned agencies for the sustainability of the watershed.

Keywords

Barangay Pandan, Floral Characteristics, Watershed, Stratification, Antique Philippines

1. Introduction

The Philippine watershed areas are already in critical condition. Deforestation

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contributes a lot to the degradation of almost 2.6 million hectares of identified critical watershed areas of the country. These situations caused a considerable reduction in the productivity of the forest, agricultural lands, and fisheries, and decrease returns from major investments in hydroelectric power generation and irrigation systems [1]. However, improper management and insufficient existing laws on watershed protection and preservation can cause rapid degradation of watersheds in the past [1] [2]. The destruction of forests and watersheds can cause massive soil erosion, declining soil productivity, sedimentation of river channels and dam siltation, catastrophic floods, and acute water shortages during the dry season [3]. Hence, healthy watersheds are the building blocks of sound natural resource stewardship [4]. In addition, healthy watersheds have an important role in climate change mitigation and adaptation. Furthermore, forests play an important role in watershed health; however, the connection between forests, watershed conditions, and water quality and quantity are frequently overlooked [5]. Therefore, watersheds should be managed properly, which can be accomplished by gathering sufficient data to characterize the watershed. One of the economically and socially important watersheds in the Northwest Panay Peninsula Natural Park (NWPNP) and part of it is the Bugang River watershed.

The Malumpati Health Spring and Tourist Resort is one of Panay's most popular tourist destinations, and it is located on the banks of the Bugang River. Aside from its distinct tourism value, the river also serves as a source of potable water for many Pandan households. Furthermore, during the First National Summit the cleanest inland water body in the Philippines, won the "Dangal ng Ilog" award. It also received the "Hiyas ng Turismo" award from the Gawad Pangulo sa Kapaligiran in 2006 [6]. Additionally, the Bugang River is undeniably socially and economically important, and requisite to its sound management is the need for a piece of scientific information. However, there is no substantial data on the floral component of the watershed, its characteristics, and the lack of existing maps of vegetation of the watershed. Hence, the main objectives of this study are to determine the physical features of the watershed in terms of area, elevation, slope, climatic factors, and major land use; describe the physical characteristics of forest soil in terms of soil texture, soil structure, and forest floor thickness (cm); identify and classify the existing floral species of the area such as trees, palms, and bamboos; and evaluate the tree species on the area in terms of diameter at breast height (dbh), stratification, volume and canopy cover.

2. Review of Related Literature

2.1. The Current State of Watershed in the Philippines

A watershed is simply defined as all land area that drains into a stream system, upstream from its mount, and is surrounded by a divide. A watershed, if properly managed, will supply water for agricultural and industrial use, including water for domestic consumption [2]. Further, Paragas [2] mentioned that three

(3) watershed forest reserves covering 3179 hectares were proclaimed. This new proclamation increased the number of watershed forest reserves to 117, covering an area of 1368 million hectares. The Philippine watershed areas, on the other hand, are already in critical condition [2]. Deforestation contributes a lot to the degradation of almost 2.6 million hectares of identified critical watershed areas of the country.

2.2. Watershed Management Legislation, Policies, and Institutional Arrangement

Watershed management is the process of organizing and directing the use of land, water, and other natural resources in a watershed in order to provide appropriate goods and services while minimizing the impact on the soil and watershed resources [7]. It entails socioeconomic, human-institutional, and biophysical interactions between soil and water, as well as the connection between upland and downstream areas [8]. Section 3 of Presidential Decree (PD) No. 705, known as the Revised Forestry Code of the Philippines, mandated that critical areas of a river system supporting existing and proposed hydroelectric power and irrigation works need immediate rehabilitation as they are too fast denudation causing accelerated erosion and destructive floods. These areas must be closed for logging until fully rehabilitated [9]. DENR Memorandum Circular No. 17 series of 1989 states that "effective immediately, all DENR offices involved in planning and implementation of watershed and reforestation programs and projects are instructed to incorporate Assisted Natural Regeneration (ANR) methods in all such projects, whenever applicable, regardless of whatever these are carried out by the administration, by contract or by combination thereof.

2.3. Importance of Forested Watershed

Forested watersheds improve water quality and enhance water storage naturally regulate stream flows, reduce flood damages and storm water runoff, replenish groundwater and provide a myriad of other benefits [10]. Moreover, water draining from undisturbed forested watersheds is generally of the highest quality, particularly with regard to beneficial uses including drinking water, aquatic habitat for native species, and contact recreation [11].

