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Assessment on Plant Biodiversity of the Alaungdaw Kathapa National Park in Myanmar

Thaung Naing Oo (Range Officer)

Lwin Ko Oo (Range Officer)

Yin Yin Kyi (Assistant Director)

Forest Botany and Tree Improvement Sub-division

Forest Research Institute

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Contents

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အလောင်းတော်ကဿပ အမျိုးသားဥယျာဉ်၏ အပင်ဇီဝမျိုးစုံမျိုးကွဲများအား ဆန်းစစ်အကဲဖြတ် လေ့လာခြင်း

သောင်ါ်သိုင်ဦါ် (တောအုပ်ကြီါ်)

ႀုခ. ႃ(သမန္ျအမပ)ယ ႀုခ. ႃ(သမန္ျအွ မသစ.)႔ႀ့ိ-မန္ျိနညယ္ွနမာညေပ)

လွင်ကိုဦါ်(တောအုပ်ကြီါ်)

ႀုခ. ႃ(သမန္ျအမပ) ယ ႀုခ. (ဏူညေအေအေသည ႀေညညေါနာနညအ) (႔နဖငည)

၏င်၏င်ကြည် (လက်ထောက်ညွှန်ကြာါ်ဓေါ်လွ်ါ်)

ႀုခ. (ႀသအညေပ) (႔ညေါသည ႔ညငလနမ္ငအေပ)

သစ်တောသုတေသနဌာန၊ဓေါ်ဆင်ါ်ႀ

စာတမ်းအကျဉ်းချုပ်

အလောင်းတော်ကဿပ အမျိုးသားဥယျာဉ်၏ အပင်ဇီဝမျိုးစုံမျိုးကွဲများအား ဆန်းစစ်အကဲဖြတ် လေ့လာခြင်း သုတေသနလုပ်ငန်းသည် အပင်အမျိုးအစား ခွဲခြားခြင်း၊ မှတ်တမ်းတင်ခြင်း၊ အပင်ဇီဝ မျိုးစုံမျိုးကွဲများ၏ အခြေနေအား အကဲဖြတ်ခြင်း၊ ဥယျာဉ်အနီးရှိ ကျေးရွာများ၏ လူမှုစီးပွါးရေး အခြေအနေများကို စစ်တမ်းကောက်ယူခြင်းနှင့် ဒေသခံပြည်သူများ၏ နေ့စဉ် စားဝတ်နေရေးတွင် သစ်တောများ၏ အရေးပါမှု စသည်တို့ကို ဘက်စုံစုပေါင်း၍ လေ့လာတင်ပြထားသော စာတမ်းဖြစ်ပါသည်။ ဤသုတေသနလုပ်ငန်းကို ၂၀၀၃ -၂၀၀၄ ခုနှစ်တွင် အလောင်းတော်ကဿပ အမျိုးသားဥယျာဉ် (Core zone) ၏ အတွင်းပိုင်းတွင်၄င်း၊ ၂၀၀၄ -၂၀၀၅ ခုနှစ်တွင် (Core zone) ၏ အပြင်ပိုင်းတွင်၄င်း အပင်ဇီဝမျိုးစုံမျိုးကွဲများအား စနစ်တကျ စာရင်းကောက်ယူ လေ့လာခဲ့ပါသည်။ အပင်မျိုးစိတ် တစ်ခုနှင့်တစ်ခုဆက်စပ်မှု၊ အပင်ဇီဝမျိုးစုံမျိုးကွဲများ တည်ရှိမှုပမာဏ၊ တော၏ဖွဲ့စည်းမှု နှင့် ပြောင်းလဲမှုများကို လေ့လာတင်ပြထားသည့်အပြင် အပင်ဇီဝမျိုးစုံမျိုးကွဲ များကြွယ်ဝမှုကို ညွှန်ပြသည့် အတိုင်းအတာများ ဖြစ်သည့် Species richness, eveness, species frequency, abundancy, species density and Importance Value Index (IVI) တို့ကိုပါ အသေးစိတ် တင်ပြထားပါသည်။ အပင်ဇီဝမျိုးစုံမျိုးကွဲများကြွယ်ဝမှုကို Simpson and Shannon Diversity Indices အညွှန်းကိန်းများ ဖြင့်လည်း တင်ပြထားပါသည်။ ဥယျာဉ်အနီးရှိ ကျေးရွာများ (ကျေးရွာ ၈ ရွာ)၏ လူမှုစီးပွါးရေး ခြေအနေများ နှင့်ဒေသခံပြည်သူများ၏ နေ့စဉ် စားဝတ်နေရေးတွင် သစ်တောများ (အမျိုးသားဥယျာဉ်) ၏ အရေးပါမှု တို့ကိုလည်း တင်ပြထားပါသည်။ သုတေသနတွေ့ရှိချက်များကို အခြေခံ၍ အပင်ဇီဝမျိုးစုံ မျိုးကွဲများအား စဉ်ဆက်မပြတ် ထိမ်းသိမ်းကာကွယ်နိုင်ရန် သင့်လျော်သော နည်းလမ်းများကိုလည်း တင်ပြထားပါသည်။

Assessment on Plant Biodiversity of the Alaungdaw Kathapa National Park in Myanmar

Thaung Naing Oo
B.Sc. (Forestry), M.Sc. (Forest Trop.) (TU-Dresden, Germany)
Range Officer
Lwin Ko Oo
B.Sc. (Forestry) , M.Sc. (Plantation Manangement) (Yezin)
Range Officer
Yin Yin Kyi
B.Sc. (Botany) (Yangon University)
Assistant Director
Forest Research Institute, Yezin.

Abstract

The plant diversity research is an integrated approach in which assessment of plant species diversity, identification and documentation of the plant species, collection of the socioeconomic information of the local communities and linkage between the livelihoods and forests are incorporated. The research activities were carried out in two portions i.e., inner portion and outer portion of the core zone of the park, in the project year four (2003-2004) and project year five (2004-2005) respectively. Plant species identification and specimen collection were carried out through forest inventory and systematic botanical studies. The ecological linkage between and among the plant species, quantitative estimate of plant species diversity, stand structure and stand dynamic of the park were also investigated. The quantitative estimate of plant species diversity and ecological linkage between and among species are presented by using diversity indices (i.e. Simpson and Shannon Diversity Indices) and main parameters of vegetation study such as species richness, evenness, number of individuals or density (abundance), frequency and Importance Value Index (IVI). Social aspects of the National Park are also presented in order to realize and highlight the important role of forests for the livelihoods of the rural people living around the National Park. Based on overall results of the different research activities, appropriate means and ways and recommendations for sustainable conservation of plant species diversity of the Alaungdaw Kathapa National Park as well as a protected area system are presented.

Contents

1. Introduction

Myanmar is still endowed with diverse forest resources. More than half of the country is covered with forests. In Myanmar, reserved forests (RF), protected public forests (PPF) and protected areas system (PAS) constitute the permanent forest estate (PFE). Under the Myanma Forest Law (1992), RF and PPF enjoy almost equal legal status and PAS is administered in accordance with the Protection of Wildlife and Wild Plants and the Conservation of Protected Areas Law. Forest Department (FD) has been forming PPF as an interim process, as PPF formulation procedure is easier to manage and quicker to implement, since the settlement officer is a forester. PPF will be upgraded to RF in due course. In 2002, an area of PFE reached 173,739 km^2 or 25.68% of the total area of the country. A stable PFE is basic to sustainable forest management (SFM). Out of 173,739 km^2 of PFE, PAS occupies 31,945 km^2 or 4.72% of the total land area. In Myanmar, there are 41 PAS and it makes vital contributions to the conservation of the world's natural and cultural resources. Wildlife sanctuary, national park, botanical garden belong to the Protected Areas System. The Myanmar Forest Policy seeks to extend the Protected Area System (PAS) by gazetting 5% of the total land of the country from 4.7% at present to 10% in the long run.

Alaungdaw Kathapa National Park is very well known National Park in Myanmar because of its diverse florisitic composition and ample sources of habitats for wild animals. It also plays an important role in Myanmar religious belief. The Alaungdaw Kathapa shrine is located in the park and it is one of the most holy shrines in Myanmar. The scenery of the park attracts people for recreation and the diverse forest flora and fauna provide substantial opportunities for ecotourism development.

Therefore, the sustainability of the forest resources of the national park is of crucial important as well as the documentation and assessment of plant species diversity of the park is inevitably needed. Hence, this study consists of three major components: (1) identification and documentation of plant species (2) assessment of plant species diversity using main parameters of plant diversity and (3) collection on socioeconomic information of the local communities.

1.1. Profiles of the study area

1.1.1. Location

The Alaungdaw Kathapa National Park is located between 22° 25″ N and 94° 26″ E in Mingin (Yinmabin) Township of Sagaing Division. It covers an area of 160,600 hectare comprising the Patolon Reserved Forest and two-thirds of the adjoining Taungdwin Reserved Forest. The park is richly endowed with diverse flora, which contributes habitats for wildlife such as elephant, tiger, leopard, gaur, sambur, barking deer, bear, jungle goat, mountain goat, wild boar, jungle cat and many kinds of birds (Ministry of Forestry, 2000). Five forest types i.e., Moist upper mixed deciduous forests (MUMD), Dry upper mixed deciduous forests (DUMD), Indaing (Dipterocarp) forests, Semi-evergreen forests and Pine forests are dominant in the park.

1.1.2. Topography

The series of parallel ridges are major features of the area and are characterized by fairly steep escarpments on the eastern face and moderate slopes on the west. Two rivers, namely Patolon and Taungdwin, are separated from each other and form the adjoining valleys to the west and east by long north-south ridges at an elevation of from about 610 meter (2000 feet) to over 1220 meter (4000 feet). The Mahudaung (Easternmost ridges), Letpandaung (Southern ridges) and Modaung (Northern ridges) have at an elevation from averages about 915 meters (3000 feet) to just over 1220 meter (4000 feet) forming watersheds between the Patolon and the Taungdwin valleys.

1.1.3. Climatic and edaphic conditions

The area has a monsoon climate but is sheltered to some extent from the full effects of the South-west monsoon by the western Chill Hills. Rainfall is therefore residual with an annual mean of 1495 mm (58.9″). Rainfall occurs mainly between May and October and is heaviest in August and September. Temperature range from a mean minimum of 10.7° C (51.3° F) in January to a mean maximum of 41.5° C (106.7° F) in April, the hottest month. The average relative humidity is 72.3 %. Prevailing winds are from the south-west during the monsoon and from the north-west during the cold season. The soil is generally a sandy loan with varying proportion of sand (FRI, 2003).

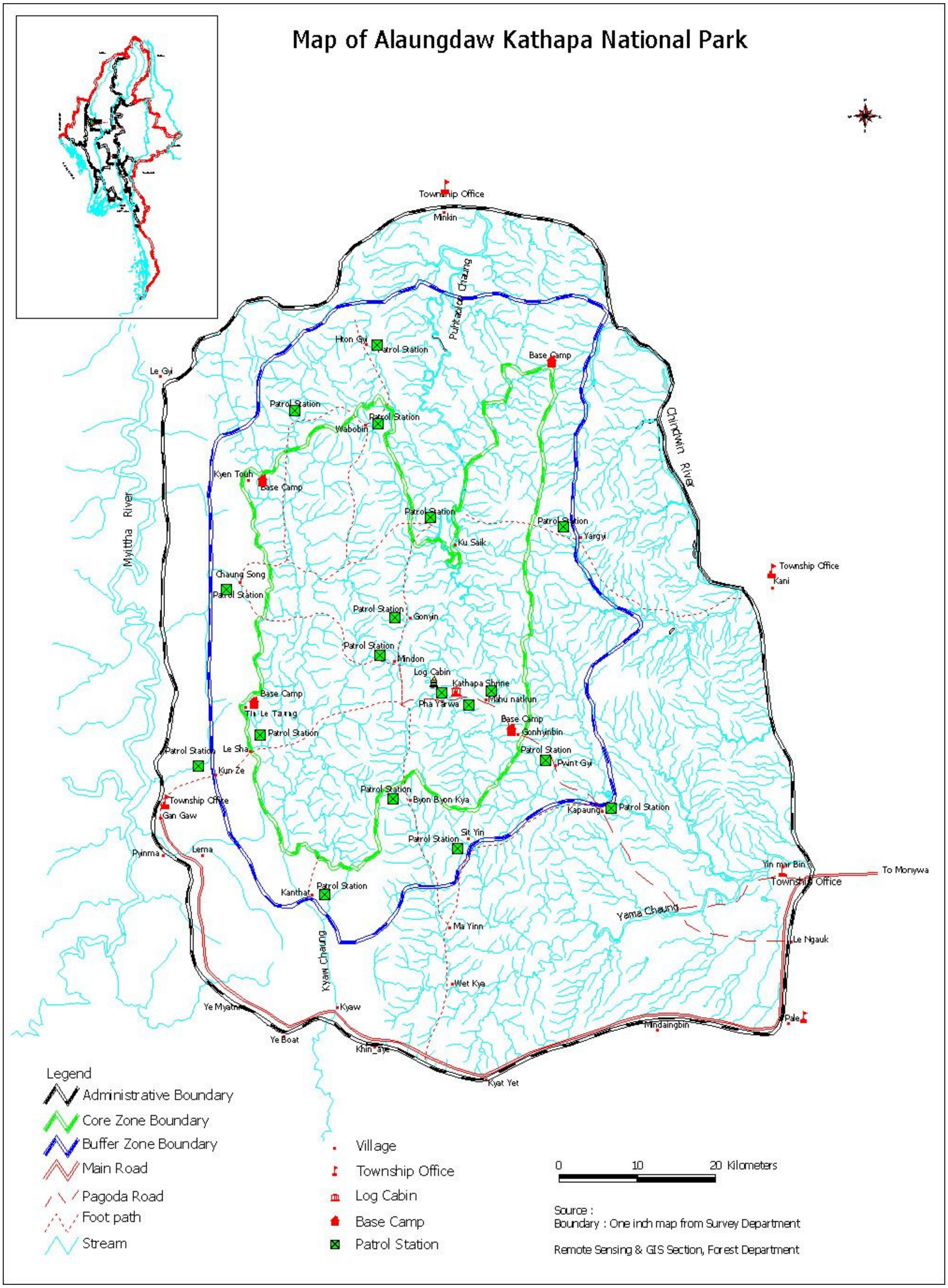

Figure 1. Location map of the Alaungdaw Kathapa National Park

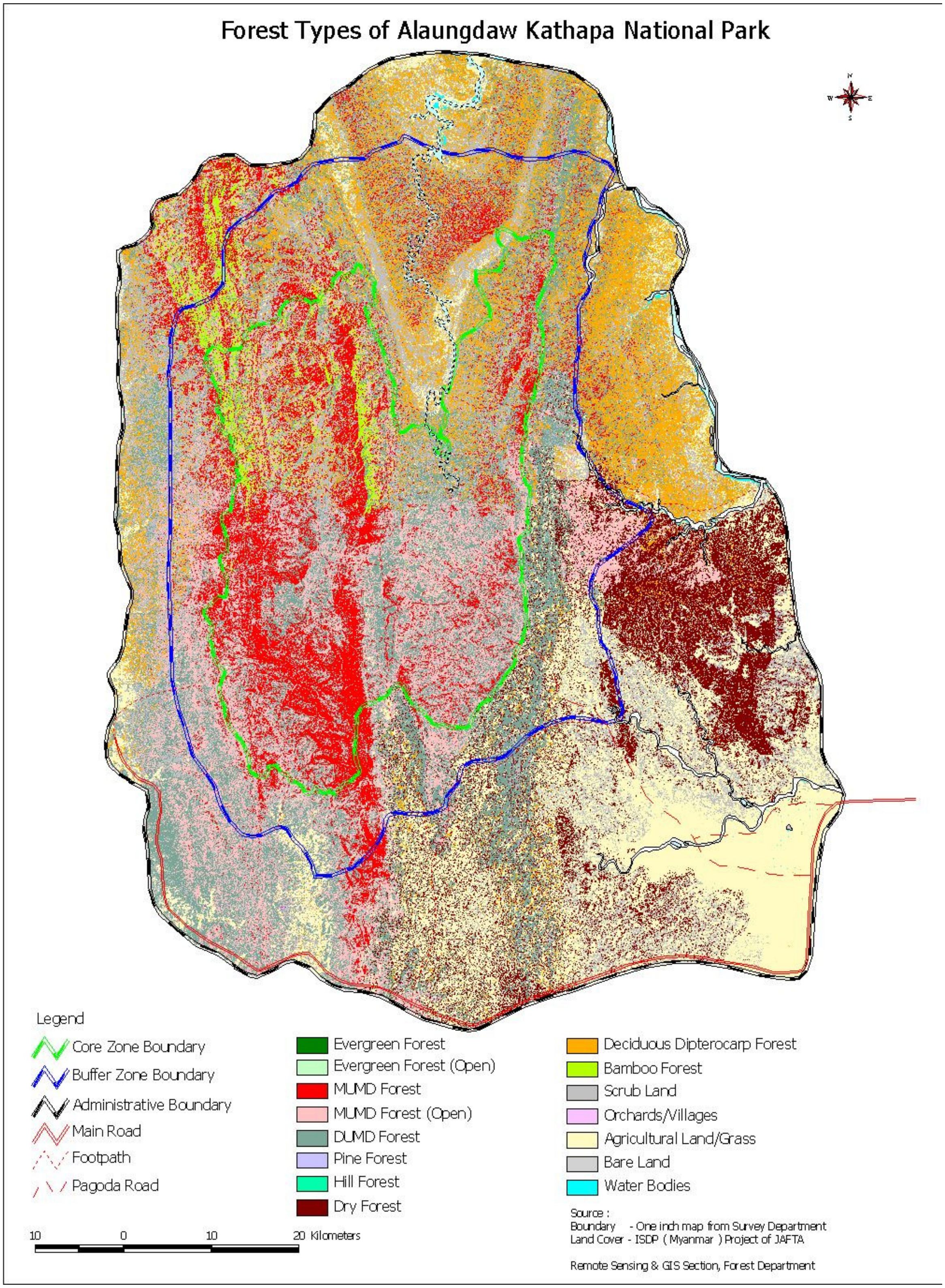

Figure 2. Map of forest types of the Alaungdaw Kathapa National Park

1.1.4. Religious value and ecotourism potential

The Alaungdaw Kathapa National Park plays an important role in Myanmar religious belief. The Alaungdaw Kathapa shrine is located in the park and it is one of the most holy shrines in Myanmar. The site of the shrine is visited every dry season (November to April) by large numbers of devout pilgrims from all over Myanmar. Moreover, the scenery of the park attracts people for recreation and the diverse forest flora and fauna provide substantial opportunities for ecotourism development. The pristine conditions of the park are great opportunities for the natural scientist. According to the trustee of the pagoda, about 70,000 people (pilgrims) visited the shrine and the park in 2004 (AKECOP, final report, 2005).

