

The Regenerating Forest of Magbukún Aeta in Morong, Bataan, Philippines: A Biological Hotspot for Protection and Conservation

Dean Carlo F. Galias^{1,2*} And Virginia C. Cuevas²

ABSTRACT

This research focused on the study of a tropical semi-evergreen rain forest community structure within the ancestral domain of the Aetas in Morong, Bataan. Point-Centered Quarter Method (PCQM) was used where five 200 m transects were laid across a 28-ha study site. Trees with ≥ 1 cm diameter at 1.3 m from the ground (diameter at breast height [DBH]) were sampled. Trees encountered were categorized into four groups: seedlings, saplings, pole trees and standard trees based on girth classes. A total of 76 tree species belonging to 61 genera and 35 families were recorded. The most represented family was Moraceae, followed by Dipterocarpaceae, Sapindaceae and Lauraceae. The species with highest importance percentage (IP) were *Shorea contorta* Vidal (Dipterocarpaceae) (IP=9.731), *Macaranga tanarius* (L.) Muell.-Arg. (Euphorbiaceae) (IP= 5.659) and *Canarium europhyllum* G. Perkins (Burseraceae) (IP= 4.538). Very high values of species diversity were calculated ($H' = 3.817$; $D' = 0.968$). The area was previously a dipterocarp forest and can now be classified as a young regenerating forest, composed primarily of seedlings many of which are dipterocarps. There were 17 threatened species, including two critically endangered and two endangered species (listed in The IUCN Red List of Threatened Species (2017-3) and DAO (2017-11) as well as twelve endemic species identified as present in the area. This forest is a biological hotspot that needs utmost protection and conservation.

KEYWORDS: Ancestral domain, Endemic, PCQM, Threatened species, Tree diversity

INTRODUCTION

The Philippine forestlands provide various ecosystem services including biodiversity maintenance, carbon sequestration, timber and non-timber forest products (Arnaiz, 2012), watershed services, and landscape beauty (Calderon *et al.*, 2013). They also supply numerous environmental, economic and social services, all of which are significant to human development (PTFCF, 2013). In addition, approximately 30% of the population, including some 12 to 15 million indigenous peoples, are dependent on forests for their survival and cultural needs (DENR 2009, as cited by PTFCF, 2013).

The forests of Morong, Bataan in Luzon have long been the

ancestral domain of the Magbukún Aeta, who rely heavily on forest resources for food, medicine, clothing and shelter. The Magbukún Aeta reside in the Kanawan Negritos Reservation Area (KNRA) which, is part of the 10,000 ha ancestral domain of the Aeta that includes some portions of the Subic Bay Forest Reserve (south of Boton River) and a portion of the Bataan Natural Park (BNP) on the northwestern side of Mt. Natib in Morong, Bataan (Cruz, 2010). The BNP is 23,688 ha and is severely deforested (PTFCF, 2013).

The destruction of tropical forests results in the decline in biodiversity and disruption of ecosystem services (Diereck and Holscher, 2009). In the case of the Aeta (Magbukún tribe of Morong, Bataan), the present ancestral domain covering 10,000 ha that was once forested is now much reduced. With the forest degradation within their ancestral domain and reducing their sources of food, the Aeta have been marginalized and are living below the poverty line with a per capita income of 0.47 USD/day (Cruz, 2010).

This study conducted a vegetational analysis of the canopy tree species to determine the community structure of the remaining forest within the KNRA. The result of the study

¹ Department of Biology, College of Science, Bicol University, Legazpi City, Philippines

² Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Baños, Laguna, Philippines

*Corresponding author: galias.deancarlo@gmail.com

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led to the inventory of the tree species present in the remaining forest of the KNRA. This information was used in determining the relative importance of each tree species and in obtaining estimates of tree population densities. These data were used in determining the successional stages of the forest. This study is also valuable for the conservation, rehabilitation and sustainability of the remnant native forest.

MATERIALS AND METHODS

Study Area. The study was carried out within the 188 ha KNRA in Sitio Kanawan, Barangay Binaritan in Morong, Bataan (14°41'N and 120°16'E) (Fig. 1). Kanawan is on a ridge of Mt. Silangan located across the Bataan River from the Bataan Technological Park (Motin, *et al.*, 2006). Bataan province lies in the entirety of the Bataan Peninsula, along the west coast of Luzon island facing the West Philippine Sea. It is 80 km west of Manila, 175 km by road to the north around Manila Bay and then through the rugged terrain of Bataan Province (Bustos, *et al.*, 1997). Bataan has an average annual temperature of 26.1°C, coolest during the months of November to December (23.3°C) and warmest during April (28.6°C). The average annual relative humidity is 78%, ranging from 73% in May to 83% in July. The monthly rainfall varies from 0 (during the dry months of January to May) to 314.6 mm (during the rainy months of June to September), with a mean precipitation of 66.7 mm. The rainfall pattern can be variable through the years depending on the onset and end of the monsoon rains (Bustos, *et al.*, 1997).

Plant Inventory. The tree vegetation analysis was conducted

within the two identified forests of the KNRA (Site 1/Hulo: 12.11 ha, Site 2/Buod: 15.14 ha). The PCQM of Mueller-Dombois and Ellenberg (1974) was used where five 200 m transects were laid across the 28 ha study site. Points were set at 10-m intervals. Trees with ≥1 cm diameter at 1.3 m from the ground (DBH) were sampled. Common tree species were identified on site by Aeta members who were trained on taxonomy, and using a pictorial guide of Galang and coworkers (2012). For plants unknown to them, leafy branches, flowers, fruits (if available) and other plant parts containing important characters were photographed and were brought to the University of the Philippines Los Baños- College of Forestry and Natural Resources (UPLB- CFNR) for identification. Taxonomic information of all plant samples were verified using the on-line database of Pelter and coworkers (2011). Trees encountered were categorized into three groups: seedling, sapling and adult based on girth classes (Omeja, *et al.*, 2004). Shannon-Wiener's and Simpson's diversity indices were also computed. The distribution and conservation status of plant samples were based on The IUCN Red List of Threatened Species (2017-3) and the Department of Environment and Natural Resources Administrative Order (DAO) (2017-11).

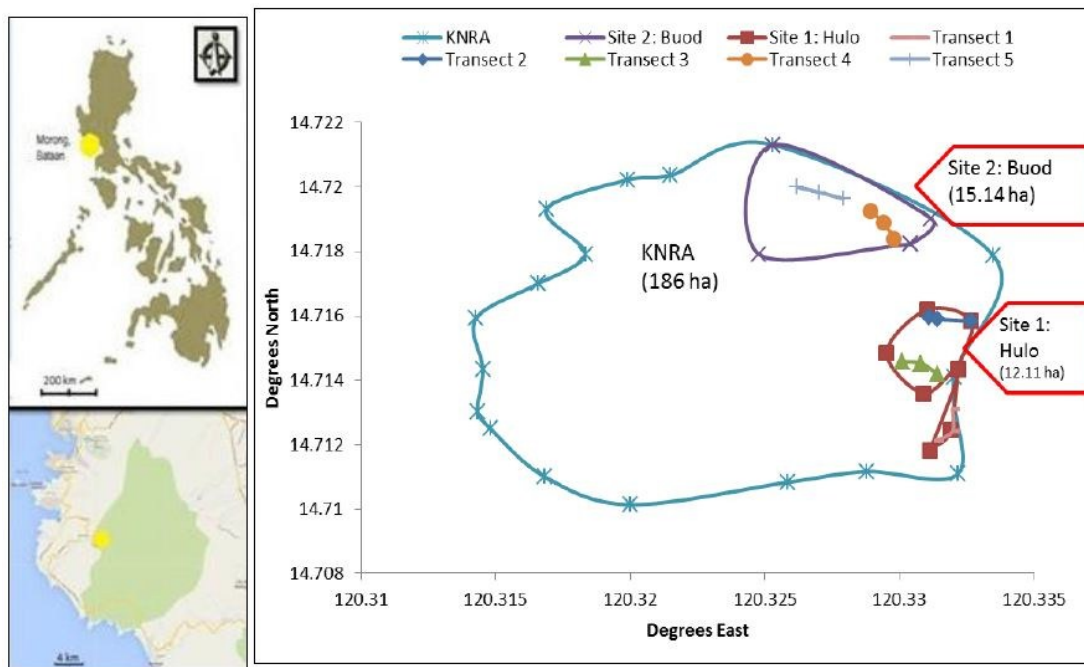


Figure 1. Map showing the location of the study area and the five transects as sampling sites for plant inventory under PCQM within the two forest patches of the KNRA.

RESULTS AND DISCUSSION

Tree species composition of the two forests in the Kanawan Negritos Reservation Area

A total of 398 tree individuals were recorded from the five 200 m transects laid across the 28-ha KNRA. These were further classified into 76 species belonging to 61 genera of the 35 plant families (Fig. 2). Comparing the two forests, Site 1 is composed of 57 species from 46 genera of the 28 families. On the other hand, there were 46 species, 37 genera and 28 families recorded in Site 2. All the trees encountered together with their distribution and conservation status are listed in Table 1.