2.4. Forest Resource Inventory and Its Relevant to Watershed Management

Forest inventory is a process for obtaining information on the quality and quantity of forest resources and forms the foundation of forest planning and forest policy. While the early concept of sustainable forest management and forest inventory focused on timber production [12]. Modern forest inventory is well-established means of obtaining information on forest areas, usually with an emphasis on timber resources [13]. In addition, forest inventory essentially started with mapping of forest stands as homogeneous units with regard to species composition, density, and size, and strongly developed during the 20^{th} century with the establishment of a wide array of sampling techniques, focusing on timber volume and forest stand structure [14] [15].

3. Materials and Methods

3.1. Materials

In the conduct of the study, different materials were used such as a record book, ballpen, meter stick, steel tape, and tree caliper for the collection of data. Quadrant samples were located using a GPS device in obtaining the coordinates and elevation.

3.2. Research Ethics of the Study

This study followed the principles of research ethics to guarantee that all plant subjects were not harmed during identification. Municipal Mayor, Barangay officials, and other involved persons had their own free will to participate and they have fully informed regarding the procedures of the study and any potential risks.

3.3. Secondary Data Gathering

The secondary data such as the area, elevation, slope, climatic factors, forest soil component, major land uses, and other related information were gathered from maps and reports from the Department of Environment and Natural Resource (DENR), Water District of the Local Government Unit (LGU) of Pandan and barangays of San Rosario, Guia, and Candari.

3.4. Sampling Design and Procedure

Assessment of floral components was conducted particularly for the tree, palm, and bamboo species through Quadrant Sampling using stratified random sampling. With the use of a topographic map, there were seven (7) elevation ranges identified and these were the following (**Table 1**).

A maximum of three (3) by 50 m × 20 m (1000 m^2) plots were laid out at every elevation range. And a total of 21 sampling plots were laid out. However, the actual location of the plots was dependent on the accessibility of the site.

Table 1. The different elevation ranges of Bugang River Watershed.

Elevation Ranges (m)
50 - 100
100 - 150
150 - 200
200 - 250
250 - 300
300 - 350
350 - 400

3.5. Sampling Design and Procedure

Species of trees, palms, and bamboo inside the plot were identified with the help of local experts, available books, journals, and references such as the book of [16] and [17] and counted accordingly. Other trees, palm, and bamboo species outside the plots were also documented.

3.5.1. Physical Features

The watershed was delineated, and the total area of the Bugang River Watershed was determined through Geographic Information System (GIS). The mean elevation of the area was determined by measuring on a topographic map the area lying between successive pairs of contours or elevation ranges. The total percentage of each area constituted was computed using the formula:

- **Mean Elevation** $(E) = (a \times e)/A$

where:

a is the area between two contours;

e is the mean class elevation;

A is the area of the basin.

The slope of the watershed was described by determining the vertical and horizontal distance of the area in every 50 meters elevation difference.

3.5.2. Forest Soil Component

The Soil samples were collected within the 50 m × 20 m plot established in every elevation range. There were six (6) 2 cm thick, and 5 cm wide soil samples gathered from each plot per elevation range. After collection, soil samples were air-dried. The soil texture was identified through the roll method and soil type was also described using the soil map of the Philippines [18].

3.5.3. Forest Floor Thickness (cm)

The forest ground cover was determined by measuring the height of piled up residues taken immediately above the soil surface, and this is a mixture of the fresh, under composed litter (L layer) and F layer of the forest floor which consist of fragmented organic materials in a stage of partial decomposition of the floor.

3.5.4. Trees

All trees 10 cm and above dbh found in the 50 m × 20 m plot were identified and recorded. Data gathered were local, common, scientific names, diameter at breast height, and total height estimated to determine the volume per plot.

3.5.5. Tree Volume Determination

The diameter at breast height was measured at 4.5 ft or 1.30 m above the ground level for trees with dbh of 10 cm and above using a meter stick. The height was determined using a meter stick or Biltmore stick. The tree volume was determined using the DENR scaling formula as shown below:

- **Tree Volume** (m^3) $= 0.7854 \times d^2 \times L$

where:

d^2 is diameter at breast height (dbh) squared;

L is the height of the tree.

The mean volume m^3 was determined with the formula:

- **Mean volume** (Total volume of all trees/Total number of Trees) × 100.