1.1.5. Demography and socioeconomic conditions of the surrounding villages

There are about 25 villages around the park. The people in the surrounding villages of the park are primarily engaged in agricultural activities cultivating especially rice, groundnuts, beans, wheat and maize. As a nature of the rural community, local people rely on forests for forest products in order to fulfill their livelihoods and basic needs. They collect a variety of forest produces including timber, poles & posts, fuelwood, bamboo, resin, gums and edible food such as honey, mushroom, bamboo shoot etc., from the outer portion and buffer zone of the national park. Moreover, livestock rearing is another source of income earning opportunity for the rural people and it is a kind of saving function for them. So raising livestock is very common in this area. The socioeconomic conditions of the surrounding vilalges, their faming systems, demography and literacy rate are shown in Table 1 (AKECOP final report, 2005). This information would be useful to gain people's participation in the park management, and in preparing integrated national park management plan on a sustainable basis in the future.

Table 1. Demography of eight villages

No.	Villages	Total hh	Population growth rate (%)**	Ave: family size	Farm area (acre)	Major employment	Literacy rate (%)
1	Kabaing	470	3.2	5.9	5.9	Agri:	97.2
2	Thi-kone	375	3.0	4.5	4.5	Agri:	95.1
3	Kan-pyu	160	3.8	7.2	7.2	Agri:	95.4
4	Paung-wa	142	3.6	6.9	6.9	Agri:	93.3
5	Tha-lauk	210	4.1	3.8	1.9	Agri:	94.5
6	Kyet	76	-*	5.9	3.5	Agri:	91.4
7	Wun-kone	304	3.5	5.8	5.0	Agri:	93.6
8	Thit-ya-bin	141	3.1	6.1	4.2	Agri:	96.2

*Population is decreased year by year and villagers are shifting to other villages because of scarcity of water and poor accessibility. ** between 1995 - 2005

Among eight surrounding villages, Kabaing is the biggest one in terms of households, total populations and area of the village whereas Kyet is the smallest. Average family size per household was found to be the largest in Kan-pyu (7.2 per household) and the smallest in Tha-lauk (3.8 per household). It was also observed that the population growth rate between 1995 and 2005 varies from 3.1% in Thit-ya-bin village to 3.8% in Kan-pyu village. The average population growth rate of the whole country is only 1.84% so that these villages have a higher population growth rate than that of the country total. Moreover, due to poor extension activities of family planning in these villages, average family size per household is larger than of the urban families. Population growth rate and family planning should be carefully taken into account and regulated if possible by using various prevention measures in these rural communities because it would affect to the long-term existence of forest resources of national park and sustainable management of protected areas. Of interest, the total population of Kyet village has been decreasing year by year because of scarcity of water, low productivity and poor accessibility. This village used to be a big one but at present the inhabitants are shifting to other villages or places to have better access for their livelihoods and over-all development.

Because of limited conditions of off-farm employment opportunities, agricultural activities plays vital role for the livelihoods of the local people. The amount of annual income of the local communities is closely related to the climatic conditions so that it varies year by year. In addition, the market prices of the agricultural products such as paddy, groundnut, beans & peas, wheat, sesame and maize are also another factor influencing the annual income of rural people. The estimated average annual income of a household of each village ranges from Kyats 750,000 to Kyats 1,200,000 (AKECOP final report, 2005).

The amount of annual income of a household is very important for their livelihoods. Generally it reflects the ways of living style of the people and probably it is closely linked to the standard of living, education, health, social welfare and so on. The conservation programme would not succeed no matter how carefully it had been designed, unless the local people's basic needs are addressed and their annual incomes are improved to the extent of meeting the needs of their livelihoods. Thus the balance between the annual income and expenditure are very important for households in order to live better lives.

1.1.6. Livelihood and infrastructure development of the surrounding villages

People in eight villages are primarily engaged in agriculture for their livelihoods. The production is mainly for subsistence consumption. The extra income opportunities i.e., off-farm employments are considerably less in these villages. Livestock rearing is the only opportunity for the people to earn extra income and it is also a kind of saving for them. Generally, livelihoods of the rural people are mainly based on farm-household systems. It consists of three inter-linked and interactive subsystems. The farms with its crops, livestock rearing activities as the production units of the farming system and the household activities, which is a decision making unit are the major components of the typical rural community. Off-farm components and social relationships are also important in rural society.

The households the villages possess farm area ranging from 1.9 acre to 7.9 acre and cultivating especially paddy, groundnut, various kinds of beans and peas, sesame, maize and wheat are carried out (AKECOP final report, 2005). As nature subsistence agriculture, cultivating activities are carried out manually with the aid of cattle. Naturally, application of pesticides and fertilizers are limited because of their financial constraints. Almost all the agricultural lands are rain-fed and irrigation facilities are not available in these villages. Therefore, crop productivity is totally dependent on good climatic conditions and the lives of the local people still remain as subsistent farmers. Income opportunities have remained limited in these communities. As a combined effect of population growth and unsustainable resource use in the past, the ecological balance is now rapidly degrading through excessive removal of forest cover near the villages.

Due to location, poor accessibility and lack of rural development initiatives in the past, the infrastructure and the public services are relatively limited in all villages except Kabaing where High School, small-village-hospital, police station, forest station, village library and monastery are found. Other surrounding villages have to depend on Kabaing for health and education. Transportaion (accessibility to the nearest town-Yinmabin & Monywa) between these villages and the town is just fair and only indirect access is possible to the main road by vehichle in the dry season. In the rainy season, transportation by cart or going on foot is very common in this area. Therefore the overall development programme for these rural communities should be planned and implemented with multidisciplinary approach.

Generally people are very united under the guidance of the presiding monks and the village head-men. They take part with enthusiasm in religious, social and village development affairs. Religious, social and developmental organizations were found in almost all villages. These organizations are able to contribute to the health, social, educational, economical benefits for overall development of community as a whole. In all villages, social and developmental organizations such as the Union of Solidarity and Development Association, Red Cross, Religion Group, Fire Management Committee, Young Men/Women Group and Village Women's Federation are running regularly in these communities in order to fulfill the needs of the local communities. However, it does not necessarily mean that such activities are enough for development of these communities. The communities should have other organizations/associations such as income generation group, farmer's organizations, village co-operatives etc., which could contribute to the socioeconomic development and crop productivity of the rural communities through information sharing among members, creating off-farm employment opportunities within the communities.

1.1.7. Dependency of villages on the forest resources

In this rural area, there is no physical market for forest products. Naturally, local people visit the buffer zone and national park whenever they are free from agricultural activities in order to collect edible fruits, twigs, leaves, honey, bamboo shoots, medicinal plants, fuelwood, timber, pole & post, bamboo, thatch and specific wood for their agricultural implements. The amount of edible food and medicinal plants are not available because they collect these products for immediate uses so that the financial value of these products could not be included in the calculation. The financial value of pole & post, fuelwood, bamboo and fancing materials are presented based on local market prices of each item. Figure 3 shows monetary value of each forest product annually consumed by a house of each village (AKECOP final report, 2005).

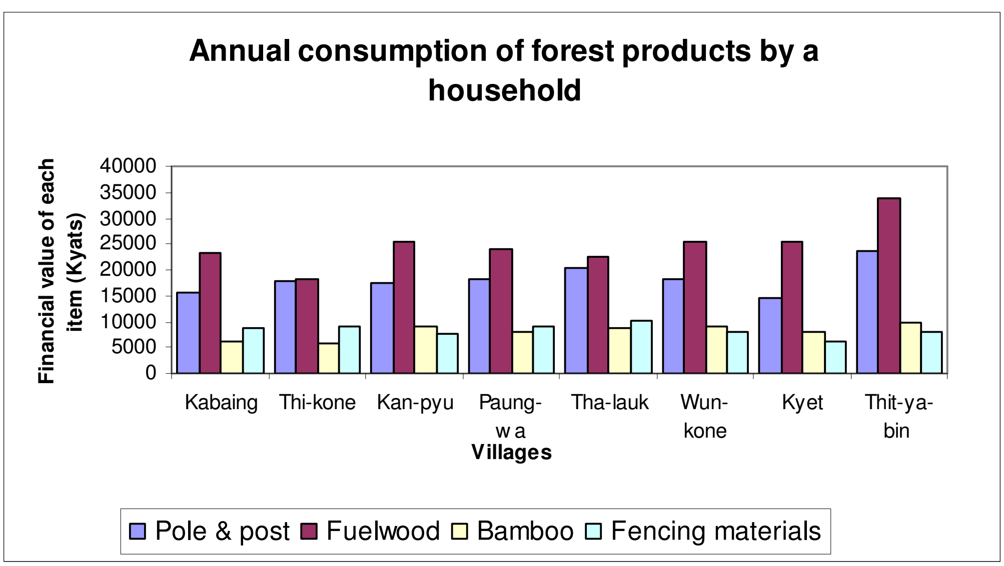

Figure 3. Annual consumption of each item of forest products by a household

The financial value of fuelwood annually consumed by a household of each village is more than these of other forest products. In this area, fuelwood is the most commonly used energy for many purposes because it is very cheap and easily available for subsistence consumption. There were hardly any alternative sources of energy. Agricultural residues are also used in some households. According to the surveys, the amount of fuelwood annually consumed by a household of each village ranges from 12 cartloads to 17 cartloads (AKECOP final report, 2005).

Some households of villages have been using A-1 stove, which is a product of Forest Research Institute, Yezin. These stoves were distributed by a NGO (Forest Resources Environment Development Association-FREDA) free of charge. According to the local people who are using A-1 stove, they could save approximately half of the targeted amount of fuelwood by using these A-1 stoves. Hence, it would contribute to effective conservation of forest resources of the park if the Forest Department, NGOs and other organizations cooperate and collaborate in energy saving programmes and distribution of energy saving stocks programmes in the rural areas.

Local people collect poles & posts for subsistence consumption and these are used for household consumption and sometime as agricultural implements. The financial value of pole & post annually consumed by a household is the second largest in all villages and is followed by that of bamboo and fencing materials. Bamboos are commonly used for roof, house construction, homestead-fencing, agricultural implements and some household items etc.

In Myanmar, due to the lack market value of grazing, the actual financial value of grazing cattle per head per year could not be calculated. However, the financial value of fodder which could be consumed by cattle per day was used as an alternative for calculating the grazing value for cattle in order to know the approximate amount and to estimate how the forests contribute to the livelihoods of the local people (AKECOP final report, 2005). Table 2 shows the estimated financial value of grazing per head per day.

Table 2. Estimated financial value of grazing utilized by a household

No.	Villages	No. cattle/household	Cost/ hh/day (Kyats)
1	Kabaing	5.6	2,800
2	Thi-kone	5.2	2,600
3	Kan-pyu	6.5	3,250
4	Paung-wa	8.4	4,200
5	Tha-lauk	3.0	1,500
6	Kyet	3.1	1,550
7	Wun-kone	3.0	1,500
8	Thit-ya-bin	3.6	1,800

Source: Adapted from AKECOP final report, 2005.

The households of the four villages, namely, Kabaing, Thi-kone, Kan-pyu and Paung-wa are raising cattle not only for agricultural activities but also for the purpose of extra income generation. People can raise cattle because they have good access to the forests i.e., reserved forests and buffer zone of the national park. They considered cattle rearing as a kind of saving and thus they are used to sell cattle whenever they need money for specific purpose. Raising large herds of cattle would affect adversely the sustainable management of national park and long-term existence of its forest resources.

All the households living around the National Park are subsistent farmers, who hardly have any alternative source of energy. Local people are dependent upon the existing natural resources of the Reserved Forests and buffer zone of the national park and they had a large herds of cattle and practised pastoralism. These facts indicate that the socioeconomic development of the local people should be taken into consideration. This would be the key to the success of the sustainable national park management as well as the conservation progarmmes.

1.2. Objectives and rationale of the study

1.2.1. Objectives

The objectives of the study are:

- to collect, identify and document the plant species as permanent specimen for herbarium
- to investigate the ecological interrelationship within and among the plant species
- to gather information on uses and medicinal value of plant species
- to assess the contributions of the park to the livelihood of the local people
- to compare the plant species diversity of the inner portion of the core zone and that of outer portion (periphery) of the park so as to elaborate appropriate means and ways for plant species conservation.

1.2.2. Rationale of the research project

In Myanmar, systematic wildlife conservation activities started in 1981 under the UNDP/FAO Nature Conservation and National Park Project. Myanmar Forest Department has tried successively to conserve natural environment and forest ecosystems of Alaungdaw Kathapa National Park with the purposes of contributing towards regional and global biodiversity conservation and accruing environmental benefits for all mankind. Myanmar is also committed to fulfill the stipulations laid down by the Convention on Biodiversity in 1992. Myanmar Forest Policy, which was issued in 1995, focuses on protection of soil, water, wildlife, biodiversity and environment. It also seeks to extend the Protected Areas System (PAS) by gazetting from 4.7 % at present to 5 % of the total area of the country.

As other developing countries, population pressure and its socio-economic mixed factors are unavoidable so that illicit cutting, over-exploitation of non-timber forest products including variety of orchids and medicinal plants and encroachment into the buffer zone area have been challenging to the sustainable management of the national park and conservation of plant species diversity. Hence, identification, documentation and assessment of plant species need to be implemented urgently before they are lost forever due to increasing demands of forest products. All plant species would be useful for potential medicinal values.

In order to conserve the plant species diversity, assessment of existing plant species is an essential step and then effective conservation measures are developed. In this context, technical aspect alone is hard to achieve sustainable management and conservation of plant species. Active participation of local indigenous communities plays an essential role and their indigenous environmental knowledge can make to biodiversity protection and natural resource utilization. Current conservation and management system of protected areas including national parks and wildlife sanctuaries in Myanmar are lack of social dimensions of people living around the protected areas.

Therefore, socioeconomic aspects such as livelihood strategies, farming systems, dependence on forests (park), health and education etc., of local communities are incorporated into this study. The outcomes of this research project will contribute social, technical, botanical and ecological information to the decision makers (policy makers) and to the biodiversity conservation programme of the country.

2. Literature review

Conservation of biological diversity is widely understood as meaning conservation of rare and endangered species or rare and endangered communities such as wetlands. Biological diversity was defined by the 1992 Convention on Biological Diversity as (Ian F. Spellerberg,1996), “The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems”.

In ecology, the terms species richness, species composition and species diversity are used as measures of variety (Ian F. Spellerberg, 1996). Indices of species diversity have been devised so as to provide data in a simple and collective manner. In community ecology use is made of the terms alpha diversity (i.e., the diversity of species in a habitat), Beta diversity (i.e., a measure of the rate and extent of change in species along a gradient from one habitat to another) and Gamma diversity (i.e., the diversity of species within the geographical area).

