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Research Paper

COMMUNITY DYNAMICS AND FLORISTIC COMPOSITION OF NATURAL VEGETATION IN ABAYA HAMASSA, RIFT VALLEY OF ETHIOPIA

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ABSTRACT **Ethiopia, with its multidimensional biogeo terrain is unique for its species diversity and bizarre dispersion of wood land. A total of 315 plant species representing 198 genera**
ts species diversity and bizarre dispersion of wood land. A total of 315 plant species representing 198 genera and 59 families were identified in Abaya-Hamassa ***natural vegetation in the rift valley of Ethiopia. Six plant communities were identified and described. Community-environment correlation was assessed based on Ecological, physiological and pedological data collected from 55 quadrates (400 square meters) belonging to eight selected sites between October 2013 to June 2014.The environmental parameters such as altitude, slope, aspect, PH, electrical conductivity, total nitrogen and soil texture (% sand, % clay and% slit) were measured for all quadrats. Among the environment parameters, altitude was negatively correlated with sand and clay. The floristic composition, floral diversity, identification of community type and community-environment interaction were investigated. The Percentage of coverage, Canopy, abundance and frequency of species were estimated and converted as per the modified Brawn-Blanquet 1-9 scale.***

KEYWORDS :Abaya Hamassa, Biodiversity, Communit,Environment ,interaction,

INTRODUCTION

Biodiversity refers to the variety of life forms, genetic diversity and the assemblage they form. According to Kumer (1981), and Paul (1993) species diversity can be viewed in terms of species richness, species endemism, evenness and taxonomic diversity. Biological systems, whether tundra, forests, savannahs, grasslands, deserts, lakes, rivers, wetlands, coastal communities or marine ecosystems are functionally complex and this complexity is associated in often obscure ways, with the diversity of their component species (U.S. National Research Council, 1992).Most of the estimates suggest that there are about 250,000 species of vascular plants in the world (U.S. National Research Council, 1992). Approximately two-thirds of these are found in the tropics. One-sixth of the earth's diversity of plant life about 45,000 species can be found in Latin America followed by Africa. The diversity of higher plant species increases as one moves from poles to the equator. Ensermu Kelbessa estimated about 6000 species of higher plants in Ethiopia, of which nearly 10.5% are endemic.The alarming population increase obviously leads to an increase in the demand for natural resources, including arable land, water, wood for construction and energy. The increase in population size, urban development, and expansion of commercial and subsistence farming has exerted considerable influence on woodland vegetation in the Rift Valley region of Ethiopia. For the last few decades much of the natural vegetation had been converted into crop fields for undertaking intensive farming activities. Deforestation for various domestic exercises, demand for charcoal had decimated the vegetation. Most of the land is now either cultivated or barren leaving the woodland fragmented into small patches (Zerihun Woldu, *et al*., 1999). It seems thus doubtful that the forests once covered 40% of the country (FAO,1980) had reduced to negligible percentage today, with only 2.7% of the country extremely forested and 0.9% of the original Coniferous forest (*Podocarpus and Junperus), 11% of the original broad leaved* forests and 7.6% of the original savanna woodlands remained depicting an alarming picture for future generations (WCMC,1991).The Rift Valley of Ethiopia is generally characterized by semiarid climatic condition. Although there subsist a number of wood- land and bush land resources but literature on these vegetation is meager. The natural vegetation of Abaya-Hamassa is under threat by the combined forces of resources exploitation and forest degradation due to activities akin to frequent burning, clearing and grazing. In order to suggest the mechanisms to maintain and restore these resources on a sustainable basis, a clear understanding on vegetation structure and floristic composition is crucial for proper management. This is due to the fact that knowledge about vegetation composition and structure provides insight about the potential of plant community to succeed after disturbance.

1-Description of the Study Area

The study area is located in between Wolaita and Gamo-Gofa zones at 6 27.404'N - 637.368'N and 6 44.042'E - 3652.169' E, in the Southern Nations, Nationalities and Peoples' Regional State (SNNPRS) within the central Rift Valley of Ethiopia. The area is located to the east of western escarpment of Rift Valley to the west and northeast of Lake Abaya.The elevation ranges from 1184 m.a.s.l. at the coast of Lake Abaya to 1410 m.a.s.l. at Wanke derya. The elevation decreases towards the Lake by forming tiers in a long distance. The drain- age pattern follows the general topographic orientation from west to east. Small rivers and streams rising from Wolayta and Chencha highlands drain to Lake Abaya and Lake Chamo. The soil along the floor of the Rift Valley and Lake Abaya are alluvial of Hare stream (Vaukasinvic, 1969) and colluvial materials and lacustrine deposits of the Pleistocene (Mohr, 1971) categorized also as Fluvisols of the FAO/ UNESCO revised legend (1990). The average annual rainfall of the study area ranges from 650 to 800 mm. Rainfall is bimodal occurring from March to may (short rain) and June to September (long rain). The mean monthly temperature of the area is between 22 to 28ºC (Wolayta Zone Agricultural Office, 2013).

