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Quantitative Analysis of Forest Structure in the Middle Part of the Goktwin Area, Northern Shan State

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Abstract

The present study deals with the assessment of quantitative structure and floristic composition of forest in Goktwin area, northern Shan State. A total of 72 tree species representing 51 genera and 28 families were analyzed in the study area. Importance Value Index (IVI), Shannon-Wiener (H) index, Simpson (D) index, Shannon-Wiener evenness (E) index were calculated. *Shorea siamensis* (Kurz.) Miq. (Ingyin) is found to be one of the ecologically dominant species contributing highest (IVI) (24.82%) with relative density (6.74%), relative frequency (3.25%), and relative dominance (14.83%). The diversity indices of Shannon-Wiener (H) and Simpson (D) value for tree species were 5.401, 0.965, shrubs were 3.062, 0.828, and herbs were 4.228, 0.931 respectively. Shannon-Wiener evenness (E) index for trees, shrubs and herbaceous plants were 0.875, 0.804 and 0.90. All the diversity indices pointed out that the study site is floristically high diverse.

Introduction

The quantitative study of vegetation gives description of the vegetation, prediction and classification of its pattern and knowing useful and value species in a meaningful way. It indicates species diversity which determines the distribution of individuals among the species in a particular habitat (Horkar and Khatri 2003 as cited in Sahu *et al*. 2007).

The diversity of tree is fundamental to total forest biodiversity because trees provide resources and habitat structure for almost all other species. Information on the distribution and abundance of tree species is of primary importance in the planning and implementation of biodiversity conservation. Tree species diversity in the study area varies greatly from place to place mainly due to variation in biogeography, habitat and disturbance (Padalia *et al*. 2004).

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On account of their economic exploitation, the forests are most threatened ecosystems in the Goktwin area, Northern Shan State. But so far no efforts have been made to quantify the tree species parameters in this study area. The present study is an attempt to record structural composition and diversity of tree species in the Goktwin area, Northern Shan State.

The main objective of the present study are to present information on the vegetation and floristic composition of plant species, to assess the plant species diversity, the quantitative analysis of the forest structure.

Materials and Methods

Study Area

The study area is Goktwin in Northern Shan State. It lies between 96° 48' and 96° 57' E longitude, and between 22° 16' and 22° 22' N latitude. The total area is 103.62 square kilometers and stretches for 12.97 kilometers from East to West and 8.05 kilometers from North to South.

The elevation of Goktwin area varies from 270 to 1010 m above sea level. This area is consisted of Shan plateau, deep valleys and plains. The location map of the study area as shown in Figure (1).

The climate condition of the study area is warm and wet tropical climate. The monthly mean rainfall, temperature and relative humidity were recorded for 2008-2009. According to the record, the area received maximum rainfall during August (413 mm) in 2008 and during August (525 mm) in 2009 while minimum rainfall (1mm) occur in March 2008 and (2 mm) occur in November 2009. The highest mean temperature was 25.6°C in April 2008, 25.7°C in April 2009. The highest relative humidity was recorded in December (89%) during 2008, in August (87%) during 2009.

