PLANT DIVERSITY IN THE FOREST ECOSYSTEM OF CARRANGLAN WATERSHED, NUEVA ECIJA, PHILIPPINES

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Forests are home to 50-90% of the Earth's species providing food, wood, fiber, energy, raw materials, industrial chemicals, and medicine. Biodiversity is a vital part of the earth's capital, preserving the plant's genes, species, and ecosystems hence, biodiversity conservation should be a priority. This study assessed plant diversity in Carranglan, Nueva Ecija, Philippines to determine the exploitation and conservation status of its forest ecosystem. Plants were collected, preserved, described, identified and classified. The number and distribution of each species of plants were noted for diversity assessment. Data were gathered using quadrat sampling method with ten pre-selected stations: five were located at Barangay Gen. Luna and five were at Barangay Burgos. There were a total of 292 different plant species in the area, under 91 families with families Moraceae, Myrtaceae, Araceae, and Rubiaceae as most represented. Trees, shrubs and vines are the most common, with some ferns, mosses, herbs, grasses, sedges, and epiphytes. Shannon's Diversity Index showed that the study areas exhibited very high diversity.

There were 25 plants found to have been part of the International Union for the Conservation of Nature (IUCN) Red List of 2013. Four species of these belonging to the genus *Shorea* were listed as critically endangered, two of which are endemic to the Philippines. Near threatened, endangered, threatened, vulnerable, and plant of least concern were recorded. Twenty four endemic plants, 15 introduced plant species and four invasive plant species were also recorded. Three species, namely *Oncosperma. horridum* (Griff.) Scheff., *Dinochloa luconiae* (Munro) Merr. and *Radermachera gigantea* (Blume) Miq. could serve as potential biodiversity indicator species in both of the study areas due to their high number of individuals, frequency, and abundance. Threats to the Carranglan Forest ecosystem include fires, timber poaching, *kaingin* practices, soil erosion, and small-scale mining.

KEYWORDS: diversity, plants, watershed, biodiversity indicator, degradation

INTRODUCTION

THE CARRANGLAN WATERSHED (CW) in Central Luzon covers a total area of 97,318 ha of which 4, 023ha comprise the water reservoir. It lies at 15°44′ to 16°88′ north latitude and 120°36′ to 122°00′ east longitude (Lasco, Cruz, Pulhin, & Pulhin, 2010). The Caraballo mountain ranges border the watershed in the north while the southern portions are bordered by the Sierra Madre mountain ranges.

The CW experiences two pronounced seasons: dry from December to April and wet for the other months. The annual average rainfall is 1,766.5 mm (Saplaco, Bantayan, & Cruz, 2001; NPC, 1995 and 1997, as cited in Lasco et al., 2010). Temperature ranges from 23.21°C to 33.71°C, with an average annual humidity of 83.37% (NPC 1995 and 1997, as cited in Lasco et al., 2010). The topography of CW ranges from level, undulating and sloping, up to steep hilly landscapes. These landscapes are often dissected by narrow, flat-bottomed valleys formed by streams running in these mountains. The soils in these mountains were products of the weathered materials from volcanic activities and diorite. The major soil textures are silty clay loam, clay loam, and clay.

Biodiversity refers to the variety of life in all its forms found on earth. It has to be conserved because it leads to a stable and balanced ecosystem, underpinning for agriculture and forestry, source of medicine, natural service for vegetative cover, recreational, aesthetic, ecotourism, scientific, and commercial values (Alberto, 2005). Likewise, natural plant biota serve to maintain air quality as they fix CO_2, release O_2, and help to assimilate other air pollutants by absorbing considerable solar radiation and, by releasing water vapor through transpiration, they moderate temperature and help maintain climate (Cunningham & Cunningham, 2007).

Duelli and Orbist (2003) state that biodiversity indicator is a linear correlate to the entity or aspect of biodiversity under evaluation. Biodiversity indicators represent three value systems such as conservation (protection and enhancement of rare and threatened species), ecology (ecological resilience and ecosystem functioning based on species diversity) and biological control (diversity of antagonists of potential pest organisms). Biodiversity indicators could be used as quantifiable environmental factors in scientific research.

Threatened species lists are designed primarily to provide an easily understood qualitative estimate of risk extinction (Possingham, et al., 2002). There are four ways by which these lists could be used, namely [a] to set priorities for resource allocation for species recovery; [b] to inform reserve system design; [c] to constrain development and exploitation; and [d] to report on the state of the environment. However, there are limitations on the use of threatened species lists. According to Possingham, et al. (2002), threatened species lists are inappropriate to use for resource allocation because resources for conservation are limited. The use of threatened species as surrogates for biodiversity is also limited because most invertebrate animals and nonvascular plants are not included in any threatened species lists. Moreover, these lists can lead to the illogical outcome that developments with small impacts might be curtailed by a listed species but those developments with large impacts on one or more nonlisted species can proceed with no mitigation requirements. The threatened species lists might also increase threats to a species. In addition, threatened species lists might have limited value as indicators of change in the state of the environment because of uneven taxonomic treatment, variation in observational effort, and the changes in the lists reflect change in knowledge of status rather than change in status itself (Possingham, et al., 2002).

