Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), 11(X), 2023:
http://dx.doi.org/10.7770/safer-V11N1-art613

Floristic composition and plant community analysis of vegetation in Buska Mountain Range, Southwestern Ethiopia.

Composición florística y análisis de la comunidad vegetal de la vegetación en la cordillera de Buska, suroeste de Etiopía.

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ABSTRACT

The current investigation was conducted in the vegetation of Buska Mountain range, Hamar area, Southwestern Ethiopia. The main goals of the study were investigating plant diversity, community types, vegetation structure, regeneration status, and the major environmental threats of the vegetation. Accordingly, the required data were collected from 92 quadrats of 20m x 20m (400 m^2) for woody species and five subplots of 25 m^2 for shrubs and five subplots of 4 m^2 for herbaceous plant species within the main plots. The plots were laid out in a systematic manner along eight transect lines that were one kilometer apart. The height and Diameter at Breast Height (DBH) of woody plant species with the height ≥2 m and DBH ≥2.5 cm were measured, and the cover abundance was estimated. Community classification was conducted using agglomerative hierarchical method. The Shannon-winner diversity and Evenness indices were used to calculate plant species diversity, richness, and evenness. DBH, basal area, density, height, frequency, and importance value indices were used to describe the vegetation structure. A total of 272 vascular plant species within 202 genera and 77 families were identified. Fabaceae (with 33 species; 12 %) was the most dominant family, followed by the Asteraceae (16 species; 6 %). Shrubs were the most frequent growth habit (43%) in the vegetation. The community types three and two, respectively had the highest (3.94) and lowest (3.33) Shannon-Wiener diversity indices. The result of CCA ordination analysis revealed that the altitude, grazing, slope and ringing were some of the environmental factors influencing the plant species distribution and community types' formation. The study area provisions a greater variety of plant species despite its arid climate and vulnerability. However, the vegetation is currently threatened by natural and anthropogenic interventions. As a result of the realized diversity as well as vulnerability, the study vegetation necessitates immediate interventions to mitigate the disturbances.

Keywords: Community types, Floristic composition, Mountain range, Regeneration status

RESUMEN

La presente investigación se llevó a cabo en la vegetación de la cordillera Buska, área de Hamar, suroeste de Etiopía. Los principales objetivos del estudio fueron investigar la diversidad de plantas, los tipos de comunidades, la estructura de la vegetación, el estado de regeneración y las principales amenazas ambientales de la vegetación. En consecuencia, los datos requeridos se recolectaron en 92 cuadrantes de 20 mx 20 m (400 m2) para especies leñosas y cinco subparcelas de 25 m2 para arbustos y cinco subparcelas de 4 m2 para especies de plantas herbáceas dentro de las parcelas principales. Las parcelas se dispusieron de manera sistemática a lo largo de ocho líneas transversales separadas por un kilómetro. Se midieron la altura y el diámetro a la altura del pecho (DAP) de especies de plantas leñosas con una altura ≥2 m y un DAP ≥2,5 cm, y se estimó la abundancia de cobertura. La clasificación de las comunidades se realizó mediante el método jerárquico aglomerativo. Se utilizaron los índices de diversidad y uniformidad de Shannon-Winner para calcular la diversidad, riqueza y uniformidad de las especies de plantas. Para describir la estructura de la vegetación se utilizaron índices de DAP, área basal, densidad, altura, frecuencia y valor de importancia. Se identificaron un total de 272 especies de plantas vasculares dentro de 202 géneros y 77 familias. Fabaceae (con 33 especies; 12 %) fue la familia más dominante, seguida por Asteraceae (16 especies; 6 %). Los arbustos fueron el hábito de crecimiento más frecuente (43%) en la vegetación. Los tipos de comunidad tres y dos, respectivamente, tuvieron los índices de diversidad de Shannon-Wiener más altos (3,94) y más bajos (3,33). El resultado del análisis de ordenación del ACC reveló que la altitud, el pastoreo, la pendiente y el anillamiento fueron algunos de los factores ambientales que influyeron en la distribución de las especies de plantas y la formación de los tipos de comunidades. El área de estudio ofrece una mayor variedad de especies de plantas a pesar de su clima árido y vulnerabilidad. Sin embargo, la vegetación se encuentra actualmente amenazada por intervenciones naturales y antropogénicas. Como resultado de la diversidad y vulnerabilidad observadas, la vegetación del estudio requiere intervenciones inmediatas para mitigar las perturbaciones.

Palabras clave: Tipos de comunidades, Composición florística, Cordillera, Estado de regeneración

INTRODUCTION

In many developing countries, forest resources typically make a significant contribution to the well-being of rural communities, particularly the poorest households during times of adversity (Rasmussen et al., 2017). However, the consequences of current climate change, combined with the effects of human intervention, threaten the functions and services provided (TEEB, 2009). Biodiversity evaluation at the level of community types, according to (Goldsmith *et al*., 1986), provides a larger view of biodiversity since it contains structural and functional aspects identifying its physiognomy, as well as its component species.