The importance of biodiversity conservation gained international concern only recently. The World Commission on Environment and Development (WCED) constituted by the General Assembly of the United Nations published its report in 1987 which provided a major boost and endorsement to the need for conservaing the world’s rich biodiversity, particularly that of the tropical areas. The total number of species (flora) in the world is estimated to be around 5 to 30 millions out of which, about 1.4 million species have been described (P.C. Kotwal and Sujoy Banerjee, 2000; P.C. Kotwal and Suijoy Banerjee et., al.).

The most commonly quoted level of biological diversity is the number of species in an area. This is used because it is relatively easy and practical to count species and because conservation efforts in the past have concentrated on species protection (Ian F. Spellerberg et. al, 1996). Quantifying biological diversity at the species level is done simply by counting the species. However, there is more to species richness than just the number of species. Species are interacted each other. Differrent groups of species are found together in different places. This would be useful and relevant when comparing the biological diversity at species level of different sites. The number of species, the species composition and the taxonomic levels combined seem to be a useful way of quantifying and monitoring change in biological diversity at the species level. There are some species which are represented by only a few individuals but, generally speaking, species are made up of different populations and each population is made up of different individuals (Ian F. Spellerberg et. al, 1996).

Protected areas system play a vital role in the conservation of forest genetic resources as well as biodiversity conservation. The PAS serves three basic functions viz., benefit, education and recreation In the majority of the developing countries, it will possible to conserve genetic resources of only a relatively small proportion of socioeconomically important tree species within the protected areas (Lex Thomson and Ida Theilade, 2001).

The World Conservation Strategy suggests that the initial efforts of biodiversity conservation should aim at establishment and maintenance of a network of Protected Area system (IUCN, 1980). The strategy also lays down that considering the stress on environment, all countries should aim at earmarking 10% of their land area for PA network for biodiversity conservation. At a global level about 30,350 protected areas have been established and these covered 8.8% of the Earth's land area (IUCN, 1998). In Myanmar, 41 PAS have been established throughout the country and PAS occupies an area of 31,945 km^2 which covers 5.2 % of the country's total land area (FD, 2005).

Protected Areas System (PAS) is the most suitable strategy for biodiversity conservation because PAS are the "areas especially dedicated to the protection and maintenance of biological diversity and associated cultural resources, and managed through legal or other effective means" (IUCN, 1994). They cover various situations ranging from managed resources areas, protected watersheds, national parks and strictly protected reserves, to sacred forest groves. A well managed forest may be able to provide sustainable supply of a few forest tree or plant species, or a group of species in perpetuity. However, there is no molel of management yet known to be applicable within the short span of human life. The conserved PAS attract attention of global community and there is a clamour for visits to these areas for the purpose of research, education and enjoyment of the people. Thus the range of services and the values that the protected areas offer cannot be compared with other forest areas and therefore the management objective of protected areas cannot be the same as applicable to other areas in general.

In the Steering Committee meeting of the Commission of National Parks and Protected Areas (CNPPA) of World Conservation Union (IUCN) held in 1993, a consensus was reached to have the following set of categories for the PAS (S.C.Dey, 2000; P.C. Kotwal and Suijoy Banerjee et., al.).

Category I	Strict nature Reserve/Wilderness Areas: Protected areas managed maninly for science or wilderness protection
Category II	National Park: Protected areas managed mainly for ecosystem conservation and recreation
Category III	Natural Monument: Protected areas managed mainly for conservation of specific natural features.
Category IV	Habitat/Species Management Areas: Protected areas mainly for conservation through management intervention.
Category V	Protected Landscape/Seascape: Protected areas managed mainly for the landscape/seascape conservation and recreation
Category VI	Managed Resource Protected Area: Protected areas managed mainly for the sustainable use of natural ecosystems.

According to IUCN categories, National Parks in Myanmar fall in Category II and Wildlife Sanctuaries come under Category IV respectively. It can be seen that in National Parks, the main objective should be ecosystem conservation and recreation. The National Park should be kept inviolate so as to maintain biodiversity and continue ecological processes. Living resource conservation as well as biodiversity conservation is also one of a number of conditions necessary to assure human survival and well-being. It has three specific objectives (IUCN: World Consrvation Strategy, 1980):

1) To maintain essential ecologica processes and life-support systems on which human survival and development depend;

2) To preserve genetic diversity on which depend the breeding programmes necessary for the protection and improvement of cultivated plants and domesticated animals;

3) To ensure the sustainable utilization of species and ecosystems which support millions of rural communities as well as major industries.

In planning to harmonize protected areas conservation and human needs, a three-part strategy is generally adopted in many countries (Anon. 1996 cited by Lex Thomson and Ida Theilade, 2001):

1) Broadending the range of categories of protected areas, by extending beyond the traditional focus on strict protection and national parks to include those areas in which people live and use natural resources sustainably.

2) Broadening the approach to planning and management of protected areas by: threating them as part of the larger landscape, and better addressing the needs of local people.

3) Broadening the number of partners involved in the establishment and management of protected areas, so that the role of national government is complemented by the involvement of regional and local governments, indigenous peoples, community groups, NGOs and the private sector.

In areas of high population pressure, a primary focus of planning in situ conservation programme as well as protected areas system should be reconcile conservation activities with immediate human needs. In areas of high resource-use conflict, planning of protected area conservation measures must include formulation of local participatory development schemes for the management, production and protection of renewable forest resources (Lex Thomson and Ida Theilade, 2001).

In order to strengthen the role of protected areas for forest genetic resources conservation as well as biodiversity conservation, a number of specific measures to be undertaken are presented as follows (Lex Thomson and Ida Theilade, 2001):

1) Take conservation of forest genetic resources into greater consideration in the planning of new protected areas
2) Improve linkages and coordination between government departments involved in conservation and management of forest genetic resources.
3) Undertake inventory of forest tree species.
4) Institute effective protection of forest genetic resources.
5) Actively manage forest genetic resources.
6) Restore degraded areas within protected areas and buffer zones.
7) Develop and implement a comprehensive bio-regional conservation plan which includes establishment of forested corridors to link protected areas with other forested parts of the landscape.
8) Establish additional protected areas in managed categories.
9) Ensure that forest genetic resources within protected areas remain available for scientific, conservation and other appropriate purposes.
10) Identify national and international priorities.
11) Ensure the sustainability of protected areas.

It is important to formulate appropriate strategies to conserve threatened genetic resources before they are lost forever. The strategies must be simple, flexible, and cost-effective as much as possible. Both in situ conservation and ex situ conservation strategies are important because in situ conservation is the ideal method of conserving wild plant genetic resources and ex situ conservation is a valuable complementary method for many species in order to secure genetic resources threatened with inevitable loss in their natural habitats (FAO, 1985). Therefore, they need to be considered complementary and be carried out in parallel as an integral part of the programmes.

3. Materials and methods

The following methods were incorporated into this study in order to collect the required data and to fulfill the set objectives:

(a) rapid inventory of plant species,
(b) systematic botanical studies and
(c) Rapid rural appraisal (Semi-structured interviews and formal questionnaire survey)

In order to conduct this study, tape, diameter tape, compass, hypsometer, taxonomy references, herbarium specimen were used for systematic botanical studies and forest inventory. Forest inventory and systematic botanical studies were conducted in the outer portion of the core zone of the park in the project year five. Identification and number of plant species occurring in the established sample plots were used to assess the level of plant diversity.

For the purpose of description on quantitative estimate of plant species diversity of inner portion of the core zone, transect lines were laid down systematically from a predetermined point, which is located approximately in the centre of the park, towards the four different directions i.e., Northeast, Southeast, Southwest, Northwest. Eight sample plots of each 50 m x 20 m (0.1 ha) in size were distributed with equal interval (0.8 km) on each direction in the project year four (for inner portion).

For the project year five i.e., outer portion, each direction was extended from the each of last-4-plots, which were investigated in the project year four, towards four directions respectively and sample plots were distributed systematically as the same procedure as inner portion. The aim is to obtain the representative tree species from different forest ecosystems of the park, to provide a quantitative estimate of plant species diversity, silvicultural conditions and stand dynamic of the forest. There were altogether 32 sample plots for outer portion of the core zone of the park, which cover an area of 3.2 hectare. Layout of sample plot was designated according to Joan Iskandar and Rusydi Kotanegara, 1995. In order to record, quantify and measure different parameters, each sample plot was divided into three different sized sub-plots for trees, shrubs, saplings, seedlings, climbers and herbs.

Semi-structured interviews and formal questionnaire survey were used for socio-economic study of eight surrounding villages, namely Kabaing, Thi-kone, Kan-pyu, Paung-wa, Kyat, Wun-kone, Tha-lauk and Thit-ya-bin, which are located about 10-20 km away from the boundary of the National Park. Five percent of households from each village were selected randomly and conducted the interview and formal questionnaire survey to quantify the consumption of forest products such as pole & post, fuelwood, bamboo, roofing materials (Thin-baung) and fodder by the households and to study the uses of medicinal plants. In this paper, the results of semi-structured interviews and formal questionnaire survey are presented as backgournd information of the study area in order to pay more attention on assessment of plant species diversity of the park. Data obtained from forest inventory, systematic botanical studies and socioeconomic survey were processed and analyzed using MS Excel 2000 in order to fulfill the set objectives.

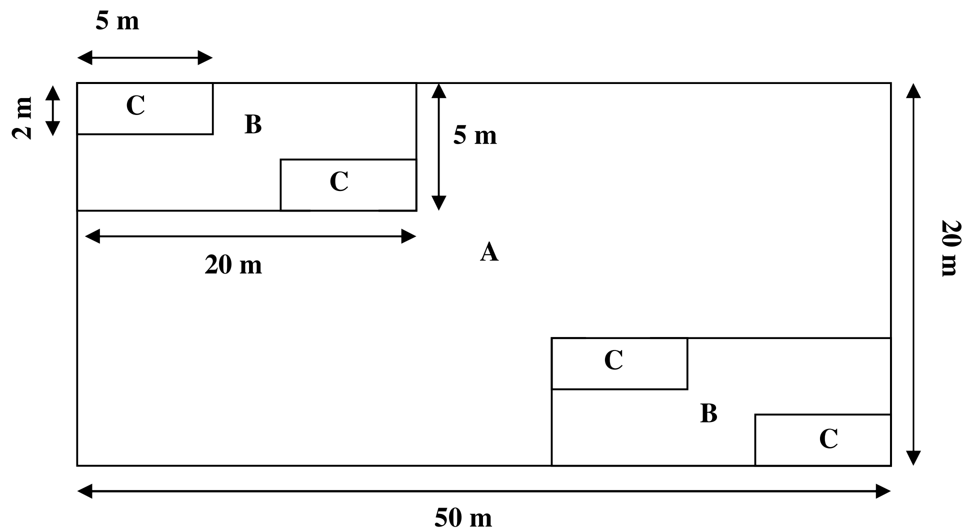

Figure 3. Layout of sample plots

Sub-plot A : 0.1 ha (50 m x 20 m) - record all trees with DBH ≥ 10 cm.

Sub-plot B : 0.01 ha (20 m x 5 m) - record of shrubs and saplings <10 cm dbh and > 130 cm in height.

Sub-plot C : 0.001 ha (5 m x 2 m) - count herbs, climbers and seedlings between 30 cm and 130 cm in height.

Distribution of sample plots in the inner portion and out portion of the core zone of the Alaungdaw Kathapa National Park

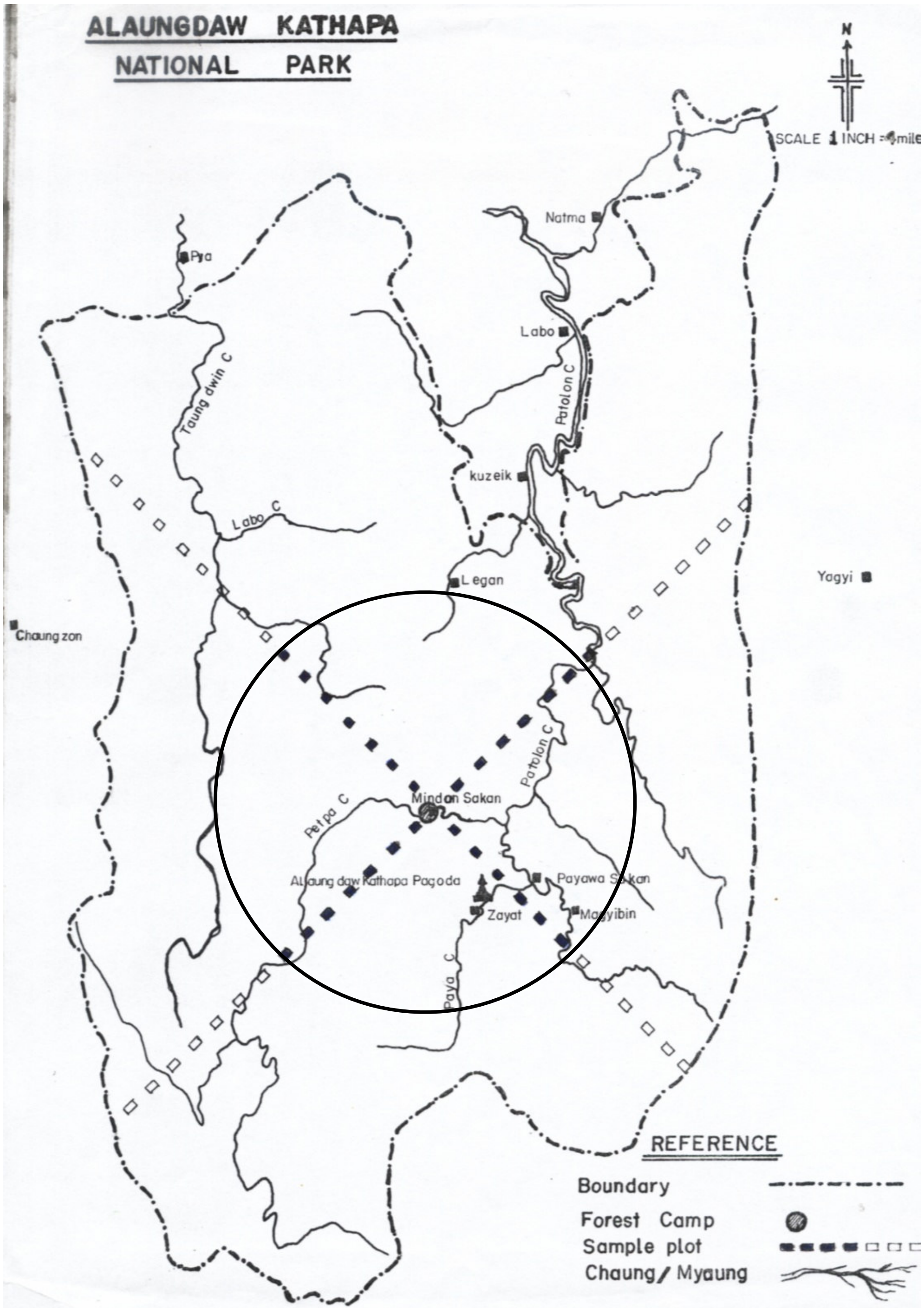

Figure 4. Distribution of sample plots

4. Results and discussion

4.1. Results of the study

During the project year four and five, the research activities were implemented in the inner portion and outer portion of the core zone of the national park respectively. The number of family, genera and species of trees, shrubs, climbers, herbs and bamboo, which were found in the established sample plots, are shown in Table 3.

Table 3. Number of families, genera and species of tree species occurred in inner and outer portions

No.	**Categories**	**Inner portion of the core zone (Project year four)**			**Outer portion of the core zone (Project year five)**		
		Family	**Genera**	**Species**	**Family**	**Genera**	**Species**
1	Trees*	47	110	145	45	112	165
2	Shrubs	22	29	33	19	25	28
3	Climbers	17	21	29	16	20	25
4	Herbs	7	10	14	7	10	13
5	Bamboos	1	3	5	1	3	5

*Trees with DBH≥10 cm

4.1.1. Species-area relationship (species area curve)

The species - area curve expresses the number of species in relation to the size of the area. It is the best criterion for determination of the minimum study area. It was drawn to show that a representative sample of the species composition was obtained by the sample plots. According to Cain (1959) and Lamprecht (1986), a sample plot is considered representative when an enlargement of the sample area by 10% results in a species number increase less than 10%. Under this study, the minimum study was determined based on such procedure so that it can be said that the sample area is sufficient as a minimum representative area for the study. The relationships between the number of species and area of the inner and outer portions of the core zone of the national park are shown in Figure 5.