The study was conducted to assess the diversity of plants in the

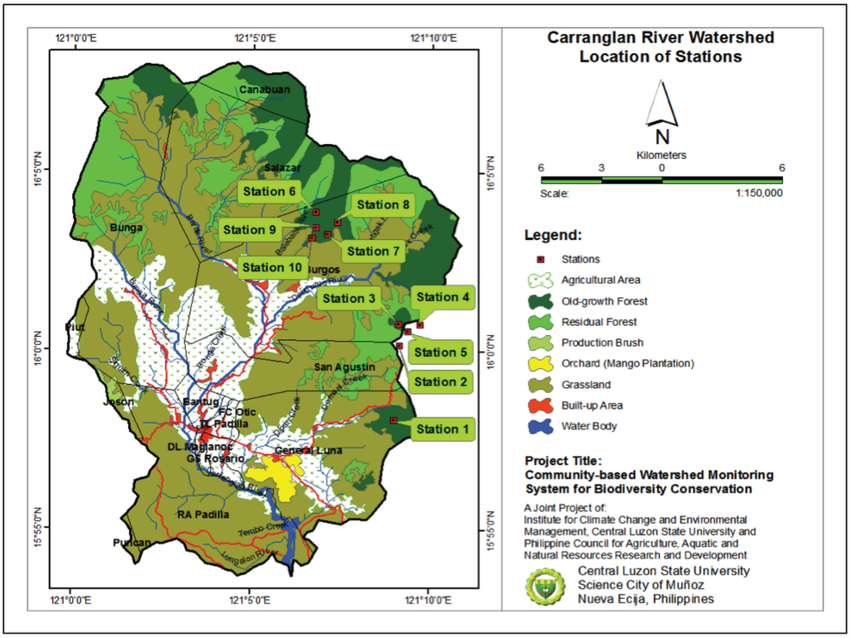

Figure1. The ten study sites at Carranglan Watershed.

Carranglan Watershed, to identify the endemic and introduced/ invasive plants species, to determine the ecological/economic roles/functions of plants in the forest ecosystems, to identify biodiversity indicators and to determine the sources and impact level of environmental problems in the forest ecosystem.

METHODOLOGY

Study Sites

Forested areas from two barangays, General Luna and Burgos in Carranglan, Nueva Ecija (Figure 1) were selected as study areas. Barangay Gen. Luna has a total land area of 9,406.02 ha. The forested area encompasses 6,078.47 ha with 206.50 ha of bodies of water. Open spaces and grassland occupy 650.48 ha (CENRO-Muñoz, 2001). These areas are often cultivated and serve as pasture for animals. The mountains of Barangay Gen. Luna exhibit varying steepness—from flat to very steep—and numerous streams. The upper parts of the forested area are dominated by large trees with many small shrubs and vines. Some portions are dominated by tall grasses and large ferns.

Barangay Burgos has a total land area of 9,745.47 ha of which 4,428.28 are forested. Bodies of water (e.g., major rivers and falls) comprise 419.26 ha. Grasslands are present starting from the foot up to about half of some mountains. The surveyed mountain has a steep to very steep terrain. The soil is rocky to clayey. Large trees, shrubs, bamboo and vines are present in the study areas.

The sampling areas

A total of ten stations were established at Carranglan Watershed equally distributed between Barangay Gen. Luna and Barangay Burgos. Selection of the stations and quadrats were guided by digitized maps. Each station contained ten preselected quadrats measuring 10m x 12m. A total of 12,000 sq. m. of the primary and old-growth forest located within Barangay Gen. Luna and Barangay Burgos was surveyed in Carranglan Watershed. These areas have rocky and clayey terrain with elevation range from 500-1000 meters above sea level and most of them have steep terrain. Several small streams and large rivers are present in the area. Water from these areas are utilized as sources of potable water and irrigation. The rivers emptied into Pantabangan Hydroelectric Dam.

