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Structure and Composition of Dry Forest in Central Myanmar

Terminalia Forest

Dry Deciduous Forest

Dry Dipterocarp Forest

Study Area Location Map

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Abstract

In this study, forest inventory was conducted on 1 hectare as the representative area of each forest type, Than-dahat Forest, Dry Deciduous Forest and Low Indaing Forest. Then, the basic factors such as tree species and forest structure were studied. The research results can provide a scientific basis for formulating an appropriate management plan and making positive contributions to promoting the sustainable development of dry zone areas. According to the results, Tectona hamiltoniana, Terminalia oliveri, Shorea siamensis, Lannea coromandelica, and Dipterocarpus tuberculatus were the highest numbers of trees while Verbenaceae, Combretaceae, Fabaceae, Dipterocarpaceae and Anacardiceae were the most important families in Dry Forest. According to the density of natural regeneration, the total number of species in the regenerations of the Low Indaing Forest was the highest in the three types of forest. The study observed that the number of species in Than-dahat Forest was 11 species, the Dry Deciduous Forest was 19 species and the Low Indaing Forest was 24 species. In the Dry Zone of Myanmar, appropriate and proper management systems should be adopted based on the nature of forests to systematically and sustainably manage different forest types. The distribution of tree species and the diversity results in the study will provide a good database for dry forest management and conserve natural dry forests effectively and efficiently.

Keywords: Dry Forest, Species diversity, Stand Structure, Natural regeneration, Sustainable development

မြန်မာနိုင်ငံအလယ်ပိုင်းဒေသရှိ တောခြောက်များ၏ သစ်မျိုးစိတ်များ ရောနှောပေါင်းစပ် ဖွဲ့စည်းပုံနှင့် ပင်စုတည်ဆောက်ပုံများအားလေ့လာခြင်း

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စာတမ်းအကျဉ်း

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Structure and Composition of Dry Forest in Central Myanmar

1. Introduction

Arid lands are widely distributed in the world. They cover about 41% of the surface of Earth (FAO 2015). These areas include the hyper-arid (1 billion hectares), arid, semi-arid and sub-humid (5.1 billion hectares) regions that span most of the continent (Middleton N et al. 1997). Most of them are found at latitudes 15° to 30° in the northern and southern hemispheres. It is estimated that 728 million people live in arid and semi-arid regions.

Arid and semi-arid regions are prone to drought and various factors (deforestation, over-harvesting, drought, overgrazing, etc.) fruit and eventually turn into a desert, the United Nations Environment Program (UNEP) estimates that the world will lose a third of arable land to desertification by the end of this century. The process of desertification and degradation of ecosystems is a major threat to the ecological function and thus to human welfare.

Myanmar is one of the countries suffering from threatening of desertification. Although 50% of the total land area of the country is still covered with vast and diverse forests, the central part of Myanmar is barren and with no forests, threatening desertification. The ratio of the annual rainfall of precipitation (P) to potential evapotranspiration (PE) in the central part of Myanmar falls within the range of 0.05 to 0.65 (UNCCD 2000). The dry zone of Myanmar occupies about 10% of the total land area and various environmental degradations are observed in this region as a result of deforestation, population pressure, fuelwood demand, over-cultivation, and over-grazing.

Dry Forests are (2,904,100) ha wide and 10% of the forest-covered in Myanmar. There are three types of dry forests in Myanmar as Terminalia forest (Than-dahat Forest), Dry Deciduous Forest, and Dry Dipterocarp Forest (Low 'Indaing') (Mu Mu Aung 2001).The dry zone of Myanmar is being rehabilitated by two different methods, of which one is plantation establishment and the other is conservation of remnant natural vegetation. From the ecological point of view, rehabilitation through conserving natural forests is more advocated.

The climate in the zone plays a challenging role in planting trees since less than 600 mm of rainfall is available and the temperature is relatively higher than in other regions. The rainfall depth and pattern may determine the survival rate of planted trees which rain is used as the only source of water availability.

Soil fertility is a governing factor for the thriving of plantations and natural forests. Most of the areas have limited moisture content as the dominant soil texture is sandy loam. The remaining natural forests and plantations of the zone have undergone overcutting of fuelwood due to population growth and their subsistence businesses, and cattle grazing in some areas. Fuelwood is the main energy source in the region and is used for both domestic and local industry requirements. Therefore, another prominent issue is that people encroach on forest areas to convert into agricultural land.

Also, forest fire spreads dry forests causing interruption of the growth of trees and natural regeneration, especially in the dry season. The expenditure budget reflects the effectiveness of rehabilitation works especially dealing with plantations. To effectively manage dry forests requires scientific research emphasizing technical issues and social conflicts. There are still a few kinds of research dealing with the management of dry forests.

The study is conducted in a short period which covers the species composition, richness, diversity, and growth condition of different forest stands in Dry Zone of Mandalay Region. The study area was chosen in three sites for three different forest types, because of some preventative measures of Covid-19 diseases, time constraints, and political situation, so it is hard to make it in more detail. Therefore, I did not measure some environmental factors such as elevation, and slope gradient due to the limitation of time during the study period. The study is more on field data such as diameter at breast height, height, and basal area. In addition, human disturbance in dry forest did not study in this research. Due to the Covid-19 outbreak in Myanmar, a social survey to assess human disturbance in dry forest did not conduct in the study area.

2. Objective

The research study mainly focuses on the following objectives:

- To know the current ecological status of tree species at three selected sites.
- To compare the species composition, diversity, and stand structure in Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest of central Myanmar.
- To provide effective information for future Dry Forest management.

3. Material and Methods

3.1 Study Sites

As the total area of the Dry Zone is 77700 km^2, it was not possible to carry out a representative field study for the whole area due to limited time and financial constraints. The study intends to contribute to rehabilitation management and natural forest conservation in the dry zone in some ways. The selection of the study area was based on the three types of dry forest, namely Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest. A case study for three types of the dry forest will be conducted in a Kainary Protective Public Forest located in Thadaroo Township, Taungyi Kone Reserved Forest located in Wundwin Township and Gyinikan Protective Public Forest located in Yamethin Township of Mandalay region. Researching this area will identify the problems that appeared to manage or rehabilitate dry forests, and will establish solutions addressing such issues in support of the management of forests with similar conditions over the dry zone.

Climate data for 2021 were obtained from the meteorological station of the Mandalay. In Terminalia Forest, the annual rainfall is 935 mm and the annual temperature is 30.4 ºC. The maximum and minimum monthly average temperature is 37.6 ºC and 21.5 ºC respectively (Source, Meteorological Station of Mandalay). Comparatively, In Dry Deciduous Forests, the annual rainfall is 627 mm and the annual temperature is 28.4 ºC. The maximum and minimum monthly average temperature is 33.7 ºC and 21.8 ºC respectively (Source, Meteorological Station of Mandalay). However, In Dry Dipterocarp Forest, the annual rainfall is 630 mm and the annual temperature is 27.1 ºC. The maximum and minimum monthly average temperature is 31 ºC and 22 ºC respectively (Source, Meteorological Station of Mandalay).

3.2 Experiment Design

The purpose of forest inventory is to calculate and compare the species diversity of Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest. An area of 1 ha, as the representative area of each forest type, was selected from 192 ha of each forest. Then, ten sample plots were randomly taken within the selected area. Each sample plot has 0.1 ha (40 m × 25m). One sample plot consists of 16 quadrats (sub-plots) of size (10m × 6.25 m). Only 5 quadrats (sub-plots) from 16 quadrats were measured for seedling and sapling.