Data Collection

Plant cover data were collected during July and October in 2009. A total of 10 sample plots (each sample plot was 30x30m) were laid down and studied. All the plots were systematically surveyed for all trees ≥ 10cm diameter at breast height (DBH). To account overall species diversity two subplots 5×5m (for shrubs), four subplots 1×1m (for herbs) were laid down in the plot (Braun-Blanquet 1964).
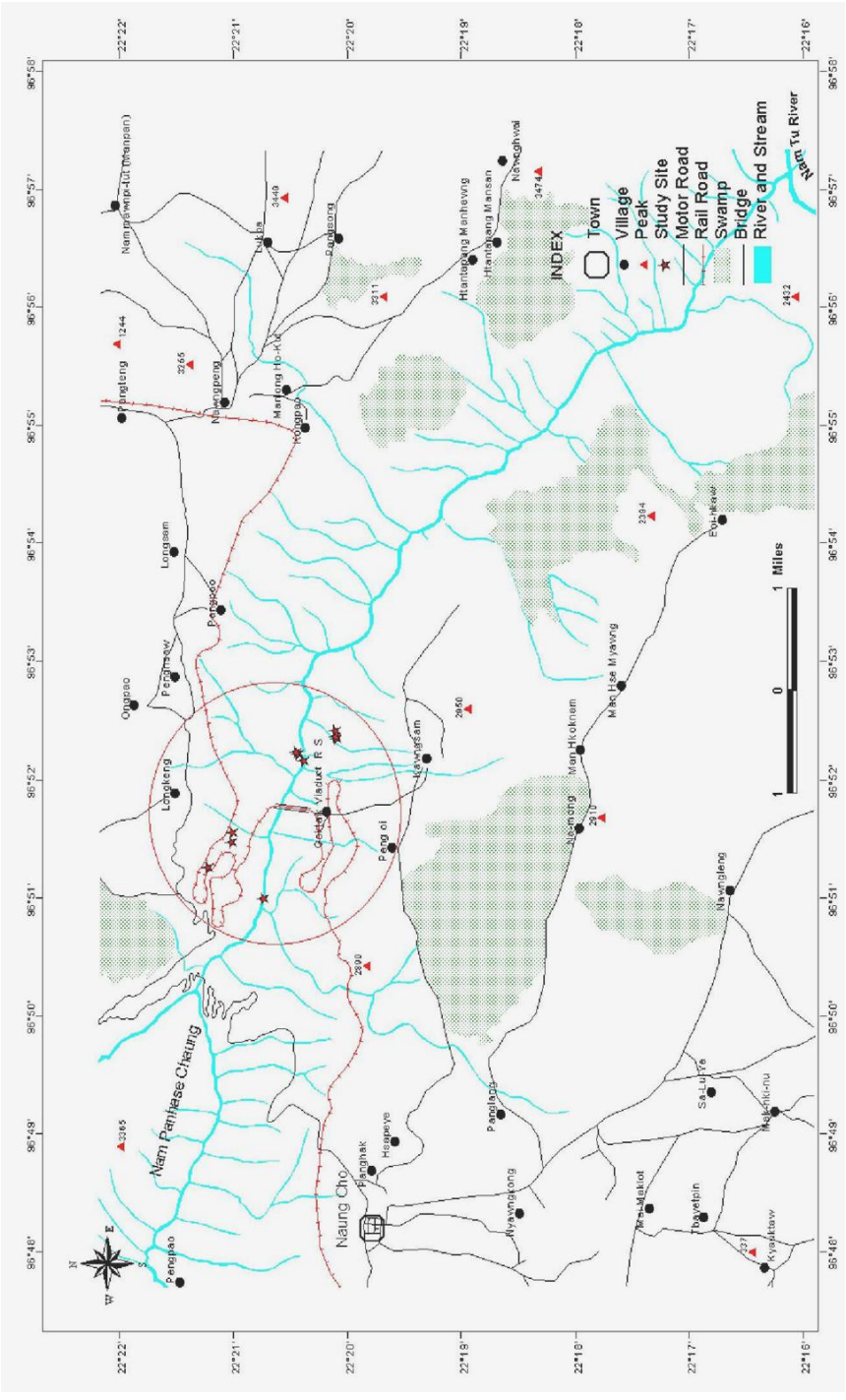
Figure (1) Location of study area source: Topographic Map No. 93B/15

The spatial location (latitude, longitude and altitude) of each quadrat was collected using a Global Positioning System (GPS). Care has been taken to cover different elevation, and slope gradients to study overall spectrum of tree species diversity. All sampled plants ($\geq$ 10 cm diameter at breast height) were systematically measured and the height of all trees was visually estimated. All shrubs and herbs in the subplots were listed and counted.