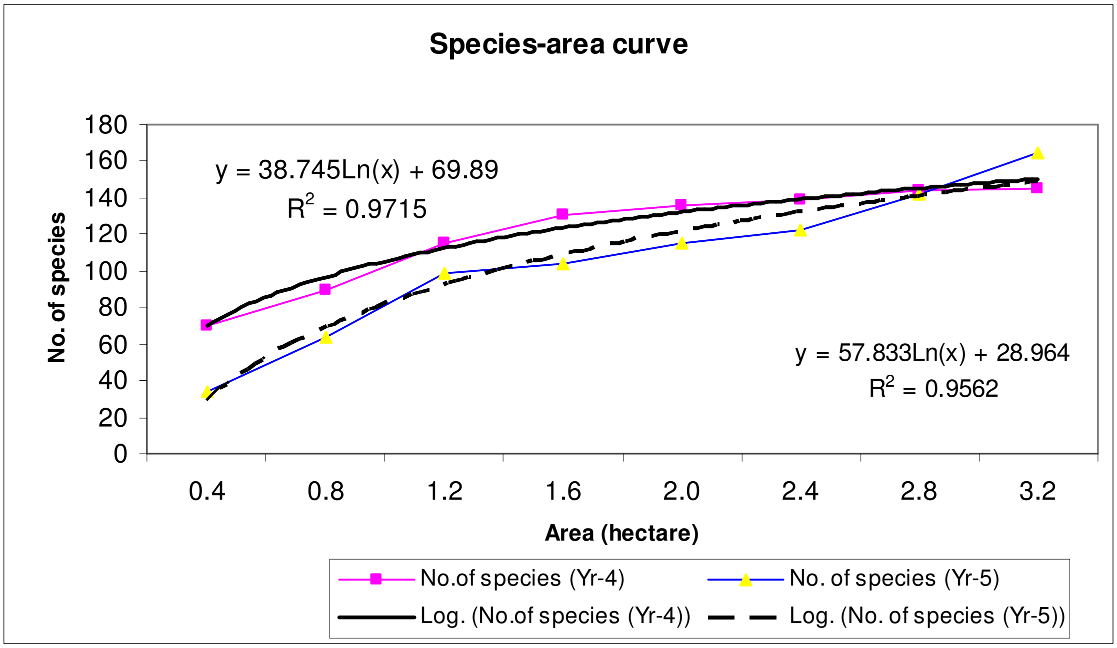

Figure 5. Species area curves of inner and outer portions for trees dbh ≥10 cm

The species area curves indicate species diversity in relation to increasing size of area. Both curves for all trees with diameter at breast height equal and greater than 10 cm (≥ 10 cm DBH) show a higher number of species per unit area. According to the curves, the number of species in the outer portion of the core zone is relatively higher than that of the inner portion.

4.1.2. Species richness

The number of species per unit area is used to measure the species richness and diversity in individual forest communities. The species richness is commonly expressed the number of species (tree species over a specified minimum diameter at breast height) per hectare (ha), which is also mentioned as species density. In forest vegetation analysis, the number of tree species over 10 cm diameter at breast height (dbh) is commonly quoted. Due to the results of the study, 45 species and 52 species per ha were found in the inner and outer portions of the core zone respectively. In addition, Jackknife estimator was also adopted in order to estimate the species richness per study area. This estimate is based on the observed frequency of rare species in the community. According to Heltshe and Forrester (1983), the equation of Jackknife estimate of species richness is as follows:

- **Jackknife estimate of species richness**

$$\hat{s} = s + \left(\frac{n-1}{n}\right)^{k} \qquad (1)$$

where, $\hat{s}$ = Jackknife estimate of species richness
s = observed total number of species in " n " sample plots
n = Total number of plots sampled
k = number of unique species

the variance of the Jackknife estimate of species richness is

$$\text{Var}(\hat{s}) = \left(\frac{n-1}{n}\right)\left(\sum_{j=1}^{s} (j^2 \cdot f_j) - \frac{k^2}{n}\right) \qquad (2)$$

where, Var $(\hat{s})$ = variance of Jackknife estimate of species richness
n = total number of plots sampled
k = number of unique species
f_j = number of plots containing "j" unique species (j = 1,2,3,…,s)

The variance can be used to obtain confidence limits for the Jackknife estimator as follows;

$$\hat{s} \pm t_{\alpha} \sqrt{\text{var}(\hat{s})} \qquad (3)$$

where, tα = Student's value for (n-1) degrees of freedom for the appropriate value of "α" .

(In this study, 95 % confidence tα = 2.26).

Table 4. Jackknife estimate of species richness

Parameters of Jackknife estimate species richness	Quantitative estimate of species richness (Inner portion of core zone)	Quantitative estimate of species richness (Outer portion of core zone)
Total number of quadrats sampled (n)	32	32
Number species per hectare	45	52
Total number of species (s)	145	165
Total individuals in all sample plots	1018	1120
Total number of unique species (k)	33 (3.06% of total individuals)	41 (3.66 % of total individuals)
Jackknief estimate of species richness (S)	**145.35**	**165.27**
Variance of Jackknife estimate of species richness var(S)	-29.09	-47.01
Confidence limits for Jackknife estimator	**145.35 + or - 12.19**	**165.27 + or - 15.5**
Upper limit	157.54	180.77
Lower limit	133.16	149.77
95 % confidence limit of t-alpha is 2.26		

Table 4 shows that the jackknife estimate of species richness of inner portion is 145.35 + or - 12.19 and that of outer portion is 165.27 + or - 15.5. It was observed that the inner portion of the core zone of the park is mainly dominated by Deciduous forest type because typical species of deciduous forest such as teak (*Tectona grandis*), Pyinkado (*Xylia xylocarpa*), Taukkyan (*Terminalia crenulata*), Padauk (*Pterocarpus macrocarpus*), Thinwun (*Millettia pendula*), Gyo (*Schleichera oleosa*), Hnaw (*Adina cordifolia*), Zinbyun (*Dillenia pentagyna*) etc., and bamboo species such as Tinwa (*Cephalostachyum pergracile*) and Wabo (*Dendrocalamus brandisii*) were found throughout the inner portion of the core zone. However, in the outer portion of the core zone, deciduous forest, semi-evergreen, pine forest, Indaing (Dipterocarp) forest and dry forest types were found in patches across the outer portion due to the widespread locations of the sample plots and consequently high differences between plots in terms of topography, geology, climatic and edaphic conditions.

4.1.3. Species diversity and evenness

Species diversity is a combination of richness and evenness. Species diversity and evenness is somehow related to the frequency of rare and common species. Species diversity expresses the degree of evenness of the mixture of species. Diversity is greatest if each species contributes the same proportion of the number of individuals of the forest community (Bruenig, 1989 quoted in Dr. Nyi Nyi Kyaw, 2004). In any ecosystem, the typical feature of specie frequency distribution is that many rare species with only few individuals are found in combination with a few species, which possess comparatively large number of individuals. The species frequency distributions of the inner and outer portions of the core zone are shown in Figure 6 and 7.

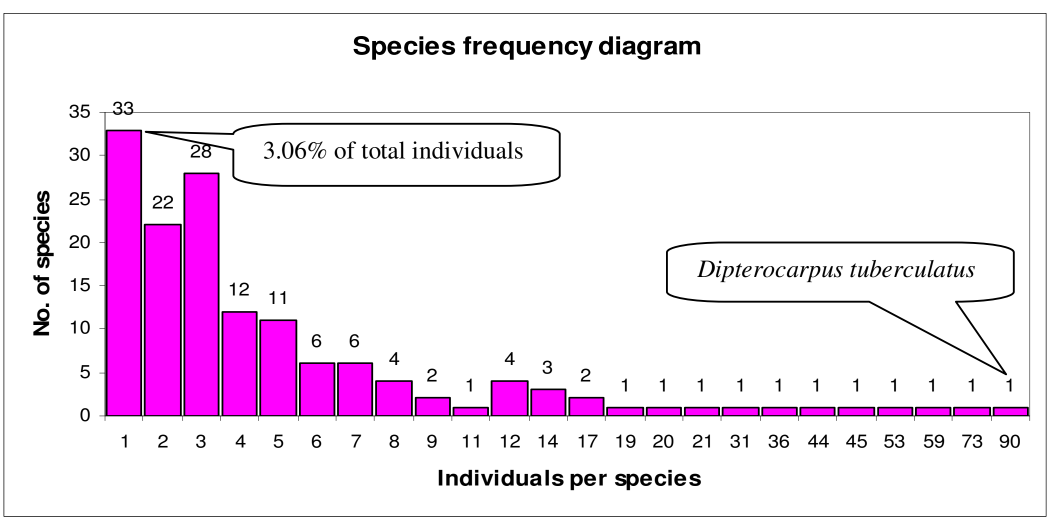

Figure 6. Species frequency distributions of the inner portion of the core zone

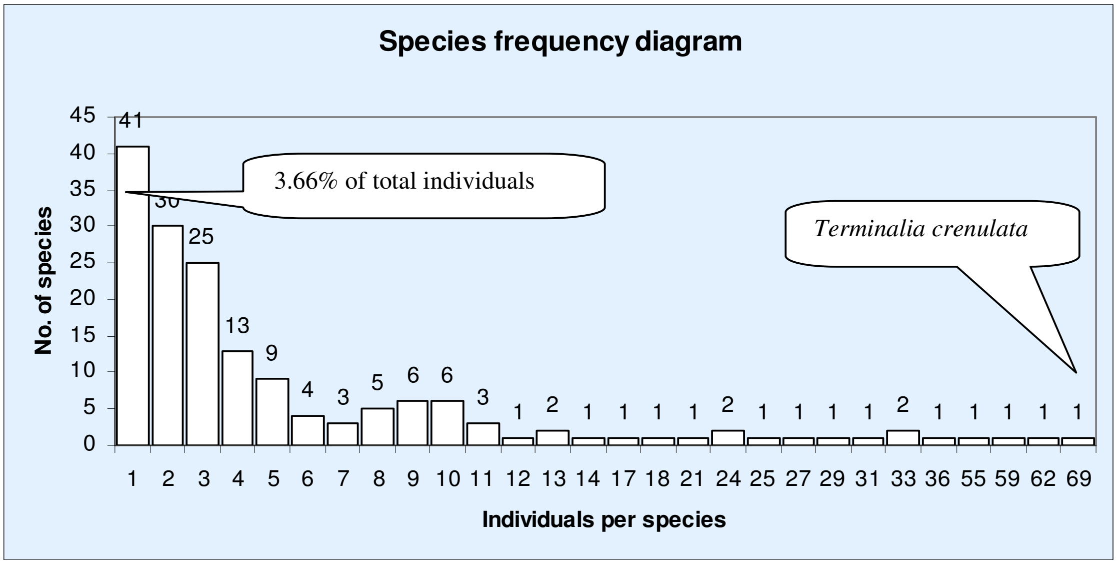

Figure 7. Species frequency distribution of the outer portion of the core zone

It was observed that 33 species (3.06% of total individuals) occupied only one individual each in the inner portion of the core zone whereas 41 species (3.66% of total individuals) with only one individual in the outer portion. In the inner portion of the core zone, In (*Dipterocarpus tuberculatus*) was found to be the most abundant species followed by Taukkyan (*Terminalia crenulata*), Teak (*Tectona grandis*) and Pyinkado (*Xylia xylocarpa*) etc.

In the outer portion of the core zone, Taukkyan (*Terminalia crenulata*) was found to be the most abundant species followed by In *(Dipterocarpus tuberculatus),* Pyinkado (*Xylia xylocarpa),* Than (*Terminalia oliveri*) and Teak (*Tectona grandis)* and etc. *Tectona grandis* and *Xylia xylocarpa* are the most valuable tree species in Myanmar. According to the results, the number of rare species which has only one individual, in the outer portion is more than that of inner portion of the core zone of the national park. The list of unit species which were found in the inner and outer portions of the core zone of the national park can be seen in Annex 1.

4.1.4. Species diversity (Simpson Diversity and Shannon Diversity Indices)

Diversity indices are better measure of the species diversity of a forest than the species density and mixture ration and more informative than species counts alone (Weidelt, 2000). According to Magurran (1998), species diversity is often expressed by two indices, namely, Shannon index (H'), Evenness (E%) and Simpson’s index (D). Shannon diversity index places more weight on the rare species while Simpson’s diversity index emphasis on the common species (Weidelt, 2000). It is generally accepted that both indices give appropriate measures of diversity, and provide different insights into the diversity of the forest. In order to provide the quantitative estimate of plant diversity and its main parameters, the equations of Shannon and Simpson indices are shown.

- **Simpson's Diversity Index**

$$D = \sum_{i=1}^{s} \frac{(n_i (n_i - 1))}{(N (N - 1))} \qquad (4)$$

where, D = Simpson's index of diversity

n_i = number of individuals of species "i" in the sample

s = number of species in the sample

N = total number of species in the sample

- **Shannon Diversity Index**

$$H' = \sum_{i=1}^{s} P_i l_n (P_i) \qquad (5)$$

where, H' = index of species diversity

S = number of species in the sample

Pi = proportion of total sample belonging to "i^{th}" species

ln = the theoretical maximum value of diversity by a given number of total species (S) found in the sample.

- **Evenness**

$$E(\%) = 100.H'/lnH_{max} \qquad (6)$$

where, E = Shannon’s Evenness (evenness measure, range 0-1)

H' = Shannon-Wiener function

H_{max} = ln (S); the theoretical maximum value of diversity by a given number of total species (S) found in the sample.

In Simpson’s diversity index, as the value of D increase, diversity decreases. Therefore, Simpson’s diversity index is usually expressed as reciprocal form (i.e. 1/D or 1-D). This ensures that the value of the index increases with increasing diversity (Magurran, 1988). The calculated diversity parameters are shown in Table 5.

Table 5. Shannon and Simpson diversity indices and diversity parameters of inner and outer portions of the core zone

Parameters of plant diversity	**Quantitative estimate (inner portion of the core zone)**	**Quantitative estimate (outer portion of the core zone)**
Number of species per ha	45	52
Number of trees (individuals) per ha	318	350
Individuals per species	0.14	0.15
Shannon's Diversity Index (H')	**4.17**	**4.38**
Shannon's Evenness (E%)	**84%**	**86%**
Simpson's Diversity Index (D)	0.029	0.021
(1 - D)	0.971	0.98
(1/ D)	34.48	47.62

According to the results of the study, the plant species diversity of the outer portion of the core zone is relatively higher than that of the inner portion of the core zone. The result from Simpson's index is also inline with Shannon index. Similarly, the evenness of outer portion of the core zone is also slightly higher than that of the inner portion.

4.1.5. Coefficient of similarity

The coefficient of similarity is generally used as a means of comparing stands from floristic point of view (Lamprecht, 1989 quoted in Dr. Nyi Nyi Kyaw, 2004).The formula of the coefficient of similarity was proposed by Sörensen (1948) as follows:

$$Ks = \frac{2c}{a + b} \times 100 \qquad (7)$$

Ks = Coefficient of similarity
a = number of species in the inner portion of the core zone
b = number of species in the outer portion of the core zone
c = number of species common to both stand

Sörensen index is based on the presence or absence of species. If both stands (portions) are floristically identical, Ks value is 100 and if they are completely different, Ks is zero. The coefficient of similarity modified by Weidelt (2000), which is based on the calculation of dominance (basal area) of species, was also used in this study. The formula of the modified coefficient of similarity is as follows:

$$K_G = \frac{2Gc}{Ga + Gb} \times 100 \qquad (8)$$

K_G = Coefficient of similarity

Ga = total basal area of the species in the inner portion of the core zone

Gb = total basal area of the species in the outer portion of the core zone

Gc = sum of smaller values of basal area of each common species in both stands (portions)

Table 6. Coefficient of similarity of the inner and outer portion of the core zone

Category	**Quantitative estimate of coefficient of similarity**
Coefficient of similarity (Sörensen index), based on presence or absence of species (Ks)	**80.65**
Coefficient of similarity (Weidelt), based on dominance (basal area of species) (K_G)	**78.61**

The coefficient of similarity for the inner portion and outer portion of the core zone are calculated and presented in Table 4. According to the results, Ks gives the higher similarity value between two portions in terms of floristic composition. There are altogether 125 common species, which were found in both portions. The geographical situations, edaphic and climatic conditions of these two portions are not much different and thus the major forest types, which were dominant in both portions, are more or less the same. As a result, the coefficient of similarity as well as the number of common species is high between two portions. On the other hand, the coefficient of similarity, which is based on the dominance of the species (K_G), also shows a higher similarity between two portions. It indicates that the two portions have the more or less the same structure and basal area cover. If the basal area covers of two portions are different, the value of coefficient of similarity would be low. Based on two coefficients of similarities, it can be concluded that the inner and outer portions of the core zone of the park is considerably the same in species composition and structure of the stand.

