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Floristic Composition and Structure of Woody Vegetation along Lagadara River in South Ethiopia

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ABSTRACT

The floristic composition and structure of the woody vegetation along the Lagadara River in southern Ethiopia were assessed. Data were collected from 50 sample plots between February to March 2012 using a systematic sampling design. We found 76 woody plant species from 39 families within the plots. The most diverse families were Euphorbiaceae, Fabaceae and Moraceae whilst tree was the predominant growth form (55.26%). Cluster analysis identified three major community types that were characterized by *Diospyros abyssinica-Lantana camara*, *Coffea arabica-Millettia ferruginea* and *Bridelia atroviridis-Maytenus arbutifolia*. Shannon-Wiener diversity Index (*H'*) ranged from 2.96-3.88 while evenness index (*E*) ranged from 0.75-0.921 in the three communities. The total density of individuals of mature trees and shrubs (dbh ≥ 2 cm) was 983.5/ha and total basal area was 21.24 m^2/ha. The dbh classes < 20 cm had greater density (85.21%) and density declines with increasing dbh size. The nine importance taxa identified: *Ficus ovate, Syzygium guineense* subsp. *afromontanum*, *Coffea arabica*, *Millettia ferruginea*, *Diospyros abyssinica*, *Croton macrostachyus*, *Albizia grandibracteata, Bersama abyssinica* and *Eucalyptus camaldulensis*, constitute the main structure of the vegetation and together account nearly half of the total important value indices (IVIs). Analysis of stage structure of the five dominant tree taxa indicated that they showed good recruitment except *Ficus ovata* that had very fewer seedlings and saplings. It is hoped that the results of this study will provide base line information that enable in selecting appropriate conservation and management strategies of vegetation in the area.

Keywords: floristic composition, vegetation structure, woody vegetation, diversity indices, Ethiopia

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INTRODUCTION

Ethiopia and Eritrea are countries in the Horn of Africa endowed with rich flora. The diversity of vascular plants was estimated between 6500-7000 species, out of which about 12% are endemic [1]. *Flora of Ethiopia and Eritrea (FEE), volumes 1-8*, published over the period 1980 to 2009 describes the diverse species that occur in these tropical countries. The average wild plant species richness was estimated to be 1,500-2,000/10,000 km², despite variations among the floristic regions. The heterogeneous nature of the flora was explained mainly by diverse topography and other ecological factors that have resulted in different vegetation zones [2]. Earlier classifications by [3, 4] recognized nine vegetation types in the flora area. The previously accepted categorization was revised using data from successive years of field studies and with the application of GIS. The later classification has, however, recognized twelve major vegetation types and three sub-types. Riverine vegetation is one among the major vegetation types and distributed across the countries in areas along river systems [5].

Successive studies on riverine vegetation of Ethiopia indicated variability in floristic composition, structure and regeneration regime from region to region.They were also reported to have high ecological and economic importance particularly in maintaining landscape and biodiversity. Nonetheless, vegetation along most of the major rivers in the country have been highly influenced over time through a combination of factors such as vegetation removal for agriculture, urbanization, overgrazing; and reduced rainfall and river flows. These anthropogenic and environmental factorshave again resulted in vegetation degradation, elimination of native plant species and alteration of areas in the courses of the Rivers [5-8].

The knowledge of woody species composition and structure are valuable parameters that provide more reliable indices on habitat status for vegetation monitoring. Consequently, quantitative data on the above characteristics of vegetation are crucial for selecting sound management practices that can eventually be applied [9]. However, no such analysis has been reported for the vegetation along Lagadara River in south Ethiopia. This study was thus aimed to describe the floristic composition and structure of the vegetation in the study area.

MATERIALS AND METHODS

The study area

Lagadara is a perennial river located at around 06° 25’N latitude and 038°19’E longitude. The altitudinal gradient along the course of the river is narrow ranging between 1404 m to 1575 m. The study area administratively falls within Sidama and Gedeo zones of the Southern Nations and Nationalities and Peoples Regional State (SNNPRS) of Ethiopia (figure 1). The area is characterized by warm sub humid tropical climate and experiences a mean annual rainfall of 1200 to1800 mm and a mean annual temperature of 18 to 27°c. Different soil types, mainly the Cambisols and Leptosols are common in the area; and vegetation is characterized by forests and woodlands of varying types [10].

