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SPECIES DIVERSITY AND STAND STRUCTURE OF DRY ZONE FOREST IN SHINMA TAUNG HILL, YESAGYO TOWNSHIP, MAGWAY REGION

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Abstract

A quantitative study of tree species was carried out in Shinma taung hill, Yesagyo Township. To find out the diversity of trees and to know the forest stand structure, 20 quadrates [20m x 20 m] in the study site were established and studied. Species diversity was presented by diversity index. In the study area, Shannon Wiener's index and Simpsom index were 4.24 and 0.74. In the present study, 54 species, 44 genera belonging to 29 families were found in study area. Relative density, relative frequency, mean basal area and relative dominance were calculated. IVI values of major tree species were presented by ranking order. In this study area, ecologically the most successful species were *Tectona hamiltoniana* Wall. (Dahat) 58.13%, *Terminalia oliveri* Brandis *(*Than) 47.88%, *Hiptage benghalensis* (L) Kurz. (Bein nwe) 14.86%, *Bridelia retusa* (L.)A.Juss (Seik chi) 11.95% and *Capparis flavicans* Wall (Saung gyan) 9.17%. It was influenced by *Tectona hamiltoniana Wall.* (Dahat) and *Terminalia oliveri* Brandis *(*Than) in this region.

Keywords: species diversity, forest stand structure, frequency class

Introduction

Biological diversity is fundamental to our life. Not only does it secure our material needs, it also provides valuable services that humans require from their environment, such as food, clothing, clean drinking water, and medical care. It ensures the stability of our habitats and is an essential basis of our culture and civilization. Biodiversity also means genetic diversity and is our best safeguard against environmental changes. No one knows how many species of organisms exist in the world. According to the World Wide Fund for Nature (WWF), 34,000 terrestrial and marine species are currently endangered, and the number of extinctions per day is estimated between 2 and 130. This global mass extinction is the cumulative result of local extinction events, which lead to a decrease in the diversity of local ecosystems long before these species are definitively extinct. Today the biosphere's greatest problems are the human-caused landscape changes that can be observed around the globe, the climate changes, and the accompanying loss of biological diversity. Basically three different aspects of biological diversity can be distinguished: firstly, biodiversity as a product of evolution, which has brought forth and continues to develop a diversity of populations and species; secondly, biodiversity as a resource for humans; thirdly, biodiversity as a prerequisite for the functioning of ecosystems.

Yesagyo Township is situated in the easternmost part of Magway Region in central Myanmar. The studied area was in Yesagyo Township. Shinma taung hill is an isolated hill in central flat land. The elevation of Shinma taung hill peak point is 525 meter above the sea level. The road was also constructed around the area of the hill. The structure of this hill forest was consequently changing due to the factor of over exploitation (eg. Thanakha). In study area, density of individual trees and number of species were decreasing over time and floristic composition and forest stand structure had altered. The degradation of forests and destruction of habitat occurred in the study area due to overexploitation by humans and climate changes. Degradation of forest ecosystem was the major cause of declination to the plant diversity.

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Forest stands can be described by horizontal and vertical structure. Horizontal structure represents a spatial distribution of individual trees and vertical structure describes the spatial vertical distribution of canopy. The vertical structure of tree communities is formed by the variations in growth forms or tree physiognomy (Kimmins, 1997). Stand level spatial distribution is a fundamental part of forest structure that influences many ecological processes and ecosystem functions. Vertical and horizontal spatial structure provides key information for forest management. Although horizontal stand complexity can be measured through stem mapping and spatial analysis, vertical complexity within the stand remains a mostly visual and highly subjective process. Stand structure is defined as the spatial arrangement of the components of vegetation (Lincoln *et al*. 2003). Stand structure is not static; it is a constantly changing part of forest ecosystem. Forests are continuously subject to disturbances at many scales, ranging from death of an individual tree within a stand to high severity fires that wipe out large forest communities. The diversity of type and frequencies of natural disturbances lead to a high diversity of structural conditions: from even-aged, single species stands to multi-age, compositionally diverse, multilevel canopy forest structures. Stand structure reflects ecosystem's resistance and resiliency to disturbance. An ecosystem's recovery from a disturbance is one of the factors that determine the structural arrangement of trees as the stand progresses through the stages of development from stem initiation to stem exclusion, to vertical and horizontal diversification (Van Pelt 2007). This study was conducted to achieve following objectives are to assess the diversity of growing trees, to describe the stand structure and species composition, to understand the relationship between plant species and their environment and to know the calculation of diversity indices.