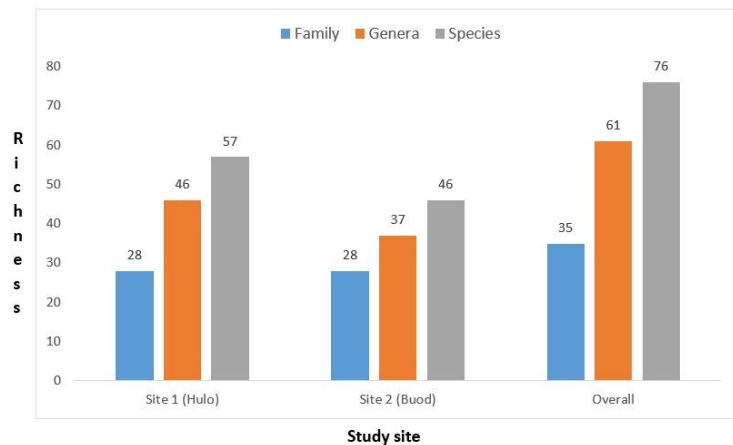


Figure 2. Species composition of the different sites

The most represented family was Moraceae, having eight species (10.53%) composed of 71 individuals. Six out of the seven species of Moraceae are from the genus *Ficus*, which included *F. benjamina* L., *F. nota* (Blanco) Merr., *F. odorata* (Blanco) Merr., *F. septica* Burm. f., *F. variegata* Blume and *F. subcordata* Blume. The other two species representing this family were *Artocarpus blancoi* (Elmer) Merr. and *A. ovatus* Blanco. The result of the present study is comparable to the work of Arsenio *et al.*, (2011) in Mt. Maculot in Batangas where the most represented family was Moraceae with seven species belonging to three genera. Also, the genus *Ficus* was the most represented genus with five species.

The study of Cottee-Jones and co-workers (2016), demonstrated the important role of *Ficus* trees in ecological succession. They found out that the density of saplings growing under *Ficus* trees, was twice as high as the density of saplings growing under other non-*Ficus* trees. Also, in terms of species richness, saplings under *Ficus* trees were also significantly higher. Their result indicated that *Ficus* trees are more effective restoration nuclei than other remnant tree types. Furthermore, *Ficus* is believed to be a very important genus of fleshy-fruited tree for a wide range of frugivores

because in intact forests, its unusual asynchronous fruiting cycle, large crop sizes, and pan-tropical availability means that over 1,200 tropical birds and mammals have been recorded consuming its fruit (Shanahan, *et al.*, 2001).

The second most represented families were the Dipterocarpaceae, Lauraceae and Sapindaceae all with six species (7.89%) identified each. Next were the Fabaceae (6.58%) and Anacardiaceae (5.26%) having five and four species identified, respectively. The dipterocarp family was represented by *Anisoptera thurifera* (Blanco) Blume, *Dipterocarpus gracilis* Blume, *D. grandiflorus* Blanco, *Hopea plagata* (Blanco) Vidal, *Shorea contorta* Vidal, *S. guiso* (Blanco) Blume and *S. polysperma* (Blanco) Merr. The Sapindaceae was represented by *Allophyllus cobbe* (L.) Raeusch., *Dimocarpus longan* Lour. ssp. *malesianus* Leenh, *Elattostachys* sp., *Ganophyllum falcatum* Blume, *Guioa koelreuteria* (Blanco) Merr. and *Mischocarpus* sp. Although the Dipterocarpaceae only ranked second in terms of representative species; the most dominant species in each site based on importance percentage (IP) were dipterocarps. From these data we can summarize that the forest was once a dipterocarp forest.

Other families included were Rubiaceae and Euphorbiaceae both with three species (3.95%) each, followed by the Apocynaceae, Cannabaceae, Clusiaceae, Phyllantaceae and Sterculiaceae each with two species identified. The remaining 25% was allotted to 19 families which all have one species recorded.

In terms of the total basal area cover, the Dipterocarpaceae dominated with 120,417 cm² or (32.28%) of the total basal area. Next was the Moraceae having a total basal area of 77,428 cm² (20.76%). This was followed by the Sapindaceae at 32,626 cm² (8.75%), and Burseraceae at 23,943 cm² (6.42%).

According to the forest formations of the Philippines scheme by Fernando, *et al.*, (2008) the study area can be classified as a tropical semi-evergreen rain forest. This is a type of forest formation where there is a yearly water stress of some duration or a very distinct strong dry season. Because of this pronounced dry season, the tropical semi evergreen rain forest, when cut, is more frequently replaced by grasses dominated by *Imperata cylindrica* (L) P. Beauv. and *Saccharum spontaneum* L. (Fernando, *et al.*, 2008). In fact, almost three-fourths of the mountain where Site 2 (Buod) was located was already covered by different kinds of grasses, chiefly *I. cylindrica*.

This forest formation included both evergreen and deciduous trees in a mixture, but with a tendency towards

Table 1. List of tree species (≥ 1 cm at 1.3 m = DBH) observed using Point-Centered Quarter Method (PCQM) in the forest of Kanawan Negritos Reservation Area (KNRA), Barangay Binaritan, Morong, Bataan, Philippines (27.25 ha). Elevation: 180 to 348 m.a.s.l.

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
ANACARDIACEAE			
<i>Buchanania arborescens</i> (Blume) Blume	Balinghasai	Tenasserim, Andaman Isls, Thailand, Indochina, Taiwan, across Malesia from Sumatra to New Britain, Solomon Isls and NE Australia. Throughout the Philippines, chiefly in lowland forests, along river banks, secondary forest (Pelser, <i>et al.</i> , 2011).	2
<i>Koordersiodendron pinnatum</i> (Blanco) Merr.	Amugis	Philippines, Sulawesi, Moluccas, New Guinea, N. Luzon (Cagayan) to Palawan and Mindanao. Lowland forests, rarely up to 450 m elevation, on dryland or occasionally inundated areas (Pelser, <i>et al.</i> , 2011). Other Threatened Species (DAO 2017-11)	1
<i>Mangifera altissima</i> Blanco	Pahunan	Common. Philippines, Sulawesi, Lesser Sunda Isls, Moluccas, New Guinea, S New Britain, Solomon Isls. LUZON: Ilocos Sur, Cagayan, Nueva Ecija, Zambales, Rizal, Laguna, Quezon, Camarines, MINDORO, PALAWAN, SIBUYAN. Chiefly in lowland primary forests whether inland or sometimes coastal, ascending to 400 m (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Semecarpus paucinervis</i> Merr.	Ligas-ilanan	Borneo (Sabah), Philippines, PALAWAN: Mt Pulgar and Mt. Victoria. Lowland primary forests along stream bank (Pelser, <i>et al.</i> , 2011). Vulnerable (DAO 2017-11)	1
ANNONACEAE			
<i>Milium vidalii</i> J. Sincl.	Takulau	No available data.	2
APOCYNACEAE			
<i>Alstonia scholaris</i> (L.) R. Br.	Dita	Pakistan, Nepal, India, Bhutan, Bangladesh, Sri Lanka, China (Yunnan), Myanmar, Thailand, Cambodia, Laos, Vietnam, throughout Malesia, Solomon Isls and Australia (Queensland), Philippines. LUZON: (Cagayan) to PALAWAN and MINDANAO, in most or all islands and provinces. In primary and secondary forests at low and medium elevation (Pelser, <i>et al.</i> , 2011).	1
<i>Tabernaemontana pandacaqui</i> Poir. in Lam.	Pandakaki	LUZON: Bataan prov., Mt. Mariveles, Lamao River, S. China, Taiwan, Thailand, Java, Borneo (Sabah), Philippines, Sulawesi, Java, Lesser Sunda Isls, Moluccas, New Guinea, N and E parts of Australia, Micronesia. In the Philippines common in most islands and provinces (Pelser, <i>et al.</i> , 2011).	1
BOMBACACEAE			
<i>Bombax ceiba</i> L.	Malabulak	India to S China, southward to Sumatra and Java, LUZON: Abra, Nueva Ecija, Bulacan, Bataan, Rizal, MINDORO, CAMIGUIN, MINDANAO. Scattered in secondary and primary forest at low and medium elevation (Pelser, <i>et al.</i> , 2011).	1 & 2

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
BURSERACEAE			
<i>Canarium europhyllum</i> Perkins	Mayakiat	Throughout the Philippines except Palawan. Rather common in lowland forests, ascending to 800 m (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Canarium luzonicum</i> (Blume) A. Gray	Piling liitan	Endemic. LUZON, ALABAT, MINDORO, MASBATE, TICAQ, BOHOL, MINDANAO (Pelser, <i>et al.</i> , 2011). Other Threatened Species (DAO 2017-11)	1 & 2
BYTTNERIACEAE			
<i>Kleinhovia hospita</i> L.	Tan-ag	Tropical Africa and Asia. Throughout the Philippines, at low and medium elevation, a characteristic tree of thickets, secondary growth forests, and deserted clearings (Pelser, <i>et al.</i> , 2011).	2
CALOPHYLLACEAE			
<i>Calophyllum inophyllum</i> L.	Bitaoq	Tropical E. Africa to India, SE Asia, Hainan, Taiwan, Ryukyu Isls, across Malesia to N. Australia, New Caledonia to Polynesia. Introduced to the Neotropics and tropical W Africa (Pelser, <i>et al.</i> , 2011).	1 & 2
CANNABACEAE			
<i>Celtis philippinensis</i> Blanco	Malaikmo	Tropical Africa to Madagascar, India, Myanmar, SE China, Hongkong, Taiwan, Thailand, Indochina, throughout Malesia to NE Australia. N LUZON to MINDANAO and PALAWAN (Pelser, <i>et al.</i> , 2011).	1
<i>Trema orientalis</i> (L.) Blume	Anabiong	Tropical Africa, Sri Lanka, India, Myanmar, Thailand, Indochina, China, Hainan, Taiwan, S Japan, Sumatra, Peninsular Malaysia, Java, Lesser Sunda Isls, Borneo, Philippines, Sulawesi, Moluccas, New Guinea (including New Britain), Australia (Queensland), Solomon Isls, Marianas, Polynesia (Fiji; Tonga; Tahiti) (Pelser, <i>et al.</i> , 2011).	1
CHRYSOBALANACEAE			
<i>Maranthes corymbosa</i> Blume	Liusin	S. Thailand, Sumatra, Peninsular Malaysia, Java, Borneo, Philippines, Sulawesi, Lesser Sunda Isls, Moluccas, New Guinea, New Britain, Admiralty Isls, Solomon Isls, Caroline Isls, Australia (Queensland, Northern Territory). N LUZON to PALAWAN and MINDANAO. Lowland and medium elevation forests (Pelser, <i>et al.</i> , 2011).	1
<i>Garcinia</i> sp.	-	-	1 & 2
<i>Terminalia foetidissima</i> Griff.	Talisay gubat	Peninsular Malaysia (Selangor, Negeri Sembilan, Melaka), S- Burma (Taninthayi, Yangon), S-Thailand, Sumatra, Borneo, Philippines (Luzon, Mindoro, Panay, Mindanao) (Pelser, <i>et al.</i> , 2011).	2

