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The Effect of Altitude on Species Composition, Diversity and Stand Structure @ Ver Bridge Region

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Contents

အမြင့်ပေ ခြားနားခြင်းအလိုက် တောတစ်တော၏ ပါဝင်သော သစ်မျိုးများ၊ သစ်မျိုးစုံလင်မှုနှင့် တော၏ ဖွဲ့စည်းပုံအခြေအနေ ပြောင်းလဲမှုတို့ကို လေ့လာဆန်းစစ်ခြင်း

ဝေမိုးလှိုင်
ဒေါက်တာသွယ်သွယ်ဝင်း
သစ်တောနှင့်ပတ်ဝန်းကျင်ဆိုင်ရာတက္ကသိုလ်

စာတမ်းအကျဉ်း

သဘာဝပေါက်ပင်များနှင့် ၎င်းတို့ ရှင်သန်ကြီးထွားပေါက်ရောက်မှုအပေါ် သက်ရောက်နေသော မြေဆီလွှာ၊ ရာသီဥတုအခြေအနေနှင့် ၎င်းတို့ကြားဆက်နွယ်မှုများကို လေ့လာခြင်း အားဖြင့် သဘာဝပေါက်ပင်များကို ထိန်းသိမ်းရာတွင် အလွန်အရေးပါသည်။ အပင်များ၏ ပေါက်ရောက်တည်ရှိပုံ သဘာဝကို လေ့လာခြင်းအားဖြင့် ဇီဝမျိုးစုံမျိုးကွဲများကို ထိန်းသိမ်းရာတွင် လည်းကောင်း သဘာဝ သယံဇာတများကို စီမံအုပ်ချုပ်ရာတွင် လည်းကောင်း များစွာအထောက်အပံ့ ပေးနိုင်သကဲ့သို့ နောင် အနာဂါတ်တွင် ဂေဟဗေဒစနစ် မည်သို့မည်ပုံ ပြောင်းလဲနိုင်သည်ကိုပါ လေ့လာခန့် မှန်းနိုင်ပါသည်။ သစ်တောသယံဇာတ ကောက်ယူခြင်းကို ပင်လယ်ရေမျက်နှာပြင်အထက် (၃၈၀-၁၀၀၀) မီတာတွင် လည်းကောင်း၊ (၁၀၀၀-၁၅၀၀) မီတာတွင်လည်းကောင်း၊ (၁၅၀၀-၂၀၀၀) မီတာ တွင်လည်းကောင်း အသီးသီး ကောက်ယူခဲ့ပါသည်။ အမြင့်ပေအသီးသီးရှိ နမူနာကွက် ၃ ဟက်တာ မှ ကောက်ယူရရှိသော ကိန်းဂဏန်းအချက် အလက်များအရ အပေါ်ဆုံးအလွှာ၌ တစ်ဟက် တာတွင် ပါဝင်ပင် (၁၅၈၈) ပင်၊ အလယ်လွှာတွင် (၂၁၃၉) ပင်နှင့် အောက်ဆုံးလွှာ တွင် ၉၀၈ ပင် အသီးသီးတွေ့ရှိခဲ့ရပါသည်။ ထို့အပြင် အပေါ်ဆုံးအလွှာ၌ တစ်ဟက်တာတွင် သစ်မျိုး (၃၅) မျိုး၊ အလယ်လွှာတွင်- (၆၈) မျိုးနှင့် အောက်ဆုံး လွှာတွင် (၃၉)မျိုး အသီးသီးတွေ့ရှိခဲ့ရပါသည်။ တော၏ ဖွဲ့စည်းပုံအခြေအနေကို သိရှိလိုသဖြင့် လုံးပတ်နှင့်အမြင့်ပေအလိုက် အပင်များ ပေါက်ရောက် နေပုံကို လေ့လာဆန်းစစ်ရာတွင် လုံးပတ်အငယ်ဆုံးနှင့် အမြင့်ပေအနိမ့်ဆုံး အပင်များမှာ အပင် အရေတွက် အများဆုံးဖြစ်သည်ကို တွေ့ရှိရပြီးလုံးပတ်နှင့် အမြင့်ပေ ကြီးလာလေလေ အပင် အရေအတွက် နည်းလာလေလေ ဖြစ်သည့်အတွက် သဘာဝတောနှင့် နီးစပ် တူညီသည်ကို တွေ့ရှိရပါသည်။ လုံးပတ် (၅-၁၀) စင်တီမီတာနှင့် (၁၀-၂၀) စင်တီမီတာ ရှိသော အပင် များမှာ အရေအတွက် အများဆုံးဖြစ်သည်ကိုတွေ့ရှိရပါသည်။ ထို့အပြင်အမြင့် (၇-၉)မီတာနှင့် (၁၀-၁၂) မီတာရှိသော အပင်များမှာ တောတစ်ခုလုံး၏ ၅၀ ရာခိုင်နှုန်းခန့် ရှိသည်ကို တွေ့ရှိခဲ့ရပါသည်။ ဤ စာတမ်းမှာ သဘာဝတောများကို ထိန်းသိမ်းရာတွင် အထောက်အပံ့ကောင်းများပေးနိုင်ရန် ရည်ရွယ်ပါ သည်။

