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Full Length Research Article

Phytosociological Analysis of Native Tree Species and Causes of Deforestation: A case of Burka Dhintu Woreda, Oromia region,Ethiopia

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ABSTRACT

Phyto sociological analysis was a science that used to study the distribution, diversity, evenness, richness as well as it is a prerequisite for understanding the structure and function of any forest area. This study reports the result of phyto-sociological Analysis of Native Tree Species and Cause of deforestation in Burka Dhintu Woreda, Oromia Region, Ethiopia. The study was conducted in two kebeles/sites of the woreda which were B/Oromia and Anuba Kebeles/sites of study. The data for the study were collected using 20 sample plots for the phyto-sociological analysis and survey questionnaire, in depth interviews and focus group discussions for analysis of the cause of deforestation in the area. The results of investigation showed that, in the study area 28 native tree species belonging to 15 families were recorded during the field survey and the diversity indices result shows that the native tree species was moderately diversified; which was dominated by few native tree species as well as the Important value Index (IVI) value was range between 70.36 and 3.03. The area has better native tree species community similarity between both sites, while the species area curve result also shows that the number of species was increased as the size of the area increased. The native tree species of the study area is highly degraded. The major cause of deforestation in the area were fuel wood and charcoal production, livestock and pond fencing, settlement, grazing, fire and agriculture land expansion which are the direct cause, while population growth, low income and lack of awareness are another cause of deforestation that was highly affecting the native species. Different management activity like watershed management, plantation, area closure and bush clearing that involve the community was undertaken in the area. The management activities gives low consideration for native tree species as it more focus on the non-native one through plantation and conservation activity.

Introduction

"Biological diversity is the diversity of life at genetic, organism and ecological levels, and there have been attempts to include cultural biodiversity as a fourth component" (Jeffries 2005). Ethiopia is an agrarian country with a great altitude range from 110m below sea level at Dalol Depression of Afar region to 4620m above sea level at Mountain Ras Dashin of Amhara region. Because of its topographic difference and position in the tropics, Ethiopia has diverse climate conditions and the resulting diverse ecosystems. As a result, the country is well endowed in natural resources. Ethiopia is a country of diverse plant species forming the line Share flora of 6200 species out of the total flora species of 7850 in East Africa of this diversity, about 12% woody plants are endemic(Birhanu et al., 2004). Tesfaye et al, (2015) indicates that Vegetation resources in all areas of the Ethiopia in general and in fragmented landscape in particular, especially forests are declining at an alarming rate due to increased population (with growth rate 3%) followed by deforestation and land degradation .However, deforestation has gone for the last five decades. Forests which were above 40% of the country's landmass in the beginning of 20th century are reduced into 2.36% in 2000. The main causes are agricultural expansion; the increasing demand for construction material, industrial use, fuel wood and charcoal; lack of a forest protection and conservation policy; absence of a strong forest administration system capable of arresting the rapidly increasing rate of deforestation; lack of effort to ensure the participation of communities in forest protection and conservation and the sharing of benefits, and failure to clearly demarcate and enforce the boundaries of natural forest reserves. New settlements in forests are increasing from time to time and hence resulted in the conversion of forested land into agricultural and other land use systems (Zeleke, 2001). The human interferences are almost everywhere and all the existing forests including woodlands and bushlands are highly disturbed. Their structure and species composition often witnesses disturbance in the past. In general, the current trend indicates a decline in forest resources and an increase

in degradation. The annual loss of the high forest area is estimated to be 150,000 ha/year. If the current trend of forest destruction is allowed to continue, the country will lose all its natural high forests within the coming few years (Demel, 2001).

Studying tree species distribution in response to environmental factors helps to generate information for a better understanding of ecological processes and in managing tree species. The study of plant community involves the study of species diversity, evenness and similarity. Often different scholars have used the values given by one or more diversity indices to quantify Species diversity and many studies have been carried out on plant diversity of different part of the world. However, in the study area there is no any study undertaken regarding the distribution of native tree species and their cause of deforestation. So, it is important to study and document the remaining vegetation resources upon which sound management plans of conservation and sustainable utilization can be based. The study has one general objective which was: *"studying the distribution of native tree species and their causes of deforestation in Burka DhintuWoreda, Oromia Region of Ethiopia".* As well as three specific objectives which were: *studying the native tree species diversity and richness, assessing the causes of deforestation and assessing the management systems undertaken and role of community participation to rehabilitate the degraded resource in Burka DhintuWoreda*.