Ethiopia is a tropical country with forests and woodland vegetation, including four major vegetation types found in arid and semiarid regions: wide-leaved deciduous woodland, small-leaved deciduous woodland, lowland dry forest, and lowland semi-desert and desert, which cover a large portion of a country (Friis, 1992). In addition, the country is home to two of the world's 36 biodiversity hotspots (Mittermeier et al., 2004; Cunningham and Beazley, 2018). As a result, Ethiopia is regarded as a country with high-biodiversity in Horn of Africa. The high mountain regions and the Ogaden area were observed as the centers of endemism in the country (Teshome *et al*., 2004).

However, the country's great biodiversity is under threat from deforestation and land degradation, overexploitation, habitat loss, invasive species, and some water pollution (Feyera *et al*., 2001; EBI, 2009). Shifting cultivation, agricultural land expansion into forest habitats, logging, overgrazing, and fuel wood exploitation are the primary drivers of deforestation in Ethiopia.

The majority of Ethiopia's remaining forests are located in the country's south and southwest (Kumelachew and Tamrat, 2002). The vegetation of Hamar community at the Buska Mountain range is one of the remaining vegetation in the Lower Omo region, situated in arid and semi-arid climatic conditions, and has been passed down from generation to generation by Hamar tribe elders in Southwestern Ethiopia (Figure 1).

Figure 1. The Community leader of Hamar people who has been taking care of the vegetation

To combat the ever-increasing challenges to the ecosystem, understanding the floristic composition, structure and the factors affecting, as well as the indigenous way of forest management is crucial (Feyera *et al*., 2014). The natural vegetation of Buska Mountain range, which is sandwiched between the Omo rift valley and the Woito semi-desert climatic condition, is currently threatened by the natural and anthropogenic interventions and needs a comprehensive investigation and justification for its sustainability. Therefore, the current research was carried out to investigate the floristic composition, community types, and vegetation structure in the area, along with the associated threats, thereby endorsing future inferences for the conservation of biodiversity in Buska Mountain range.

MATERIALS AND METHODS

The research was conducted in the Buska Mountain range, Hamar district, Southwestern Ethiopia. The vegetation is located 880 kilometers south of Addis Ababa (the capital of Ethiopian) at 5° 12′ 40′′ N latitudes and 36° 20′ 10′′ E longitude. Semi-arid and dry climatic conditions cover the vast majority of the study district, with a highly variable mean annual precipitation of 757 mm and an average annual temperature of 22.7°$_C$. The district has a bimodal rainfall pattern, with the main rainy season spanning March to May and a shorter wet season from September to October. The average monthly maximum and minimum temperature records of the area are 33.2°$_C$ and 14.2°$_C$ respectively (Figure 2).

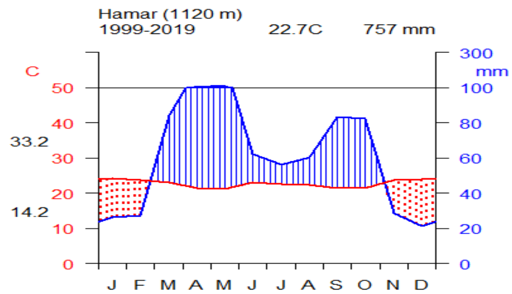

Figure 2: Climate diagram of the area with the rainfall distribution and temperature record from 1999 to 2019.

Vegetation data collection

A systematic sampling design was used to collect the data from 92 quadrats (20m x 20m) following Mueller-Dombois, and Ellenberg (1974), laid along eight transect lines established at 1km apart from each other. All the vascular plant species encountered in each plot were collected based on (Tamrat, 1993); the seedlings, saplings and herbaceous plant species were recorded within the subplots of 4m^2; one at the center and the other four at the corners of the main plot. The height and DBH of each woody plant species with the height ≥2 m and DBH ≥2.5 cm were measured using Hypsometer and Caliper respectively. If the tree branched near to the ground level, the diameter was measured separately for the branches and averaged (Bharali *et al*., 2012) and treated as a single individual. The plant species < 2.5 cm DBH and <2 m height were considered as seedlings/ saplings. The cover-abundance was estimated based on modified 1–9 Braun-Blanquet scale as converted by (van der Maarel, 1979).

The collections were first named using the local names for field identification; their habits were recorded, coded, pressed, dried and taken to Ethiopian National Herbarium, Addis Ababa University for formal taxonomic identification using flora of Ethiopia and Eritrea. The identified and verified Voucher specimens were deposited in the herbarium.

Environmental data collection

The geographical data including altitude, slope, aspect, coordinates were recorded and the codes for aspect readings were assigned based on (Zerihun *et al.*, 1989) as: North =0; East=2; South=4; West=2.5 and NW=1.3. Likewise, any of the disturbances observed in the vegetation were recorded as present or absent respectively when occurred or not occurred in each plot. Following Feyera Senbeta *et al*., (2014), the degree of the disturbances was rated from 0-4, with the slight modification based on their status in the area. The values were coded as 0= no any disturbance, 1= slightly disturbed (when any one of the disturbance occurred), 2= mordantly disturbed (when any two of the disturbances occurred), 3= highly disturbed (when any three of the disturbances occurred); 4= extremely disturbed (when all of the environmental factors disturbing the vegetation were discovered).