The Effect of Altitude on Species Composition, Diversity and Stand Structure @ Ver Bridge Region

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Abstract

By studying vegetation, and different environmental factors such as physiographic, soil and climate can sustain plant communities, and the correlation between these factors and the vegetation is very important and practical (Basiri, 2003). The information resulted from vegetation study can be useful to solve the ecological problems such as biological conservation and natural resources management and the future of an ecosystem trends can be forecasted using those information. Forest inventory data were collected at three elevation level (380-1000) m, (1000-1500) m and (1500-2000) m. Based on the 3-ha sample plots for each on all three layers , average stem density range from 1588 trees h^{-1} in the upper layer, 2139 trees h^{-1} in the middle layer and 908 trees h^{-1} in the lower layer. According to Jackknife estimator for species richness was recorded in the upper layer - 35 species h^{-1}, 68 species h^{-1} in the middle layer and 39 species h^{-1} in the lower layer, so rich in species diversity. The diameter and height distribution of trees was investigated in order to know the stand structure of forests and in this study higher species richness and diversity were found in small DBH classes and small height classes. This show all forest at different elevation level has the reverse J shape pattern and the stands had the growing population structure. The highest tree density are found in the lower diameter of 5-10 cm and 10-20 cm, and height classes of 7-9 m and 10-12 m which contribute more than 50 % of total tree density. This study can give better information for effective rehabilitation and restoration of those resources.

Keywords: Environmental Factors, Elevation, Rehabilitation, Species Richness

1. Introduction

Myanmar is located on the dividing line between the Indian sub- continent and South-east Asia, and holds incredibly rich biodiversity. Myanmar has different kind of forest type extending dry forest to alpine forest according to the geological, climatic, and edaphic condition. Myanmar has different kinds of forest such as Tidal forests, Beach and Dune forest, Swamp forest, Tropical Evergreen forest, Mixed Deciduous forest, Dry forest, Deciduous Dipterocarp (Indaing) forest, hill and temperate evergreen forest. However the rich biodiversity is under increasing threat. Threats include human encroachment, overexploitation, and agricultural expansion, overexploitation of NTFP, shifting cultivation, infrastructure development, forest fire and mineral extraction.

Demand for wood and non-wood forest products increases along with increasing population (FAO, 2009). These activities vary over time and space and also have different degrees of impact on forest vegetation. Due to overexploitation and deforestation, tropical forests are disappeared at an alarming rate. Between 1990 and 2005, tropical forests lost about 13 million hectares a year and deforestation and forest degradation were the main cause of species extinction. Myanmar is a heavily forested country with the high rate of deforestation of 0.93% annually in the last decade of 2000 and 2010 (FAO, 2010).

Forests in Myanmar have been under severe pressure due to population growth accompanied by increase in resource use and increasing demand for timber resources from neighboring countries. Information on composition, diversity of tree species and species-rich communities is of primary importance in the planning and implementation of biodiversity conservation efforts. In addition, the diversity of trees is fundamental to the total tropical rainforest diversity as trees provide resources and habitat structure for almost other forest species (Cannon *et al.*, 1998). According to Singh (2002), biodiversity is essential for human survival and economic wellbeing and ecosystem function and stability.