2-Vegetation

The vegetation types of semi-arid regions in Ethiopia include *Acacia* woodland, bush-land and tickets, types belonging to open grasslands (Coppock, 1994). White (1983) classified the vegetation of Ethiopia under the Sudanian Regional Center of Endemism, Somalia-Massai Regional Center of Endemism, Afromontane Regional Center of Endemism and Afro Alpine Archipelago-like Regional Center of Endemism. The present study area can be plunged in the Somalia-Massai Regional Center of Endemism but if based on the broad categorization of the vegetation, the study area was mainly small– leaved deciduous woodland type. Some sort of *Acacia-commiphora* woodland was found mainly between altitudes of 500-1900 m. a. s. l. with an average annual temperature of 18ºC to 27ºC and rainfall between about 410-820 mm. This woodland area had traditionally been a grazing land (Ensermu Kelbessa *et al.,* 1992).

3-Vegetation Data Collection

In order to identify sampling sites reconnaissance survey was made and eight sampling sites were selected based on physiognomy of the vegetation. Then sample plots were selected and vegetation data was collected from all the 55 quadrats. During sampling, visually checked homogeneous representative stands were selected and delimited for sampling. At each sampling area, plots (quadrats) of 400 m 2 (20 m x 20 m) were measured. Inside quadrat, nested plots of 10 m x 10 m for trees, 5 m x 5 m for shrubs and 2 m x 2 m for grasses and other herbs were established. All plant species in the quadrats were recorded and voucher specimens were pressed in the field for subsequent identification at the Herbarium of Wolayta Soddo University. Percentage cover values of trees, shrubs, herbs and grasses were estimated in the field and later converted to cover /abundance values of Braun-Blanquet scales as modified by van der Maarel (1979). The collected specimens were identified by using standard keys as published one to nine Volumes of Flora of Ethiopia and Eritrea.

4-Environmental Data

The following environmental data and topographic parameters were gathered for each plot.Altitude, slope, aspect and position for each plot were determined respectively with an Altimeter, Suunto Clinometer, Su- unto compass and GPS-48. Soil samples were collected from 5 sites in each plot (quadrat), four at the corners and one at the middle of the plot at 0-20 cm. Composite soil samples weigh- ing about 1.5 kg were brought to the soil laboratory for further analysis. The samples were air dried, sieved with a mesh size of 0.5 mm and 2 mm, were analyzed at the soil laboratory, following the methods of Jackson (1973) and Juol (1978). The analyzed parameters were soil texture, pH, total nitrogen and electrical conductivity. Texture was determined using Bouycous Hydrometer method; pH was measured using a pH meter at 1:2.5 distilled water to soil suspension while total nitrogen was determined by using Kjedahl method. Electrical conductivity was measured by using conductivity meter (Table-6).Fifty grams of 2 mm sieved dried soil sample was added to 50 ml of 5% sodium hexametaphosphate along with 100 ml distilled water. The suspension was stirred with a glass rod and then al- lowed to stand for 30 minutes. The soil suspension was stirred using a multi-mix machine for 15 minutes, and then transferred into a one liter glass cylinder. The suspension was diluted with distilled water up to a one liter mark. The soil suspension was mixed by covering the mouth of the cylinder by hand and inverting it several times. Hydrometer and temperature readings were taken at 40 seconds and the soil suspension was allowed to settle for 2 hours. After 2 hours the readings of Hydrometer and temperature were taken for the second time. Then the different soil factions were calculated as follows:

1. % SAND = 100-[H1+0.2 (T1 – 68) – 2] x 2
2. % CLAY = [H2 + 0.2 (T2 – 68) – 2] x 2
3. % SILT = 100 – (%SAND - % CLAY)

Where H1 = the first hydrometer reading after 40 seconds.

T1 = the temperature reading after 40 seconds.H2 = the hydrometer reading after 3 hours.

T2 = the temperature reading after 3 hours.Soil pH was determined following Juol (1978). A 1: 2.5 soil sus- pension in water was made by dissolving 10g of soil that has passed through 2 mm sieve with 25 ml of distilled water. The suspension was stirred with a glass rod and allowed to settle for 30 minutes. The pH was measured using pH meter.Nitrogen was determined using the macro Kjeldahl method. The analysis of soil nitrogen requires a complete breakdown of the organic nitrogen (digestion), followed by distillation and titration. In the process of digestion organic nitrogen would be converted into ammonium nitrogen. Nitrogen was estimated then from the amount of ammonia librated by distillation of the digestion with alkali. The procedure started by taking one gram of air dried soil that had passed through 0.5mm sieve.It was placed in a dry 500ml Kjeldahl flask, mixed with 7g of potassium sulfate and 0.8g of copper sulfate to catalyze the reaction and 12ml of concentrated sulfuric acid was added to it. The digestion flasks were then put to the digestion system which was pre-heated (420 deg. Celsius). Samples were allowed to be digested for about one hour until all the samples were clear of green colour. After the racks of the tubes were cooled for 15 minutes, 75ml of distilled water was added into the tube. In a conical flask 25ml of receiver solution was added and the flask was placed into the distillation unit. In the distillation unit 50ml of 40% sodium hydroxide was dispensed and distillation allowed to go for about 4 minutes until the receiver solution in the distillate flask became green in colour indicating the presence of alkali ammonia. The distillate was then titrated with standardized 0.1N HCl until the blue gray end point was reached.The whole reaction can be summarized as follows:- K2SO4

5-Digestion: THE EQUATION IS NOT IN A STRAIGHT LINE, SHOULD BE WRITTEN IN A SINGLE LINE.