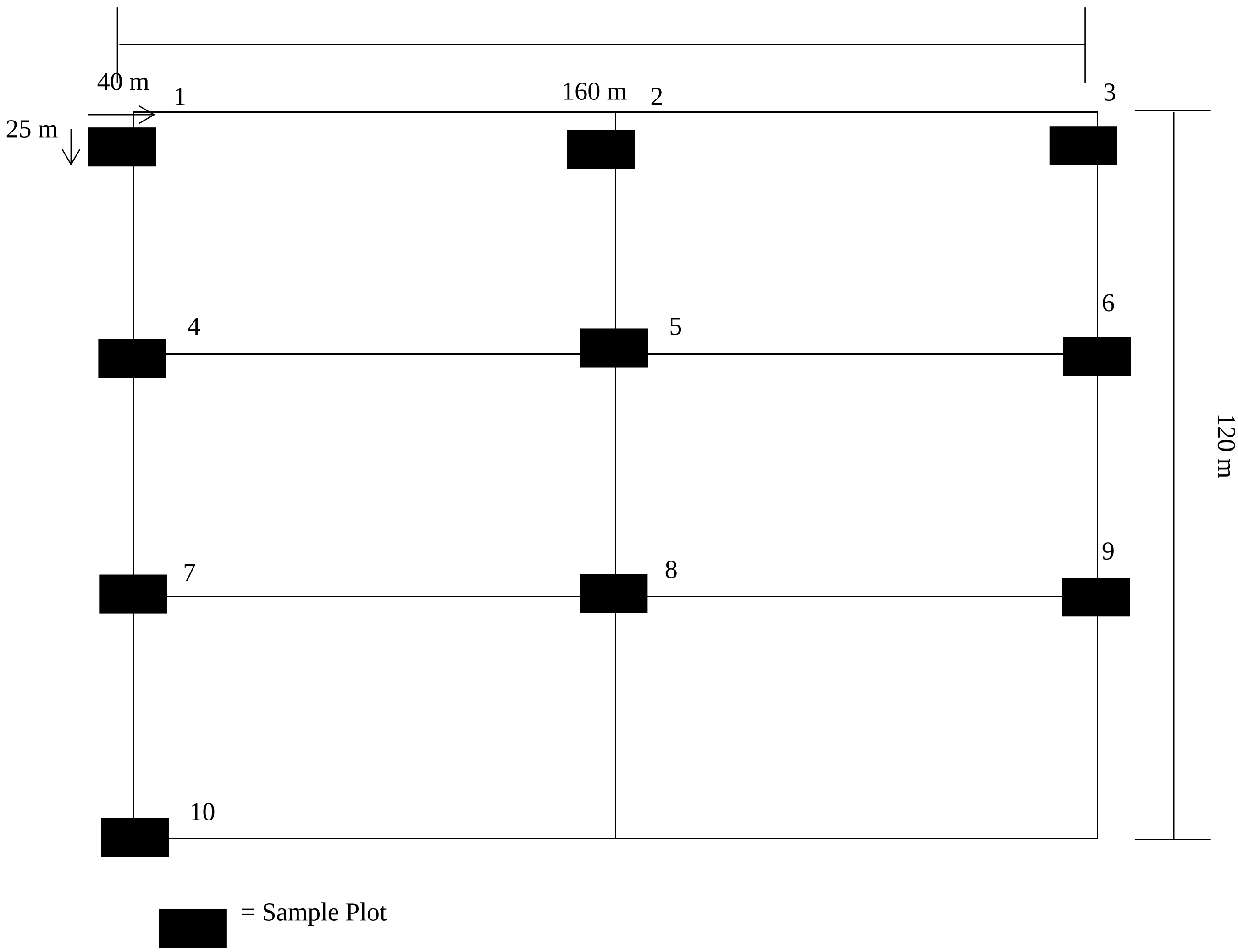

Figure 1 Distribution of sample plots

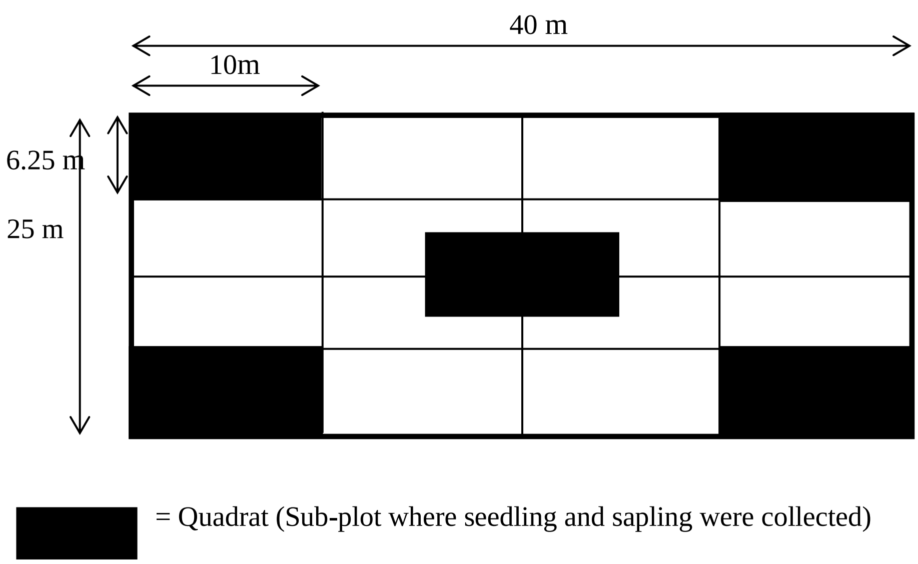

Figure 2 Layout of sample plot

3.3 Collection of Stand Data

The vegetation was grouped into three groups based on DBH and height. The survey was carried out in all quadrats (10 quadrats) for all threes with DBH ≥ 5cm and only 5 quadrats (sub-plots) from each plot were measured for seedlings with DBH< 2cm (height up to 0.3 m) and saplings with 2cm ≤ DBH < 5cm(Table 1). Forest growth data including tree species composition were gathered by conducting one short forest inventory.

Table 1 Collection of Stand Data

Classification	Side length	Area	What to measure	Notes
Plot (1,2,3…,10)	40m X 25m	1000 m^2	Adult Trees	DBH ≥ 5cm
Sub-plot (1,2,3,4,5)	10m X 6.25m	60 m^2	Saplings	Height ≥ 1.3 m to ≤ 4 m DBH < 5cm to ≥ 2cm
Sub-plot (1,2,3,4,5)	10m X 6.25m	60 m^2	Seedlings	Height ≥ 0.3 m to < 1.3 m DBH < 2cm

3.4 Measurement and Calculation of Investigation Parameters

3.4.1 Measurement of Tree Diameter at Breast Height (DBH)

The numbers of the species with the diameter at breast height (DBH ≥ 5 cm) for adult trees were measured in every 40 m x 25 m plots. The measurement of DBH for leaning and abnormal trees followed the methods of Van Larr & Akca, 2007 (Van Larr A. and Akca A 2007).

3.4.2 Measurement of Tree Height

In 40 m x 25 m plots, the total height of all trees, of which their diameters had already been recorded, will be measured. The tree height was measured by using Suunto Clinometer. Small trees were measured by using a normal stick.

3.4.3 Natural Regeneration

The trees with DBH lower than 5 cm to greater or equal than 2 cm and height greater or equal to 1.3 m to lower or equal than 4 m were regarded as a young saplings and were counted, heights lower than 1.3 m to greater or equal than 0.3 m and DBH lower than 2 cm were measured for seedlings. Within the sub-plot measuring (10 m x 6.25 m), the numbers of the species for saplings and seedlings were measured.

3.4.4 Species

Tree species were identified in the field with the support of local experts and expert staff from the Dry Zone Greening Department. In the case of unidentifiable trees, “Standard Nomenclature of Forest Plants, Myanmar, U Hote Linn” was referenced.

3.4.5 Species-Area Curve

The species-area curve is an important estimation tool and is the best way to determine the minimum research area (FD 2020). It applies to a variety of research works and it can be used to determine the representativeness of the sample. Moreover, it is applied as criteria to calculate a minimum area of a community and it serves as a quick identification tool in community descriptions. As the survey area expands, the species-area curve could represent the number of new species found and as the survey area extends, the number of new species were discovered (Preston K.A et al. 2006). It is acceptable if the increase of species per unit area remains less than 10% while the area expands by 10%. The species-area curve was formulated by using trees with a height of ≥ 1.3 m and a diameter ≥ 5cm DBH on 10 plots (1 ha) of each forest types.

3.4.6 Floristic Composition

Forest types vary in their species composition and stand structure. Ecological research depends on the estimation of species composition. Ecologists used importance value to assess the ecological composition of a forest community. The most common approaches used to assess species differences in floristic composition and ecologically significant species are the Importance Value Index (IVI) at the species level. The importance value index provides data on important species of a plant community and this index is used to determine the overall importance of each species in the community structure. The calculation of the relative density, relative frequency, and relative dominance of observed tree species are all components of the important value of observed tree species. In this study, the importance value index (IVI) was used as an indicator of species rank. This index, proposed by Curtis, 1951 was applied to describe species composition in the following manner:

$$IVI = R_{dom} + R_{den} + R_{freq} \quad (1)$$

Where, R_{dom} = relative dominance,
R_{den} = relative abundance,
R_{freq} = relative frequency.

