Assessment of the Diversity of Trees in Mt. Tapulao, Palauig, Zambales

Nina Arra DJ. Rivera and
Annie Melinda Paz-Alberto
Central Luzon State University,
Science City of Munoz, Nueva Ecija,
Philippines

This study focused on the assessment of the current status of the diversity of trees present in Mt. Tapulao, Palauig, Zambales. The assessment was limited to the identification of the trees present in the area, their conservation status, endemism, functions, and economic uses. Assessment and evaluation of the anthropogenic threats that may have an effect on ecological integrity were also conducted. Quadrat method method was used in the assessment of trees, with two quadrats designated in each five stations. Results revealed 77 species of trees present in the area with a diversity value of 3.77 based on Shannon's Diversity Index. This value represents a very high diversity. Twenty three were identified at the species level, most of which were native to (57%) and endemic (43%) in the Philippines. The National List of Threatened Philippine Trees (DAO 2017-11) indicated that among the identified trees, six (6) species were under vulnerable conditions while some were endangered or critically endangered. According to the IUCN Red List, four (4) of the identified species were categorized as critically endangered, three (3) were vulnerable, two (2) were under the least concern category, and one (1) was an endangered species. Among the surveyed trees, majority were classified as forest trees (88.31%) while the rest were fruit trees (10.39%). Most (90.90%) of the fruit trees were utilized as a source of lumber for shelter.

The forest ecosystem of Mt. Tapulao is experiencing anthropogenic threats. It was determined that the major threats were road construction, wildlife hunting, soil erosion or silt runoff, and tourism areas or recreational areas. Meanwhile, mining, solid waste, ecotourism, and quarrying indicated moderate impacts. The passage of ordinances and programs that aim to protect, conserve, and manage Mt. Tapulao's resources played a key role in maintaining the biodiversity of the forest ecosystem. These ordinances and programs should be further

implemented and improved in order to fully protect and conserve the ecological integrity of Mt. Tapulao.

Keywords: Mt. Tapulao, biodiversity assessment, environmental degradation, forest ecosystem

INTRODUCTION

The complex geological history of the Philippines has resulted in an extraordinary wealth of biodiversity (Ambal et al., 2012). The country is considered as one of the 17 megadiversity countries, as it possesses 70 to 80 percent of global biodiversity. The Philippine rainforest harbors about 13,000 species of plants which comprise 5% of the world's total number of plant species (Balatibat, 2008). However, continued exploitation and destruction of natural resources have led to the depletion of the country's rich biodiversity. Without appropriate actions, further degradation of resources will continue and may eventually result in species extinction. Among the world's tropical regions, Southeast Asia is of particular conservation concern because it has the highest rate of habitat loss. Specifically, Southeast Asia has the highest relative rate of deforestation of a major tropical region; thus, it could lose three quarters of its original forests and up to 42% of its biodiversity by 2100 (Sodhi et al., 2009).

Zambales mountain range is situated on the west-central area of Luzon. Specifically, the mountain range is located by the South China Sea and extends from the western to the northern part of Luzon, with the Central Plains to the east, and Subic Bay and Mt. Natib complex to the southeast. Based on the composition of endemic flora and rich avian fauna, the mountain range is designated as a Key Biodiversity Area and has been recognized as a high priority conservation area in the Philippines (Ong, 2002). Mt. Tapulao with an altitude of 2037 m is considered as the highest point on the Zambales mountain range (Ong et al., 2012). This study was conducted in order to assess the diversity of trees in the forest ecosystem of Mt. Tapulao. Specifically, the study determined the ecological parameters, conservation status, endemism, and population trend of the trees present in the study area. The functions and economic importance of the assessed trees were also determined. Threats affecting the population of trees and the sources of all levels of impacts of environmental problems and degradation of Mt. Tapulao's forest ecosystem were also identified. It is important to manage

Mt. Tapulao's forest ecosystem as it serves as a huge contributor to natural and economic resources through food supply, livelihood, other revenues, and environmental services that it provides. The results obtained from the study will therefore enrich existing information and knowledge about plants and animals. This information will help in the protection of the plants and wildlife from extinction. Overall, this study shows the characteristics of trees which are endemic, native, or introduced in the area, thereby promoting knowledge of the treasured flora of Mt. Tapulao.