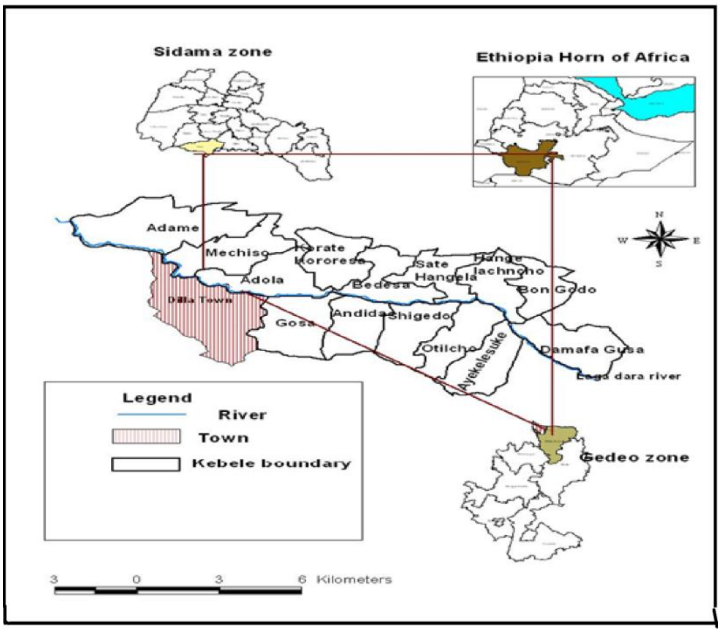


Figure 1: Map showing the study area

The study design and data collection

A total of 50 plots (2 hectares) were systematically sampled between February to March 2012. Each 400 m^2 plot was a (20 m x 20 m) quadrate placed at minimum of 100 m interval in both sides along the river. In each quadrat, woody plants were sampled and recorded for their heights and diameters. Diameters were measured at 1 m height above the ground surface approximating diameter at breast high (dbh) for mature trees and shrubs. Herbarium specimens were prepared from plants sampled in the field and identified by using keys in the *FEE, volumes 1-8* and also by comparing with the already identified collections in the National Herbarium (ETH.). Voucher specimens were deposited at ETH.

DATA ANALYSIS

Floristic composition

All the species sampled were sorted into their respective families and characterized into different growth forms. The presence of introduced (exotic) and endemic species was verified [11]. The most diverse families and distribution in the growth forms based on percentages of species encountered in the vegetation were presented in figures 2 a, & b respectively.The classification of the vegetation into communities was carried out by the method of clustering using R-package for windows version 2.15.0 [12]. Abundance of species in each plot was used as input data for the cluster analysis and the resulting dendrogram was used to identify community types (figure 3). The mean abundance value of each species in a cluster was computed and characteristic species that displayed the highest mean abundance values were used in naming community types. Diversity indices, that reflect the manner in which abundance of species is distributed among the community types, were determined from the Shannon-Wiener's information functions [13]. $H' = -\Sigma pi \log^2 pi$. Where, H' = SHANNON-WIENER-Index**,** pi = ni/N, denotes the abundance value of each species; ni = number of individuals of the species i and N = total number of individuals.

The SHANNON-WIENER-Index reaches its theoretical maximum value *Hmax* when the number of individuals is distributed completely evenly across the species: *Hmax = ln (Nspecies)*. Where: *Hmax*= mathematical maximum diversity value at a given number of species, Nspecies = total number of species. The ratio between *H´* and *Hmax* expresses the index evenness *E*, which characterizes the actual distribution of individuals: *E = H´/Hmax* [14]. Alpha diversity of each community was expressed by its total number of species (table 2). The relation between species richens to number of sampling unit was compared by using *EstimateS* software [15] (figure 4). Sorensen`s similarity coefficient was used to determine the pattern of species turnover among successive communities. *Ss = 2a/ (2a+b+c)*. Where, *Ss*= Sorensen's similarity coefficient; a = the total number of species found in both communities; b = Number of species in community 1; and c = Number of species in community 2.

Vegetation structure

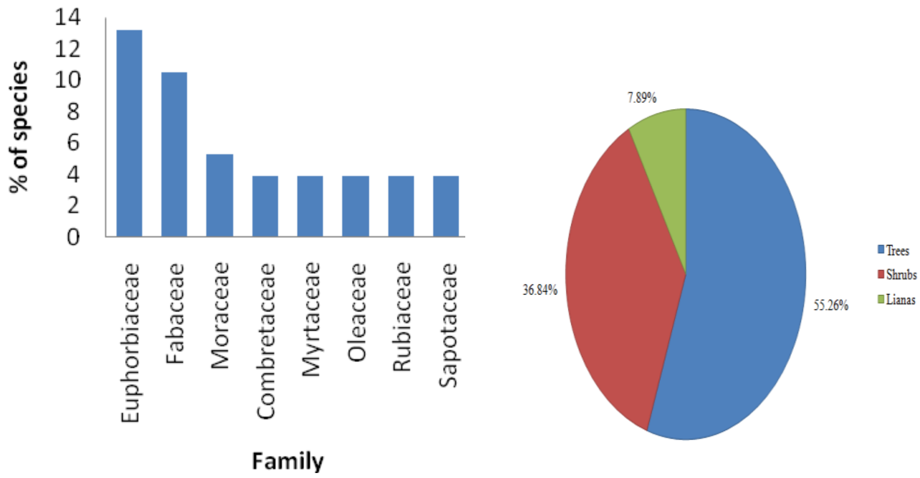
The fundamental parameters for characterization of vegetation structure, density (number of individuals of a species), dominance (degree of cover of one species expressed by basal area) and frequency (recurrence of a species) of mature trees and shrubs were used. Six dbh size classes were defined:<10 cm, 10-20 cm, 20-30 cm, 30-40 cm, 40-50 cm and >50 cm. Density distribution was determined by the number of individuals/ha in different size classes of dbh (figure 5).The basal areas were determined from their respective dbh as follows: BA = $\pi d^2/4$, where, π= 3.14; d = dbh (cm). Total basal area was obtained by summing up the stem cross-sectional area at breast height on a per-hectare basis. In turn, dbh values were calculated from circumference measurements by using the formula as follows: d = C/π. The contribution of the dbh classes to the total density and basal area was presented in table 2. Importance value index (IVI) was calculated by adding together the relative values of density, dominance and frequency [16]. Table 3 shows the nine most important taxa identified in the Lagadara vegetation with importance value index ≥ 10.