The three indices were calculated using the following equations:

$$R_{dom} = \frac{\sum_{Gi}}{\sum_{Gij}} \times 100\ \% \quad (2)$$

$$G = \pi \times (DBH/2) \quad (3)$$

Where, $\sum Gi$ = total basal area for each species,
$\sum Gij$ = total basal area for all species,
G = basal area,
DBH = diameter at breast height.

$$R_{den} = \frac{N_i}{\sum N_{ij}} \times 100\ \% \quad (4)$$

Where, N_i = the number of individuals of a species,
$\sum N_{ij}$ = total number of individuals of all species.

$$R_{freq} = \frac{F_i}{\sum F_{ij}} \times 100\ \% \quad (5)$$

Where, F_i = the frequency of a species,
$\sum F_{ij}$ = a sum frequency of all species.

3.4.7 Diversity Indices

In this study, Simpson's (1-D'), Shannon-Weaver (H'), and the Pielou's Evenness (J') indices were applied for their widespread use and low-to-moderate sensitivity to sample size. Simpson (1949) calculated both richness and evenness. In comparison to the Shannon-Weaver index, Simpson's index of variation is more influenced by evenness than richness. The Simpson index gives the probability of any two individuals of different species drawn at random from an infinitely large community (Russell L 1996). Simpson's index value is usually between 0 and 1; the higher the value, the more diverse the sample. This index is heavily weighted towards the most abundant species in the sample while being less sensitive to species richness. The Simpson index was calculated according to Magurran, 1988.

$$1\text{-D} = 1 - \sum \frac{ni(ni-1)}{N(N-1)} \quad (6)$$

Where, D = Simpson index of dominance,
n = number of individuals of each species,
N = the total number of individuals of all species.

The Shannon-Weaver index is the most widely used index for comparing diversity between habitats (Spellerberg et al. 2001). The Shannon-Weaver index is mainly used to quantify the degree of uncertainty associated with a certain category within a given community set. These indices are also influenced by the number of species present and their distribution homogeneity. Shannon diversity index values are normally between 1.5 and 3.5, seldom reaching 4.5 (Gaines et al. 1999). The Shannon-Wiener index is defined as:

$$\text{H}' = -\sum_{i=1}^{S} p_i \times \text{Ln}\, p_i \quad (7)$$

Where, p_i = the proportion of individuals of species i in community,
S = the total number of species in the sample,
i =the total number of individuals in one species.

Species diversity depends not only on the number of species found but also on their numbers in an area. The Evenness index will be used to know how evenly individuals are distributed among different species. Pielou's evenness index (J) is the most widely used measure that has the greatest coverage for a larger sample. These estimations appear to indicate that when a single 29 species dominate the population, evenness values tend to zero, and when species' abundance are relatively close together, evenness values tend to one (Evangelista et al. 2012). Equitability is supposed to be a value between 0 and 1, with 1 indicating that the distribution is completely even. The Evenness index expresses how evenly individuals are distributed among different species and was calculated according to Pielou, 1966.

$$\text{J}' = \frac{\text{H}'}{\ln(\text{s})} \quad (8)$$

Where, H′ = Shannon Weaver diversity,
S = the total number of species in a sample.

3.4.8 Diameter Distribution

Tree diameter distribution gives us a lot of the information needed for sustainable management, and it can also be predicted with a high degree of accuracy (Ciceu A et al. 2021). Uneven-aged stands, particularly in natural forests, contain a variety of diameter classes and a J-shaped distribution pattern, with a large number of trees falling into the smaller diameter classes (Curtis R. O 1975). Many mathematical equations may be used to approximate the diameter distribution of uneven-aged natural forests, but the negative exponential function is the one that is the most frequently used and best-fitted model in this study. The negative exponential function can be described by the following equation:

$$n = k * e\ (a * d) \tag{9}$$

Where,
- n = number of stems per ha,
- k, a = constant,
- d = DBH of trees.

3.4.9 Height Curves

Table 2 The fitted height-diameter functions for all species of the Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest in Dry Zone

Source	Equation
(Van Larr & Akça, 2007)	$H = 1.3 + d^2 / b_0 + b_1 \times DBH + b_2 \times DBH^2$
(Van Larr & Akça, 2007)	$H = b_0 + b_1 \times DBH + b_2 \times DBH^2$
(Van Larr & Akça, 2007)	$H - 1.3 = b_1 \times DBH + b_2 \times DBH^2$
(Van Larr & Akça, 2007)	$H = b_0 + b_1 \times \ln(DBH)$
(Van Larr & Akça, 2007)	$\ln(H) = b_0 + b_1 \times \ln(DBH)$
(Van Larr & Akça, 2007)	$H = b_1 \times (1 - e^{-b}{}_2 \times DBH)$

Where,
- H = the total height,
- DBH = the diameter at breast height,
- b0, b1, b2 = the parameters of the regression.

Communities of the study sites were assessed using height-diameter relationships based on stand density, basal area, and site index. Stem diameter at breast height (DBH) and tree height (H) are regularly used measurements of tree growth (Dawkins and Phillips 1998). Stand height is necessary for calculating the volume of the stand, determining the site, forecasting future growth, and conducting silvicultural experiments (Van Larr A and Akca A 2007). The slope of the height curve is also determined by the quality of the site; a high-quality site has a steep curve on the right-hand side of the graph. The relationship between the DBH and height was constructed by using several applied models (Van Larr A and Akca A 2007). The following equation was the best-fitted model to show the relationship between DBH and height for all types of forests in this study.

$$H = b_0 + b_1 \times \ln(DBH) \tag{10}$$

Where,
- H = the total height,
- DBH = the diameter at breast height,
- b0, b1, b2 = the parameters of the regression

3.5 Data Analysis

All data were entered into Microsoft Excel 2010 spreadsheets for statistical analysis. Furthermore, it was also used to construct the height-diameter distribution curve. Species-area curve was formulated based on Cain's method. To explore the species composition of tree species and the Importance Value Index (IVI) were calculated. To explore the species richness and equitability among the species, Simpson's index of dominance, the Shannon-Weaver index, and Shannon's measure of evenness were calculated. To compare the structural parameters, nonparametric statistical analyses, such as Kruskal-Wallis test was used in SPSS software (e.g., species richness, diversity indices, densities, diameter at breast height, tree height, basal area) among the forest types.

4. Results

4.1 Species Composition Analysis

4.1.1 Species Area Curve

Plantation ecology is usually outlined by contrasting the differences between most natural forest ecosystems and most kinds of plantations. In this study, the author focuses on the species diversity of the remnant natural forest of the Dry Zone. For the determination of representative minimum area for a species spectrum, it is common by showing the so-called species area curve. According to Lamprecht (1989), 0.5 – 1 hectare is enough for the moist forests but less in the dry forests for species area curves. In this study, an area of 1 ha was used for the determination of the representative minimum area. Figure 3 shows the species area curve for the determination of representative minimum area.

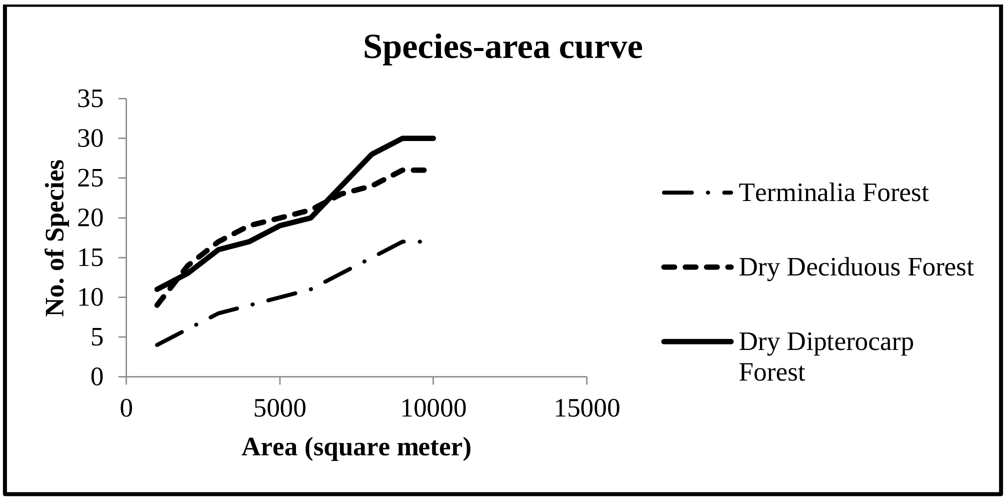

Figure 3 Species-area curve of Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest

According to Figure 3, the new species were increased up to 0.9 hectares in the natural forest and the numbers of species in and out were stable in an area of 1 hectare. Therefore, this study area can be identified as a minimum representative area for dry zone tree species.

4.1.2 Silvicultural Parameters and Importance Value Index (IVI)

Silvicultural Importance Value Index is the most well-known indicator to generalise the analytical results of individual forest surveys in order to gain a quick overview and to make immediate comparison between different surveys. Perhaps best known is the Important-Value-Index (IVI) of Curtis and McIntosh.