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
DIPTEROCARPACEAE			
<i>Anisoptera thurifera</i> (Blanco) Blume	Palosapis	It is native to the Philippines, Indonesia and Papua New Guinea (Pelser, <i>et al.</i> , 2011). Vulnerable (IUCN 2017-3)	1 & 2
<i>Dipterocarpus gracilis</i> Blume	Panau	The species is native to India, Bangladesh, Indochina, Borneo and the Philippines. Within Indochina the species is found in Myanmar, Thailand, Peninsular Malaysia and Singapore. (Pelser, <i>et al.</i> , 2011). Vulnerable (IUCN 2017-3, DAO 2017-11)	1
<i>Dipterocarpus grandiflorus</i> Blanco	Apitong	The species is native to India, Indochina, the Philippines, Indonesia and Sabah. It is found in India (Andaman Islands), Vietnam, Myanmar, Thailand, Peninsular Malaysia and Singapore (Pelser, <i>et al.</i> , 2011). Endangered (IUCN 2017-3), Vulnerable (DAO 2017-11)	2
<i>Hopea plagata</i> (Blanco) Vidal	Saplungan	Native: Malaysia (Sarawak); Philippines (IUCN) NE Borneo and the Philippines. LUZON: Cagayan, Nueva Vizcaya, Nueva Ecija, Pangasinan, Bulacan, Bataan, Rizal, Laguna, Quezon, Camarines, Sorsogon, Mindoro, Tablas, Bohol, Mindanao, Basilan, Tawi Tawi (Pelser, <i>et al.</i> , 2011). Vulnerable (DAO 2017-11)	2
<i>Shorea contorta</i> Vidal	White lauan	Endemic to the Philippines. Babuyan Isls. (Calayan), LUZON (in most provinces), POLILLO, MINDORO, SIBUYAN, MARINDUQUE, MASBATE, NEGROS, LEYTE, SAMAR, MINDANAO: Zamboanga, Lanao, Agusan, BASILAN. Common in primary lowland forests from semi-seasonal to everwet areas, in the former often semi-gregarious (Pelser, <i>et al.</i> , 2011). Critically endangered (IUCN 2017-3), Vulnerable (DAO 2017-11)	1 & 2
<i>Shorea guiso</i> (Blanco) Blume	Guijo	Peninsular and SE Thailand, S Vietnam, Peninsular Malaysia, Sumatra (Aceh, Tapanuli, Palembang), Borneo (mainly in E), Philippines. LUZON (widespread in most provinces), Mindoro, Masbate, Panay, Negros, Leyte, Samar, Mindanao, Basilan (Pelser, <i>et al.</i> , 2011).	1 & 2
EBENACEAE			
<i>Diospyros pilosanthera</i> Blanco	Bulong-eta	Luzon: Batangas Province, Punta Santiago, in dry forest (Pelser, <i>et al.</i> , 2011). Vulnerable (DAO 2017-11)	1 & 2
ELAEOCARPACEAE			
<i>Elaeocarpus curanii</i> Merr.	Kalumbago	LUZON: Ilocos Norte (Pasuquin), Cagayan, Zambales, Bataan, Pampanga, Quezon, Camarines. Low elevation forests (Pelser, <i>et al.</i> , 2011)	2

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
EUPHORBIACEAE			
<i>Fahrenheitia</i> sp.	-	-	2
<i>Macaranga grandiflora</i> (Blanco) Merr.	Takip- asin	Endemic. LUZON: La Union, Benguet, Cagayan, Nueva Vizcaya, Pangasinan, Bataan, Rizal, Batangas, Laguna, Quezon, MINDORO (Pelser, <i>et al.</i> , 2011). Vulnerable (DAO 2017-11)	1 & 2
<i>Macaranga tanarius</i> (L.) Muell.-Arg.	Binunga	Nicobar Isls, Andaman Isls, Thailand, S China, Taiwan, Ryukyu Isls, Sumatra, Peninsular Malaysia, Java, Borneo, Philippines, Sulawesi, Lesser Sunda Isls, Moluccas, New Guinea, NE Australia, Melanesia, Micronesia (Pelser, <i>et al.</i> , 2011).	1 & 2
FABACEAE			
<i>Azelia rhomboidea</i> (Blanco) Vidal	Tindalo	Sumatra, Borneo (Sabah, Kalimantan), and the Philippines. N Luzon to Palawan and Mindanao (Pelser, <i>et al.</i> , 2011). Vulnerable (IUCN 2017-3), Endangered (DAO 2017-11)	1
<i>Archidendron merrillii</i> (J.F.Macbr.) I.C. Nielsen	Anagap- bangin	Luzon: Benguet Prov., W of Baguio (Pelser, <i>et al.</i> , 2011).	1
<i>Cynometra</i> sp.	-	-	1
<i>Millettia merillii</i> Perkins	"Malabai" Pam	Endemic. LUZON: Cagayan to Bataan, Bulacan, Rizal, Laguna (Mt Makiling), MINDORO, PALAWAN, NEGROS. Lowland and medium elevation thickets and secondary forests, also along riverbanks. Locally abundant (Pelser, <i>et al.</i> , 2011). Other Threatened Species (DAO 2017-11)	1 & 2
<i>Parkia timoriana</i> (DC.) Merr.	Kupang	NE India, Bangladesh, Burma, Thailand, Sumatra, Peninsular Malaysia, Java, Lesser Sunda Isls (W Sumbawa; Timor), Borneo, Philippines, Sulawesi, Moluccas, New Guinea (W Irian). LUZON: La Union to Laguna, PALAWAN (Pelser, <i>et al.</i> , 2011).	2
LAMIACEAE			
<i>Vitex turczaninowii</i> Merr.	Lingo- lingo	LUZON: Ilocos Sur, Pangasinan, Cagayan, Isabela, Bataan, Rizal Laguna, Quezon, Camarines, Sorsogon, MINDORO, TICAQ, LEYTE, MINDANAO: Agusan, Surigao, Lowland forests (Pelser, <i>et al.</i> , 2011).	2
LAURACEAE			
<i>Alseodaphne longipes</i> Quisumb. & Merr.	Babulo	LUZON: Benguet (Tania), Isabela (Mt. Moises), Nueva Vizcaya (Caraballo Mtns), Quirino (Mt Alzapan), Benguet, MINDANAO (Agusan del Norte). Forests, sometimes streams, 970-1700 m (Pelser, <i>et al.</i> , 2011).	1 & 2

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
<i>Cryptocarya acuminata</i> Merr.	Karaskas	MINDORO: Mindoro Oriental prov. Mt. Halcon. LUZON: Isabela, Pampanga, MINDORO: Mt. Halcon, type locality, Bongabong River. In primary forests at low elevation, ascending to 500 m (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Cryptocarya</i> sp.	-	-	1
<i>Litsea grandis</i> (Wall. ex Nees) Hook.f.	Marang Iapara	Myanmar, Thailand, Sumatra, Peninsular Malaysia, Singapore, Borneo, Philippines, LUZON: Isabela, Aurora, Quezon, Camarines, SAMAR, MINDANAO: Zamboanga, Misamis, Lanao. Primary forest at low and medium elevation (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Litsea glutinosa</i> (Lour.) C.B. Rob.	Sablot	India to S China through Malesia to tropical Australia, Throughout the Philippines, in secondary and primary forests at low and medium elevation (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Litsea</i> sp.	-	-	1
LECYTHIDACEAE			
<i>Barringtonia racemosa</i> (L.) Blume ex DC.	Putat	E & S Africa (Kenya; Tanzania, incl. Zanzibar; Mozambique; Natal), Mafia Is, Madagascar, Comoros, Seychelles, India (Malabar and Coromandel coasts), Sri Lanka, Bangladesh (Sundarbans), Andaman Isls, Nicobar Isls, Myanmar, S Thailand, Laos, Hainan, Taiwan, Ryukyu Isls (Iriomote), throughout Malesia, Bismarck Archipelago, Vanuatu, Marianas (Guam), Caroline Isls. (Palau, Yap, Truk, Ponape), NE Australia (Queensland), New Caledonia, Fiji, Samoa (Pelser, <i>et al.</i> , 2011).	1
LEEACEAE			
<i>Leea philippinensis</i> Merr.	Kaliantan	Endemic. Philippines: BATAN, LUZON: Apayao, Benguet, Pangasinan, Cagayan, Isabela, Nueva Ecija, Aurora, Zambales, Rizal, Quezon, Laguna (Mt Makiling), MINDORO: Mindoro Oriental, Mindoro Occidental, MINDANAO: Zamboanga del Norte, Davao, Surigao (Pelser, <i>et al.</i> , 2011).	1 & 2
LYTHRACEAE			
<i>Lagerstroemia speciosa</i> (L.) Pers.	Banaba	Borneo, Cambodia, China (Yunnan), India, Java, Laos, Lesser Sunda Isls, Moluccas, Myanmar, Peninsular Malaysia, Sulawesi, Sumatra, Thailand, Vietnam, Philippines. LUZON, MINDORO, PALAWAN, LEYTE, MINDANAO, SAMAR. Mostly in secondary forests at low and medium elevation (Pelser, <i>et al.</i> , 2011).	2
MAGNOLIACEAE			
<i>Elmerifolia</i> sp.	-	-	1