3.5.6. Canopy Cover

The canopy cover was the total measure crown diameter of the dominant trees. Dominant trees were the tallest and with the widest crown diameters following from the cardinal direction (North, South, East, and West).

3.5.7. Major Land Use

The land uses within the watershed were determined through the use of a map taken from the Comprehensive Land Use Plan (CLUP), and other available maps of the area as reference. Likewise, field validation was done.

3.6. Data Management and Analysis

The data gathered were analyzed using descriptive statistics. The flora species were identified and the average height of trees, volume, and canopy cover were determined.

3.6.1. Relative Frequency

All species within the sample plot were counted to determine the total population of the area. The relative frequency (RF) was derived using the formula:

- **Relative Frequency** (Frequency value for a species/Total frequency for all species).

3.6.2. Average Height

The average height of the species was computed by dividing the sum of all the heights by the total of individual species.

3.6.3. Relative Height

The relative height was determined using the formula:

- **Relative Height** (Average height of species/Total average height of all species) × 100.

4. Results and Discussion

4.1. Physical Feature

Bugang River watershed was estimated at 1881.43 hectares or approximately 18.23 percent of the total upland areas of the municipality of Pandan. The highest elevation of the watershed was 400 meters above sea level (masl) and the mean elevation of the watershed is about 54 masl. The percent slope of the area gradually increases as the elevation increases. The lower elevations were gently sloping to undulating, middle elevation ranges were rolling to moderately steep, and the height elevation ranges were steep to very steep. The slope of the area was recorded from 50 to 100 masl lies between 3 to 8 percent, from 100 to 150 meters the slope was within the range of 9 to 18 percent, and from 150 to 200 meters the slope was from 19 to 30 percent. The slope ranges from 31 to 50 percent when the elevation above sea level reached 250 to 300 meters and 50 percent and above when the elevation measures up to 300 to 400 masl. Elevation and latitude are well-known broad-scale factors affecting species richness [19]. In addition, the climatic factors (temperature, potential evaporation, length of the growing season, humidity, air pressure, ultraviolet radiation, moisture index, and rainfall) vary with elevation [20].

The municipality of Pandan belongs to climate Type III where seasons were not very pronounced, it is relatively dry from November to April and wet for the rest of the year. The average annual temperature in the area is 27.5˚C and about 4448 mm of precipitation falls annually. The driest month is April, with about 87 mm of rain, and the month of July has the most rainfall amount, with an average of 679 mm. The warmest month is May with an average of 28.8˚C and January is the coldest with an average temperature of 26.3˚C. Land-use change was observed in the area over a five-year period (2010-2015). Changes in land use have an impact on the watershed, particularly on run-off volume, sedimentary yield, and stream flows. According to a field survey and interviews with local residents, a portion of the watershed was a Kaingin area. The conservation efforts of the government and other involved organizations, in collaboration with the local people, were strengthened in the recent year, resulting in partial reforestation and rehabilitation of the area.

4.2. Forest Soil Component

The soil component of the watershed area was identified as Alimodian Sandy clay with medium granular and slightly friable structure and sandy clay with gravel soil texture. The clay loam soil was reddish-brown to yellow-red in color and ranged in elevation from 50 to 150 masl with nearly level to moderately steep lands. Species from the Araliaceae and Meliaceae families were the most numerous at this elevation. On the elevated plains, moderately steep, rolling hills, and mountain landscapes with elevations ranging from 150 to 300 masl, a clayey, deep, and well-drained soil was observed, which was dominated by species from the Bignoniaceae and Fabaceae families. Elevation ranging from 300 to 400 masl, brown to reddish clay soi was observed on elevated plains, hilly to moderately steep to steep mountainous areas. The species belonged to the Anacardiaceae family, and the genus Buchanania dominated in this elevation range. In general, the soil structure was determined visually, and it was discovered that the soil structure in the area was granular, with nearly spherical grains that allowed water to circulate freely. Soil is an important component of the forest ecosystem as it helps regulate important ecosystem processes, such as nutrient uptake, decomposition, and water availability [21].