Materials and Methods

Study area

Yesagyo Township is situated in the easternmost part of Magway Region in central Myanmar. It is located between north latitude 21° 08′ to 21° 51′ and east longitude 95° 01′ to 95° 20′. The total area of Yesagyo Township is 99000 ha or 989.99 km^2 (244634.328 acres). Shinma taung hill is an isolated hill in central flat land. The elevation of Shinma taung hill peak point is (525 meters) above sea level.

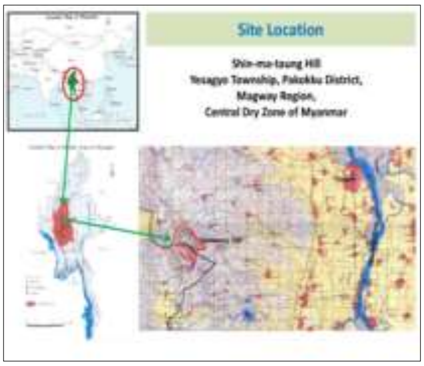


Figure 1 Location map of study area in Yesagyo Towbnship

Figure 2 Location map of

Data collection

The field investigation was carried out from December, 2018 to June, 2019. In the study area, 20 sample plots (20 × 20 m) located at various elevations from 233 m to 433 m were laid out systematically for sampling the forest. The spatial location (latitude, longitude and altitude) of each quadrat was collected by using a Global Positioning System (GPS). The girths of sampled plants (≥ 10 cm girth at breast height) at breast height (GBH) and height were systematically measured.

Jackknife estimate of species richness

Species richness is the simplest measure of biodiversity and is simply a count of the number of different species in a given area. Heltshe and Forrester (1983) proposed the formula of Jackknife estimate of species richness;

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

$\hat{S}$ = Jackknife estimate of species richness

S = observed total number of species in "n" sample plots

n = total number of plots sample

k = number of unique species

Calculation of species diversity and evenness

Species diversity indices and Evenness or equitability were calculated to determine for each species. Species diversity expresses the degree of evenness of the mixture of species. Species diversity was measured by Shannon-Wiener (1963) and Simpson (1949) indices.

$$H = -\sum_{i=1}^{S} (p_i)(\log_2 p_i) \qquad D = 1 - \sum_{i=1}^{S} (p_i)^2$$

H = Shannon-Wiener's index of species diversity

S = number of species

P_i = proportion of total sample belonging to the i^{th} species

D = Simpson's index of species diversity

Evenness

Two components of diversity are combined in the Shannon-Wiener function: (1) number of species (2) equitability or evenness of allotment of individuals among the species diversity.

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

E = evenness (range 0-1)

H = index of species diversity

H_{max} = species diversity under conditions of maximal equitability

S = number of species

Evaluation of relative density, relative frequency and relative dominance

Vegetation was quantitatively analysed for relative density and mean basal area following Curtis & McIntosh (1950).

$$\text{Relative Density (R.D)} = \frac{\text{No. of individuals of the species}}{\text{No. of individuals of all the species}} \times 100$$

$$\text{Relative Frequency (R.F)} = \frac{\text{No. of occurrences of the species}}{\text{No. of occurrences of all the species}} \times 100$$

$$\text{Mean basal area (MBA)} = \frac{\text{Total basal area}}{\text{Number of trees}}$$

The basal coverage or the area covered by a species is used to express dominance. The Relative Dominance (R.Dm) of a species is calculated by-

$$\text{Relative Dominance (R.Dm)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all the species}} \times 100$$

Investigation of Importance Value Index (IVI)

The index was calculated by summing the three relative values, viz., relative density, relative frequency and relative dominance as per the methods of Curtis (1959). This total value out of 300 is called Importance Value Index (IVI) of the species.

Tree species distribution by frequency classes

The law of frequency analysis (Raunkiaer,1934) was used to assess the rarity commonness of the tree species. In this classification the percentage frequency of the species was classed as A, B, C, D and E; Where A represents rare (1-20%), B is low frequency (21-40%), C is intermediate frequency (41-60%) , D is moderate high frequency (61-80%) and E is high frequency or common (81-100%). These frequency classes were used to determine whether the vegetation of the study area is homogeneous or heterogeneous.