Data gathering, documentation and collection of samples

The local name, habit, number of individual plant per species and the quadrats where they were present were gathered and recorded from 2011-2013. The data were used to compute for the various ecological parameters such as frequency and dominance, among others using the following formulas (Smith & Smith, 1998):

1. Percentage Occurrence

$$\text{Percentage Occurrence} = \frac{\text{No. of Stations where sp. occurred}}{\text{Total No. of Stations}} \times 100$$

2. Frequency Distribution (F)

$$F = \frac{\text{No. of quadrats where the species occurred}}{\text{Total No. of Quadrats}}$$

3. Relative Frequency (RF)

$$RF = \frac{\text{Frequency of 1 species}}{\text{Total Frequency}} \times 100$$

4. Density = Number of individuals of a species per area sampled

$$D = \frac{\text{No. of Individuals}}{\text{Total Area Sampled}}$$

5. Relative Density (RD)

$$RD = \frac{\text{Density of a species}}{\text{Total Density of all Species}} \times 100$$

6. Dominance (Do)

Where: $$Do = \frac{\sum ni\,(ni - 1)}{N\,(N - 1)}$$

7. Relative dominance (RDo)

$$RDo = \frac{\text{Dominance of 1 species}}{\text{Total Dominance}} \times 100$$

8. Importance Value Index (IVI) = RF + RD +RDo

9. Shannon Diversity Index

$H' = \sum pilnpi$

Where: H'= Shannon index of diversity
pi = proportion of species from the total species
ln = natural logarithm

10. Biodiversity Indicator Value (Dufrene & Legendre, 1997)

IndValij = Aij x Bij x 100

Where: Aij= N individuals ij \ N individuals i
ij= the average amount of the species i in zone j (abundance)
i= mean values for species i in all zones

Bij= N sitesij \ N sites i
ij= no. of sites in zones j where species i is present (frequency)
i= number of sites in zone j

Information on uses of the plants recorded and associated beliefs, if any, were also gathered. The plants were photographed in their natural habitat. In case of very tall trees whose leaves are not observable due to their height and the understory trees that obscure viewing, bark of young individuals were photographed instead. Samples were collected to aid in identification and also preserved as herbarium specimens and archived at the Biodiversity Museum of the Institute for Climate Change and Environmental Management, Central Luzon State University. As much as possible, parts with reproductive organs were collected. Small shrubs, ferns, mosses and herbs were collected whole. Specimens were also categorized based on the IUCN Red List of Threatened Species (2013).

Sources and Levels of Impact of Environmental Degradation of the Terrestrial Ecosystems

The condition of the ecosystem was assessed through ocular inspections. The checklist on the sources and impact level on environmental degradation of forest ecosystems (Alberto, 2005) was utilized. There are four levels of impact in each source of environmental degradation; a value was assigned for each level. The level of impact is estimated based on the percentage of impact/damage in the study area. The checklist was rated using the values 1-4 by a minimum number of ten evaluators from the CENRO, Department of Environment and Natural Resources, Central Luzon State University, and PCAARRD, DOST to determine the present condition of the forest ecosystem. Respondent answers were averaged and a scale (Table 1) was used to interpret the scores for impact level on environmental degradation of the ecosystem.

Table 1. **Impact Level Scale Values.**

Scale	Impact Level
1.01 – 1.75	No Significant Impact
1.76 – 2.50	Small Impact
2.51 – 3.25	Moderate Impact
3.26 – 4.00	Major Impact

RESULTS

Assessment of Flora in Carranglan Watershed, Nueva Ecija, Philippines

A total of 292 plants were observed from all the stations surveyed at the Carranglan Watershed—165 and 163 in Brgy. Gen. Luna and Brgy. Burgos, respectively. Thirty-six species were present in both study areas. The plants were classified under 91 families. Family Moraceae, Myrtaceae, Araceae and Rubiaceae were the most represented families with more than nine representative species each. The flora observed were mostly trees, shrubs, and vines. Likewise, herbs, grasses, sedges and mosses were also observed in the study areas (Figure 2).

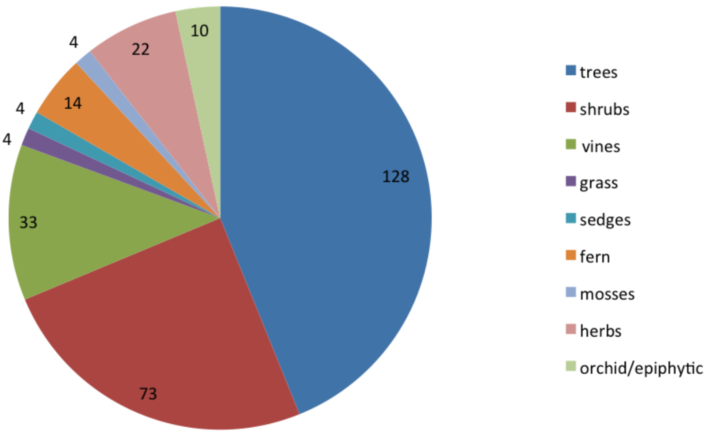

Figure 2. Plant types present in Carranglan Watershed.

The six species of plants found to occur in all the stations surveyed were *Philodendron lacerum* (Jacq.) Schott.,a tree; "biakal" [*Dinochloa luconiae* (Munro) Merr.], a grass species; "yantok" (*Pinanga aculate* Porte ex Lemaire), a shrub; "yantok" [*Oncosperma horridum* (Griff.), Scheff.], a tree; "white lauan" [*Shorea contorta* (Vid.) Merr. and Rolfe], a tree; and *Pueraria lobata* (Willd.) Ohwi, a vine.