6-Distillation:

The percentage of total nitrogen was then calculated as follows:-*Where,*

T= titration of volume for sample

B= titration volume for blank

N= normality of acid To measure soil electrical conductivity a soil water suspension in a ratio 1: 2.5 was prepared. In this case soil water suspension was made by dissolving 10g of soil by 25ml of distilled water and stirred for 30minutes with automatic stirrer. Then electrical con- ductivity was measured using conductivity meter. All the environmental data is presented in Table-6 and 7.

7-Data analysis

Multivariate techniques were used to study the complex nature of plant communities. In aiming for a detailed floristic veg- etation description, two major approaches were distinguished. These were the relevé analysis for classification and the continu- um analysis for ordinates (Mueller-Dombis and Ellenberg, 1974). These two approaches toward vegetation study were based on different concepts of the essential nature of vegetation. Classification aims at grouping individual stands into categories. The stands those were similar to one another form one class, which was separated from other classes that also consist of similar stand (Mueller-Dombois and Ellerberg, 1974). This method emanated from the belief that vegetation was composed of certain distinct and fairly discrete plant communities (the concept of community unit theory) (Whittaker, 1962 and 1967; Shimwell,1971).The properties common to a group of similar stands in a class were then abstracted to serve as description of that class. Plots were grouped into clusters with aid of the program TWIN- SPAN. Jaccard's coefficient of similarity was computed to see the species composition turnover of the communities and species composition grades gradually or in discontinuity (Table-4). Srensen's Coefficient was calculated to analyze the species similarities between the study areas with other natural vegetation types in different parts of the country (table-8).

8-Description of floristic composition

A total of 315 species of plants representing 198 genera 59 families were recorded from the study area were summarized in the Table-I Of these, Poaceae had 39 (12.38%) species standing largest and some 19 families had each 1 (0.32%) species as least.Out of these species identified in the study area, 145 (45.63%) species were herbs, 76 (24.06%) species were shrubs, 38 (12.19%) species were trees, 36 (11.25%) species were trees/shrubs,18 (5.63%) species were climber and 2 (0.63%) species were ferns and epiphytes each.Species such as *Acacia brevispica, Acacia tortilis, Acalypha fruticosa, Baphia abyssinica, Cissus quadaragularis, Combretum molle, Croton* *zambesicus, cinerea, Diospyros abyssinica, Euphorbia tirucalli, Grewia bicolor, Grewia veluntina, Harrisonia Dichrostachys abyssinica, Lecaniodiscus fraxinifolius, Maerua triphylla, Pap- pea capensis, Rhus natalensi, Sansevieria abyssinica, Sansevieria ehrenbergii, Tamarindus indica, Teclea nobilis, Terminalia brownii, Ximenia americana,* and *Ziziphus mucronata* were widely distributed species with high frequency.

Serial No	Family	No. of species recorded	Percent (%) of composition
1	Poaceae	39	12.38
2	Fabaceae	38	12.06
3	Asteraceae	22	6.98
4	Euphorbiaceae	15	4.76
5	Malvaceae	14	4.44
6	Acanthaceae	13	4.13
7	Tiliaceae	12	3.81
8	Cyperraceae	11	4.49
9	Amaranthaceae	10	3.17
10	Lamiaceae	9	2.86
11	Rubiaceae	7	2.22
12	Vitavaceae	7	2.22
13	Celastraceae	6	1.90
14	Cappariaceae	6	1.90
15	Asclepiadaceae	6	1.90
16	Spindaceae	5	1.59
17	Anacardiaceae	5	1.59
18	Moraceae	5	1.59
19	Solanaceae	5	1.59
20	Burseraceae	5	1.59
21	Polygonaceae	4	1.27
22	Asparagaceae	4	1.27
23	Commelinaceae	4	1.27
24	Cucurbitaceae	4	1.27
25	Oleaceae	4	1.27
26	Boragintaceae	3	0.95
27	Chenopodiaceae	3	0.95
28	Combretaceae	3	0.95
29	Crassulaceae	3	0.95
30	Dracaenaceae	3	0.95
31	Rhaminaceae	3	0.95
32	Apiaceae	2	0.63
33	Flacourtiaceae	2	0.63
34	Annonaceae	2	0.63
35	Apocynaceae	2	0.63
36	Balanitaceae	2	0.63
37	Ebenaceae	2	0.63
38	Loranthaceae	2	0.63
39	Olacaceae	2	0.63
40	Rutaceae	2	0.63
41	Actinopteridacea	1	0.32
42	Aizoaceae	1	0.32
43	Aloaceae	1	0.32
44	Anthericaceae	1	0.32
45	Cactaceae	1	0.32
46	Loganiaceae	1	0.32
47	Molluginaceae	1	0.32
48	Mytraceae	1	0.32
49	Nyctaginaceae	1	0.32
50	Ochnaceae	1	0.32
51	Onagraceae	1	0.32
52	Plumbaginaceae	1	0.32
53	Portulacaceae	1	0.32
54	Pteridaceae	1	0.32
55	Salvadoraceae	1	0.32
56	Santalaceae	1	0.32
57	Scrophulariaceae	1	0.32
58	Sinaroubaceae	1	0.32
59	Zygophyllaceae	1	0.32

Table 1. The summary of floristic composition identified in the study area.

