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Biodiversity and Habitat Assessment of Mount Malindawag, Naawan, Misamis Oriental, Philippines

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Abstract. Habitat fragmentation results to displacement of inhabiting floral and faunal species. The resulting geographic isolation of various species affect regeneration, genetic flows and recruitment. Hence, a study was conducted in a forested area of Mt. Malindawag in Naawan, Misamis Oriental. Sampling stations were designated at the agro-forest, mid-forest and upper-forest habitat types. Species characterizations were based on DAO 2007-01 and IUCN Red List for conservation status. Results showed highest diversity index of flora at mid-forest while lowest diversity was observed in the agro-forest area. A tree species *Canarium racemosum* obtained highest Species Importance Value (SIV) at 38.6%, 42% and 30.8%, respectively in the three habitat types. The highest endemicity of flora was at mid-forest with 24% per DAO 2007-01 and 26% per IUCN conservation status. Majority of faunal species were birds that were mostly resident and common and were usually observed at upper-forest habitat. The relatively low diversity and endemicity of flora and fauna species could be due to the influx of human population. Various activities undertaken were threatening the inhabiting biodiversity, and therefore, demand immediate protection and conservation measures from formulating policies to increasing awareness of various stakeholders. Future related studies were recommended to increase scientific understanding on the interrelationships of socio-economic and ecological interactions of biodiversity to the inhabiting human population.

Introduction

Philippines is considered as one of the megadiverse countries in the world. Considering 7,100 islands, the country has many endemic species of plants, birds, mammals, reptiles, amphibians, freshwater species, and invertebrates. With this rich biodiversity, the different islands and mountains harbor variety of species, their genetic make-up, and various communities or population of organisms.

The high biodiversity is attributed to a large number of islands and the presence of many high mountains. Majority of plant and animal species in the country are unique and cannot be found elsewhere. The country's species are among the world's top 10 in terms of endemism. Given the land density and the density of both flora and fauna, the Philippines may even be considered to be the world's most megadiverse country [1].

The unique biodiversity features had been threatened by anthropogenic activities leading to overconsumption of resources to sustain the basic needs. Delivery of goods and services in terms of food, clothing and shelter for the increasing human population, therefore, compromises the status of biodiversity.

Mindanao, the second largest island in the Philippine Archipelago, supports a wide range of biodiversity. Like the rest of the archipelago, the area is covered by natural forests that need conservation to protect wide range of inhabiting organisms [2].

In the province of Misamis Oriental, particularly in the municipality of Naawan, a lush forest is present at its mountainous areas known as Mt. Malindawag. The area has been promoted and popularly introduced as a tourism site due to its unique water falls known as the Lubilan water falls. A vast areas of forest has been burned in 1979, damaging the natural stands of high-value tree species like Almaciga (*Agathis philippinensis* Warb), Salong (*Canarium racemosum* Merrill),

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Shorea species and other associated tree stands. The vast and lush forest gradually decreases due to land conversion and illegal activities. Accordingly, Almaciga stand contains an important resin and has been the source of Manila Copal, a quality resin used for high quality varnish, fuel for torch, caulking for boats, incense materials and other valuable economic source.

Mount Malindawag, which has an elevation of more or less 1,000 masl covering an area of approximately more than 900 hectares is located in Barangay Lubilan, Naawan, Misamis Oriental. This mountain has been identified as the remaining source of water that runs through the rivers in Lubilan and Tagbalogo as source of potable water and ricefield irrigation.

This remaining forested areas were threatened by various unregulated anthropogenic activities. Thus, this study was conducted to provide an assessment on the status of biodiversity in the area, its species composition, abundance, distribution and endemicity. The information generated is important in knowing the ecosystems health condition of Mt. Malindawag and an urgent measure for resources conservation, protection and management.

Materials and Methods

A.) Study Area

Mt. Malindawag is a mountainous and forested land area covering more than 900 hectares and at 1,000 masl, geographically located at 8^{o} 23’ 31 north latitude and 124^{o} 24’ 41 east longitude in Barangay Lubilan, Naawan, Misamis Oriental (Fig. 1).