4.1.6. Importance Value Index (IVI)

Silvicultural Importance Value Index is the most well known indicator to generalize the analytical results of individual forest surveys in order to gain a quick overview and to make immediate comparison between different surveys. On the other hand, the ecological significance of a species can be compared by IVI in a given type (Lamprecht, 1989). It is noted that the best known is the Importance-Value-Index (IVI) of Curtis and McIntosh (Lamprecht, 1989). Importance Value Index for each species is calculated by adding up relative dominance, relative abundance and relative frequency. Mathematically, it can be expressed as follows:

$$IVI = R.A + R.F + R.B.A \qquad (9)$$

where,

Relative abundance (R.A) = percentage of each species on total stem number per hectare

Relative frequency (R.F) = percentage of each species contribution to the sum of absolute frequency

Relative dominance (R.D) = percentage of each specie's basal area on sum of basal area of all species. Relative basal area (R.B.A) stands for the dominance of the species

$$R.B.A = \frac{\text{Total basal area of a given species}}{\text{Sum of total basal area of all species}} \times 100 \qquad (10)$$

The dominance, abundance, frequency and importance value index (IVI) for 10 most important species of the inner portion of the core zone is shown in Table 7.

Table 7. Importance value index (IVI) of 10 most important species in the inner portion of the core zone

No.	Common name	Scientific name	Abundance (n/ha)	Frequency (%)	B.A/ha (m^2)	IVI
1	Taukkyan	*Terminalia crenulata*	23	75	3.75	**18.46**
2	Kyun	*Tectona grandis*	18	47	4.46	**16.70**
3	Pyinkado	*Xylia xylocarpa*	17	50	4.66	**16.67**
4	In	*Dipterocarpus tuberculatus*	28	28	3.13	**16.21**
5	Tha-bye	*Syzygium cumini*	14	41	1.91	**10.32**
6	Thit-ya	*Shorea obtusa*	14	34	1.22	**8.59**
7	Gyo	*Schleichera oleosa*	6	41	1.81	**7.58**
8	Tinyu	*Pinus khasya*	11	9	1.62	**7.04**
9	Ingyin	*Shorea siamensis*	10	31	0.99	**6.70**
10	Padauk	*Pterocarpus macrocarpus*	5	28	1.64	**6.32**
11	**Other species**		**172**		**29.77**	**185.40**
	Total		**318**		**54.95**	**300**

Regarding the species composition, the most abundant species in the investigated stand is *Terminalia crenulata* and it also possesses the greatest IVI value followed by *Xylia xylocarpa* and *Tectona grandis*. However, the relative dominances (basal area) of *Xylia xylocarpa* and *Tectona grandis* are found to be the largest in the stand. According to the IVI values of two most abundant species, associated type of the investigated stand may be recognized as *Terminalia crenulata*, *Tectona grandis.* The dominance, abundance, frequency and importance value index (IVI) for 10 most important species of the outer portion of the core zone is shown in Table 8.

Table 8. Importance value index (IVI) of the 10 most important species in the outer portion of the core zone

No.	Common name	Scientific name	Abundance (n/ha)	Frequency (%)	B.A/ha (m^2)	IVI
1	Pyinkado	*Xylia xylocarpa*	18	66	5.90	**22.46**
2	Taukkyan	*Terminalia crenulata*	22	56	2.49	**15.11**
3	Kyun	*Tectona grandis*	14	44	3.15	**13.73**
4	In	*Dipterocarpus tuberculatus*	19	19	1.98	**11.11**
5	Than	*Terminalia oliveri*	14	19	2.20	**10.18**
6	Thinwun	*Milletia pendula*	9	38	1.27	**7.68**
7	Tinyu	*Pinus Khasya*	10	9	1.39	**6.65**
8	Thabye	*Syzygium cumini*	8	28	1.24	**6.61**
9	Yon	*Anogeissus acuminate*	5	38	1.22	**6.50**
10	Ingyin	*Shorea siamensis*	8	22	1.21	**6.45**
11	**Other species**		222		22.31	**193.52**
	Total		**350**		**44.37**	**300**

According to the results shown in Table 8, the most abundant species in the investigated stand is *Xylia xylocarpa* and it also possesses the greatest IVI value followed by *Terminalia crenulata, Tectona grandis, Dipterocarpus tuberculatus and Terminalia oliveri etc*. However, the relative dominances (basal area per hectare) of *Xylia xylocarpa* and *Tectona grandis* are found to be the largest in the investigated stand. According to the IVI values of two most abundant species, associated type of the investigated stand may be recognized as *Xylia xylocarpa - Terminalia crenulata.*

In both portions of the core zone, it was observed that the four species i.e., *Tectona grandis*, *Xylia xylocarpa*, *Terminalia crenulata* and *Dipterocarpus tuberculatus* possess the greatest IVI value and the species of high IVI value (i.e., 10 most important species) can be considered as representative species of a forest type and they should be taken into account ecologically important species in conservation activities. The detail list of IVI value of each species can be seen in Annex 2.

4.1.7 Stand structure

4.1.7.1. Horizontal structure

In the inner and outer portion of the core zone, there were 312 trees and 350 trees (>10 cm dbh) per hectare respectively. The total number of saplings, shrubs, climbers, herbs and seedlings, which were found in the sample plots, are shown in Table 9.

Table 9. Horizontal structure of the outer portion of the inner and outer portions of the core zone

DBH Classes	**Total number (inner portion of the core zone)**			**Total number (outer portion of the core zone)**		
	BA/ha (m^2)	**Trees/ha**	**Small trees/study area**	**BA/ha (m^2)**	**Trees/ha**	**Small trees/study area**
Plot A (≥10 cm dbh)						
10 - 19.9 cm	1.34	72		1.57	89	
20 - 29.9 cm	2.68	55		3.93	82	
30 - 39.9 cm	5.16	53		7.03	73	
40 - 49.9 cm	6.44	42		6.26	40	
50 - 59.9 cm	8.27	36		6.48	28	
60 - 69.9 cm	7.37	21		5.31	16	
70 - 79.9 cm	4.89	11		3.94	9	
80 - 89.9 cm	3.75	7		2.26	4	
90 - 99.9 cm	3.71	5		3.06	4	
> 100 cm	11.34	10		4.59	4	
Total (≥10 cm)	**54.95**	**312**		**44.43**	**350**	
Subplot B (0.64 ha)						
Saplings <10cm dbh >130cm ht.			533			155
Shrubs			139			115
Subplot C (0.064ha)						
Seedlings (between 30 cm and 130 cm in ht.			809			238
Climbers			174			170
Herbs			73			69
Total (<10 cm dbh)			**1728**			**747**

The relative abundance-diameter distribution diagram and relative basal area–diameter distribution diagram of the inner and outer portions of the core zone of the park are shown in Figure 8 and 9 respectively in order to compare the stand conditions of two portions of the core zone.

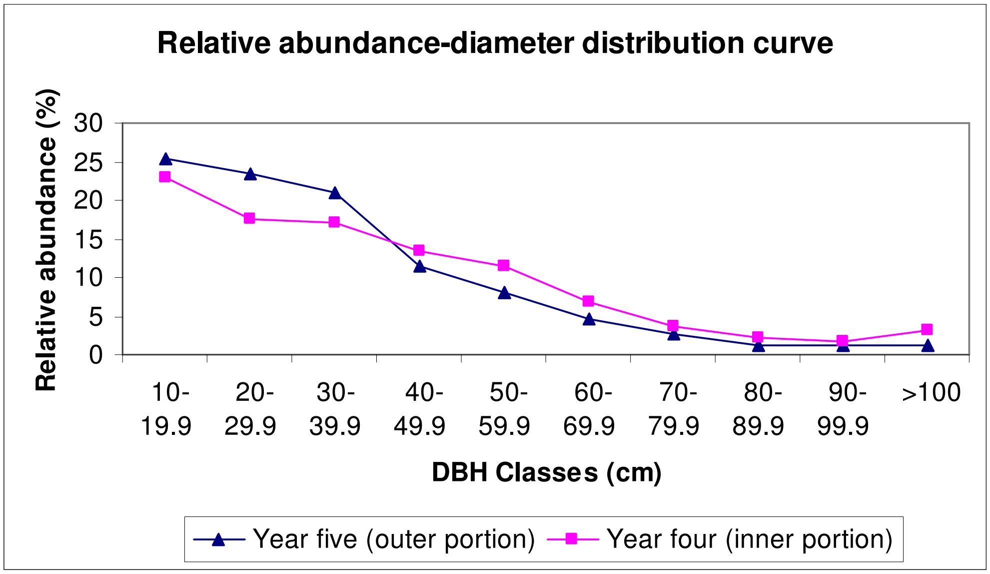

Figure 8. Relative abundance - diameter distribution of the inner and outer portions of the core zone

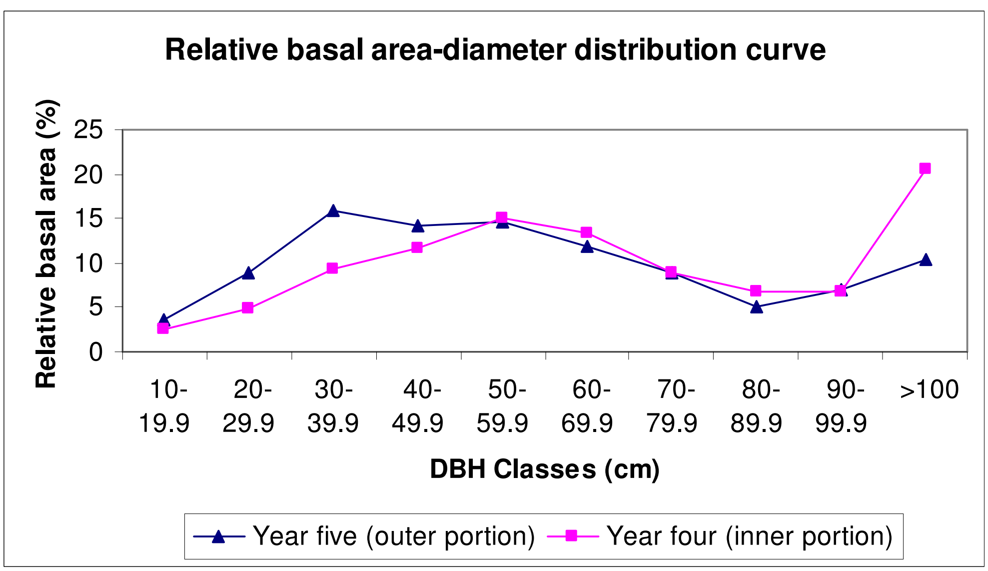

Figure 9. Relative basal area – diameter distribution of the inner and outer portions of the core zone

As shown in Figure 8, the relationship between two portions in terms of relative abundance-diameter distribution is not much different. The number of small diameter classes of the outer portion is relatively more abundant than that of inner portion. But the number of larger diameter classes of inner portion is slightly more than that of outer portion.

Figure 9 show that the diameter class (30-39.9 cm) possesses the highest percentage of relative basal area in the outer portion whereas diameter classes (50-59.9 cm) and over 100 cm occupied the highest percentage. The horizontal species occurrence and percentage of total species found in the inner and outer portion of the core zone of the park are presented in Table 10.

Table 10. Horizontal species occurrence and percentage of total species of two portions

DBH Classes (cm)	**Inner portion of the core zone**		**Outer portion of the core zone**	
	No. of species	**% of total species**	**No. of species**	**% of total species**
≥ 120	7	5	4	2.42
< 120 ≥ 90	28	19	13	7.88
< 90 ≥ 60	51	35	35	21.21
< 60 ≥ 30	95	66	108	65.45
< 30≥ 10	115	79	119	72.12

In the inner portion of the core zone, 7 species were observed to be the biggest trees (≥ 120 cm dbh) which have 5% of total species. These species are Kyaung-byu (*Maesa spp.*),Gyo (*Schleichera oleosa*), Thit-seint (*Terminalia bellerica*), Myauk-lok (*Artocarpus lakoocha*), Gyoke (*Diospyros montana*), Pyinkado (*Xylia xylocarpa*) and Thabye(*Syzygium cumini*).

In the outer portion of the core zone, 4 species were observed to be the biggest trees (≥ 120 cm dbh) which have 2.4% of total species. These species are Thapan (*Ficus glomerata*),Baing (*Tetrameles nudiflora*), Pyinkado (*Xylia xylocarpa*) and Myauk-ngo (*Duabanga grandiflora*). The second biggest tree species in the investigated stand (100 cm<DBH>120cm) are Myauk-ngo (*Dubanga grandiflora*), Pyinkado (*Xylia xylocarpa*), Teak (*Tectona grandis*), Sit (*Albizzia procera*), Thabye (*Syzygium cumini*) and Padauk (*Pterocarpus macrocarpus*).

4.1.7.2. Vertical stand structure

Species occurring in different vertical layers are summarized for the investigated stand in order to realize the regeneration and successional patterns of the species. The vertical storey distribution was distinguished into 7 different patterns for the analysis of the species represented in different storeys as shown in Table 11.

Table 11. Vertical structure of the inner and outer portions of the core zone

Canopy classes	**Inner portion of the core zone**			**Outer portion of the core zone**		
	Total species /each storey	**% of total species**	**Species/ha**	**Total species / each storey**	**% of total species**	**Species/ha**
U+M+L	27	18.6	8.4	15	9.1	4.7
U+M	7	4.8	2.2	25	15.15	7.8
U+L	2	1.4	0.6	18	10.9	5.6
U	1	0.7	0.3	28	17.0	8.8
M+L	56	38.6	17.5	69	41.81	21.6
M	25	17.2	7.8	116	70.3	36.3
L	28	19.3	8.8	115	69.7	35.9

U+M+L= Species occurring in all storeys (Upper, Middle and Lower)
U+M = Species occurring in Upper and Middle storey
U+L = Species occurring in Upper and Lower storey
U = Species occurring in Upper storey
M+L = Species occurring in Middle and Lower storey
M = Species occurring in Middle storey
L = Species occurring in Lower storey

U+M+L: Species occurring in all storeys: In the inner and outer portions of the core zone**,** 27 species and 15 species were found in all storeys. Nine species, which have the grestest IVI value, namely, Teak (*Tectona grandis*), Pyinkado (*Xylia xylocarpa*) and Padauk (*Pterocarpus macrocarpus*), In (*Dipterocarpus tuberculatus*), Taukkyan (*Terminalia crenulata*), Thabye (*Syzygium cumini*), Thitya (*Shorea obtusa*) , Ingyin (*Shorea siamensis*), Gyo (*Schleichera oleosa*) were included in all storeys of the inner portion of the core zone. Seven species, which possesses the greatest IVI value in the investigated stand, namely, Teak (*Tectona grandis*), Pyinkado (*Xylia xylocarpa*), Taukkyan (*Terminalia crenulata*), Thabye (*Syzygium cumini*), Thin-wun (*Milletia pendula*), Than (*Terminalia oliveri*) and Yon (*Anogeissus acuminata*) were included in all storeys of the outer portion.

U+M: Species occurring in the Upper and Middle storeys: In the inner and outer portions, 7 and 25 species were found respectively in two storeys i.e., upper and middle storeys of the respective stand (portion). It was noticed that these species have no young stage trees for succession.

U+L: Species occurring in Upper and Lower storeys: Two species in the inner portion and 18 species in the outer portion were found in two storeys, namely, upper and lower storeys. These species are missing in the upper storey of the respective stand (portion).

U: Species occurring only in the Upper storey: In this storey, the medium and small sized trees are missing. Only one species and 28 species were included in the upper storey of the inner and outer portions respectively

M+L: Species occurring in Middle and Lower storeys., There are 56 species and 69 species in the inner and outer portions respectively and these species were found in the middle and lower storeys of the respective stand (portion)

M: Species occurring only in the Middle storey. There are 25 species in the inner portion and 116 species in the outér portion of the core zone. The young stages of these species are missing in the respective portion for their succession.

L: Species occurring only in the Lower storey. The mother trees or seed trees with large size of these trees may exist outside the plots. Most of the species which were found only in the lower storey are non-economically important species which are always remain small in height. There are 28 species in the inner portion and 115 species in the outer portion of the core zone.

4.2. Discussion

Generally, the current management regimes of existing PAS including the Alaungdaw Kathapa National Park are typically designed for conservation of forest ecosystems, which is often compatible with conservation of genetic resources in situ but not always so. The current PAS are not likely to provide conservation of important plant species. It is necessary to consider that mere establishment of protected areas does not ensure species conservation and socioeconomic development. Therefore, PAS need to be designed for conservation of many species (especially priority species) coupled with the socioeconomic development of the local people.