Methodology

Description of the Study Area

Burka Dhintu Woreda is one of pastoral Woreda among West Harerghe Woredas. It is geographically located between 7^0 41'09" up to $9^0$14'27"N latitude and 4^0 09' 41" upto 41^0 41'40"E longitude with altitudinal range of 1600-2100m above sea level. It is located in the Eastern part of Oromia National Regional State in West harerghe zone at the distance of 468 km from the capital city of the country, Addis Ababa in east direction and from the town of west harerghe ciro town at 151km in south direction. Burka Dhintu woreda shares common boundaries with Boke woreda in north, Bale zone in the south, East hareghe zone in east and Hawi Gudina woreda in west direction. The woreda agro climatic is characterized by namely warm to hot semi-arid climate (*gamoji/ qola*). The total area of the woreda is estimated to be 219,177 hectare. The woreda is characterized by average annual rainfall of 250-900 mm/year and average annual temperature of 25-36 ^{0}C. The study was conducted in two sites (Kebeles) of the woreda which are site 1(Anuba kebele) and site 2(B/Oromia kebele) and found at the distance of 48 km and 19km from the town of the woreda, respectively.

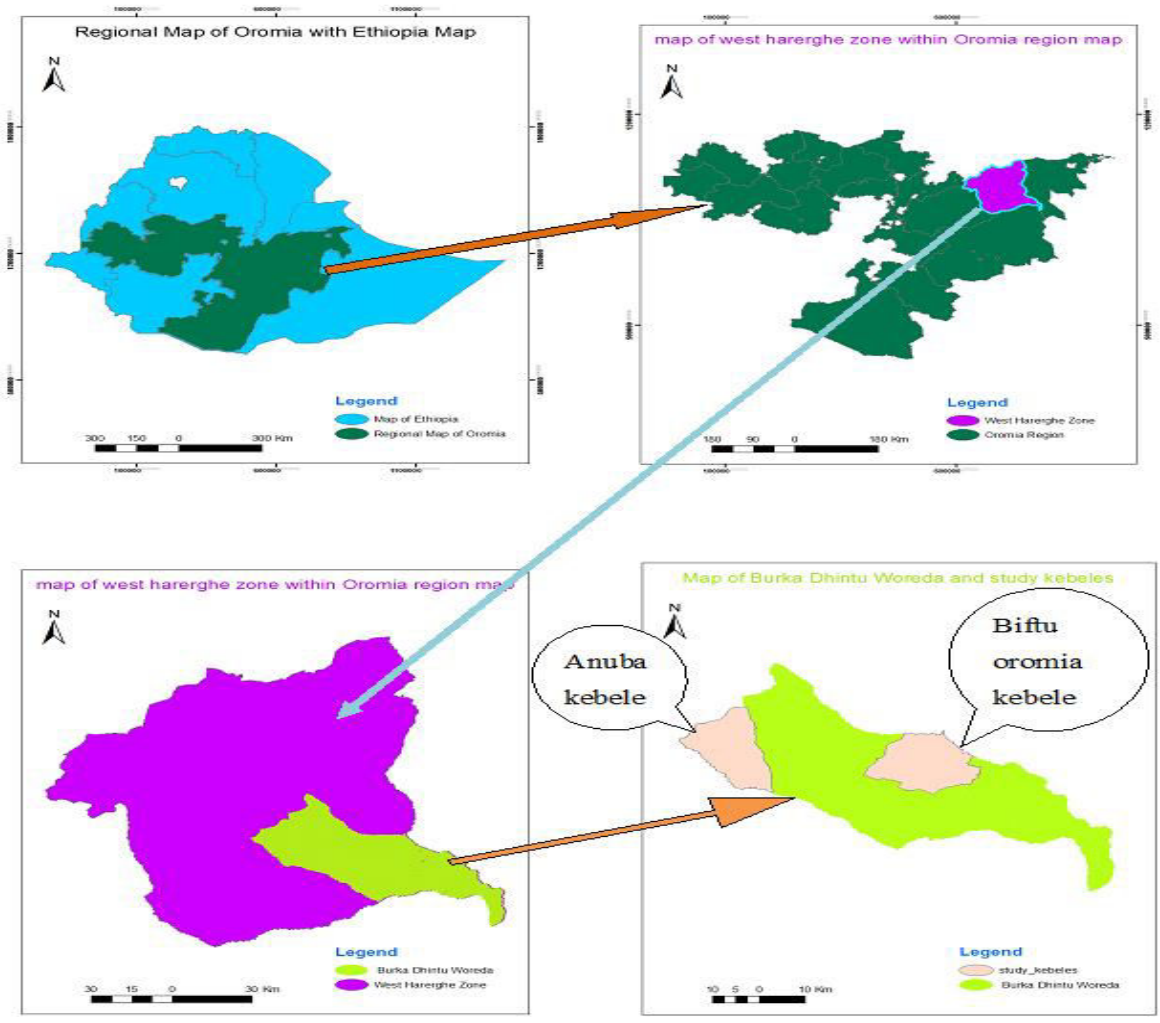

Fig 1: Map of the Study Area (*Source: by Author using Arc GIS, 2018.)*

Research Design

The time dimension of the research design was used both cross sectional and longitudinal study. In this study descriptive and explanatory method was used as well as both Qualitative and Quantitative research approaches were applied.

Method of Data Collection

Both qualitative and quantitative data were used in combination in order to get reliable information regarding the issue /case under study. Field data was used by undertaking sample from the selected site of study in order to know the species diversity, richness, evenness, important value index and also questionnaire, interview, focus group discussion and secondary document from different offices to collect both qualitative and quantitative data.

Vegetation sampling

Sample plot of size 10 × 10 m quadrats was used for this particular study. A total of 20 sample plots for both kebeles were used in order to collect the Phyto- sociological analysis data. The 20 quadrats of sample plot were laid down randomly on two sites, one at Biftu Oromia kebele and the second site at Anuba kebele and all native tree species were recorded from the site on the data collecting sheet.

Plant Identification