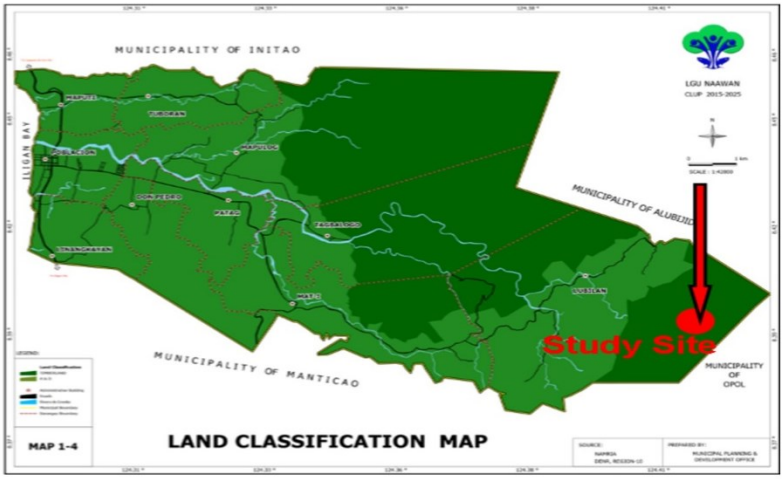

Figure 1. The proximity of Mt. Malindawag in Barangay Lubilan within the municipality of Naawan, Misamis Oriental.

B.) Flora Inventory

Nested Plot and habitat sampling methods were used during the inventory of flora. Baseline establishment was done in the North and South directions of the mountain. Sampling plots were set up in the East and West directions per habitat type perpendicular to the baseline. Three (3) stations were established within the forest range with corresponding elevation and habitat type. In every station, three (3) replicates of 20m x 20 m quadrat plot were established starting from the baseline and corresponding quadrat were set up with a 50 meter interval along the baseline for the identification of pole, standard, veteran tree species, shrubs and pteridophytes. Along each plot a 5m x 5m quadrat was established as subplot for the identification of saplings, seedlings and non-tree species [3].

Analysis and identification of tree species were based on the standard taxonomic classification [4]. The tree community was described in terms of species diversity. Ecological and conservation status of each species was determined as per IUCN Red List of trigger species, DAO 2007-01 of threatened Philippine plant species and other available references.

C.) Fauna Inventory

Inventory of fauna species found in Mount Malindawag was conducted using a combination of transect walk/ opportunistic and ethno zoological interview methods. To ensure maximum listing of wildlife resources, a two (2) kilometer transect line was established in three (3) favorable location along the area namely, agro-forest, mid-forest and upper- forest. Ethno zoological survey was conducted through interviews of people residing in the area particularly the persons who served as guides in the study sites. Survey of birds, mammals, reptiles and amphibians was also done in the area and identified to species level [5]. Ecological and IUCN conservation status of the species were taken.

Results and Discussion

A.) Flora Inventory

Three habitat types were identified for flora inventory, namely, the agro-forest areas adjacent to agro ecosystem with geographical coordinates of N 8^0 23' 42.5 and E 124^0 24' 14.8 with altitude of 554 meters above sea level (masl). Mid-forest is located in the middle portion of the range and situated around N 8^0 23' 38 and E 124^0 24' 32 with an altitude of 631 masl. The upper-forest is located at N 8^0 23' 31 and E 124^0 24' 41 with altitude of 809 masl.

A total of 184 species were identified belonging to 82 families. Most of the species were abundant in the mid-forest (Table 1).

Table 1. Total number of families, species and species richness per habitat type.

Plant Group	Families	Species	Habitat Type		
			Agro-forest	Mid-forest	Upper-forest
Trees and Shrubs	45	122	81	95	68
Herbs, Vines and Palm	26	46	29	41	24
Pteridophytes	11	16	5	14	15
Total	82	184	115	150	107

Assessment of Conservation Status and Endemism

Assessment of the conservation status of species was based on the Department of Environment and Natural Resources Administrative Order No. 1 series of 2007 (DAO 2007-01) referring to the List of Threatened Philippine Plants. Other reference was from the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.

Endemicity of species per habitat type per sampling plots revealed that the mid- forest had the highest number of endemic species at 24.2% (DAO 2007-01) and 25.77% (IUCN Red List), respectively (Table 2). This result was quite higher than the study conducted at Mt. Malindang [2] at 24% endemicity. Percent endemism of species was computed using the formula [6]:

$$\% \text{ Endemism} = \frac{\text{No. of endemic species x } 100}{\text{Total number of species}}$$

A number of species was critically endangered, while others were at vulnerable status. Majority of the species was not evaluated and of least concern status. This could be due to their abundance in the area and lack of further scientific categorization of their conservation status.

Table 2. Assessment of conservation status and percent endemism of flora species per habitat type of Mt. Malindawag, Naawan, Misamis Oriental.

