Evaluating the Value of Urban Forest in Hlawgar Natural Park, Yangon Region

Thiri Nyo[1], Myat Myat Moe[2], May Myo Htun[3]

ABSTRACT

The present research was conducted during June 2017 and March 2018 by 54 quadrats (20x20) m^2 established in three different sites. This research deals with the assessment of quantitative structure and floristic composition of Hlawgar Natural Park forest in Yangon Region. A total of 112 tree species and 91 genera of 41 families were analyzed in the study area of three different site (Site 1, Site 2 and Site 3). The collected field data will be analyzed for the number of species, total number of individuals, percentages of total individuals, basal area per hectare, stand density (trees) per hectare. Species diversity of each study site will be based on species richness, evenness and diversity indices by using the Shannon-Wiener and Simpson indices (1949). Shannon-Wiener index (H) ranges from 4.56 at Site 1, 5.09 at Site 2and 4.17 at Site 3. The Simpson index (D) 0.92, 0.96 and 0.89. The Simpson index of evenness (E) varies from 0.79, 0.86 and 0.72 respectively. All the diversity indices show that Site 2 is more diverse than the others. Species richness will be mathematically calculated by Jackknife estimate (Heltshe and Forrester 1983). Population structure of tree species will be analyzed across through fixed DBH classes and height class intervals. *Lagerstroemia macrocarpa* Kurz is found to be one of the ecologically dominant species contributing highest IVI value. The total of Above Ground Biomass of tree species were 230.263 ton/ha in Site 1, 233.472 ton/ha in Site 2 and 270.335 ton/ha in Site 3. The present study can be applied for evaluation, baseline information for monitoring of habitat and conservation management of Hlawgar Natural Park forests in the urban area of Yangon Region.

Introduction

Vegetation ecology includes the investigation of species composition and sociological interaction of species in communities (Mueller-Dombois and Ellenberg, 1974). The quantitative parameters, namely, density, relative density, frequency, relative frequency, mean basal area and relative dominance are measured to determine the distribution and ecological aspects of the species.

Current species diversity reflects historical as well as environmental factors since environmental change and human actives lead to changes in species composition and competition (Barbour *et al*., 1998). It is one of the chief characters to determine the relative dominance of a species and nature of the community (Santra. *et al*, 1999).Vegetation ecology includes the investigation of species composition and sociological interaction of species in communities (Mueller-Dombois and Ellenberg, 1974). The quantitative parameters, namely, density, relative density, frequency, relative frequency, mean basal area and relative dominance are measured to determine the distribution and ecological aspects of the species.

Forest structure is the physical and temporal distribution of trees in a stand and include within the description; the distribution of the species, vertical and horizontal spatial patterns, size of trees or tree parts, tree age, or combination (Oliver and Larson, 1990). Tree and woody biomass play important role in the globalcarbon cycle. Forest biomass account for over 45% of terrestrial carbon stocks. (Cairns *et al*., 1997, Mokany *et al*., 2006). Aboveground biomass (AGB) in tropical forests is mainly contained in

[1] Dr.,Lecturer, Department of Botany, Dagon University
[2] Dr.,Head of Professor, Department of Botany, Dagon University
[3] Dr.,Lecturer, Department of Botany, Dagon University

trees. It can be quantified by the direct (destructive) or indirect method where the biomass quantification is estimated using mathematical models. Tropical forests have motivated a worldwide interest because the reduction in forest extent contributes about 20% of the current atmospheric increase in CO_2 concentration (Houghton & Hackler 2006, Ramankutty et al. 2007).

