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# Geographic Information System Based Floral and Faunal Assessment of Alapang Communal Forest of Benguet, Philippines

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**Abstract :** This study was conducted to assess the existing flora and fauna, and to develop a spatial map of Alapang communal forest located in the province of Benguet, Philippines. A total of 52 species belonging to 27 families were identified during the inventory in this communal forest using the quadrat method while a total of 30 species belonging to 18 families were recorded using line intercept technique for the assessment of grasses, herbs, vines and other low-lying vegetation. The diversity index of the species in Alapang communal forests using the quadrat method was 2.6649 while for the line intercept technique it was 2.5446. The most dominant species in this area was found to be *Pinus kesiya* Royle ex Gordon (Benguet pine) under Family Pinaceae with an importance value of 106.74%. In the faunal assessment, four species of birds and a small mammal particularly a rodent were identified during the study. Aside from the high species diversity of this communal forest, the presence of endemic and indicator species in the area denotes that this forest was still in good condition hence must be protected. Spatial maps and database system were generated based from data gathered in the field using Geographic Information System (GIS).

***Key words*** **:** *Alapang communal forests, Pinus kesiya, diversity index, GIS*

## Introduction

High biodiversity abounds in different biogeographic regions of the Philippines. In this country, there are 15 biogeographic zones in which Cordillera Administrative Region(CAR) is included and where Alapang communal forest is located(DENR-UNEP, 1997 as cited by Bacudo, *et al.*, 2006). These biogeographic zones are created due to its richness in the biological resources particularly the flora and fauna. Species distribution varies from one location to another especially in tropical places because of biogeography, disturbance and habitat(Whitemore, 2003).

CAR is characterized by mountainous topography consisting of variety of flora and fauna that provides food, wood, fodder and shelter to its inhabitants. It also provides protective benefits against disastrous calamities like typhoon and is also responsible for the gentle climate of the region. However, the diversity of the region's resources seems not given enough attention and the extinction of important species has been going on unnoticed. The rate of loss of biodiversity in the country is higher anywhere else in the world as a result of habitat destruction (PCSD-IEMSDP, 1998). Thus, there is an immediate need to address the growing and non-stop degradation of the environment so as to prevent biodiversity loss and extinction of different organisms. This gives local government an interest to create a plan and program for the management and protection of these biological resources. Therefore, this study on assessing the flora and fauna is relevant and timely especially no study yet has been conducted in this area. According to Phillips *et al.* (2003), it is necessary to conduct a floristic inventory in order to determine the species diversity and understand the species distribution. The output will serve as the groundwork for monitoring of changes and designing appropriate strategies for the management of this forest for the stakeholders. Moreover, this will serve as basis for policy formulation concerning the areas to which it may focus into the preservation and protection of the forests (Bacudo *et al*., 2006).

The purpose of this study is to assess the existing flora and fauna in Alapang communal forest and develop a spatial map and database. It specifically aims to establish and generate information on the most dominant species of flora, determine the biodiversity index and identify the presence of endemic, threatened and endangered species.

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## Material and Methods

### 1. Study site

*Barangay* Alapang is situated on a mountain slope on the central part of the municipality of La Trinidad at geographical coordinates of 16° 21" latitude and 120° 25" longitude. It is two kilometer from the Municipal Hall, seven kilometer from the city of Baguio and 252 kilometer Northeast of Manila.

The Department of Environment and Natural Resources (DENR) Cadastral survey shows that Alapang has a total land area of 201.22 hectare. Of the total area, 45.53% is agriculture, 36.74% forest, and 17.73% built up areas. It is the fifth smallest *barangay* in La Trinidad municipality. It has five *sitios* namely: Samoyao, Alapang Proper, Dapiting, Ettong, and Camp Dangwa.

Alapang is generally hilly to mountainous from gentle slopes to very steep slopes ranging from 18 to 30 degrees. Elevation ranges from 900 to 1,400 meter above sea level.