4.3. Forest Floor

The height of the piled-up forest residues was used to determine the thickness of the forest floor. The thickness of the forest floor was measured in various sampling areas. The elevation range of 50 to 100 masl had 0.04 to 0.69 cm piled forest residue, 100 to 200 masl had 2.02 cm to 2.67 cm piled forest residue, 200 to 300 masl had 2.68 cm to 3.33 cm piled forest residue, and 300 to 400 masl had the highest piled residue of about 4.00 to 4.65 cm. It was discovered that as elevation increased, the thickness of the forest floor increased. The difference in forest floor thickness was influenced by the density of trees by elevation level, as more trees were found at higher elevations, affecting the rate of accumulation of litterfall. Furthermore, the higher the elevation, the higher the humidity in a forested area aids in the rate of decomposition of organic materials [22].

4.4. Forest Species of the Area

The Bugang River watershed is home to a diverse range of tree and palm species. The total number of species discovered in the sampling plots was 1583, which included trees, palms, and bamboo. Gogo (*Entada phaseoloides*) had the most, accounting for 222 of the total species (14 percent). This study included 60 trees, palms, and bamboo species from 31 families and 52 genera, and 47 of the 60 species were identified, leaving 13 unidentified due to a lack of available references (**Table 2**).

Outside of the sampling plots tree, palm, and bamboo species were identified (**Table 3**). These species were abundant in number and can be found on river easements, residential areas, and in some parts of the forest.

There were five (5) palm species and 1 higher form of grass among the 60 species (**Table 4**). The majority of the palm and bamboo were observed at an elevation ranging from 50 to 150 masl, near local community plantations and cultivated areas. Furthermore, some areas had previously been subjected to slash and burn (Kaingin), and these areas were now covered with grasses, coconut, and bamboo.

4.5. Diameter at Breast Height (DBH) and Height of Trees

All trees with a diameter of 10 cm or greater were measured. **Figure 1** demonstrated that the average diameter of species decreased as elevation increased, with the highest average diameter of species identified at 50 - 100 masl elevation and the lowest at 300 - 350 masl elevation. Species at higher elevation levels were denser than those at lower elevation levels. The density of species per area influences the development of stem diameter [23], but other factors such as edaphic and climatic factors may also influence the secondary growth of tree species.

The average height of species was determined for each elevation range. The highest average height of species was recorded at an elevation of 300 - 350 masl, while the lowest was recorded at elevations of 200 - 250 masl. In the 300 - 350 masl range, species from the Lecythidaceae and Sterculiaceae families predominated. The study hypothesized that increasing elevation has a direct effect on the height of tree species. **Figure 2** showed, however, that the average height of species did not increase significantly as elevation increased.

Table 2. Number of tree, palm, and bamboo species per elevation range.

SPECIES				TOTAL NUMBER PER ELEVATION							
Family Name	**Local Name**	**Common Name**	**Scientific Name**	**50 - 100**	**100 - 150**	**150 - 200**	**200 - 250**	**250 - 300**	**300 - 350**	**350 - 400**	**Total**
Anacardiaceae	An-an	Balinghasai	*Buchanania arborescens*	0	2	0	3	7	1	38	**51**
	Dao	Dao	*Dracontomelon dao*	0	0	1	0	0	0	0	**1**
Anonaceae	Ilang-ilang	Ilang-ilang	*Cananga odorata*	0	0	0	2	0	0	0	**2**
Apocynaceae	Batino	Batino	*Alstonia marcrophylla*	2	0	3	0	2	2	2	**11**
	Bita	Dita	*Alstonia scholaris*	1	3	1	2	0	0	0	**7**
Araceae	Arim	Cuckoo pint	*Arum maculatum*	2	15	32	51	16	4	21	**141**
Araliaceae	Bungliw	Malapapaya	*Polyscias nodosa*	1	91	0	10	4	1	1	**108**
Araucariaceae	Badiangaw	Almaciga	*Agathis philippinensis*	0	1	0	0	0	0	0	**1**
Arecaceae	Niyog	Niyog	*Cocos nucifera*	6	7	4	9	0	8	6	**40**
	Tapikan	Fishtail palm	*Caryota mitis*	1	1	3	33	5	2	3	**48**
	Pitogo	Arayat pitogo	*Cycas riuminiana*	0	0	0	0	0	0	1	**1**
	Bunga	Areca nut	*Areca catechu Linn.*	22	0	0	0	3	1	0	**26**
	Ibiok	Kaong	*Arenga pinnata*	1	1	0	0	2	0	0	**4**
Bignoniacea	Badlan	Badlan	*Stereospermum quadripinatum*	0	1	1	91	5	10	4	**112**
Burseraceae	Salung	White dhup	*Canarium Hirsutum Willd.*	0	1	0	1	0	1	1	**4**
	Manok-manok	Garuga	*Garuga floribunda*	0	0	24	1	1	1	0	**27**
Clusiaceae	Batuan	Batuan	*Garcinia morella*	1	1	0	12	6	0	5	**25**
	Dangkalan	Dangkalan	*Calophyllum obliquinervium Merr.*	0	1	0	0	0	0	0	**1**
	Palo maria	Palo maria	*Calophyllum Inophyllum L.*	0	1	1	0	0	0	0	**2**
Combretaceae	Talisay	Talisay	*Terminalia catappa*	4	0	0	0	0	0	0	**4**
Cyatheaceae	Palad-buaya	Pakong-buwaya	*Cyathea contaminans*	0	0	0	0	0	0	1	**1**
Dilleniaceae	Katmon	Katmon	*Dillenia philippinensis*	0	0	0	0	0	1	1	**2**

