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Assessment of Plant Species Diversity, Relative Abundances and Distribution in Haramaya University, Ethiopia

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ABSTRACT

The study attempts to investigate the plant species diversity, their abundance and distribution in Haramaya University, Main Campus. An intensive inventory was made to collect the required data. Sample plot of size 10 × 10 m quadrant was used for this particular study. Fifteen quadrats of sample plot for two sites, one at Main Campus main gate (M) and site two, arboretum (A) were systematically laid down to collect the data. The study revealed that 34 different species were recorded in site one, 40 different plant species were recorded in site two, and 22 species were found in common in both sites, accounted about 76% of the species richness for the first site and 69% of the second site. Out of the 34 species recorded in the first site *Lantana camara* accounted 14.7% of the relative abundance followed by *Thuja accidantalis*, *Podocarpes falcatus* and *Cupressus lussitanica* accounting 11, 9.2 and 6.6% of the relative abundance, respectively. In second site, out of the 40 species, it is found that *L.camara* accounted for about 11.8% of the relative abundance followed by *C.lussitanica*, *Phoenix reclinata* and *Juniperus procera* accounting 11.4, 6.9 and 6.3%, respectively. Shannon diversity index indicates that plot two (A) is more diverse (H=3.26) than plot one (M) (H=2.97).The Simpson index of site one and site two are 0.063 and 0.05, respectively. Generally, it is possible to conclude that the university has various plants species having different habitats of tree (T) and shrubs (S).

Key words: Plant species diversity, Plant abundances, Plant distribution and Haramaya University.

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INTRODUCTION

Ethiopia is a country of diverse plant species forming the line Share flora of 6200 species out of the total flora species of 7850 in East Africa (Birhanu et al., 2004; IBC, 2012). Of this diversity, about 12% woody plants are endemic. Vegetation resources in all areas of the country, Ethiopia in general and in fragmented landscape in particular, especially forests are declining at an alarming rate due to increased population (with growth rate 3%) followed by deforestation and land degradation (Tesfaye et al., 2015; Newton and Cantarello, 2015). Furthermore, study conducted by USAID revealed that trees and forests of Ethiopia are under tremendous pressure with a drastic decline in mature forest cover due to the continual pressures of population increase, rudimentary farming techniques, land use competition, land tenure, and forest degradation and conversion (USAID, 2008). In line with this, indigenous knowledge on medicinal and other useful plants is already eroded with the destruction of the forests (Kitessa and Tsegaye, 2008). According to IUCN Red List Categories, Ethiopia possessed 1 endangered, 21 vulnerable, one lower risk/conservation dependent, 30 near threatened (includes lower risk/near threatened, one data deficit, and 3 least concern (includes lower least concern) plant species (Baillie et al., 2004). To document sufficient information on Ethiopia's vegetation resources a study of their floristic composition is an important issue of concern. Moreover, information of plant diversity is needed for the study of dynamic nature of vegetation under specific eco-environmental situation. Ecology, which is the study of diversity of species, has been used for the analysis of pattern, cause of extinction and management practice (Hartley and Kunin, 2003). Now days, Ethiopia has

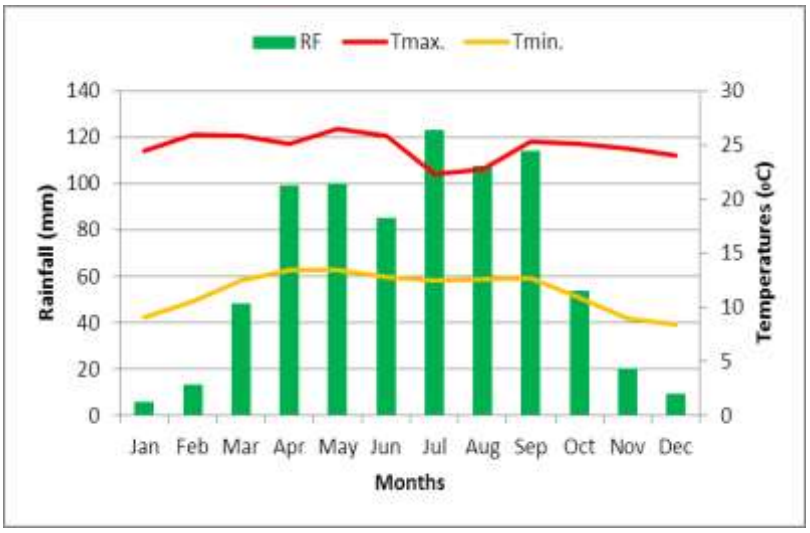

Figure 1. Mean monthly rainfall and temperature feature of the study area.

established protected areas throughout the country and designated many protected areas of land as national parks, wildlife ranches, wildlife sanctuaries, wildlife reserves, and biosphere reserves and national forest priority areas for biodiversity, wildlife and forest conservation (Kelboro and Stellmacher, 2012).