The information regarding CBH (circumference at breast height), and species of the trees in each plot was noted for carrying out of Phyto-sociological analysis. All woody species ≥31.5cm CBH were considered as trees; 10.5 - 31.4cm CBH sapling and ≤10.5cm CBH as seedling (Ralhan, 1982).On each sample plot tree species seedlings (≤10.5 cm CBH and height < 1 m), saplings of tree species 10.5 – 31.4 cm CBH and height 1 - 2 m) and trees (≥ 31.5cm CBH and height ≥ 2 m) was recorded by complete count of each .For all tree species having height ≥ 2m the circumference at breast height (CBH at 1.3 m) was recorded. Generally, the data collection for this study was undertaken with a total sample size of 20 quadrant plots for native tree species distribution and 138 households in the selected two kebeles, 6 experts from different office as well as 6 participants from each kebeles for the questionnaire, key informant and focus group discussion, respectively.

Data Sources

Both primary and secondary data were used for this studythrough questionnaire, interview and focus group discussion of households sample survey as well as obtained from different governmental offices to generate both qualitative and quantitative data

Method of Data Analysis

Two types of data analysis were used in this study: quantitative and qualitative data analysis.

Quantitative Data Analysis

The quantitative data collected through questionnaires was analyzed through frequency and percentage by using software's like IBM SPSS and Microsoft Excel and also Arc GIS was used to extract the land use and land cover of the woreda from land sat image.
Primary analysis of the vegetation was carried out to obtain the values of various parameters like, relative frequency, relative density, relative abundance, and importance value index (IVI) by using the following formula:

Quadrant data was pooled by plots to estimates relative density, relative frequency, and relative dominance (Muller-Dombois and Ellenberg, 1974)

Relative Density (%): Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative Density (RD)} = \frac{\text{No. of Individuals of the species}}{\text{No. of Individuals of all species}} \times 100$$

Relative Frequency (%): is the degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$\text{Relative Frequency (RF)} = \frac{\text{Number of occurrence of the species}}{\text{Number of occurrence of all species}} \times 100$$

Relative Dominance: Dominance of a species is determined by the value of the basal area. Relative dominance is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

$$\text{Relative Dominance (RDo)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \times 100$$

Whereas, Basal area $= \frac{(\text{circumference at breast height})^2}{12.56}$

Importance Value Index: This index was used to determine the overall importance of each species in the community structure. In calculating this index, the percentage values of the relative frequency, relative density and relative dominance (Relative Basala Area) were summed up together and this value is designated as the Importance Value Index or IVI of the species.