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
MALVACEAE			
<i>Pterospermum celebicum</i> Miq.	Bayok-bayokan	Taiwan, Sulawesi and the Moluccas. All over the Philippines especially in Luzon. Primary and secondary forests particularly in lower forested regions, in rocky woods, including river banks, open areas	1 & 2
MORACEAE			
<i>Artocarpus blancoi</i> (Elmer) Merr.	Antipolo	Endemic. BATAN, LUZON, MINDORO, PALAWAN, NEGROS, CEBU, MINDANAO. Thickets and forests at low and medium elevation (Pelser, <i>et al.</i> , 2011). Vulnerable (IUCN 2017-3)	1
<i>Artocarpus ovatus</i> Blanco	Anubing	LUZON: Abra (Manabo), Kalinga (Lubuagan), Benguet, Isabela (San Mariano), Nueva Vizcaya (near Dupax), Nueva Ecija, Zambales (Mt. Pinatubo), Bataan (Lamao), Pampanga, Bulacan (Angat), Rizal (Mt. Angilog, Montalban, Antipolo, Bosoboso), Laguna (Los Baños, Mt. Makiling, Sta. Maria, Mabitac), Quezon (Laguimanoc, Padre Burgos, Lucban), Camarines Sur (Mt. Bagacay, Mt. Isarog), Sorsogon (Mt. Bulusan), CATANDUANES, MINDORO: Mindoro Oriental (Mansalay, Manual and Mt. Yagaw), PALAWAN (Irawan), BALABAC (Cape Melville), MARINDUQUE, SIBUYAN (Mt. Giting-giting), MASBATE, TICAPO, PANAY: Iloilo, NEGROS: Negros Occidental (Danao, Cadiz), Negros Oriental (Cuernos Mtns), CEBU. In forest 760 m, often common (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Ficus benjamina</i> L.	Salisi/ Balete	India, S China, Myanmar, Thailand, Indochina to Australia (Arnhem Land and Queensland). Throughout Malesia. Philippines (Batan, Luzon, Mindoro), Forests up to 1300 m. Often in secondary growth or planted (Pelser, <i>et al.</i> , 2011).	2
<i>Ficus nota</i> (Blanco) Merr.	Tibig	N Borneo, Philippines. Lowland montane forest, often along stream, up to 1300 m (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Ficus odorata</i> (Blanco) Merr.	Pakiling	BATANES, LUZON, PANAY, NEGROS, BOHOL, LEYTE, SAMAR, MINDANAO. Lowland forests, often in secondary, near streams, and on rocks (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Ficus septica</i> Burm.f.	Hauili	NE India to S China, Taiwan, throughout Malesia to Australia (Queensland) to Vanuatu. Lowland and montane forests or secondary growth, often near rivers, up to 1800 m (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Ficus subcordata</i> Blume	Marabotum	Thailand, Indochina, Sumatra, Peninsular Malaysia, Java, Borneo, Philippines, Sulawesi, Lesser Sunda Isls (Bali, Flores, Sumbawa, Timor), New Guinea, New Britain. Forests, up to 1000 m (Pelser, <i>et al.</i> , 2011).	1

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
<i>Ficus variegata</i> Blume	Tangisang-bayawak	NE India to Myanmar, S China, Taiwan, Ryukyu Isls, Indochina, S Andaman Isls, and to Thailand, Malesia, the Solomon Isls, and Australia (Queensland). In Malesia throughout the region. Forest and secondary growth up to 1200 m; often villages and gardens (Pelser, <i>et al.</i> , 2011).	1
MYRISTICACEAE			
<i>Myristica philippinensis</i> Lam.	Duguan	Endemic to the Philippines. Throughout the Philippines (except Palawan). Primary lowland forests up to c.400 m (Pelser, <i>et al.</i> , 2011) Other Threatened Species. (DAO 2017-11)	1 & 2
MYRTACEAE			
<i>Syzygium</i> sp.	Malaruhat pula	-	1 & 2
PHYLLANTHACEAE			
<i>Bischofia javanica</i> Blume	Tuai	Australia, Bangladesh, Borneo, China, Cook Isls, Fiji, India, Japan, Java, Laos. Lesser Sunda Isls, Malay Peninsula, Moluccas, Nepal, New Caledonia, New Guinea, Solomon Isls., Sulawesi, Sumatra, Taiwan, Thailand, Tonga, Vanuatu, Vietnam, Philippines. Throughout the Philippines. Pioneer species up to 1500 (-2350) m (Pelser, <i>et al.</i> , 2011).	2
<i>Cleistanthus angustifolius</i> Merr.	Aniatan kitid	Endemic to the Philippines. LUZON: Cagayan, BUCAS GRANDE. On forested ridges and slopes at low elevation (Pelser, <i>et al.</i> , 2011).	1
POLYGALACEAE			
<i>Xanthophyllum flavescens</i> Roxb.	-	Throughout continental SE Asia, Sumatra, Simalur, Banka, Peninsular Malaysia, Borneo, Philippines, LUZON: Benguet, Cagayan, Nueva Ecija, Zambales, Bataan, Rizal, Laguna, Albay, Sorsogon, MINDORO, BUSUANGA, CULION, PALAWAN, MASBATE, GUIMARAS, NEGROS, MINDANAO: Zamboanga, Low and medium elevation forests (Pelser, <i>et al.</i> , 2011).	1 & 2
RUBIACEAE			
<i>Kanapia monstrosa</i> (A. Rich.) Arriola & Alejandro	Tadiang-anuang	Sulawesi, Philippines. LUZON: Aurora, Camarines Sur, Ilocos Norte, Ilocos Sur, Abra, La Union, Apayao, Mt. Province, Benguet, Cagayan, Isabela, Nueva Vizcaya, Pangasinan, Zambales, Bataan, Pampanga, Bulacan, Rizal, Laguna, Cavite, Quezon, LEYTE, MINDORO, NEGROS. Low and medium elevation secondary forests, often common (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Morinda citrifolia</i> L. var. <i>bracteata</i> (Roxb.) Kurz	Nino	Malesia (widespread). Throughout the Philippines in most islands and provinces. Lowland thickets and secondary forests (Pelser, <i>et al.</i> , 2011).	1

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
<i>Wendlandia philippinensis</i> Cowan	Mamboi	Endemic to the Philippines. LUZON: Benguet Province, Daklan to Kabayan (Pelser, <i>et al.</i> , 2011).	1
SALICACEAE			
<i>Casearia fuliginosa</i> (Blanco) Blanco	Talitan	LUZON, MINDORO, TICA0, MASBATE, SIBUYAN, SAMAR, DINAGAT, MINDANAO, TAWI-TAWI. Rather common in thickets and secondary forests below 250 m, also near the sea, often on sandy or gravelly riverbanks and along creeks (Pelser, <i>et al.</i> , 2011).	1
SAPINDACEAE			
<i>Allophylus cobbe</i> (L.) Raeusch.	Malalagundi/ Barotongol	S. America, S. Africa, Madagascar, Myanmar, Indochina through Peninsular Malaysia to New Guinea. Widespread in the Philippines in most islands and provinces (Pelser, <i>et al.</i> , 2011).	2
<i>Dimocarpus longan</i> Lour. <i>ssp. malesianus</i> Leenh.	Alupag	Myanmar, Laos, Cambodia, S. Vietnam, Sumatra, Peninsular Malaysia, Borneo, Sulawesi, Moluccas, Philippines LUZON: Bataan, Pampanga. Lowland forests (Pelser, <i>et al.</i> , 2011). Near Threatened (IUCN 2017-3)	1 & 2
<i>Elattostachys</i> sp.	Malakanuie	-	1
<i>Ganophyllum falcatum</i> Blume	Arangen	Andaman Isls, Nicobar Isls, across Malesia to Australia (Western, Australia Northern Territory and Queensland), Philippines (Pelser, <i>et al.</i> , 2011).	1
<i>Guioa koelreuteria</i> (Blanco) Merr.	Alahan	Borneo, Throughout the Philippines in most islands and provinces, Low and medium elevation secondary growth forests, common (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Mischocarpus</i> sp.	-	-	1
SAPOTACEAE			
<i>Palaquium philippense</i> (Perr.) C.B. Rob.	Malak-malak	Endemic to the Philippines. LUZON: Isabela, Bataan, Tarlac, Bulacan, Rizal, Batangas, Quezon, Camarines Sur, Albay, Sorsogon, MINDORO: Mindoro Occidental (Mt. Calavite), PANAY: Capiz, NEGROS, LEYTE (Ormoc, Lake Danao), MINDANAO: Davao (Mt. Apo). Common in lowland and medium elevation primary forests (Pelser, <i>et al.</i> , 2011). Vulnerable (DAO 2017-11)	1
<i>Palaquium tenuipetiolatum</i> Merr.	Maniknik	Endemic to the Philippines. LUZON: Bataan, Laguna, Quezon, Camarines Sur, Sorsogon, MINDORO. Common in primary forests and dry hill forests at low and medium elevation (Pelser, <i>et al.</i> , 2011).	1 & 2