In forest management operations, inventories on biodiversity are used to determine the nature and distribution of biodiversity resources of the forest to be managed (Sagar, *et al*, 2003). For a good forest conservation plan, understanding tree species composition and knowledge of the forest stand structure is necessary (Farhadi, *et al* 2013). Quantification of tree species diversity is an important aspect as it provides resources for many species (sannon *et al.*, 1998). Using resource inventory as a basis of stand structure, species composition and dynamic is important for development of strategies for achieving sustainable management of forest (FAO, 2003) .Therefore, it is critical to examine the current status of species diversity using latest inventory data as such data will provide appropriate guidelines for developing effective system of forest conservation and forest management.

A fundamental characteristic of mountain ecosystems is the drastic change in vegetation as well as in climate from the base to the top of the mountain. There is a tight relationship between the plants and other parts of a given ecosystem. Plant species select their own sites based on their ecologic niches. The information resulted from vegetation study can be useful to solve the ecological problems such as biological conservation and natural resources management and the future of an ecosystem trends can be forecasted using those information. Elevation gradients create varied climates, along with resultant soil differentiation, promotes the diversification of plant species (Brown, *et al*, 2001).The observable associations between species distribution and elevation bands may help to understand the possible effects of climate change, e.g., by providing baseline information from which to measure or gauge the effect of climate change and anthropogenic changes on vegetation.

The identification of key biodiversity areas (KBA) is considered to be a suitable approach to identify appropriate areas for further study and evaluation of PAS status (WCS, Myanmar). As the study area is a proposed Key Biodiversity Area, if we can adopt the Ver Bridge Area as a Key Biodiversity Area, after analyzing the biodiversity status of this area and then adding the data from my study, we can conserve not only the plant species diversity but also contribute the need for the expansion of Protected Area System, which is one of the main objective of the 30 year Forestry Master Plan. The KBA approach helps conservationists, managers and investor to make urgent conservation decision in the face of accelerating threats and pressure.

2. Objectives

The main objective of the study is to determine the level of species composition, diversity and distribution in this area.

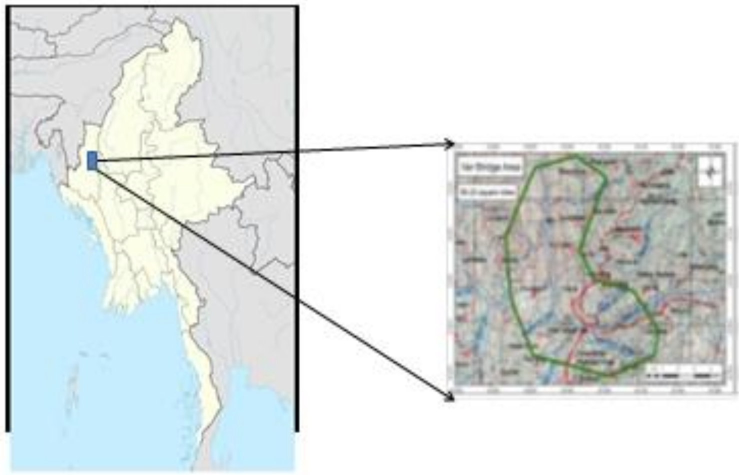
The specific objectives are:

- To determine the forest type, the level of species composition, diversity and distribution in the area-
- To provide a valuable reference for forest assessment on the effect of altitude on forest type formation.
- To make a better information for effective rehabilitation and restoration of those resources.

3. Materials and Method

3.1 Study Area

The study area is located in Northern Chin State, between Falam Township and Kalay Township, Sagaing Region. It lies between 22º 57´ N to 23º 58´N and 92º 41 ´ E to 93º 47 ´. The area is the watershed area of the Minipura River which starts from India to Chin Stae, near Falam Township and merges with the Myittha River, a tributary of the Chindwin River, which is one of the most important rivers in Myanmar. It has temperate zone climate and the highest temperature is 32.0 ° C and the lowest temperate is 2.8 ° C and the annual rainfall is 0.71 inches to 44.41 inches. The area is wide enough 56. 22 square mile (WCS, 2016).The study area is proposed Key Biodiversity Area (KBA). The elevation ranges from 380m to 1837 m absl.