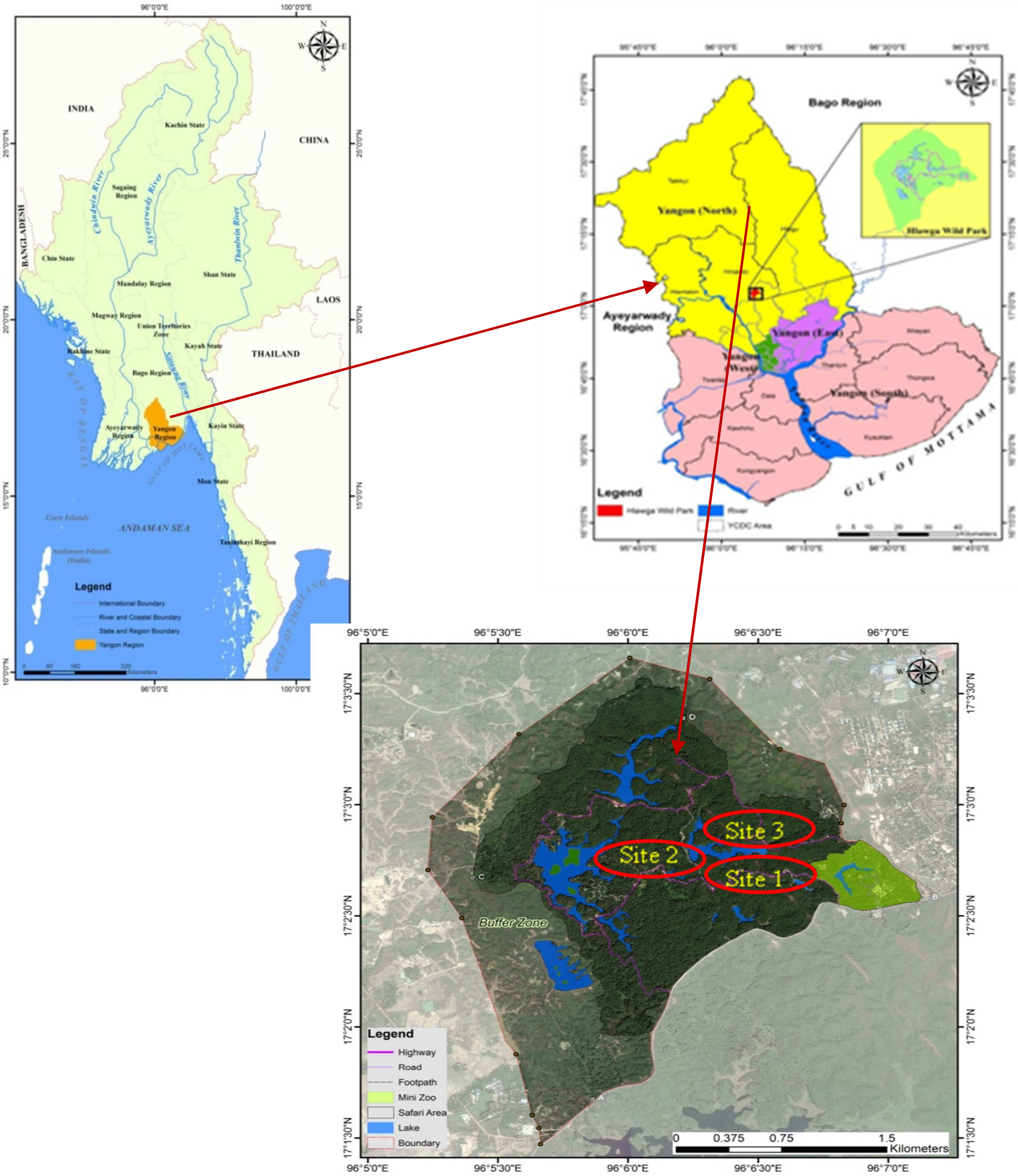
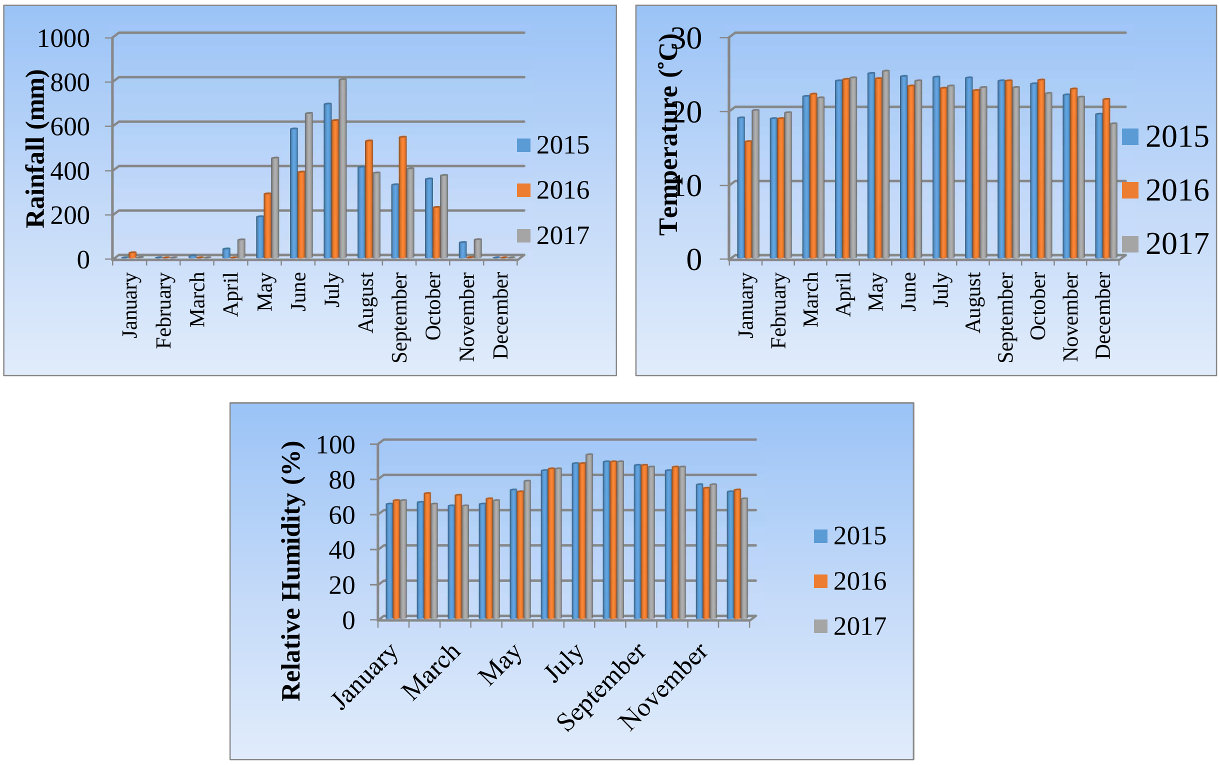