Stratification: Horizontal and Vertical Stand structure

Population structure of tree species were analysed across fixed girth classes (Horizontal structure). Species and their corresponding individuals were proportionately analysed by height class intervals (Vertical structure).

Methodology

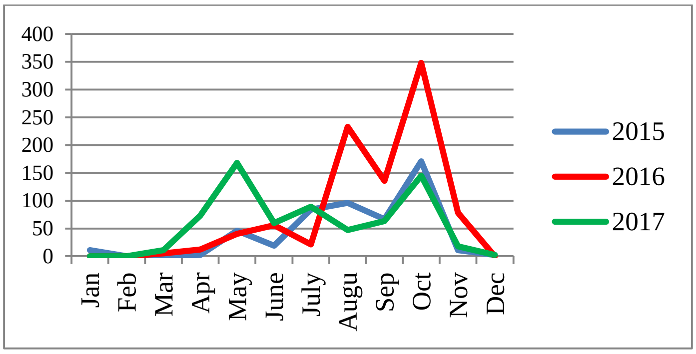
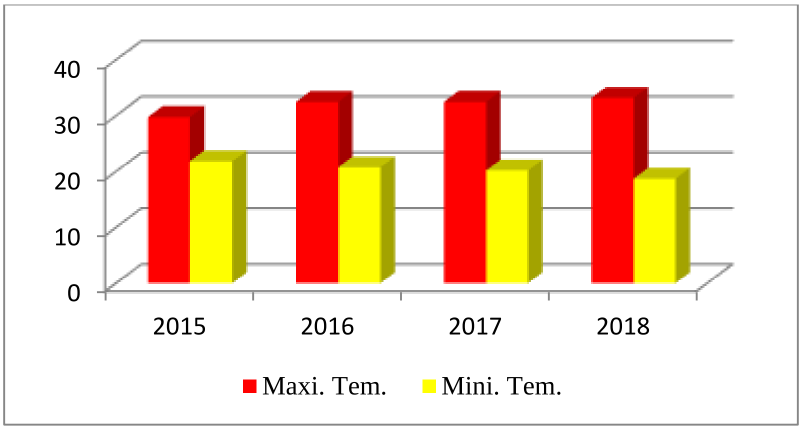


Figure 3 Monthly mean rain fall



Source: Department of Meteorology and Hydrology, Yesagyo

Figure 4 Monthly mean Temperature

Results

Plant species diversity

In the present study, a total of tree individuals, representing 54 species, 44 genera belong to 29 families and a total of 2680 tree individuals were recorded. The most number of growing species in the number of 10 species was possessed by family Fabaceae, the second were Euphorbiaceae, Rubiaceae with 4 species in the study site. The most number of growing individuals 700 was possessed by Verbenaceae, the second was Combretaceae with 512 individuals and the third one was Fabaceae with 410 in the study site.

Table 1 Number of families, genera and species of trees in study area

Taxonomic rank	Number
Family	29
Genus	44
Species	54
Individual	2680

Jacknife estimate of species richness

Result data show that Jackknife estimate of species richness was 54.9 (Table. 2). In the study area, 54 species belonging to 29 families were recorded and 2 species possessed only one individual.

Table 2 Jackknife estimate of tree species richness

	Quantitative estimate of species richness
Total no. of species (s)	54
Total individual in all sample plots	2680
Total no. of unique species (k)	2
Jackknife estimate of species richness ($\hat{S}$)	54.90

Shannon-Wiener (H), evenness (E) and Simpson index (D)

Diversity indices are better measure of the species diversity of a forest and these indices were used to compare among diversities of communities. According to Magurran (1988), species diversity is often expressed by two indices: Shannon-Wiener index (H), Eveness (E) and Simpson Index (D). According to the results of the study area, the species diversity were Shannon-Wiener index (H) 4.24, evenness (E) 0.74 and Simpson Index (D) 0.89.

Table 3 Tree species diversity indices in study area

Diversity category	**Study site**
Jackknife estimate of species richness ($\hat{S}$)	54.90
Shannon-Wiener Index (H)	4.24
Shannon- Wiener Evenness (E)	0.74
Simpson Index (D)	0.89

Tree species distribution by frequency classes

According to Raunkiaer (1934), five frequency classes of species frequency distribution were found in the study area. 2 species were in highest frequency class E (81-100%), 2 species were found in frequency class D (61- 80%), 7 species were found in the frequency class C (41-600%), 9 species belong to frequency class B (21- 40%) and 34 species belong to lowerest frequency class A (1-20%) in the study area.