The temperature in this *barangay* ranges from 6 to 20 degrees centigrade. The coldest months are from December to February. It has two pronounced seasons. Rainy days are usually from May to September with August being the wettest month with an average rainfall of 1,000 mm and dry during the rest of the year.

Two types of soil exist in the *barangay*, namely: loam and coarse loam. The so called Puguis gravelly loam and Benguet loam are found in the area and offers good to excessive drainage. External drainage is excessive while internal drainage is fair.

### 2. Data collection

In this study, combinations of qualitative and quantitative approach were performed. The quantitative part made use of vegetational analyses using mathematical formula on biodiversity indices, density, frequency, and dominance while qualitative approach covered the identification of flora and fauna present in the area.

The information gathered in the field include the common name, scientific name, and family name of each individual tree species; northing and easting coordinates of each tree and the four corners of each quadrat; and diameter at breast height in centimeter and total height in meter of each individual tree species.

The transect count/ time area method for avian fauna and the trapping method for small mammals were the two methods of faunal survey used in the field. Counting of bird species was done during the inventory through establishment of an imaginary transect line. Birds seen and heard during site visits were recorded. Nets and cage traps with bait were placed and left at strategic areas to study the small mammals living in the area. After pictures and other relevant information were taken, trapped animals were released.

The primary data collected from Alapang communal forest were exported to the GIS software to show the locations of the trees and the quadrats. The boundary of *Barangay* Alapang was overlaid to the location of all the quadrats and trees. Editing was done in order to have accurate information and maps. New themes (polygon, line and point) were generated and these were boundary of *Barangay* Alapang, location of three quadrats, location of all trees in each quadrat, and 30 meter buffer zone for the threatened and vulnerable species.

### 3. Data analysis

Vegetation analysis was used to analyze the data gathered. The importance value, dominance index and diversity index were computed. These information will provide a better index on the species importance and function in its habitat than the density alone. The rank or order for a particular species within the forest community can be determined and quantified (Kent and Coker, 1992; Mueller-Dumbois and Ellenberg, 1974). Quadrat method was used in the assessment of trees, saplings and seedlings employing 10% sampling size. The number of quadrats laid out on the field was determined based from the reconnaissance performed by the team. A total of three 50 m × 20 m plots were established in Alapang communal forests. All trees, saplings and seedlings that fell within the established quadrats were identified, counted and measured. Likewise grasses, herbs and ferns were assessed using the line intercept technique. This was done with the establishment of 150m transect lines along the established quadrats. The line was subdivided further into equal intervals of 20 meters.

Vegetation analyses were computed using the following formulae (Odum and Barett, 2005; Krebs, 1985)

$$\text{Density(D)} = \frac{\text{No. of plants of a certain species}}{\text{Total area sample}} \times 100$$

$$\text{Relative Dentisty(RD)} = \frac{\text{Density of a species}}{\text{Total density for all species}} \times 100$$

$$\text{Relative Frequency(RF)} = \frac{\text{Frequency value for a species}}{\text{Total frequency all species}} \times 100$$

$$\text{Relative Height(RH)} = \frac{\text{Height of a species}}{\text{Total height}} \times 100$$

$$\text{Importance Value(IV)} = \text{RD} + \text{RE} + \text{RH}$$

Diversity indices and dominance index were also computed using the Shannon-Weiner and Simpson's Index formula as follows:

Diversity index (Shannon-Weiner)

$$H' = -\sum p_i \ln p_i$$

Where: $H'$ = diversity index
$P_i$ = proportion of individual species i
ln = natural logarithm.

Dominance Index (DI), (Simpson's formula):

$$DI = \left[\frac{Y}{N}\right]^2$$

Where: DI = Dominance Index
Y = Importance of a given species
N = Sum importance value of all species.

## Results and Discussion

### 1. Floral assessment

In the quadrat method, a total of 52 species belonging to 27 families were identified during the inventory in Alapang communal forests. Most dominant families in the study site were Lamiaceae, Moraceae, Phyllanthaceae, Caprifoliaceae, Meliaceae, Myrsinaceae and Rubiaceae (Figure 1). While the dominant species was *Pinus kesiya* (Benguet pine), a member of family Pinaceae with importance value of 106.74% and dominance index of .12659 (Table 1). This species was followed by *Melastoma malabathricum* and *Psidium guajava* with 17.07% and .00324 and 16.39% and .00298 importance values and dominance index, respectively.