Data analysis

Agglomerative Clustering technique was applied using similarity ratio (Zerihun, 2014). Each community was described based on the higher synoptic values obtained from cover-abundance values as stated in (Van der Maarel *et al.*, 1979) and the community types were named by two characteristic species chosen with high synoptic values. Plant diversity, richness and evenness were evaluated by using the Shannon-Wiener Diversity Index by the formula:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

Where: H'= Shannon Diversity Index, s= the number of species, Pi= the proportion of individuals or the abundance of the i^{th} species expressed as a proportion of total cover;

ln= natural logarithm; Σ= Summation symbol. Shannon evenness index (J) was calculated from the ratio of observed diversity to maximum diversity using the equation:

$$J = H'/H_{max} = H'/\ln S$$

The higher value of J indicates the more evenly distribution of the species within the sample.

The similarity of community types concerning species composition within the study area was computed by using Sørensen's similarity index applying:

$$Ss = \frac{2a}{(2a + b + c)}$$

where Ss = Sorenson`s similarity coefficient a = Number of species common to both communities, b = number of species in community1, c = number of species in community 2

Ordination analysis: The relationship between the vegetation and environmental factors was carried out by using Cannonical Correspondence Analysis (CCA) using R (version 4.1.3 statically packages). The longest arrow of the environmental factors in the ordination diagram, the strongest is its influence on the species composition and community formation. To describe the vegetation structure of the study forest, density, frequency, height, DBH, basal area and species importance value were calculated as:

$$BA = \pi d^2/4 \quad \text{where BA=Basal Area in } m^2 \text{ per hectare}$$

$$d\text{=diameter at breast height (m)} \quad \text{and} \quad \pi=3.14$$

Importance Value Index (IVI): Is used to express the relative ecological rank of the species in the forest. The greatest IVI shows the dominance and abundance of a given species in relation to the other species in the area and it is used for ranking species management practices and helps to identify their sociological structure. As a result, the IVI was computed following Mueller-Dombosis and Ellenberg (1974).

IVI = Relative Density (RD) + Relative Dominance (RDO) + Relative Frequency. Where:

$$RD = \frac{\text{number of all individuals of a species}}{\text{Total number of all individuals in the sample}} \times 100$$

$$RDO = \frac{\text{basal area of a species}}{\text{Total basal area of the sample}} \times 100$$

$$RF = \frac{\text{Frequency (F) of a species}}{\text{Sum of the frequencies of all species}} \times 100$$

Where: $$F = \frac{\text{number of the quadrat in w/c a species occur}}{\text{Total number of quadrats lay}} \times 100$$

RESULTS

Floristic Composition: A total of 272 plant species within 77 families were identified from the vegetation area. Fabaceae family contributed the most species number (33, 12%), followed by Asteraceae 16 (6%), Euphorbiaceae 13(4.8%), and Solanaceae 13 (4.8%). The Lamiaceae and Poaceae families each had 12 species, Acanthaceae (9 species), Tialiaceae (8 species), Rubiaceae and Rutaceae each had 7 species, while the remaining plant families each represented by one to six plant species. Thus, about 57% of the total species in the forest was contributed by the first 14 most species rich plant families. In terms of genera distribution, out of the total 202 genera, Fabaceae contributed 20 genera followed by Poaceae (12 genera). Thus, the top ten genus rich plant families such as Fabaceae, Asteraceae, Euphorbiaceae, Lamiaceae, Poaceae, Acanthaceae, Solanaceae, Cucurbitaceae, Rubiaceae and Rutaceae have contributed more than 45% of the genera recorded from the vegetation (Table 1).

Table1. The first 14 most species rich plant families in the vegetation

Family	No. of Spp.	Percentage	No. of Genera	Percentage
Fabaceae	33	12.2	20	9.8
Asteraceae	16	5.9	11	5.4

Euphorbiaceae	13	4.8	9	4.4
Solanaceae	13	4.8	7	3.4
Lamiaceae	12	4.4	9	4.4
Poaceae	12	4.4	12	5.9
Acanthaceae	9	3.3	7	3.4
Tialiaceae	8	2.9	2	1.0
Rubiaceae	7	2.6	6	2.9
Rutaceae	7	2.6	6	2.9
Boraginaceae	6	2.2	4	1.9
Capparidaceae	6	2.2	4	1.9
Cucurbitaceae	6	2.2	6	2.9
Anacardiaceae	6	2.2	3	1.5

Plant community classification: Four plant community types emerged from the vegetation analysis based on the cover abundance data matrix of the plant species. Each of the community was named by two species with the highest synoptic values in the group. Accordingly, the communities were described as *Combretum molle-Terminalia brownii* (Community type 1), *Olea europaea-Juniperus procera* (Community type 2), *Acacia mellifera – Euclea racemosa* (community type3) and *Dichrostachys cinerea-Dodonaea angustifolia* (community type 4). The highest number of species was occupied by community number three followed by community number four while the least number of species was recorded in community number one (Figure 3).