Sampling Course per Habitat Type	Conservation Status											
	Threatened Philippine Plants (DAO 2007-01)						IUCN Red List Status					
	CR	EN	VU	Th	NE	*% Endemism*	CR	VU	NT	LC	NE	*% Endemism*
Agro-forest	0	2	11	5	63	**22.2**	3	12	0	4	63	**23.17**
Mid-forest	1	3	13	6	72	**24.2**	3	14	1	7	72	**25.77**
Upper-forest	0	2	7	7	52	**23.5**	0	8	1	6	50	**23.08**
Total	**1**	**7**	**31**	**18**	**187**	**70**	**6**	**34**	**2**	**17**	**185**	**72**

CR = Critically Endangered, EN = Endangered, VU = Vulnerable, Th = Threatened
NT = Near Threatened, LC = Least Concern, NE = Not Evaluated

There were 41 species of plants that need to be conserved due to their high economic values (Table 3). Most of these species was *Canarium, Shorea* and *Agathis spp*. Besides, these are endemic species and might be sensitive to further exploitation for various economic uses.

Species Importance Value (SIV)

Trees were categorized into seedlings (less than 3ft in height), saplings (3ft height – 10 cm diameter), pole (11cm – 30cm diameter), standard (31cm – 60cm diameter), veteran (> 60cm diameter) [2]. Most of the species were on their standard and veteran categories, while secondary growths were at saplings and poles categories.

Species Importance Value (SIV) was computed using the formula:

$$\mathbf{SIV = RD + RF + Rdom},$$

where: RD is the Relative Density, RF is the Relative Frequency, and Rdom is the Relative Dominance.

Canarium spp. were the species with highest importance values present in three habitat types. Tree species that is used as source of spice was noted particularly the *Cinnamomum mercadoi* Vidal at the upper forest (Table 4).

Table 3. Threatened species of plants that must be given high priority for protection and conservation.

	Species	**Family**	**Status**	**Habitat Type**
1)	*Agathis philippinensis* Warb	*Araucariaceae*	*VU*	*Uf*
2)	*Alstonia macrophylla* L.	*Apocynaceae*	*LC*	*Af, Mf, Uf*
3)	*Alstonia scholaris* L.	*Apocynaceae*	*LC*	*Af, Mf, Uf*
4)	*Artocarpus blancoi* Merr.	*Moraceae*	*VU*	*Af,Mf*
5)	*Canarium asperum* Benth.	*Burseraceae*	*Th,LC*	*Af, Mf, Uf*
6)	*Canarium hirsutum* Benth.	*Burseraceae*	*Th,LC*	*Af, Mf, Uf*
7)	*Canarium hirsutum forma racemosum Merr.*	*Burseraceae*	*Th,*	*Af, Mf, Uf*
8)	*Canarium luzonicum* Gray	*Burseraceae*	*Th,VU*	*Af, Mf, Uf*
9)	*Canthium dicoccum synonym Psydrax dicoccos Merr.*	*Rubiaceae*	*VU*	*Mf,Uf*
10)	*Celtis luzonica* Warb.	*Cannabaceae*	*VU*	*Mf*
11)	*Cinnamomum mercadoi* Vidal	*Lauraceae*	*VU*	*Af,Mf, Uf*
12)	*Dillenia philippinensis Rolfe*	*Dilleniaceae*	*Th,VU*	*Af, Mf, Uf*
13)	*Diospyros longiciliata* Merr.	*Ebenaceae*	*EN*	*Uf*
14)	*Diospyros pyrrhocarpa Merr,*	*Ebenaceae*	*EN,LC*	*Mf, Uf*
15)	*Gnetum gnemon* L.	*Gnetaceae*	*LC*	*Af*
16)	*Gnetum montanum* L.	*Gnetaceae*	*LC*	*Af,Mf, Uf*
17)	*Litchi chinensis Sonn. ssp. Philippinensis Leenh.*	*Sapindaceae*	*EN*	*Af,Mf*
18)	*Lithocarpus apoensis Elmer*	*Fagaceae*	*VU*	*Af, Mf, Uf*
19)	*Lithocarpus sulitii* Elmer	*Fagaceae*	*VU*	*Af, Mf, Uf*
20)	*Medinilla magnifica* Merr.	*Melastomataceae*	*EN*	*Af,Mf, Uf*
21)	*Medinilla pendula* Merr	*Melastomataceae*	*EN*	*Af,Mf, Uf*
22)	*Mitrephora lanotan* Merr.	*Annonaceae*	*VU*	*Af, Mf, Uf*
23)	*Mussaenda philippinensis* Merr	*Rubiaceae*	*EN*	*Af,Mf, Uf*
24)	*Nageia wallichiana* Kuntze	*Podocarpaceae*	*Th,LC*	*Uf*
25)	*Neolitsea vidalii Merr.*	*Lauraceae*	*VU*	*Af,Mf, Uf*
26)	*Palaquium luzoniense Vidal*	*Sapotaceae*	*VU*	*Af,Mf*
27)	*Palaquium philippense Vidal*	*Sapotaceae*	*VU*	*Af,Mf, Uf*
28)	*Parashorea malaanonan* Merr	*Dipterocarpaceae*	*VU,CR*	*Af*
29)	*Podocarpus rumphii* Blume	*Podocarpaceae*	*Th,NT*	*Uf*
30)	*Pouteria macrantha* Merr.	*Sapotaceae*	*VU*	*Af,Mf, Uf*
31)	*Prunus fragrans Blume*	*Rosaceae*	*LC*	*Mf*
32)	*Prunus grisea Blume*	*Rosaceae*	*LC*	*Mf,Uf*
33)	*Pterocarpus indicus* Wild	*Fabaceae*	*VU*	*Af,Mf*
34)	*Reutealis trisperma* Blanco	*Euphorbiaceae*	*CR,VU*	*Mf*
35)	*Shorea almon* Foxw	*Dipterocarpaceae*	*VU,CR*	*Af,*
36)	*Shorea contorta* Vidal	*Dipterocarpaceae*	*VU,CR*	*Af,Mf*
37)	*Shorea guiso* Blume	*Dipterocarpaceae*	*VU,CR*	*Af*
38)	*Vitex parviflora* Juss	*Lamiaceae*	*EN,VU*	*Af,Mf*
39)	*Alocasia zebrina* Koch	*Araceae*	*VU*	*Mf,Uf*
40)	*Hedychium philippinense* K.	*Zingiberaceae*	*EN*	*Af,Mf,Uf*
41)	*Cyathea contaminans Wall*	*Cyatheaceae*	*VU*	*Af,Mf,Uf*