Table 4 Tree species distribution by frequency classes in study area

	Frequency class	**Frequency range**	**No. of species**	**% total species Frequency distribution**
1	A	1-20%	34	62.96
2	B	21-40%	9	16.67
3	C	41-60%	7	12.96
4	D	61-80%	2	3.70
5	E	81-100%	2	3.70

Importance Value Index (IVI)

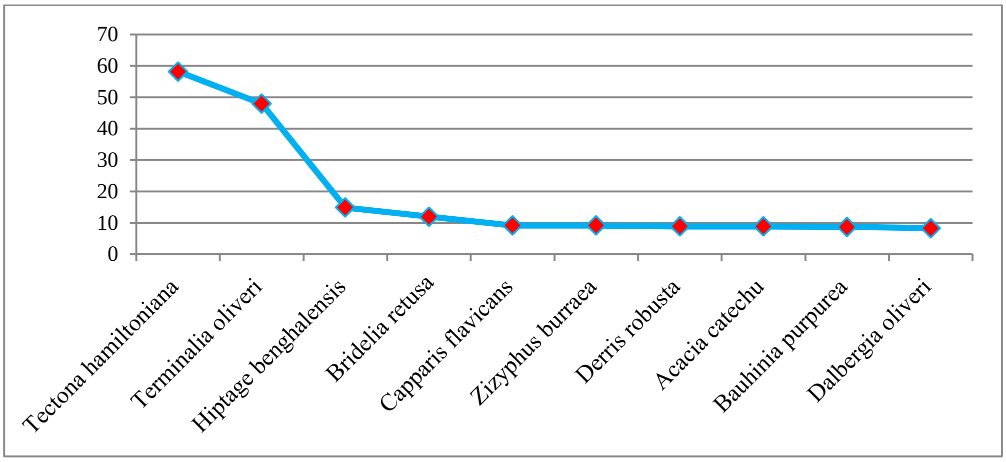


Figure 3 Importance Value Index value of top ten species

Horizontal stand structure

The horizontal species occurrence and horizontal structure of the study sites were shown in Table (5).

In the study area, two species were observed to be the biggest trees (<90≥70cm GBH) which were 3% of the total species. These species were *Tectona hamiltoniana* Wall. (80 cm) and *Terminalia oliveri* Brandis. (70 cm). There were 53 species in lower class (<30cm GBH) which were 98.1% of the total species. In the stand portion of site, there were 2680 trees per hectare and basal area varied from 0.001 to 2.697. Total mean basal areas per hectare were 0.222 m^2 ha^-. The number of basal area per hectare with < (30) cm GBH was relatively more abundant than other GBH. (Table. 5.)

Table 5 Tree species distribution by DBH classes (cm) in site

No.	DBH Classes	No. of individuals	No. of species	Species %
1	<30	2327	53	98.1%
2	<50 ≥ 30	330	34	62.9%
3	<70 ≥ 50	18	9	16.7%
4	<90 ≥ 70	5	2	3.7%
5	<110 ≥ 90	-	-	-

Vertical stand structure

Different growth forms determine the stratification, or vertical layering of the community. Because plant populations have a limited height range, plant communities have a vertical structure, whose nature depends upon the height ranges of the different species it includes. The vertical structuring of communities is an important component affecting how communities function at the level of photosynthesis in plants.

Species occurring in all storeys

In the study site, eight species were found in all storeys. These species were *Acacia catechu* (L.f.) Brandis, *Azidirachta indica* A. Juss, *Boscia variabillis* Collett & Hemsl, *Dalbergia oliveri* Gamble, *Lannea coromandelica (*Houtt.) Mrr., *Shorea robusta* Gaertn., *Tectona hamiltoniana* Wall. *and Terminalia oliveri* Brandis.

Table 6 Tree species distribution by height classes (m) in site

Sr. No	Height class	No. of individuals	No. of species
1	<5	2041	53
2	<7 ≥ 5	625	35
3	<9 ≥ 7	14	8
4	<11 ≥ 9	-	-

Discussion and Conclusion

In the study area, among 54 tree species, only a few species abundantly distributed and the most species were lower in number. The species richness was moderate but many rare and unique species occurred in this forest stand. Jackknife estimate of species richness was 54.90 (table 3). Results from this study indicated that evenness (E) for tree species was 0.74 in site. This data was shown that the forest has lower equitability in individual number of each species. Shannon-Wiener (H) and Simpson index (D) calculated for this site was 4.24, 0.89 (Table 3).