Source: WCS (2016,July)

3.2 Data Collection Method

Data were carried out in a quadrat of 20 m × 20 m (400 m^2) sample plot 25 units, using stratified random sampling plots at three different altitudes (380-1000) m, (1000-1500) m and (1500-1827) m absl. The sample plots were established randomly in each stratum in order to they encompassed all levels of these variables within the selected area. The height (Ht) and diameter at breast height (DBH) of all trees (DBH ≥ 5 cm, Ht ≥ 1.3 m) were measured in each plot. Within the main sample plot, 75 units of (10×10m) size plots (25 units at each elevation level) will be laid out in order to count and mark shrub, herbaceous and climber species (DBH≤ 5 cm, Ht ≥ 1.3 m) and 100 units of (5×5 m) plots (25 units at each elevation level) will be laid out in order to count the sapling (Ht ≤ 1.3 cm). Diameters at breast height were measured with calipers, while crown projection was recorded as two perpendicular diameters checked with a tape measure.

3.3 Data Analysis

The data were analyzed for species composition, richness, diversity, species Importance Value Index (IVI). The species richness was estimated using the Jackknife estimator. To provide quantitative estimates of plant diversity, Simpson’s index and Shannon’s index were used. Evenness indices, which are a structural composition index reflecting the dominance of species were be calculated. The Sorenson’s quantitative index which accounts for the relative abundance of shared species was used to assess the degree of floristic similarity within and between the different elevation levels. For assessing the ecological importance or significance of a species, IVI was used. To assess taxonomic and structural composition between the forest types based on altitude, the IVI value will be calculated at the level of families. Family important values will be computed as the average of the relative basal area, density and frequency. “A Checklist of the Trees, Shrubs, Herbs and Climbers of Myanmar”, “Seed Plants of Natma Taung National Park, Myanmar”, “Biodiversity of Nat Mataung National Park” and “ Tree, Shrubs, Herbs and Principal Climbers etc” were used to identify plant species by botanical and local names with assistance of taxonomic experts. The data were analyzed using SPSS 16.0 statistical software, PC-ORD software, Microsoft Office Excel (2010). One-way analysis of variance (ANOVA) and T-test was used to determine differences in the parameters involved.

4. Results and Discussions

4.1 Species Richness and Diversity

Species richness is the basic component of diversity of any community (De, 2007). The jackknife estimator for species richness of tree (DBH≥5 cm) showed that the middle layer of the elevation (1000-1500m) has the greatest number of species (68species) followed by the lower layer (38 species) and the upper layer (35 species) **(Table 1)**.

Tree species diversity indices provide important information about rarity and commonness of species in a community (Suratman, 2012). Shannon's diversity index (H') places more weight on the rare species while Simpson's diversity index (1-D) gives more weight to those species which occur more frequently (Magurran (1988). In Ver Bridge Region, the middle layer has the highest value of Shannon-Wiener Index and Simpson's diversity index, 2.89 and 0.9 respectively. The larger the value of of H', the greater the species diversity, and vice vasa the greater the species diversity, the larger the value of H' (Magurran, 1988).Shannon-Wiener index (H') value are 2.89 at middle layer, 2.19 at upper layer and 1.35 at lower layer, indicating that among different elevation gradient, the middle layer has the more diverse species composition whereas the upper layer has the simplest species composition.

Species Evenness (E) is a measure of equitability of distribution. Value obtained were 0.83 in the upper layer, 0.90 in the middle layer and 0.5 in the lower layer. The species in the middle layer were more abundant, and the percentage of evenness j (%) was close to 1.0. Therefore, Shannon's evenness (j) shows that the middle layer has the highest species diversity and the lower layer has the lowest species diversity.