Figure 1 Location Map of Hlawgar Natural Park



Source : Department of Meteorology and Hydrology, Kaba aye, Yangon

Fig (2) Rainfall, Temperature and Relative Humidity of 2015, 2016 and 2017

According to the climatic condition of 2015, 2016 and 2017 data: the maximum rainfall was 802 mm in July, 2017. Moreover, the minimum and maximum temperature of these 3 years were 15.7 ˚ C in January, 2016 and 24.9 ˚ C in May, 2015. The maximum and minimum relative humidity between these 3 years were 93% in July, 2017 and 64% in March, 2015.

METHODOLOGY

Data Collection

In vegetation studies of Hlawgar Natural Park Forest, a total of 54 quadrats size of 20 x 20m were separated into three different sites to study by using random sampling method. All the plots were systematically surveyed for all plants at □ 1.3 m GBH (Girth at Breast Height) during September to November 2017. All sample plots were representatives of the most common forest type. All of plant species were recorded and counted. Plant specimens were collected, pressed, dried and identified with Herbarium specimens of Botany Department, Dagon University and checking Hundley and Chit Ko Ko, 1961; Kress *et al*., 2003, Hooker, 1885-1897 and Dassanayake, 1980-2001 whenever verification is needed.

The spatial location (lactitude, longitude and altitude) of each quadrat was collected using a Global Positioning System (GPS). Care has been taken to cover different elevation, slope, aspects, drainage density, rainfall and temperature gradients to study overall spectrum of tree species diversity. Shannon-Weiner index (H), Simpsons index (D), Simpsons evenness index (E) and Jackknife estimate of species richness □ index were calculated.

Jackknife estimate of species richness

The number of species in a community shows the richness of its species. Species richness is widely used in ecology as a measure of species diversity (Baumgärtner 2005). The species richness is commonly expressed the number of species per unit area, which is also mentioned as species density. Jackknife estimate was also adopted in order to estimate the species richness per study area. This estimate is based on the frequency of rare species in the study sites. According to the Heltshe and Forrester 1983, the formula of Jackknife estimate of species richness is:

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

□ = 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

Measurement of plant species diversity and evenness

Species diversity is the number of different species in a particular area (species richness) weighted by some measure of abundance such as number of individuals or biomass. Species diversity expresses not only measure the species richness and but also takes the relative abundance of species into account (Kumar 1996). Two commonly used measures are Shannon’s index and Simpson’s index. Shannon-Wiener diversity index places more weight on the rare species while Simpson’s diversity index emphasis on the common species (Weidelt 2000). Applying this approach to information theory, Shannon and Wiener 1963, used the term “relative information.” The Shannon index is based on percentage composition by species.