In order to investigate an overview on floristic composition of the study area, the silvicultural parameters and IVI for species level were calculated and shown in Table 3.

Table 3 Silvicultural parameters and IVI for tree species ≥ 5cm DBH in Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest related to 1 hectare

No.	Scientific Name	Abundance	Dominance	Frequency	IVI
	Terminalia Forest				
1	*Tectona hamiltoniana*	580	4.7894	100	126.6936015
2	*Terminalia oliveri*	265	2.3015	100	67.52743433
3	*Pterocarpus macrocarpus*	72	0.8825	80	29.39570052
4	*Milletia pendula*	29	0.2288	80	17.75245774
5	*Lannea coromandelica*	14	0.1215	50	10.44548829
6	*Dalbergia muliflora*	12	0.1000	10	3.85227674
7	*Vitex limonifolia*	10	0.0632	50	9.391286377
8	*Acacia catechu*	10	0.1100	20	5.307561768
9	*Vitex pubescens*	9	0.0595	30	6.174837675
10	*Dalbergia oliveri*	5	0.0381	40	7.077080004
11	7 other spp.	13	0.1110		16.38227507
	Total	**1019**	**8.8057**		**300**
	Dry Deciduous Forest				
1	*Shorea siamensis*	370	1.7233	100	68.8055
2	*Lannea coromandelica*	147	1.3202	100	41.9815
3	*Bombax ceiba*	111	1.1580	90	35.3554
4	*Dalbergia oliveri*	86	0.3454	90	20.0542
5	*Dalbergia cultrata*	67	0.2332	70	15.0393
6	*Terminalia tomentosa*	59	0.2703	70	14.9041
7	*Xylia xylocarpa*	44	0.1627	70	11.8101
8	*Dalbergia oliveri*	41	0.1971	60	11.3470
9	*Vitex limonifolia*	30	0.1226	90	11.3710
10	*Hiptage benghalensis*	26	0.0929	60	8.3078
11	16 other spp.	114	0.6162		61.0240
	Total	**1095**	**6.2422**		**300**
	Dry Dipterocarp Forest				
1	*Dipterocarpus tuberculatus*	257	1.4768	100	66.7552
2	*Shorea obtusa*	113	0.5277	100	31.0540
3	*Shorea siamensis*	104	0.4536	80	27.0589
4	*Melanorrhoea usitata*	77	0.5009	100	26.3111
5	*Dalbergia cultrata*	55	0.2605	100	18.9623
6	*Buchanania latifolia*	49	0.6216	100	25.4351
7	*Lannea coromandelica*	42	0.2012	90	15.5274
8	*Dillenia pentagyna*	37	0.2286	90	15.4873
9	*Bridelia tomentosa*	16	0.0695	50	6.9279
10	*Xylia xylocarpa*	12	0.1052	20	4.9641
11	20 other spp.	93	0.5873		61.5168
	Total	**855**	**5.0326**		**300.0000**

Table 4 Diversity indices and evenness of Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest of the Dry Zone based on trees ≥ 5cm DBH

Parameters	Terminalia Forest	Dry Deciduous Forest	Dry Dipterocarp Forest
Total no of species	17	26	29
Total no of individuals	1019	1095	855
∑ LN (pi)	-81.05	-115.04	-138.67
∑ Pi x LN(Pi)	-1.31	-2.33	-2.40
Shannon-Wiener Diversity Index (H′)	1.31	2.33	2.40
Simpson Diversity Index (1-D)	0.60	0.84	0.85
Shannon-Wiener Evenness (J)	0.19	0.33	0.36

According to the results presented in Table 4, Shannon-Wiener Diversity Index (H') shows that the tree species diversity of Terminalia Forest is 1.31, Dry Deciduous Forest is 2.33 and Dry Dipterocarp Forest is 2.40 whereas Simpson Diversity Index (1-D) exhibits a diversity of 0.60, 0.84 and 0.85. In relation to the evenness, Shannon-Wiener Evenness (J) indicates that the evenness of Terminalia Forest is 0.19, Dry Deciduous Forest is 0.33 and Dry Dipterocarp Forest is 0.36.

In this study, non-parametric statistical analysis (Kruskal-Wallis test) was employed to evaluate diversity indices as an additional measure of diversity. According to the results, all p-value is less than 0.05 (all p-values < 0.05), and therefore the Simpson, Shannon-Weiner, and Evenness indices were significantly different between the Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest.

4.1.3 Density of Species

The Terminalia Forest had a lower number of 17 tree species and 9 families but a highest mean diameter of 9.86 cm. The mean diameter of the Dry Deciduous forest and Dry Dipterocarp Forest were almost the same at 8.06cm and 8.00 cm respectively. The Dry Deciduous Forests had 26 tree species and 16 families while the Dry Dipterocarp Forests had a higher number of 29 tree species and 17 families. Furthermore, a statistical analysis such as the Kruskal-Wallis test was performed to analyze the variations between the Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest based on 1 ha. When a non-parametric Kruskal-Wallis test was used (all p values < 0.05), the diameter at breast height were significantly different between the three forest types.

4.2 Stand Structure Analysis

4.2.1 Stand Structure of Remnant Natural Forest

For stand structure analysis, a tree population is the best form to describe stand table, which is a basic parameter for description of forest structure in forest management. Stand table includes the number of trees, basal area or volume by diameter classes. It can be also separated by species or economic groups (Dawkins and Phillips 1998). Under this study, the stand structure of Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest are arranged by DBH classes for each species as shown in Table 5, 6, 7.

Table 5 Stand structure of the Terminalia Forest is arranged by DBH classes for each species

No.	Scientific Name	DBH class			Total
		≥5cm and <10cm	≥10cm and <15cm	≥15cm	
1	*Tectona hamiltoniana*	370	187	23	580
2	*Terminalia oliveri*	174	79	12	265
3	*Pterocarpus macrocarpus*	40	22	10	72
4	*Milletia pendula*	20	6	3	29
5	*Lannea coromandelica*	10	3	1	14
6	*Dalbergia muliflora*	8	3	1	12
7	*Acacia catechu*	4	5	1	10
8	*Vitex limonifolia*	8	2	0	10
9	*Vitex pubescens*	6	3	0	9
10	*Dalbergia oliveri*	3	2	0	5
11	*Albizia chinensis*	2	1	0	3
12	*Albizia odoratissima*	1	2	0	3
13	*Stereospermum personatum*	1	1	0	2
14	*Azadirachta indica*	1	1	0	2
15	*Tamarindus indica*	0	1	0	1
16	*Diospyros montana*	1	0	0	1
17	*Butea monosperma*	1	0	0	1
	Total	**650**	**318**	**51**	**1019**

According to the results, the DBH of most of the trees falls between the range of 5 cm and 10 cm (≥5cm and < 10 cm). *Tectona hamiltoniana* was found to have the highest number of trees in the study area. *Terminalia oliveri* has the second largest proportions as compared with other species in the study area. Other important tree species such as *Pterocarpus macrocarpus* and *Milletia pendula* were found very frequently. However, the number of trees of *Acacia catechu*, which is one of the widely used species in the Dry Zone, was very low (only 10 trees in all sample plots).

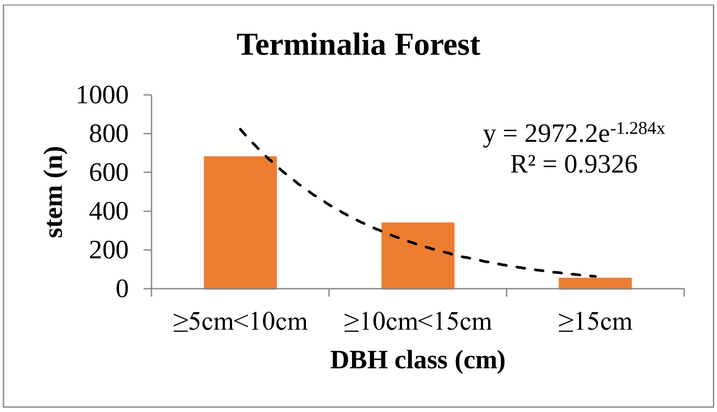

Fig 4 Stand structure of the Terminalia Forest is arranged by DBH classes for each species

Table 6. Stand structure of the Dry Deciduous Forest is arranged by DBH classes for each species