Table1. Species richness and diversity in Ver Bridge Region

Paremeter	**Upper**	**Middle**	**lower**
Species richness (Jackknife estimator)	35.75	68.00	38.45
Shannon-Winer index	2.19	2.89	1.35
Simpson's diversity Index (1-D)	0.83	0.9	0.5
Shannon eveness (j') (%)	80.95	83.89	38.06

*****Upper= Elevation (1500-2000) m, Middle= Elevation (1000-1500) m, Lower=Elevation (380-1000) m

4.2 Species Composition

The important value index (IVI) is used to assess the species composition and stand structure.**Table (2)** shows that, in the upper layer, the most abundance species were *Pinus khasya Royle.* (26.4% IVI), *Heteropanax fragrans (Roxb) Seem* (9.3% IVI) and *Quercus gluca Thunb* (8.2 % IVI). The highest IVI value belongs to the species of *Pinus khasya Royle,* (26.4% IVI) in the upper layer, *Castanopsis tribuloides A DC* (13.01%IVI) in the middle *Shoew robusta Roxb.C.F Guertn* (26.03% IVI) in the lower layer.

Table 2. Ten Highest species important value index (IVI) of Ver Bridge Region

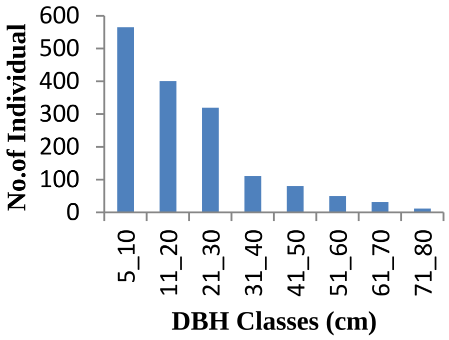
	Scientific Name	SD (n/ha)	BA (m2/ha)	RD(%)	RA(%)	RF(%)	IVI
Upper layer	*Pinus khasya Royle.*	333	7.43	15.68	53.24	10.15	26.4
	Heteropanax fragrans (Roxb.) Seem	487	3.40	7.18	12.04	8.63	9.3
	Quercus gluca Thunb	145	2.30	4.85	9.50	10.15	8.2
	Castanopsis tribuloides A DC	133	3.40	7.18	5.20	8.63	7.0
	Calicarpa arborea Roxb.	101	3.00	6.33	4.72	8.63	6.2
	P.cerasoides (Roxb) Bedd	93	4.00	8.44	1.89	8.12	6.0
	Daphniphyllum himalayense (Benth) Mull.Arg	43	2.76	5.83	3.48	8.63	6.2
	Bixa orellana L.	21	1.35	2.84	2.46	4.57	6.0
	Emblica officinalis Gaertn	24	1.54	3.25	0.93	5.08	3.3
	Others	178	18.20	38.41	6.55	27.41	24.1
	Total	1558	47.38	100.00	100.00	100.00	100
Middle layer	*Castanopsis tribuloides A DC*	390	7.40	14.28	18.02	6.72	13.01
	Pinus khasya Royle.	346	4.76	9.19	27.54	4.20	12.40
	Quercus gluca Thunb	146	3.11	6.00	13.76	6.72	8.83
	Ilex dipyrena Wall.	219	2.40	4.63	5.97	4.76	5.12
	C.arborea Roxb.	253	2.00	3.86	8.40	6.72	6.33
	Albizzia odoratissima (L.f) Benth	154	2.00	3.86	3.02	5.32	4.07
	Heteropanas fragrans (Roxb.) Seem	109	3.54	6.83	2.53	3.08	4.15
	Emblica officinalis Gaertn	150	2.30	4.44	1.24	5.04	3.57
	Daphniphyllum himalayense (Benth) Mull.Arg	113	3.10	5.98	2.23	5.60	3.60
	Other	1880	21.20	40.92	17.29	51.82	38.45
	Total		51.81	100.00	100	100	100
Lower layer	*Shorea robusta Roxb. C.F Guertn*	346	5.22	19.03	46.56	12.50	26.03
	Celtix tetrandra Roxb.	160	3.12	11.37	6.12	13.10	10.20
	Albizzia chinensis (Osbek) Merr.	78	1.29	4.70	10.06	9.52	8.09
	Albiaaia odoratissima (L.f) Benth	90	1.28	4.67	6.46	9.52	6.88
	Chukrasia velutina Roem.	37	1.87	6.82	6.15	8.33	7.10
	Steospermum tetragonum DC.	41	0.51	1.86	4.75	8.33	4.98
	schebera swietenoides Roxb.	37	0.50	1.82	6.36	7.14	5.11
	Vitex limonifolia Wall.	32	0.23	0.84	4.86	7.74	4.48
	Duabanga grandiflora (DC) Walp	29	0.18	0.66	1.93	6.55	3.05
	Other	58	13.23	48.23	6.74	17.26	24.08
	Total	908	27.43	100	100.00	100	100