Identification of collected specimens were carried out by referring to flora of British India (Hooker 1885-1897), flora of Java (Backer 1965), flora of Ceylon (Dassanayake 1980-2001), etc.

Data Analysis

The vegetation data were quantitatively analysed for relative density, relative frequency and relative dominance. The Importance Value Index (IVI) for the tree species was calculated from the relative frequency, relative density and relative dominance (Curtis 1950). The species diversity and evenness in each plot were quantified using Shannon-Wiener (1963) and Simpson (1949) indices.

$$H = -\sum_{i=1}^{S} (p_i)(\log_2 p_i)$$

$$D = 1 - \sum_{i=1}^{S} (p_i)^2$$

H = Shannon-Wiener's index of species diversity
S = number of species
P_i = proportion of total sample belonging to the ith species
D = Simpson's index of species diversity

$$E = \frac{H}{H_{max}} \qquad\qquad H_{max} = \log_2 S$$

E = Evenness (range 0-1)
H = index of species diversity
H_{max} = species diversity under conditions of maximal equitability
S = number of species

<div style="text-align:center">

Results

</div>

Vegetation analysis

In the present study, a total of 72 tree species belonging to 53 genera and 28 families were recorded. There were 7 families with 12 genera and 14 species of shrubs and 11 families, 15 genera and 18 species of herbs in this area.

The location and elevation of sample plots were shown in Table (1) and Figure (2). At the result of quantitative analysis, relative density (R.D), relative frequency (R.F) and relative dominance (R.Dm) were shown in Table (2).

It can be seen that, from the result of the relative density, *Grewia polygama* Roxb ex. Mast. had the highest relative density value (7.79%), followed by *Dalbergia oliveri* Gamble and *Tectona grandis* L.f. (6.87%) etc, Table (2). Therefore these species were abundantly occurred in the study area.

The 10 species were found rarely which had the lowest value of relative density (0.13%) in this area. They were *Bridelia barmanica* Hook.f., *Castanea* sp., *Dillenia pentagyna* Roxb., *Gardenia sessiliflora* Wall., *Gardenia turgida* Roxb., etc. as shown in Table (2).

According to the results, for the relative frequency of the species *Dalbergia cultrata* Grah. and *Grewia polygama* Roxb.ex.Mast. have the highest relative frequency value (3.72%), followed by *Croton persimilis* Muell, *Shorea siamensis* (Kurz.) Miq. and *Tectona grandis* L.f. have the second relative frequency value (3.25%), etc. in Table (2). Due to such relative frequency values, these species were found in most plot of this study area.

The 19 species which had the lowest value of relative frequency (0.46%) were found in this area. These species were *Anogeissus acuminata* Wall., *Bridelia barmanica* Hook.f., *Castanopsis armata* Spach., *Castanea* sp., *Croton joufra* Roxb., etc. as shown in Table (2). Because of the lowest value of relative frequency, these species were rarely frequent distribution at the study area.

According to the results of relative dominance, the orders of most common tree species were *Shorea siamensis* (Kurz.) Miq. (14.83%), *Tectona grandis* L.f. (7.67%), *Croton persimilis* Muell. (5.65%) etc. in Table (2). Thus *Shorea siamensis* (Kurz.) Miq. had larger basal diameter and occupied the area more than other tree species.

Gardenia sessiliflora Wall., *Rhus semialata* Murr., possessed the lowest relative dominance value (0.01%). Thus they had small size of stem and occupied the smaller area more than other tree species.

Ranking of ecological significance by IVI of 72 major tree species in the study area were given in Table (2). As a combination results of the relative values of density, frequency and dominance of all recorded tree species, the highest IVI of major dominant tree species was *Shorea siamensis* (Kurz.) Miq. (24.82 %). The second most dominant species is *Tectona grandis* L.f (17.78 %) and *Croton persimilis* Muell. (14.71 %) is third Figure (3).

According to the results of quantitative analysis, the majority of the high IVI value tree species were ecologically and economically important.