Status: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; Th = Threatened , NT = Near Threatened, LC = Least Concern. Vegetation types: Af = Agro-forest, Mf = Mid-forest, Uf = Upper-forest

Table 4. Summary of top five category of tree species per habitat type based on Species Importance Value (SIV).

Habitat Type and Species of Trees	Common Name	% Species Importance Value (SIV)				
		Seedling	Sapling	Pole	Standard	Veteran
Agro-forest						
Canarium racemosum Merrill	Salong	42	36	47	30	38
Ficus minahassae Miq.	Hagimit	40	41	39	52	46
Palaquium luzoniense Vidal	Red Nato	34	31	32	27	22
Dillenia philippinensis Rolfe	Katmon	31	30	24	26	12
Wikstroemia lanceolata Merr.	Salago	22	21	8	0	0
Mid-forest						
Canarium hirsutum Wild.	Duklit	44	52	48	46	52
Canarium racemosum Merrill	Salong	42	43	51	44	30
Canarium luzonicum Gray	Piling Liitan	41	47	46	42	21
Canarium asperum Benth.	Pagsahingin	34	39	43	44	18
Shorea contorta Vidal	White Lauan	34	25	38	19	0
Upper-forest						
Casuarina equisitifolia L.	Agoho	43	51	49	45	51
Cinnamomum mercadoi Vidal	Kalingag	42	49	46	38	44
Canarium racemosum Merrill	Salong	36	44	19	36	19
Agathis philippinensis Warb	Almaciga	33	39	16	15	14
Canthium dicoccum syn Psydrax dicoccos Merr.	Malakape	31	39	8	0	0

B.) Fauna Inventory

Inventory of faunal species was generally categorized into avian, reptilian, amphibian and mammalian species. There were 86 species identified belonging to 50 families. Mid-forest habitat had the highest diversity of species. This could be due to its promixity adjacent to the agro-forest and upper forest areas. Results of the study has similar results observed in Mt. Malindang [5] (Table 5).

Table 5. Total number of fauna species per families and species per habitat type.

Fauna Group	**Families**	**Species**	**Habitat Type**		
			Agro-forest	**Mid-forest**	**Upper-forest**
Avian	35	61	39	51	50
Reptilian	5	10	6	10	9
Amphibian	5	10	3	9	9
Mammalian	5	5	2	4	5
Total	**50**	**89**	**50**	**74**	**73**

Fauna Conservation Status and Endemism

Conservation status of fauna in Mount Malindawag were assessed based on Ecological and IUCN Red List of Threatened Species [5, 8-10]. Spatial distribution and endemicity of species were also assessed [7]. Endemicity were highest at the upper – forest and lowest at the agro-forest (Table 6). There were 21 species that need to be conserved due to their higher endemicity yet had vulnerable and threatened status (Table 7).