Medium-sized to large trees were harvested as sources of timber such as the "Tuai" (*Bischofia javanica* Blume.). Thirty-three (trees) are sources of high to medium quality timber [e.g. "Red Lauan" (*Shorea negrosensis* Foxw.)]. Medicinal and ornamental plants were also common such as "Pakong Gubat" (*Pityrogramma calomelanos* L.) and "Dapo" (*Asplenum nidus* L.), respectively. Other plants were used for handicraft such as "Bamban" [*Donax cannaeformis* (G. Forster) K. Schum.] and as roping materials like "Yantok" (*Calamus usitatus*); forage for animals such as "Jalakjak" (*Cyrtococcum patens* (L.) A. Camus), sources of edible fruits like "Pahutan" (*Mangifera altissima* Blanco), and some can be source of dyes such as "Taluto" (*Pterocymbium tinctorium* (Blco.) Merr.). Some species like *Dendrocnide luzonensis* (Wedd.) Chew secretes irritating chemicals.

Shannon's Diversity Index showed that Carranglan Watershed has very diverse flora, with a value of 3.68. Each station surveyed also showed very high diversity. Station 5 located at Brgy. Gen. Luna recorded the highest diversity with a total of 101 species (Table 2.)

Ecological status of plants present in CW

Twenty-five plants from Carranglan Watershed have been listed in the IUCN Red List (2013). Their ecological status was also determined. Three species under the genera of Shorea; two of which are endemic to the Philippines, are listed as critically endangered. Dipterocarpus gracilis (Blume) was also listed as critically endangered. During the survey, these species recorded low number of individuals. These trees are source of good quality timber, thus these are targeted by loggers (Table 3, Figure 3.)

Twenty-five species are also found to be endemic to the Philippines. Other plants recorded from Carranglan are endemic to Southeast Asia. Ten species are non-native to the Philippines. Four of these are ornamentals; two were planted as crops (*Coffea*

Table 2. **Diversity Indices of Plants Observed in the Ten Stations of Carranglan Watershed.**

Station	No. of Species	No. of Individuals	Diversity Index	Interpretation
Station 1	69 species	803	3.583	Very high diversity
Station 2	87 species	836	3.866	Very high diversity
Station 3	94 species	1039	3.521	Very high diversity
Station 4	91 species	825	3.798	Very high diversity
Station 5	101 species	773	4.142	Very high diversity
Station 6	97 species	1134	3.203	High diversity
Station 7	93 species	898	3.686	Very high diversity
Station 8	77 species	667	3.627	Very high diversity
Station 9	92 species	696	3.875	Very high diversity
Station 10	93 species	846	3.746	Very high diversity
AVERAGE			**3.68**	**Very high diversity**

Table 3. **Critically Endangered, Endangered, Vulnerable, Near-threatened, and Least Concerned Species Observed in Carranglan Watershed Based on IUCN 2013.1**

Species	Ecological Status
Dipterocarpus gracilis Blume	Critically endangered
Hopea malibato Foxw.	Critically endangered
Parashorea malaanonan (Blco.) Merr.	Critically endangered
Shorea contorta (Vid.) Merr. and Rolfe	Critically endangered
Shorea negrosensis Foxw.	Critically endangered
Shorea polysperma (Blco.) Merr.	Critically endangered
Mangifera decandra Ding Hou	Endangered
Aglaia macrocarpa (Miq.) Pannell	Near threatened
Dimocarpus longan ssp. *malesianus* var. schinatus Leenh.	Near threatened
Agathis philippinensis Warb.	Vulnerable
Artocarpus treculianus Elm.	Vulnerable
Canarium luzonicum (Blume) A. Gray	Vulnerable
Cinnamomum mercadoi Vid.	Vulnerable
Mangifera altissima Blanco	Vulnerable
Pterocarpus indicus Willd	Vulnerable
Vitex parviflora A.L. Juss.	Vulnerable
Actinodaphne pruinosa Nees.	Least concern
Aphanamis polystachya (Wall) R.N. Parker	Least concern
Caesalpinia sappan L.	Least concern
Calophyllum inophyllum L.	Least concern
Calophyllum soulattri Burm. F.	Least concern
Canarium asperum Benth.	Least concern
Canarium littorale Blume, Bijdr.	Least concern
Dacryodes costata (Benn.) H.J. Lam	Least concern
Knema glomerata (Blco.) Merr	Least concern