The computed diversity index of species in this forest employing the quadrat method for upper vegetation analysis was 2.6649. On the other hand, there were 30 species belonging to 18 families found in the established 150 meter transect line or the line intercept method for grasses and low-lying vegetation. A total of 2.5446 diversity index were computed in this vegetation type (Table 2).

Most of the uses of flora species present in this communal forest are mainly for timber, lumber, and furniture purposes. Among the families which fall under this purpose include Pinaceae, Fabaceae, Lamiaceae and Myrtaceae. Other uses of some species in the area are for food, condiments, beverages and extractives. Apiaceae, Myrtaceae, Verbenaceae, Poaceae and Rutaceae are among the families suited for these utilizations. Families with medicinal use include Asteraceae, Malvaceae, Fabaceae, Poaceae and Rosaceae. There are also species from Dennstaedtiaceae, Davalliaceae, Apocynaceae, Maranthaceae, Poaceae and Verbenaceae families suited for ornamental and landscaping purposes.

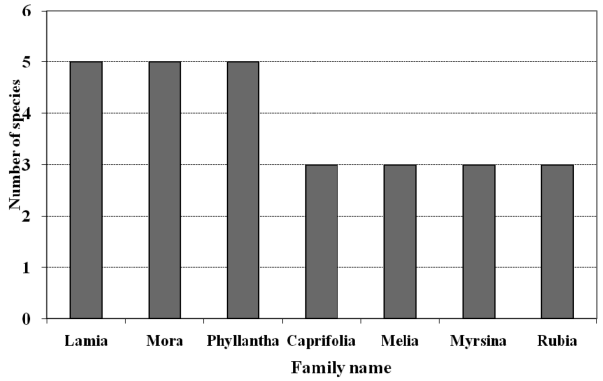


**Figure 1. Families having the highest number of species in Alapang communal forest.**

*Pinus kesiya* (Benguet Pine), the most dominant species is endemic to the region and used as rallying calls for conservation in the community. It is also considered as one of the major species under the DENR reforestation program. Endemicity of species in the area also connotes ecological importance such that they are considered good indication of the status of habitats and ecosystems. There are about 10 species noted endemic in the country particularly in Luzon area. Of these identified endemic species, three are endemic in Benguet where the study site is located. These are *Glochidium subfalcatum* (Nadong), *Prunus subglabra* (Kanumog) and *Ficus benguetensis* (Tabul).

Other species with distinct ecological function belongs to families Moraceae, Caprifoliaceae, Cyatheaceae and Euphorbiaceae. An example of species with this function is the *Ficus spp.* (tropical figs) under Moraceae family which appeared to be one of the abundant families present in this type of forest. *Ficus spp.* can be designated as an umbrella species and keystone species since, according to Terbogh as cited by Catinbog-Sinha and Heaney (2006), this species provides food to a wide variety and numerous fruit-eating birds, wild pigs, native rodents, among others. Aside from this, *Ficus nota* (Tibig) and *Cyathea contaminans* are usually associated with the abundance of water or moisture in an area (Bacudo *et al.,* 2006).

The presence of many indicator species in the study areas imply that this communal forest still have a good health condition and diversity status. However, there were three species found in the area that fall under threatened conditions. Two of these species were under the vulnerable category, and these were *Cyathea contaminans* (tree fern) and *Saurauia bontocensis* (Deguai). Another threatened species that was identified in the area was *Prunus subglabra* (Kanumog) located in quadrat one of Alapang communal forest (DAO 2007-01, 2007).