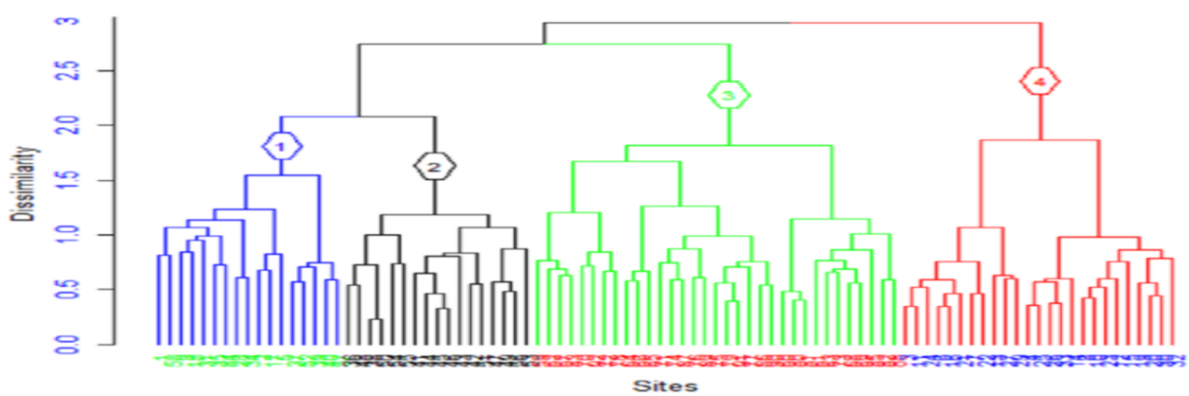

Figure 3: Dendrogram constructed from sample plots in the vegetation of Buska Mountain Range

Community type1: *Combretum molle-Terminalia brownii* community type was represented by 17 plots that occupy 160 plant species. It is distributed in altitude range of 1460-2021ma.s.l with an average altitude of 1787m. The dominant woody species, in addition to the two community naming species include *Grewia velutina, Dalbergia lactea, Adenium obesum, and Euclea racemosa* subsp. *schimperi*, while the most common understory species in this community were *Jasminum grandiflorum*, *Solanum incanum*, *Ipomoea kituiensis* and *Rhus natalensis.*

Community type 2: *Olea europaea-Juniperus procera* community type was distributed within the altitudinal range of 1911-2098m a.s.l at an average altitude of 1989m. It is represented by 17 plots and 208 plant species. In addition to the representative species of the community, *Croton macrostachyus*, *Euclea racemosa* subsp. *schimperi* and *Podocarpus falcatus* were seen to be the dominant woody species in the community. On the other hand, the under canopy was covered by shrub and herbaceous species such as *Calpurnia aurea*, *Achyranthes aspera*, *Heteromorpha arborescens*, *Brucea antidisenterica*, *Indigofera suaveolens* and *Phytolacca dodecandra.*

Community type 3: *Acacia mellifera – Euclea racemosa* community type. This community type was distributed within the altitudinal range between 1136-1848a.s.l with the average altitude of 1615 m. This community stands for 33 plots and 352 associated plant species. The dominant species other than the community specifying species in this community include: *Acacia nilotica, Acacia seyal, Grewia velutina, Grewia trichocarpa, Lannea fruticosa* and *pavetta ayssinica.* The herbaceous layer of the community was mostly dominated by *Cyperus bulbosus, Hypoestes forskaolii*, and *Sporobolus africanus.*

Community type 4: *Dichrostachys cinerea- Dodonaea angustifolia* community type. The fourth community type in the study area, which was comprised of 25 plots and 212 plant species. This community type is distributed within the altitude range of 1402-1817a.s.l and an average altitude of 1593m. The community also covered by some other dominant species in addition to the representative species of the community, such as: *Adenium obesum*, *Ximenia americana, Acacia mellifera, Carissa spinarium, Euphorbia tirucalli, Pterollobium stellatum, Ziziphus spina-christi* and *Acacia seyal.* The herbaceous layer of the community was mostly covered by *Senna occidentalis, Solanum cerasiferum, Stipagrostis foexiana, Sansevieria abyssinica* and *Pennisetum setaceum.*

Table 2: List of top ten species with relatively higher synoptic values in each community type

Shannon-Wiener diversity index revealed that the maximum species diversity value was found in the *Acacia mellifera – Euclea racemosa* community type (Community type 3), whereas the species evenness value was higher in community one (*Combretum molle- Terminalia brownii* community type). The least species diversity was discovered in Community type two, which is situated at a higher altitudinal range in the area. The fourth community type (*Dichrostachys cinerea- Dodonaea angustifolia* community type), which possessed the lowest average altitude range in the study site, was distinguished by intermediate species diversity and richness (Table3).