A total of 2680 tree individuals, representing 54 species, 44 genera belong to 29 families were recorded in the study area. The most number of growing species in the number of 10 species was possessed by family Fabaceae, the second was Euphorbiaceae and Rubiaceae with 4species and the third was Apocynaceae with 3 in the study area. The most number of growing individuals 700 was possessed by Verbenaceae, the second was Combretaceae with 512 individuals and the third was Fabaceae with 410 in the study area. 2 unique species were observed. These are *Carissa carandas* L. (Khan) and *Syzygium cumini* (L.) Skeels (Thaphay- phyu).

Timber and fuel-wood cutting, overgrazing and construction of hill road also known as anthropogenic effect occurred in the study area; these effects caused habitat degradation and reduced plant species diversity. According to this research data, it can be concluded that this site has the lower diversity index due to the habitat degradation by anthropogenic effect. And forest fires also caused deforestation. The conservation of natural habitat and the protection of biological diversity were important for the stability of this forest stand.

Tectona hamiltoniana Wall (Dahat) and *Terminalia oliveri* Brandis (Than) have the highest relative density value in both sites. It means that those species occurred more number of individuals in this environment. These species were found in more places because they can be distributed more than other species in this forest. Important value index (IVI) is imperative to compare ecology significance of species (Lamprecht, 1989). The highest IVI value possessed 2 species which were *Tectona hamiltoniana* Wall. (Dahat) and *Terminalia oliveri* Brandis (Than) in the study area. These data indicated that these top 2 species were predominantly growing and the most ecologically important in this environment. The highest IVI of those species indicated their dominance and ecological success, in the form of its better regeneration and greater ecological amplitude. This result indicates that the most trees were small in size and the larger trees were cut down for various uses. If the small tree could not reach the reproductive stage it would not produce fruits and the succeeding generation of this species could disappear near future.

Shinma taung hill used to be covered with good dry forest until 1960. One of the famous species from this region is *Hesperethusa crenulata* (Roxb.) M. Roem. locally called Thanakha. The species diversity of Shinma taung hill area was crucial for forest conservation and management for this area. In a region, the more diversed wild and domesticated forms of plants existed, the more sources for food, medicine and housing for human near villages were supported. The diversity of tree was primarily important to total forest biodiversity because trees provided resources and habitat for almost all organisms. The information on distribution and abundance of tree species gave fundamental support in planning and management of biodiversity conservation. The structure of this hill forest was consequently changing due to the factor of over exploitation (eg. Thanakha) (Ba Kaung, 2013). Now, the collaboration of forest staffs and villagers were leading to re-planting the trees. So juvenile trees were found in the bottom of the hill. Now, it was also found that a lot of Thanakha were cultivated in the bottom of the hill. Key factors of diversity such as density of individual trees and number of species were decreasing over time and floristic composition and forest stand structure were altered. The degradation of forests and destruction of habitats occurred in the study area due to the overexploitation by humans and climate changes. Degradation of forest ecosystem was the major cause of declination to the plant diversity.

According to the above results, Shannon-Wiener index (H) and evenness (E), similarly Simpson Index (D) were relatively lower in number. It was also found that a greater number of individuals and species decrease in these forests therefore species diversity indices (D), (H) and equitable distribution among species (E) also decrease. The result data indicate that Verbenaceae was ecologically significant family and *Tectona hamiltoniana* Wall. was ecologically significant species in this area. If the afforestation work is carried out in this area, these species must be aware to be successful replantation. The combination of this data indicated that status of trees in this forest was very poor and forest conservation was urgently needed before this forest disappeared. The quantitative analysis of a certain forest provides extended knowledge to meet the current and future challenges in the data management for complex tropical forest data. Although many forestry data collected in Myanmar have been altered due to the anthropogenic effects and unlawful extraction of many goods, it is statistically helpful in future data complication and provides more precise data management. This will undoubtedly improve the rigor inherent in dry zone forest data analysis as well as ascertaining elements of precision and correctness in data analysis during several decades. The results of this study may provide insight into forest management and ecological study that would be applicable to other tropical region.

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