Shannon-Wiener Index

$$H = -\sum_{i=1}^{s}\left(p_i\right)\left(\log_2 p_i\right)$$

H = index of species diversity
S = number of species
p_i = proportion of total sample belonging to the i^{th} species

Simpson Index (1949)

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

D= Simpson's index of species diversity
S= number of species
Pi= proportion of individual of i species in the community

Evenness

Another measure of species diversity is the species evenness, and it is the relative abundance with which each species is represented in an area. An ecosystem in that all the species are represented by the same number of individuals has high species evenness. An ecosystem where some species are represented by many individuals, and other species are represented by very few individuals has low species evenness.

The species evenness or Species Abundance Distribution (SAD) is important in characterizing ecosystems (Paul. *et al.* 2005). Species evenness is a diversity index, a measure of biodiversity which quantifies how equal the communities are numerically. Shannon-Wiener function (1963) is the most meaningful measure of evenness as follow;

$$E = \frac{H}{H_{\max}}$$

$$H_{\max} = Log_2 S$$

E =*evenness (range 0-1)*
H =*index of species diversity*
S =*number of species*
H max =*species diversity under conditions of maximal equitability*

Biomass Estimation

Above ground biomass was estimated using the biomass regression equation developed by Brown et al., (1989) and Martinez Yrizar et al., (1992). The ratio of below ground biomass was estimated as 0.28% of above ground biomass (Monkany et al.., 2006). From the computed above ground biomass and then above carbon stock was calculated by multiplying each AGB 0.5 Carbon is 50% of the dried biomass (Petrokofsky et al., 2012; West, 2009).

Y = 42.69 – 12.800 (D) + 1.242 (D2)
Y = Biomass per tree in kg,
D = DBH (Diameter at Breast Height) in cm

RESULTS

Plant species diversity

The Diversity Index ranges from 0 (no diversity) to 100 (complete diversity). Site 1 consisted of 62 species, 53 genera and 29 families. In Site 2 was 69 species 58 genera and 33 families and Site 3 was 62 species, 55 genera and 31 families.

Jackknife estimate of species richness

According to the results of Jackknife estimate of species richness; the canopy layer of Site 1, Site 2 and Site 3 were 62.95, 69.94 and 62.93 respectively as shown in Table 8.

Among these study sites Site 2 shows the highest species richness and Site 3 shows the lowest.

Species diversity indices

Shannon-Wiener and Simpson Indices

Measures of diversity are regarded as indicators of the well-being of ecological system (Magurran 1988). The most widely used diversity indices are the Shannon-Wiener index (H*'*), which combines species richness and relative abundance and Simpson Index (D). Shannon-Wiener diversity index places more weight on the rare species while Simpson's diversity Index emphasized on the common species.

It was observed that Shannon-Wiener index ranged from 4.56, 5.09 and 4.17 respectively. In the same way Simpson index ranged from 0.92, 0.96 and 0.89 as in Table 1. According to these results, both these two indices of Site 2 had maximum diversity index (5.09, 0.96). Similarly, Site 1 (4.56, 0.92) and Site 3 (4.17, 0.89) had lower diversity indices than Site 2.

Evenness (E)

The Shannon-Wiener function is the most widely used index of species diversity because it incorporates both species richness and abundance (E). As the results of Shannon-Wiener evenness, range from (0.79, 0.86 and 0.72) respectively. According to these results, Site 2 (0.86) was more evenly distributed among the species than the Site 1 (0.79) and Site 3 (0.72) as, shown in Table 1.

Table (1) Consolidate detail of species inventory of Site 1, Site 2 and Site 3

Parameters	Site 1	Site 2	Site 3
No. of sample plots	18	18	18
No. of species	62	69	62
Density(stem/ha)	324.72	288.00	320.40
Basal area (m^2/ha)	39.19	37.63	42.29
Shannon-Weiner diversity index (H)	4.56	5.09	4.17
Simpson diversity index (D)	0.92	0.96	0.89
Simpson evenness index (E)	0.79	0.86	0.72
Jackknife estimate of species richness □	62.95	69.94	62.93

Stratification: Horizontal and Vertical Stand Structure

Forest stand structure can be studied in two forms: horizontal and vertical structures. Stratification or layering occurs not only among the trees but may also be seen among the shrubs and herbs, since some may be tall and some short.