MATERIALS AND METHODS

Study Area

Mt. Tapulao is specifically located between the coordinates of 15˚24'25" and 15˚31'22" latitude and 120˚02'00' and 120˚12'04" longitude. With an approximate total area of more than 17,000 hectares, the mountain is located within the municipalities of Palauig, Iba, and Masinloc in Zambales and in some parts of Mayantoc, Tarlac (Department of Environment and Natural Resources Region 3 [DENR Region 3], 2019). Mt. Tapulao's name originated from the Sumatran pine, Pinus merkusii, locally known as "tapulao" which is present in the area (Balete, Heaney, Veluz, & Rickart, 2008).

The mountain has distinct ecosystems--a long stretch of dipterocarp forest with patches of grassland ecosystem dominated by cogon. The upper part of the mountain consists of a pine forest located at approximately 1, 389 masl and a mossy montane forest at 1, 859 masl. The presence of a plantation of fruit trees was observed on the lower part of the study area. The study of Ong et al., (2012) described Mt. Tapulao as consisting of five different forest types: tropical semi-evergreen rainforest, tropical lowland evergreen rainforest, tropical lower montane rainforest including pine forest, tropical upper rainforest, and tropical sub-alpine forest. These forest types serve as a habitat preference of different types of species which are mostly composed of birds, mammals, and herpetofauna, respectively.

Selection of sampling areas

A total of five (5) stations within the study area were established as the

sampling points. The sampling sites were established from varying elevational gradients of 1910 m, 1360 m, 957 m, 618 m, and 456 m. The stations were located at the western slope of Mount Tapulao facing the South China Sea. In each station, two (2) quadrats with a scale dimension of 10 X 12 meters were established. Potential sampling stations were assigned to ensure that the different types of niches for different types of animals were included (Alberto, 2005).

Figure 1. The study site with the designated sampling stations on Mt. Tapulao, Palauig, Zambales (Source: Google Earth Pro)

Collection, Identification, and Documentation of Tree Species

Trees with a diameter of breast height greater than 10 cm present inside the quadrats were included in the study. Samples were collected, properly labeled, and placed in a plastic bag for identification purposes. Information, such as local name of the trees, number of individuals per species, and the quadrats where species occurred were also noted. The samples were collected to aid in the identification process and were preserved as herbarium specimens. Moreover, necessary permits from DENR were acquired prior to the conduct of the study. Courtesy calls to the barangay and municipality of Palauig were also sought. Each tree was identified up to its species level, when possible, with the help of the available references and with the assistance of a plant taxonomist from the

National Museum of the Philippines. The conservation status of each species was determined according to the International Union for Conservation of Nature (IUCN) Red List Categories and DAO 2017-11 (Updated National List of Philippine Threatened Trees). Species endemism and population trend were also determined based on IUCN and multiple studies.

The trees were also categorized based on their economic uses (e.g., forest trees and fruit trees). Hence, additional data such as the economic uses of the trees were recorded.

Ecological Parameters of Trees

Different ecological parameters such as percentage of occurrence, total number of individual species, frequency, relative frequency, dominance, relative dominance, density, relative density, species importance value and Shannon's diversity index were obtained. The formulas were adapted from Smith and Smith (1998) as cited in Alberto (2005).

Sources and Level of Impacts of Environmental Degradation of Mt. Tapulao

In order to obtain firsthand information on Mt. Tapulao's forest area, the following data-gathering methods were conducted: a) focus group discussions (FGDs) with the locals of Sitio Dampay, Brgy. Salaza, Palauig, which is the nearest community to Mt. Tapulao; and b) key informant interviews (KIIs) with the representatives of local government units and people's organizations. The FGDs and the KIIs using semi-structured interview questionnaires were employed to gather additional information on the community's utilization of the resources provided by Mt. Tapulao, specifically the mountain's influence on the people's socio-economic condition. These methods also aided in identifying problems that affected the vegetation in the area.