Among different elevation level, the most frequently occurring species in the upper layer is *Pinus khasya Royle* with 333 individuals recorded with a relative frequency of 10.15 %. Due almost solely to its high relative importance value of 26.4 .The next most frequently occurring species in the middle layer is *Castanopsis tribuloides A DC* with 390 individuals recorded with a relative frequency of 6.72 and in the lower layer, the most frequently occurring species is *Shorea robusta Roxb. C.F Guertn* with individuals recorded with a relative frequency of 12.5.

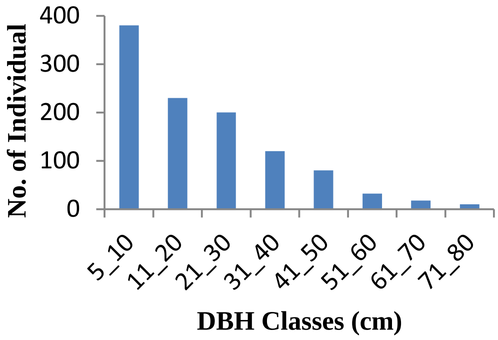
4.3 Stand Structure

4.3.1 Horizontal Stand Structure

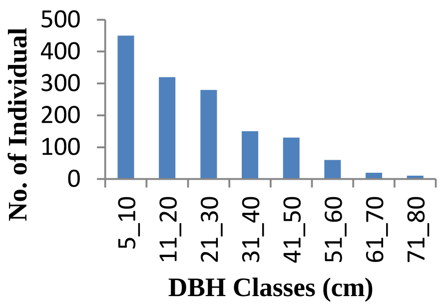
Figure 1(a), (b) and (c) show the distribution of individuals at three different elevations (Upper, middle, lower) by diameter classes. According to this figures the lower diameter classes had larger number of trees than the higher diameter classes, indicating that the reverse of small diameter trees in topical forest was in any case adequate to replace the losses of larger diameter classes. The finding in this study indicates that, where tree density is generally higher in small DBH classes compared to lager DBH classes.



(a)