No.	Scientific Name	DBH class			Total
		≥5cm<10cm	≥10cm<15cm	≥15cm	
1	*Shorea siamensis*	333	32	5	370
2	*Lannea coromandelica*	81	46	20	147
3	*Bombax ceiba*	46	53	12	111
4	*Dalbergia oliveri*	82	4	0	86
5	*Dalbergia cultrata*	65	2	0	67
6	*Terminalia tomentosa*	53	6	0	59
7	*Xylia xylocarpa*	43	1	0	44
8	*Dalbergia oliveri*	37	4	0	41
9	*Vitex limonifolia*	29	1	0	30
10	*Hiptage benghalensis*	25	1	0	26
11	*Premna tomentosa*	15	4	0	19
12	*Buchanania latifolia*	13	4	0	17
13	*Bombax insigne*	10	2	0	12
14	*Schleichera oleosa*	11	1	0	12
15	*Bridelia retusa*	7	3	0	10
16	*Tectona hamiltoniana*	10	0	0	10
17	*Gardenia obtusifolia*	10	0	0	10
18	*Grewia tilifolia*	5	1	0	6
19	*Milletia pendula*	4	2	0	6
20	*Flacourtia indica*	2	1	0	3
21	*Sterculia foetida*	1	1	0	2
22	*Croton oblongifolius*	2	0	0	2
23	*Melanorrhoea usitata*	2	0	0	2
24	*Adina cordifolia*	1	0	0	1
25	*Heterophragna adenophylla*	1	0	0	1
26	*Stereospermum personatum*	1	0	0	1
	Total	**889**	**169**	**37**	**1095**

According to the results, the DBH of most of the trees falls between the range of 5 cm and 10 cm (≥5cm and < 10 cm). One of the valuable tree species in Myanmar, *Shorea siamensis* was found to have the highest number of trees in the study area. *Lannea coromandelica* and *Bombax ceiba* have the second and third largest proportions as compared with other species in the study area. Other important tree species, *Xylia xylocarpa, Dalbergia oliveri, Terminalia tomentosa* and *Dalbergia cultrate* were found very frequently. (Table 6)

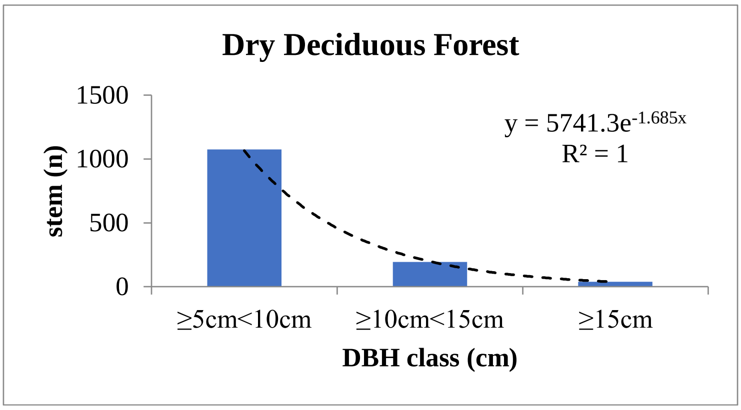

Fig 5 Stand structure of the Dry Deciduous Forest is arranged by DBH classes for each species

Table 7 Stand structure of Dry Dipterocarp Forest is arranged by DBH classes for each species

No.	Scientific name	DBH class			Total
		≥5cm<10cm	≥10cm<15cm	≥15cm	
1	*Dipterocarpus tuberculatus*	210	44	3	257
2	*Shorea siamensis*	104	9	0	113
3	*Shorea obtusa*	98	6	0	104
4	*Melanorrhoea usitata*	56	20	1	77
5	*Dalbergia cultrata*	47	8	0	55
6	*Lannea coromandelica*	27	12	10	49
7	*Buchanania latifolia*	36	6	0	42
8	*Dillenia pentagyna*	31	4	2	37
9	*Strychnos nux-blanda*	24	0	0	24
10	*Tectona grandis*	7	5	0	12
11	*Xylia xylocarpa*	11	1	0	12
12	*Pterocarpus macrocarpus*	8	2	0	10
13	*Dalbergia oliveri*	8	2	0	10
14	*Terminalia chebula*	7	1	1	9
15	*Bridelia tomentosa*	7	0	0	7
16	*Schleichera oleosa*	3	2	0	5
17	*Cassia fistula*	5	0	0	5
18	*Grewia tilifolia*	3	1	1	5
19	*Bombax ceiba*	3	1	0	4
20	*Terminalia arjuna*	3	1	0	4
21	*Anogeissus acuminata*	2	1	0	3
22	*Bombax insigne*	1	1	0	2
23	*Terminalia tomentosa*	1	1	0	2
24	*Markhamia stipulata*	0	1	1	2
25	*Sterculia foetida*	1	0	0	1
26	*Albizia odoratissima*	1	0	0	1
27	*Eugenia bracteolate*	1	0	0	1
28	*Gardenia sootepensis*	1	0	0	1
29	*Chukrasia tabularis*	1	0	0	1
	Total	**707**	**129**	**19**	**855**

According to the results, the DBH of most of the trees falls between the range of 5 cm and 10 cm (≥5cm and < 10 cm). *Dipterocarpus tuberculatus* was found to have the highest number of trees in the study area. The valuable tree species in Myanmar, *Shorea siamensis* and *Shorea obtusa* have the second and third largest proportions as compared with other species in the study area. Other important tree species such as *Buchanania latifolia*, *Lannea coromandelica, Melanorrhoea usitata* and *Dalbergia cultrata* were found very frequently. (Table 7)

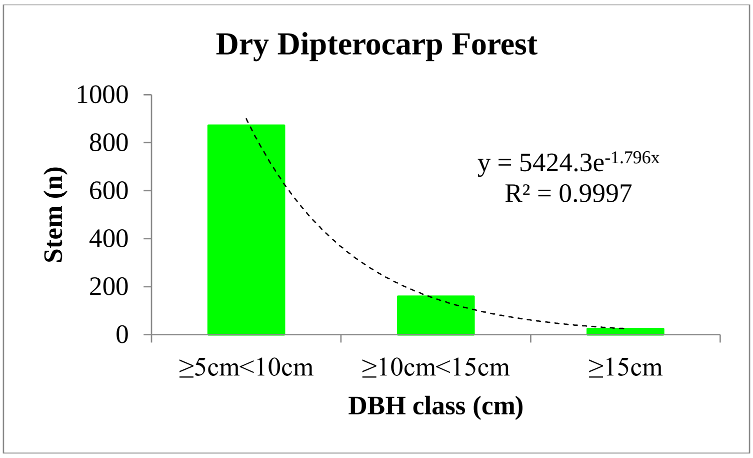

Fig 6 Stand structure of Dry Dipterocarp Forest is arranged by DBH classes for each species

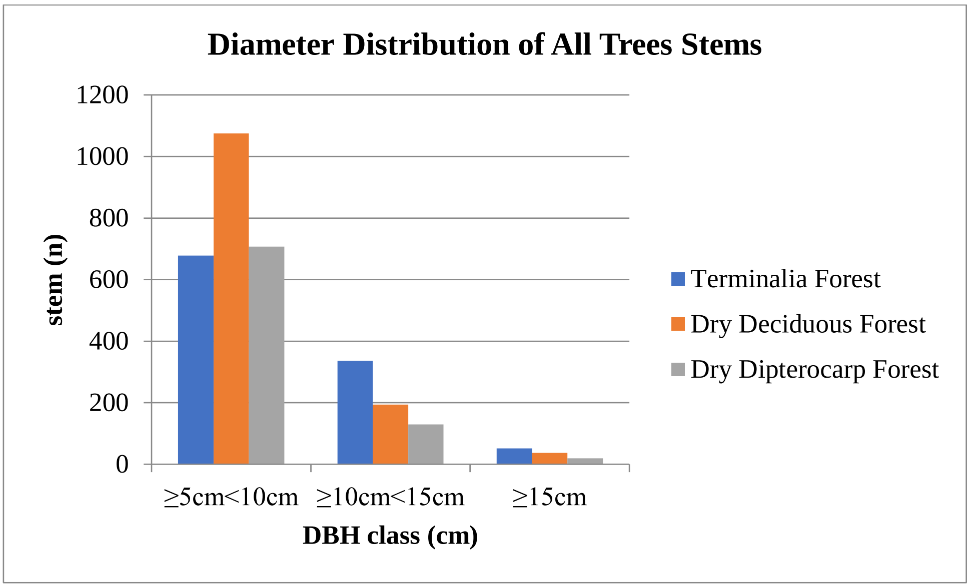

Fig 7 Diameter distribution of all trees stems

According to the result, the Dry Deciduous Forest had the highest numbers of trees between the range of 5 cm and 10 cm (≥5cm and < 10 cm). On the other hand, the Terminalia Forest and Dry Dipterocarp Forest had nearly the same in these ranges. But the Terminalia Forest had the highest numbers of trees between the range of 10 cm and 15 cm (≥10cm and < 15 cm); and above and equal to 15 cm (≥ 15 cm). (Fig 7)

4.2.2 Stand Parameter Differentiation

Degradation process can lead original vegetation types to diminish, less productive and less resistant forest types, and finally to communities without trees or other woody vegetation. Intensive human intervention such as fire, grazing and fuelwood and fodder collection has significantly transformed the dry forests almost everywhere and affected stand parameters of the forest. In order to compare three forests, the stand parameters which are based on all trees of DBH≥5cm in 1 hectare of Terminalia forest, Dry Deciduous forest and Dry Dipterocarp forest are given in Table 8.