Table 6. Assessment of conservation status and percent endemism per habitat type.

Sampling Course per Habitat Type	Conservation Status																			
	Ecological Status														IUCN Red List Status					
	R	*C*	*RC*	*RU*	*RM*	*E*	*EC*	*EU*	*NU*	*ER*	*M*	*MC*	*VU*	***% End***	*EN*	*VU*	*Th*	*LC*	*NE*	***% End***
Agro-forest	1	9	16	1	1	3	4	0	1	0	0	3	0	**4**	0	3	1	26	11	**17**
Mid-forest	1	16	27	1	1	5	11	1	1	1	1	2	1	**11**	0	4	2	47	15	**30**
Upper-forest	1	15	29	2	0	3	14	1	2	1	1	1	1	**11**	1	5	2	50	12	**32**
Total	**3**	**40**	**72**	**4**	**2**	**11**	**29**	**2**	**4**	**2**	**2**	**6**	**2**	**26**	**1**	**12**	**5**	**123**	**38**	**79**

R = Resident , C=Common, RC = Resident/Common, RU = Resident/Uncommon, RM = Resident/Migrant, E= Endemic, EC= Endemic/Common, EU = Endemic/Uncommon, NU = Non-Endemic/Uncommon, ER = Endemic/Rare, M= Migrant, MC = Migrant/Common, VU = Vulnerable, EN = Endangered, Th = Threatened, LC = Least Concerned, NE = Not Evaluated

Table 7. Endemic, endangered, and threatened species of fauna that must be given high priority for protection and conservation.

	Species	**Family**	**Status**
1)	*Actenoides hombroni* K.	Alcedinidae	E, VU
2)	*Anas luzonica* K.	Anatidae	E, VU
3)	*Dicaeum austral* K.	Dicaeidae	E, LC
4)	*Lanius validirostris* K.	Laniidae	E, NT
5)	*Parus elegans* K.	Paridae	E,LC
6)	*Gallus gallus* K.	Phasianidae	LC,VU
7)	*Loriculus philippensis* K.	Psittacidae	E, LC
8)	*Ixos philippinus* K.	Pycnonotidae	E, LC
9)	*Pycnonotus urostictus* K.	Pycnonotidae	E, LC
10)	*Sarcops calvus* K.	Sturnidae	E,LC
11)	*Macronus striaticeps* K.	Timaliidae	E
12)	*Zosterops meyeni* K.	Zosteropidae	E, L.C.
13)	*Naja siamensis* K.	Elapidae	VU
14)	*Ophiophagus hannah* K.	Elapidae	VU
15)	*Tropidophorus misaminus* A.	Scincidae	E, R
16)	*Ansonia muelleri* A.	Bufonidae	E, VU
17)	*Limnonectes magnus* A.	Dicroglossidae	E, NT
18)	*Philautus acutirostris* A.	Rhacophoridae	E, LC
19)	*Macaca fascicularis* ssp. philippensis R.	Cercopithecidae	EN
20)	*Megachiroptera species* K.	Pteropodidae	E, Th
21)	*Sus philippensis* R.	Suidae	E, VU

Status: E = Endemic; R = Rare, EN = Endangered; VU = Vulnerable; Th = Threatened, NT = Near Threatened, LC = Least Concern.

Conclusions and Recommendations

Majority of the species particularly in the upper forest harbored higher percent endemism, thus, contained diverse genetic information. As the habitat type changes, it also affects endemism of species that reduced eventually. Habitat modification due to agricultural expansion and overexploitation of endemic species were observed. These put the endemic flora species into threatened and vulnerable species. In terms of fauna species, mostly comprised of avian species, were mostly endemic and resident at mid-forest. Generally, result of the study depicted diverse endemic species distributed per habitat types but contained threatened and vulnerable species.

Further studies need to be conducted to arrive more scientific findings for proper enactment of regulatory measures among the policy-makers. Likewise, an improved non-regulatory measures must be undertaken to various concerned stakeholders like farmers and indigenous communities on the significant values of the organisms inhabiting Mt. Malindawag. This can be done through improved information, education, and communication materials, capacity building among the communities, rehabilitation, monitoring and provision of livelihood opportunities. This is to provide sustainable utilization of the resources for the benefits of the present and future generations.

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