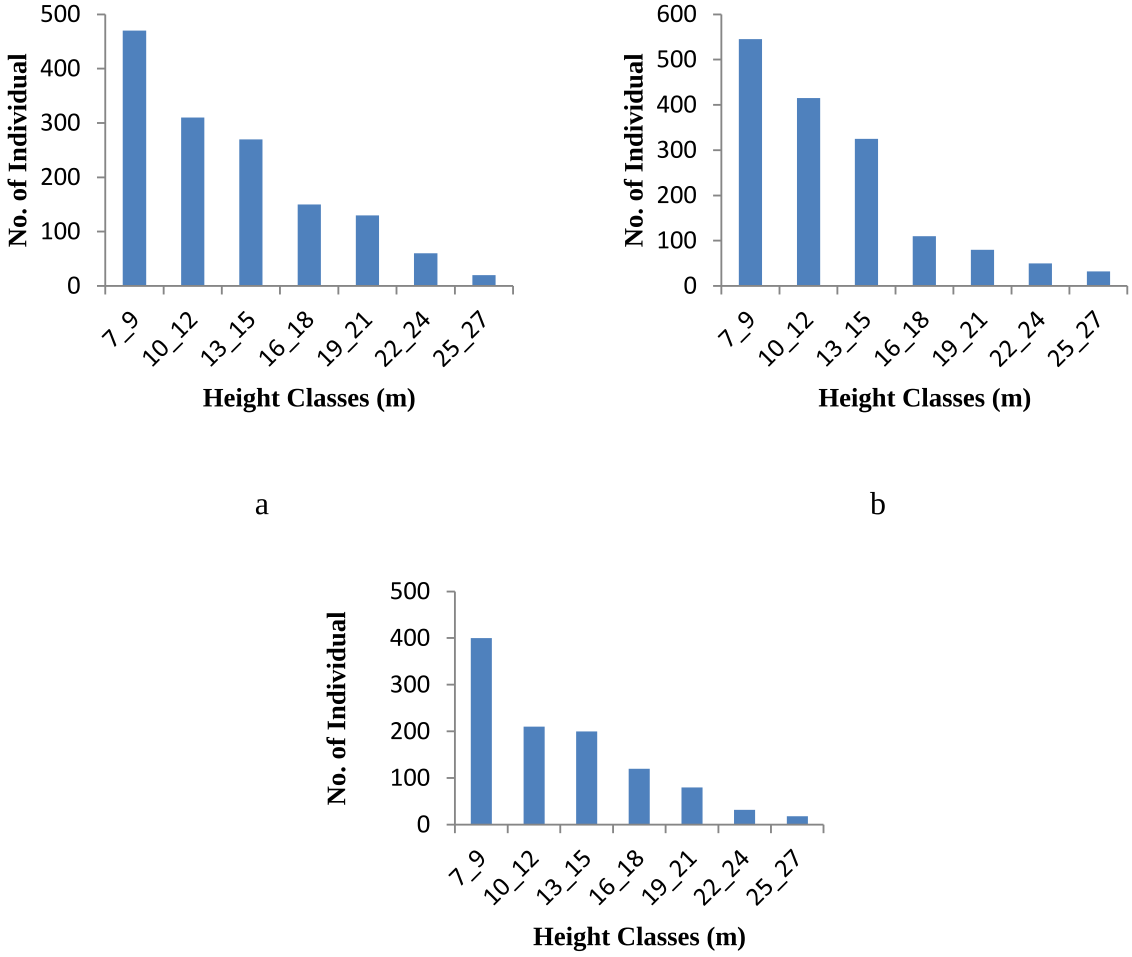
(b)



(c)

Figure1. Distribution of individuals by DBH classes, DBH≥5cm

At all elevations, the greater number of diameter classes in found at (5-10cm). The diameter distribution follows the reverse J shape pattern in **Fig 1 (a), (b) and (c).** This pattern indicated that stands are developing and regeneration is occurring in the forest showing a high potential for species substitution when mature trees in the dominant species die.



c

Figure 2. Distribution of individuals by Height C classes, DBH≥5cm

4.3.2 Vertical Stand Structure

Fig 2(a), (b) and (c) show the distribution of individual by height classes. It can be found that the number of individual decreased with increasing height at three different elevation levels. As the diameter of a tree closely related to its height (Akihiro Sumida et al., 2012), larger number of trees were found in the lower height classes at all elevations. The tree density at all elevations gradient were accumulated I the lowest height classes of 7-9 m ; representing approximately 33 % of total tree density at the lower level, 35% of total density at the middle level and 37 % of total tree density at the upper level. It seems to be formation of different forest types.

4.4 Species-Area Curve

The representative sample of species composition in the investigated forest types can be determined by using species area curve. **Fig 3** shows species area curve. It can be seen that the middle layer has a greater richness of tree of stem diameter ≥ 5 cm than that of the other level. In this figure the curve of all forests at different elevations was found to increase up to 8000m^2 and becomes flat with parallel to x-axis. The species area curve parallel with the x-axis. Lamprecht (1989) described that the species area curves are the best criterion for the determination of the minimum study area and also recommended that the stock with DBH≥10 cm is usually sufficient for plotting species area curve. But, smaller trees including young trees are also required to be surveyed for the analysis of stand structure and dynamic processes (Lamprecht, 1989). The minimum representative area would be reached if the number of species increases by less than 10% when the expansion of sampling area is 10% (Cani and Castro, 1995). According to species area cure 1- ha sample size represented the minimum area for each elevation level since there wer only minimum number of new species discovered up to 8000m^2.