Table 2: List of top ten species with relatively higher synoptic values in each community type

Species	C1	C2	C 3	C4	P-value
Combretum molle	4.1	0.11	0.36	0.29	0.001
Terminalia brownii	2.19	0	0.36	0	0.001
Piliostigma thonningii	0.77	0	0.18	0.14	0.04
Ozoroa insignis	0.68	0.06	0.18	0	0.02
Dalbergia lactea	0.48	0.17	0.18	1.07	0.011
Combretum collinum	0.42	0.19	0	0.14	0.055
Ximenia americana	0. 91	0	0. 42	1.5	0.02

Rhus vulgaris	0.39	0.06	0.18	0	0.03
Tamarandus indica	0.39	0	0.14	0	0.054
Entada abyssinica	0.35	0.19	0	0	0.139
Olea europaea	0.06	1.94	0	0	0.001
Juniperus procera	0	0.92	0	0	0.001
Podocarpus falcatus	0	0.67	0	0	0.001
Calpurnia aurea	0.58	0.53	0.18	0	0.001
Dombeya torrida	0	0.47	0.13	0	0.016
Croton macrostachyus	0.32	0.44	0	0	0.001
Phoenix reclinata	0.1	0.42	0.02	0	0.002
Prunus africana	0	0.33	0	0	0.004
Balanites rotundifolia	0.21	0.28	0	0	0.022
Heteromorpha arborescens	0.23	0.28	0	0	0.003
Acacia mellifera	0	0	5.27	0.79	0.001
Euclea racemosa	1.26	0.97	2	0.43	0.001
Acacia seyal	0	0	1.64	1.36	0.001
Acacia tortilis	0.19	0.06	0.91	0.5	0.003
Acacia nilotica	0.42	0	0.91	1.5	0.007
Acacia bussei	0.23	0.02	0.73	0.5	0.021
Grewia velutina	0	0.06	0.55	0	0.008
Stereospermum kunthianum	0.19	0.14	0.55	0.14	0.021
Sterculia africana	0.09	0	0.55	0.36	0.143
Pavetta ayssinica	0.06	0.11	0.45	0.07	0.504
Dichrostachys cinerea	0.1	0.42	0.64	4.93	0.001
Dodonaea angustifolia	0.77	0.47	0.36	2.57	0.002
Carissa spinarium	0.55	0.22	0.36	0.64	0.07
Pterollobium stellatum	0.06	0.03	0	0.57	0.319
Grewia frugenia	0	0	0	0.36	0.262
Acacia senegal	0.06	0.14	0.27	0.29	0.015
Boswellia neglecta	0	0.03	0	0.29	0.127
Solanum somalense	0	0	0	0.29	0.158
Ziziphus spina.christi	0.06	0	0.27	0.29	0.013
Ziziphus mucronata	0.23	0	0.18	0.29	0.81

Table 3: Species richness, diversity and evenness values of plant communities

Community types	Altitudinal range	Species Richness(S)	Diversity Index(‘H)	Shannon Evenness(J)
1	1460-2021	160	3.82	0.47
2	1911-2098	208	3.33	0.19
3	1136-1848	352	3.94	0.23
4	845-1749	212	3.43	0.25

According to Sorensen's similarity coefficient for the four identified communities, the species composition of communities one and three had the highest similarity (17.76 %), while communities 2 and 4 have a low similarity (8.73 %). Generally, the communities recorded in the study area were less comparable to one another (Table 4).

Table 4: The Sorensen's similarity of the communities

Community types	1	2	3	4
1	-	0.1722	0.1776	0.1053
2	-	-	0.1333	0.0873
3			-	0.1006
4				-

Ordination analysis: Based on the species and sites relationship biplots using ordination methods, the altitudinal variation, followed by grazing and slope, were the most influential elements in the floristic composition and community formation in the area (Figure 4).