Horizontal stand structure

In Site 1, thirty three species were observed to be the big tree (□ 100cm GBH) which have 53.22% of total species. In Site 2, twenty two species were observed to be the biggest trees (□ 100cm GBH) which occupied 31.88% of the total species. Twenty seven species; 43.55% of total species (□ 100cm GBH) was found in the Site 3. In these study sites, the number of species with □ 100cm GBH class at Site 1 is more than Site 2 and Site 3.

In stand portion of Site 1, Site 2 and Site 3 were 324.72, 288 and 320.40 trees per hectare respectively with □ 20cm GBH and basal area varied from 0.10 to 1.55, 0.06 to 2.25 and 0.03 to 1.23 m2 ha-1 respectively. Total relative basal areas per hectare of these three sites were 39.19, 37.63 and 42.29 per hectare respectively. The number of basal area per hectare with □ 100cm GBH of Site 3 was relatively more abundant than Site 1 and Site 2. The number of basal area per hectare with GBH < 100cm □ 90cm of Site 2 was relatively more abundant than Site 1 and Site 3. The numbers of basal area per hectare with GBH < 90 cm □ 80 cm of Site 1 was relatively more abundant than Site 2 and Site 3. Each of GBH class between GBH <60 cm and □ 40cm of Site 1 was relatively more abundant than other two sites.

Table (2) Horizontal structure of Site 1, Site 2 and Site 3

GBH Class	Site 1		Site 2		Site 3	
	BA/ha ($m^2 ha^{-1}$)	Tree/ha	BA/ha ($m^2 ha^{-1}$)	Tree/ha	BA/ha ($m^2 ha^{-1}$)	Tree/ha
□100cm	28.01	120.83	26.32	112.50	31.44	100
90-99.99cm	1.55	22.22	2.25	31.94	1.23	1.81
80-89.99cm	2.11	37.50	1.49	26.39	1.82	31.94
70-79.99cm	1.31	30.56	2.35	54.17	1.86	41.67
60-69.99cm	2.93	68.06	1.95	59.72	1.26	38.89
50-59.99cm	1.10	47.22	1.27	54.17	1.77	75
40-49.99cm	1.02	66.67	0.95	62.50	1.16	76.39
30-39.99cm	0.72	76.39	0.81	83.33	1.13	123.61
20-29.99cm	0.32	65.28	0.17	34.72	0.58	98.61
□20cm	0.10	91.67	0.06	36.11	0.03	13.89
Total □20cm	39.19	626.4	37.63	555.55	42.29	601.81

Vertical stand structure

Vertical structure describes the top to bottom structure of a forest stand. A diverse stand would have multiple layers from tall to smaller trees, shrubs, grasses, mosses and coarse woody debris. Vertical forest structure is an attribute of forests that is of interest to many disciplines and is consistently discussed in the context of ecosystem management.

The vertical structuring of communities is an important component affecting how communities function at the level of photosynthesis in plants. The vertical distribution of plant elements (e.g., foliage and wood) within a forest can yield important information on stand structure. The vertical storey distributions were distinguished into five different height classes for the analysis of the species represented in different height classes as shown in Table 3.

Table (3) Population density of tree species in height class intervals of Site 1, Site 2 and Site 3

Height (m)	No.of species			Total number of individual			% of Total individual		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
□12	35	39	32	78	116	65	17.3	29	14.6
12□9	27	34	27	73	102	123	16.2	25.5	27.64
9□6	34	39	32	188	136	220	41.7	34	49.44
6□3	14	15	8	82	38	35	18.2	9.5	7.87
<3	7	4	2	29	8	2	6.4	2	0.45
□12	35	39	32	78	116	65	17.3	29	14.6
12□9	27	34	27	73	102	123	16.2	25.5	27.64
9□6	34	39	32	188	136	220	41.7	34	49.44
6□3	14	15	8	82	38	35	18.2	9.5	7.87
<3	7	4	2	29	8	2	6.4	2	0.45
Total	62	69	62	450	400	445	100	100	100