### 2. Faunal assessment

There were four species of birds identified during the study and three of them were endemic in the Philippines. These were *Nectarinia jugularis jugularis* (yellow breasted sunbird), *Sercop calvus calvus* (Coleto) and *Lonchura malacca* (maya). Other non-endemic bird species found was *Pycnonotus goiavier goviaer* (Kulkul). Birds are considered keystone species because they are seed dispersers and vital to the recruitment of certain plant species in tropical forest (Catinbog-Sinha and Heaney, 2006).

**Table 1. Overall vegetation analysis, importance value and dominance indices of species present in Alapang communal forest using Quadrat Method.**

| Family | Common Name | Scientific Name | Relative Density (RD) | Relative Height (RH) | Relative Frequency (RF) | Importance Value (IV) | Dominance Index (DI) |
|---|---|---|---|---|---|---|---|
| Actinidiaceae | Deguai | *Saurauia bontocensis* | 0.46 | 1.09 | 1.47 | 3.02 | 0.00010 |
| Apocynaceae | Pandakaking-gubat | *Tabernaemontana mucronata* | 0.31 | 0.15 | 1.47 | 1.93 | 0.00004 |
| Betulaceae | Japanese alnus | *Alnus japonica* | 0.15 | 0.07 | 1.47 | 1.69 | 0.00003 |
| Boraginaceae | Tanaua | *Ehretia acuminata* | 0.31 | 0.69 | 1.47 | 2.46 | 0.00007 |
| Caprifoliaceae | Apit | *Viburnum glaberrimum* | 0.62 | 0.17 | 1.47 | 2.25 | 0.00006 |
| Caprifoliaceae | Apit-laparan | *Viburnum platyphyllum* | 0.15 | 0.31 | 1.47 | 1.94 | 0.00004 |
| Caprifoliaceae | Taringongog | *Viburnum luzonicum* var. *sinuatum* | 0.46 | 0.78 | 1.47 | 2.71 | 0.00008 |
| Chloranthaceae | Baraw-baraw | *Chloranthus elatior* | 0.15 | 0.09 | 1.47 | 1.71 | 0.00003 |
| Chloranthaceae | Gipas | *Sarcandara glabra* | 4.48 | 1.08 | 1.47 | 7.03 | 0.00055 |
| Clethraceae | Apiit | *Clethra luzonica var. novoguineensis* | 2.94 | 2.48 | 2.94 | 8.36 | 0.00078 |
| Clusiaceae | Tunkin | *Cratoxylum sumatranum* spp. *blancoi* | 0.46 | 0.32 | 1.47 | 2.26 | 0.00006 |
| Cunoniaceae | Kalion | *Weinmannia cuneatifolia* | 0.15 | 0.50 | 1.47 | 2.12 | 0.00005 |
| Ericaceae | *Vaccinium* sp | *Vaccinium* sp | 0.31 | 0.32 | 1.47 | 2.10 | 0.00005 |
| Euphorbiaceae | Agai | *Bridelia tomentosa* | 0.31 | 0.14 | 1.47 | 1.92 | 0.00004 |
| Euphorbiaceae | Balanti | *Homalanthus populneus* | 0.93 | 0.11 | 1.47 | 2.51 | 0.00007 |
| Fabaceae | Calliandra | *Calliandra calothyrsus* | 6.49 | 0.76 | 1.47 | 8.72 | 0.00084 |
| Fabaceae | Smooth Narra | *Pterocarpus indicus* forma *indicus* | 0.15 | 0.07 | 1.47 | 1.69 | 0.00003 |
| Juglandaceae | Lupisan-liitan | *Engelhardtia serrata* | 0.46 | 1.34 | 1.47 | 3.27 | 0.00012 |
| Juglandaceae | Ped-ped | *Engelhardtia spicata* var. *colebrookeana* | 0.93 | 0.31 | 1.47 | 2.71 | 0.00008 |
| Lamiaceae | Agnai | *Callicarpa magnifolia* | 3.09 | 1.33 | 4.41 | 8.83 | 0.00087 |
| Lamiaceae | Anuyup | *Callicarpa platyphylla* | 0.15 | 0.09 | 1.47 | 1.72 | 0.00003 |