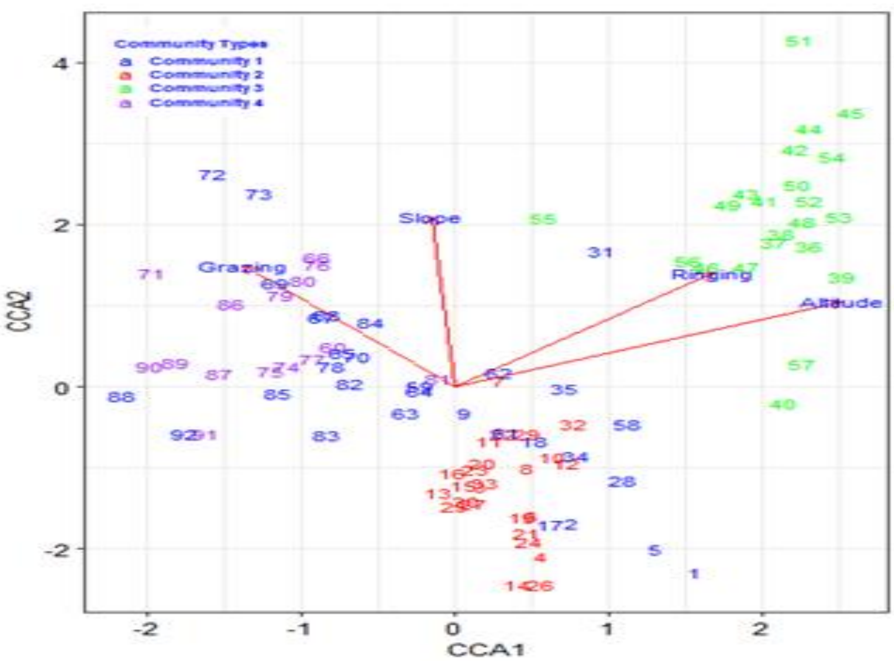

Figure 4: CCA ordination of sites and species constrained by environmental variables

Vegetation structure of Buska Mountain Range: The overall density of tree and shrub species with DBH greater than 2.5 cm was 1460 individuals per hectare. The top elven densest plant species which contribute relatively higher share of the density in the forest include *Euclea racemosa* subsp. *schimperi*, *Combretum molle* , *Acacia seyale*, *Olea europaea, Juniperus procera, Acacia mellifera, Dodonaea angustifolia*, *Terminalia brownii* , *Dichrostachys cinerea , Croton macrostachyus and Ximenia americana*. Thus, about 51% of the density was occupied by these elven species. About 73.4% of the individuals' species along the DBH class distribution found in the first two lower DBH classes. The result along the DBH classes also showed that the number of individuals gradually decreases from the lower to higher DBH classes (Figure 5).

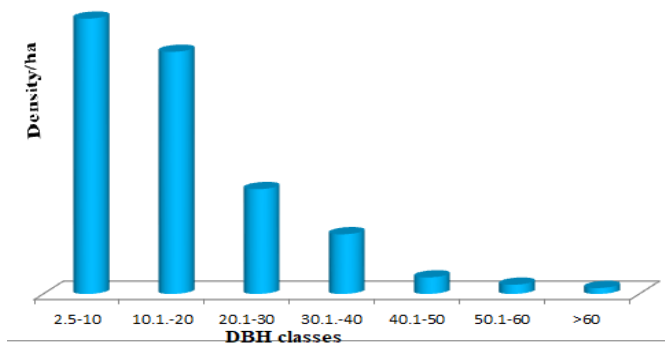

Figure 5: DBH class distribution of woody species in Buska Mountain vegetation

The height class distribution revealed that the number of individuals at lower height classes was greater than that of the higher height categories. About 80% of the total individuals across the height categories was contributed by the first two lower height classes; while only about 9 % of the height class was occupied by the highest (>25m) height class(Figure 6).

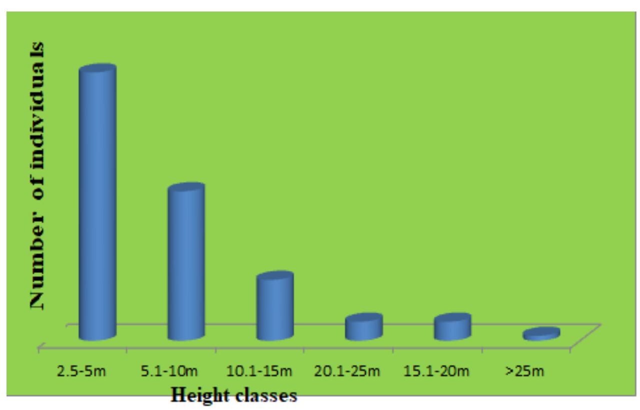

Figure 6: The height class distribution of woody species in Buska Mountain range

The top height recorded in the vegetation of Buska Mountain range is 33m, which was attained by *Juniperus procera* Hochst.ex Endl. Therefore, the upper story of the forest was 23-33m; the middle story was recorded to be 12-22m and the lower story less than 12 m. Only about 6 % of the individuals of the plant species were realized in the upper canopy. The species in this canopy include: *Juniperus procera*, *Terminalia brownii*, *Podocarpus flcatus*, *Tamarindus indica*, *Sysygium guineense* and *Ficus vasta*. About 16% of the species were distributed in the middle story of the forest; mainly including: *Combretum molle*, *Balanites aegyptiaca*, *Acacia goetzei*, *Euclea racemosa* subsp. *schimperi*, and *Acacia nilotica*. However, about 78% of the individuals of the species were found to be at lower canopy of the forest in the area (Figure 7).