To assess the present condition of the forest ecosystem and the sources and levels of impact on environmental degradation, the researchers utilized a checklist adapted from Alberto (2005) along with direct observation. To determine the present condition of the forest ecosystem of Mt. Tapulao, evaluators from DENR, researchers, and LGUs who were knowledgeable about the area rated the four-point (i.e., 1-4) checklist. Four levels of impact under

each source of environmental degradation were used; a value was assigned to each level. The level of impact was measured based on the percentage of impact or damage observed in the study area. In order to determine the mean of respondents' answers, the sum of the answers for each level was divided by the total number of respondents. A scale was used in interpreting the scores on the levels of impact of the environmental degradation on the ecosystem.

RESULTS AND DISCUSSION

Assessment of Trees in Mt. Tapulao, Palauig, Zambales

Abundance

Based on the results of the study, 77 species of trees were assessed. Sixty-five (65) tree species were identified and classified while 12 trees were identified only through their local names. Table 1 shows that only three (3) out of 77 species of plants recorded the highest percentage occurrence of 80%. Results showed that *Eugenia xanthophylla* (Panlumbuyen), *Terminalia microcarpa* (Kalumpit), and Ficus sp. 9 (Talakitik) occurred in four out of five stations. This was due to the different kinds of habitat and physical parameters such as elevation, temperature, and humidity of each station. It is also possible that the aforementioned species were the only plants that had adapted to such kind of environment. It is surprising to note that *Eugenia xanthophylla* was one of the plant species that had the highest percentage of occurrence since this plant is considered as uncommon and thrives well at low elevations (Jansen, Jukema, Oyen, & Van Lingen, 2016). Meanwhile, *Terminalia microcarpa* has a wide distribution in the Philippines, also grows well at low elevations, and is found in different parts of the rainforest (Fern, Fern, & Morris, 2018). Furthermore, the *Ficus* genera is extant in different forest types and elevations in the Philippines (Pelser, 2017a).

Diversity

Based on the results of the study, 77 species of trees were assessed. Sixty-five (65) trees species were identified and classified while 12 trees were identified only through their local names. In the survey conducted, *Sterculia* sp. (Bubu)

had the highest number of individual tree species (24 individuals), while *Ficus* sp. 9 (Talakitik) had the highest relative frequency at 4.67%. *Sterculia* sp. also had the highest relative density and relative dominance at 7.55% and 18.67%, respectively. *Sterculia* sp. also had the highest IVI at 28.89%. This was followed by *Shorea astylosa* (Yakal) (25.88%) and *Pygeum* sp.1 (Paitan pula) (19.35%). This finding indicates that these trees were the most important tree species observed among the 77 species of trees assessed in this study (Table 1). In the Philippines, species under the genus *Sterculia* thrive in different habitats, ranging from coastal thickets to different types of forests such as primary and secondary forests at low and medium elevations, semi-open forests, dry forest, and forested ravines (Pelser, 2018). Moreover, *Shorea astylosa* is considered as a premium species of the tropical rainforest. It is noteworthy that this species, which is abundant in the study area, is highly sought for its timber (Pacific Consultants International, 2006). *Pygeum* spp. in the Philippines also thrive widely in different types of forests (i.e., primary and secondary forests, mossy forests, forests, montane forests, and forest edges) (Pelser, 2018c). Shannon's Diversity Index on the surveyed area showed a value of 3.77, which exhibits a very high diversity according to Fernando's Biodiversity Scale interpretation. This shows that there were numerous trees species present in the study area, and this explains why the tree species present were abundant and evenly distributed. This high diversity of trees was due to conservation programs that were being instigated in the area for the purpose of reforestation and preservation. The inclusion of Mt. Tapulao as a new protected area under New Conservation Areas in the Philippines Project (NewCAPP) plays a main role in the protection on the biodiversity in the area.