FAMILY / SPECIES	COMMON NAME	DISTRIBUTION	SITE/S LOCATED
SPARMANNIACEAE			
<i>Grewia multiflora</i> Juss.	Danglin	Peninsular Malaysia to New Guinea, LUZON: Cagayan to Quezon, MINDORO, PALAWAN, GUIMARAS, CAMIGUIN, MINDANAO. Common in thickets and secondary forests (Pelser, <i>et al.</i> , 2011).	1
STEMONURACEAE			
<i>Gomphandra luzoniensis</i> Merr.subsp. <i>luzoniensis</i>	Mabunot	Endemic to the Philippines. LUZON: Ilocos Norte, Ilocos Sur, La Union, Cagayan, Nueva Ecija, Bataan, Rizal, Laguna, Cavite, Batangas, MINDORO, MARINDUQUE, PALAWAN. Common in primary forests under partial shade or along forest edges at low elevation, rarely to 850 m (Pelser, <i>et al.</i> , 2011).	2
<i>Gomphandra</i> sp.	Balinghasai	-	2
STERCULIACEAE			
<i>Heritiera sylvatica</i> Vidal	Dungon	Sulawesi. Philippines LUZON (Cagayan to Albay), MINDORO, MASBATE, PANAY, SAMAR. In dry primary forests at low and medium elevations (Pelser, <i>et al.</i> , 2011).	1 & 2
<i>Pterocymbium tinctorium</i> (Blanco) Merr.	Taluto	Myanmar, Sumatra, Peninsular Malaysia, Java, Lesser Sunda Isls, Borneo (Sabah), Sulawesi, Philippines. BABUYAN ISLS, LUZON (widespread from at least Cagayan to Camarines Sur), PALAWAN, CAMIGUIN, MINDANAO. In secondary or thin primary forests at low and medium elevations (Pelser, <i>et al.</i> , 2011).	1

gregariousness (Whitmore, 1990; Fernando, *et al.*, 2008). Examples of evergreen trees recorded in the area included: *Anisoptera thurifera* (Blanco) Blume, *Cleistanthus angustifolius* Merr., *Ficus variegata* Blume, *Hopea plagata* (Blanco) Vidal, *Kleinhovia hospita* L., *Koordersiodendron pinnatum* (Blanco) Merr., *Macaranga grandiflora* (Blanco) Merr., *Mangifera altissima* Blanco, *Palaquium philippinense* (Perr.) C.B. Rob., *Shorea contorta* Vidal, *S. guiso* (Blanco) Blume and *Trema orientalis* (L.) Blume. Correspondingly, examples of deciduous and semi-deciduous trees included: *Azelia rhomboidea* (Blanco) Vidal, *Bischofia javanica* Blume, *Bombax ceiba* L., *Lagerstroemia speciosa* (L.) Pers. and *Parkia timoriana* (DC.) Merr. Most of these evergreen and deciduous/ semi-deciduous tree species were also mentioned in the book of Fernando, *et al.*, (2008). The lauan-apitong type of dipterocarp forest described by Whitford (1911) and the apitong-lauan association referred to by (Fernando, *et al.*, 2008) belonged to this forest formation.

Categorization of the tree species according to diameter at 1.3 m (DBH)

To identify the regeneration status of the forest, the different tree species encountered were categorized according to different diameter classes (Fig. 3). Analysis of data from PCQM showed that 34.45% of the individuals in Site 1 (Hulo) belonged to the seedlings class and 30.25% were saplings. Furthermore, 22.69% were pole trees and only about 12.61% were standard trees. Some of these pole trees and standard trees could be the possible mother trees of these seedlings and saplings. It is noteworthy that as the diameter class increases, its abundance decreases. This might mean that not all of the individuals were able to proceed to the next class. There were three large trees in this area having a DBH of ≥ 100 cm: *Mischocarpus* sp. (kamingi) (DBH: 143.2 cm), *Ficus subcordata* Blume (payapa) (DBH: 137.8 cm), and *Ganophyllum falcatum* (matang-ulang) (DBH: 101.5 cm). Next bigger trees were *Macaranga tanarius* (L.) Muell.-Arg. (binunga) (90.1 cm) and *Dimocarpus longan* ssp. *malesianus* (alupag lalaki) (84.0 cm). These trees were the possible remnants of the original primary forest in the area.

The top two seedling species in Site 1 were *Shorea contorta* Vidal (white lauan) (14.6%) and *Canarium europhyllum* (kila) (8.5%) both of which are climax species (Table 2). The presence of these species suggested that the conditions in this remaining forest were favorable for growth and development of climax tree species that can pave the way for the regeneration of the former forest stand. It was also interesting to note that *white lauan* is an endemic species and is considered as a critically endangered species (per IUCN Red List 2017-3). As shown in Table 3, among the top 10 sapling species in this site were four endemic and/or

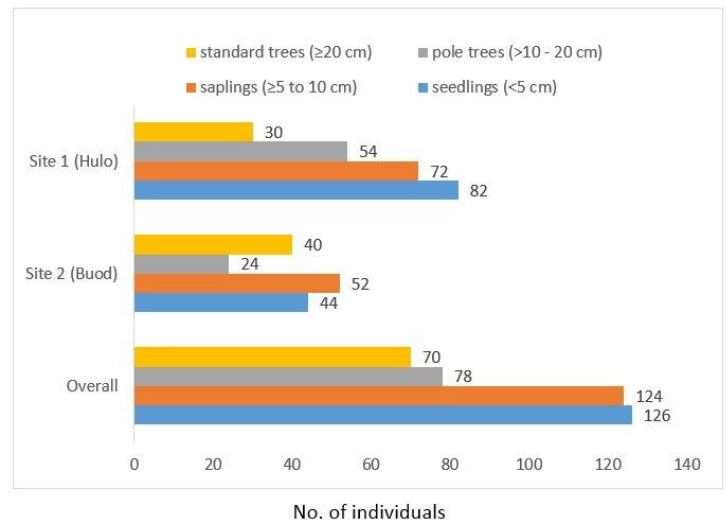


Figure 3. Categorization of tree species encountered according to diameter classes

threatened species which included *Leea philippinensis* Merr., *Shorea contorta* Vidal, *Diospyros pilosantha* Blanco and *Artocarpus blancoi* (Elmer) Merr. The pole and standard trees were dominated by *Macaranga tanarius* (L.) Muell.-Arg. (25.9%) and *Shorea contorta* Vidal (20%), respectively (Tables 3 & 4).

On the other hand, 33.3% of the seedlings in the Site 2 (Buod) were all considered as threatened species. They were: *Hopea plagata* (Blanco) Vidal (yakal), *Anisoptera thurifera* (Blanco) Blume (palosapis), *Diospyros pilosantha* Blanco (bulongeta), *Shorea guiso* (Blanco) Blume (guiso) and *Dimocarpus longan* ssp. *malesianus* (alupag lalaki), *Macaranga grandiflora* (Blanco) Merr. (takip-asin), *Myristica philippinensis* Lam. (duguan), and *Shorea contorta* Vidal (white lauan). Furthermore the top sapling was the endemic *Leea philippinensis* Merr. (14.7%) (Table 3). Ranked 5th was *Diospyros pilosantha* Blanco (bulongeta) which is considered as an endangered species under DAO No. 2017-11. There were also three threatened pole trees in this site. Finally, the largest adult tree species in this site were *Alseodaphne longipes* (malabunga) (150.2 cm), *Myristica philippinensis* Lam. (tambaaw) (118.7 cm), *Macaranga tanarius* (L.) Muell.-Arg. (Binunga) (105.7 cm) and *Canarium luzonicum* (Blume) A. Gray (bulaig) (101.9 cm). Sixty per cent (60%) of the top 10 standard trees (DBH ≥ 20 cm) in this site were considered threatened species (Table 5).

Considering that there were only two transects laid here, it is worth mentioning that there were four species of adult dipterocarp species recorded. The average DBH of adult trees in this area was 61.2 cm, which was close to the mean DBH for Hulo at 66.7 cm, where three transects were laid. This can strongly suggest that, indeed, the area was

Table 2. Undergrowth (seedlings; DBH ≤5 cm) encountered within the forest of KNRA.