Based on the TWINSPAN output and ecological evaluations in field, six ecologically meaningful community types (clusters) designated as I, II, III, IV, V and VI were identified.The plant communities were named by the dominant and/or char- acteristic species, which occur in each group, using the relative magnitude of mean cover/abundance. The mean cover abundance of major species in the community type was estimated. As a re- sult, the six community types were named after two or three of the dominant and/or characteristic species and the communities are described as given below (table-2).

9-Communities

Community I. *Canthium setiflorum – Acacia hockii – Pappea capensis type.*

This community is found at an altitudinal range of 1184–1309 ma.s.l. *Pappea capensis, Acacia hockii,* and *Combretum molle* are dominant tree species. The shrub layers are *Rhus natalen- sis, Ximenia americana, Acacia brevispica and Grewia bicolor.* Less abundant but still dominant tree species are *Commiphora Africana,Terminalia brownii and Boswellia rivae. Hyparrhenia rufa, Cynodon dactylon, Laggera crispata, Heteropogon con- tortus, Bothriochloa insculpta, and Abutilon firarianum* are ele- ments of the herb layer of the community. *Cardiospermum halicacabum, cissuss quadrangularis, C. rotundifolia, Cyphosemma adenocaule and kleinia squarrosa* are climbers encountered in this community.

Community II. *Commiphora africana – Acacia Senegal – Bal-anites aegyptiaca types.*

The altitudinal range of this community is from 1241-1410m.a.s.l. The dominant tree-shrub species are *Commiphora africana, Rhus natalensis, Acacia senegal, Harrisonia abyssinica, Balanites aepytiaca, Xeminia americana, Dichrostachys cineria, Mystroxylo aethiopcum, Ziziphus mucronata,* and *Grewia villosa. Helichrysum schiperi, Jastica flava, Leptochloa rupestris, Sehima nervosum, Cyperus dubiud, Acalypha ciliate,Clitoria,ternatea, Sansevieria ehrenbergii* herb surface layers.

Community III. *Zanthoxylum chltbeum - Commiphora habessinca – Grewia villosa* types.

This community type is found at an altitudinal range of 1233–1283masl. *Zanthoxylon, chalybeum,* is characteristic shrub species of the community.*Terminalia brownie, Commiphora habessinica, Boswellia riae, Mystrxylon aeyhiopicum, Grewia villosa, Croton zambesicus, Diospyros abyssinica, Grewia velutina,Tamarindus indica* are dominant tree – shrub species. *Leptochloa rupestris, Sporobolus pyramidals,* and *S. ioclados* are dominant grass species in the community.

Community IV. *Acaltpha fruticosa – teclea nobilis – Baphia abyssinica type.*

This community exists at altitudes between 1188 -1397masl. *Aca-lypha fruticosa,Teclea nobilis, Baphis byssinsca Croton zambscus, Euphoribia tirucalli, Acacia nilotica, Indigofera schimpheri, Lecaniodiscus fraxinifolius,* and *Acacia tortilis* are dominant tree –

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shrub species. Less abundant but important species in this community are *Maerua triphylla, Diospyros abyssinica, Olea capensis, subspp.macrocarpa* and *Grewia velutina.* On the other hand climber species in this community are also contain *Abrus precatorius, Glycine wightil, Monanthotaxis parvifolia, Cissus petiolata, Cynanchum altiscandens,* and *Salacia congolensis* with lesser cover values. Species such as *Persitrophe pancudata, Gomphocarpus purpurascens, Momordica friesiorum,* and *Bidens pilosa,* are with relatively less surface cover.

Community V. *Maerua triphylla – Diospyros abyssinica – Olea cpensis type.*

Altitudinal distribution of this community type is found between 1213 **–** 1280masl**.** Dominant tree species of this community were *Baphia abyssinica, Lecaniodiscus fraxinifolius, Diospyios abyssinica,* and *Olea capensis, Maerua triphylla, Grewia velutina, Dodonaea angustifolia, Euclea divinorum, Carissa spinarum,* and *Acokanthera schimperi* are tree–shrub species. *Tamarindus indica, Carissa spynarum,* and *Euclea ddivinorum* characteristic species of this community. Species such as *Syzygium giuneense, Olea europaea,* and *Flacourtia indica* were with relatively high cover value. *Ageratum conyzoides, Cynodon dactylon, Xanthium spinosum, Triumfetta rhomboida, Amaranthus caudatus, Centella asiatica, Lactuca inermis* are herbaceous surface layer species.

Community VI. *Croton zambesicus – Harrisonia abyssinica – Diospyros abyssinia type.*

This community type was distributed at altitudes between 1225–1258masl. *Salacia congolensis* is the characteristic shrub species of the community. Species such as *acalypha racemosa, Syzygium guineense, Olea europaea,* and *Flacourtia indica* tree– shrub species with high cover value. On the other hand the following species *Portulaca oleracea, Pupalia lappacea Ruellia prostrata, Annonia senegalensis, Datura stramonium, Chenopo- dium schimperianum, Ficus vasta, Galinsoga parviflora, Hippocratea africana, Hygrophila schulli, Mollugo nudicauls, Oncoba spinosa, Ocimum urticifolium,* and *Ozoroa insignis* are only re-orded at this community in the entire study area.