Table 4. **Endemic, Introduced/Invasive Plants in Carranglan Watershed**

Species	Habit	Ecological Status
Hopea malibato Foxw.	Tree	Endemic (Philippines)
Shorea contorta (Vid.) Merr. and Rolfe	Tree	Endemic (Philippines)
Shorea polysperma (Blco.) Merr.	Tree	Endemic (Philippines)
Agathes philippinensis Warb.	Tree	Endemic (Philippines)
Mangifera altissima Blanco	Tree	Endemic (Philippines and Southeast Asia)
Aglaonema commutatum Schott.	Herb	Endemic (Philippines and Southeast Asia)
Alocasia heterophylla (Presl.) Schott.	Herb	Endemic (Philippines)
Carmona retusa (Vahl.) Masam	Shrub	Endemic (Philippines and Southeast Asia)
Caryota mitis Lour.	Palm	Endemic (Philippines and Southeast Asia)
Dendrocnide luzonensis (Wedd.) Chew	Shrub	Endemic (Philippines)
Doryopteris ludens (Wall. ex Hook.) J. Sm.	Fern	Endemic (Philippines and Southeast Asia)
Ficus balete Merr.	Tree	Endemic (Philippines)
Ficus nota (Blco.) Merr.	Tree	Endemic (Philippines and Southeast Asia)
Ficus pseudopalma L.	Tree	Endemic (Philippines)
Macaranga grandifolia (Blco.) Merr.	Tree	Endemic (Philippines)
Medinilla pendula Merr.	Shrub	Endemic (Philippines)
Melicope triphylla (Lam.) Merr.	Tree	Endemic (Philippines and Southeast Asia)
Oncosperma horridum (Griff.) Scheff.	Tree	Endemic (Philippines and Southeast Asia)
Pandanus luzonensis Merr.	Tree	Endemic (Philippines)
Pinanga maculata Porte ex Lemaire	Shrub	Endemic (Philippines)
Pinanga philippinensis Becc.	Shrub	Endemic (Philippines)
Piper interruptum Opiz. var. *loheri* (C. DC.) Quis.	Vine	Endemic (Philippines and Southeast Asia)
Spathiphyllum commutatum Schott.	Herb	Endemic (Philippines and Southeast Asia)
Syzygium calubcob (C.B. Rob.) Merr.	Tree	Endemic (Philippines)
Begonia imperialis Lem.	Herb	Introduced
Chamaeranthemum venosum M.B.F. ex Wassh. & L.B. Sm.	Herb	Introduced
Philodendron lacerum (Jacq.) Schott.	Epiphyte	Introduced

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Table 4. **Endemic, Introduced/Invasive Plants in Carranglan Watershed** (CONTINUED...)

Species	**Habit**	**Ecological Status**
Coffea arabica L.	Tree	Introduced
Coffea canephora Pierre ex Frehn.	Tree	Introduced
Gliciridia sepium (Jacq.) Steud	Tree	Introduced
Leucaena leucocephala (Lam.) de Wit.	Tree	Introduced
Philodendron microstictum Standl. & L.O. Williams	Epiphyte	Introduced
Pileostigma malabaricum (Roxb.) Benth.	Tree	Introduced
Pueraria lobata (Willd.) Ohwi	Vine	Introduced
Tectona grandis L. f.	Tree	Introduced
Chromolaena odorata (L.) R.M. King & H. Robinson	Shrub	Introduced, Invasive
Cyperus iria L.	Sedge	Introduced, Invasive
Mikania cordata (Burm. f.) B.L. Rob.	Vine	Introduced, Invasive
Urena lobata Linn.	Shrub	Introduced, Invasive

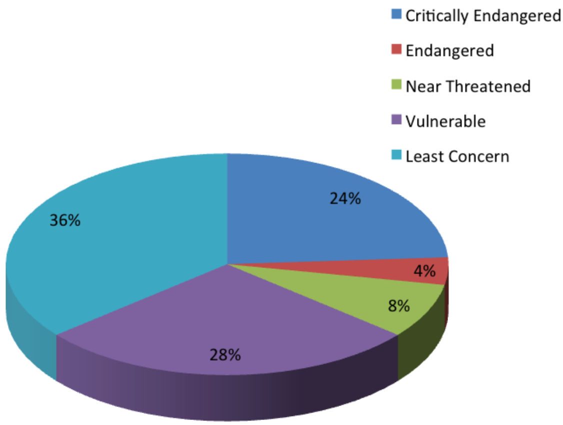

Figure 3. Ecological status of species found in Carranglan Watershed.

arabica L. and *Coffea canephora* Pierre ex. Frehn.). There were also three introduced tree species observed at Brgy. Burgos. These trees were planted to reforest the lower part of one of the mountains surveyed (Table 4).

Invasive species are organisms that thrive in new territory where they are free of predators, diseases and resource limitations that may have controlled their population in their native habitats (Cunningham & Cunningham, 2007). The populations of these species grow so large in numbers that they are able to out-compete native species for valuable resources (Pancho & Obien, 1995). Four invasive species—*Chromolaena odorata* (L.) R.M. King & H.E.Robins, *Cyperus iria* L., *Mikania cordata* (Burm. f.) B.L. Rob. and *Urena lobata* Linn.—were observed in some of the stations. These plants were common in grassy area and forest boundaries of the mountains and some individuals were also observed within the forest.