SITE 1 (HULO)			SITE 2 (BUOD)		
Rank	Species/ Family	(%)	Rank	Species/ Family	(%)
1	** <i>Shorea contorta</i> Vidal (Dipterocarpaceae)	14.6	1	** <i>Hopea plagata</i> (Blanco) Vidal (Dipterocarpaceae)	18.2
2	<i>Canarium europhyllum</i> Perkins (Burseraceae)	8.5	2	** <i>Anisoptera thurifera</i> (Blanco) Blume (Dipterocarpaceae)	9.1
3	<i>Cleistanthus angustifolius</i> Merr. (Phyllantaceae)	7.3		** <i>Diospyros pilosanthera</i> Blanco (Ebenaceae)	9.1
4	** <i>Artocarpus blancoi</i> (Elmer) Merr. (Moraceae)	6.1	3	<i>Ficus septica</i> Burm. f. (Moraceae)	6.8
	** <i>Semecarpus paucinervia</i> Merr. (Anacardiaceae)	6.1	4	<i>Artocarpus ovatus</i> Blanco (Moraceae)	4.5
5	<i>Grewia multiflora</i> Juss. (Sparmanniaceae)	4.9		<i>Ficus nota</i> (Blanco) Merr. (Moraceae)	4.5
6	<i>Pterospermum celebicum</i> Miq. (Malvaceae)	3.7		<i>Gomphandra</i> sp. (Stemonuraceae)	4.5
	** <i>Canarium luzonicum</i> (Blume) A. Gray (Burseraceae)	3.7		<i>Palaquium tenuipetiolatum</i> Merr. (Sapotaceae)	4.5
	<i>Syzygium</i> sp. (Myrtaceae)	3.7		** <i>Shorea guiso</i> (Blanco) Blume (Dipterocarpaceae)	4.5
7	<i>Heritiera sylvatica</i> Vidal (Sterculiaceae)	2.4	5	<i>Calophyllum inophyllum</i> L. (Calophyllaceae)	2.3
	<i>Xanthophyllum flavescens</i> Roxb. (Polygalaceae)	2.4		<i>Canarium europhyllum</i> Perkins (Burseraceae)	2.3
	<i>Palaquium tenuipetiolatum</i> Merr. (Sapotaceae)	2.4		<i>Cratoxylum arboreum</i> Elmer (Clusiaceae)	2.3
	<i>Guioa koelreuteria</i> (Blanco) Merr. (Sapindaceae)	2.4		<i>Cryptocarya acuminata</i> Merr. (Lauraceae)	2.3
	<i>Ficus odorata</i> (Blanco) Merr. (Moraceae)	2.4		** <i>Dimocarpus longan</i> ssp. <i>malesianus</i> Leenh. (Sapindaceae)	2.3
	<i>Palaquium philippense</i> (Perr.) C.B. Rob. (Sapotaceae)	2.4		<i>Elaeocarpus curanii</i> Merr. (Elaeocarpaceae)	2.3
8	<i>Alseodaphne longipes</i> Quisumb. & Merr. (Lauraceae)	1.2		<i>Guioa koelreuteria</i> (Blanco) Merr. (Sapindaceae)	2.3
	** <i>Anisoptera thurifera</i> (Blanco) Blume (Dipterocarpaceae)	1.2		<i>Heritiera sylvatica</i> Vidal (Sterculiaceae)	2.3
	<i>Archidendron merrillii</i> (J.F. Macbr.) I.C. Nielsen (Fabaceae)	1.2		<i>Kanapia monstrosa</i> (A.Rich.) Arriola & Alejandro (Rubiaceae)	2.3
	<i>Celtis philippinensis</i> Blanco (Cannabaceae)	1.2		** <i>Macaranga grandiflora</i> (Blanco) Merr. (Euphorbiaceae)	2.3

SITE 1 (HULO)			SITE 2 (BUOD)		
Rank	Species/ Family	(%)	Rank	Species/ Family	(%)
	<i>Cryptocarya</i> sp. (Lauraceae)	1.2		<i>Macaranga tanarius</i> (L.) Muell.-Arg. (Euphorbiaceae)	2.3
	<i>Cynometra</i> sp. (Fabaceae)	1.2		** <i>Myristica philippinensis</i> Lam. (Myristicaceae)	2.3
	<i>Diospyros pilosanthera</i> Blanco (Ebenaceae)	1.2		<i>Pterospermum celebicum</i> Miq. (Malvaceae)	2.3
	<i>Elmerifollia</i> sp. (Magnoliaceae)	1.2		** <i>Shorea contorta</i> Vidal (Dipterocarpaceae)	2.3
	<i>Garcinia</i> sp. (Clusiaceae)	1.2		<i>Xanthophyllum flavescens</i> Roxb. (Polygalaceae)	2.3
	<i>Litsea glutinosa</i> (Lour.) C.B. Rob. (Lauraceae)	1.2			
	** <i>Macaranga grandiflora</i> (Blanco) Merr. (Euphorbiaceae)	1.2			
	** <i>Mangifera altissima</i> Blanco (Anacardiaceae)	1.2			
	<i>Shorea guiso</i> (Blanco) Blume (Dipterocarpaceae)	1.2			

Table 3. Intermediate layer (saplings; DBH≥5 - 10 cm) encountered within the forest of KNRA.

SITE 1 (HULO)			SITE 2 (BUOD)		
Rank	Species/ Family	(%)	Rank	Species/ Family	(%)
1	<i>Ficus nota</i> (Blanco) Merr. (Moraceae)	15.3	1	<i>Leea philippinensis</i> Merr. (Leeaceae)	19.2
2	<i>Leea philippinensis</i> Merr. (Leeaceae)	13.9	2	<i>Gomphandra</i> sp. (Stemonuraceae)	13.5
3	** <i>Shorea contorta</i> Vidal (Dipterocarpaceae)	9.7		<i>Ficus septica</i> Burm. F. (Moraceae)	13.5
4	<i>Canarium europhyllum</i> (Burseraceae)	6.9	3	<i>Guioa koelreuteria</i> (Blanco) Merr. (Sapindaceae)	9.6
	<i>Macaranga tanarius</i> (L.) Muell.-Arg. (Euphorbiaceae)	6.9	4	<i>Ficus nota</i> (Blanco) Merr. (Moraceae)	7.7
5	<i>Cleistanthus angustifolius</i> Merr. (Phyllanthaceae)	5.6	5	** <i>Diospyros pilosanthera</i> Blanco (Ebenaceae)	5.8
6	<i>Barringtonia racemosa</i> (L.) Blume ex DC.	4.2	6	<i>Pterospermum celebicum</i> Miq. (Malvaceae)	3.8
	** <i>Diospyros pilosanthera</i> Blanco (Ebenaceae)	4.2		<i>Milium vidalii</i> Sinc. (Annonaceae)	3.8
	<i>Ficus septica</i> Burm. F. (Moraceae)	4.2		<i>Hopea plagata</i> (Blanco) Vidal (Dipterocarpaceae)	3.8
7	<i>Litsea grandis</i> (Wall. ex Nees) Hook.f. (Lauraceae)	2.8		<i>Kleinhovia hospita</i> L. (Byttneriaceae)	3.8
	<i>Mischocarpus</i> sp. (Sapindaceae)	2.8	7	** <i>Dipterocarpus grandiflorus</i> Blanco (Dipterocarpaceae)	1.9
	<i>Pterospermum celebicum</i> Miq. (Malvaceae)	2.8		<i>Vitex turczaninowii</i> Merr. (Lamiaceae)	1.9
	<i>Artocarpus ovatus</i> Blanco (Moraceae)	2.8		<i>Parkia timoriana</i> (DC.) Merr. (Fabaceae)	1.9
	** <i>Artocarpus blancoi</i> (Elmer) Merr. (Moraceae)	2.8		<i>Macaranga tanarius</i> (L.) Muell.-Arg. (Euphorbiaceae)	1.9
8	<i>Cryptocarya acuminata</i> Merr. (Lauraceae)	1.4		<i>Allophyllus cobbe</i> (L.) Raeusch. (Sapindaceae)	1.9
	** <i>Myristica philippinensis</i> Lam. (Myristicaceae)	1.4		** <i>Anisoptera thurifera</i> (Blanco) Blume (Dipterocarpaceae)	1.9
	<i>Milleta stipulata</i> Dunn. (Fabaceae)	1.4		<i>Buchanania arborescens</i> (Blume) Blume (Anacardiaceae)	1.9
	<i>Palaquium tenuipetiolatum</i> Merr. (Sapotaceae)	1.4		<i>Calophyllum inophyllum</i> L. (Calophyllaceae)	1.9
	<i>Grewia multiflora</i> Juss. (Sparmanniaceae)	1.4			
	** <i>Anisoptera thurifera</i> (Blanco) Blume (Dipterocarpaceae)	1.4			

SITE 1 (HULO)			SITE 2 (BUOD)		
Rank	Species/ Family	(%)	Rank	Species/ Family	(%)
	<i>Tabernaemontana pandacaqui</i> Lam. (Apocynaceae)	1.4			
	<i>Calophyllum inophyllum</i> L. (Calophyllaceae)	1.4			
	<i>Elattostachys</i> sp. (Sapindaceae)	1.4			
	<i>Bischofia javanica</i> Blume (Phyllantaceae)	1.4			
	<i>Ficus odorata</i> (Blanco) Merr. (Moraceae)	1.4			

** Threatened species included in The IUCN Red List of Threatened Species 2017-3 and/or DAO No. 2017-11.

Table 4. Co-dominant (pole trees; DBH >10 - 20 cm) encountered within the forest of KNRA.