Diversity indices are better measure of the species diversity of a forest and more informative than species counts alone. The calculated diversity parameter is shown in Table (3).

According to the results of the diversity indices of Shannon-Wiener (H) and Simpson (D) value for tree species were 5.401, 0.965, shrubs were 3.062, 0.828 and herbs were 4.228, 0.931 respectively.

As the result of Shannon-Wiener Evenness (E) index for trees, Shrubs and herbaceous plants were 0.875, 0.804 and 0.90. It was observed that as the species diversity was higher, the evenness was higher in the study area. Therefore, all the diversity indices indicated that the study site is floristically high diverse.

Table (1) Location and elevation of sample plots

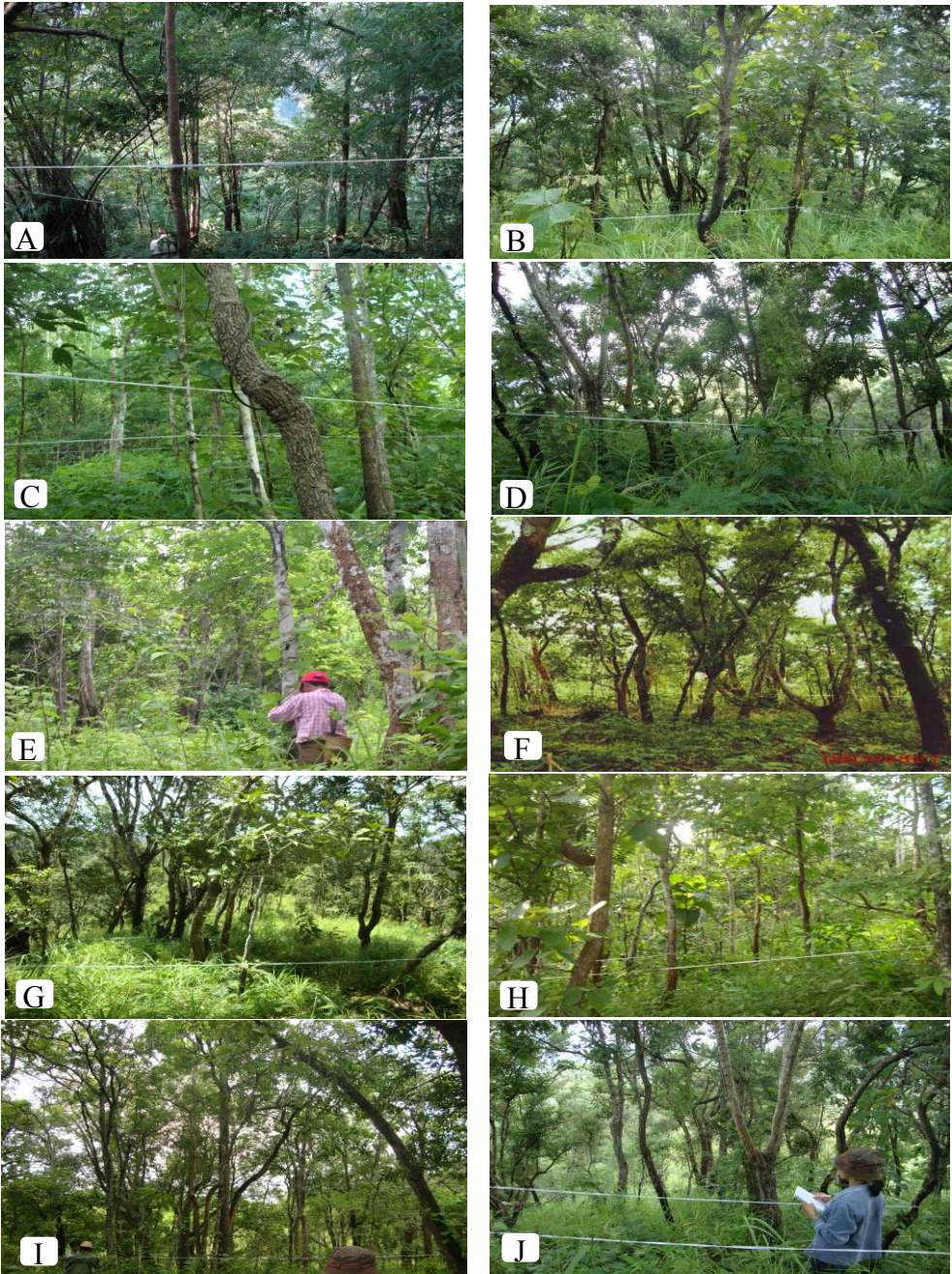| No. of plot	Latitude	Longitude	Elevation (m)
1	22° 20' 06"	96° 52' 21"	656.67
2	22° 20' 06"	96° 52' 22"	685.76
3	22° 20' 06"	96° 52' 24"	637.88
4	22° 20' 26"	96° 52' 13"	605.76
5	22° 20' 27"	96° 52' 14"	686.06
6	22° 20' 23"	96° 52' 10"	599.7
7	22° 21' 00"	96° 51' 33"	746.36
8	22° 21' 01"	96° 51' 28"	787.58
9	22° 21' 13"	96° 51' 16"	828.48
10	22° 20' 44"	96° 51' 00"	609.45

