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Diversity, endemism and conservation status of flora in Mt. Katayagan, Agoo, La Union, Philippines

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Abstract

Mount Katayagan, the highest peak in the Agoo Mountain Range, La Union, Philippines, is a vital but understudied natural resource. This research addresses the biodiversity gap in non-protected areas like Mt. Katayagan, emphasizing its role as a watershed, supplying water for irrigation, households, and providing essential commodities. Despite its ecological and economic significance, there is a lack of research on Mt. Katayagan's biodiversity. The study utilized a quantitative descriptive methodology, following the Terrestrial Ecosystem Biodiversity and Assessment Monitoring Manual. Data collection involved desktop research, community engagement, reconnaissance survey, forest land assessment, visual documentation, flora identification, and determination of endemism and conservation status. The research documented 102 plant species from 40 families and 92 genera, revealing a Shannon-Weiner Diversity Index of 4.032, signifying very high diversity. Noteworthy findings include 48 native species, 31 La Union endemics, and the identification of four threatened species per the IUCN Red List and five according to DAO No. 2017-11.

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Introduction

Biodiversity, encompassing the vast array of life forms and ecosystems on Earth, is integral to the sustenance of life and the provision of essential ecosystem services (National Geographic Society, 2021). Recognizing its significance, efforts worldwide have been directed towards understanding, managing, and conserving biodiversity. High biodiversity is associated with ecosystem health, stability, and resilience to ecological disturbances (Diaz *et al.*, 2019). The global recognition of biodiversity's importance was underscored by the Convention on Biological Diversity during the 1992 Rio Earth Summit, prompting nations to prioritize biodiversity management (Tsioumani *et al.*, 2020). The multifaceted value of biodiversity, ranging from economic and ecological to recreational, cultural, and scientific aspects, emphasizes its critical role in human well-being and environmental sustainability (Australia State of the Environment, 2018). As human activities continue to impact biodiversity, it becomes imperative to assess and manage it comprehensively. However, many proposed development areas lack sufficient biodiversity information, leading to irreversible consequences such as habitat destruction and overexploitation (Paller, 2021).

In addressing the need for comprehensive biodiversity assessments, this study focuses to determine the diversity, endemism, and conservation status of the plants found in Mt. Katayagan The significance of this research is underscored by the gaps in legal frameworks such as the Philippine Environmental Impact Assessment System (PEIAS) and the Wildlife Resources Conservation and Protection Act of 2001, which often face challenges due to inadequate biodiversity information (Convention on Biological Diversity, 2021; Republic Act 9147). Crucially, this research addresses the broader context of biodiversity conservation by focusing on Mt. Katayagan, the highest peak in the Agoo Mountain Range, covering a land area of 41.03 hectares with an elevation of 250 meters above sea level (Arengarden, 2017). Despite its ecological and economic importance, Mount Katayagan lacks comprehensive biodiversity studies, making it an ideal subject for research. As unprotected areas like Mount Katayagan are vulnerable to various threats, the preservation of this region becomes crucial for combating biodiversity loss and addressing global-scale crises (Kohler *et al.*, 2009). It is noteworthy that most biodiversity assessment studies tend to concentrate on protected areas, leaving other sites, such as Mount Katayagan, vulnerable to destruction. Since 2015, Mount Katayagan has drawn numerous visitors from La Union, not only for its breathtaking views but also for the essential functions it serves for the local community. As a watershed, Mt. Katayagan plays a pivotal role in supplying water for irrigation and household use in the municipalities of Agoo, Tubao, and Sto. Tomas. Its sloping topography acts as a natural catch basin for rainwater, supporting agriculturally dependent communities. Beyond its hydrological importance, the mountain provides residents with access to free water and serves as a source of valuable commodities such as fruits and timber (Eisma *et al.*, 2015). Therefore, this research serves as a baseline for potential future developments, aligning with the mandates of existing legal frameworks and supporting conservation initiatives. Through a detailed analysis of land cover, forest formation, stand maturity, and upper canopy species, this study contributes valuable information essential for sustainable development and biodiversity management.

Materials and methods

Research design

This research utilized a quantitative descriptive approach to thoroughly examine the flora diversity of Mt. Katayagan. The choice of this research design is deemed suitable as it allows for the comprehensive evaluation of the overall flora diversity at Mt. Katayagan (Addison, 2017). Parameters such as number of plant species, biomass, count, and percent cover are collected for the computation of flora diversity of Mt. Katayagan. The 2017 manual "Terrestrial Ecosystem Biodiversity and Assessment Monitoring Manual," from the Biodiversity Management Bureau was used as a guide for the step-

by-step procedure of the study with slight modifications to fit the needs of the study.

Time and place

The study duration spanned from May 31, 2022, to October 31, 2022, and was conducted at Mt. Katayagan in Agoo, La Union. Precise geographic coordinates (16°19'49"N, 120°23'33"E / 16°18'47"N, 120°29'14"E / 16°18'32"N, 120°23'12"E / 16°18'34"N, 120°23'03"E) were determined using Google Earth Pro (v. 7.3.6.9345), released on January 04, 2023 as shown in Fig. 1, with the collected voucher specimen authenticated at the Jose Vera Santos Memorial Herbarium, University of the Philippines Diliman.

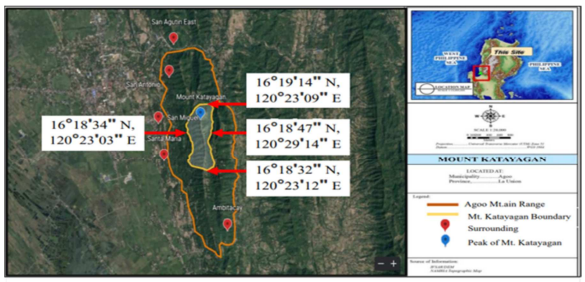

Plate 1. Location of Mt. Katayagan at the Agoo Mountain Range from the Department of Environment and Natural Resources

Fig. 1. Location of Mt. Katayagan at the Agoo mountain range from the department of environment and natural resources

Materials

Several tools and equipment were utilized to facilitate this study. Google Earth Pro (v. 7.3.6.9345), released on January 04, 2023 and ARCGIS™ software were used for mapping. Specialized tools for field data collection included data sheets, surveyor's tapes, visible flagging ribbons, permanent markers, waterproof paper, GPS-equipped mobile phones, a compass, DSLR camera, binoculars, and tools for gathering voucher specimens.