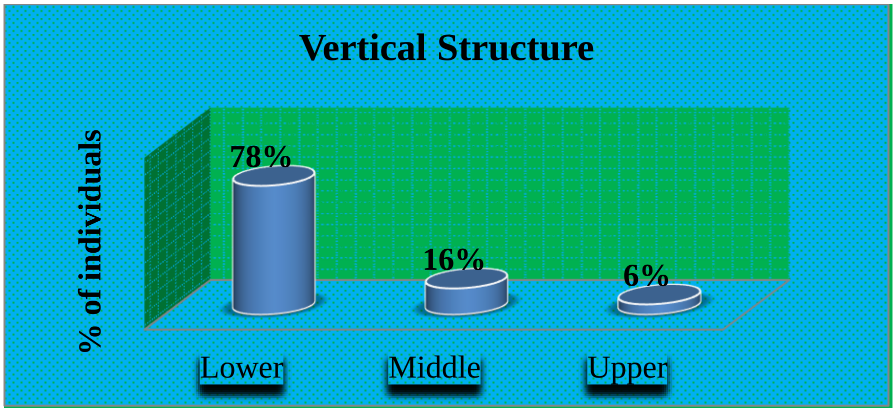

Figure 7: Vertical structure of the species in the forest

Frequency: The most frequent plant species in the study vegetation in decreasing order include: *Euclea racemosa* subsp. *schimperi*, *Combretum molle*, *Dodonaea angustifolia*, *Juniperus procera*, *Olea europaea*, *Croton macrostachyus, Calpurnia aurea*, *Acacia seyal*, *Acacia mellifera*, *Carissa spinarium*, *Ximenia americana* and *Terminalia brownii* (Table 5).

Table 5. The top elven most frequent tree/shrub species in the vegetation

Species	no. of plot	frequency	Frequency (%)	Relative frequency
Euclea racemosa	54	0.587	58.696	5.167
Combretum molle	33	0.359	35.869	3.158
Dodonaea angustifolia	34	0.366	35.869	3.158
Olea europaea	33	0.359	35.869	3.158
Juniperus procera	29	0.316	31.522	2.775
Croton macrostachyus	23	0.250	25	2.200
Acacia seyal	22	0.239	23.913	2.105
Ximenia Americana	19	0.207	20.653	1.818
Acacia mellifera	18	0.196	19.565	1.723
Carissa spinarium	18	0.196	19.565	1.723
Terminalia brownie	17	0.185	18.478	1.627

Basal area: About 60 % of the total basal area in the vegetation was contributed by the top ten most dominant tree species namely: *Juniperus procera*, *Combretum molle*, *Olea europaea* subsp. cuspidata, *Podocarpus falcatus*, *Syzygium guineense*, *Terminalia brownii*, *Ficus vasta*, *Euclea racemosa* subsp. *schimperi*, *Acacia goetzei* and *Tamarindus indica.*

Importance Value Index (IVI): The highest IVI values were attained by *Juniperus procera*, followed by *Combretum mole* (Table 6).

Table 6: The Importance Value Index (IVI) of the top ten woody species based on (RF= Relative frequency, RD= Relative density, and RDo= relative dominance).

Species	RF	RD	RDo	IVI
Juniperus procera	3.700333	0.116485	11.64854	15.46536
Combretum molle	2.903087	0.091388	9.138832	12.13331
Olea europaea	2.753937	0.086693	8.669312	11.50994
Podocarpus falcatus	1.976002	0.062204	6.220396	8.258602
Syzygium guineense	1.469206	0.04625	4.625017	6.140473
Terminalia brownii	1.410881	0.044414	4.44141	5.896705
Ficus vasta	1.381522	0.043490	4.348989	5.774000
Euclea racemosa	1.339838	0.042178	4.21777	5.599786
Acacia goetzei	1.104182	0.034759	3.475931	4.614871
Tamarindus indica	0.991691	0.031218	3.121812	4.144721

DISCUSSION

The Buska Mountain range has 272 vascular plant species within 202 genera and 77 families. As a result, the plant species richness of the Mountain range vegetation is higher than that of some other similar studies conducted in other parts of the country, such as 196 plant species recorded from southwest Ethiopia (Dereje, 2006); 264 plant species from Wejig-Mahgo-Waren Massif (Mebrahtu, 2019); 171 plant species recorded from Dello Menna woodland vegetation (Motuma *et al*., 2010); 174 plant species from the Vegetation of Chencha Highlands (Desalegn and Zerihun, 2005). However, it is less diverse and species rich than the study result conducted in Wof-Washa Forest in the North Shewa zone of the Amhara region, which found 394 species (Abiyou, 2018). The observed differences in species richness between research sites might be attributed to the broader altitudinal and climate variability as well as the variations in the vegetation types in the areas. Tamrat (1993) and Schmitt *et al*. (2013) have stated that the altitudinal variation and climate variability affect the species distribution and community formation.

Fabaceae was found to be the most leading plant family in the forest, followed by Asteraceae. Different studies on the floristic survey (Haile *et al*., 2012; Birhanu, 2010) in Ethiopia have revealed the dominance of the Fabaceae and Asteraceae families. That might be as a result of the fact that their most species richness and wider distribution range in Ethiopia's Flora regions (Mesfin, 2004). The supremacy of shrubby species in the study area could be due to the damage of tree species by selective cutting and ringing as well as the actuality of overgrazing affecting herbaceous species in the area. Other study in Ethiopia also found shrubs to be dominant (Ermias, 2014). This discovery, however, contradicts the findings of (Haile *et al*. 2008; Leul, 2015; Abiyou, 2018), who found that herbaceous species predominated over other life forms, and (Zerihun *et al*., 2017), who found that trees and herbs were equally dominant over shrubs.