Figure (2) Location of sample plots from Goktwin area

(A) Plot 1   (B) Plot 2   (C) Plot 3   (D) Plot 4   (E) Plot 5

(F) Plot 6   (G) Plot 7   (H) Plot 8   (I) Plot 9   (J) Plot 10

Table (2) Ranking of Importance Value Index in the Study Area

No.	Scientific Name	Local Name	R.D (%)	R.F (%)	R.Dm (%)	IVI (%)
1	*Shorea siamensis* (Kurz.) Miq.	Ingyin	6.74	3.25	14.83	24.82
2	*Tectona grandis* L.f.	Kyun	6.87	3.25	7.67	17.78
3	*Croton persimilis* Muell.	Thetyin gyi	5.81	3.25	5.65	14.71
4	*Grewia polygama* Roxb.ex.Mast	Tayaw	7.79	3.72	2.48	13.99
5	*Dalbergia oliveri* Gamble	Tamalan	6.87	2.79	4.09	13.75
6	*Dalbergia cultrata* Grah.	Yindaik	4.76	3.72	3.99	12.46
7	*Schleichera oleosa* (Lour.) Oken	Gyo	3.17	2.79	4.49	10.45
8	*Buchanania* sp.	Thitsibo	3.70	2.32	3.93	9.95
9	*Albizia odoratissima* (L.f) Benth.	Taung magyi	3.17	2.32	3.44	8.93
10	*Quercus helferiana* A.DC.	Yingu akyi	1.98	1.86	4.66	8.50
11	*Terminalia tomentosa* Wight & Arn	Taukkyant	2.77	1.86	3.63	8.26
12	*Spondias mangifera* Willd.	Gwe	1.98	2.79	2.06	6.83
13	*Lithocarpus lindleyanus* (Wall.) Camus	Phet kyan	1.06	1.39	3.61	6.06
14	*Castanopsis armata* Spach	Thit e	0.53	0.46	4.54	5.53
15	*Premna tomentosa* Willd.	Kyunbo	1.59	0.93	3.04	5.55
16	*Terminalia chebula* Retz.	Panga	1.59	1.86	1.29	4.74
17	*Swintonia floribunda* Griff.	Taung thayet	0.66	0.93	2.60	4.19
18	*Dipterocarpus tuberculatus* Roxb.	In	1.98	0.93	1.17	4.08
19	*Syzygium jambos* (L.) Alston	Thabye nyo	1.06	1.86	1.36	4.28