Table 8 Stand parameter differentiation of Terminalia forest, Dry Deciduous forest and Dry Dipterocarp forest

Type	No. of Trees	Mean DBH (cm)	Basal Area ($m^2.ha^{-1}$)	*Standing Volume ($m^3.ha^{-1}$)
Terminalia forest	1019	9.87	8.81	50.23
Dry Deciduous forest	1095	8.06	6.24	31.80
Dry Dipterocarp forest	855	8.19	5.03	21.82

Source : The author analysis, 2022
*Based on all tree ≥ 5cm DBH

It is obviously found that the total number of trees per hectare of Terminalia forest and Dry Deciduous forest are nearly the same however Dry Dipterocarp forest is significantly different. The total number of trees per hectare of Terminalia forest and Dry Deciduous forest amounted to 1019 and 1095 with basal area of only 8.81 m^2 per hectare and 6.24 m^2 per hectare. In Dry Dipterocarp forest, there were 855 trees per hectare with a basal area of 5.03m^2 per hectare. It means the basal area of Terminalia forest is greater than that of Dry Deciduous forest and Dry Dipterocarp forest. The standing volume of Terminalia forest was attained by 50.23m^3 per ha whereas that of Dry Deciduous forest and Dry Dipterocarp forest was only 31.80 m^3 per ha and 21.82 m^3 per ha. Thus, the standing volume of Terminalia forest is higher (about two times) than that of Dry Dipterocarp forest even in the Dry Zone.

4.2.3 Height Curve Fitting

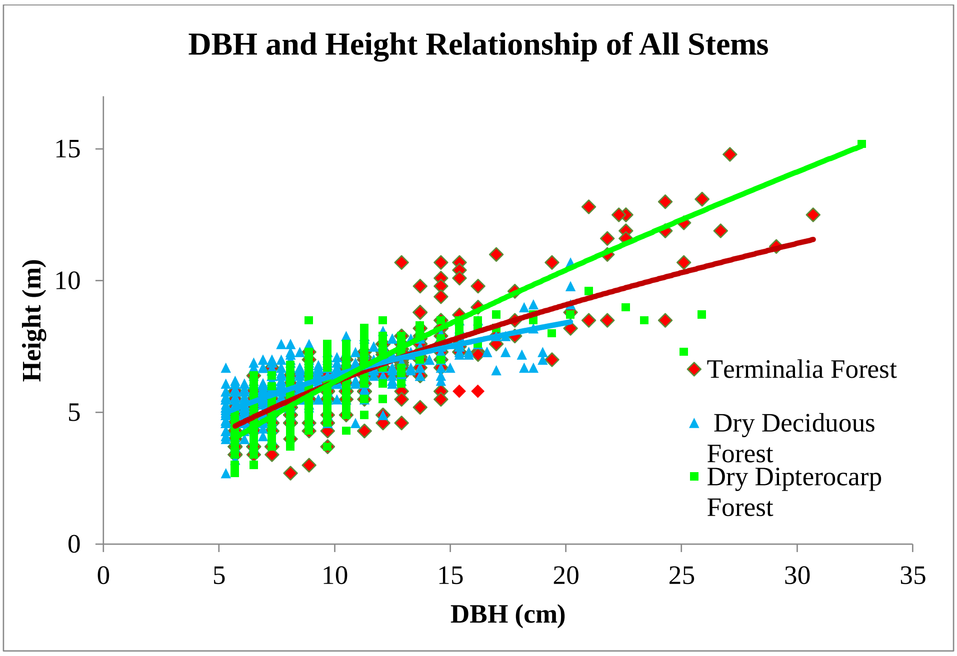

Figure 8 DBH and height relationship of all stems

Figure 8 showed the relationship between diameter at breast height and height Terminalia forest, Dry Deciduous Forest and Dry Dipterocarp Forest. The curves of all types showed the same trends but the height curve of the Dry Dipterocarp Forest showed steeper than Terminalia Forest and followed by Dry Deciduous Forest. In this study, the biggest diameter at breast height for the Dry Dipterocarp Forest was 32.8 cm, the Terminalia Forest was 30.7 cm and the Dry Deciduous was 20.2 cm. Based on the shape of those curves, it can be concluded that height can increase with a larger diameter in both stands and the curves reach the constant level at the highest diameters.

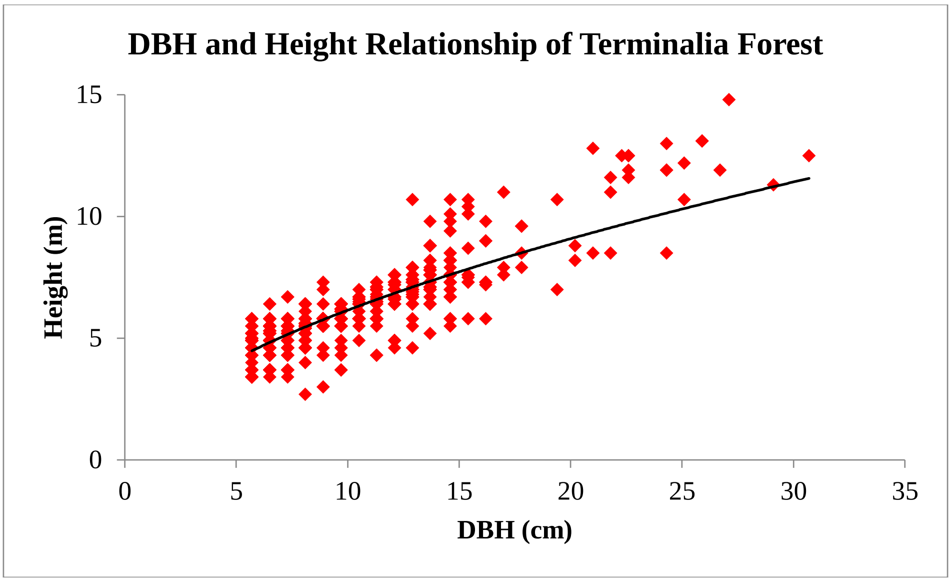

Figure 9 DBH and height relationship of Terminalia Forest

The relationship between diameter at breast height and height of the Terminalia Forest is illustrated in Figure 9. For Terminalia Forest, the numbers of stands were 1019, the range of the diameter was (5.7 cm – 30.7 cm). The range of the height was (2.7 m – 14.8 m).

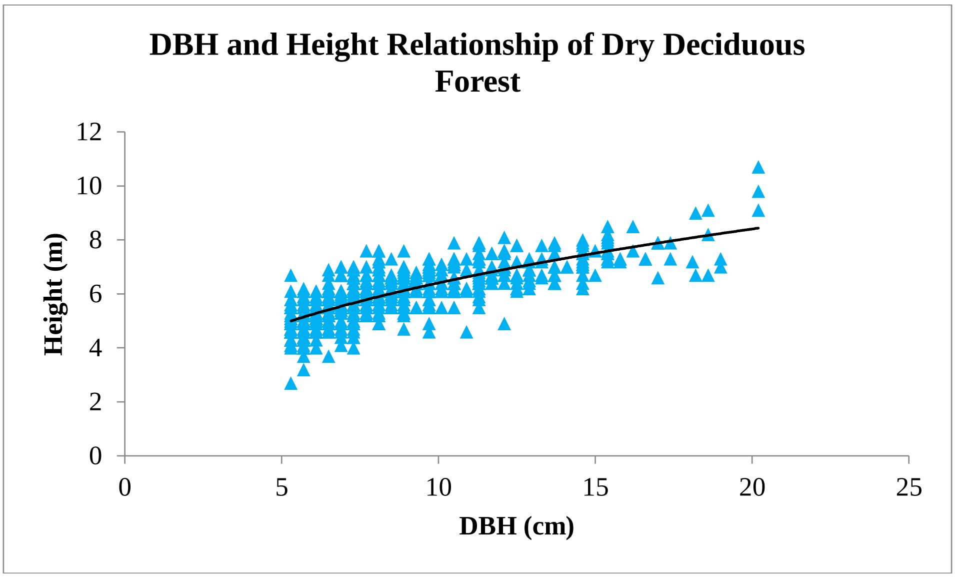

Figure 10 DBH and height relationship of Dry Deciduous Forest

The relationship between diameter at breast height and height of the Dry Deciduous Forest is illustrated in Figure 10. For Dry Deciduous Forest, the numbers of stands were 1095, the range of the diameter was (5.3 cm – 20.2 cm). The range of the height was (2.7 m – 10.7 m).