Community type cluster size	**I** **11**	**II** **17**	**III** **5**	**IV** **11**	**V** **6**	**VI** **5**
Canthium setiflorium	**1.8**	0.0	0.0	0.0	0.0	0.0
Acacia hockii	**1.3**	0.0	0.2	0.0	0.0	0.9
Pappea capensis	**1.3**	0.2	0.3	0.0	0.0	0.0
Acacia brevispica	**1.4**	0.9	0.6	2.0	1.9	0.7
Grewia bicolor	**1.3**	1.0	0.6	1.5	0.0	0.4
Combretum molle	**1.9**	0.2	1.3	1.7	0.2	0.6
Commiphora Africana	0.5	**4.1**	0.2	0.0	0.1	0.0
Rhus natalensis	1.3	**4.0**	1.6	0.5	0.1	0.0
Acacia Senegal	0.5	**2.6**	0.0	0.0	0.0	0.0
Harrisonia abyssinica	1.0	**2.0**	0.7	0.1	1.6	4.0
Balanites aegyptiaca	0.2	**1.2**	0.0	0.0	0.0	0.0
Ximenia Americana	0.6	**1.1**	0.0	0.0	0.0	0.0
Ziziphus mucronata	0.3	**1.5**	0.4	0.0	0.6	1.3
Dicrosttachys cineria	0.0	**1.4**	0.4	0.7	0.1	1.0
Terminalia brownie	0.5	0.2	**3.4**	0.8	0.7	0.4
Zanthozylon chalybeum	0.3	0.0	**1.8**	0.0	0.0	0.0
Commiphora habessinica	0.0	0.2	**1.5**	0.0	0.0	0.0
Boswellia rivae	0.6	0.4	**1.9**	0.1	0.0	0.0
Mystroxylon aethiopicum	0.0	0.8	**1.3**	0.6	0.0	0.0
Sansevieria ehrenbergei	0.3	0.9	**1.3**	0.2	0.0	0.0
Grewia villosa	0.0	0.7	**1.2**	0.0	0.2	0.0
Acalypha fruticosa	1.0	1.0	0.0	**2.9**	0.7	0.3
Teclea nobilis	1.0	0.2	0.1	**2.6**	2.8	1.0
Baphia abyssinca	0.0	0.0	0.2	**2.4**	4.3	3.0
Croton zambesicus	0.2	0.0	1.3	**1.9**	1.6	4.6
Euphorbia tirucalli	0.0	0.0	0.3	**1.8**	0.8	2.6
Acacia nilotica	0.2	0.6	0.0	**1.7**	0.1	0.0
Indgofera schimperi	0.1	0.1	0.0	**1.5**	0.2	0.0
Lecniodiscus fraxinifolius	0.0	0.0	0.6	**1.2**	2.4	0.2
Maerua triphylla	0.8	0.2	0.5	0.5	**3.6**	0.0
Diospyros abyssinica	0.0	0.0	0.7	0.7	**3.8**	3.2
Olea capensis	0.0	0.0	0.0	0.5	**3.0**	1.3
Grewia velutina	O.8	0.7	0.9	0.4	**2.7**	0.4
Tamrindus indica	0.0	0.0	1.0	0.0	**2.1**	0.0
Dodonaea angustifolia	0.0	0.4	0.0	0.1	**1.9**	0.2
Allophylus rubifolius	0.0	0.1	0.1	0.0	**1.3**	0.0
Euclea divinorum	0.0	0.0	0.0	0.2	**1.3**	0.0
CarissaSpinarum	0.0	0.0	0.0	0.0	**1.3**	0.1
Acokanthera schimperi	0.0	0.0	0.1	0.1	**1.3**	0.3
Syzygium guineense	0.0	0.0	0.0	0.0	0.8	**1.8**
Olea europaea	0.0	0.0	0.0	0.0	0.9	**1.6**
Acalypha rasemosa	0.0	0.0	0.0	0.0	0.3	**1.4**
Slacia congolensis	0.0	0.0	0.0	0.0	0.0	**1.2**

Table 2. Synoptic table of the Abaya – Hamassa vegetation with diagnostic species having high cover value and characteristic species. (The figures printed in bold indicates species having high cover value and characteristic species).

Community and Species Diversity Indices

The Shannon diversity index (H) was a commonly used index to characterize species diversity in a community. Among the six communities, the Shannon – Wiener diversity index result shows community I to be the richest in number of species, whereas, community VI has the lowest number of species. Community I has the highest species diversity (2.798) with the highest number of species (144) followed by II, IV, V, VI and III with species diversity 2.381 (111), 2.360 (72), 1.606 (620, and 1.578 (71) respectively.Generally, diversity follows the trends observed in species richness (Whittaker, 1975). It is highest in species rich and lowest in species poor community. It has been proposed that, the more numerous the species in a community, the greater the stability. In other words, high environmental stability leads to high community stability, which in turn permits high diversity of species (Bormann and Kellert, 1991). Accordingly, community types I, II and IV are in high stable environment and therefore, have high species richness. The high species richness is probably attributed to the optimum environment that supports the woodland species or attributed to the minimum level of disturbances.Species evenness measures the equity of species in a given sample area, or indicates lack of dominance by few species. It shows the relative proportional abundance of a species in communities. Low evenness value indicates the dominance of few species in the sample area. The community, which is relatively lower in species richness, appears to have high evenness. Based on this, communities III, VI and V have the lower evenness values. Community I has the highest evenness value. In this regard, communities I, IV and II have more even representation of aver all species.Jaccard's Coefficient of similarity is computed to see the similarity and dissimilarity of the six communities identified in the study area. Results of this analysis indicate that species composition similarity among the six communities is high. Communities I and II, V and VI, and II and III have relatively high similarity of species composition, whereas, I and V and I and VI have high dissimilarity of species composition. The most probably reason of species composition similarity or dissimilarity is the soil particles composition and the soil texture. The soil textural composition of communities I, II and III is sandy clay loam and that of communities V and VI is sandy loam. The lowest species composition similarity is recorded between communities I and VI, that is 0.132 (13.2%). There is transition between communities I and VI and I and V. Comparatively small proportion of species occur in the two groups of communities in common (13.2%) and (16.8%) respectively. Generally, in all other communities the transition is gradual and species composition diversity is similar.