Table 1

Ecological Parameters of the Surveyed and Identified Trees Species in Mt. Tapulao

Species name	No. of individuals	Percentage Occurrence	Relative Frequency	Relative Density	Relative Dominance	Importance Value Index
Schizostachyum lumampao	7	20%	1.33	2.201	1.421	4.96
Calophyllum inophyllum	2	20%	0.67	0.629	0.068	1.36
Dillenia philippinensis	1	20%	0.67	0.314	0.000	0.98
Diospyros discolor	1	20%	0.67	0.314	0.000	0.98

Diospyros pilosanthera	1	20%	0.67	0.314	0.000	0.98
Palaquium obovatum	3	20%	1.33	0.943	0.203	2.48
Palaquium philippense	1	20%	0.67	0.314	0.000	0.98
Palaquium sp.	2	40%	1.33	0.629	0.068	2.03
Lecythidiaceae	1	20%	0.67	0.314	0.000	0.98
Ardisia sp.	1	20%	0.67	0.314	0.000	0.98
Rubiaceae 1	1	20%	0.67	0.314	0.000	0.98
Rubiaceae 2	5	40%	2.00	1.572	0.677	4.25
Rubiaceae 3	1	20%	0.67	0.314	0.000	0.98
Cinnamomum mercadoi	4	40%	1.33	1.258	0.406	3.00
Cinnamomum sp.	5	60%	2.67	1.572	0.677	4.92
Goniothalamus amuyon	2	20%	1.33	0.629	0.068	2.03
Haplosticanthus sp.	1	20%	0.67	0.314	0.000	0.98
Phaeanthus sp.	1	20%	0.67	0.314	0.000	0.98
Euphorbiaceae	6	20%	1.33	1.887	1.015	4.24
Euphorbia sp.	10	20%	2.00	3.145	3.045	8.19
Antidesma sp. 1	3	20%	0.67	0.943	0.203	1.81
Antidesma sp. 2	1	200%	0.67	0.314	0.000	0.98
Breynia vitis-idaea	5	40%	2.00	1.572	0.677	4.25
Eleocarpaceae	2	20%	0.67	0.629	0.068	1.36
Sterculia sp.	24	60%	2.67	7.547	18.674	28.89
Moraceae 1	13	60%	4.00	4.088	5.277	13.37
Moraceae 2	1	20%	0.67	0.314	0.000	0.98
Ficus benjamina	1	20%	0.67	0.314	0.000	0.98
Ficus septica	5	40%	1.33	1.572	0.677	3.58
Ficus sp. 1	3	40%	0.67	0.943	0.203	1.81
Ficus sp. 2	1	20%	0.67	0.314	0.000	0.98
Ficus sp. 3	2	20%	0.67	0.629	0.068	1.36
Ficus sp. 5	1	20%	0.67	0.314	0.000	0.98
Ficus sp. 6	1	20%	0.67	0.314	0.000	0.98
Ficus sp. 7	2	20%	1.33	0.629	0.068	2.03
Ficus sp. 8	6	40%	2.00	1.887	1.015	4.90
Ficus sp. 9	16	80%	4.67	5.031	8.119	17.82
Ficus sp. 10	3	20%	1.33	0.943	0.203	2.48
Streblus asper	2	40%	0.67	0.629	0.068	1.36
Anacardiaceae	2	20%	0.67	0.629	0.068	1.36
Anacardium sp.	1	20%	0.67	0.314	0.000	0.98
Combretaceae	4	20%	2.00	1.258	0.406	3.66