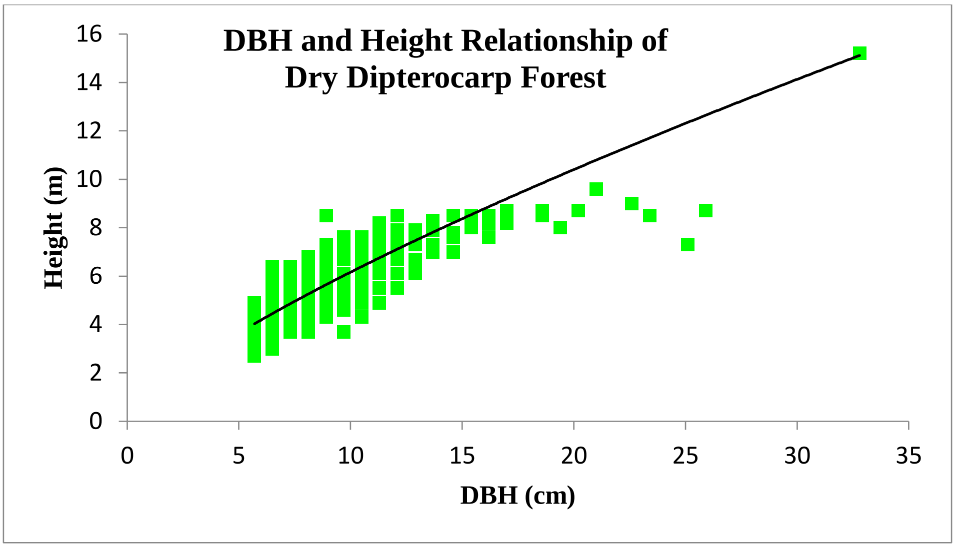

Figure 11 DBH and height relationship of Dry Dipterocarp Forest

The relationship between diameter at breast height and height of the Dry Dipterocarp Forest is illustrated in Figure 11. For Dry Dipterocarp Forest, the numbers of stands were 855, the range of the diameter was (5.7 cm – 32.8 cm). The range of the height was (2.7 m – 15.2 m).

4.3 Natural regeneration status in Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest

The regeneration in the study area was measured in 5 plots. Under this study, the seedling is defined as a tree having DBH below 2cm (height up to 1.3 m) and sampling is the tree having 2cm≤DBH<5cm.

It was found that there were 72 seedlings (72 trees per ha) in the existing Terminalia forest while 97 seedlings occurred in all sample plots of the Dry Deciduous Forest and 200 seedlings in the Dry Dipterocarp forest. In Terminalia forest, 120 saplings (120 trees per ha) were recorded whereas there was 344 sapling in the Dry Deciduous Forest and 229 saplings in the Dry Dipterocarp forest. Table 9 shows the regeneration status of the Terminalia forest, Dry Deciduous forest and Dry Dipterocarp forest.

Table 9 The number of seedlings and saplings in Terminalia forest, Dry Deciduous forest and Dry Dipterocarp forest

Plots	Terminalia Forest		Dry Deciduous Forest		Dry Dipterocarp forest	
	Seedling	Sapling	Seedling	Sapling	Seedling	Sapling
Plot 1	5	5	13	19	10	12
Plot 2	7	8	7	25	15	20
Plot 3	7	8	5	32	18	14
Plot 4	6	3	9	42	24	42
Plot 5	6	8	12	23	22	25
Plot 6	4	8	11	42	21	29
Plot 7	8	4	8	38	32	30
Plot 8	11	24	5	27	11	22
Plot 9	15	40	17	51	28	24
Plot 10	3	12	10	45	19	11
Total	**72**	**120**	**97**	**344**	**200**	**229**

Source, The author analysis 2022

5. Discussion

The species-area curve was applied as an important parameter to determine the minimal area of a community (Cain S. A. 2012) and it was also the best criterion for the contribution of the minimum study area (Dr. Nyunt Khaing and others et al. 2014). The trend in the species-area curve showed that as the number of plots increases, more the number of species appear, and it also indicates that 1 ha for the Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest was a representative area to access tree species in forest communities. The total study area (1 ha) had a listing of 17 species (9 families) for the Terminalia Forest, 26 species (16 families) for Dry Deciduous Forest and 29 species (17 families) for the Dry Dipterocarp Forest.

The tree species recorded in Kainary Protective Public Forest, Taungyi Kone Reserved Forest, and Gyinikan Protective Public Forest (Mandalay Region) are comparable to the other studies in Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest in Myanmar. In this study, 17 species were found from the Terminalia Forest and 26 species were found from Dry Deciduous Forest and 29 species were found from the Dry Dipterocarp Forest. Dr.Nyunt Khaing and other et al., (2014) listed 9 species were found from the Terminalia Forest and 22 species were found from the Dry Dipterocarp Forest in a 1 ha plot in Sagaing Region of Central Myanmar. Thaung Naing Oo et al ., (2002) reported 15 tree species were found from Dry Deciduous Forest on the 1.2 ha study site in the Koekwe Reserved Forest located in Mandalay region. Therefore, the Kainary Protective Public Forest, Taungyi Kone Reserved Forest, and Gyinikan Protective Public Forest (Mandalay Region) can be considered rich in biodiversity.

Concerning the tree species diversity, the Shannon-Wiener Diversity Index (H') showed that the diversity of Terminalia Forest, Dry Deciduous Forest, and Dry Dipterocarp Forest were 1.31, 2.33 and 2.40 (see Table 4). It is followed by the assumption of Washington (1984) i.e. the Shannon-Wiener Index does not seem to exceed 5. Dry Deciduous Forest and Dry Dipterocarp forests also followed the assumption of Margalef, (1975) that the value of the Shannon-Wiener index is usually found to fall between 1.5 and 3.5. When comparing the diversity indices of Shannon and Simpson, the Shannon index is always higher than the Simpson index. It means that rare species change in the study area is naturally higher than abundant species change. This phenomenon is normally found in most natural forests.

In the Dry Zone, the new species are difficult survive due to the harsh environmental condition. Thus, the number of species is more or less stable in and out of the study area. All the species in the study area are distributed more or less evenly in all plots except a few species (see Table 4). The total number of tree species in all sample plots is not as high as those of moist forests (e.g Teak Bearing Forest in Myanmar), the forest is composed of locally important species which offer potential crop trees (see Table 4).

According to the results of the IVI assessment presented in Table 3, it was observed that some valuable tree species such as *Tectona hamiltoniana*, *Terminalia oliveri*, *Pterocarpus macrocarpus,* and *Milletia pendula* showed the highest IVI in Terminalia Forest. All sample plots reflected these dominant tree species of typical dry forests with high frequency. Concerning the basal areas of tree species, *Tectona hamiltoniana* possessed the largest basal area. Comparatively, *Shorea siamensis, and Lannea coromandelica* were the highest IVI in Dry Deciduous Forests. However,*Dipterocarpus tuberculatus, Shorea obtuse, Shorea siamensis, and Melanorrhoea usitata* showed the highest IVI in Dry Dipterocarp Forest. Dr.Nyunt Khaing and other et al., (2014) reported *Terminalia oliveri* and *Tectona hamiltoniana* were the most important tree species in the Terminalia forest based on IVI values, representing approximately 90% of total species abundance and dominance in the forest stand. Also,*Dipterocarpus tuberculatus*, *Melanorrhoea usitata*, and *Xylia xylocarpa* were the dominant species in the Dry

Dipterocarp Forest in Sagaing Region. Thiri Toe Khaing and others et al., (2019) found that *Dipterocarpus tuberculatus*, *Shorea obtuse*, and *Lannea coromandelica* were the dominant species in Dry Deciduous Forests while *Dipterocarpus tuberculatus*, *Shorea oblongifolia*, and *Dioecrescis erythroclada* was the most important tree species in the Dry Dipterocarp Forest in Chatthin Wildlife Sanctuary, Sagaing Region. The results of this study showed that the floristic diversity of the Kainary Protective Public Forest, Taungyi Kone Reserved Forest, and Gyinikan Protective Public Forest (Mandalay Region) was not very much different from other Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest. Also, Forest Department and Dry Zone Greening Department should provide intensive treatments for the future development of valuable tree species.