The integrated conservation of forest ecosystems serve as a reservoir of continually evolving tree species and population and fulfill the basic needs of the people. Thus, special measures need to be planned and undertaken in order to conserve, if possible, each species or habitat or biological diversity. Forest resources in PAS also need to be assigned consumptive and non-consumptive values so that the conservation of forest resources can be linked to the sustainable socio-economic development of the local people.

Sustainable forest management (SFM) and conservation of forest resources are interdependent. From stand point of biodiversity conservation regarding SFM, it is the multipurpose management of the forest to ensure that its capacity to provide goods and services is not diminished over time. Many target species are not adequately represented in protected areas, nor included in plantation and domestication programmes. The management practices of the forests in Myanmar are favoring the development of only a few commercial species overlooking the future use of other species which are not economically important at present. Some of the lesser known or less economically important species may depend on complicated ecological interaction. Therefore, an integrated approach encompassing management of natural stands and establishment of specific conservation populations is advocated.

As one of the key objectives of SFM is the maintenance of viable breeding populations of the main commercial timber species as well as species which provide non-wood forest products for local communities, monitoring and assessment on the current forest management practices are needed. Detailed planning and good management, including special attention to basis silvicultural practices, can ensure compatibility among the sustainable productive, protective and social functions of the forests. Then management interventions are necessary that will better ensure genetic conservation, and need to be properly integrated into forest management practices.

The forest working plans need to have exhaustive lists of species and the working plan prescriptions need to be extended to conserve all the species occurring in the area rather than covering only a few selected species. A list of endangered species, their distribution and status are necessary to document, update, and maintain for all areas (management units). More knowledge about the species, habitats and the intricate relationship between species are required for planning of forest resources conservation and management. Similar information regarding species, which are commercially exploited (legal or illegal), must be well documented and their illegal exploitation must be curbed. Accordingly, harmonizing conservation and management objectives and practices in production-oriented or multiple-use native forests is essential for conservation of forest genetic resources of the above-mentioned species.

The reproductive ecology and population dynamics remain unknown or poorly understand for the majority of tree species in Myanmar. If such key information of species is available, this can help to develop better conservation plans. It will also help to identify how species can be better utilized in a more sustainable way. This will not improve their conservation status, but also benefit of the people or countries utilizing the resources.

Integrated buffer zone management approach in protected areas is becoming very popular throughout the world because it can contribute not only protective function to the core zone of the national park or protected areas but also productive functions to the socioeconomic development of the indigenous people. In Myanmar, buffer zone approach in protected areas including the Alaungdaw Kathapa Naitonal Park does not work well to fulfill its objective completely. Thus effective buffer zone management including buffer zone agroforestry needs to be taken into account for sustainable conservation of plant diversity.

The most important fact is that conservation without local people's involvement is almost invariably not a viable option. However, it can be difficult to develop sustainable use systems in a social environment where tenure and user rights are poorly defined. Nevertheless, a combined conservation and sustainable use approach has the greatest lager potential to provide substantial benefits to people near and remote from such protected areas.

5. Recommendations

In order to conserve biological diversity of the Alaungdaw Kathapa National Park as well as other PAS on a sustainable basis, the following recommendations are developed.

1) Plant diversity of the Alaungdaw Kathapa National Park should be conserved as a matter of principle because all species are components of life support system of human being and all species in an ecosystem are interdependent.
2) Buffer zone of the Alaungdaw Kathapa National park should be managed more comprehensively and intensively in order to prevent the core zone from the encroachments including agricultural land expansion, human settlement and livestock grazing etc. Integrated approach as well as joint management can gain people's participation in the protection of all zones and responsible use of resources from the buffer zone of the PAS and multiple use zones around them.

3) Forest fire is prevalent during summer in the Alaungdaw Kathapa National Park. This has a lot of adverse effects including loss of biodiversity, biomass and damage to regeneration. Therefore, the forest fire needs to be taken into consideration for future conservation programme.
4) Infrastructure development as well as upgrading of the the Alaungdaw Kathapa National Park should be carried out with great care and it should be minimal impacts on especially environment and social and cultural aspects of the indigenous people.
5) Evaluation and assessment on biodiversity conditions in the Alaungdaw Kathapa National Park and in other PAS should be carried out as an instrument for sustainable conservation/management of national level and regional level as well. Identification of specific factors responsible for loss of plant diversity/biodiversity in each PAS is inevitably needed for the planning of long term existacne of plant species.
6) Thorough inventories need to be undertaken of forest tree species present in each protected area and their status. Information also ought to be gathered on each population, habitat, associated species including its extent and size, with detailed location. This information can be used for planning of conservation programme.
7) The management plan of a national park or a PAS should include certain recommendations for the protection of all species existing in each national park or PAS. For this purpose, detailed inventory of all the species has to be prepared. This list should include the status of each species, i.e., of occurrence, abundance, frequency, their uses and threat to existence.
8) List of threatened species at the local level ought to be prepared and updated so that conservation efforts may be focused on these species in the given area (conservation area).
9) Networking of PAS is essential for biodiversity conservation and to avoid inbreeding. For this purpose, forest corridors connecting protected areas need to be specifically mapped, marked and protected.
10) Conventional national park management system, in general, should be shifted into integrated approach (or participatory approach). It means that policy makers, development planners or Forest Department and forest conservators should cooperate with indigenous people in a common approach to resource management and socioeconomic development.

11) The objectives of the establishment of a national park or PAS should define not only the technical aspect of biodiversity conservation but also include in the context of local needs, aspirations, attitudes, traditions, usages, priorities, and values as priority of conservation. Indigenous knowledge and ethno-biological values of species by local communities should be used for biodiversity conservation.
12) Ever growing human and cattle population should be checked annually since it is the root cause of biodiversity erosion. Population growth rate and family planning should be carefully taken into account and regulated in villages nearby the national park or PAS.
13) The generation of awareness regarding environment and importance of forests becomes a necessary ingredient for the conservation of biodiversity so that local people should be trained and encouraged to improve their environmental knowledge and to motivate and participate in national park management activities as well as conservation efforts. The attitude and perception of the peoples need to be chaged from “Government forest, they should protect it” to “Our forests, we will protect it”.
14) Unless financial income is genereated and there is economic stake for the people for protecting these areas, the problems could multiply and biodiversity conservation goals may not be achieved to the desired level. In parallel with biodiversity conservation, the development of socioeconomic conditions of the indigenous people should be one of the urgent priorities.
15) Environmental education, awareness building and motivation initiatives on biodiversity issues should be part of the management strategy. Ideal traditional plant and wildlife knowledge and skills should be identified, documented and used as educational tools.
16) Foerst Department needs to develop closer working relations in order to help identify, monitor and better conserve forest resources within protected areas. A greater focus ought to be placed on coserving priority forest resources in the planning of Protected Areas network, both in the identification of new areas and zoning in the existing protected areas.

6. Conclusion

Biodiversity is part of daily lives and livelihoods of human being and constitutes the resource upon which families, communities, nations and future generation depend. Every gene, species or ecosystem lost represents the loss of an available option to adapt to local and global change. The problem of biodiversity conservation has become a global issue. It is being realized that the forests existing in a country is not a resource just for that country, but for the whole of the world. Although the planning, execution and management of the Alaungdaw Kathapa National Park as well as a PAS is the primarily the responsibility of the Forest Department (government), the local people and non-governmental organizations should be fully involved to ensure that all the resources available to conservation are deployed coherently and to accelerate the achievement of conservation objectives. It is well recognized that the forests within reserved forests and protected areas system exist today because of the legal protection offered to such areas. Thus the provision of law should be strengthened by changing of people's perception towards conservation, combined with certain measures which will ensure and fulfill the basic needs of the local people.

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ANNEX 1

Unique species which were found in the inner portion of the core zone of the Alaungdaw Kathapa National Park

No.	Local Name	Family	Botanical Name
1	Chinbyit	Caesalpiniaceae	*Bauhinia malabarica Roxb.*
2	Hmaik	Boraginaceae	*Cordia grandis Roxb.*
3	Hman	Rubiaceae	*Xeromphis spinosa Lamk.*
4	Hman-byu	Rubiaceae	*Gardenia turgida Roxb.*
5	Hpaw	Araliaceae	*Trevesia palmate (Roxb. Ex Lindl.)*
6	*	Meliaceae	*Dysoxylum spp.,*
7	Kinmalin	Euphorbiaceae	*Antidesma spp*
8	Kuthan	Rubiaceae	*Hymenodictyon orixense (Roxb.) Mabb.*
9	Kyet-yo	Verbenaceae	*Vitex peduncularis Wall.*
10	Kyungauk-new	Verbenaceae	*Vitex limonifolia Wall.*
11	Lettok-thien	Apocynaceae	*Wrightia arborea (Dennst.) Mabb.*
12	Linyaw	Dilleniaceae	*Dillenia parviflora Griff.*
13	Ma-hlwa	Bignoniaceae	*Markhamia stipulata(Wall.)Seeme.exK.*
14	Ngu-shwe	Caesalpiniaea	*Cassia fistula L.*
15	Nibase	Rubiaceae	*Moninda tinctoria Roxb.*
16	Linlun	Euphorbiaceae	*Sapium baccatum Roxb.*
17	Palan	Caesalpiniaceae	*Bauhinia racemosa Lam.*
18	Pet-le-zin	Verbenaceae	*Vitex peduncularis Wall.*
19	Phet-wun	Tiliaceae	*Berrya mollis Wall.*
20	Pyaukseik	Ulmaceae	*Holoptelea integrifolia Plench*
21	Shawni	Sterculiaceae	*Sterculia villosa Roxb.*
22	Si-gye	Verbenaceae	*Premna macrophylla*
23	Taung-letkok	Sterculiaceae	*Pterygota alata(Roxb.)R.Br.*
24	Taw-kanako	Euphorhiaceae	*Cleidion spiciflorum Merr.*
25	Taw-kyet-mauk	Sapindaceae	*Erioglossum spp.*
26	Tawyuzana	Rutaceae	*Murrya paniculata W.t.A*
27	Te	Ebenaceae	*Diospyrous burmanica Kurz.*
28	Thaminza	Rubiaceae	*Randia dumetorum Lam.*
29	Tha-nat	Boraginaceae	*Cordia dichotoma Forst.*
30	Thit-e	Fagaceae	*Castanopsis argyrophylla King*
31	Thit-ma-gyi	Mimosaceae	*Albizia odoratissima(L.f.)Benth.*
32	Yingat-gale	Rubiaceae	*Gardenia obtusifolia Roxb.*
33	Zaung-gyan	Santalaceae	*Osyris wightiana Wall.*

* Local name is not available.

ANNEX 1

Unique species which were found in the outer portion of the core zone of the Alaungdaw Kathapa National Park

No.	Local name	Family	Botanical name
1	*	Rubiaceae	*Canthium umbellatum*
2	Dauk-yut	Symplocaceae	*Symplocos racemosa Roxb.*
3	Hmaik	Boraginaceae	*Cordia grandis Roxb.*
4	Htama-soke	Euphorbiaceae	*Glochidion coccineum Muell. Arg.*
5	Kadet	Capparaceae	*Crateva magna (Lour.) DC.*
6	Kadut	Moraceae	*Ficus hispida L.f.*
7	Kanyin	Dipterocarpaceae	*Dipterocapus turbinatus Gaertn.f.*
8	Kha-aung	Moraceae	*Ficus hirta Vahl.*
9	Khaung	Anacardiaceae	*Rhus paniculata Wall.*
10	Kin-malin	Euphorbiaceae	*Antidesma spp.*
11	Kyauk-thabye	-	*Unidentified*
12	Kyet-ma-oak	Myrsinaceae	*Ardisia humilis Vahl*
13	Kyetsataw	-	*Unidentified*
14	Lein	Combretaceae	*Terminalia pyrifolia Kurz*
15	Letpan	Bombacaceae	*Bombax ceiba L.*
16	Mahlwa	Bignoniaceae	*Markhamia stipulata(Wall.)Seem.ex. K.*
17	Mayanin-kyet-su	Rutaceae	*Zanthoxylum budrunga Wall.*
18	Myauk-lok	Moraceae	*Artocarpus lakoocha Roxb.*
19	Nyaung	Moraceae	*Ficus retusa L.*
20	O-dein	Simaroubaceae	*Ailanthus triphysa (Dennst.) Alston*
21	On-don (2)	Lauraceae	*Litsea polyantha Juss.*
22	Ondon-laukya	Lauraceae	*Litsea monopetala (Roxb.) Pers.*
23	Pantama	Meliaceae	*Melia composita Willd.*
24	Phet-lezin	Verbenaceae	*Vitex peduncularis Wall.*
25	Phet-waing	Euphorbiaceae	*Macaranga denticulata Muell. Arg.*
26	Pyauk-seik	Ulmaceae	*Holoptelea integrifolia Planch.*
27	Sagwe	-	*Unidentified*
28	Shaw-ni	Sterculiaceae	*Sterculia villosa Roxb.*
29	Taung-letkok	Sterculiaceae	*Pterygota alata (Roxb.) R.Br.*
30	Taungtangyi	Verbenaceae	*Premna integrifolia L.*
31	Taw-Khanpin	Apocynaceae	*Carissa spinarum A.DC.*
32	Taw-yuzana	Rutaceae	*Murraya paniculata (L.) Jack*
33	Thabye-ywet-they	Myrtaceae	*Syzygium fruticosum DC.*
34	Thaminsa	Rubiaceae	*Randia dumetorum Lam.*
35	Thanat	Boraginaceae	*Cordia dichotoma Forst.*
36	Thayet-cho	Sapotaceae	*Xantolis tomentosa Raf.*
37	Thin-dwe-nyo	Ebenaceae	*Diospyros coaetanea*
38	Thitkado	Meliaceae	*Toona ciliata M.Roemer*
39	*	-	*Unidentified*
40	Yethaphan	Moraceae	*Ficus glomerata Roxb.*
41	Zi-talaing	Rhamnaceae	*Zizyphus rugosa Lam.*

*Local name is not available.

ANNEX 2

Importance Value Index (IVI) of the tree species (DBH≥10 cm) in the inner portion of the core zone of the Alaungdaw Kathapa National Park

No.	Local name	Botanical Name	R. A.	R.F	R.B.A	IVI
1	Taukkyan	*Terminalia crenulata (Heyne)Roth*	7.17	4.47	6.82	18.46
2	Kyun (Teak)	*Tectona grandis L.f*	5.80	2.79	8.11	16.70
3	Pyinkado	*Xylia xylocarpa (Roxb)Toub.*	5.21	2.98	8.49	16.67
4	In	*Dipterocapus tuberculatus Roxb.*	8.84	1.68	5.69	16.21
5	Tha-bye	*Syzygium cumini (L.) Skeels.*	4.42	2.42	3.48	10.32
6	Thit-ya	*Shorea obtusa Wall.*	4.32	2.05	2.22	8.59
7	Gyo	*Schleichera oleosa(Lour)Oken.*	1.87	2.42	3.29	7.58
8	Tinyu	*Pinus khasya Royle ex Parl.*	3.54	0.56	2.95	7.04
9	Ingyin	*Shorea siamensis(Kurz)Miq.*	3.05	1.86	1.80	6.70
10	Padauk	*Pterocarpus macrocarpus Kurz*	1.67	1.68	2.98	6.32
11	Zinbyun	*Dillenia pentagyna Roxb.*	2.06	2.79	1.47	6.32
12	Binga	*Mitragyna rotundifolia (Roxb.) Kuntze*	1.96	2.23	2.04	6.24
13	Nagye	*Pterospermum semisagittalum Buch-Ham.*	1.18	1.86	1.61	4.65
14	Yon	*Anogeissus acuminate Wall.*	1.38	2.05	1.10	4.53
15	Yindaik	*Dalbergia cultrata Grah.*	1.38	2.05	1.03	4.45
16	Sai-kya	*Quercus mespilifolia Wall.*	1.67	1.49	1.27	4.43
17	Pyinma-ywet-gyi	*Lagerstroemia macrocarpa Kurz.*	1.18	1.68	1.49	4.34
18	Kyun-nalin	*Premna pyramidata Wall.*	1.18	1.68	1.17	4.02
19	Thit-seint	*Terminalia bellerica Roxb.*	0.69	1.30	1.94	3.93
20	Tamalan	*Dalbergia oliveri Gamble*	1.08	1.68	0.75	3.50
21	Bambwe	*Careya arborea Roxb.*	0.79	1.30	1.33	3.42
22	Khabaung	*Strychnox nux-blunda A.W. Hill*	0.88	1.68	0.74	3.30
23	Myauk-lok	*Artocarpus lakoocha Roxb.*	0.39	0.56	2.30	3.25
24	Thet-yin-gyi	*Croton roxburghianus.N.P.Balakr*	1.38	1.12	0.73	3.22
25	Kyaung-byu	*Maesa spp.*	0.29	0.37	2.18	2.84
26	Thinwin	*Milletia pendula Benth.*	0.79	1.30	0.58	2.67
27	Myauk-chaw	*Homaliun tomentosum Benth.*	0.88	1.12	0.67	2.67
28	Phankha	*Terminalia chebula Retz*	0.69	1.12	0.79	2.60
29	Phet-than	*Heterophragna adenophylla (Wall)*	0.69	1.30	0.57	2.56
30	Thit-pwe	*Elaeocarpus floribundus Blume.*	0.49	0.74	1.29	2.52
31	Taw-thidin	*Mallotus philipinensis(Lam).Muell.Arg.*	0.69	1.30	0.51	2.50
32	Chinyok	*Garuga pinnata Roxb.*	0.49	0.93	1.07	2.50
33	Gyoke	*Diospyros montana Roxb.*	0.49	0.56	1.41	2.46
34	Daukyat	*Symplocos racemosa Roxb.*	1.18	0.93	0.31	2.42
35	Thadi	*Protium serratum Engl.*	0.59	0.93	0.85	2.37
36	Thit-ni	*Wendlandia tinctoria DC.*	0.69	0.93	0.67	2.29
37	Seik-chi	*Bridelia retus (L.)A.Juss.*	0.59	1.12	0.40	2.11
38	Lettok-gyi	*Holarrhena pubescens Wall.exG.Don*	0.59	1.12	0.34	2.04
39	Letpan-kha	*Alstonia scholaris(L.)R.Br.*	0.49	0.74	0.73	1.97