10-Similarity between vegetation of the study area with other vegetation types in Ethiopia.

The vegetation of Abaya Hamassa woodland can be compared with other vegetation types in Ethiopia. The vegetation of Key Afer-Shala Luqa and Southwest of Lake Chamo (Teshome Soromessa, 1997), Vegetation of Lake Abaya to Chencha Highland (Desalegn Wana, 2002), Rangeland Vegetations of Alagae and Neteli (Ali Seid, 2004), Vegetation of dry land part of North Shewa (Hussien Adal, 2004), Vegetation of the Savanna grassland and woodland in Nechisar National Park (Tamrat Andargie, 2001) and Vegetation of semi-wetland of Cheffa area South Wello (Bayafers Tamene, 2000) differ significantly with some sort of similarities with the vegetation types in the present study (Table-8).Key Afer-Shala Luqa Vegetation is located about 709 km south- west of Addis Ababa and 200 km South of Arbaminch between longitudes 370 20' and 370 32' E and latitudes 50 41' and 50 56' N. Key Afer-Shala Luqa lies between 600-1900m.a.s.l. in altitude. Southwest of lake Chamo is found between longitudes 360 34' and 360 56' E and latitudes 50 15' and 50 40' N which is about 530 km from Addis Ababa. Altitudinal ranges between 1100m.a.s.l. around Lake Chamo and 1900m.a.s.l. around Zeyise. The vegetation of Lake Abaya to Chencha highlands is located 60 05' and 60 12' N and longitudes 370 33' and 370 39' E. Altitudinal ranges between 1177m.a.s.l. around Lake Abaya and 2718ma.s.l. in Chencha highlands. Rangeland Vegetations of Alagae and Neteli is located whithin the Ziway-Shalla drainage basin in lati- tude 70 00' and 70 30' N and longitudes 380 00' and 380 30' E. the altitude of the area ranges from 1540m.a.s.l. to 2075m.a.s.l. The vegetation along the Eastern escarpment of Wello has an altitudi- nal range of 1660-1900m.a.s.l.Dry land vegetation of North Shewa is situated between latitudes 80 38' and 100 42' N and longitudes 380 40' and 400 30' E. The elevation of the area ranges between 1050-1290m.a.s.l. Nachisar National park is located near Arbaminch town, 505 km South of Addis Ababa. It is positioned at the center of the Ethiopian Rift Valley between latitudes 50 55' and 60 05' N and longitudes 370 48' E of the equator. The comparison was based on the similari- ties in distribution. A similarity analysis was carried out based on the presence of species in order to evaluate the relationship between these vegetations. The similarity index used was Sö- rensen's Similarity Coefficient 2c/a+b where c is the number of species shared by the vegetations compared, a is the number of species in one vegetation and b is the number of species in the other vegetation.The vegetation in Abaya-Hamassa was floristically related more to the vegetation of key Afer-Shala Luqa and Southwest of Lake Chamo, Vegetation along the Eastern Escarpment of Wello and Vegetation of Semi-Wetland of Cheffa area South Wello than to the Rangeland Vegetation of Alagae and Neteli and Dry land Vegetation of North Shewa. The species composition of Veg-etation of Nechisar National Park and Vegetation of Lake Abaya to Chencha Highlands were relatively similar to vegetation of Abaya-Hamassa. However, Range land vegetation of Alagae and Neteli and Dry land Vegetation of North Shewa show some vari- ation may be due to vegetation disturbance.Species those which were common in all these areas were: *Aca- cia seyal, A. tortillis, Acalypha fruticosa, Achyranthes asperra, Acokanthera schimperi, Asparagus africanus, Balanites aegyptiaca, Barteria eranthemoides, Cadaba farinose, Cissus spp., Combretum spp. commiphora spp, Ficus spp, Grewia spp, Cyperus spp, Rhus natalensis, Ximenia americana and Ziziphus spp.*