Table (4) Above ground Biomass and Carbon Distribution over the GBH class interval at Site 1, Site 2 and Site 3

GBH Class(cm)	No. of species			Total number of individual			% of Total individual		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
□100	120.83	181.286	127.295	112.50	179.726	89.863	100	221.987	110.994
90-99.99	22.22	8.939	4.469	31.94	12.767	6.383	1.81	6.950	3.475
80-89.99	37.50	11.593	5.796	26.39	8.077	4.039	31.94	9.922	4.961
70-79.99	30.56	6.265	3.133	54.17	11.968	5.984	41.67	9.570	4.785
60-69.99	68.06	10.378	23.515	59.72	9.227	4.613	38.89	5.911	2.955
50-59.99	47.22	4.673	2.337	54.17	5.379	2.689	75	7.517	3.759
40-49.99	66.67	3.656	1.828	62.50	3.389	1.694	76.39	4.141	1.071
30-39.99	76.39	2.065	1.033	83.33	2.338	1.169	123.61	3.182	1.591
20-29.99	65.28	0.673	0.337	34.72	0.372	0.186	98.61	1.079	0.540
<20	91.67	0.735	0.367	36.11	0.225	0.112	13.89	0.076	0.038
Total	626.4	230.263	170.11	555.55	239.462	116.732	601.81	270.335	134.169

Table (5) Ranking of Above and Below ground Biomass (ton/ha) of Hlaw Gar Natural Park

No.	Species	AG Biomass	BG Biomass	Total Biomass
1.	*Crypteronia paiculata* Blume.	104.402	0.292	104.694
2	*Microcos paniculata* L.	74.496	0.229	74.725
3	*Anogeissus acuminata* Wall.	58.929	0.165	59.094
4	*Eugenia megacarpa* Craib.	51.551	0.144	51.695
5	*Lannaeacoromandelia (Houtt.)Merr.*	45.299	0.127	45.426
6	*Schleichera oleosa (Lour.)Oken*	41.144	0.115	41.259
7	*Strychnosnux-blanda A.W.Hill*	36.026	0.101	36.127

Table (6) Ranking of Above and Below ground Carbon (ton/ha) of Hlaw Gar Natural Park

No.	Species	AG Biomass	BG Biomass	Total Biomass
1.	*Microcos paniculata* L.	73.900	1.035	74.935
2	*Crypteronia paiculata* Blume.	52.201	2.820	55.021
3	*Anogeissus acuminata* Wall.	29.464	8.250	37.714
4	*Eugenia megacarpa* Craib.	25.776	1.937	27.713
5	*Lannaea coromandelia (Houtt.)Merr.*	22.650	6.248	28,898
6	*Schleichera oleosa (Lour.)Oken*	20.572	5.496	26.068
7	*Strychnosnux-blanda A.W.Hill*	18.013	5.043	23.057

According to these research, *Crypteronia paiculata* Blume. had highest above ground biomass and carbon stock. The second was *Microcos paniculata* L. and followed by *Anogeissus acuminata* Wall as in Table (5). All these species are among characteristic species having a high indicator value. On the basis of the present investigation, these forests should be maintained by increasing number of seedlings and reducing disturbance (over grazing and cutting) (Thaung Naing Oo *et al*. 2008). Therefore, these may be regarded as the representative and ecologically important species.

DISCUSSION AND CONCLUSION

In this study area, 112 tree species and 91 genera belonging to 41 families were recorded. The total basal area of Site 1 (37.63 m^2ha^{-1}) was the lowest spatial and total number of trees was the fewest (288 tree/ha) among the study sites. On the other hand, the total number of trees in Site 1 was highest (62.64tree/ha). Tree distribution by height class intervals shows that total number of individual of Site 2 had more species than the other in the height class of 9□6. Of the global scale secondary forest are important carbon sink, that partially compensates for carbon emission form tropical deforestation. (Pan *et al*., 2001)

The total of biomass and carbon stock (above and below ground) of Site 3 was greater than the other sites. The comparison of biomass accumulation and carbon sequestion in the three sites showed the largest biomass in site 3 area because it possesses large total basal area. Among these stands, *Crypteronia paniculata* Blume. and *Microcos paniculata* L. have contributed for the greatest total carbon stock in the study area.