No.	Scientific Name	Local Name	R.D (%)	R.F (%)	R.Dm (%)	IVI (%)
20	*Macaranga denticulata* Muell.Arg.	Phet wun	1.98	1.39	0.71	4.08
21	*Gmelina arborea* Roxb.	Yemanae	1.32	0.93	1.62	3.87
22	*Vitex* sp.	Than pai	1.45	2.32	0.40	4.18
23	*Wendlandia ligustrina* Wall., Cat.	Thitni	1.59	1.86	0.47	3.91
24	*Albizia lucidior* (Steud.) Nielsen	Thanthat	0.92	1.86	1.11	3.90
25	*Vitex limonifolia* Wall.	Kyungauk nwe	1.06	1.39	1.14	3.59
26	*Lithocarpus truncata* King	Kyetsa net	1.19	2.32	0.31	3.82
27	*Sideroxylon burmanicum* Collett & Hemsl.	Thitcho	1.06	1.86	0.79	3.70
28	*Quercus mespilifolia* wall.	Yingu athe	0.53	0.93	1.95	3.41
29	*Ziziphus incurva* Roxb.	Sugauk	1.06	2.32	0.30	3.68
30	*Erythrina* sp.	Kathit	0.79	1.86	0.88	3.53
31	*Bombax ceiba* L.	Letpan	0.79	2.32	0.39	3.50
32	*Canthium dicoccum* Merr.	Mauklong	0.92	1.86	0.54	3.32
33	*Harrisonia bennetii* A.W.Benn	Suchin	0.92	2.32	0.16	3.40
34	Vernonia volkamriaefolia (Wall.) DC.	Pya	0.92	1.86	0.31	3.10
35	*Antidesma diandrum* Roth.	Kinbalin	0.92	1.86	0.29	3.08
36	*Dalbergia rimosa* Roxb.	Daung talaung	1.19	0.93	0.69	2.81
37	*Chukrasia tabularis* A.Jass	Yinmar	0.66	1.39	0.71	2.76
38	*Phyllanthus emblica* L.	Zibyu	1.32	0.93	0.32	2.57
39	*Lithocarpus dealbatus* Hook.f.	Kywetsa ni	0.79	0.93	0.80	2.52

No.	Scientific Name	Local Name	R.D (%)	R.F (%)	R.Dm (%)	IVI (%)
40	*Grewia* sp.	Tayaw	0.66	1.39	0.49	2.54
41	*Mallotus philippinensis* (Lam.) Muell. Arg.	Tawthidin	0.66	1.39	0.49	2.54
42	*Shorea* sp.	Thitphyu	0.79	0.93	0.45	2.17
43	*Cratoxylum cochinchinense* Blure,Mus.	Saklay ohnnauk	0.53	0.93	0.68	2.13
44	*Croton joufra* Roxb.	Thetyin kado	0.92	0.46	0.56	1.95
45	*Melanorrhoea usitata* Wall.	Thitsi	0.79	0.93	0.33	2.05
46	*Oroxylum indicum* (L.) Vent.	Kyuang sha	0.66	1.39	0.07	2.12
47	*Callicarpa arborea* Murr.	Daung sat pya	0.79	0.93	0.24	1.96
48	*Schima wallichii* (DC.) Korth.	Thityah	0.53	1.39	0.10	2.02
49	*Dalbergia* sp.	Unknown	0.66	0.93	0.27	1.86
50	*Strychnos nux-vomica* L.	Kabaung	0.66	0.93	0.19	1.78
51	*Litsea glutinosa* (Lour.) C.B.Robison.	Ondon	0.40	0.93	0.34	1.67
52	*Schoepfia fragrans* Wall.	Daukyat	0.79	0.46	0.29	1.54
53	*Samadera indica* Gaertn.	Kathi	0.40	0.93	0.22	1.54
54	*Sterculia foetida* L.	Shawphyu	0.40	0.93	0.18	1.51
55	*Gardenia* sp.	Unknown	0.40	0.46	0.52	1.37
56	*Anogeissus acuminata* Wall.	Yon	0.79	0.46	0.10	1.35
57	*Holarrhena antidysenterica* Wall.	Lethtoke gyi	0.66	0.46	0.21	1.33