Biodiversity indicators

A species could be a biodiversity indicator species. It can be one of a species whose presence indicates the presence of a set of other species and whose addition or loss from an ecosystem leads to major changes in abundance or occurrence of at least one species or a species whose presence indicates human-created abiotic conditions. It can also be like dominant species that provides much of the biomass or number of individuals in an area or one that indicates a particular environmental condition. In addition, an indicator species is a sensitive species that can serve as early warning indicator of environmental changes or species that reflects the effects of a disturbance regime or efficacy of efforts to mitigate disturbance effects (Lindenmayer, Margules, & Botkin, 2000).

Of the 165 species recorded from Barangay Gen. Luna, five species had an indicator value of more than 60%; two species belong to family Arecaceae (*O. horridum* and *P. maculata*); one is a species of bamboo (*D. luconiae*) and two species are trees (*R. gigantea* and *P. luzonensis*). Moreovr, four species of plants out of the 163 recorded in Brgy. Burgos showed more than 60% indicator values. Three species—*O. horridum* (Griff.) Scheff., *D. luconiae* (Munro) Merr., and *R. gigantea* (Blume) Miq.—could serve as potential biodiversity indicator species in both the study areas (Table 5).

These species are considered as indicators of biological diversity due to the high number of individuals, frequency, and abundance (Dufrene & Legendre, 1997). These species were usually present in the areas surveyed with large number of individuals, either living close together or growing in wide areas.

Table 5. **Biodiversity indicators species present in Carranglan Watershed**[1]

Area	**Species**	**Indicator value (%)**
Brgy. Gen. Luna	*Oncosperma horridum* (Griff.) Scheff.	86.46
	Dinochloa luconiae (Munro) Merr.	79.27
	Radermachera gigantea (Blume) Miq.	73.02
	Pinanga maculata Porte ex Lemaire	71.66
	Pandanus luzonensis Merr.	66.08
Brgy. Burgos	*Radermachera gigantea* (Blume) Miq.	75.68
	Mangifera indica L.	72.15
	Dinochloa luconiae (Munro) Merr.	72.03
	Oncosperma horridum (Griff.) Scheff.	67.55

[1] Species with 60% indicator value is a biodiversity indicator (Dufrene & Legendre,1997)

Table 6. **Major Sources of Environmental Degradation at Carranglan Watershed.**

Sources	Impact value	Interpretation
Fires	2.92	Moderate impact
Kaingin/shifting cultivation	2.76	Moderate impact
Illegal logging/timber poaching	2.69	Moderate impact
Mining	2.67	Moderate impact
Soil erosion/silt run-off	2.66	Moderate impact
Quarrying	2.18	Small impact
Wildlife hunting	2.13	Small impact
Introduced species	1.37	No significant impact

1.00–1.75 = No significant impact 1.76 – 2.50 = Small impact
2.51 – 3.25= Moderate impact 3.26 – 4.00= Major impact

Threats to plant biodiversity

Seven sources of environmental degradation in Carranglan Watershed were observed and evaluated (Table 6). Five of these showed moderate impacts on the diversity of the forest ecosystems in Carranglan Watershed which include fires, kaingin/shifting cultivation, timber poaching/illegal logging, mining, and soil erosion. Quarrying had small impacts while introduced species had no significant impact in the Carranglan Watershed.

DISCUSSION

According to Pulhin et al. (2006), the Carranglan Watershed is comprised of 4,023 ha of water reservoir and the climate largely falls under the Philippine Climatic Type I with two pronounced seasons, namely, dry from December to April and wet the rest of the year. The average monthly temperature recorded is at 23.21 ^{o}C to 33.71 ^{o}C and the average annual relative humidity is 83.37%. The topography of the watershed is characterized by complex land configuration and mountainous, rugged terrain. It ranges from nearly level, undulating and sloping, to steep hilly landscapes. Its soils originated mostly from weathered products of meta-volcanic activities and diorite. Surface soil textures are silty clay loam and clay loam to clay. There are four types of soils in the watershed, namely Annam, Bunga, Guimbaloan, and Mahipon

(Saplaco et al., 2001). These soil types are recommended for trees and forest crops. The major land use types found in Carranglan Watershed are forests, open grasslands and reforestation sites. Due to the physical factors present in Carranglan Watershed, the forest ecosystems are favorable to have good growth for trees and other plants hence, the result of the diversity assessment study is still very high.