The present research mentioned above are with the highest IVI value contributing the largest AGB in the system. So, the canopy tree of these species in the study area can hold more than half of the total AGB carbon which helps in reducing carbon emission to atmosphere as climate changes mitigation. In order to evaluate the future capacity of vegetation in carbon capture, the gross and net primary production should be estimated (Chaiyo *et al*., 2012) Thus, the present research suggests that avoiding deforestation and can play a major role in global climate change mitigation.

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation and gratitude to Dr. Win Naing Rector, Dr. Nay Thwe Kyi, Pro rector and Dr. Nu Nu Yee, Pro rector, Dagon University, for allowing me to carry out this research.

I would like to express my gratitude to Dr. Myat Myat Moe, Professor and Head, Department of Botany, Dagon University, for her suggestion and encouragement to carry out the research successfully. My special thanks are due to Dr. Khin Lat Lat Mon , Professor, Department of Botany, Dagon University for her encouragment and suggestion.

I would like to acknowledge to Dr. May Myo Htun, Lecturer, Department of Botany, Dagon University, as my supervisor for designating the title of dissertation, for formatting the recent study, for his invaluable supervision, patient guidance and support throughout my research work.

I would like to acknowledge to Dr. May Myo Tun; Lecturer, Department of Botany, Dagon University for providing facilities for the fieldwork.

I would like to express my gratitude to all my colleagues who assist me in various ways. I would like to express my gratitude to all my colleagues who assist me in various ways.

REFERENCES

Barbour, M.G., Burk, J.H., Pitts, W.d., Gilliam, F.S & Schwartz, M.W.,(1998). Terrestrial Plant Ecology,3rd Ed. Addison Wesley Longman, Menlo Park, California, 649.

Brown,S.,A.J.R.Gillespie and A.E.Lungo.1989. Biomass estimation methods for tropical forests with applications to forest inventory data. Forest Science 35:881-902.

Chaiyo,U.,S. Garivait and K.Wanthongchai.2012.Structure and Carbon Storage in Aboveground Biomass of Mixed Deciduous Forest in Western Region,Thailand. GMSARN International Journal 6(2012)143-150.

Heltshe, J.F.& Forrester, N. E.(1983). Estimating Species Richness using Jacknife procedure. Biometric 39, 1; 1-11.

Ilorkar, V.M. and P.K. Khatri, (2003). Phytosociological Study of Navegaon National Park (Maharashtra). Indian Forester, 129: 377 387.

Kent, M., and P. Coker, (1992). Vegetation description and analysis: A practical approach, London.

Kimmins, J. P. (1996). Forest ecology. New York: Macumillan Co.Ltd.

Mokany,K.,J.R.Raison,and A.S.Prokushkin.2006. Critical analysis of root:shoot in terrestrial biomes. Global Change Biology 12:84-96.

Mueller-Dombois, D. and E. Ellenberg, (1974). Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York.

Munishi, P.K.T, F.Philipina, R.P.C.Temu and N.E.Pima. 2008. Tree species composition and local use in agricultural landscapes of west Usambaras Tanzania. African journal of ecology,46:66- 73.

Oliver, C. D. and B.C. Larson. (1990). Forest stand dynamics. New York: McGraw-Hill Inc.

Pan,Y.,R.A.Birdsey,J.Fang,R.Houghton,P.E.Kauppi,W.A.Kurz,O.L.Phillips,S.L.Lewis,J.G.Canadell,P.C iais,R.B.Jackson,S.W.Pacala,A.D.Mcguire,S.Piao,A.Rautiain en,S.Sitch,and D.Hayes.2011.A large and persistent carbon sink in the world's forests,Science.333,988-993.

Petrokofsky G.*et a*l.,(2012),Comparison of method for measuring and carbon stock changes in terrestrial carbon pools,Environment evidence Vol.1(6)

Raunkiaer C., 1934. The Life Form of plant and Statistical plant Geography. Claredon Press, Oxford.

Santra, S.C. *et al* (1999) College Botany Practical Vol. I. 2nd edition, New Central Book Agency Ltd.,Calcutta, India.

Shannon, C.E., and W. Wiener,(1963). The Mathematical Theory of Communication, University of Illinois Press, Urbana, USA.

Simpson, E.H.,(1949). Measurement of diversity, Nature, 163, 688.