11-Discussion

Plant growth is influenced by physical and chemical properties soil, conduced environmental conditions and availability of water. These soil properties are important factors in determining plant growth and vegetation distribution. The test for variance made in present investigation for physical and chemical soil properties revealed that, the differentiation of communities can be partly explained by the variations of soil texture and physical and chemical parameters.The environmental data collected from Abaya–Hamassa were average in accordance with the community types identified and tested statistically for significant differences between communi- ties. There was significant variation in particle size and distribution of sand, where as the variation in the size and percentage distribution of clay and silt particles was not so significant varying only 0.05 level of significance. Soil particle size distribution has a considerable effect on the vegetation of the study area affecting soil aeration, water movement, root penetration and water holding capacity.The top soil samples collected from 55 quadrats were categorized into 3 textural classes, sandy clay loam (Communities I and II), Sandy silt loam (communities III and IV), and sandy loam (communities V and VI). Soil texture was an important soil parameter that affects site quality. It influenced the nutrient supplying ability of soil solids, soil moisture, root development and air relations. Comparison of the community types based on the sand content of the soil had shown that the community type III is significantly different from communities II, IV, and V and is significantly different from communities I, II, IV, V and VI in its clay composition. Community type IV is significantly different from communities I, II, III, V and VI in its silt composition.Soil particles distribution along the communities was more or less similar. The proportion of sand in community III is the highest (52.2%) and the lowest (48.5%) in community V. The proportion of clay was high (27.09%) in community II and it was low (21%) in community III. The proportion silt was high (27.2%) in community IV and it was low (23.6%) in community I. In general, the variation of soil particle distribution among communities was small. It can be mooted that the variation of sand among communities was lowest when compared with clay and silt variation.Soil PH affects the growth of plants and the allocation of plant types by its effect on the availability of mineral nutrients and decomposition of organic matter. The average PH values of the six communities ranged between 6.58 – 7.12 values. Soils of communities II, III, IV, V and VI have neutral PH values whereas, community I is slightly basic. The neutrality and slightly basic character of the soil is due to low breakdown of organic matter and low leaching of soil attributable to the very low annual rainfall. There is no significant differences in soil PH except the slight variations obtained among the communities.The total nitrogen contain of the soil was significantly varied in six communities. Soil of community V has higher total nitrogen content but community III had lower total nitrogen content. The mean values of total nitrogen in decreasing order of magnitude include communities V, IV, II, VI, I and III. In the total nitrogen content of the soil community type V was significantly different from community types III, I, VI, II and IV (Table-7).The total nitrogen content of the soil was determined by the amount of organic matter. It is higher in those community types with higher organic matter content and lowers in those having lower organic matter content. Climatic conditions especially temperature and rainfall, exerted a dominant influence on the amounts of nitrogen and organic matter in the soils. In general, the decomposition of organic matter was accelerated in warm climates. Dry soils are generally, low in the organic matter hence the total nitrogen content of the study area was low, since the area falls in between arid or semi arid region.The electrical conductivity of the soil solution was mainly deter- mined by soluble salts of carbonates, bicarbonates, sulphates, chlorides and nitrates (Chopra and Kanwar,1982). Electrical conductivity in communities II and III is the highest (3.60 and 3.62 mmhos/cm) respectively. It is lowest in community V (2.83 mmhos/cm).Vegetation reacts variously to exposure; light loving communities (Hliophytes) reach their highest limits on southern exposure, while shade plants, shade loving communities reach their high- est limits on north, northeast and northwest exposures. Light absorption between south and north slopes in the mountain is very considerable, much greater than in the plains. The total light in a south exposure reaches 1.6 to 2.3 times higher values than in a north exposure. The effect of slope aspect as a control of radiation may not appear to be pronounced due to the low variation of alti- tudinal gradients among communities. Therefore, it has no significance in determining the distribution of the vegetation.The slope of the soil surface affects vegetation directly as well as indirectly. The indirect effect was due to the influence up on the water supply of the soil and the shifting of the angle of incidence of the sun's rays, modifying the intensity of insulation. The effect of slope was seen in its influence on the run–off and drainage and consequently upon the nutrient, depth and water content of the soil. In the present study slope had shown a significant difference in the distribution of the communities. Community type I had gentle slope with high species diversity. This could partly be due to high retention of water and moderate composition of soil particles. Community type III had steep slope, and fairly high percentage surface stone cover with low species diversity. This may be due to less retention of water in the soil for having steep slope. Community types II and V have same mean values of slope. But both communities had different species diversity.The diversity index calculated for the 6 communities had shown that the species diversity of community type II was 2.381 and the species diversity of community type V was 1.775.The difference in species diversity in community type II and in community type V may occurred as of different amounts of total nitrogen content in the soils of two communities. The mean values of total nitro- gen content of community type II was 0.84 and that of community type V was 1.72. High species diversity in community type II could partly be due to the low available total nitrogen content in the soil. This agrees with the generally held belief that highly nutrient rich soils would tend to support low species diversity (Huston, 1994). This is the reason that community type II sup- ports high species diversity with low nutrient content in the soil, while community type V supports low species diversity with high nutrient content in the soil. Since both communities have the same averaged values of slope.Altitude is an important environmental factor that affects atmospheric pressure, moisture, and temperature, and temperature which has a strong influence on the growth of plants and the distribution of vegetation. The mean altitudinal variation among 6 communities identified and was significant at $P < 0.05$ level of significance. The mean values of altitude in communities range between 1239.60 to 1288.18m.a.s.l.In order to examine the significant differences and/or similarities between the community types identified, Pearson's product moment correlation coefficient comparison test was employed for the environmental parameters. There was significant cor- relation between percentage (%) with total nitrogen. All other environmental parameters were correlated insignificantly at $P< 0.05$ level of significance. Altitude was negatively correlated with % of sand and % of clay. Except these correlations, all the other environmental variables were positively correlated. With increasing altitude, the steepness of the surface increases and this results in the loss of soil particles. This may be the reason that altitude was negatively correlated with percentage of sand and clay.Based on the findings, it was suggested that the present trend of heavy exploitation of plant species in the area reducing the vegetation cover and may lead to local extinction of species. Hence a proper exercise of conservation practice that which can promote natural regeneration based on well worked out management plans should be adopted at the earliest possible time. The conservation of this vegetation types should be given the priority concern for the conservation of biodiversity. It was also suggested that further investigation of the vegetation–environment relationships is essential by considering factors such as moisture, ambient temperature, disturbance and dispersal effects in community organization and diversity.