SITE 1 (HULO)			SITE 2 (BUOD)		
Rank	Species/ Family	(%)	Rank	Species/ Family	(%)
1	<i>Macaranga tanarius</i> (L.) Muell.-Arg. (Euphorbiaceae)	25.9	1	**Shorea guiso (Blanco) Blume (Dipterocarpaceae)	8.3
				**Canarium luzonicum (Blume) A. Gray (Burseraceae)	8.3
2	<i>Ficus nota</i> (Blanco) Merr. (Moraceae)	11.1		<i>Litsea glutinosa</i> (Lour.) C.B. Rob. (Lauraceae)	8.3
3	<i>Ficus odorata</i> (Blanco) Merr. (Moraceae)	9.3		<i>Ficus nota</i> (Blanco) Merr. (Moraceae)	8.3
	<i>Ficus septica</i> Burm. F. (Moraceae)	9.3			
4	**Artocarpus blancoi (Elmer) Merr. (Moraceae)	5.6	2	<i>Kanapia monstrosa</i> (A. Rich.) Arriola & Alejandro (Rubiaceae)	4.2
5	**Macaranga grandiflora (Blanco) Merr. (Euphorbiaceae)	3.7		<i>Diospyros pilosanthera</i> Blanco (Ebenaceae)	4.2
	<i>Lagerstroemia speciosa</i> (L.) Pers. (Lythraceae)	3.7		<i>Fahrenheitia</i> sp. (Euphorbiaceae)	4.2
	<i>Litsea grandis</i> (Wall. ex Nees) Hook.f. (Lauraceae)	3.7		<i>Ficus odorata</i> (Blanco) Merr. (Moraceae)	4.2
	<i>Litsea</i> sp. (Lauraceae)	3.7		<i>Ficus septica</i> Burm. f. (Moraceae)	4.2
				<i>Gomphandra</i> sp.	4.2
6	<i>Morinda citrifolia</i> L. f. <i>bracteata</i> (Roxb.) Hook.f. (Rubiaceae)	1.9		<i>Guioa koelreuteria</i> (Blanco) Merr. (Sapindaceae)	4.2
	**Afzelia rhomboidea (Blanco) Vidal (Fabaceae)	1.9		<i>Heritiera sylvatica</i> Vidal (Sterculiaceae)	4.2
	<i>Bombax ceiba</i> L. (Bombacaceae)	1.9		<i>Litsea grandis</i> (Wall. ex Nees) Hook.f. (Lauraceae)	4.2
	**Dipterocarpus gracilis Blume (Dipterocarpaceae)	1.9		**Mangifera altissima Blanco (Anacardiaceae)	4.2
	**Koordersiodendron pinnatum (Blanco) Merr. (Anacardiaceae)	1.9		<i>Miliusa vidalii</i> Sinc. (Annonaceae)	4.2
	<i>Xanthophyllum flavescens</i> Roxb. (Polygalaceae)	1.9		<i>Palaquium tenuipetiolatum</i> Merr. (Sapotaceae)	4.2
	<i>Alstonia scholaris</i> (L.) R. Br. (Apocynaceae)	1.9		<i>Pterospermum celebicum</i> Miq. (Malvaceae)	4.2
	<i>Shorea guiso</i> (Blanco) Blume (Dipterocarpaceae)	1.9		***Shorea contorta Vidal (Dipterocarpaceae)	4.2
				<i>Syzygium</i> sp. (Myrtaceae)	4.2

SITE 1 (HULO)		
Rank	Species/ Family	(%)
	<i>Pterospermum celebicum</i> Miq. (Malvaceae)	1.9
	<i>Maranthes corymbosa</i> Blume (Chrysobalanaceae)	1.9
	** <i>Semecarpus paucinervia</i> Merr. (Anacardiaceae)	1.9
	<i>Wendlandia philippinensis</i> Cowan (Rubiaceae)	1.9
	<i>Litsea glutinosa</i> (Lour.) C.B. Rob. (Lauraceae)	1.9

**Threatened species included in The IUCN Red List of Threatened Species 2017-3 and/or DAO No. 2017-11.

Table 5. Dominant (standard trees; DBH ≥20 cm) encountered within the forest of KNRA.

SITE 1 (HULO)			SITE 2 (BUOD)		
Rank	Species/ Family	(%)	Rank	Species/ Family	(%)
1	*** <i>Shorea contorta</i> Vidal (Dipterocarpaceae)	20.0	1	** <i>Hopea plagata</i> (Blanco) Vidal (Dipterocarpaceae)	17.5
2	<i>Canarium europhyllum</i> Perkins (Burseraceae)	16.7	2	** <i>Diospyros pilosanthera</i> Blanco (Ebenaceae)	15.0
3	<i>Bombax ceiba</i> L. (Bombacaceae)	10.0		*** <i>Shorea contorta</i> Vidal (Dipterocarpaceae)	
4	<i>Alseodaphne longipes</i> Quisumbing & Merr. (Lauraceae)	3.3	3	<i>Heritiera sylvatica</i> Vidal (Sterculiaceae)	7.5
	<i>Cleistanthus angustifolius</i> Merr. (Phyllanthaceae)	3.3		** <i>Anisoptera thurifera</i> (Blanco) Blume (Dipterocarpaceae)	7.5
	<i>Pterocymbium tinctorium</i> (Blanco) Merr. (Sterculiaceae)	3.3		** <i>Dimocarpus longan</i> ssp. <i>malesianus</i> Leenh. (Sapindaceae)	7.5
	** <i>Trema orientalis</i> (L.) Blume (Cannabaceae)	3.3	4	<i>Macaranga tanarius</i> (L.) Muell.-Arg. (Euphorbiaceae)	5.0
	** <i>Macaranga grandiflora</i> (Blanco) Merr. (Euphorbiaceae)	3.3		** <i>Shorea guiso</i> (Blanco) Blume (Dipterocarpaceae)	5.0
	<i>Ficus variegata</i> Blume (Moraceae)	3.3		<i>Ficus benjamina</i> L. (Moraceae)	5.0
	** <i>Azelia rhomboidea</i> (Blanco) Vidal (Fabaceae)	3.3	5	<i>Ficus septica</i> Burm. f. (Moraceae)	2.5
	<i>Casearia fuliginosa</i> (Blanco) Blanco (Salicaceae)	3.3		<i>Vitex turczaninowii</i> Merr. (Lamiaceae)	2.5
	<i>Cynometra</i> sp. (Fabaceae)	3.3		<i>Milusa vidalii</i> Sinc. (Annonaceae)	2.5
	<i>Diospyros pilosanthera</i> Blanco (Ebenaceae)	3.3		<i>Bombax ceiba</i> L. (Bombacaceae)	2.5
	** <i>Mangifera altissima</i> Blanco (Anacardiaceae)	3.3		<i>Parkia timoriana</i> (DC.) Merr. (Fabaceae)	2.5
	** <i>Anisoptera thurifera</i> (Blanco) Blume (Dipterocarpaceae)	3.3		<i>Terminalia foetidissima</i> Griff. (Combretaceae)	2.5
	** <i>Dimocarpus longan</i> ssp. <i>malesianus</i> Leenh. (Sapindaceae)	3.3		<i>Milleta stipulata</i> Dunn. (Fabaceae)	2.5
	<i>Ganophyllum falcatum</i> Blume (Sapindaceae)	3.3		** <i>Canarium luzonicum</i> (Blume) A. Gray (Burseraceae)	2.5
	<i>Ficus subcordata</i> Blume (Moraceae)	3.3		** <i>Myristica philippinensis</i> Lam. (Myristicaceae)	2.5
	<i>Mischocarpus</i> sp. (Sapindaceae)	3.3		<i>Alseodaphne longipes</i> Quisumbing & Merr. (Lauraceae)	2.5

**Threatened species included in The IUCN Red List of Threatened Species 2017-3 and/or DAO No. 2017-11.

previously a dipterocarp forest. One possible reason why there are still large dipterocarp trees in this site would be the steep terrain in this forest patch. According to some Aeta elders, this topographic constraint is the reason why loggers were not able to harvest these big trees. This statement was supported by Langenberger (2006) and according to him dipterocarp forest remnants are now generally found in localities where large-scale logging was not profitable and where access was hampered by the difficult terrain as in rugged and mountainous areas.

Vegetation Structure

Species dominance. Overall, the top five species with highest IP included *Shorea contorta* Vidal (white lauan; Dipterocarpaceae) (IP=9.731) followed by *Macaranga tanarius* (L.) Muell.-Arg. (binunga; Euphorbiaceae) (IP=5.659), *Canarium europhyllum* (kila; Burseraceae), (IP=4.538), *Ficus septica* Burm. F. (hauili; Moraceae) (IP=4.450) and *Ficus nota* (Blanco) Merr. (tibig; Moraceae) (IP=4.416). The dominance of *white lauan* was attributed to its high density (125 trees/ha) and high dominance (TBA=49,797 cm²). Nonetheless, out of the 29 *white lauan* individuals listed, about 55% are seedlings (DBH \geq 10 cm, mean=3.9 cm), and only four individuals have a 100 cm and bigger DBH. From this we can infer that most of them were still small trees, and are just starting to be established in the area. Interestingly two other dipterocarps were among the top 10 most dominant trees; these were *Anisoptera thurifera* (Blanco) Blume (ranked 6th) and *Hopea plagata* (Blanco) Vidal (ranked 8th). Moreover, close behind was *Shorea guiso* (Blanco) Blume, another dipterocarp and ranked 11th.

Although *Macaranga tanarius* (L.) Muell.-Arg. (binunga) has the highest frequency (appeared 13 out of 60 quadrats), it only ranked second. This was mainly because of its low density (94 trees/ha) and low dominance (TBA=12,736). *Ficus subcordata* Blume (payapa) has the highest mean basal area (14,920 cm²) in this site, from the lone large individual of *payapa* tree recorded.