Myrtaceae	1	20%	0.67	0.314	0.000	0.98
Terminalia microcarpa	9	80%	4.00	2.83	2.436	9.27
Eugenia xanthophylla	10	20%	2.67	3.145	3.045	8.86
Eugenia sp. 1	2	80%	1.33	0.629	0.068	2.03
Eugenia sp. 2	1	20%	0.67	0.314	0.000	0.98
Syzygium sp. 1	2	80%	1.33	0.629	0.068	2.03
Syzygium sp. 2	1	40%	0.67	0.314	0.000	0.98
Pygeum megaphyllum	1	20%	0.67	0.314	0.000	0.98
Pygeum preslii	2	20%	0.67	0.629	0.068	1.36
Pygeum sp. 1	18	20%	3.33	5.66	10.352	19.35
Pygeum sp. 2	10	20%	2.67	3.145	3.045	8.86
Semecarpus sp. 1	1	20%	0.67	0.314	0.000	0.98
Semecarpus sp. 2	1	60%	0.67	0.314	0.000	0.98
Canarium sp.	1	60%	0.67	0.314	0.000	0.98
Sapindaceae	2	20%	1.33	0.629	0.068	2.03
Ailanthus triphysa	1	20%	0.67	0.314	0.000	0.98
Dipterocarpaceae	3	20%	0.67	0.943	0.203	1.81
Shorea astylosa	22	20%	3.33	6.918	15.629	25.88
Shorea contorta	13	40%	1.33	4.088	5.277	10.70
Shorea palosapis	8	20%	3.33	2.516	1.894	7.74
Shorea polysperma	15	60%	2.00	4.717	7.104	13.82
Cyathea contaminans	14	60%	1.33	4.403	6.157	11.89
Alawi	1	40%	1.33	0.314	0.000	1.65
Bagni	4	40%	1.33	1.258	0.406	3.00
Buligri	1	40%	0.67	0.314	0.000	0.98
Camilia	1	20%	0.67	0.314	0.000	0.98
Gualberto	1	20%	0.67	0.314	0.000	0.98
Lapnit	1	20%	0.67	0.314	0.000	0.98
Lapugan	1	20%	0.67	0.314	0.000	0.98
Magkakalamansi	2	20%	0.67	0.629	0.068	1.36
Magkakato	3	20%	1.33	0.943	0.203	2.48
Malabyong	1	20%	0.67	0.314	0.000	0.98
Parayna	3	20%	1.33	0.943	0.203	2.48
Tarukan	3	20%	2.00	0.943	0.203	3.15
Tuey	2	20%	0.67	0.629	0.068	1.36
Total	**318**		**100.00**	**100**	**100.000**	**300.00**

Assessment of the Conservation Status and Endemism of the Trees Species Present in the Forest Ecosystem of Mt. Tapulao

National List of Threatened Philippine Trees (DAO 2017-11) showed that among the identified trees, six (6) species were under vulnerable condition. Thus, these species were under threat from adverse factors throughout their range and were likely to move to the endangered category (Table 2). *Shorea astylosa* (Yakal) as a Critically Endangered Species was facing an extremely high risk of immediate extinction in the wild, and *Cyathea contaminans* (Mountain Tree Fern) was considered as endangered. The survival of C. *contaminans* in the wild was unlikely if the causal factors continued operating. *Cinnamomum mercadoi* (Cinamomon) was categorized under Other Threatened Species. This species was also under threat from adverse factors throughout its range and was likely to move soon to the vulnerable category. According to the IUCN Red List, four (i.e., *Shorea astylosa, Shorea contorta, Shorea palosapis* and *Shorea polysperma*) species were categorized as critically endangered, and three (i.e., *Dillenia philippinensis, Palaquium philippense,* and *Cinnamomum mercadoi*) were vulnerable. Moreover, two (i.e., *Calophyllum inophyllum* and *Pygeum preslii*) were under the least concern category, and one (i.e., *Diospyros discolor*) was an endangered species.

Among the 23 trees species that were identified up to their species level, majority (57%) were native to and endemic in the Philippines while 43% could be found only in the Philippines (Philippine endemic) (Figure 2). This finding indicates that the integrity of Mt. Tapulao's forest ecosystem was still intact and healthy and that there were no invasive tree species that have successfully established in the area, out-competed the endemic species, and constrained the goods available from the ecosystem (Thomson, 2011).

With the 10 trees species evaluated by the IUCN, only one (i.e., *Calophyllum inophyllum*) showed a stable population trend (Barstow, 2019) while the rest (i.e., *Dillenia philippinensis, Diospyros discolor, Palaquium philippense, Cinnamomum mercadoi, Terminalia microcarpa, Pygeum preslii, Shorea astylosa, Shorea contorta, Shorea palosapis,* and *Shorea polysperma*) had an unspecified population trend. Nevertheless, due to the threats (e.g., wood harvesting, habitat destruction, and illegal trade of high-quality timber) these tree species were facing, an immediate decline in the population of these species was highly possible.