In Terminalia Forest, *Tectona hamiltoniana* and *Terminalia oliveri* were found to have the highest number of trees within the range of DBH≥5cm>10cm. In addition, the numbers of other species were considerably lower than those of *Tectona hamiltoniana* and *Terminalia oliveri* (see Table 6). Therefore, remedial treatments for those species should be provided where necessary and favourable environmental conditions should be created for the development of natural regeneration of those species.

In Dry Deciduous Forests, *Shorea siamensis* was a significantly higher number of trees than other species. Therefore, remedial treatments for those species should be provided where necessary and favourable environmental conditions should be created for the development of natural regeneration of those species.

In Dry Dipterocarp Forest, *Dipterocarpus tuberculatus*, *Shorea siamensis* and *Shorea obtuse* were found to have the highest number of trees within the range of DBH≥5cm>10cm. Moreover, the numbers of other species were considerably lower than those of *Dipterocarpus tuberculatus*,*Shorea siamensis* and *Shorea obtuse* (see Table 8). Therefore, remedial treatments for those species should be provided where necessary and favourable environmental conditions should be created for the development of natural regeneration of those species.

The forest structure of the Dry Dipterocarp Forest had a high degree of floristic heterogeneity and diversity of species based on the diversity indices. When using the non-parametric statistical analysis (Kruskal-Wallis test), all p-values are less than 0.05, and therefore the Simpson, Shannon Weiner, and Evenness indices were significantly different between the three different forest types. The diameter at breast height and height were also significantly different between the three forest types. The mean diameter of the Terminalia Forest (9.87 cm) was larger than the Dry Deciduous Forest (8.06 cm) and the Dry Dipterocarp Forest (8.19 cm). Also, the basal area of 8.81m^2 of the Terminalia Forest was higher than the basal area of the Dry Deciduous Forest of 6.24 m^2 and the Dry Dipterocarp Forest of 5.03 m^2 respectively. Thaung Naing Oo et al., (2002) reported the mean diameter of the Dry Deciduous Forest was 6.93 cm and the basal area is 1.86 m^2. Therefore, the Dry Deciduous Forest in Taungyi Kone Reserved Forest is better site quality than the Dry Deciduous Forest in the Koekwe Reserved Forest.

The height curves of both forest stems showed the same trends but the height curve of the Dry Dipterocarp showed steeper than the other forest types. In this study, the biggest diameter at breast height for the Terminalia Forest was 30.7 cm, the Dry Deciduous was 20.2 cm and the Dry Dipterocarp Forest was 32.8 cm. The tree density of the Terminalia was 1019 stems, the Dry Deciduous Forest was 1095 stems and the Dry Dipterocarp was 855 stems per 1 ha. The abundant stem of Dry Deciduous Forest is the highest and the Dry Dipterocarp is the smallest.

In the Terminalia forest, *Tectona hamiltoniana*, *Terminalia oliveri*, and *Milletia* *pendula*recorded the highest number of seedlings and saplings in the natural forest. Among them, *Tectona hamiltoniana* was found to have the highest number in the study area. *Milletia pendula* are one of the most valuable species in the export market. However, *Tectona hamiltoniana* and *Terminalia oliveri* are very useful on the plantation as good survival rate and regeneration ability.

In the Dry Deciduous forest, *Shorea siamensis*, *Dalbergia cultrata*, *Dalbergia oliveri, Dalbergia oliveri* recorded the highest number of seedlings and saplings in the natural forest. Among them, *Shorea siamensis* was found to have the highest number in the study area. It is one of the most valuable species in the local and export market.

In the Dry Dipterocarp forest, *Dipterocarpus tuberculatus*, *Shorea siamensis*, *Melanorrhoea usitata*and, *Shorea obtuse*were recorded as the highest number of seedlings and saplings in the natural forest. Among them, *Dipterocarpus tuberculatus* and *Shorea siamensis* were found to have the highest number in the study area. They are a valuable species in dry zone areas.

6. Conclusion

Myanmar is one of the countries suffering from threatening of desertification. Various environmental degradations are observed in the dry zone of Myanmar as a result of deforestation, population pressure, fuelwood demand, over-cultivation, and over-grazing. Moreover, forest fire spreads dry forests causing interruption of the growth of trees and natural regeneration, especially in the dry season from February to May. Also, the expenditure budget reflects the effectiveness of rehabilitation works especially dealing with plantations and protection of the remnant natural forest. To effectively manage dry forests requires scientific research emphasizing technical issues. Therefore, the focus of this study was on tree species by analyzing the distribution pattern and growth conditions of the Terminalia Forest, Dry Deciduous Forest and Dry Dipterocarp Forest in Mandalay Region, Central Myanmar.

The study was conducted in February 2022 at the Kainary Protective Public Forest, Taungyi Kone Protective Public Forest and Gyinikan Reserved Forest in Mandalay Region. The 17 species in 9 families, the 26 species in 16 families and 29 species in 17 families per 1 ha (DBH $\geq$ 5 cm and H $\geq$ 1.3 m) were found in the Terminalia Forest, Dry Deciduous Forest and the Dry Dipterocarp Forest of the dry zone. In Central Myanmar, the Dry Dipterocarp Forest had the most species richness. *Tectona hamiltoniana* and *Terminalia oliveri* were the highest numbers of trees while Verbenaceae, Combretaceae and Fabaceae were the most abundant families in Terminalia Forest. *Shorea siamensis* and *Lannea coromandelica* were the highest numbers of trees while Dipterocarpaceae and Anacardiceae were the most abundant families in Dry Deciduous Forest. Comparatively *Dipterocarpus tuberculatus* was the most dominant species while Dipterocarpaceaewas the most abundant family in the Dry Dipterocarp Forest.

The Simpson, Shannon Weiner, and Evenness indices were significantly different between the three different forest types. The diameter at breast height and height were also significantly different between the three forest types. The mean diameter of the Terminalia Forest, the Dry Deciduous Forest and the Dry Dipterocarp Forest were 9.87 cm, 8.06 cm, and 8.19 cm respectively. The basal area of the Terminalia Forest, the Dry Deciduous Forest, and the Dry Dipterocarp Forest were 8.81m^2, 6.24 m^2, and 5.03 m^2 respectively.

The diameter distribution curves of all stems followed the regular (reverse J-shaped) pattern. For all stems, the highest number of individuals was found in the diameter classes between 5 cm to 9.9 cm. The Terminalia Forest discovered 16 species (94.12 %), the Dry Deciduous Forest discovered 26 species (100%) and the Dry Dipterocarp Forest discovered 28 species (96.56 %) of the total species in the 5 cm to 9.9 cm DBH class. However, the Terminalia Forest discovered 15 species (88.24 %), the Dry Deciduous Forest discovered 19 species (73.08%) and the Dry Dipterocarp Forest discovered 21 species (72.41 %) of the total species in the 10 cm to 14.9 cm DBH class. But the Terminalia Forest discovered 7 species (41.18 %), the Dry Deciduous Forest discovered 3 species (11.54 %) and the Dry Dipterocarp Forest discovered 7 species (24.14 %) of the total species above 15 cm DBH class.

In this study, the biggest diameter at breast height for the Terminalia Forest, the Dry Deciduous, and the Dry Dipterocarp Forest were 30.7 cm, 20.2 cm and 32.8 cm. There are 1019 stems, 1095 stems and 855 stems per 1 ha had been recorded for Terminalia Forest, Dry Deciduous Forest and the Dry Dipterocarp. The abundant stem of Dry Deciduous Forest is the highest and the Dry Dipterocarp is the smallest.

The number of species in the seedling and sapling of the Terminalia Forest was 11 species, the Dry Deciduous Forest was 19 species and the Dry Dipterocarp was 24 species. Moreover, the total number of species in the regenerations of the Dry Dipterocarp was the highest in the three types of forest.

The study draws the conclusion that the Terminalia forest of Myanmar is less diverse than other forest formations in terms of tree species and families. On the other hand, the highest number of regenerations species found in the Dry Dipterocarp forest. The Verbenaceae, Combretaceae, Fabaceae, Dipterocarpaceae and Anacardiceae were the most abundant families dominated the central area of Myanmar. Of the dry forest tree species, *Tectona hamiltoniana,Terminalia oliveri,Shorea siamensis, Lannea coromandelica,Dipterocarpus tuberculatus* are widely distributed over all of central Myanmar.The Dry Deciduous Forest had the highest number of stem followed by the Terminalia Forest. According to the result, the Teminalia Forest possessed the biggest mean diameter and basal area. Finally, the distribution of tree species and the patterns of diversity in the study will provide a good database for future Dry Forest management effectively and efficiently.

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