Continued

Euphorbiaceae	Takip-asim	Coral tree	*Macaranga grandifolia*	0	1	0	1	1	0	0	**3**
	Alim	Alim	*Melanolepis multiglandulosa*	0	0	1	0	0	0	0	**1**
Fabaceae	Gogo	Gogo	*Entada phaseoloides Linn.*	0	39	89	21	28	11	34	**222**
	Ipil-ipil	Ipil-ipil	*Leucaena leucocephala*	1	0	11	0	1	0	2	**15**
Flacourtiaceae	Sarali	Coffee plum	*Flacourtia jangomas*	1	0	0	1	0	0	1	**3**
Lamiaceae	Germilina	Yemane	*Gmelina arborea*	2	0	0	1	0	0	0	**3**
	Mulawon	Molave	*Vitex parviflora*	1	0	4	2	0	2	1	**10**
Lauraceae	Batikulin	Batikuling	*Litsea leytensis*	0	0	19	0	2	2	1	**24**
Lecythidaceae	Toog	Toog	*Petersianthus quadrialatus*	2	0	0	0	0	0	0	**2**
	Uyauy	Lamog	*Planchonia spectabilis*	0	1	0	0	0	0	0	**1**
	Burobituon	Botong	*Barringtonia asiatica*	0	0	0	0	1	1	0	**2**
Malyaceae	Bobog	Kalumpang	*Sterculia foetida*	1	4	4	1	1	0	0	**11**
	Santol	Santol	*Sandoricum koetjape*	31	0	0	0	0	1	0	**32**
	Mahogani	Mahogany	*Sweitenia macrophyla*	36	0	0	0	0	0	0	**36**
	Malasantol	Malasantol	*Sandoricum vidalili*	0	0	5	0	0	0	0	**5**
	Bulog	Bulog	*Aglaia everettii Merr.*	0	0	0	0	0	0	1	**1**
Moraceae	Kubi	Kubi	*Artocarpus nitida*	6	5	0	1	2	1	1	**16**
	Malanangka	Malanangka	*Gymnartocarpus woodi Merr.*	2	31	2	0	0	20	7	**62**
	Tipolo	Antipolo	*Artocarpus blancoi*	12	32	11	2	3	0	3	**63**
	Biri	Fig	*Ficus sp.*	0	0	0	0	0	1	2	**3**
	Labnog	Hawili	*Ficus septica*	1	0	0	0	1	0	0	**2**
	Balete	Balete	*Ficus balete*	2	3	0	0	0	0	0	**5**
	Kamansi	Kamansi	*Artocarpus altilis*	1	0	0	0	0	0	0	**1**
Pandanaceae	Bariw	Pandan	*Pandanus tectorius*	3	23	0	1	2	0	0	**29**