Procedures

The research data for this study was systematically gathered through a multi-phase procedure. The initial step, termed the desktop phase, involved compiling relevant literature from various sources and developing initial land cover map (Wesson Environmental, 2018). The subsequent phase focused on local community engagement, requiring authorization from the Municipality of Agoo, notifying barangay officials regarding the conduct of the study. This engagement served as an opportunity to gather valuable insights from community members regarding trails, floral composition, and ecosystem services of Mt. Katayagan (de Weger *et al.*, 2019). Following the local community engagement, a reconnaissance survey was conducted through on-site ocular inspection and drone assessments to calibrate and validate the initial data gathered in the desktop phase (Southwell *et al.*, 2021). The next step involved the updating of the land cover map by a licensed forester. This process included data processing using ARCGIS™ software. The accuracy of the updated land cover map is crucial to decide what appropriate sampling technique will be used and how the 2km transect line will be laid-out. Subsequently, the site selection for the 2km transect line prioritized forested areas over grassland and shrubland to avoid underestimation of biodiversity. It considered factors such as elevation gradients and alignment with existing trails for accessibility. Since Mt. Katayagan is dominated by closed forest, Forest Land Assessment using the Belt-Transect Method by B+Wiser (2014) was deemed to be the appropriate sampling technique to characterize the plant diversity of Mt. Katayagan (Biodiversity Management Bureau, 2017). This sampling technique involves setting up a 2km transect line and establishing a quadrat in alternative direction at every 250m marked with visible flagging ribbon and GPS reading. To gather the data in determining the flora diversity of Mt. Katayagan, Species Level Assessment data sheet was filled out in each quadrat with a size of 20x20m. Within the 20m × 20m quadrat for upper canopy assessment, 5m × 5m quadrat and 1m x 1m quadrat were laid out for understorey and ground cover assessment, respectively. In the 20m x 20m quadrat, the upper canopy observation was focused on trees whose diameter is equal to or greater than 4 inches of diameter at breast height (DBH). The understorey assessment was done in the 5m x 5m quadrat. It was focused on the frequency of poles, saplings, shrubs, and herbs which will often determine successful

generation. The ground cover assessment was done in the 1m x 1m quadrat. It focused on the percent of cover species <1m in height, such as grasses, vines, ferns, sedges, and non-vegetative components like rocks and soil. The remarks are noted in the remarks column to observe the flowering and fruiting of the individual trees and other tree disturbances in all the quadrats.

Additionally, visual documentation of flora specimens followed ethical guidelines, including securing Gratuitous Permit from the Department of Environment and Natural Resources and adhering to established procedures for specimen photography of (Grabowski, 2015). Flora species identification was initially conducted relying on captured photos, referencing authoritative sources such as the Flora Malesiana (Van Steenis and Van Steenis-Kruseman, 1950), Flora of Manila (Merrill, 1912), Enumeration of Philippine Flowering Plants Vol.1-4 (Merrill, 1923), Terrestrial Ecosystems Biodiversity Assessment and Monitoring Manual (Biodiversity Management Bureau, 2017), and Leaflets of Philippine Botany (Elmer, 1906). Final authentication was sought from the Jose Vera Santos Memorial Herbarium at UP Diliman, referencing various reputable botanical publications. Lastly, the endemism and conservation status of the flora found within Mt. Katayagan were determined based on authenticated plant specimens. For the plant species' endemism, online databases such as Co's Digital Flora of the Philippines (Pelser *et al.*, 2011 onwards), Enumeration of Philippine Flowering Plants Vol. 1-4 (Merrill, 1923), and Revised Lexicon of the Philippine Trees (Rojo, 1998) were consulted. While in the plant species' conservation status, Philippine Plant Conservational Committee (PPCC) of the Protected Areas and Wildlife Bureau (PAWB), DENR Administrative Order No. 2017-11, also known as "Updated National List of Threatened Philippine Plants and their Categories", and the listing of threatened species by the International Union for Conservation of Nature better known as the IUCN Red List (2022) were used as basis.

Data gathered

The research on Mt. Katayagan's flora diversity involved a comprehensive examination of key parameters crucial for understanding its ecosystem. The study meticulously documented the number of plant species, their biomass, count, and percent cover, providing a quantitative foundation for computing the overall plant diversity in the area. The taxonomic classification of the identified plants offered insights into the systematic organization and evolutionary relationships within the local flora. Additionally, the investigation explored the dimensions of endemism and conservation status, shedding light on the presence of unique and potentially threatened plant species in the ecosystem. Collectively, these data points contribute significantly to a nuanced understanding of the plant diversity, taxonomy, and conservation priorities in Mt. Katayagan

Data analysis

The land cover types of Mt. Katayagan were classified based on the Terrestrial Ecosystem Biodiversity Assessment and Monitoring Manual (2017).

The Shannon-Weiner Diversity Index (H') was chosen for assessing plant diversity on Mt. Katayagan due to its comprehensive consideration of both species richness and evenness and supported by a robust classification system developed by Fernando *et al.* (1998). Shannon-Weiner Diversity Index (H') was generated using Microsoft Excel (v. 365, released in 2016) with the data on the list of identified plant species and its count (Table 1).

SDI was computed using this formula:

$$H' = -\sum_{i=1}^{S} = [(\frac{ni}{N}) \times ln\left(\frac{ni}{N}\right)]$$

Where

H′ = Shannon-Weiner Diversity Index

S = number of species in the community

n_i = number of individuals of the i-th species

N = total number of individuals for the site

ln = the natural log of the number

Table 1. Classification Scheme for the Shannon-Weiner Diversity Index (H')

Relative values	Shannon-Weiner (H') Index
Very High	3.5 and above
High	3.0 – 3.49
Moderate	2.5 – 2.99
Low	2.0 – 2.49
Very Low	1.9 and below

Research ethics

This research investigation strictly adhered to research ethics protocols, by obtaining a gratuitous permit from the Department of Environment and Natural Resources – Regional Office I. This permit enabled the study to be carried out in Mt. Katayagan, Agoo, La Union, Philippines. Furthermore, a Local Community Engagement was executed to elucidate the study's objectives to the barangay officials who hold jurisdiction over the study site.