No.	Scientific Name	Local Name	R.D (%)	R.F (%)	R.Dm (%)	IVI (%)
58	*Phyllanthus pectinatus* Hook.f.	Shit sha	0.40	0.93	0.05	1.38
59	*Celastrus* sp.	Taung poe	0.26	0.93	0.10	1.30
60	*Millettia* sp.	Wunu	0.26	0.46	0.39	1.11
61	*Terminalia bellerica* Roxb.	Thitseint	0.40	0.46	0.21	1.06
62	*Phyllanthus reticulatus* Poir.	Yechinya	0.40	0.46	0.13	0.99
63	*Syzygium grande* (Wight) Walp.	Thabye gyi	0.13	0.46	0.23	0.82
64	*Bridelia barmanica* Hook.f.	Saikchi	0.13	0.46	0.21	0.81
65	*Castanea* sp.	Gone	0.13	0.46	0.17	0.76
66	*Nothapodytes foetida* (Wight)Sleumer.	Thit hla	0.13	0.46	0.13	0.72
67	*Callicarpa macrophylla* Vahl.	Pebok	0.13	0.46	0.08	0.67
68	*Dillenia pentagyna* Roxb.	Zinbyun	0.13	0.46	0.05	0.64
69	*Gardenia turgida* Roxb.	Thaminzani	0.13	0.46	0.04	0.63
70	*Cinnamomum obtusifolium* (Roxb.) Nees.	Nalingaw	0.13	0.46	0.04	0.63
71	*Gardenia sessiliflora* Wall.	Thaminza phyu	0.13	0.46	0.01	0.61
72	*Rhus semialata* Murr.	Myatpok chin	0.13	0.46	0.01	0.61
	Total		100.00	100.0	100.00	300.00

12

Species name
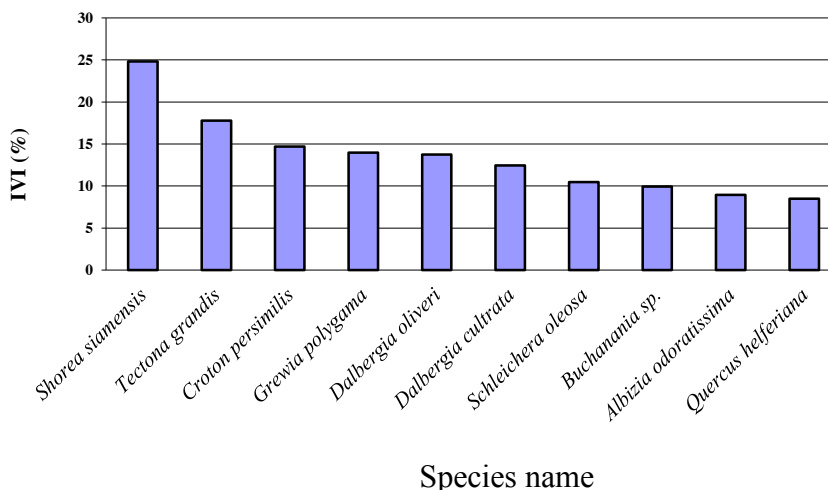
Figure (3) Importance Value Index (IVI) of Tree Species

Table (3) Diversity Indices

Diversity indices	Habit		
	Tree	Shrub	Herb
Shannon-Wiener Index (H)	5.401	3.062	4.228
Simpson Index (D)	0.965	0.828	0.931
Evenness (E)	0.875	0.804	0.90

Discussion

In this research work, the vegetation data were quantitatively analysed for frequency, relative frequency, density, relative density, mean basal area and relative dominance were calculated.

According to the results of quantitative analysis of vegetation, it was observed that the major tree species, *Shorea siamensis* (Kurz.) Miq. (Ingyin) possessed the highest IVI value (24.82%) and the relative dominance value (14.83%). Thus *Shorea siamensis* (Kurz.) Miq. (Ingyin) had the largest basal diameter and occupied the area more than other tree species.