Regarding community types, the most probable reason for community type one to have the least number of species, could be the situation of most of the plots in the community at the peripheral areas of the forest which was prone to most anthropogenic disturbances occurring in the area. This substantiates the idea of (Whittaker *et al*., 2003) that states the pattern of species distribution in communities is linked to environmental variables such as anthropogenic and livestock disturbances. On the other hand, community type three had the highest number of species. This might be due to its location at a medium average altitude interval, which is more favorable for the growth of a variety of species in the area, as well as the observed lower disturbance rate to the center of the forest, as most of the plots recorded in this community were realized to be out of the edge of the study forest. The Shannon-Wiener diversity index of the current study (H'=3.94) was higher than those reported by Melese and Wendawek (2016) and Mebrahtu (2019), which were (H'=3.79) and (H'=3.87), respectively.

The species composition of communities one and three had the highest similarity (17.76%), which could be because of the situation of most of the plots in these communities are in similar aspects and altitudinal range which supported more similar species distribution, while the similarity between communities 2 and 4 was relatively low (8.73 %). In general, the communities were less similar to one another, which might be attributed to differences in species distribution throughout the communities as a result of the broad altitudinal variation and various environmental variables. Feyera and Demel (2003) also stated that forest disturbances and local climate fluctuations were among the factors determining species similarity between communities in a given vegetation area. The greater impact of grazing reveled in the relationship between environmental factors and species distribution might be associated with alteration in plant composition, plant physiology and morphology resulted from defoliation and trampling by grazers. Similarly, the variation in species diversity and distribution with altitude might be due to variation in moisture. The idea is constant with (Givnish, 1998), that states in dry areas diversity should initially increase with elevation due to the increased availability of moisture and then decline.

In terms of height and DBH class distribution, the first two lower classes provided higher percentage of the total record, suggesting the dominance of smaller trees and shrubs in the area. The attendance of only 6% of the species in the upper canopy could be attributed to the incidence of abandoned fire in the past in the forest and the resulting formation of secondary vegetation in majority of the study plots. The most frequently recorded species in the vegetation might be credited to competitive ability, wider range distribution and adaptation capacity of the species to the environmental factors. The total basal area documented from the study forest was (32 m^2 ha^{-1}), laid at a normal scale of basal area measurement for the tropical forest. Because, according to (Lamprecht, 1989), the normal basal area record for virgin tropical forests in Africa is (22- 37m^2ha^{-1}). The fact that only ten dominant species account for 60% of total basal area per hectare, as well as the highest share of IVI values, suggests that management activities should be in place to conserve the majority of rare and endangered plant species.

CONCLUSION

The vegetation of Buska mountain range is one of the last remaining forests in the Lower Omo region of Southwestern Ethiopia which is characterized by arid climatic conditions and passed down from generation to generation by Hamar tribe leaders. The outcome of the study revealed that the vegetation is characterized by higher floristic composition and diversity recording 272 vascular plant species distributed in four community types. As a result, it is regarded as one of the most critical management areas for biodiversity conservation, particularly in light of the current state of climate change and its consequences, particularly in arid climate zones. Despite the local community's long-term efforts to maintain the ecosystem, variety of environmental factors today pose a threat to the area's biodiversity. The main factors affecting species diversity and distribution in the research plots and communities were found to be altitude, overgrazing, and ringing.

The vegetation of the Buska Mountain Range is home to a diverse range of plant biodiversity, including the majority of the countries ecologically and economically important plant species, as well as others that are endemic to the country. Despite having great ecological, economic, aesthetic, and cultural value to the country and the Hamar community in particular, there are a number of limiting factors. Overgrazing, selective cutting, and ringing were considered to be the main anthropogenic interventions in the area in addition to the natural environmental factors.

As a result, the existing local communities’ forest management and conservation system should be supported and fostered by the government and non-governmental organizations through increased awareness and the provision of numerous alternatives for the community's harvesting needs from the vegetation.

ACKNOWLEDGEMENTS

The Corresponding author acknowledges Ethiopian Biodiversity Institute for providing an opportunity to Ph.D study and Addis Ababa University for financial support. The cooperation and support of Hamar community during data collection is highly acknowledged.

AUTHORS’ CONTRIBUTION STATEMENT

The first author (Melese Bekele) collected and analyzed the data, and wrote the manuscript. The other authors (Professor Sebsebe Demissew, Professor Tamrat Bekele & Dr. Feleke Woldeyes) have contributed to the research design, interpretation, and editing of the manuscript. All the authors have read and approved the final manuscript.

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Received: 13th Jule 2022; Accepted: 18th January 2023; First distribution: 18th September 2023