Results and discussion

This study delves into the diversity, endemism, and conservation status of Mt. Katayagan, as shown in Table 2. The richness and even distribution of plant species in this ecologically significant area are exposed through the Shannon-Weiner Diversity Index (H'). Beyond diversity, the investigation explores the endemism of plant species, highlighting the native and distinctive plants that shape Mt. Katayagan's botanical identity. An examination of the conservation status brings attention to the delicate balance between thriving biodiversity and imminent threats to specific plant species, underscoring the necessity for strategic preservation efforts.

Diversity

The metric used to quantify and assess the flora diversity of Mt. Katayagan is the Shannon-Weiner Diversity Index (H'), which takes into account both species richness and evenness within a community (Nolan *et al.*, 2006). The study conducted on Mt. Katayagan revealed very high plant species diversity, as indicated by a H' value of 4.032 (Table 2). This value is a quantitative representation of the complexity of plant species composition within the ecosystem. This outcome is similar to the H' of Mt. Banahaw de Dolores in the Philippines, which stands at 4.058 (Gascon *et al.*, 2013). According to the classification scheme developed by Fernando *et al.* (1998), diversity index values fall into various ranges, each indicating a level of biodiversity. In this classification, a value falling within the range of 3.5 and above is considered indicative of a very highly diverse ecosystem. Therefore, the calculated index for Mt. Katayagan signifies that the plant species diversity in this region is indeed substantial and robust. The very high plant species diversity observed in Mt. Katayagan has several important implications for both the ecosystem itself and the surrounding environment. A diverse plant community can enhance ecosystem stability and resilience, making it more adaptable to changes such as climate fluctuations and natural disturbances (Diaz *et al.*, 2019). Additionally, diverse plant species provide a variety of ecosystem services, including habitat provision, nutrient cycling, and carbon sequestration (Diaz *et al.*, 2019). Conservation efforts that aim to protect and sustain this biodiversity hotspot are not only crucial for the survival of the various plant species within the ecosystem but also for the countless other organisms that depend on these plants for food, shelter, and other resources. The derived index was substantiated by the documented 102 plant species, encompassing 92 genera distributed across 40 families (Table 2). This investigation unveiled significant similarities in plant species distribution across diverse geographical contexts in the Philippines. For instance, the results exhibited striking similarities with the plant species composition observed along the landscapes of Cabadbaran River in Agusan Del Norte, Philippines. This region was found to house a total of 109 plant species, classified into 46 families and represented by 88 genera (Sarmiento *et al.*, 2022). Additionally, a comparable concurrence was identified with the botanical makeup of Mt. Banahaw de Dolores, Philippines, where a total of 92 plant species were documented, associated with 37 families (Gascon *et al.*, 2013). Similar patterns were discerned in the context of the agroforest ecosystem situated in Makilala, North Cotabato, Philippines.

Table 2. Shannon-Weiner Diversity Index (H'), Endemism, and Conservation Status of the 102 Plant Species in Mt. Katayagan

Family Scientific name	Common name	Count	$(\frac{n_i}{N}) \times ln(\frac{n_i}{N})$	Endemism	Conservation status IUCN red list / DAO No. 2017-11 year assessed
Amaranthaceae					
Alternanthera brasiliana	Bunga-bunga	8	-0.021320002	Nat	NE -
Anacardiaceae					
Anacardium occidentale	Kasuy	2	-0.03732853	Nat	LC / 2021 -
Buchanania arborescens	Balinghasay	6	-0.051332277	NE-LU	LC / 2020 -
Mangifera indica	Manga	13	-0.081336198	Nat	DD / 2021 -
Spondias dulcis	Balolong	1	-0.111524372	Nat	NE -
Annonaceae					
Annona muricata	Guyabano	3	-0.029649743	Cult	LC / 2018 -
Annona reticulata	Anonas	3	-0.029649743	Nat	LC / 2018 -
Annona squamosa	Atis	5	-0.091964247	Nat	LC / 2018 -
Uvaria sp.	-	2	-0.011987869	-	-
Apocynaceae					
Tabernaemontana	Kampupot	8	-0.011987869	NE-LU	LC / 2018 -
pandacaqui	Pandakaking-tsina	3	-0.051332277	Cult	LC / 2020 -
Tabernaemontana divaricata	Lanete	19	-0.057820502	NNE-LU	LC / 2019 -
Wrightia pubescens					
Araceae					
Syngonium podophyllum	Arrowhead Plant	4	-0.011987869	Nat	NE -
Arecaceae					
Caryota sp.	-	13	-0.011987869	-	- -
Cocos nucifera	Buko	1	-0.051332277	NNE-LU	NE -
Roystonea regia	Rayal Palm Tree	1	-0.03732853	Cult	LC / 2018 -
Saribus rotundifolius	Anahaw	3	-0.011987869	NE-LU	NE OTS
Asparagaceae					
Dracaena trifasciata	Snake Plant	3	-0.011987869	Cult	NE -
Asteraceae					
Bidens biternata	Spanish Needles	3	-0.011987869	NNE-LU	NE -
Blumea balsamifera	Sambong	3	-0.011987869	NE-LU	LC / 2018 -
Chromolaena odorata	Hagonoy	14	-0.03732853	Nat	NE -
Bignoniaceae					
Oroxylum indicum	Pingka-pingkahan	5	-0.174556094	NNE-LU	NE -
Boraginaceae					
Ehretia microphylla	Tsaang-gubat	1	-0.044523273	NNE-LU	NE -
Bromeliaceae					
Ananas comosus	Pinya	6	-0.011987869	Cult	NE -
Cannabaceae					
Trema orientale	Anabiong	2	-0.057820502	NNE-LU	LC / 2017 -
Caricaceae					
Carica papaya	Papaya	2	-0.03732853	Nat	DD / 2016 -
Combretaceae					
Terminalia catappa	Talisay	7	-0.03732853	NE-LU	LC / 2018 -
Euphorbiaceae					
Hevea brasiliensis	Rubber Tree	1	-0.03732853	Cult	LC / 2020 -
Macaranga tanarius	Binunga	11	-0.021320002	NE-LU	LC / 2018 -
Mallotus philippensis	Banato	5	-0.011987869	NE-LU	LC / 2018 -
Manihot esculenta	Kamoteng Kahoy	4	-0.021320002	Nat	NE -
Melanolepis multiglandulosa	Alim	7	-0.029649743	NE-LU	LC / 2018 -
Fabaceae					
Albizia sp.	-	4	-0.021320002	-	- -
Bauhinia purpurea	Butterfly Tree	4	-0.051332277	Cult	LC / 2010 -
Centrosema pubescens	-	1	-0.011987869	Nat	NE -
Desmodium sp.	-	5	-0.011987869	-	- -
Enterolobium cyclocarpum	Earpod Tree	2	-0.029649743	Cult	LC / 2018 -
Indigofera hirsuta	Tauiman	2	-0.029649743	NNE-LU	NE -
Leucaena leucocephala	Ipil-ipil	10	-0.011987869	Nat	NE -
Mimosa pudica	Makahiya	9	-0.120596444	Nat	LC / 2010 -
Peltophorum pterocarpum	Siar	1	-0.120596444	NNE-LU	NE -
Phanera bidentata	Pride of Selangor	4	-0.011987869	Nat	NE -
Pterocarpus indicus	Narra	41	-0.199823595	NE-LU	EN / 2018 VU
Samanea saman	Acacia	3	-0.057820502	Nat	LC / 2018 -