The structure of the vegetation was also evaluated using the developmental stages of individuals in the populations of the fifty four selected tree and shrub species. Individuals were characterized into three developmental stage classes namely, mature tree and shrub; sapling and seedling. Accordingly, density distribution of all mature trees and shrubs (dbh ≥ 2 cm and height ≥ 2 m); saplings (height < 2 m - ≥ 1 m) and seedlings (height < 1 m) was determined. The stage structure of the vegetation was computed as proportion of these individuals in the stage classes defined on hectare basis. Similarly, the stage structuresof the five dominant and important tree taxa (*Ficus ovate, Millettia ferruginea, and Syzygium guineense subsp. afromontanum, Diospyros abyssinica* and *Croton macrostachyus*) was presented in figure 6 and commented for their regeneration status.

RESULTS

Floristic composition

We found 76 woody plant species from 39 families within the plots. Annex 1 lists all the species sampled in the Lagadara vegetation with their families, growth forms and importance value indices. The most diverse families in terms of number of species were Euphorbiaceae (10 species, 13.2%) followed by Fabaceae (8 species, 10.5%), and Moraceae (4 species, 5.3%). Each of the five relatively less diverse families: Combretaceae, Myrtaceae, Oleaceae, Rubiaceae, and Sapotaceae were represented by (3 species, 3.9%) (figure 2a). The remaining 31 families together had a total of 39 species with as many as 26 families recording single species. The woody species identified in the vegetation naturally fell into three growth forms namely trees, shrubs, and woody climbers (lianas). Accordingly, the vegetation was primarily composed of tree species (55.26%), followed by species of shrubs (36.84%) and lianas (7.89%) (figure 2b).The majority of the species recorded were natives except few introduced (exotic) species of tree (e.g. *Eucalyptus camaldulensis, Cupressus lustanica* and *Persea americana*) and shrub (e.g. *Lantana camara*). *Millettia ferruginea* was the only endemic species sampled.



a) b)

Figure 2 a) the eight most diverse families and b) distribution in the growth forms (tree, shrub and lianas); based on percentages of species encountered in the study area

Cluster analysis showed strong divisions forming three plant communities (figure 3). These community types identified were *Diospyros abyssinica-Lantana camara* (Community type 1), *Coffea arabica-Millettia ferruginea* (Community type 2) and *Bridelia atroviridis-Maytenus arbutifolia* (Community type 3). Community type I consisted of 30 sample plots and comprised 67 species, *Diospyros abyssinica* being the most abundant followed by *Lantana camara*. This community type were also characterized with other woody members such as*, Bersama abyssinica, Croton macrostachyus*, *Vernonia auriculifera*, *Coffea arabica*, and *Albizia grandibracteata* in decreasing order of abundance value. In contrast, community type II consisted of 15 sample plots and comprised 52 species, *Coffea arabica* and *Millettia ferruginea* being the most abundant species. The other common species found were: *Manilkar abutugi*, *Albizia gummifera, Bersama abyssinica*, *Eucalyptus camaldulensis*, and *Syzygium guineense* subsp. *afromontanum*. Community type III consisted of only 5 plots and consisted of 38 species. The most common species associated with this community were *Bridelia atroviridis*, *Maytenus arbutifolia*, *Clutia abyssinica*, *Terminalia schimperina*, and *Carissa spinarum.*

Table 1 shows diversity indices of the community types identified in the Lagadara vegetation. Diversity according to total number of species (alpha-diversity) indicated that community type I displayed the highest (67) compared to the other communities. On the other hand, community type II (52) was intermediate and community type III (38) exhibited the least in species number. Shannon diversity index (*H'*) varied among community types, ranging from 2.96 (community type III), 2.98 (community type II) to 3.88 (community type I). Evenness index (*E*) was also found to be highest for community type I (0.92) followed by community type III (0.81) and community type II (0.75. The level of similarity in species composition among the communities ranged from 0.46 to 0.86. The highest percentage of species (86%) was shared between community types I and III followed by community types I and II that had (57%) of species in common. Community types II and III showed the least similarity with (46 %) species co-occurring.

Table 1: Diversity indices of the community types identified in the Lagadara vegetation

Attributes	Community type 1	Community type 2	Community type 3
Alpha diversity®	67	52	38
Shannon diversity index (*H'*)	3.88	2.98	2.96
Shannon evenness (*E*)	0.92	0.75	0.82

® The numbers do not add up to the total number of species identified in the study because of overlaps across the three communities

Estimates of diversity according to species richness are often sensitive to sample size. Therefore, comparison was made by plotting species richness to sampling units. Simple correlation indicated that species richness varied at specific sampling unit and also with increasing sample size. For example, species richness corresponding to five sampling units (0.25 ha) slightly varied and found to be 42, 39 and 38 for community types I, II and III respectively. However, the magnitude of variations increases with increasing sampling units. Generally, species richness curve for community type I remain above the other two for sampling units ≥ 3 indicating that community type I has relatively displayed the highest species richness (figure 4).