Among the major tree species, *Grewia polygama* Roxb.ex. Mast (Ta yaw) possessed the highest relative density value (7.79%) and highest relative frequency value (3.72%). *Tectona grandis* L.f. (Kyun) occupied the

second relative density value (6.87%) and the second relative frequency value (3.25%). Therefore these two species occurred almost everywhere and contained in most sample plots.

The importance value index is imperative to compare the ecological significance of species and stated that the species with the greatest importance value were the leading dominants of the forest.

Accordingly, the ten leading dominants in study area were *Shorea siamensis* (Kurz.)Miq.(Ingyin), *Tectona grandis* L.f. (Kyun), *Croton persimilis* Muell. (Thetyin gyi), *Grewia polygama* Roxb.ex.Mast (Tayaw), *Dalbergia oliveri* Gamble (Tamalan), *Dalbergia cultrata* Grah. (Yindaik), *Schleichera oleosa* (Lour.) Oken (Gyo), *Buchanania* sp. (Thitsibo), *Albizia odoratissima* (L.f.) Benth. (Taung magyi) and *Quercus helferiana* A.DC. (Yingu akyi). Those tree species may regard as the ecological indicator tree species of the study area.

The highly valued tree species like *Shorea siamensis* (kurz.) Miq. (Ingyin) economically significant species like *Tectona grandis* L.f. (Kyun), *Dalbergia oliveri* Gamble (Tamalan) were abundantly found in the study area. So this forest not only important ecologically but also remarkably commercial.

Diversity indices are better measure of the species diversity of a forest and more informative than species counts alone. According to the Magurran (1988), species diversity is often expressed by two indices: Shannon-Wiener Index (H), Evenness (E) and Simpson Index (D).

The number of tree species growing in study area was 72, the individual number of trees in diameter of 10cm and above in 10 sample plots was 757. The total of 789 shrubs individuals, representing 14 species and the total of 275 herbs individuals, representing 18 species were recorded.

According to the results of Shannon-Wiener Index (H) it was observed that the index of this area was 5.401 for trees, 3.062 for shrubs and 4.228 for herbs. Similarly Simpson Index (D) of the area was 0.965 for trees, 0.828 for shrubs, 0.931for herbs. At the results of Shannon-Wiener evenness (E) 0.875 for trees, 0.804 for shrubs and 0.90 for herbs.

In this study, there was a correlation between species diversity and evenness. It was observed that as the species diversity was higher, the evenness was higher in the study area.

Human impact like cutting for fire wood, charcoal, illegal logging and agricultural encroachment were occurred in the study area. It is one of the influencing factors for forest structure. Logging was the major

destructive force in the forest. *Shorea siamensis* (Kurz.) Miq. (Ingyin), *Tectona grandis* L.f. (Kyun). *Danbergia oliveri* Gamble (Tamalan), *Dipterocarpus tuberculatus* Roxb. (In), *Gmelina arborea* Roxb. (Yemanae) were the preferred species.

According to the IUCN Red List of Globally Threatened and Endangered species (2008, 2009): *Shorea siamensis* (Kurz.) Miq. (Ingyin), *Dipterocarpus tuberculatus* Roxb. (In) and *Dalbergia oliveri* Gamble (Tamalan) in study area are included in globally threatened species Table (4). Therefore special priority should be given to conserve these species.

Table (4) Globally Threatened Species of Study Area

No.	Scientific Name	Family Name	Local Name	IUCN Criteria	Year Assessed
1	*Shorea siamensis* (Kurz.) Miq.	Dipterocarpaceae	Ingyin	TH	2009
2	*Dipterocarpus tuberculatus* Roxb.	Dipterocarpaceae	In	TH	2009
3	*Dalbergia oliveri* Gamble	Fabaceae	Tama lan	EN	2008

TH = Threatened,   EN = Endargered

Acknowledgements

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