| Lamiaceae | Gmelina | *Gmelina arborea* | 0.46 | 0.07 | 1.47 | 2.01 | 0.00004 |
| Lamiaceae | Taringaw-liitan | *Callicarpa subintegra* var. *parva* | 0.93 | 0.49 | 2.94 | 4.36 | 0.00021 |
| Lamiaceae | Tigaw-sangahan | *Callicarpa ramiflora* | 1.39 | 0.41 | 1.47 | 3.28 | 0.00012 |
| Lauraceae | Marang-laparan | *Litsea ampla* | 0.15 | 0.03 | 1.47 | 1.66 | 0.00003 |
| Maesaceae | Maesa sp | *Maesa* sp | 7.42 | 2.71 | 4.41 | 14.54 | 0.00235 |
| Melastomataceae | Malatungaw | *Melastoma* | 9.74 | 2.93 | 4.41 | 17.07 | 0.00324 |
| Meliaceae | Balubar | *Aglaia subviridis* | 0.62 | 0.25 | 2.94 | 3.81 | 0.00016 |
| Meliaceae | Batuakan | *Chisocheton pentandrus* ssp. *paucijugus* | 0.46 | 0.25 | 1.47 | 2.18 | 0.00005 |
| Meliaceae | Mahogany | *Swietenia macrophylla* | 1.08 | 0.30 | 1.47 | 2.85 | 0.00009 |
| Moraceae | Hauili | *Ficus septica* | 0.77 | 0.86 | 1.47 | 3.10 | 0.00011 |
| Moraceae | Malatibig | *Ficus congesta* | 0.46 | 0.40 | 2.94 | 3.80 | 0.00016 |
| Moraceae | Siningsing | *Ficus annulata* | 1.08 | 1.17 | 1.47 | 3.72 | 0.00015 |
| Moraceae | Tabul | *Ficus benguetensis* | 2.78 | 0.74 | 1.47 | 5.00 | 0.00028 |
| Moraceae | Tibig | *Ficus nota* | 0.15 | 0.16 | 1.47 | 1.78 | 0.00004 |
| Myrsinaceae | Pamutul | *Ardisia zambalensis* | 0.15 | 0.06 | 1.47 | 1.69 | 0.00003 |
| Myrsinaceae | Panabon | *Ardisia serrata* | 0.15 | 0.06 | 1.47 | 1.69 | 0.00003 |
| Myrtaceae | Guava | *Psidium guajava* | 9.12 | 2.86 | 4.41 | 16.39 | 0.00298 |
| Myrtaceae | Murray red gum | *Eucalyptus camaldulensis* | 0.15 | 0.31 | 1.47 | 1.94 | 0.00004 |
| Phyllanthaceae | Bagnang gubat | *Glochidion nitidum* | 0.15 | 0.08 | 1.47 | 1.70 | 0.00003 |
| Phyllanthaceae | Karkarmai | *Glochidion ligulatem* | 0.15 | 0.05 | 1.47 | 1.68 | 0.00003 |
| Phyllanthaceae | Karmai-bugkaw | *Breynia acuminata* | 0.31 | 0.19 | 1.47 | 1.97 | 0.00004 |
| Phyllanthaceae | Matang-katang | *Breynia cernua* | 0.15 | 0.06 | 1.47 | 1.69 | 0.00003 |
| Phyllanthaceae | Nadong | *Ghlochidium subfalcatum* | 1.55 | 0.79 | 2.94 | 5.27 | 0.00031 |
| Pinaceae | Benguet Pine | *Pinus kesiya* | 33.54 | 68.79 | 4.41 | 106.74 | 0.12659 |
| Rosaceae | Kanumog | *Prunus subglabra* | 0.62 | 1.74 | 1.47 | 3.83 | 0.00016 |
| Rubiaceae | Lingong | *Lucinaea monocephala* | 0.15 | 0.31 | 1.47 | 1.94 | 0.00004 |
| Rubiaceae | Loher siganog | *Praravinia loheri* | 0.31 | 0.28 | 1.47 | 2.06 | 0.00005 |
| Rubiaceae | Rado | *Wendlandia warburgii* | 0.46 | 0.12 | 1.47 | 2.05 | 0.00005 |
| Rutaceae | Matang-araw | *Melicope triphylla* | 0.31 | 0.15 | 1.47 | 1.93 | 0.00004 |
| Staphyllaceae | Anongo | *Turpinia ovalifolia* | 0.15 | 0.19 | 1.47 | 1.81 | 0.00004 |
| Theaceae | Basbasit | *Eurya acuminata* | 1.55 | 0.99 | 2.94 | 5.48 | 0.00033 |
| | | Total | 100.00 | 100.00 | 100.00 | 300.00 | 0.14190 |