Table 2
Conservation Status and Endemism of the Assessed Trees Present in Mt. Tapulao

Scientific Name	IUCN	DAO 2017-11	Endemism
Schizostachyum lumampao	NE	Not listed	Philippine Endemic
Calophyllum inophyllum	LC	Not listed	Native
Dillenia philippinensis	VU	Not listed	Philippine Endemic
Diospyros discolor	EN	VU	Native
Diospyros pilosanthera	NE	VU	Native
Palaquium obovatum	NE	Not listed	Native
Palaquium philippense	VU	VU	Philippine Endemic
Cinnamomum mercadoi	VU	OTS	Philippine Endemic
Goniothalamus amuyon	NE	Not listed	Philippine Endemic
Breynia vitis-idaea	NE	Not listed	Native
Ficus benjamina	NE	Not listed	Native
Ficus septica	NE	Not listed	Native
Streblus asper	NE	Not listed	Native
Eugenia xanthophylla	NE	Not listed	Philippine Endemic
Pygeum megaphyllum	NE	Not listed	Native
Pygeum preslii	LC	VU	Native
Ailanthus triphysa	NE	Not listed	Native
Shorea astylosa	CR	CR	Philippine Endemic
Shorea contorta	CR	VU	Philippine Endemic
Shorea palosapis	CR	Not listed	Philippine Endemic
Shorea polysperma	CR	VU	Philippine Endemic
Cyathea contaminans	NE	EN	Native

*Note: LC=Least Concern, NT=Near Threatened, CR=Critically Endangered, EN=Endangered, VU=Vulnerable, NE=Not Evaluated, OTS=Other Threatened Species

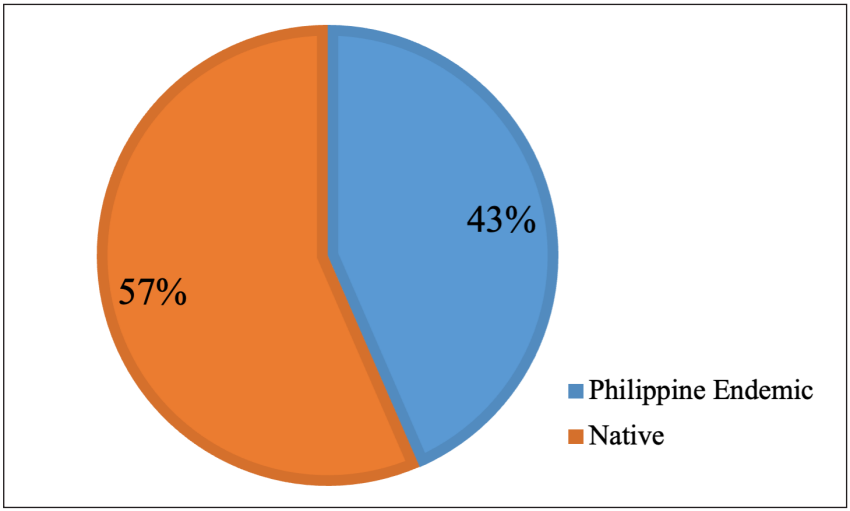

Figure 2. Endemism of the assessed and identified trees in Mt. Tapulao.

Functions and Economic Importance of the Surveyed Trees

Table 3 presents the functions and economic importance of the assessed trees in Mt. Tapulao. Among the surveyed trees, majority (88.31%) were categorized as forest trees while the rest (10.39%) were considered as fruit trees. Through an interview with the local guides, the study further assessed the trees based on their economic use. Twenty-eight (28) species were classified and used by the locals as a good source of lumber. These species were considered as hard wood trees. Meanwhile, 18 trees were used for shelter, specifically as foundation for small houses as these were soft wood trees. Seven (7) of the tree species were utilized as firewood and some of them were known sources of food for wild animals such as birds, monkeys, and wild boars (6 trees species). Moreover, four (4) of tree species were considered safe for human consumption, and two (2) tree species were utilized as a source of medicine. Some of them (i.e., 9 species) were exploited for furniture making. Another tree species had ornamental functions (i.e., one species), provided nectar for the bees (i.e., one species), and was considered important for its water-holding capacity (i.e., one species). However, it was also noted that cutting of trees to produce firewood was already prohibited in the area as utilizing trees for firewood production entailed having to cut them. It was stressed by an interview respondent that the trees used for water storage and those that served as food for the animals must not be cut because these trees were