Most of the plants observed in the stations were trees, shrubs, and vines. Several herbs, grasses, sedges and mosses were also seen in the study areas. Overall there were 128 tree species, 73 shrubs, 33 vines, four grass species, four sedges, 14 fern species, four mosses, 22 herbs, and 10 orchid/epiphytic species found in the study areas. However, there were six species of plants found to occur in all the stations that were surveyed: *Philodendron lacerum* (Jacq.) Schott., "biakal" [*Dinochloa luconiae* (Munro) Merr.], "yantok" (*Pinanga maculata* Porte ex Lemaire), "yantok" [*Oncosperma horridum* (Griff.) Scheff.], "white lauan" [*Shorea contorta* (Vid.) Merr. and Rolfe] and *Pueraria lobata* (Willd.) Ohwi.

Philodendron are rainforest species that grow and develop more during the rainy season. In nature, most *Philodendron* species live on the trunks or branches of trees and do not need soil to survive. A *Philodendron* species' roots are designed to collect rain water during the wet season and suffer through the dry season. But even in the dry season a *Philodendron* sp. can collect enough water from the humidity around their exposed roots to survive (Lucas, n.d.).

Philodendron lacerum grows as either an epiphyte (ep-a-FIT) or a hemiepiphytic species. An epiphyte is a species that grows upon the side of branches of a tree as a result of a seed being placed in the tree in the droppings of a bird, animal or bat. A hemiepiphyte (hem-a-EPA-fit) normally begins life as a seed that has fallen to the ground and then climbs the host tree. Hemiepiphytes may also be epiphytic (a plant that begins life on the branch of a tree) and then drop roots to the soil that become firmly established (Lucas, n.d.).

"Biakal" [*D. luconiae* (Munro) Merr.] is a true and climbing bamboo found throughout the Philippines and this plant is a natural component of secondary and disturbed secondary forest at low to medium altitudes. In virgin forests, these plants are found as rare climbers primarily due to the limited light brought about by the closed canopy (PCARRD, 2006).

Pinanga maculata Porte ex Lemaire is a solitary medium-sized palm growing to 4-5m tall with purplish/brown crownshaft. The leaves are large with irregular spaced leaflets, dark green above with large irregular areas of lighter green (Tiger stripes). This is an attractive endemic palm found in the primary forest in the Philippines from low to high altitudes. The juvenile plant is attractive because of its mottled leaves and the mature plant is elegant in form (Vaile, 2014a).

Oncosperma horridum (Griff.) Scheff. is found growing wild in lowland forests in the Philippines and indigenous to Indo-China and Malesia ecozone. It is a slender, tall and clustering palm native to rainforests that can reach to about 700m. Its stem is covered in black and downward pointing spiones with pinnate leaves (Vaile, 2014b).

Shorea contorta (Vid.) Merr. and Rolfe is a large tree found in the lowland seasonal semi-evergreen dipterocarp forest. It is endemic in the Philippines and now considered to be a critically endangered plant based on the IUCN Red List of Threatened Species version 2014.3 (as cited in Ashton, 1998). The white lauan can reach up to a height of about 30-50m. It has brown to nearly black bark, although it can look grey when exposed to bright sunlight. The upper part of the trunk may have distinct longitudinal ridges. This tree belongs to the dipterocap family, a group of important timber trees that dominate the lowland forests in the Philippines.

However, it is very interesting to note that an introduced species or an invasive plant is already present in all the stations surveyed in the Carranglan Watershed. This plant is the *Pueraria lobata* (Willd.) Ohwi or called "kudzu," a native of Japan. Kudzu is a perennial, trailing or climbing vine of the legume family (DCR—VNPS, n.d.). Dark green leaves, starchy fibrous roots, and elongated purple flowers with a fragrance reminiscent of grapes readily identify this aggressive vine. Rarely flowering, kudzu stems and roots spread out in all directions from root crowns, with new plants beginning every one to two feet at stem nodes. This dense packing of kudzu can result in tens of thousands of plants occupying a single acre of land. Kudzu leaves are hairy beneath, often tri-lobed, and in groups of three on the vine. The $^1/_2$ to $^3/_4$ inch purple flowers are pea-like in shape and are produced on plants exposed to direct sunlight. Kudzu fruits, present in October and November, are hairy, bean-like pods that produce only a few viable seeds in each pod cluster. It is thought that some seeds can remain dormant for several years before they germinate. During the peak growing season in early summer, this prolific vine can grow at a rate of a foot a day, easily covering and choking trees and understory vegetation.