Vegetation structure

On the basis of dbh size class distribution, six classes of individuals were recognized (figure 5). The dbh classes < 10 cm (69.19%) and 10-20 cm (16.01%); together had highest proportion (85.21%) of individuals of trees and shrubs revealing greater density in the lower dbh classes. However, density declines with increasing dbh size where individuals with dbh≥ 20 cm altogether comprised only 14.79% of the total density. The number of species that were present in each dbh class follow more or less similar trend except for dbh class 40-50 cm that had much lower proportion of individuals. Some examples of species that contributed to such higher density in the smallest class (dbh < 10 cm) were *Coffea arabica*, *Diospyros abyssinica*, *Bersama abyssinica, Maytenus arbutifolia*, and *Psidium guajava*. In contrast, individuals in the largest class (dbh> 50 cm) were mainly large tree taxa of *Ficus ovata*, *Syzygium guineense* subsp. *afromontanum*, *Croton macrostachyus, Ficus sychomorus*, and *Cordia africana.*

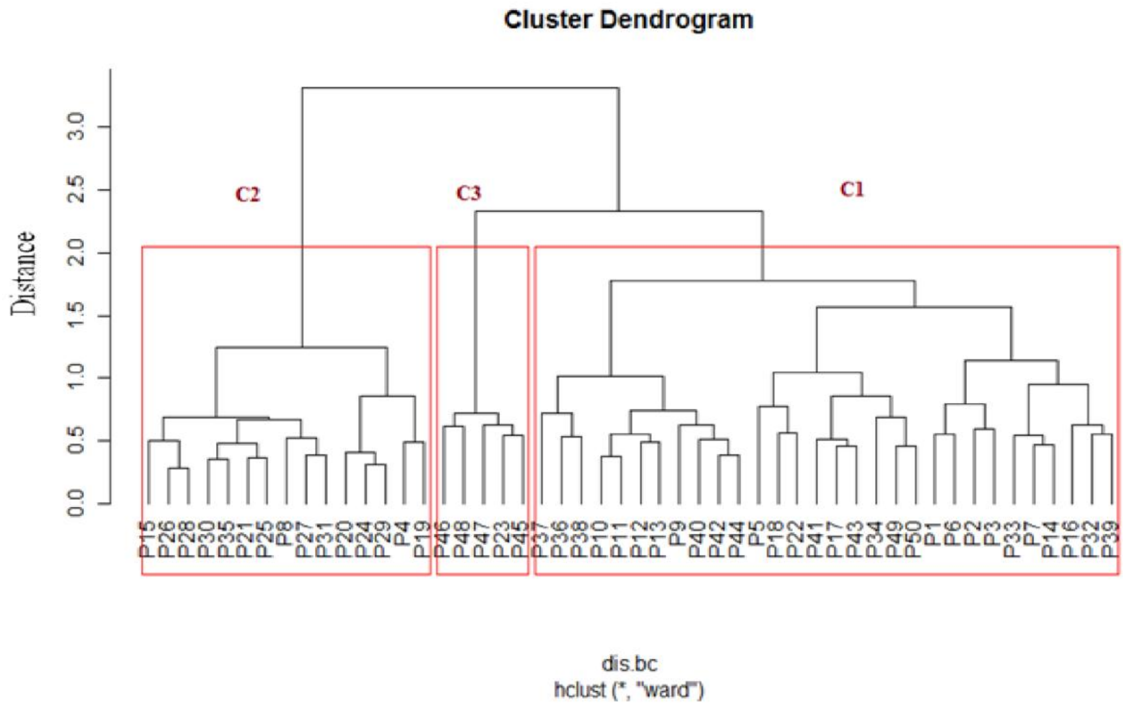


Figure 3 Cluster dendrogram showing sample plots in the community types identified from Legadara vegetation (sample plots vs. Euclidian distance)

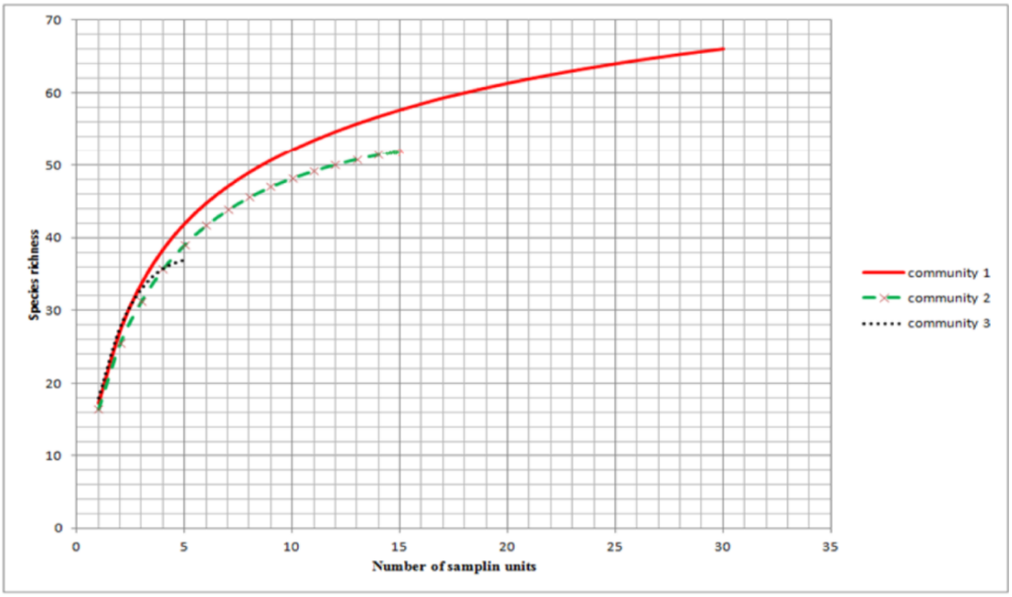


Figure 4: Simple correlation of species richness to the number of sampling units constituting each of the communities.