Continued

Phyllanthaceae	Tuai	Tuai	*Biscofia javanica*	0	1	0	0	0	0	0	**1**
	Matang-hipon	Matang-hipon	*Brynia cernua*	0	0	0	1	0	0	2	**3**
Pittosporaceae	Balingkawayan	Mamalis	*Pittosporum pentandrum*	0	1	0	0	0	0	0	**1**
Poaceae	Botong	Bolo	*Gagantochloa levis*	13	22	0	1	1	0	0	**37**
Rubiaceae	Anino	Tumbong-aso	*Morinda citrifolia L.*	0	1	4	0	0	0	0	**5**
	Hamboaya	Malakape	*Canthium dococcum*	1	0	0	0	1	1	1	**4**
	Lisak	Kalamansanai	*Neonauclea bartlingii*	0	1	0	0	0	1	0	**2**
Sapindaceae	Rambutan	Rambutan	*Nephelium lappceum*	2	0	0	1	0	0	0	**3**
	Uyakya	Malugai	*Pometia pinnata*	0	13	0	0	0	0	1	**14**
Sapotaceae	Baid	Pourteria	*Pourteria macranthum*	0	0	0	0	1	5	0	**6**
Sterculiaceae	Bayok	Bayog	*Pterospermum acerifolium*	0	1	38	50	10	0	1	**100**
	Bayok-bayokan	Bayok-bayokan	*Pterospermum niveum Vid.*	0	0	14	0	1	0	0	**15**
Thymelaeaceae	Badjuko	Gonystylus sp.	*Gonystylus macrophyllus*	0	2	0	7	4	21	0	**34**
Urticaceae	Alagasi	Alagasi	*Leucosyke capitellata*	1	0	0	0	0	0	0	**1**
Unknown	Mayobo	Unknown	*Unknown*	3	2	2	3	0	2	0	**12**
Unknown	Tagpu	Unknown	Unknown	1	0	0	0	1	0	0	**2**
Unknown	Hag-um	Unknown	Unknown	0	51	0	1	0	1	1	**54**
Unknown	Malabatuan	Unknown	Unknown	1	1	0	0	0	3	0	**5**
Unknown	Panyat	Unknown	Unknown	0	1	0	3	6	12	39	**61**
Unknown	Lumbayao	Unknown	Unknown	0	0	0	0	0	1	0	**1**
Unknown	Taluto	Unknown	Unknown	0	0	0	0	1	2	0	**3**
Unknown	Dural-ug	Unknown	Unknown	1	1	18	1	12	4	6	**43**
Unknown	Kansilay	Unknown	Unknown	0	0	0	0	1	1	0	**2**
Unknown	Bunot-bunot	Unknown	Unknown	0	0	0	0	0	1	0	**1**
Unknown	Sandulawan	Unknown	Unknown	0	0	0	0	0	1	0	**1**
Unknown	Ipot-ipot	Unknown	Unknown	0	0	0	0	0	1	0	**1**
							Total				**1583**

Table 3. Species identified outside the study area.

SPECIES			
Family Name	**Local Name**	**Common Name**	**Scientific Name**
Anacardiaceae	Mangga	Mangga	*Mangifera indica*
	Kasoy	Cashew Nut	*Anacardium occidentale*
Annonaceae	Babana	Guyabano	*Annona muricata*
Arecaceae	Nipa	Nipa	*Nypa fruticans*
	Buri	Buri	*Corypha utan Lam.*
Bixaceae	Achuete	Annato	*Bixa orellana*
Fabaceae	Narra	Narra	*Pterocarpus indicus*
	Ipil	Ipil	*Instia bijuga*
	Madre de cacao	Kakawate	*Gliricidia sepium*
	Acacia	Rain tree	*Samanea saman*
	Auri	Acacua auri	*Acacia auriculiformis*
	Saraca	Red Saraca	*Saraca declinata*
Lythraceae	Banaba	Banaba	*Lagerstroemia speciosa*
Malvaceae	Kakao	Cacao	*Theobroma cacao*
Meliaceae	Lansones	Lansones	*Lanceum domestican*
Moraceae	Langka	Nangka	*Artocarpus heterophylla*
Muntigiaceae	Aratilis or Sarisa	Datiles	*Muntingia calabura*
Musaceae	Saging	Banana	*Musa sp.*
Myrtaceae	Lumboy	Duhat	*Syzygium cumini*
Oleaceae	Kalonakon	Northern Olive	*Linociera ramiflora*
Phyllanthaceae	Inyam	Inyam	*Antidesma sp.*
Poaceae	Kawayan	Kawayang tinik	*Bambusa blumeana*
Polygonaceae	Palosanto	Palosanto	*Bursera graveolens*
Rutaceae	Sutil	Calamansi	*Citrofortunella microcarpa*
Sapotaceae	Star apple	Caimito	*Chrysophyllum cainito*

Table 4. Palm and Bamboo species were identified within the study area.