The study of plant community involves the study of species diversity, evenness and similarity. Species diversity is the number of different species that are represented in a given community. The effective number of species refers to the equally abundant species needed to obtain the same mean proportional species abundant as that observed in the data set of interest (where all species may not equally abundant). Species richness and evenness, species richness is a simple count of species whereas species evenness quantifies how equal the abundance of the species (Kent and Coker, 1992). Often different scholars have used the values given by one or more diversity indices to quantify Species diversity. Such indices include species richness, the Shannon index, the Simpson index and the complement of the Simpson index (also known as the Gini Simpson index when interpreted in ecological terms). Species richness quantifies the actual rather than effective number of species. Many studies have been carried out on plant diversity of different part of the world (Stanisci et al., 2005; Backéus et al., 2006; Banda et al., 2006; DeFries et al., 2010). However, since it is not an easy task that the study of plant diversity with time over specific place is highly required. Therefore, the aim of this study was to have sufficient information on relative density, diversity and richness of woody plant species at Haramaya University Arboretum, Rare.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at Haramaya University Arboretum, Rare. The area lies between 9°23´12.27´´-9°31´9.85´´ N and 41°58´28.02´´- 42°8´h10.26´´ E (UTM Zone 38) (Figure 1). The elevation ranges from 1800 to 1825 m above sea level. Climate data analysis of thirty two years (1980 to 2011) obtained from Ethiopian National Meteorological Agency of Ethiopia indicates that the mean annual rainfall and mean maximum and minimum temperatures of Haramaya University, Rare are 790 mm/yr, 24.7 and 11.5°C, respectively. The area received bimodal pattern of rainfall (Figure 1) (Sorecha, 2017).

Data Collection

An intensive inventory was made to collect the required data. Sample plot of size 10 × 10 m quadrant was used for this particular study. Fifteen quadrats of sample plot were systematically laid down on two sites, one at Main campus main gate (G) and site two, arboretum (A) and all woody plant species were recorded from the site on the data collecting sheet.

Data Analysis

The collected data were analyzed using Microsoft excel and other software packages. Descriptive statistics was applied to determine the relative frequency and abundance of species. The species diversity, richness and evenness indices were calculated using PAST after properly encoding the parameter in to the proper indices formula. The following formulas were used to analyze the data as per the (Rosenzweig, 1995). Shannon Wiener index: H = -SUM [(pi) * ln (pi)] E=H/Hmax Hmax=ln(S). Where, SUM = Summation, pi is Number of individuals of species i/total number of samples, S is Number of species

Table 1. Observed plant species with their family, habit, number of individuals, frequency, relative frequency, density and relative density at site Main campus Main gate (M), Haramaya University.