Senna alata	Akapulko	6	-0.011987869	Nat	LC / 2018	-
Tamarindus indica	Sampalok	2	-0.011987869	Nat	LC / 2017	-
Lamiaceae						
Clerodendrum minahassae	Baguak na Puti	4	-0.029649743	NE-LU	LC / 2021	-
Gmelina arborea	Gmelina	3	-0.029649743	Nat	LC / 2019	-
Premna serratifolia	Alagau-gubat	1	-0.021320002	NNE-LU	LC / 2020	-
Tectona grandis	Teak	27	-0.091964247	Nat	EN / 2021	-
Vitex negundo	Lagundi	7	-0.021320002	NE-LU	LC / 2018	-
Vitex parviflora	Molave	3	-0.086730137	NE-LU	LC / 2018	-
Lauraceae						
Litsea sp.	-	1	-0.021320002	-	-	-
Persea Americana	Abukado	3	-0.011987869	Cult	LC / 2017	-
Lygodiaceae						
Lygodium sp.	-	1	-0.021320002	-	-	-
Lythraceae						
Lagerstroemia speciosa	Banaba	3	-0.044523273	NE-LU	NE	-
Malvaceae						
Grewia laevigata	Dangli	4	-0.011987869	NE-LU	LC / 2018	-
Kleinhovia hospita	Tan-ag	6	-0.029649743	NE-LU	LC / 2018	-
Pterospermum obliquum	Bayog	1	-0.029649743	NE-LU	LC / 2017	-
Sida sp.	-	2	-0.064034116	-	-	-
Sterculia foetida	Kalumpang	1	-0.029649743	NNE-LU	NE	-
Urena lobate	Dalupang	17	-0.029649743	Nat	LC / 2019	-
Marantaceae						
Maranta arundinacea	Araro	2	-0.011987869	Cult	NE	-
Meliaceae						
Azadirachta indica	Balunga	1	-0.011987869	Nat	LC / 2018	-
Swietenia macrophylla	Mahogany	36	-0.184424045	Nat	VU / 1998	-
Sandoricum koetjape	Santol	3	-0.029649743	NNE-LU	LC / 2017	-
Moraceae						
Allaeanthus luzonicus	Himbabo	1	-0.011987869	NE-LU	NE	-
Artocarpus camansi	Kamansi	4	-0.057820502	Nat	NE	-
Artocarpus heterophyllus	Langka	2	-0.011987869	Nat	NE	-
Ficus altissima	Council Tree	2	-0.021320002	NNE-LU	LC / 2018	-
Ficus benjamina	Balete	1	-0.051332277	NNE-LU	LC / 2018	-
Ficus minahassae	Hagimit	1	-0.021320002	NNE-LU	LC / 2018	-
Ficus nota	Tibig	1	-0.029649743	NNE-LU	LC / 2018	-
Ficus septica	Hauili	7	-0.075767864	NE-LU	LC / 2018	-
Streblus asper	Kalios	33	-0.044523273	NE-LU	LC / 2018	-
Musaceae						
Musa acuminata	Lakatan	1	-0.064034116	NNE-LU	LC / 2016	-
Myrtaceae						
Psidium guajava	Bayabas	3	-0.03732853	Nat	LC / 2018	-
Syzygium cumini	Duhat	5	-0.044523273	Nat	LC / 2018	-
Oxalidaceae						
Averrhoa bilimbi	Kamias	1	-0.09705085	Nat	NE	-
Passifloraceae						
Passiflora foetida	Prutas-Baguio	1	-0.011987869	Nat	NE	-
Phyllanthaceae						
Antidesma bunius	Bignay	1	-0.029649743	NNE-LU	LC / 2018	-
Antidesma ghaesembilla	Binayuyo	12	-0.044523273	NE-LU	LC / 2018	-
Bridelia stipularis	Kuto-kuto	1	-0.070007638	NE-LU	LC / 2019	-
Flueggea leucopyrus	Spinous Fleuggea	1	-0.03732853	-	LC / 2020	-
Pittosporaceae						
Pittosporum pentandrum	Mamalis	2	-0.021320002	NNE-LU	NE	-
Poaceae						
Bambusa sp.	-	2	-0.011987869	-	-	-
Eleusine indica	Paragis	1	-0.021320002	Nat	LC / 2010	-
Setaria sp.	-	1	-0.011987869	-	-	-
Pteridaceae						
Adiantum sp.	-	1	-0.011987869	-	-	-
Rhamnaceae						
Ziziphus talanai	Balakat	1	-0.011987869	NE-LU	VU / 1998	OTS
Rutaceae						
Harrisonia perforata	Mamikil	3	-0.029649743	NNE-LU	LC / 2018	-
Micromelum minutum	Tulibas Tilos	1	-0.021320002	NE-LU	LC / 2019	-
Murraya paniculata	Kamuning	2	-0.011987869	NNE-LU	NE	-