A hardy opportunist, kudzu grows in a variety of habitats and environmental conditions, but does best on deep, well-drained, loamy soils. Almost any disturbed area is suitable habitat for this vine. Roadsides, old fields, vacant lots and abandoned yards are all prime spots for new kudzu growth. Where it grows, kudzu has the ability to out-compete and eliminate native plant species for sunlight, moisture, and soil nutrients, thereby upsetting the natural diversity of plant and animal communities. Its extremely rapid growth rate and habit of growing over objects threatens natural areas by killing native vegetation through crowding and shading, and can seriously stifle agricultural and timber production. Because of its hardy nature and lack of natural enemies, kudzu is able to colonize diverse habitats and achieve a widespread distribution (DCR—VNPS, n.d.). This plant can destabilize trees by its weight (up to 400 lbs) and either tips them over or cracks their branches or trunks (Noah, n.d.). *P. lobata* has negative effects on crop production, forestry production and the natural environment, as it smothers existing flora. Once introduced into an area, it is difficult to control or eradicate (EMPP, 2007).

Management and control of this invasive plant should be done before it could affect and harm the endemic and native plant species in the forest ecosystems of Carranglan Watershed. Results reveal that this plant has no significant impact yet in the forest ecosystems of the Carranglan Watershed but in time if no management action will be made this invasive plant can lead to loss of diversity of plants in the watershed.

Biodiversity indicators are quantitative data to measure aspects of biodiversity, ecosystem condition, ecosystem services and drivers of change. They also help us understand how biodiversity is changed over time and space (UNEP—WCMC, n.d.). Biodiversity indicators are those species whose presence or absence affects the biodiversity of a particular area. They can serve as important sources of food for the other species and they can serve as indicators of habitat/ecosystem conditions. Species with more than 60% biodiversity indicator values are considered as biodiversity indicator species.

In this study, three species, *O. horridum* (Griff.) Scheff., *D.*

luconiae (Munro) Merr., and *R. gigantea* (Blume) Miq. could serve as potential biodiversity indicator species in both the study areas. The presence of these species is important in determining the habitat/ecosystem condition and the disturbances experienced in the area. The absence of these species may mean that the area is disturbed or is not in good condition anymore. The absence of these species, too, may indicate that the biodiversity in the forest ecosystem is already changing. Hence, biodiversity indicators may form an essential part of monitoring and assessment to give the status of biodiversity in the area.

A number of environmental conditions posed threats to the forest ecosystems in Carranglan. Fires, shifting cultivation and illegal logging or timber poaching, mining and soil erosion showed high values with moderate impacts on the forest ecosystems.

Fires were common especially during the dry season. Often the grassland areas and areas near *kaingin* are the main sources of fires. Fires are also rampant in areas where tall grasses and pine trees co-exist. According to CENRO-Muñoz (2001), these fires are either caused accidentally (e.g. lightning) or intentionally to give way to new kaingin areas.

Lands near the foot of the mountain and even in higher areas were used for cultivating vegetables such as beans and eggplants. The soil in these areas is often exposed after harvest season making them vulnerable to soil erosion and landslides during rainy season. Evidence of timber poaching was also observed. There was a time when freshly cut timber was observed in the mountains of Brgy. Burgos. According to the residents, it is legal to cut trees if it is only used for personal use (i.e. for house construction). Wildlife hunting also posed small impact on the forest ecosystem especially in the forested areas in Brgy. Burgos. During the duration of the fieldwork in that area, numerous traps or "silo" were observed. Many of these were newly set-up with fresh bait such as banana. Forest fowl or "labuyo," monitor lizards, wild pigs, deer, and civet cats were the most common animals caught by the people near the area.

Other sources of environmental degradation include mining and quarrying (the operation has ceased according to DENR), soil erosion, and introduced species.

CONCLUSIONS

Carranglan Watershed has a very diverse flora. The flora present has a lot of economic importance but some are already evaluated as critically endangered such as *Shorea sp.* and *Dipterocarpus gracilis* (Blume). Three species—*O. horridum* (Griff.) Scheff., *D. luconiae* (Munro) Merr., and *R. gigantea* (Blume) Miq.—could serve as potential biodiversity indicator species in the forest ecosystems of Barangays General Luna and Burgos. Anthropogenic activities are the main contributors in the degradation of the forest ecosystem. Fires, shifting cultivation (*kaingin*), illegal logging/ timber poaching, mining and soil erosion posed moderate threats to the forest ecosystems of Carranglan. The effects of quarrying such as habitat loss and sedimentation to the lower part of the river posed threats to the forest ecosystem while the presence of introduced species has no significant impact yet in the Carranglan Watershed.

RECOMMENDATIONS

The research team recommends further studies on the flora of the other areas not surveyed during the duration of the study. These include the forest areas in other mountains present in both barangays. These areas were not surveyed due to their inaccessibility, far distance, and safety issues of the field researchers. It is also recommended that intensive survey on the economic uses of the plants be done with interviews on the local community. Collection of samples is better done during months when trees are most likely to bloom (November to January). This is to make sure that identification of plants will be easier. Moreover, studies on the impact of invasive species should be conducted in the Carranglan Watershed to verify the extent of growth and distribution as well as damage on the endemic and native trees in the watershed. Results could be used as guide in the establishment of ecological tourism spot for forest ecosystems in Central Luzon.

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