No	Scientific name	Family	Habit	n	Frequency	RF (%)	Density	RD (%)
1	*Podocarpes falcatus*	Podocarpaceae	T	38	0.3	1.12	0.003	0.09
2	*Cupressus lussitanica*	Cupressaceae	T	27	0.2	0.79	0.002	0.07
3	*Lantana camara*	Verbenaceae	S	60	0.5	1.76	0.004	0.15
4	*Croton macrostachyus*	Euphorbiaceae	S	4	0.1	0.12	0.0003	0.01
5	*Acacia seyal*	Fabaceae	T	12	0.2	0.35	0.001	0.03
6	*Callistemon lanceolatum*	Myrtaceae	T	13	0.1	0.38	0.001	0.03
7	*Sebania sesban*	Fabaceae	T	15	0.1	0.44	0.001	0.04
8	*Nerium oleander*	Apocynaceae	S	16	0.3	0.47	0.001	0.04
9	*Acacia abyssinia*	Fabaceae	T	3	0.3	0.09	0.0002	0.01
10	*Cordia africana*	Boranginaceae	T	5	0.1	0.15	0.0003	0.01
11	*Vernonia amygdalina*	Asteraceae	S	3	0.1	0.09	0.0002	0.01
12	*Senna surattensis*	Fabaceae		1	0.1	0.03	0.000007	0.002
13	*Juniperus procera*	Cupressaceae	T	22	0.2	0.65	0.001	0.05
14	*Dodnal angisistfolia*	-	S	2	0.1	0.06	0.0001	0.004
15	*Albizia schimperiana*	Fabaceae	T	23	0.3	0.68	0.002	0.06
16	*Melia azedarach*	Meliaceae	T	14	0.1	0.41	0.001	0.03
17	*Opuntica ficus-indica*	Cactaceae	S	3	0.1	0.09	0.0002	0.01
18	*Citrus sinenesis*	Rutaceae	S	12	0.1	0.35	0.001	0.03
19	*Eucalptus salgna*	Myrtaceae	T	18	0.1	0.53	0.001	0.04
20	*Carrais adules*	-	S	2	0.1	0.06	0.0001	0.004
21	*Olea africana*	Oleaceae	T	14	0.2	0.41	0.001	0.03
22	*Spathoda campanulata*	Bignana ceae	T	5	0.1	0.15	0.0003	0.01
23	*Grevillea robusta*	Poteaceae	T	12	0.2	0.35	0.001	0.03
24	*Erythrina brucei*	Fabaceae	T	1	0.1	0.03	0.000007	0.002
25	*Carica papaya*	Caricaceae	S	2	0.1	0.06	0.001	0.004
26	*Mangifera indica*	Anacardiaceae	T	1	0.1	0.03	0.000007	0.002
27	*Parkinsonia aculeate*	Fabaceae	S	5	0.1	0.15	0.0003	0.01
28	*Ensete ventricosum*	Musaceae	S	11	0.2	0.32	0.001	0.03
29	*Moringa oleifera*	Moringaceae	T	3	0.1	0.09	0.0002	0.01
30	*Thuja occidentalis*	Cupressaceae	S	45	0.1	1.32	0.003	0.11
31	*Casuarina equisetifolia*	Casuarinaceae	T	10	0.1	0.29	0.001	0.02
32	*Casuarina montana*	Casuarinaceae	T	2	0.1	0.06	0.001	0.004
33	*Eucalptus citriodora*	Myrtaceae	T	2	0.1	0.06	0.001	0.004
34	*Phoenix reclinata*	Arecaceae	T	3	0.1	0.09	0.0002	0.01

or species richness. ln is the natural logarithm Hmax = Maximum diversity possible and E= Eveness. Simpson`s index (D) = SUM ($pi^2$) Simpson`s reciprocal index = $\frac{1}{D}$ Simpson`s index of diversity = 1-D. Beta diversity (Ecosystem diversity): B= (S_1-C) + (S_2-C). Where: S_1=Total number of species record in the first community. S_2=Total number of species record in the second community. C=Number of species common in both community. Basic beta diversity index= 2C/ (S_1+S_2). Sorensen`s similarity index: B= 2C/ (2C+S_1+S_2). Density (D) = Number of individual of species A/ area sampled. Relative density (RD) = (Di/DN)*100. Where: Di=Number of individual of species A. DN=Total number of individual in the area. Frequency (F) = Number of plots in which species A occurs/Total number of plot sample. Relative frequency (RF) = (n/N)*100. Where: n= number of individual of a particular species in the sample plot. N=total number of all species in the sample area.

RESULTS AND DISCUSSION

The results of the study revealed that a total of 52 plant species belonging to different family with different habit (shrub and tree) were recognized in Haramaya University, Ethiopia. Of the plant species, about 21 were shrubs and 31 were trees. The maximum plant species recorded in the university were for family of Fabaceae and Myrtaceae. Moreover, the study investigated that the most frequent plant species families in the study place A were found to be in a descending order: verbenaceae (7), Podocarpaceae, Aponyceae and Fabacea (4), respectively. While in site two, G: cupressaceae (9), Verbenaceae and Arecaceae (8) are the most frequent plant species families.

Species Density

Lantana camara (66 plant individuals), *Thuja accidantalis* (45 plant individuals),and *Podocarpus falcatus* (38 plant individuals) were found to be the most densely populated species in the Arboretum (A), whereas, *L. camara* (65 plant individuals), *Cupressus lussitanica* (63 individuals) and

Table 2. Observed plant species with their family, habit, number of individuals, frequency, relative frequency, density and relative density at site two, Arboretum (A), Haramaya University.