Oplismenus undulatifolius	Wavyleaf Basketgrass	1	-0.011987869	NNE-LU	NE	-
Salicaceae						
Flacourtia indica	Palutan	1	-0.029649743	NNE-LU	LC / 2018	-
Sapindaceae						
Elattostachys verrucosa	-	3	-0.153198141	NNE-LU	LC / 2021	-
Nephelium lappaceum	Rambutan	1	-0.021320002	NNE-LU	LC / 2017	VU
Sapotaceae						
Chrysophyllum cainito	Caimito	7	-0.057820502	Cult	LC / 2020	-
Pouteria campechiana	Tiesa	6	-0.011987869	Cult	LC / 2018	-
Verbenaceae						
Lantana camara	Kantutay	19	-0.029649743	Nat	NE	-
Vitaceae						
Leea manillensis	Abang-abang	2	-0.029649743	NE-LU	NE	-
Zingiberaceae						
Hedychium coronarium	Kamia	1	-0.021320002	Nat	DD / 2019	-
Shannon-Weiner Diversity Index (H') =	4.032424768					

Legend: Nat- Naturalized; Cult- Cultivated; NE-LU- Native/Endemic to La Union; NNE-LU- Native/Non-endemic to La Union; NE- Not Evaluated; LC- Least Concern; DD- Data Deficient; VU- Vulnerable; EN- Endangered; OTS- Other Threatened Species

Table 3. Tree Species Abundance per Family across Mt. Katayagan, Agoo, La Union

Families	No. of species	Families	No. of species	Families	No. of species
Amaranthaceae	1	Combretaceae	1	Oxalidaceae	1
Anacardiaceae	4	Euphorbiaceae	5	Passifloraceae	1
Annonaceae	4	Fabaceae	14	Pittosporaceae	1
Apocynaceae	3	Lamiaceae	6	Poaceae	4
Araceae	1	Lauraceae	2	Pteridaceae	1
Arecaceae	4	Lygodiaceae	1	Rhamnaceae	1
Asparagaceae	1	Lythraceae	1	Rutaceae	3
Asteraceae	3	Malvaceae	6	Salicaceae	1
Bignoniaceae	1	Marantaceae	1	Sapindaceae	2
Boraginaceae	1	Meliaceae	3	Sapotaceae	2
Bromeliaceae	1	Moraceae	9	Verbenaceae	1
Cannabaceae	1	Musaceae	1	Vitaceae	1
Caricaceae	1	Myrtaceae	2	Zingiberaceae	1

The area exhibited the presence of an extensive collection of 110 floral species, categorized within 58 families and represented by 95 genera (Agduma *et al.*, 2011). The congruence extended further to the floral distribution observed in Mt. Malarayat, Batangas, Philippines, where a substantial compilation of 104 floral species was identified, spanning 60 families (Lunar *et al.*, 2011).

At the level of botanical families, notable prominence was observed among several families, with the Fabaceae leading the representation with 14 species (constituting 5.6%), followed by the Moraceae with nine species (3.6%); the Lamiaceae and Malvaceae, each with six species (2.4%); and the Euphorbiaceae with five species (2%). Additionally, the Anacardiaceae, Annonaceae, Arecaceae, Phyllanthaceae, and Poaceae families exhibited a presence of four species each (1.6%). The remaining set of 30 families held a lower representation, each with fewer than four species (Table 3).

These findings displayed a remarkable degree of similarity with the dominant family composition observed in the Quezon Protected Landscape, Philippines. Within this area, prominent families included Fabaceae, Arecaceae, Moraceae, Malavaceae, Poaceae, Euphorbiaceae, and Anacardiaceae (Paclibar *et al.*, 2020). This similarity extended to the context of Makilala, North Cotabato, where dominant families encompassed Moraceae, Eurphorbiaceae, Fabaceae, Arecaceae, and Poaceae (Agduma *et al.*, 2011). Meanwhile, Madulid (2000) identified dominant families as Euphorbiaceae, Arecaceae, Moraceae, Fabaceae, and Annonaceae in Samar Island, Philippines.

At the taxonomic level of plant genera, this study reveals that *Ficus* emerged as the most prevalent genus, comprising a total of five plant species. Following this, the genus *Anonna* is represented by three species, while the genera *Antidesma*, *Artocarpus*, *Tabernaemontana*, and *Vitex* each contribute two species to the dataset. The remaining set of 76 genera exhibits a comparatively diminished presence, each containing less than one species.

This trend observed in the distribution of genera aligns with the results documented by Coritco *et al.* (2020) within the Mt. Tago Range of Mindanao, Philippines, and the outcomes from the secondary forest of Mount Pangasugan, Leyte, Philippines (Polinar *et al.*, 2010), where the dominance of the *Ficus* was prominently noted. The ecological significance inherent in *Ficus*, commonly known as fig trees, emanates from their pivotal role as keystone species, significantly bolstering populations of seed-dispersing creatures that heavily rely on the fruits for sustenance. Moreover, fig trees command a notable presence within riparian zones, contributing substantively to the stability of adjacent rivers or streams (Pothasin *et al.*, 2014). This sentiment is echoed by Cottee-Jones *et al.* (2016), who further accentuated the paramount importance of fig trees as integral components of tropical deciduous ecosystems, attributed to their substantial production of sizeable and nutritionally enriching fruit yields.

Within the confines of Mt. Katayagan, the only pteridophytes identified are *Lygodium species* and *Adiantum species*. Angiosperms emerged as the prevailing botanical group, constituting a significant representation of 38 families, equivalent to 95 percent of the total botanical makeup of Mt. Katayagan. In contrast, pteridophytes were of lesser prevalence, encompassing a mere two families, accounting for 5 percent of the overall botanical makeup of Mt. Katayagan. It is noteworthy that no occurrences of gymnosperms were documented within the research site (Fig. 2) since gymnosperms are commonly found in boreal and temperate forests, unlike Mt. Katayagan, which is a tropical moist deciduous forest (BYJUS, 2021). Moreover, gymnosperms are located at a high elevation range for colder environments, unlike Mt. Katayagan, which only has an elevation range of 109 to 225 meters above sea level.