40	Lunbo	*Buchanania lanzan Spreng.*	0.79	0.93	0.23	1.95
41	Yin-sat	*Dalbergia fusca Pierre*	0.49	0.74	0.70	1.94
42	Indaing-thabye	*Eugenia jambolana Lam.*	0.79	0.93	0.14	1.86
43	Nabe	*Lannea coromandelica(Houtt).Mor*	0.49	0.93	0.41	1.83
44	Kathit	*Erythrina suberosa Roxb.*	0.59	0.74	0.48	1.82
45	Taung-thabye	*Ternstroemia japonica Thunb.*	0.69	0.74	0.22	1.65
46	Taw-thayet	*Mangifera caloneura Kurz*	0.39	0.74	0.44	1.58
47	Ma-U-Lettan-she	*Anthocephalus morindaefolius Korth.*	0.39	0.56	0.62	1.57
48	Tha-pan	*Ficus glomerata Roxb.*	0.59	0.56	0.40	1.55
49	Thit-ka-la	*Diospyros spp*	0.49	0.74	0.30	1.53
50	Nyaung	*Ficus retusa L.*	0.29	0.56	0.61	1.47
51	Zaung-bale	*Lagertroemia villosa Wall.ex.Kurz*	0.49	0.56	0.36	1.41
52	Yemein	*Aporusa roxburghii Buill.*	0.59	0.19	0.61	1.38
53	Zibyu	*Emblica officinalis Gaertn.*	0.39	0.74	0.24	1.38
54	Wet-shaw	*Firmiana colorata(Roxb).R.Br.*	0.29	0.56	0.52	1.38
55	Taw-gwe	*Spondias pinnata (L.) Kurz..*	0.39	0.74	0.23	1.37
56	Yepadauk	*Bischofia javanica Blume*	0.29	0.56	0.46	1.31
57	Thabut-net	*Mitrephora teysmanni Scheff.*	0.49	0.56	0.25	1.30
58	Hman-ni	*Gardenia erythroclada Kurz*	0.49	0.74	0.05	1.29
59	Didu	*Bombax insigne Wall.*	0.29	0.56	0.43	1.29
60	Myauk-ngo	*Duabanga grandiflora(Roxb.ex DC.)Walp*	0.39	0.56	0.31	1.27
61	Tauk-sha	*Vitex glabrata R.Br.*	0.39	0.56	0.30	1.25
62	Than-te	*Stereospermum colais*	0.39	0.56	0.28	1.23
63	Dwa-ni	*Eriolaena candollei Wall.*	0.29	0.37	0.56	1.22
64	Kyaung-sha	*Oroxylum indicum(L.)Kun*	0.29	0.56	0.37	1.22
65	Shaw-byu	*Sterculia versicolor Roxb.*	0.29	0.37	0.54	1.21
66	Thit-si	*Melanorrhoea usitata Wall.*	0.49	0.37	0.33	1.20
67	Sugyin	*Harrisonia perforata Merr.*	0.29	0.37	0.53	1.19
68	Yemane	*Gmelina arborea Roxb.*	0.20	0.37	0.61	1.18
69	Thit-pa-yaung	*Nauclea sessilifolia.Roxb.*	0.29	0.56	0.31	1.16
70	Thet-yin-lay	*Croton joufra Roxb.*	0.39	0.37	0.39	1.16
71	Yinma	*Chukrasia velutina Roem.*	0.29	0.56	0.29	1.15
72	Okshit	*Aegle mamelos (L.) Correa*	0.29	0.37	0.46	1.13
73	Letpan	*Bombax ceiba L.*	0.20	0.37	0.55	1.12
74	Phet-sut	*Eriobotrya bengalensis (Roxb.) Hook. f.*	0.29	0.37	0.45	1.11
75	Hnaw	*Adina cordifolia Hook.f*	0.39	0.37	0.34	1.10
76	Yepati	*Drypetes roxburghii*	0.39	0.19	0.51	1.09
77	Than-thet	*Albizia lucidior (Steud.) Nielsen*	0.29	0.37	0.34	1.01
78	Baing	*Tetrameles nudiflora R,Br.*	0.29	0.56	0.15	1.01
79	Taw-phet-sut	*Turpinia coehinchinensis (lour.) Merr.*	0.29	0.37	0.34	1.01
80	Bebya	*Cratoxylum neriifoliam Kurz*	0.29	0.56	0.15	1.00
81	Sin-thapan	*Ficus auriculata Lour.*	0.29	0.37	0.33	0.99
82	Sanse	*Linociera terniflora Wall.*	0.29	0.37	0.32	0.99

83	Tabauk	*Dalbergia paniculata Roxb.*	0.29	0.56	0.13	0.98
84	Kha-aung	*Ficus hirta Vahl.*	0.20	0.37	0.39	0.96
85	Pantama	*Melia composita Willd.*	0.20	0.37	0.35	0.92
86	Okhne	*Streblus asper Lour.*	0.39	0.37	0.14	0.90
87	Thabyu	*Dillenia indica L.*	0.20	0.37	0.27	0.84
88	Yingat-gyi	*Gardenia coronaria Buch-Ham.*	0.20	0.37	0.24	0.81
89	Kadut	*Ficus hispida L.f.*	0.29	0.37	0.13	0.79
90	Kalamat	*Mansonia gagei J.R.Drumm.*	0.29	0.37	0.10	0.77
91	Taung-peinne	*Artoearpus chaplasha Roxb.*	0.20	0.37	0.19	0.76
92	Ondon	*Litsea glutinosa (Lour) C.B. Rob*	0.20	0.37	0.18	0.75
93	Thabut-gyi	*Milius velutina Hool.f.&Thomson*	0.29	0.37	0.08	0.75
94	Minbaw	*Caryota miltis Lour.*	0.29	0.19	0.26	0.74
95	Naywe	*Flacourtia cataphracta Roxb.*	0.29	0.37	0.07	0.74
96	Pauk	*Butea monosperma(Lam.)Kuntze*	0.29	0.37	0.07	0.74
97	Thabut-thein	*Milius roxburghiana Hook.f.& Thomson*	0.29	0.37	0.05	0.71
98	Zi-ta-laing	*Zizyphus rugosa Lam.*	0.29	0.19	0.20	0.69
99	Swedaw	*Bauhinia acuminata L.*	0.20	0.37	0.11	0.68
100	O-dein	*Ailanthus triphysa (Dennst.) Alston*	0.20	0.37	0.09	0.66
101	Thanakha	*Hesperethusa crenulata(Roxb.) Roem.*	0.20	0.19	0.28	0.66
102	Phet-wun	*Berrya mollis Wall.*	0.10	0.19	0.37	0.65
103	Linlun	*Sapium baccatum Roxb.*	0.20	0.37	0.08	0.65
104	Thitkado	*Toona ciliata M.Roemer*	0.20	0.37	0.05	0.62
105	Auchinsa	*Amoora wallichii King*	0.20	0.37	0.03	0.60
106	Madama	*Dalbergia ovata Grah.*	0.20	0.37	0.02	0.58
107	Ma-hlwa	*Markhamia stipulata(Wall.) Seem. Ex K.*	0.10	0.19	0.28	0.56
108	Taw-kanako	*Cleidion spiciflorum Merr.*	0.10	0.19	0.28	0.56
109	Taw-kyet-mauk	*Erioglossum spp.*	0.10	0.37	0.08	0.55
110	Sagawa	*Michelia champaca L.*	0.20	0.19	0.15	0.54
111	Taung-letkok	*Pterygota alata(Roxb.)R.Br.*	0.10	0.19	0.23	0.51
112	Kywe-ma-gyo-lein	*Stereospermum suaveolens DC.*	0.20	0.19	0.10	0.48
113	Te	*Diospyrous burmanica Kurz.*	0.10	0.19	0.18	0.47
114	Tayaw	*Grewia tiliifolia Vahal.*	0.20	0.19	0.08	0.47
115	Kinmalin	*Antidesma spp*	0.10	0.19	0.17	0.45
116	Thabye-ywet-they	*Syzygium fruticosum DC.*	0.20	0.19	0.06	0.44
117	Sha	*Acacia catechu Willd.*	0.20	0.19	0.06	0.44
118	Taw-kyat-sa	*Chionanthus ramiflora Roxb.*	0.20	0.19	0.04	0.42
119	Taung-tangyi	*Premna integrifolia L.*	0.20	0.19	0.02	0.40
120	Thit-e	*Castanopsis argyrophylla King*	0.10	0.19	0.07	0.35
121	Pyaukseik	*Holoptelea integrifolia Planch.*	0.10	0.19	0.06	0.35
122	Nyaung-kyat	*Ficus obtusifolia Roxb.*	0.10	0.19	0.05	0.34
123	Hpaw	*Trevesia palmate (Roxb. Ex Lindl.)*	0.10	0.19	0.05	0.34
124	Tha-nat	*Cordia dichotoma Forst.*	0.10	0.19	0.05	0.34
125	Si-gye	*Premna macrophylla Wall.*	0.10	0.19	0.05	0.33

126	Kyet-yo	*Vitex peduncularis Wall.*	0.10	0.19	0.05	0.33
127	Kyungauk-nwe	*Vitex limonifolia Wall.*	0.10	0.19	0.05	0.33
128	Nibase	*Morinda tinctoria Roxb.*	0.10	0.19	0.04	0.32
129	Hman-byu	*Gardenia turgida Roxb.*	0.10	0.19	0.04	0.32
130	Ngu-shwe	*Cassia fistula L.*	0.10	0.19	0.03	0.32
131	Palan	*Bauhinia racemosa Lam.*	0.10	0.19	0.03	0.32
132	Kuthan	*Hymenodictyon orixense (Roxb.) Mabb.*	0.10	0.19	0.03	0.31
133	Tawyuzana	*Murrya paniculata W.t.& A*	0.10	0.19	0.03	0.31
134	Lettok-thien	*Wrightia arborea (Dennst.) Mabb.*	0.10	0.19	0.02	0.30
135	Shawni	*Sterculia villosa Roxb.*	0.10	0.19	0.01	0.30
136	*	*Dysoxylum spp.*	0.10	0.19	0.01	0.30
137	Chinbyit	*Bauhinia malaborica Roxb.*	0.10	0.19	0.01	0.30
138	Linyaw	*Dillenia parviflora Griff.*	0.10	0.19	0.01	0.30
139	Pet-le-zin	*Vitex peduncularis Wall.*	0.10	0.19	0.01	0.29
140	Thit-ma-gyi	*Albizia odoratissima(L.f.)Benth.*	0.10	0.19	0.01	0.29
141	Zaung-gyan	*Oxyris wightiana Wall.*	0.10	0.19	0.01	0.29
142	Hman	*Xeromphis spinosa Lamk.*	0.10	0.19	0.01	0.29
143	Hmaik	*Cordia grandis Roxb.*	0.10	0.19	0.01	0.29
144	Yingat-gale	*Gardenia obtusifolia Roxb.*	0.10	0.19	0.01	0.29
145	Thaminza	*Randia dumetorum Lam.*	0.10	0.19	0.00	0.29
			100.00	**100.00**	**100.00**	**300.00**

* Local name is not available.

ANNEX 2

Importance Value Index (IVI) of the tree species (DBH≥10 cm) in the outer portion of the core zone of the Alaungdaw Kathapa National Park

No.	Local name	Scientific name	R.A	R.F	R.B.A	IVI
1	Pyinkado	*Xylia xylocarpa (Roxb.)Toub.*	5.27	3.90	13.29	22.46
2	Taukkyan	*Terminalia crenulata (Heyne)Roth*	6.16	3.35	5.61	15.11
3	Kyun (Teak)	*Tectona grandis L.f*	4.02	2.60	7.11	13.73
4	In	*Dipterocapus tuberculatus Roxb.*	5.54	1.12	4.46	11.11
5	Than	*Terminalia oliveri Brandis*	4.11	1.12	4.96	10.18
6	Thinwun	*Millettia pendula Benth.*	2.59	2.23	2.86	7.68
7	Tinyu	*Pinus khasya Royle ex Parl.*	2.95	0.56	3.14	6.65
8	Thabye	*Syzygium cumini (L.) Skeels.*	2.14	1.67	2.79	6.61
9	Yon	*Anogeissus acuminata Wall.*	1.52	2.23	2.75	6.49
10	Ingyin	*Shorea siamensis(Kurz)Miq.*	2.41	1.30	2.73	6.45
11	Thitya	*Shorea obtusa Wall.*	2.95	1.67	1.62	6.24
12	Binga	*Mitragyna rotundifolia (Roxb.) Kuntze*	2.23	2.23	1.25	5.71
13	Padauk	*Pterocarpus macrocarpus Kurz*	1.07	1.30	2.59	4.96
14	Pyinma-ywetgyi	*Lagerstroemia macrocarpa Kurz*	1.61	1.49	1.48	4.58
15	Taw-kanako	*Cleidion spiciflorum Merr.*	2.77	0.56	1.25	4.57
16	Thit-pagan	*Millettia brandisiana Kurz*	2.14	1.30	0.92	4.36
17	Saekya	*Quercus mespilifolia Wall.*	1.88	1.30	0.89	4.07
18	Zinbyun	*Dillenia pentagyna Roxb.*	1.16	1.67	1.06	3.89
19	Tauksha	*Vitex glabrata R.Br.*	1.25	1.49	0.63	3.36
20	Nagye	*Pterospermum semisagittatum Buch-Ham.*	1.16	1.30	0.74	3.20
21	Yindaik	*Dalbergia cultrata Grah.*	0.98	1.49	0.65	3.12
22	Kathit	*Erythrina stricta Roxb.*	0.89	0.93	1.29	3.11
23	Thanthet	*Albizia lucidior (Steud.)Nielsen*	0.71	1.30	0.92	2.94
24	Zaungbale	*Lagertroemia villosa Wall.ex.Kurz*	0.98	1.49	0.41	2.88
25	Ngu-shwe	*Cassia fistula L.*	0.98	1.49	0.38	2.85
26	Chin-yoke	*Garuga pinnata Roxb.*	0.71	1.30	0.79	2.80
27	Gyo	*Schleichera oleosa(Lour)Oken.*	0.89	1.30	0.57	2.76
28	Hnaw	*Adina cordifolia Hook.f*	0.80	0.93	0.97	2.71
29	Yepadauk	*Bischofia javanica Blume*	0.71	0.74	1.06	2.52
30	Panga	*Terminalia chebula Retz.*	0.71	1.49	0.32	2.52
31	Didu	*Bombax insigne Wall.*	0.89	0.93	0.69	2.52
32	Kywema-gyolein	*Stereospermum suaveolens DC.*	0.89	1.12	0.43	2.44
33	Tamalan	*Dalbergia oliveri Gamble*	0.89	1.30	0.22	2.41
34	Letpan-kha	*Alstonia scholaris(L.)R.Br.*	0.36	0.74	1.30	2.40
35	Kabaung	*Strychnos nux-blanda A.W. Hill*	0.80	1.30	0.17	2.27
36	Kyun-nalin	*Premna pyramidata Wall.*	0.80	0.93	0.46	2.19
37	Padauk-pho	*Unidentified*	0.71	1.12	0.35	2.18
38	Lunbo	*Buchanania lanzan Spreng.*	0.89	0.93	0.31	2.13
39	Sanse	*Linociera terniflora Wall*	0.80	0.74	0.58	2.12
40	Baing	*Tetrameles nudiflora R,Br.*	0.18	0.37	1.52	2.07
41	Thaphan	*Ficus glomerata Roxb.*	0.18	0.37	1.50	2.05
42	Okhne	*Streblus asper Lour.*	0.80	0.56	0.66	2.02