Species diversity. Using Shannon-Wiener's Index (H') and Simpson's Index (D') formulae, very high values for species diversity were observed in this site ($H' = 3.817$; $D' = 0.968$) (Table 6). This very high diversity can be the result of a very high Index of Evenness (J) (0.893) and very low Dominance (D) (0.044). This only means that the trees in this site were evenly distributed and there were no dominating tree species. Fernando and co-workers (2008) mentioned that species diversity in a semi-evergreen tropical rain forest is high but less than that in the lowland evergreen forest. These data on species diversity again showed that the remaining forest in the reservation area exhibited the stages of regeneration

characteristic of the tropical rainforest where species diversity is very high following major disturbances such as strong typhoons, earthquakes or cutting of large trees that open wide spaces that allow individuals of new species to colonize the open area. Usually the vegetation that develops right after clearing of old-growth forest (i.e., minimal land use intensity) tends to be poorer both in terms of species richness and abundance than that in cleared sites previously supporting successional vegetation (Guariguata and Ostertag, 2001). In terms of species richness, Whitmore (1990) stated that the most species-rich forest will be the one that includes patches of secondary and primary forests. The former is recovering from a big disturbance and consisting of pioneers; while the latter is composed of climax species. After the succession and the whole landscape is primary forest again, there will be no pioneers and total floristic richness will be reduced. Data from this study tend to support the statement of Whitmore (1990) on high species richness of secondary forest.

The strong need for protection and conservation of this remaining KNRA Forest

The study area is part of Morong, Bataan and located inside the Bataan Natural Park (BNP) which is one of the Key Biodiversity Areas (KBA) in the Philippines. According to the KBA booklet (Conservation International Philippines, DENR-PAWB and Haribon Foundation, *n.d.*), there are 21 Trigger Species in the area, which include one (1) Endangered Species (EN), five (5) Vulnerable Species (VU) and 15 Restricted Range Species (RR).

Rechecking the IUCN Red List (2017-3) and DAO No. 2017-11, it was found out that one species was categorized as Critically Endangered (IUCN) and one species listed in DAO 2017-11 as Endangered Species (Category B) (Tables 7 & 8).

Shorea contorta Vidal (Dipterocarpaceae) is categorized as Critically Endangered Species in the IUCN Red List (2017-3) along with eight other species listed as Vulnerable. Furthermore, *Dimocarpus longan* Lour. ssp. *malesianus* Leenh. (Sapindaceae) is already considered as near threatened species. Checking the DAO 2017-11, it was found out that *Azelia rhomboidea* (Blanco) Vidal (Fabaceae) is considered as Endangered Species (Category B). Eleven more tree species are under Category C considered as Vulnerable Species, three are listed as Other Threatened Species and one tree species, *Dimocarpus longan* Lour. ssp. *malesianus* Leenh. (Sapindaceae) is already under Near Threatened status.

The forest is also home to various endemic species such as *Artocarpus blancoi* (Elmer) Merr. (Moraceae), *A. ovatus*

Table 6. Comparison of the computed values of indices in the forest of KNRA

	Site 1 (Hulo)	Site 2 (Buod)	Overall	Mean
NO. OF INDIVIDUALS	238	160	398	
Species richness (s)	57	46	78	
Trees per hectare	1,243	1,624	1,355	1,407
Mean distance (m/tree)	2.836	2.482	2.717	2.678
TREE DIVERSITY INDICES				
Shannon Index of Diversity (<i>H</i>)	3.593	3.439	3.817	3.616
Simpson Index of Diversity (<i>D</i>)	0.958	0.956	0.968	0.961
Simpson Index of Dominance (D)	0.042	0.044	0.032	0.039
Pielou's Index of Evenness (J)	0.867	0.893	0.874	0.878

Table 7. Threatened species listed in The IUCN Red List of Threatened Species 2017-3.

FAMILY	SPECIES	COMMON NAME
Anacardiaceae	<i>Mangifera altissima</i> Blanco	Pahunan
***Dipterocarpaceae	<i>Shorea contorta</i> Vidal	White Lauan
Dipterocarpaceae	<i>Hopea plagata</i> (Blanco) Vidal	Yakal saplungan
Dipterocarpaceae	<i>Anisoptera thurifera</i> (Blanco) Blume	Palosapis
Dipterocarpaceae	<i>Dipterocarpus gracilis</i> Blume	Panau
Dipterocarpaceae	** <i>Dipterocarpus grandiflorus</i> Blanco	Apitong
Dipterocarpaceae	<i>Shorea guiso</i> (Blanco) Blume	Guiso
Moraceae	<i>Artocarpus blancoi</i> (Elmer) Merr.	Antipolo
Fabaceae	<i>Azelia rhomboidea</i> (Blanco) Vidal	Tindalo
Sapindaceae	* <i>Dimocarpus longan</i> Lour. <i>ssp. malesianus</i> Leenh	Alupag lalaki

***Critically endangered

**Endangered

*Near Threatened

Table 8. Threatened tree species listed in the Department of Environment and Natural Resources Administrative Order (DAO) No. 2017-11.

FAMILY	SPECIES	COMMON NAME
Category B: Endangered Species		
Fabaceae	<i>Afzelia rhomboidea</i> (Blanco) Vidal	Tindalo
Category C: Vulnerable Species		
Anacardiaceae	<i>Mangifera altissima</i> Blanco	Pahunan
Anacardiaceae	<i>Semecarpus paucinervia</i> Merr.	Ligas- ilanan
Dipterocarpaceae	<i>Hopea plagata</i> (Blanco) Vidal	Yakal saplungan
Dipterocarpaceae	<i>Anisoptera thurifera</i> (Blanco) Blume	Palosapis
Dipterocarpaceae	<i>Dipterocarpus gracilis</i> Blume	Panau
Dipterocarpaceae	<i>Dipterocarpus grandiflorus</i> Blanco	Apitong
Dipterocarpaceae	<i>Shorea contorta</i> Vidal	White Lauan
Ebenaceae	<i>Diospyrus pilosanthera</i> Blanco	Bulong-eta
Euphorbiaceae	<i>Macaranga grandiflora</i>	Takip- asin
Moraceae	<i>Artocarpus blancoi</i> (Elmer) Merr.	Antipolo
Sapotaceae	<i>Palaquim philippense</i> (Perr.) C.B. Rob.	Malak- malak
Category D: Other Threatened Species		
Anacardiaceae	<i>Koordersiodendron pinnatum</i> (Blanco) Merr.	Amugis
Burseraceae	<i>Canarium luzonicum</i> (Blume) A. Gray	Piling- liitan
Myristicaceae	<i>Myristica philippinensis</i> Lam.	Duguan

Table 9. List of endemic tree species encountered within the KNRA Forest

FAMILY	SPECIES	COMMON NAME
Burseraceae	<i>Canarium luzonicum</i> (Blume) A. Gray	Piling liitan
Dipterocarpaceae	<i>Shorea contorta</i> Vidal	White lauan
Euphorbiaceae	<i>Macaranga grandiflora</i> (Blanco) Merr.	Takip- asin
Leeaceae	<i>Leea philippinensis</i> Merr.	Kaliantan
Moraceae	<i>Artocarpus blancoi</i> (Elmer) Merr.	Antipolo
	<i>Artocarpus ovatus</i> Blanco	Anubing
Myristicaceae	<i>Myristica philippinensis</i> Lam.	Duguan
Phyllantaceae	<i>Cleistanthus angustifolius</i> Merr.	Aniatan kitid
Rubiaceae	<i>Wendlandia philippinensis</i> Cowan	Mamboi
Sapotaceae	<i>Palaquim philippense</i> (Perr.) C.B. Rob.	Malak-malak
	<i>Palaquim tenuipetiolatum</i> Merr.	Maniknik
Stemonuraceae	<i>Gomphandra luzoniensis</i> Merr. subsp.	Mabunot
	<i>luzoniensis</i> Merr.	



Figure 4. Some of the common forest disturbances in the KNRA: A. Charcoal making, B. Occurrence of fire

Blanco (Moraceae), *Macaranga grandiflora* (Blanco) Merr. (Euphorbiaceae), *Mangifera altissima* Blanco (Anacardiaceae), *Leea philippinensis* Merr. (Leeaceae) and *Shorea contorta* Vidal (Dipterocarpaceae) among others.

The forest is home to a long list of threatened and endemic species. This only means that the forest is a repository of these species, whose populations are already dwindling or absent in many forests in the country thus, its protection and conservation is a must. Currently, the conservation measures in the area include its designation as an Important Bird Area (IBA), (PH008) and Conservation Priority Act 29 (Conservation International Philippines, DENR- PAWB and Haribon Foundation, *n.d.*). However, during the study period, activities that are considered as threats to biodiversity were observed such as road development, charcoal making, expansion of agricultural lands and bi-annual grassland fires (see Fig. 4). No quantitative data were collected from these activities since they were outside the focus of the research.

Biodiversity hotspots are areas with exceptional endemism and experiencing habitat loss which brought the country to the brink of ecological ruin (Myers, *et al.*, 2000; Posa, *et al.*, 2008). Based on this definition and the data generated by this study, the remaining forest of KNRA can be considered as a biodiversity hotspot. The original 186 ha KNRA is now only reduced to 27.25 ha, which is home to a number of endemic species. As mentioned, the remaining forest still has good number of species that are now absent in the remaining forests of the country. These species are listed as either critically endangered, endangered or vulnerable species. Protection from fire and expansion of the remaining forest through planting of wildings of native trees in the adjacent brushland therefore is a must. Involving the community in these processes will ensure sustainability.

CONCLUSIONS AND RECOMMENDATIONS

The data generated in this study showed that the remaining forest of KNRA was once a dipterocarp forest and can now be classified as a young regenerating forest composed primarily of trees in the seedling and sapling stages. The forest is also home to a long list of threatened and endemic species. This only means that the forest serves as a repository of these species, whose populations are already dwindling or absent in many forests in the country; thus its protection and conservation are a must.

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