The total basal area of the mature trees and shrubs in the vegetation studied was 21.24 m^2/ha. The contribution of dbh classes to the total density and basal area was presented in table 2. It was observed that dbh class > 50 cm was found to contribute most (10.74 m^2/ha) to the total basal area. The species with highest basal area was *Ficus ovata* (8.40 m^2/ha). Though, dbh < 10 cm had greater density, the class accounted lower for the total basal area.

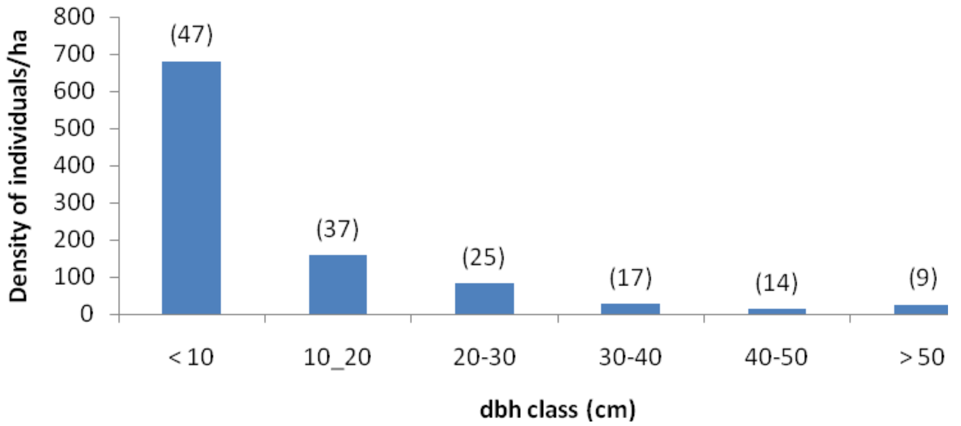


Figure 5 dbh class distributions of individuals of mature trees and shrubs in the Lagadara vegetation. The number of species that were present in each dbh class is given in parentheses.

Table 2 Contribution of dbh classes to the total density and basal area in the Lagadara vegetation

dbh class (cm)	Density		Basal area	
	Number of Individuals	%	BA	%
<10	680.5	69.19	2.08	9.79
10-20	157.5	16.01	2.97	13.98
20-30	81.5	8.29	3.03	14.27
30-40	26.5	2.69	1.66	7.82
40-50	12.5	1.28	0.76	3.58
>50	25	2.54	10.74	50.56
Total	**983.5**	**100**	**21.24**	**100**

Table 3 shows the nine taxa with highest important value index. The important value index (IVI) is the measure of the importance of a species in an area and combines such attributes as relative density, relative dominance and relative frequency. Accordingly, taxa with IVI ≥ 10.00 were identified as important. *Ficus ovata* emerged as the most important species recording an index value of 43.56, followed by *Syzygium guineense* subsp. *afromontanum*, *Coffea arabica*, *Millettia ferruginea*, *Diospyros abyssinica*, *Croton macrostachyus*, *Albizia grandibracteata, Bersama abyssinica* and *Eucalyptus camaldulensis* in decrease sequence of IVI. The rest of species evaluated had IVIs < 10. These nine taxa together account nearly half of the total IVIs of the Lagadara vegetation and therefore constitute the main structure of the vegetation.

The vegetation was assessed for developmental stages of individuals constituting the sampled species. The total density of individuals of trees and shrubs was 1486/ha. Out of this, the proportion of individuals in mature, sapling, and seedling stages were 983.5/ha (66.15%), 288.5/ha (19.41%), 214.5/ha (14.43%) respectively indicating that the vegetation was generally dominated by mature individuals. Nevertheless, each of the species population evaluated for stage structures displayed varying distribution pattern in the three stage classes. No seedling was recorded for 21 species (priority category 2) (e.g. *Acokanthera schimperi, Chionanthus mildbraedii*, and *Cordia africana*); and no sapling was recorded for 17 species, (e.g. *Citrus sinensis, Persea americana* and *Suregada procera*). And again species that lack both seedling and sapling were 14 (priority category 1), (e.g. *Apodytes dimidiata, Combretum molle*, and *Cupressus lustanica*) (table 4). However, the observed seedling and sapling densities in the vegetation were mainly of species such as *Bersama abyssinica*, *Coffea arabica*, *Diospyros abyssinica*, *Bridelia atroviridis*, *Vernonia auriculifera,* and others.

Table 3 Relative density, relative dominance, relative frequency and importance value index for the nine most important taxa in the Lagadara vegetation.

Species	Relative density	Relative dominance	Relative frequency	Importance value index
Ficus ovata	1.76	37.79	4.01	43.56
Syzygium guineense subsp. *afromontanum*	4.34	17.9	5.15	27.39
Coffea arabica	15.71	2.26	4.41	22.38
Millettia ferruginea	6.34	6.01	4.43	16.78
Diospyros abyssinica	7.13	1.59	5.15	13.87
Croton macrostachyus	5.22	2.94	4.86	13.02
Albizia grandibracteata	5.53	3.76	3.29	12.58
Bersama abyssinica	5.43	0.76	4.29	10.48
Eucalyptus camaldulensis	3.72	4.24	2.15	10.11

The stage structures for the populations of the five important tree taxa revealed that all the species were dominated by mature individuals. The density of seedlings and saplings were relatively very few for *Ficus ovata.* Other species assessed were variously represented by their seedlings and saplings but generally showed good regeneration ability from seeds (figure 6).