No	Scientific name	Family	Habit	n	Frequency	RF (%)	Density	RD (%)
1	*Cordia Africana*	Barasinaceae	T	10	0.3	0.25	0.001	0.02
2	*Cupressus Lussitanica*	Cupressacea	T	63	0.6	1.58	0.004	0.11
3	*Melia Azedarach*	Meliaceae	T	18	0.2	0.45	0.001	0.03
4	*Solanum Incenury*	Solanaceae	S	10	0.1	0.25	0.001	0.02
5	*Eucalptus Camaldulensis*	Myrtaceae	T	18	0.4	0.45	0.001	0.03
6	*Lantana Camara*	Verbenaceae	S	65	0.5	1.63	0.004	0.12
7	*Thvetia Peruviana*	Euohortceae		17	0.3	0.43	0.001	0.03
8	*Podocarpes Falcatus*	Podocarpaceae	T	11	0.3	0.28	0.001	0.02
9	*Spathodo Campanulata*	Bignonaceae	T	5	0.2	0.13	0.0003	0.01
10	*Eucalptus Citriodora*	Myrtaceae	T	22	0.3	0.55	0.001	0.04
11	*Agave sisalana*	Asparagaceae	S	8	0.1	0.2	0.001	0.01
12	*Sesbania Sesban*	Fabaceae	T	4	0.1	0.1	0.0002	0.01
13	*Echinops Giganteus*	Asteraceae	S	5	0.1	0.13	0.0003	0.01
14	*Callistemon Lanceolatum*	Myrtaceae	T	8	0.3	0.2	0.001	0.01
15	*Olea Africana*	Oleaceae	T	22	0.3	0.55	0.001	0.04
16	*Casuarina Equisetifolia*	Casuarinaceae	T	4	0.2	0.1	0.0002	0.01
17	*Hagenia Abyssinica*	Rosaceae	S	9	0.1	0.23	0.001	0.02
18	*Juniperus Procera*	Cupressaceae	T	35	0.3	0.88	0.002	0.06
19	*Vernonia Amygdalina*	Asteraceae	S	15	0.3	0.38	0.001	0.03
20	*Eucalptus Salgna*	Myrtaceae	T	10	0.1	0.25	0.001	0.02
21	*Euphobia Cotinifolia*	Euphortbiaceae	S	17	0.3	0.43	0.001	0.03
22	*Grevillea Robusta*	Poteaceae	T	10	0.3	0.25	0.001	0.02
23	*Phoenix Reclinata*	Arecaceae	T	38	0.5	0.95	0.003	0.07
24	*Carica Papaya*	Caricaceae	S	2	0.1	0.05	0.0001	0.004
25	*Nerium Olen*	Apocynaceae	S	15	0.3	0.38	0.001	0.03
26	*Ficus Elastica*	Maraceae	T	13	0.3	0.33	0.001	0.02
27	*Jacaranda Mimosifolia*	Bignonaceae	T	5	0.1	0.13	0.0003	0.01
28	*Casmiroa Edulies*	Rutaceae	T	4	0.1	0.1	0.0002	0.01
29	*Casuarina Montana*	Casuarinaceae	T	6	0.1	0.15	0.0004	0.01
30	*Dracaena Steudneri*	Dracaenaceae	S	7	0.3	0.18	0.0005	0.01
31	*Hibiscus Rosa-Sinesis*	Malvaceae	S	6	0.1	0.15	0.0004	0.01
32	*Callistemon Pallidus*	Myrtaceae	T	6	0.2	0.15	0.0004	0.01
33	*Opuntica Ficus-Indica*	Cactoceae	S	2	0.1	0.05	0.0001	0.004
34	*Allamanda Cathartica*	Apocynaceae	S	3	0.1	0.08	0.0002	0.01
35	*Araucaria Hetrophylla*	Araucariaceae	T	5	0.1	0.13	0.0003	0.01
36	*Dodnal Angisistfolia*		S	5	0.1	0.13	0.0003	0.01
37	*Psidium Guajava*	Myrtaceae	T	25	0.1	0.63	0.002	0.05
38	*Sabucus Nigra*	Adoxaceae	S	3	0.1	0.08	0.0002	0.01
39	*Albizia Schimperiana*	Fabaceae	T	12	0.2	0.3	0.0008	0.02
40	*Callistemon Citrinus*	Myrtaceae	T	10	0.3	0.25	0.001	0.02

Phonix reclinata (38 plant individuals) were the most densely populated species in the second plot, G. The study indicated that the number of *L. camara* were highly populated and expected to rises up in the university in the upcoming periods unless otherwise any critical management has to be done. On the other hand, studies conducted in other parts of Ethiopia on wood lands found different species; For instance, Eshete (2002) found out about 24 species and Asfaw (2006) identified 32 species.

Species Diversity

The value of the species diversity showed that plot two (A) is more diverse (H=3.26) than plot one, M (H=2.97). The Simpson index of site one and site two are 0.063 and 0.05, respectively. The Simpson index of diversity of site one and site two are 0.94 and 0.95, respectively. On the other hand, the Beta diversity index and the basic beta diversity index were in between the two habitat types are 30 and 0.6, respectively.