highly valuable to the environment and wildlife. Humans exerted pressure on tree resources because of the economic significance the trees had; this, however, had led to the depletion of these resources.

Table 3

Economic Importance of the Surveyed Trees of Mt. Tapulao to the Locals of Sitio Dampay

Species Name	Types		Economic Importance
	Forest Trees	Fruit Trees	
Schizostachyum lumampao			Multiple use for houses and furniture. Used in making sticks
Calophyllum inophyllum	√		Serves as a good lumber
Dillenia philippinensis	√		Source of sheltering materials and food source for humans
Diospyros discolor	√		Serves as a good lumber
Diospyros pilosanthera	√		Serves as a good lumber
Palaquium obovatum		√	Serves as a good lumber
Palaquium philippense		√	Serves as a good lumber
Palaquium sp.		√	Serves as a good lumber
Lecythidiaceae		√	Serves as a good lumber when reaches maturity
Ardisia sp.		√	Serves as a good lumber
Rubiaceae 2		√	Source of sheltering materials
Cinnamomum mercadoi		√	Medicine: Treatment for flu
*Cinnamomu*m sp.		√	Source of sheltering materials
Goniothalamus amuyon		√	Medicine: Treatment for stomachache and boils
Euphorbiaceae		√	Source of wine and food flavoring
Euphorbia sp.		√	Serves as a good lumber
Antidesma sp. 1		√	Serves as a good lumber
Antidesma sp. 2		√	Serves as a good lumber
Breynia vitis-idaea		√	Food for birds and used as a bracelet
Eleocarpaceae		√	Serves as a good lumber and used in making furniture
Sterculia sp.		√	Serves as a good lumber
Moraceae 1		√	Source of firewood and food for wild boars
Moraceae 2		√	Source of sheltering materials

Ficus benjamina		√	Food for birds and monkeys
Ficus septica		√	Serves as a good lumber
Ficus sp. 2		√	Firewood source and food for birds and humans
Ficus sp. 3		√	Source of sheltering materials
Ficus sp. 4		√	Source of sheltering materials
Ficus sp. 5		√	Serves as a good lumber
Ficus sp. 6		√	Food for birds
Ficus sp. 7		√	Source of sheltering materials
Ficus sp. 8		√	Serves as a good lumber and source of sheltering materials
Ficus sp. 9		√	Serves as a good lumber
Ficus sp. 10		√	Source of sheltering materials
Terminalia microcarpa	√		Serves as a good lumber
Eugenia sp. 1		√	Serves as a good lumber
Eugenia sp. 2		√	Serves as a good lumber and source of firewood
Syzygium sp. 1		√	Source of sheltering materials
Syzygium sp. 2		√	Source of furniture and firewood
Pygeum sp. 1		√	Serves as a good lumber
Pygeum sp. 2		√	Serves as a good lumber and used in making furniture
Semecarpus sp. 1		√	Source of sheltering materials
Semecarpus sp. 2		√	Source of sheltering materials and firewood
Canarium sp.		√	Serves as a good lumber
Dipetrocarpaceae		√	Source of sheltering materials and firewood
Shorea astylosa		√	Source of furniture
Shorea contorta		√	Source of furniture
Shorea palosapis		√	Source of furniture
Shorea polysperma		√	Serves as a good lumber
Cyathea contaminans		√	Water support
Bagni		√	Source of sheltering materials
Camilia		√	Source of sheltering materials
Lapnit		√	Serves as a good lumber
Lapugan		√	Serves as a good lumber
Magkakato	√		Source of sheltering materials and food source for humans