IVI= Relative Frequency + Relative Density + Relative dominance

Ratio of A/F: A/F was determined to evoke distribution pattern
The distribution of plants was said to be regular, random and clumped or contagious when the value of A/F ratio is <0.025, 0.025-0.05 and > 0.05 respectively (Curtis and Cottam, 1956).

$$\text{Distribution Pattern (\%)} = \frac{\text{Abundance of each species}}{\text{Frequency of each species}}$$

Diversity indices
A diversity index is a mathematical measure of species diversity in a community. Diversity indices provide more information about community composition than simply species richness (i.e., the number of species present); they take the relative abundances of different species into account. Diversity indices provide important information about rarity and commonness of species in a community. For this study the diversity indices of the sampled sample plot were calculated by using Shannon diversity which is very widely used index for comparing diversity between various habitats.

Species richness was determined as number of species per unit area (Whittaker, 1975).
Is calculated by $D=\frac{(S-1)}{\ln N}$
Where S is the total number of species and N is the total number of individuals

Shannon-wiener index
It was used to calculate the species diversity in the community and is represented by H

The Shannon diversity index is calculated as:
$H = -\Sigma^{s}_{i=1} Pi \ln Pi$
Where Pi = n1/N
H′ = Shannon-Wiener index of species diversity
s = number of species in community
pi = proportion of total abundance represented by i^{th} species

Evenness:
Species evenness was a diversity index, a measure of biodiversity which was used to measure the homogeneous distribution of tree species in sample plot. The evenness of a population was calculated by′
$E = \frac{H'}{Hmax} = \frac{H'}{\ln S}$ with Hmax = lnS

Where, E = Evenness
H′ = Calculated Shannon-Wiener diversity
Hmax = ln(s) [species diversity under maximum equitability conditions]
S = the number of species,
Pi= proportion of individuals of the i th species or the proportion of the total Species.

Simpson's diversity Index:
Simpson's diversity index was also used for this study. Simpson's diversity index was the most sensitive to changes in more abundant species and hence places more weight on the most abundant species in the community. The Simpson's diversity index was derived from probability theory and it was the probability of picking two organisms at random which are of different species. Simpson's diversity index can be represented by;
Simpson's index of diversity= $1- (D)^2$ where as $D =\sum(n/N)^2$.

Where D = Simpson's index
n = the total number of organisms of a particular species
N = the total number of organisms of all species

Qualitative Data Analysis
The qualitative data that was gather through interview, focus group discussion and open ended questioner was analyzed and interpreted through narration.

Time of the study
The study was conducted from January up to May, 2018.

Results and Discussion

Phyto-Sociological Analysis

Understanding plant communities is a critical prerequisite in ecosystem ecology, natural resource management and conservation. This knowledge is particularly important when studying rare or native species and for developing management strategies for protecting them, and/or reducing fragmentation of their habitats (Ewald, 2003). In this study a 10mx10m quadrant was used to analyze the phyto-sociological of the native tree species. The same to this study Eba et al., 2017 and A. Baleeshwar Reddy et al., 2016, also used a 10mx10m quadrant / sample plot in their study. A total of 28 native tree species were recorded during the field data collection in the study area which belonging to 15 families. Eba et al. 2017; Devi, 2006 and Lalfakawma et al. 2009 recorded 31, 17 and 32 tree species in their study, respectively. This shows that in the study site higher number of tree species was recorded compared to Devi, 2016 result while it has low number of tree species compared to Eba,2017 and Lalfakawma et al. 2009 study result.

When the number of species and families from the two sites analyzed separately, Biftu oromia kebele (site2) has higher share in all aspects. In a Biftu Oromia kebele (site2) total of 28 species were recorded with 15 families while in Anuba kebele (site 1) the number of species are declined to 22 represent 11 families. Among the families Fabaceae has showed highest number of species (7 species) followed by Burseraceae (3 species), Anacardiacea, Combretaceae, Moraceae and Rhamnaceae (2 species each). Both kebele of Anuba and B/ oromia (study sites) are dominated by Fabaceae and Burseraceae families which account 36.36% and 35.71% of the total family respectively. The same to this study the result of Eba et al. 2017 in the compound of Haramaya University and D. Srinivasa Rao, 2015 has also get that fabacea family as highest record in their study.

Species Diversity in the forest

A diversity index is a mathematical measure of species diversity in a community. Diversity indices provide more information about community composition than simply species richness (i.e, the number of species present); they take the relative abundances of different species into account. Diversity indices provide important information about rarity and commonness of species in a community (Mengistu, B, 2016). The Shannon index and Simpson's index of diversity, which combine species richness with relative abundance, are widely used in species diversity studies. Shannon diversity index was higher recorded at site 2 (B/Oromia kebele) (2.72) than site 1(Anuba kebele) (2.27). The average Shannon value in both areas contributes 2.5. Shanon diversity index typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase.