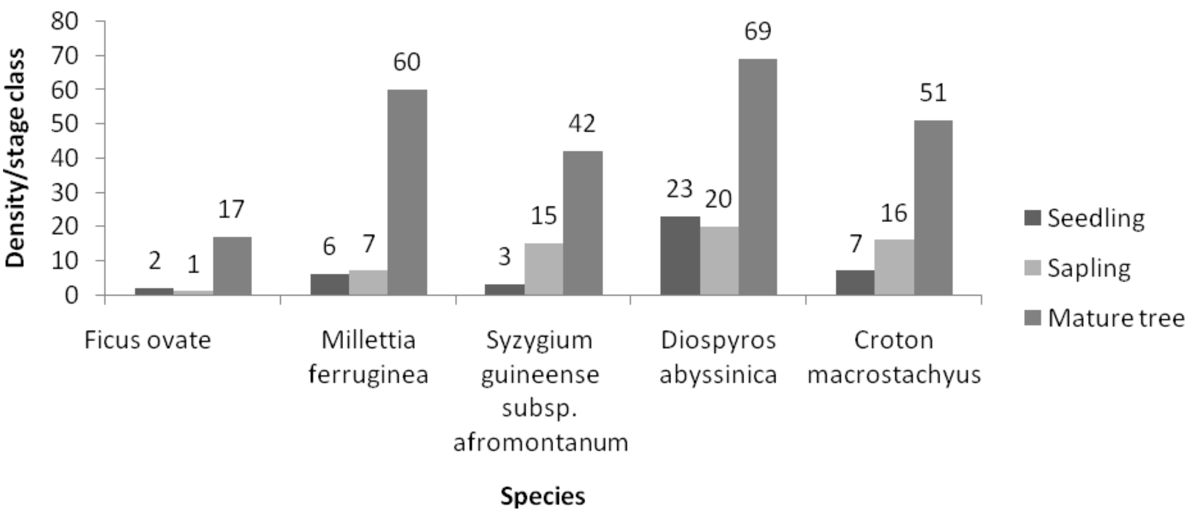


Figure 6 Stage structures in the populations of the five important tree taxa in the Lagadara vegetation

Table 4 Species in conservation priority categories from Lagada vegetation

Priority category 1	Priority category 2
Apodytes dimidiata	*Faurea rochetiana*
Ekebergia capensis	*Acokanthera schimperi*
Euphorbia candelabrum	*Chionanthus mildbraedii*
Ficus thonningii	*Cordia africana*
Ficus vasta	*Ficus sycomorus*
Manilkara butugi	*Mangifera indica*
Mimusops kummel	*Bridelia micrantha*
Olea welwitschii	*Celtis africana*
Pittosporum viridiflorum	*Terminalia schimperina*
Podocarpus falcatus	*Euclea racemosa*
Sapium ellipticum	*Vangueria madagascariensis*
Combretum molle	*Ehretia cymosa*
Cupressus lustanica	*Maesa lanceolata*
Spathodea nilotica	*Lepisanthes senegalensis*
	Combretum adenogonium
	Vernonia amygdalina
	Albizia gummifera
	Rhus vulgeris
	Euphorbia tirucalli
	Millettia ferruginea
	Ochna schweinfurthiana

DISCUSSION

The floristic composition and structure provide important information to understand the vegetation in a given area. Floristically the Lagadara vegetation is relatively less diverse when compared with Riverine vegetation in the other parts of the country. For example, the tree species richness per ha (21) of the present study is lower than vegetation along Beschillo and Blue Nile rivers in the north (43.9) [8]. This might be due to variations in altitude, rainfall intensity and human impacts associated with the areas. The three most diverse families in the studied vegetation were Euphorbiaceae, Fabaceae and Moraceae. Plants in these families are adapted to grow under stressed environmental conditions. Some members of the Euphorbaceae and Moraceae have latex, thorns, cladodes and/or relatively small leaves to conserve water and escape herbivory. Some members of Fabaceae can fix nitrogen and therefore, they can perform well in degraded parts of the vegetation. These factors may have contributed to their diversity in the study area. About 7.89% of the woody species recorded including, *Eucalyptus camaldulensis, Cupressuslustanica, Mangifera indica, Persea americana, Spathodea nilotica,* and *Lantana camara* were exotic and introduced to the vegetation.

The results of clustering and classification indicated 3 major groupings of plots. It has clearly shown in figure 3 that the 30 plots formed one major cluster (community type 1) and 15 plots formed a second cluster (community type 2). The remaining 5 plots formed a third major cluster (community type 3). The plots in major cluster one was divided at lower distance value to the third cluster than the second cluster suggesting greater similarity in species composition among the plots of the former two clusters (86%). The higher abundance and wider distribution of *Coffea arabica* in community types identified is probably because large portion of the vegetation sampled was much affected by local community and reflects the removal of large trees for coffee cultivation. Shannon-Wiener diversity Index (*H'*) ranged from 2.96-3.88 while evennessindex (*E*) ranged from 0.75-0.92 in the three communities (table 1). Diversity (*H'*) range of 1.56-0.55 and evenness (*E*) ranged 0.71-0.90 has been reported by earlier work for Beshillo and Blue Nile vegetation [8]. The diversity indices in the present study are within the reported range for the above vegetation in the northern Ethiopia.