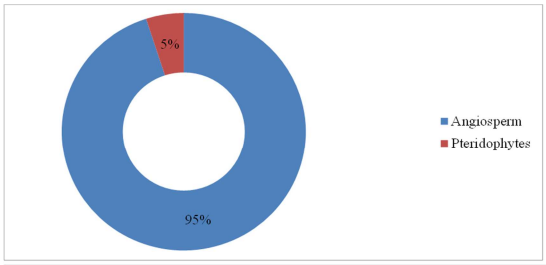

Fig. 1. Proportion of Plant Species Families in Mt. Katayagan

Fig. 2. Proportion of Plant Species Families in Mt. Katayagan

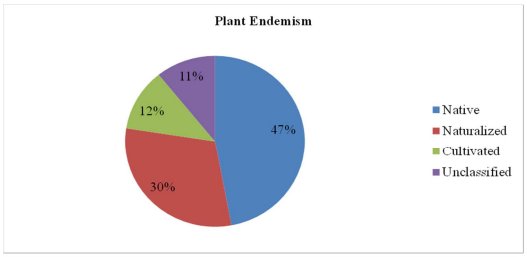

Fig. 2. Plant Classification Segmentation by Endemism Status in Mt. Katayagan

Fig. 3. Plant Classification Segmentation by Endemism Status in Mt. Katayagan

Within the confines of Mt. Katayagan, the only pteridophytes identified are Lygodium species and Adiantum species. Angiosperms emerged as the prevailing botanical group, constituting a significant representation of 38 families, equivalent to 95 percent of the total botanical makeup of Mt. Katayagan. In contrast, pteridophytes were of lesser prevalence, encompassing a mere two families, accounting for 5 percent of the overall botanical makeup of Mt. Katayagan. It is noteworthy that no occurrences of gymnosperms were documented within the research site (Fig. 2).

Endemism

Out of the 102 species documented in Mt. Katayagan, a substantial portion, comprising 47.06 percent (48 species), were recognized as native to the Philippines. This observation aligns remarkably well with the range of plant endemism suggested by both the

DENR-UNEP (1997) and Mittermeier *et al.* (1999), which falls between 45 percent and 60 percent. The prevalence of native species underscores the ecological importance of Mt. Katayagan as a repository of indigenous flora within the Philippines. A comprehensive list of plant species found in Mt. Katayagan is provided on Table 2, along with their respective levels of endemism.

The presence of naturalized species, accounting for 30.40 percent (31 species) of the total, points towards the ecological adaptability of certain plants to the study site. Additionally, the cultivation of 11.76 percent (12 species) of the identified plants highlights human intervention in shaping the botanical landscape of Mt. Katayagan. Interestingly, 10.78 percent (11 species) of the species remain unclassified, possibly warranting further taxonomic investigation. The categorization of plant classifications based on their endemism status in the area of Mt. Katayagan can be found Fig. 3.

Among the 48 native species, a fraction of 23 were determined to be endemic specifically to La Union, while the remaining 25 are non-endemic. This juxtaposition of endemic and non-endemic species underscores the importance of preserving local ecosystems, particularly in regions of high endemism like Mt. Katayagan. The unique conditions and microenvironments of these areas often give rise to specialized species that are intricately interwoven with the local ecology (Iberdrola, 2021).

The calculation of the overall percentage of endemism across all plant species within Mt. Katayagan yielded a value of 23.46 percent. This figure draws interesting parallels with other studies, such as that of Castañares *et al.* (2017) in Mt. Malindawag, Naawan, Misamis Oriental, which reported a comparable endemism rate of 24.2 percent. Furthermore, the congruence of this result with the study conducted by Amoroso *et al.* (2012) in the Northern Landscape of Mt. Malindang Range and Environs, Misamis Occidental, Philippines reinforces the notion that various geographical regions in the Philippines might harbor similar levels of plant endemism. The calculated overall endemism percentage of 23.46 percent in Mt. Katayagan reveals a substantial proportion of plant species exclusive to this specific region, indicating a unique ecological composition. This percentage underscores the ecological importance of Mt. Katayagan as a reservoir of indigenous flora within the Philippines, emphasizing the need for conservation strategies to safeguard the diverse and specialized plant communities. The value aligns with suggested ranges by environmental agencies and correlates with comparable studies in different Philippine regions, contributing to broader insights into the country's plant endemism patterns. Beyond its scientific significance, this percentage has practical implications for local conservation efforts, emphasizing the vulnerability and resilience of the endemic species to environmental changes and human interventions.

Conservation status

The analysis (Table 2) conducted using the IUCN Red List yielded a significant insight: among the documented 102 plant species at Mt. Katayagan, four of which are classified as "threatened". Notably, two of the threatened species namely: *Pterocarpus indicus* (narra) and *Tectona grandis* (teak) were designated as "endangered," signifying a critically high-risk level that mandates urgent conservation intervention. In parallel, the assessment identified two additional species, namely *Swietenia macrophylla* (mahogany) and *Ziziphus talanai* (balakat) as "vulnerable," indicating a lower but still substantial level of jeopardy faced by these plants within the ecosystem.

In addition to the insights offered by the IUCN Red List (2022), another significant information source contributing to the evaluation of plant species conservation status at Mt. Katayagan is the DENR Administrative Order No. 2017-11. Among the 102 plant species, a subset of five plant species classified as "threatened." Notably, *Vitex parviflora* (molave) was assigned the classification "endangered," signifying a critical state of endangerment and

underscoring the pressing concern for its survival. Two additional species, *Pterocarpus indicus* (narra) and *Nephelium lappaceum* (rambutan), were classified as "vulnerable." Furthermore, the assessment identified two other plant species, *Ziziphus talanai* (balakat) and *Saribus rotundifolius* (anahaw), as "Other threatened species." This categorization indicates a level of risk that, while not reaching the "endangered" or "vulnerable" status, still necessitates attention and consideration for their conservation. Remarkably, all five of these threatened plant species originate from the Philippines. Among them, four species are endemic to La Union, adding significance to their preservation within this particular locale. The only exception to this La Union endemism is *Nephelium lappaceum* (rambutan).

These findings strongly emphasize the intricate and rich ecological intricacies of Mt. Katayagan's surroundings. The noticeable presence of species at risk, which is evident from their prominent positions within the ecological structure, underscores the urgency for robust conservation strategies. Because these species are crucial for maintaining the delicate equilibrium of the ecosystem, their safeguarding goes beyond environmental concerns; it extends to a broader duty of preserving biodiversity and safeguarding the innate natural legacy contained within Mt. Katayagan. As these species contribute not only to ecological balance but also hold cultural and biological importance, their protection goes beyond environmental factors, transforming into a shared obligation to uphold the biodiversity and natural heritage intrinsic to the realm of Mt. Katayagan.