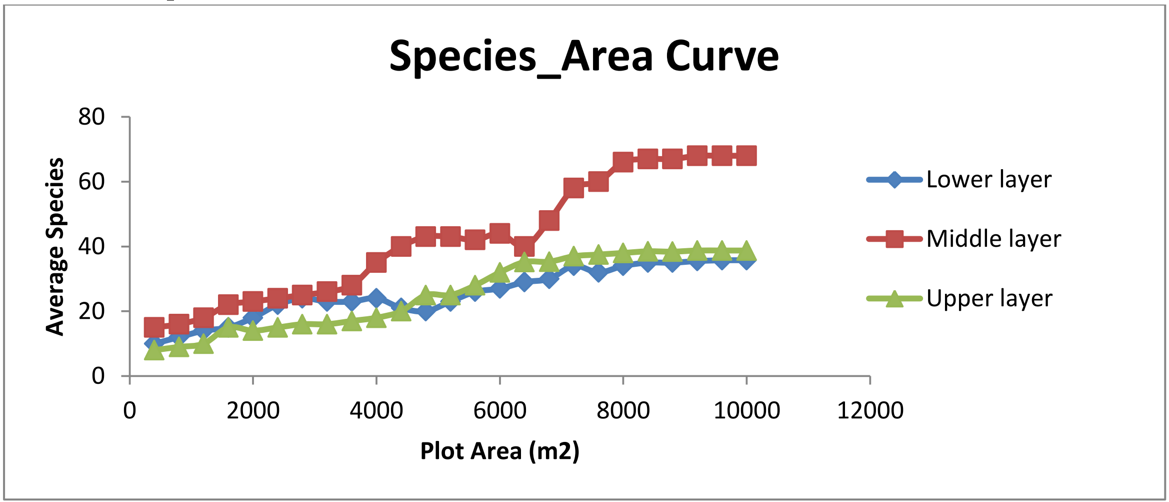


Figure 3. Species Area Curve for all trees (DBH ≥5 cm) in Ver Bridge Region

5. Conclusion

The species area curves show that sampling was adequate at different elevation levels to provide representative estimates of species diversity in Ver Bridge Region. The number of species substantially increase 0.45 ha at all elevations. The increment of species was less than 10% until the sampling area reach 1.0 ha.). The minimum representative area would be reached if the number of species increases by less than 10% when the expansion of sampling area is 10% (Cani and Castro, 1995). So, 1 ha sample plot is represented for all forest type.

The diameter and height distribution of trees was investigated in order to know the stand structure of forests and in this study higher species richness and diversity were found in small DBH classes and small height classes. This show all forest at different elevation level has the reverse J shape pattern and the stands had thea growing population structure. The highest tree density are found in the lower diameter of 5-10 cm and 10-20 cm, and height classes of 7-9 m and 10-12 m which contribute more than 50 % of total tree density. Stand structure of all forest suggested that this forest is less disturbed because many large trees were still found in these forests. This diversity rich forest stand is needed to be protected.

6. Recommendation

After analyzing the species composition, diversity and stand structure of Ver Bridge Region, I found that the forests in this region are high species diversity, natural forest stand structure. Therefore this diversity rich forests stand is need to be protected in time. Apart from the construction of physical barriers, vegetation restoration provides a powerful tool for site rehabilitation. Myanmar Agenda 21 highlighted that the existing protected Area System was not representative and comprehensive (NECA 1997). In the 30 year Forestry Master Plan, targets were set to have 5% expansion of PAS form the long term and 10% expansion of PAS for the long term to fulfill the 1995 Forest Policy and to fulfill the international commitment (MONREC).

Myanmar is obligated, as a signatory, to meet the objectives of the Convention of Biological diversity (CBD) to expand their PAS. The identification of key biodiversity areas (KBA) is considered to be a suitable approach to identify appropriate areas for further study and evaluation of PAS status (WCS, Myanmar).). As the study area is a proposed Key Biodiversity Area, if we can adopt the Ver Bridge Area as a Key Biodiversity Area, after analyzing the biodiversity status of this area and then adding the data from my study, we can conserve not only the plant species diversity but also contribute the need for the expansion of Protected Area System, which is one of the main objective of the 30 year Forestry Master Plan. The KBA approach helps conservationists, managers and investor to make urgent conservation decision in the face of accelerating threats and pressure.

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