SPECIES			
Family Name	**Local Name**	**Common Name**	**Scientific Name**
Arecaceae	Niyog	Niyog	*Cocos nucifera*
	Tapikan	Fishtail palm	*Caryota mitis*
	Bunga	Areca nut	*Areca catechu Linn.*
	Ibiok	Kaong	*Arenga pinnata*
Pandanaceae	Bariw	Pandan	*Pandanus tectorius*
Poaceae	Botong	Bolo	*Gagantochloa levis*

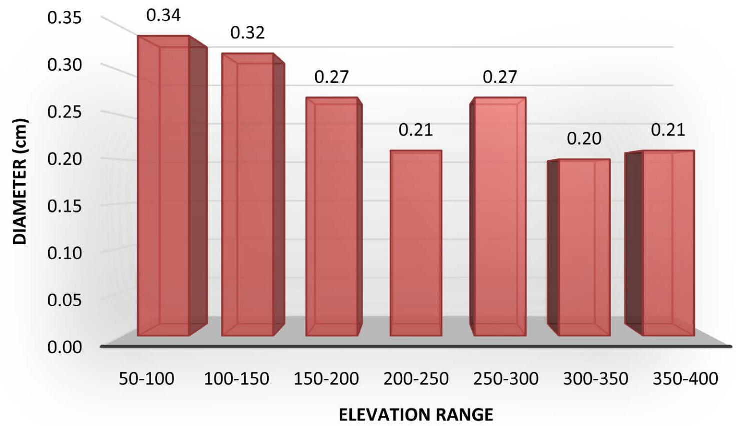

Figure 1. Average diameter at breast height (dbh) in different elevation ranges.

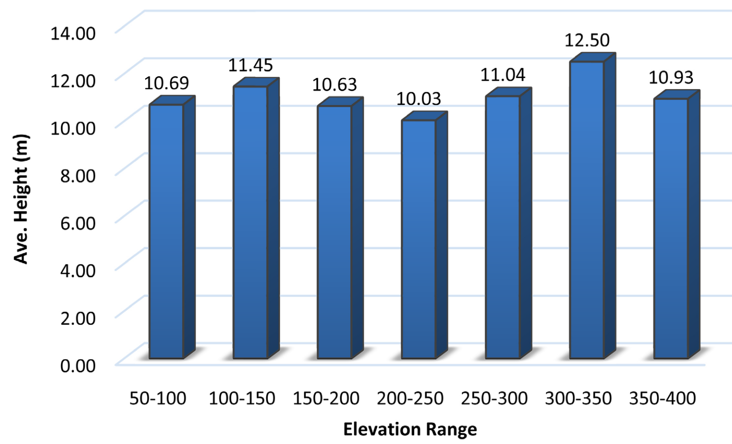

Figure 2. The average height of species per elevation range.

The volume varies by species, in this study, and the total volume of the trees and palms in the study area was 102.31 cubic meters (m^3), with a mean volume of 0.1393 m^3 per tree. The average volume of trees and palms at various elevation levels was 73.64 m^3. **Figure 3** shows that the tree species in the 50 - 100 masl elevation range have the highest average volume of 30.56 m^3 and the lowest average volume of 0.76 m^3 in the 300 - 400 masl elevation range. There was also a decrease in average volume at 200 - 250 masl, which was caused by a change in land use.

4.6. Stratification of Trees Found in the Area

Strata were determined for each tree and classified as Suppressed (S), Intermediated (I), Codominant (CD), and Dominant (D). Dominant species accounted for 3 percent of all species. These species were found at elevations ranging from 50 to 100 masl. There were 282 codominant species, accounting for 18 percent of the total number of species, 717 intermediate species, accounting for 45 percent of the total number of species, and 542 suppressed species, accounting for 34 percent of the total number of species. In higher elevations, suppressed species were abundant, and these species were saplings and seedlings (**Figure 4**).

4.7. Canopy Cover

The total crown diameter of the dominant tree species determined the area canopy cover. The elevation range of 250 - 300 masl had the lowest canopy cover of 266.91 m^2 and the highest canopy cover of 780.42 m^2. The study area's total canopy area was 3154.67 m^2 (**Figure 5**).