Malabyong		√	Serves as a good lumber
Tarukan		√	Flower serves as nectar for honeybees
Tuey		√	Serves as a good lumber
Total	10.39%	88.31%	

Threats Affecting the Diversity of Trees

FGDs with the mountain guides and members of the Aeta Tribe in Palauig were conducted in the community in order to gather first-hand information on the current threats on the tree biodiversity in the area, environmental issues present in Mt. Tapulao, and the causes of these concerns. According to the local communities, illegal logging still occurred in the area, and this had caused the decline in the number of trees present in the forest. However, these activities had become more uncommon at the time of the study than they were before.

The locals observed that there is a decrease in the vegetation on the forest area of Mt. Tapulao. Logging of trees for domestic and commercial use was considered as the main reason for the significant reduction in the number of trees in the area. However, according to the locals, these instances had become less frequent than they were before, due to the prohibitions of the government. The continuous cutting of trees, if not controlled and managed, may lead to the extinction of these species in the area. The people contended that the major causes of decreasing tree population were charcoal making and harvesting of trees for additional revenue. Increase of human population in the area was also perceived by its inhabitants as one of the reasons for the decrease of trees. That is, rapid human population growth is concomitant to the demand for natural resources, thus putting considerable pressure on them (Meijaard et al., 2013).

Assessment of the Environmental Problems and Sources of Degradation in Mt. Tapulao

The forest of Mt. Tapulao is continuously threatened by human activities. It was discerned from the study that road construction, wildlife hunting, soil erosion/silt runoff, and tourism areas, and recreational areas posed major threats to the forest ecosystem. Meanwhile, mining, solid waste, ecotourism,

and quarrying, had moderate impacts on the degradation of Mt. Tapulao. Illegal logging, fires, charcoal making, shift cultivation/kaingin, and firewood collection had small impacts on the forest ecosystem, but these should never be overlooked or neglected (Table 4).

Table 4

Sources and Level of Impacts of Anthropogenic Activities in Mt. Tapulao's Forest Ecosystem

Sources of environmental degradation	Computed value	Interpretation
Road construction	3.99	Major Impact
Wildlife hunting	3.62	Major Impact
Soil erosion/silt runoff	3.54	Major Impact
Tourism Area/Recreational Area	3.37	Major Impact
Mining	3.12	Moderate Impact
Solid Waste	2.86	Moderate Impact
Ecotourism	2.80	Moderate Impact
Quarrying	2.53	Moderate Impact
Illegal logging	2.25	Small Impact
Fires	2.16	Small Impact
Charcoal making	2.14	Small Impact
Shift cultivation/Kaingin	2.12	Small Impact
Firewood collection	1.99	Small Impact

CONCLUSION

Mt. Tapulao still preserves its forest ecosystem and has a very high diversity of tree species. The National List of Threatened Philippine Plants indicated that among the identified trees, majority were under vulnerable conditions, and others were categorized as critically endangered, and other threatened species. Meanwhile, according to the IUCN Red List, some of these species were under the critically endangered, vulnerable, and endangered species categories. Most of the identified trees were native to and endemic in the Philippines. Among the surveyed trees, majority were categorized as forest trees, and they were mostly utilized as a source of lumber and as shelter. According to the local communities, illegal logging still occurred in the area,

and this had led to the decline in the number of trees present. However, these activities had become more uncommon at the time of the study compared before. Logging of trees for domestic and commercial use were considered as the main reason for the significant reduction in their number. Furthermore, the forest ecosystem of Mt. Tapulao was being continuously threatened by human activities like road construction, wildlife hunting, soil erosion and silt runoff, and tourism/recreational areas, past mining activities, and quarrying whose impacts should not be ignored.

RECOMMENDATIONS

Considering the results of the study, the following are recommended:

1. Conduct plant diversity assessment in different periods of the year, such as the wet season.
2. Carry out vegetation assessment in other parts of Mt. Tapulao and Zambales Mountain Range.
3. Perform DNA analysis for proper identification of plants present in the area for more accurate identification.

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