In the present study, the density ranged from 157.5-680.5/ha in the two smaller diameter classes (dbh>20 cm). The distribution of density in different dbh classes revealed the dominance by small sized trees and shrubs. Only 9 tree species evaluated had individuals that exceeded > 50 cm dbh (figure 5). Similar findings, for example, were reported in Gura-Lopho Moist afromontane forest [17] and Sese forest [18]. The observed density distribution for dbh classes in studied vegetation is either due to the selective removal of larger individuals that may have encouraged recruitment into the smaller size classes or the trees and shrubs of vegetation had a limited growth in girth due to the ecology of the area such as soil nutrients and rainfall intensity.

The overall tree density is high in Lagadara (682/ha) as compared to Beshillo and Blue Nile (115/ha). Similar trend was observed for total basal area with 21.24 m^2/ha in Lagadara, 12.6m^2/ha Beshillo and Blue Nile [8]. These results indicate that the Lagadara vegetation, though disturbed and less in tree species richness; still support a higher tree density. The highest basal area in the present study was also attributed to few large sized trees that contributed (10.74 m^2/ha) to the total BA (table 2). The total basal area for Lagadara vegetation was within the reported range for wet forests of Ethiopia (e.g. 49.80 m^2/ha for Masha Anderacha [19] and 64 m^2/ha for Gurra Farda [20].

The important value index of species was used to determine its importance in the vegetation. Therefore, higher IVI for a species reflects the degree of abundance, dominance and occurrence of a given species in relation to the others in the area (table 3). IVI is also used for setting priority for species management and conservation (Kent and Coker, 1992).In the present study, we observed the highest dominance of large trees of *Ficus ovata* and Syzygium *guineense* subsp. *afromontanum* of family Myrtaceae. It is gain important to note the IVI of *Coffea arabica* was attributed to its relative higher density than relative dominance. Among important taxa identified, *Eucalyptus camaldulensis* was intentionally introduced to the vegetation for its value to the local community. Majority of the species had low IVI either may be due to unsupportive environmental conditions for growth or removal by human beings and grazing animals. For example, the IVIs were low (annex 1) for *Podocarpus falcatus* and *Olea welwitschii* due to selective cutting of mature individuals for the purpose of producing high quality wood or timber.

Analysis of stage structures at a species level based on developmental stages revealed different patterns of distribution. No seedling was recorded for 21 species and no sapling for 17 species; and again species that lack both seedling and sapling were 13 indicating that these species had low regeneration ability. *Ficus ovata* was dominant but had relatively fewer seedlingsand saplings. This suggests that this species had also poor regeneration ability from seeds. The possible reasons for poor regeneration might be associated to the physiology of the seeds (seeds remain dormant), genetic factor (where the seeds produced were infertile and cannot germinate) or environmental factors such as lack of suitable site for seed recruitment, pathogens and the like. However, it has to be noted that further investigations have to be conducted taking data from different seasons to draw conclusion in this line. Comparable results were also reported for Komto afromontane forest [21] and Munessa-Shashemene dry forest [22].

The sustainability of the vegetation depends on the regeneration capacity of its constituent species. Species sapling and seedling densities were also used to identify those species where priority should be given for a possible conservation action [18] & [23]. Therefore, it is suggested that any possible conservation practice in the Lagadara vegetation should give first priority to species where neither seedling nor sapling was recorded followed by species where no seedlings were encountered (table 4).

CONCULUSION

It is significant that the Lagadara vegetation was dominated by native species while existing in a matrix of human disturbance and introduction of exotics. There are several factors not investigated in the present study such as effects from grazing animals and climate change which could have influenced the vegetation structure and composition. However, it is hoped that the results of this study will provide base line information that enable in selecting appropriate conservation and management strategies of vegetation in the area. Furthermore, this baseline data would be useful to examine further changes in vegetation resulting from continued anthropogenic activities and natural ecological factors; and for comparison of any future work.

Annex: List of plant species identified in Lagadara vegetation with their families, growth forms, and importance value indices

Species	Family	Growth form	Importance value Index
Acacia pentagona(Schumach.)Hook,f.	Fabaceae	Lianas	-
Acokantheraschimperi (A.Dc) Schweinf.	Apocynaceae	Tree	1.48
*Albiziagrandibracteata*Taub.	Fabaceae	Tree	12.58
Albiziagummifera(J.F.Gmel.) C.A.S.M.	Fabaceae	Tree	9.9
*Apodytesdimidiata*E. Mey. exArn.	Icacinaceae	Tree	0.57
*Artabotrysmonteiroae*Oliv.	Annonaceae	Lianas	-
Asparagus africanus Lam.	Asparagaceae	Lianas	-
*Bersamaabyssinica*Fresen.	Melianthaceae	Tree	10.48
*Brideliaatroviridis*Muell.Arg.	Euphorbiaceae	Shrub	5.28
Brideliamicrantha (Hochst.) Baill	Euphorbiaceae	Tree	5.09
Cadabalongifolia (R.Br.)Dc.	Capparidaceae	Shrub	7.3