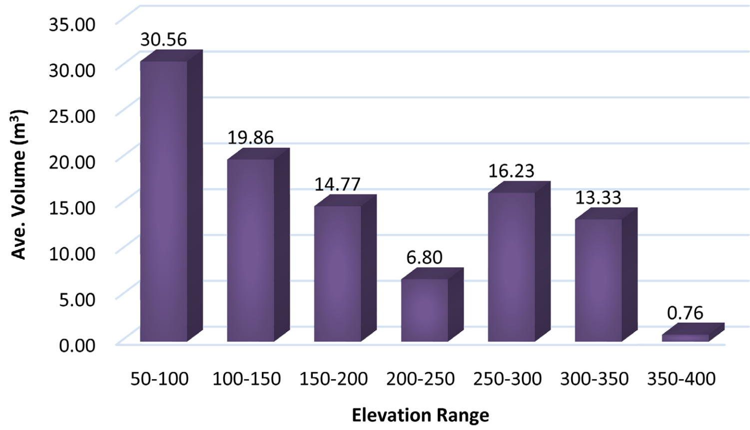

Figure 3. The average volume of trees species per elevation range.

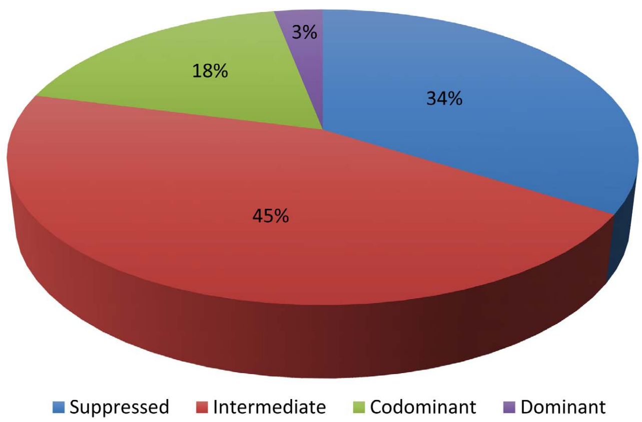

Figure 4. Total percentage of trees belonging to different Strata.

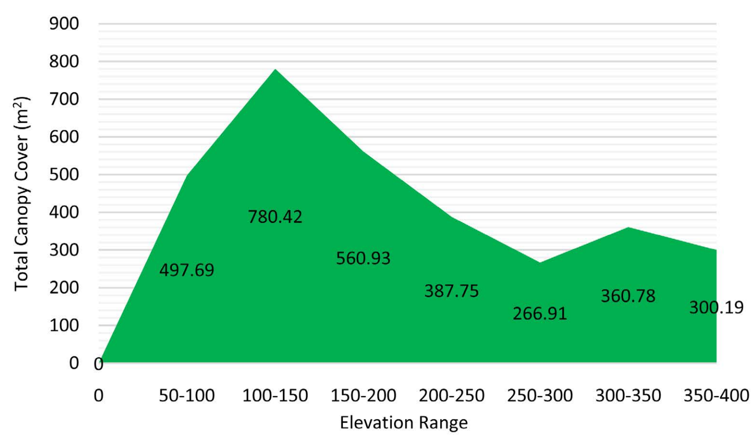

Figure 5. Total canopy cover per elevation range.

5. Conclusion and Recommendations

Based on the results of the study conducted, the Bugang River Watershed has a total estimated area of 1881.43 hectares with a mean elevation of 54 masl. The slope of the area increases as elevation increases, resulting in variation in elevation of the watershed; and surface. The soil type was Alimodian sandy clay with granular and friable structure and sandy clay with gravel soil texture. The thickness of the forest floor increases as elevation increases, which is influenced by the density and number of trees, and hastening the rate of litterfall accumulation. Furthermore, the watershed has a diverse floral composition, with 72 species identified from 31 families and 44 genera. The Bugang River watershed forest is vertically stratified, with species at various stages of tree growth. The difference in crown position between dominant, codominant, intermediate, and suppressed species is in relation to adjacent trees. There was an increasing trend in canopy cover density from lower to higher elevations.

The study produced significant and vital results that can be applied in the field of science. However, there were some limitations to the study that can be addressed in future research. First, increase conservation and protection activities such as reforestation and enrichment planting, particularly in previously kaingin forest patches. Second, a concerned organization may organize an advocacy and awareness campaign in the floristic composition of the watershed. Third, in the future, a thorough vegetation analysis may be performed. Finally, forestry-related research will be carried out on the roles of vegetation on the physical processes of the watershed, as well as the effects of utilization and harvesting.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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