Species Richness and Evenness

Species richness is the number of different species present in an area. From the sampled population in the case of this study 34 different species were recorded in plot one and 40 different species in plot two and 22 species in common in both sites. The common species accounted about 76% of the species richness for the first site and 69% of the second site. The calculation of species richness by

Table 3. Shows plant species which found common in sites Main Campus, Main gate (G) and Arboretum (A) Haramaya University.

No	Scientific name	Family	Habit
1	*Podocarpus Falcatus*	Podocarpaceae	T
2	*Cupressus Lussitanica*	Cupressaceae	T
3	*Lantana Camara*	Verbenaceae	S
4	*Callistemon Lanceolatum*	Myrtaceae	T
5	*Sesbania Sesba*	Fabaceae	T
6	*Nerium Oleander*	Aponcynaceae	S
7	*Cordia Africana*	Boranginaceae	T
8	*Vernonia Amygdalina*	Asteraceae	S
9	*Juniperus Procera*	Cupressaceae	T
10	*Dodnal Angisistfolia*		S
11	*Melia Azedarach*	Meliaceae	T
12	*OpunticaFicus- Indica*	Cactaceae	S
13	*Eucalptus Salgna*	Myrtaceae	T
14	*Olea Africana*	Oleaceae	T
15	*Spathoda Campanulata*	Bignonaceae	T
16	*Grevillea Robusta*	Poteaceae	T
17	*Carica Papaya*	Caricaceae	S
18	*Casuarina Equisetfolia*	Casuarinaceae	T
19	*Casuarina Montana*	Casuarinaceae	T
20	*Eucalptus Citriodora*	Myrtaceae	T
21	*Phonix Reclinata*	Arecaceae	T
22	*Albizia Schimperiana*	Fabaceae	T

Where 'S' is shrubs and 'T' is trees.

using Menhinick's index (which index is based on the ratio of the number of species(S) and the square root of the total number of individuals(N) D or IMn=S/√N) has showed that site two is more rich (1.7) than site one which have species richness index of (1.68). This may be due to the higher species richness which leads to the higher species diversity. This possible explanation was also forwarded to Sidama home garden (Abebe, 2005). The calculation of species evenness index by using Pielou'evenness index (the index measures equitability and allows comparison of Shannon Wiener index with the distribution of individuals in the observed species that would have the maximum diversity=H'/Log(S)) for site one and site two are 0.84 and 0.88, respectively. This result goes in line with Tynsong and Tiwari (2010), where the mean Shannon indices vary widely in tropical areas and ranged from 0.93 to 3.00. The soreness's similarity index between the two habitat types is 0.4. Furthermore, the difference in species richness from place to place could be attributed to altitude, soil type and plot size (Ewuketu et al., 2017).

Relative Abundance

Out of the 34 species recorded in the first site *L. camara* accounted 14.7% of the relative abundance followed by *T.accidantalis*, *P.falcatus* and *C. lussitanica* accounting 11, 9.2 and 6.6% of the relative abundance, respectively. In the case of the second site, out of the 40 species, it is found that *L.camara* accounted for about 11.8% of the relative abundance followed by *C.lussitanica*, *P.reclinata* and *J.procera* accounting 11.4, 6.9 and 6.3% of the relative abundance, respectively. Most plant species found within Haramaya University were frequently cited in other work in Ethiopia, such as Prunus persica, Dodonaea viscose, Curcurpita pepo (Larato, 2011), Citrus species and Psidium guajav (Wezel and Bender, 2003); Schnius molle; Rhamnus prinoides, Otostegia integrifolia, Chata edulis, Brassica integrifolia, Lycopersicon esculant, Allium cepa (Abebe et al., 2010). Wider global distribution of species shows their higher socio-economic and environmental role. On the other hand, it has been well recognized through this study that in Haramaya University, Main Campus over specified sites considered for this study (Site M and Site A), different species has been observed. Tables 1 and 2 shows those species observed over specific sites M and A, whereas, Table 3 shows those species that found in both sites, commonly.

CONCLUSION

Plant species diversity, abundance and distribution within Haramaya University, Ethiopia were determined via this study. The study revealed that Shannon diversity index for Arboretum of the university was more diverse than site plot two of the Main Campus Main Gate. About 34 different species were noticed in Main Campus Main Gate and 40 different plant species were recorded in Arboretum in Haramaya University. Overall, study showed that the university has various plants species categorized under

the different families.

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