Table 3. Shannon – Wiener Diversity index calculated among the 6 communities.

Community	Richness	Diversity Index (H)	Evenness (H/)
I	144	2.798	0.563
II	111	2.381	0.509
III	71	1.578	0.370
IV	107	2.360	0.501
V	72	1.775	0.415
VI	62	1.606	0.389

Table 4. A presence half matrix of Jaccard's coefficients calculated among 6 communities.

Community	I	II	III	IV	V	VI
I	1.000					
II	0.281	1.000				
III	0.240	0.277	1.000			
IV	0.214	0.246	0.242	1.000		
V	0.168	0.213	0.221	0.210	1.000	
VI	0.132	0.227	0.217	0.225	0.279	1.000

Table 5. Jaccard's community coefficient among adjacent communities/altitudinal. ranges

Altitudinal ranges	Similarity coefficient	Commu es
1241 - 1410/1225 – 1258	13.2%	I, VI
1214 - 1410/1213 – 1280	16.8%	I, V
1184 – 1309/1233 – 1283	27.7%	II, II
1213 – 1280/1225 – 1258	27.9%	V, V
1241 – 1410/1184 - 1309	28.1%	I, II

Table 6. Average values of environmental variables (indicate SD).

Community	Altitude (m)	Slope (0)	PH	EC (os/cm)	TN	Sand %	Clay %	Silt %	Texture
I	1242.42	6.65	7.12	3.28	0.54	50.00	26.41	23.59	Sandy clay loam
	30.89	8.02	0.48	1.09	0.48	17.47	14.23	7.47	
II	1288.18	12.09	6.67	3.62	0.84	48.45	27.09	24.45	Sandy clay loam
	49.75	10.60	0.53	0.97	0.89	13.43	9.60	7.24	
III	1257.80	15.20	6.58	3.60	0.36	52.20	21.00	26.80	Sandy silt loam
	22.02	11.95	0.32	0.24	0.24	9.91	5.66	6.53	
IV	1244.78	9.89	6.83	3.13	1.02	48.67	24.11	27.22	Sandy silt loam
	37.33	8.49	0.59	1.03	0.82	10.22	8.05	5.83	
V	1241.33	12.17	6.75	2.83	1.72	48.50	25.33	25.17	Sandy loam

5.10 0.20 0.44 1.14 4.68 1.5 6.42
26.93

VI	1239.60 12.93	9.80 9.96	6.70 0.20	3.30 0.72	0.76 0.74	50.60 19.37	25.00 11.79	24.40 9.34	Sandy loam

Table 7. Pearson's product moment correlation coefficient for correlations (bold values are significant at = 0.05). NS = not significant; S = significant; EC = electric conductivity; TN= total nitrogen.

	Altitude	Slope	PH	EC	TN	Sand	Clay	Silt
Altitude	1							
Slope	0.235 Ns 0.653	1						
PH	0.253 Ns 0.628	0.786 Ns 0.064	1					
EC	0.049 Ns 0.926	0.314 Ns 0.544	0.632 Ns 0.178	1				
TN	0.017 Ns 0.975	0.038 Ns 0.943	0.253 Ns 0.629	0.753 Ns 0.084	1			
Sand	-0.273 Ns 0.600	0.276 Ns 0.597	0.425 Ns 0.400	0.510 Ns 0.302	**0.848** Ns 0.033	1		
Clay	-0.039 Ns 0.942	0.641 Ns 0.171	0.471 Ns 0.346	0.235 Ns 0.654	0.446 Ns 0.375	0.738 Ns 0.094	1	
Silt	0.291 Ns 0.576	0.654 Ns 0.159	0.375 Ns 0.464	0.084 Ns 0.875	0.029 Ns 0.957	0.231 Ns 0.659	0.805 Ns 0.053	1

Table 8. Similarities of vegetation between Abaya and other natural vegetation in Ethiopia.

Here, N = number of species included in comparison, C = number of species in common,S = Sörensen's coefficient of similarity.

Vegetation	N	C	S
Vegetation of Key Afer-Shala Luqua and Southwest of Lake Chamo	216	93	0.54
Vegetation of Lake Abaya to	174	74	0.43

Rangeland Vegetation of Alagae and Neteli	213 Chencha	highlands 65	0.33
Vegetation along the eastern escarpment of Wello	216	97	0.58
Dryland vegetation of North Shoa.	208	67	0.34
The Savana grassland and woodland Vegetations in Nechisar National Park	199	83	0.48
Vegetation of semi-wetland of cheffa area South Wello	206	87	0.50

CONCLUSION

Based on the findings, it was suggested that the present trend of heavy exploitation of plant species in the area reducing the vegetation cover and may lead to local extinction of species. Hence a proper exercise of conservation practice that which can promote natural regeneration based on well worked out management plans should be adopted at the earliest possible time. The conservation of this vegetation types should be given the priority concern for the conservation of biodiversity. It was also suggested that further investigation of the vegetation–environment relationships is essential by considering factors such as moisture, ambient temperature, disturbance and dispersal effects in community organization and diversity.

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