**Table 2. Diversity index of low-lying vegetation in Alapang communal forest using Line Intercept Technique.**

| Family Name | Common Name | Scientific Name | No. of Species |
|---|---|---|---|
| Acanthaceae | Tuhod-manok | *Gendarussa vulgaris* | 1 |
| Apiaceae | Takip-kuhol | *Centella asiatica* | 1 |
| Apocynaceae | *Amphineurion s*p. | *Amphineurion sp.* | 2 |
| Asteraceae | Bebengtet | *Ageratina adenophora* | 13 |
| Asteraceae | Tabtabako | *Elephantopus tomentosus* | 37 |
| Asteraceae | Hagonoy | *Chromolaena odorata* | 7 |
| Asteraceae | Sipa-sipa | *Euphatorium sp.* | 66 |
| Asteraceae | Uoko | *Mikania cordata* | 6 |
| Cyatheaceae | Tree fern | *Cyathea contaminans* | 1 |
| Davalliaceae | *Davallia* sp. | *Davallia sp.* | 3 |
| Dennstaedtiaceae | Bracken Fern | *Pteridium aquilinum* | 53 |
| Gleicheniaceae | Kilob | *Dicranopteris linearis* | 46 |
| Hypoxidaceae | Abang-abang | *Curculigo capitulata* | 1 |
| sMalvaceae | Kollo-kollot | *Urena lobata* | 10 |
| Maranthaceae | *Angiopteris* sp. | *Angiopteris sp.* | 2 |
| Moraceae | Hanopol tindig | *Poikilospermum erectum* | 4 |
| Papilionaceae | Pakpak langaw | *Desmodium trifolum* | 13 |
| Poaceae | Cogon | *Imperata cylindrica* | 88 |
| Poaceae | Hairy crab grass | *Digitaria ciliaris* | 7 |
| Poaceae | Kikuyo grass | *Pennisetum clandestinum* | 1 |
| Poaceae | Kulape | *Paspalum conjugatum* | 122 |
| Poaceae | Napier | *Pennisetum purpureum* | 9 |
| Poaceae | Rono | *Miscanthus sinensis* | 3 |
| Poaceae | Sagisi | *Rotboellia exalta* | 1 |
| Poaceae | Torpedo grass | *Panicum repens* | 6 |
| Poaceae | Velvet crabgrass | *Digitaria velutina* | 10 |
| Pteridaceae | Pakong-ahas | *Pteris tripartita* | 3 |
| Rosaceae | Sapinit | *Rubus fraxinifolius* | 3 |
| Verbenaceae | Coronitas | *Lantana camara* | 37 |
| Zingiberaceae | Luya-luyahan | *Globba campsophylla* | 4 |
| | | Total | 560 |
| Diversity Index H' | | | 2.5446 |

Aside from birds, a small mammal particularly a rodent was caught during the trapping activity. The *Rattus everetti* was trapped at Alapang communal forest and this species is endemic in the country and widespread in primary forest, uncommon in secondary forest and are absent in agricultural areas. This species seldom destroys crop.