43	Bambwe	*Careya arborea Roxb.*	0.54	1.12	0.35	2.00
44	Myauk-ngo	*Duabanga grandiflora (Roxb.ex DC.)Walp*	0.18	0.19	1.59	1.95
45	Tawgwe	*Spondias pinnata (L.) Kurz..*	0.63	0.93	0.39	1.94
46	Thitpwe	*Elaeocarpus floribundus Blume.*	0.45	0.56	0.93	1.93
47	Zibyu	*Emblica officinalis Gaertn.*	0.80	0.93	0.11	1.84
48	Yinzat	*Dalbergia fusca Pierre*	0.36	0.56	0.82	1.74
49	Thadi	*Protium serratum Engl.*	0.45	0.56	0.67	1.67
50	Sit	*Albizzia procera (Roxb.) Benth.*	0.27	0.37	0.99	1.63
51	Seik-chi	*Bridelia retusa (L.)A.Juss.*	0.54	0.93	0.16	1.63
52	Lettok-gyi	*Holarrhena pubescens Wall.exG.Don*	0.63	0.74	0.24	1.61
53	Wetshaw	*Firmiana colorata(Roxb).R.Br.*	0.45	0.74	0.39	1.58
54	Kuthan	*Hymenodictyon orixense (Roxb.) Mabb.*	0.45	0.74	0.36	1.55
55	Te	*Diospyros burmanica Kurz*	0.45	0.74	0.35	1.54
56	Indaing-thabye	*Eugenia jambolana Lam.*	0.45	0.56	0.51	1.52
57	Hman-ni	*Gardenia erythroclada Kurz.*	0.63	0.74	0.10	1.47
58	Nabe	*Lannea coromandelica(Houtt).Merr.*	0.27	0.56	0.54	1.36
59	Gyok	*Diospyros montana Roxb.*	0.36	0.74	0.24	1.34
60	Na-ywe	*Flacourtia cataphracta Roxb.*	0.27	0.37	0.68	1.32
61	Thakhut	*Dolichandrone spathacea (L.f.) K. Schum*	0.36	0.56	0.35	1.27
62	Mayanin	*Pittosporum napaulensis (DG) Rehder & Wilson*	0.36	0.74	0.13	1.23
63	Taung-zibyu	*Phyllanthus albizzcoides (Kurz) Hook.f.*	0.36	0.74	0.12	1.22
64	Thabut-net	*Mitrephora teysmanni Scheff.*	0.54	0.37	0.31	1.22
65	Yemane	*Gmelina arborea Roxb.*	0.36	0.37	0.46	1.19
66	Tawthidin	*Mallotus philipinensis(Lam).Muell.Arg.*	0.36	0.74	0.09	1.19
67	Yemein	*Aporusa roxburghii Buill.*	0.54	0.56	0.07	1.16
68	Pauk	*Butea monosperma(Lam.)Kuntze*	0.18	0.37	0.56	1.11
69	Yingat-gyi	*Gardenia coronaria Buch-Ham.*	0.27	0.56	0.27	1.09
70	Shaw-phyu	*Sterculia versicolor Wall.*	0.18	0.37	0.53	1.08
71	Yinma	*Chukrasia velutina Roem.*	0.27	0.56	0.24	1.07
72	Ma-U-lettan-she	*Anthocephalus morindaefolius Korth.*	0.27	0.37	0.41	1.05
73	Myaukchaw	*Homalium tomentosum Benth.*	0.27	0.56	0.23	1.05
74	Thitpayaung	*Nauclea sessilifolia.Roxb.*	0.27	0.56	0.22	1.04
75	Palan	*Bauhinia racemosa Lam.*	0.36	0.56	0.09	1.01
76	Bebya	*Cratoxylum neriifoliam Kurz*	0.45	0.37	0.14	0.96
77	Taungpeinne	*Artocarpus chaplasha Roxb.*	0.45	0.37	0.14	0.96
78	Phetwun	*Berrya mollis Wall.ex Kurz*	0.27	0.56	0.12	0.94
79	Bu-hta-nyat	*Unidentified*	0.27	0.56	0.12	0.94
80	Kokko	*Albizzia lebbek (L.) Benth*	0.18	0.19	0.56	0.92
81	Tayaw	*Grewia tiliifolia Vahal.*	0.27	0.56	0.07	0.89
82	Thit-swele	*Engelhardtia spicata Blume*	0.36	0.19	0.33	0.88
83	Thetyin-gale	*Croton joufra Roxb.*	0.27	0.56	0.05	0.88
84	Kyaungsha	*Oroxylum indicum(L.)Kun*	0.27	0.56	0.05	0.87

85	Bonmeza	*Albizzia chinensis (Osbeck) Merr.*	0.27	0.37	0.23	0.87
86	Kyun-gauk-nwe	*Vitex limnifolia Wall.*	0.36	0.37	0.13	0.86
87	Lettok-thein	*Wrightia arborea (Dennst.) Mabb.*	0.27	0.56	0.03	0.86
88	On-don (1)	*Litsea glutinosa (Lour) C.B. Rob*	0.18	0.37	0.25	0.80
89	Thitsi	*Melanorrhoea usitata Wall.*	0.45	0.19	0.16	0.79
90	Kyaung-dauk	*Pajanelia longifolia (Willdr.) K. Schum*	0.18	0.37	0.23	0.78
91	Auchinsa	*Amoora wallichii King*	0.18	0.37	0.22	0.77
92	Thitmagyi	*Albizia odoratissima(L.f.)Benth.*	0.18	0.37	0.15	0.70
93	Myauk-ohshit	*Schrebera swietenioides Roxb.*	0.36	0.19	0.16	0.70
94	Mani-awaga	*Unidentified*	0.27	0.19	0.24	0.69
95	Yingat-gale	*Gardenia obtusifolia Roxb.*	0.27	0.37	0.04	0.68
96	Taung-thabye	*Ternstroemia japonica Thunb.*	0.27	0.19	0.22	0.67
97	Thabut-gyi	*Milius velutina Hool.f.&Thomson*	0.18	0.37	0.11	0.66
98	Okshit	*Aegle mamelos (L.) Correa*	0.27	0.19	0.21	0.66
99	Seboke	*Unidentified*	0.18	0.37	0.09	0.64
100	Phetthan	*Heterophragma adenophylla (Wall)Seem.*	0.18	0.37	0.07	0.62
101	Thetyin-gyi	*Croton roxburghianus.N.P.Balakr.*	0.36	0.19	0.07	0.61
102	Thitseint	*Terminalia bellerica Roxb.*	0.18	0.37	0.06	0.61
103	Thit-thant	*Unidentified*	0.18	0.37	0.05	0.60
104	Linyaw	*Dillenia parviflora Griff.*	0.18	0.37	0.05	0.60
105	Kyetyo	*Vitex canescens Kurz*	0.18	0.37	0.04	0.59
106	Nibase	*Morinda tinctoria Roxb.*	0.18	0.37	0.04	0.59
107	Chinbyit	*Bauhinia malabarica Roxb.*	0.18	0.37	0.03	0.58
108	Tawthayet	*Mangifera caloneura Kurz*	0.18	0.37	0.02	0.57
109	Nyaung-gyat	*Ficus obtusifolia Roxb.*	0.18	0.19	0.20	0.57
110	Sha	*Acacia catechu Willd.*	0.18	0.37	0.01	0.56
111	Shaw	*Sterculia angustifolia Jack*	0.18	0.19	0.20	0.56
112	Pan-ma	*Anneslea fragrans Wall.*	0.27	0.19	0.10	0.55
113	Kyaungbyu	*Maesa spp.*	0.27	0.19	0.09	0.54
114	Kanyin	*Dipterocapus turbinatus Gaertn.f.*	0.09	0.19	0.26	0.54
115	Ye-padi	*Drypetes roxburghii*	0.18	0.19	0.16	0.53
116	Swe-daw	*Bauhinia acuminata L.*	0.27	0.19	0.05	0.51
117	Taw-Kyetsa	*Chionanthus ramiflora Roxb.*	0.27	0.19	0.05	0.50
118	Thit-ni	*Wendlandia tinctoria DC.*	0.27	0.19	0.04	0.49
119	Pantama	*Melia composite Willd.*	0.09	0.19	0.22	0.49
120	Phet-lezin	*Vitex peduncularis Wall.*	0.09	0.19	0.21	0.49
121	Thabut-thein	*Miliusa roxburghiana Hook.f. &Thomson*	0.27	0.19	0.03	0.49
122	Ondon-laukya	*Litsea monopetala (Roxb.) Pers.*	0.09	0.19	0.19	0.46
123	Zimani	*Hiptage candicans Hook.f.*	0.18	0.19	0.08	0.44
124	Zi-talaing	*Zizyphus rugosa Lam.*	0.09	0.19	0.15	0.43
125	Hmaik	*Cordia grandis Roxb.*	0.09	0.19	0.15	0.42
126	Hman	*Xeromphis spinosa Lamk.*	0.18	0.19	0.06	0.42
127	Thitkado	*Toona ciliata M.Roemer*	0.09	0.19	0.15	0.42
128	Thitkala	*Diospyros spp.*	0.18	0.19	0.05	0.42
129	Myauk-lok	*Artocarpus lakoocha Roxb.*	0.09	0.19	0.13	0.41
130	Yethaphan	*Ficus glomerata Roxb.*	0.09	0.19	0.13	0.41
131	Tabauk	*Dalbergia paniculata Roxb.*	0.18	0.19	0.03	0.39

132	Madama	*Dalbergia ovata Grah.*	0.18	0.19	0.02	0.39
133	Nyaung	*Ficus retusa L.*	0.09	0.19	0.11	0.39
134	Taung-letkok	*Pterygota alata (Roxb.) R.Br.*	0.09	0.19	0.11	0.39
135	Hman-byu	*Gardenia turgida Roxb.*	0.18	0.19	0.02	0.38
136	Thin-dwe-nyo	*Diospyros coaetanea*	0.09	0.19	0.10	0.38
137	Letpan	*Bombax ceiba L.*	0.09	0.19	0.09	0.36
138	*	*Unidentified*	0.09	0.19	0.08	0.36
139	Htama-soke	*Glochidion coccincum Muell. Arg.*	0.09	0.19	0.08	0.35
140	O-dein	*Ailanthus triphysa (Dennst.) Alston*	0.09	0.19	0.07	0.35
141	Shaw-ni	*Sterculia villosa Roxb.*	0.09	0.19	0.07	0.35
142	Phet-waing	*Macaranga denticulata Muell. Arg.*	0.09	0.19	0.07	0.35
143	*	*Canthium umbellatum Wight.*	0.09	0.19	0.07	0.34
144	Sagwe	*Unidentified*	0.09	0.19	0.07	0.34
145	Kin-malin	*Antidesma spp.*	0.09	0.19	0.06	0.33
146	Thaminsa	*Randia dumetorum Lam.*	0.09	0.19	0.06	0.33
147	Pyauk-seik	*Holoptelea integrifolia Planch.*	0.09	0.19	0.05	0.33
148	Thabye-ywet-they	*Syzygium fruticosum DC.*	0.09	0.19	0.05	0.33
149	On-don (2)	*Litsea polyantha Juss.*	0.09	0.19	0.05	0.33
150	Lein	*Terminalia pyrifolia Kurz*	0.09	0.19	0.05	0.32
151	Kadut	*Ficus hispida L.f.*	0.09	0.19	0.04	0.32
152	Taw-yuzana	*Murraya paniculata (L.) Jack*	0.09	0.19	0.04	0.32
153	Thayet-cho	*Xantolis tomentosa Raf.*	0.09	0.19	0.04	0.31
154	Mayanin-kyet-su	*Zanthoxylum budrunga Wall.*	0.09	0.19	0.03	0.31
155	Kyauk-thabye	*Unidentified*	0.09	0.19	0.03	0.31
156	Kyetsataw	*Unidentified*	0.09	0.19	0.02	0.30
157	Taw-Khanpin	*Carissa spinarum A.DC.*	0.09	0.19	0.02	0.29
158	Khaung	*Rhus paniculata Wall.*	0.09	0.19	0.02	0.29
159	Thanat	*Cordia dichotoma Forst.*	0.09	0.19	0.01	0.29
160	Kadet	*Crateva magna (Lour.) DC.*	0.09	0.19	0.01	0.29
161	Mahlwa	*Markhamia stipulata(Wall.) Seem. ex K.*	0.09	0.19	0.01	0.29
162	Taung-tangyi	*Premna integrifolia L.*	0.09	0.19	0.01	0.29
163	Kyet-ma-oak	*Ardisia humilis Vahl*	0.09	0.19	0.01	0.29
164	Kha-aung	*Ficus hirta Vahl.*	0.09	0.19	0.01	0.28
165	Dauk-yut	*Symplocos racemosa Roxb.*	0.09	0.19	0.01	0.28
			100.00	**100.00**	**100.00**	**300.00**

ANNEX 3

List of medicinal plants which were most commonly used in the surrounding villages of the Alaungdaw Kathapa National Park

No.	Myanmar name	Family	Botanical name
1	Bonma-yaza	Apocynaceae	*Rauvolfia serpentina (L.)Benth.*
2	Eik-thara-muli	Aristolochiaceae	*Aristolochia roxburghiana Klotzsch.*
3	Gon-nyin-nwe	Mimosaceae	*Entada pursaehtha DC.*
4	Gwe-dauk	Asclepiadaceae	*Dregea volubilis Benth ex Hook.f.*
5	Kalamet	Sterculiaceae	*Mansonia gagei J.R.Drumm*
6	Kin-malin	Euphorbiaceae	*Antidesma spp.*
7	Kywe-u	Dioscoreaceae	*Dioscorea daemona Roxb.*
8	Lauk-thay	Fabaceae	*Tadchagi triquetrum (L.)H.Ohashi*
9	Letpan-kha	Apocynaceae	*Alstonia scholaris (L.)R.Br.*
10	Lettok-gyi	Apocynaceae	*Holarrhena pubescens Wall.ex G.Don*
11	Mahaga-kyansit	Polygonaceae	*Polygonum chinense L.*
12	Man-thone-gwa	Fabaceae	*Flemingia stricta Roxb.*
13	Myingaung-nayaung	Celastraceae	*Celastrus paniculatus Willd.*
14	Nan-khwe-yaing	Fabaceae	*Millettia racemosa Benth.*
15	Ngu-shwe	Caesalpiniaceae	*Cassia fistula L.*
16	Okhne	Moraceae	*Sterblus asper Lour.*
17	Panga	Combretaceae	*Terminalia chebula Retz.*
18	Pauk-nwe	Fabaceae	*Butea superba Roxb.*
19	Peik-chin	Piperaceae	*Piper cubebe L.f.*
20	Phone-mathein	Asteraceae	*Blumea balsamifera (L.)DC.*
21	Sayo	Piperaceae	*Piper attenuatum Buch-Ham.*
22	Se-ka-myin	Fabaceae	*Desmodium gyrans DC.*
23	Se-letwa	Araliaceae	*Schefflera venulosa Harms.*
24	Shaw-phyu	Sterculiaceae	*Sterculia versicolor Wall.*
25	Simidauk	Colchicaceae	*Gloriosa superba L.*
26	Sindon-ma-nwe	Menispermaceae	*Tinospora cordifolia Miers*
27	Suboke	Mimosaceae	*Acacia intsia Willd.*
28	Tabintaing-mya-nan	Vitaceae	*Cissus discolor Blume*
29	Taung-kya-yoni	Menispermaceae	*Stephania venosa (Blume)Spreng.*
30	Taung-tangyi	Verbenaceae	*Premna integrifolia L.*
31	Taw-pyindaw-thein	Rutaceae	*Clausena heptaphylla (Roxb.)Wight&Arn.*
32	Taw-sanwin	Zingiberaceae	*Curcuma aromatica Salisb.*
33	Thamya	Stemonaceae	*Stemona burkillii Prain*
34	Thet-yin-gale	Euphorbiaceae	*Croton joufra Roxb.*
35	Thet-yin-gyi	Euphorbiaceae	*Croton roxburghianus N.P.Balakr.*

36	Thit-seint	Combretaceae	*Terminalia bellerica Roxb.*
37	Wa-u-pin	Araceae	*Amorphophallus paeoniifolius (Dennst.)Nicolson*
38	Wun-u	Fabaceae	*Millettia extensa Benth.*
39	Zibyu	Euphorbiaceae	*Emblica officinalis Gaertn.*