Conclusion

The assessment of plant species diversity, measured using the Shannon-Weiner Diversity Index (H'), indicated a significant diversity value of 4.032. This value aligns with the category defined by Fernando *et al.* (1998) for values equal to or surpassing 3.5, signifying a state of notably elevated diversity and highlighting the richness of plant species within the ecosystem of Mt. Katayagan. The analysis of Mt. Katayagan's ecosystem composition revealed 102 plant species belonging to 40 families and 92 genera. At the family level, the Fabaceae family stood out, and the Ficus genus was prominent among plant genera. The ecosystem was predominantly composed of angiosperms, representing 95% of the species across 38 families, with pteridophytes accounting for 5% and belonging to two families. The endemism analysis of the identified plant species revealed the presence of 48 species native to the Philippines. Notably, 31 naturalized species were identified, along with 12 cultivated species and 11 unclassified plant species. Among the 48 native species, 23 were exclusively endemic to La Union, while the remaining 25 were not restricted to this specific location and were considered non-endemic. Assessing the conservation status of the plant species at Mt. Katayagan involved referencing the IUCN Red List (2022) and DENR Administrative Order 2017-11. According to the IUCN Red List (2022), there are four threatened species within Mt. Katayagan. Two of these species, *Pterocarpus indicus* (narra) and *Tectona grandis* (teak), are classified as "endangered," while the other two species, *Swietenia macrophylla* (mahogany) and *Ziziphus talanai* (balakat), are categorized as "vulnerable." According to DENR Administrative Order 2017-11, five identified species in Mt. Katayagan are considered threatened, with *Vitex parviflora* (molave) designated as "endangered." Two additional species, *Pterocarpus indicus* (narra) and *Nephelium lappaceum* (rambutan), are classified as "vulnerable." The remaining two plant species, *Ziziphus talanai* (balakat) and *Saribus rotundifolius* (anahaw), are categorized as "Other threatened species.

Recommendation(s)

The findings of this study suggest several key recommendations to shape future management and conservation strategies for Mt. Katayagan. Firstly, it is advisable to facilitate the establishment of Memoranda of Agreements (MOAs) with crucial government agencies and local authorities. These MOAs would formalize collaborative efforts aimed at monitoring and conserving endangered and vulnerable species within the Mt. Katayagan area.

Similarly, educational MOAs with local government units should be developed and endorsed to solidify partnerships for effective awareness campaigns. The creation of these MOAs is essential to provide a structured framework, delineating roles and responsibilities, ultimately enhancing the efficiency and sustainability of conservation initiatives on Mt. Katayagan. Furthermore, it is recommended to organize workshops and training sessions involving local communities, educators, and researchers. These initiatives are designed to elevate the proficiency of participants in utilizing the study's compendium for educational and research purposes, fostering a deeper understanding of Mt. Katayagan's biodiversity. Finally, to augment the overall comprehension of Mt. Katayagan's ecosystem, future studies should encompass both fauna and physical assessments. This comprehensive approach will yield valuable insights crucial for guiding and refining conservation efforts on Mt. Katayagan in the future.

References

Addison P, Flander L, Cook CN. 2017. Towards quantitative condition assessment of biodiversity outcomes: Insights from Australian marine protected areas. Journal of Environmental Management **198**, 183–191. https://doi.org/10.1016/j.jenvman.2017.04.054

Agduma AR, Achondo MJM, Bretaña BLP, Bello VP, Remollo LL, Mancao LS, Supremo JP, Salem JGC, Salvalia FRP. 2011. Diversity of Vascular Plant Species in an Agroforest: The Case of a Rubber (*Hevea brasiliensis*) Plantation in Makilala, North Cotabato. Philippine Journal of Crop Science **36(3)**, 57-64.

Amoroso VB, Laraga SH, Calzada BV. 2011. Diversity and assessment of plants in Mt. Kitanglad Range Natural Park, Bukidnon, Southern Philippines. Garden's Bulletin Singapore **63**, 219–236.

Australia State of the Environment. 2018. Importance of biodiversity. Australia State of the Environment Report. https://soe.environment.gov.au/theme/biodiversity/topic/2016/importance-biodiversity

Biodiversity Management Bureau. 2017. Terrestrial Ecosystem Biodiversity and Assessment Monitoring Manual, 1–136. http://www.philchm.ph/wp-content/uploads/2019/03/BMS-Manual-1.pdf

BYJUS. 2021. What are Gymnosperms? - Characteristics And Classification of Gymnosperms. https://byjus.com/biology/gymnosperms/

Castañares ED, Vedra SA, Gorospe JG. 2017. Biodiversity and Habitat Assessment of Mount Malindawag Naawan, Misamis Oriental, Philippines. International Letters of Natural Sciences **62**, 20–27. https://doi.org/10.18052/www.scipress.com/ilns.62.20

Convention on Biological Diversity. 2021. International Institute for Environment and Development. https://www.iied.org/convention-biological-diversity?gclid=CjwKCAjw9aiIBhA1EiwAJ_GTSuDf9bUL9S2EJQvoWQXttVRqZ5igfYXfQ6R5bcuwT1zREJp_BJRnixoCi4IQAvD_BwE

Coritico FP, Lagunday NE, Galindon JMM, Tandang DN, Amoroso VB. 2020. Diversity of trees and structure of forest habitat types in Mt. Tago Range, Mindanao, Philippines. Philippine Journal of Systematic Biology **14(3)**, 1-13.

Cottee-Jones HEW, Bajpai O, Chaudhary LB, Whittaker RJ. 2016. The Importance of *Ficus* (Moraceae) Trees for Tropical Forest Restoration. Biotropica **48(3)**, 413–419. https://doi.org/10.1111/btp.12304

De Weger E, Van Vooren N, Luijkx KG, Baan CA, Drewes HW. 2018. Achieving successful community engagement: a rapid realist review. BMC Health Services Research, **18(1)**. https://doi.org/10.1186/s12913-018-3090-1

DENR Administrative Order No. 2017-11. 2017. UNEP Law and Environment Assistance Platform. URL: https://leap.unep.org/countries/ph/national-legislation/denr-order-no-11-2017-updated-national-list-threatened-plants-and-their-categories

DENR-UNEP. 1997. Philippine biodiversity: An assessment and action plan. Department of Environment and Natural Resources and the United Nations Environment Programme. Bookmark, Inc., Makati, Philippines, 298p.