Other species that were observed in the communal forest were frogs, insects, scorpion, crab, snakes, earthworms and larva of insects. The frog species identified is the *Philautus poecilus*, a Philippine endemic frog and is considered threatened. Forest frogs and other amphibians have been used as indicators of the quality of streams, ponds and marshes. This practice derives from the fact that amphibians depend critically on clean water for egg laying. The presence of frog especially in Alapang forest denotes that the water in the stream is still clean. Aside from fauna species, the group also encountered species of fungi such as *Calvatia sp.* (puff balls), *Pleurotus sp.*

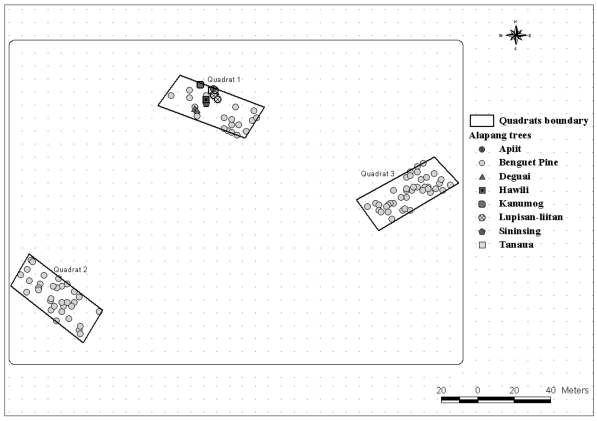


**Figure 2. Tree distribution map on three quadrats established in Alapang communal forest.**

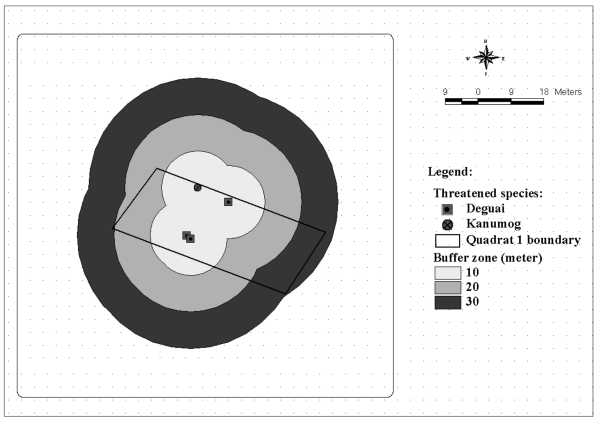


**Figure 3. Buffer zones for threatened species in Alapang communal forest.**

(oyster mushroom), *Trametes sp.* (white rot fungus) and *Polyporus sp.* (polypore fungus).

### 3. Spatial mapping and database

Trees found in each quadrant were measured and mapped (Figure 2). Each tree corresponds to one point that have a complete information on its common name, family name, scientific name, height, diameter at breast height, and use/importance. Using the 0.6 meter resolution multi-spectral satellite image of La Trinidad, the boundary of the Alapang communal forest was extracted to come up with a vector map.

An analysis of the sites showing endangered species was performed. Buffer zones showing the hotspots for endangered species were created (Figure 3). The first three 10-meter buffer zones were created to indicate the susceptibility or sensitivity of the area to disturbance. It is therefore a must that these zones or hotspots be protected by the local people and the local government unit to avoid further loss of the biodiversity wealth of the community.

## Conclusion

Characterization of different ecosystem is very important and should not be taken for granted. This study significantly created information about the current status of the Alapang communal forests. Because of this study, it was discovered that threatened species are living in the area and an immediate action to protect and manage this forest vegetation is necessary. Without conducting a biodiversity assessment, it is very difficult for the forest managers to determine the current situation particularly the species composition of an area.

*Pinus kesiya* (Benguet pine), as expected, is still the most dominant species that can be found in most ecosystem in this region. Despite of continuous conversion of forest land into agricultural area, the floral diversity of this particular area is relatively high together with other organisms like fauna and fungi. Different indicator species in the area suggested that this communal forest is still healthy. Therefore, it is recommended to conduct proper delineation of the forest reservation and there should be a visible boundary through establishment of fences in the areas. The DENR and Local Government Unit(LGU) must strictly implement laws on illegal forest activities and biodiversity conservation and initiate and intensify information education and communication campaigns together with the academic sector on biodiversity and its importance to community and their adjacent areas.

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