Calpurnia aurea(Ait.) Benth.	Fabaceae	Shrub	-
Capparistomentosa Lam.	Capparidaceae	Lianas	-
*Carissa spinarum*L.	Apocynaceae	Shrub	-
Casimiroaedulis La Llave	Rutaceae	Tree	3.17
Cassipoureamalosana (Baker)Alston	Rhizophoraceae	Tree	4.44
*Celtisafricana*Burm.f.	Ulmaceae	Tree	5.8
Chionanthusmildbraedii (Gilg&schellenb) Strean.	Oleaceae	Shrub	0.4
Citrus sinensisOsb.	Rutaceae	Tree	0.81
*Clutiaabyssinica*Jaub. &Spach.	Euphorbiaceae	Shrub	-
*Coffeaarabica*L.	Rubiaceae	Shrub	22.38
*Combretumadenogonium*Steud.ex.A.Rich.	Combretaceae	Tree	3.58
*Combretummolle*R.Br.ex.G.Don	Combretaceae	Tree	1.29
*Cordiaafricana*Lam.	Boraginaceae	Tree	7.3
*Croton macrostachyus*Del.	Euphorbiaceae	Tree	13.02
*Cupressuslustanica*Miller.	Cupresseceae	Tree	1.18
*Dalbergialactea*Vatke	Fabaceae	Shrub	1.85
Dichrostachyscinerea (L.)Wight &Arrn.	Fabaceae	Shrub	-
Diospyrosabyssinica(Hiern.) F. White	Ebenaceae	Tree	13.87
*Dodonaeaangustifolia*L.f.	Sapindaceae	Shrub	-
*Ehretiacymosa*Thonn.	Boraginaceae	Tree	4.95
*Ekebergiacapensis*Sparrm	Meliaceae	Tree	0.58
*Eucalyptus camaldulensis*Dehnh.	Myrtaceae	Tree	10.11
*Euclearacemosa*Murr.	Ebenaceae	Shrub	0.65
Euphorbia candelabrum Kotschy	Euphorbiaceae	Tree	1.53
*Euphorbia tirucalli*L.	Euphorbiaceae	Tree	0.81
Faurearochetiana (A.Rich.) Chiov. ex.Pic. Serm.	Proteaceae	Tree	0.79
*Ficusovata*Vahl.	Moraceae	Tree	43.56
*Ficussycomorus*L.	Moraceae	Tree	2.37
*Ficusthonningii*Blume	Moraceae	Tree	2.42
*Ficusvasta*Forssk.	Moraceae	Tree	1.56
*Hibiscus macranthus*Hochst.ex A. Rich.	Malvaceae	Shrub	-
*Jasminumabyssinicum*Hochst. ex DC.	Oleaceae	Lianas	-
Justiciaschimperiana(Hochst. ex Nees) T. Anders.	Acanthaceae	Shrub	-
*Lantana camara*L.	Verbenaceae	Shrub	-
Lepisanthessenegalensis(Juss.ex.poir)leenh.	Sapindaceae	Shrub	2.0
*Maesalanceolata*Forssk.	Myrsinaceae	Shrub	2.56
*Mangiferaindica*L.	Anacardiaceae	Tree	3.65
*Manilkarabutugi*Chiov.	Sapotaceae	Tree	1.54
Maytenusarbutifolia(A.Rich.) Wilczek	Celastraceae	Shrub	7.62
Millettiaferruginea(Hochst.) Bak.	Fabaceae	Tree	16.78
Mimusops kummel A. DC.	Sapotaceae	Tree	1.13
*Ochnaschweinfurthiana*F.Hoffin.	Ochnaceae	Shrub	1.05
Oleawelwitschii (Knobl.)Gilg&Schellenb.	Oleaceae	Tree	0.81
*Osyrisquadripartita*Decn.	Santalaceae	Shrub	-
*Pavettaoliveriana*Heirn.	Rubiaceae	Shrub	-
*Perseaamericana*Mill.	Lauraceae	Tree	5.36

*Phyllanthusovalifolius*Forssk	Euphorbiaceae	Shrub	-
*Phytolaccadodecandra*L.Herit.	Phytolaccaceae	Lianas	-
Pittosporumviridiflorum Sims.	Pittosporaceae	Tree	0.68
Podocarpusfalcatus(Thunb.) R. B. ex Mirb.	Podocarpaceae	Tree	0.55
Pouteriaadolfi-friederici(Engl.) Baehni.	Sapotaceae	Tree	1.48
*Psidiumguajava*L.	Myrtaceae	Tree	6.37
*Rhamnusprinoides*L.Herit.	Rhamnaceae	Shrub	-
*Rhusvulgeris*Meikle	Anacardiaceae	Tree	0.52
*Ricinuscommunis*L.	Euphorbiaceae	Shrub	-
Sapiumellipticum (Krauss) Pax.	Euphorbiaceae	Tree	4.25
Sennaoccidentalis (L.) Link	Fabaceae	Shrub	-
*Solaniumincanum*L.	Solanaceae	Shrub	-
*Spathodeanilotica*Seem.	Bignoniaceae	Tree	2.07
Suregadaprocera (Prain) Croizat.	Euphorbiaceae	Tree	1.44
Syzygiumguineense(Willd.) *DC.subsp.afromontanum F. White.*	Myrtaceae	Tree	27
*Terminaliaschimperiana*Hochst.	Combretaceae	Tree	3.44
*Vangueriamadagascariensis*Gmel.	Rubiaceae	Shrub	4.62
*Vernoniaamygdalina*Del.	Asteraceae	Shrub	5.08
*Vernoniaauriculifera*Hiern.	Asteraceae	Shrub	5.71

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