Diaz S, Settele J, Brondizio S, Ngo HT, Gueze M, Agard J, Arneth A, Balvanera P, Brauman KA, Butchart SHM, Chan KMA, Garibaldi LA, Ichii K, Liu J, Subramanian M, Midgley GF, Miloslavich P, Molnar Z, Obura D, Zayas CN. 2019. The Global Assessment Report on Biodiversity and Ecosystem Services Summary for Policymakers (ISBN No: 978–3-947851-13-3). Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Eisma RM, Asprin JR, Macusi C, Medina J, Padilla ZJ. 2014. Appraisal of Mt. Katayagan as A Watershed Resource in Agoo, La Union. Unpublished Undergraduate Thesis. Don Mariano Marcos Memorial State University - South La Union Campus.

Elmer ADE. (Ed.). 1906. Leaflets on Philippine botany. Botanical Gazette **42(3)**, 223. https://doi.org/10.1086/328965

Fernando ES. 1998. Forest Formations and Flora of the Philippines: Handout in FBS 21. Unpublished. College of Forestry and Natural Resources, University of the Philippines Los Baños.

Gascon CN, Garcia RC, Beltran FN, Faller WC, Agudilla MAR. 2013. Biodiversity Assessment of Mt. Banahaw de Dolores, Philippines. Asian Journal of Biodiversity **4(1)**, 23-45. DOI: http://dx.doi.org/10.7828/ajob.v4i1.295

Grabowski J. 2015. Best Practices to Follow When Taking Photos for Plant Identification. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/flpmctn12688.pdf

Iberdrola. 2022. Endemic species and their value to biodiversity. https://www.iberdrola.com/sustainability/endemic-species

IUCN. 2022. The IUCN Red List of Threatened Species. IUCN Red List. https://www.iucnredlist.org/about/background-history

Kohler T, Maselli D. 2012. Mountains and Climate Change (ISBN: 978–3-905835-16-8). Centre for Development and Environment (CDE), Institute of Geography. http://www.fao.org/3/i2869e/i2869e00.pdf

Lunar BC, Arcega CVS. 2011. Status of Plant Biodiversity in Mt. Malarayat, Batangas, Philippines. Asian Journal of Biodiversity **2(1)**, 1-13. DOI: http://dx.doi.org/10.7828/ajob.v2i1.90

Madulid DA. 2000. A Review and Assessment of the Floristic Knowledge of Samar Island. In Samar Island Biodiversity Study (SAMBIO), Resources, Environment and Economics Center for Studies, Inc. (REECS). Orient Integrated Development Consultants, Inc. (OIDCI) and Department of Environment and Natural Resources (DENR).

Merrill ED. 1912. A flora of Manila. https://doi.org/10.5962/bhl.title.54449

Merrill ED. 1923. An enumeration of Philippine flowering plants. http://ci.nii.ac.jp/ncid/BA32427552

Mittermeier RA, Myers N, Gil PR, Mittermeier CG. 1999. Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Conservation International, and Agrupacion Sierra Madre, Monterey, Mexico.

National Geographic Society. 2019. Biodiversity. https://www.nationalgeographic.org/encyclopedia/biodiversity/

Nolan KA, Callahan JE. 2006. Beachcomber biology: The Shannon-Weiner Species Diversity Index. Pages 334-338, in Tested Studies for Laboratory Teaching, **Volume 27** (M. A. O'Donnell, Editor). Proceedings of the 27th Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 383 pages.

Paclibar GCB, Tadiosa ER. 2020. Plant species diversity and assessment in Quezon Protected Landscape, Southern Luzon, Philippines. Philippine Journal of Systematic Biology **14(3)**, 1-13.

Paller VGV, Magcale-Macandog D, de Chavez ERC, Paraso MGV, Tsuchiya MCL, Campang JG, Pleto JVR, Bandal MZ Jr, Cabillon YCL, Elepaño AG, Macaraig JRM, Mendoza SS. 2021. The Seven Lakes of San Pablo: Assessment and Monitoring Strategies Toward Sustainable Lake Ecosystems. Philippine Science Letters, **14(1)**, 158-179.

Polinar AN, Muuss U. 2010. Tree species diversity in secondary forest of Mount Pangasugan, Baybay City, Philippines. Journal of Nature Studies **9(1)**, 105–111.

Pothasin P, Compton SG, Wangpakapattanawong P. 2014. Riparian ficus tree communities: The distribution and abundance of riparian fig trees in northern Thailand. PLOS ONE, **9(10)**, e108945.
https://doi.org/10.1371/journal.pone.0108945

Republic Act No. 9417. 2001. An Act Providing for the Conservation and Protection of Wildlife Resources and their Habitats, Appropriating Funds Therefor and for Other Purposes. Official Gazette of the Republic of the Philippines.
https://www.officialgazette.gov.ph/2001/07/30/republic-act-no-9417/

Rojo JP. 1999. Revised Lexicon of Philippine Trees. Forest Products Research and Development Institute, Department of Science and Technology.
ISBN 9716260024, 9789716260021.

Sarmiento RT, Balagon KD, Merisco FFT, Aniñon RDJ, Medrano MCV, Kitche K. 2022. Diversity and composition of riparian vegetation across forest and agroecosystem landscapes of Cabadbaran River, Agusan del Norte, Philippines. https://doi.org/10.3897/arphapreprints.e82882

Southwell D, Legge S, Woinarski JCZ, Lindenmayer DB, Lavery TH, Wintle BA. 2021. Design considerations for rapid biodiversity reconnaissance surveys and long-term monitoring to assess the impact of wildfire. Diversity and Distributions **28(3)**, 559–570.
https://doi.org/10.1111/ddi.13427

Tsioumani E, Tsioumanis A. 2020. Biological Diversity: Protecting the variety of life on Earth. International Institute for Sustainable Development.
https://www.iisd.org/articles/biological-diversity-protecting-variety-life-earth

Van Steenis CGGJ, Van Steenis-Kruseman MJ. 1950. Flora malesiana.
https://doi.org/10.5962/bhl.title.40744

Wesson Environmental. 2018. Phase 1 desktop study contamination survey and investigation services.
https://wessonenvironmental.co.uk/services/desktop-study/