A high value of H would be a representative of a diverse and equally distributed community and lower values represent less diverse community. A value of 0 would represent a community with just one species. In this study as shown in Figure1, the average Shannon index diversity value was 2.5 which show that the study area has moderately diversified and equally distributed native tree species. So, the value indicates that in order to ensure the diversity and distribution of the trees different management needs in the area, especially through increasing the regenerative capacity of the trees.

Different study has also get different Shannon diversity index in their study; A.S. Thakur, 2015, Species diversity or Shannon-Wiener diversity index (H) of tree species was 2.65. Kushwaha and Kumar, 2002 observed maximum diversity value 2.505 in Madhav National Park followed by Satpura National Park 2.254 and minimum value 1.717 was found for Pachmarhi Wildlife Sanctuary in Central India. Panchal and Pandey, 2004 was also observed 3.53 in tropical forests in sal forest in North India. Similarly the Evenness and Simpson diversity values are relatively higher at site2 (B/Oromia kebele) than site 1(Anuba). Simpson's Diversity Index is a measure of diversity which takes into accounts both richness and evenness. The value of this index also ranges between 0 and 1, the greater the value, the greater the sample diversity. In this study the average Simpson diversity index value was 0.86 this value was close to 1; according to the interpretation if the value is close to one it shows the greater the sample diversity, so in the study area according to this result the area was high diversity. Similarly Eba et al. 2017 study result at Haramaya University main campus, the Simpson index of diversity of site one and site two are 0.94 and 0.95, respectively.

Community Similarity

Sorenson's coefficient gives a value between 0 and 1, the closer the value is to 1, the more the communities have in common. Complete community overlap is equal to 1; complete community dissimilarity is equal to 0.

$$\text{Sorenson's Coefficient (CC)} = \frac{2C}{S1+S2}$$

Where C is the number of species the two communities have in common, S1 is the total number of species found in community 1, and S2 is the total number of species found in community 2. In this study the two communities which are site 1(Anuba kebele) and site 2(B/Oromia kebele) have 22 tree species in common. While the total number of species in site 1 and site 2 were 22 and 28, respectively. The result of sorenson's Coefficient (CC) was 0.733.

This indicates that both communities have high similarity since it's closer to 1. While the result observed by Eba et al 2017of Sorenson coefficient of similarity between the two habitat types was 0.4 which shows less similarity between the communities.

Frequency and Abundance of the Species in the Study Area

The frequency value ranged between 10-100%. The results reveal that Terminalia brownii Fresen, Combretum molle R.BR. ex G. Don and Acacia etbaica Schweinf were more frequent in occurrence. The rarest of occurrence were recorded by *more than half of the species* representing only 10 % of frequency values from the studied native tree species. This indicates that only a few number of species was dominate the study area. The abundance value ranges between 1 and 3.4. Higher abundance values 3.4 and 2.44 were recorded by Terminalia brownii Fresen and Combretum molle R.BR. ex G. Don, respectively. The lowest abundance value which is 1 was recorded by more than 60% of the total species.

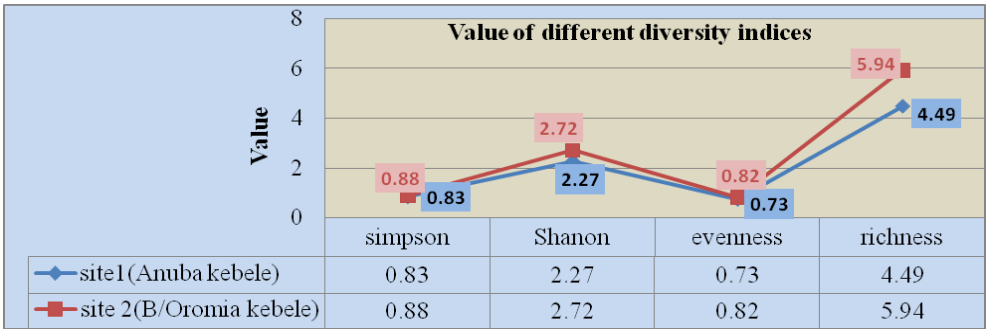

Fig 2: Value of different Diversity Indices; *Source: by Author, 2018.*

Distribution Pattern of the Native Tree Species at Both Site

According to Curtis and Cottam, (1956) the distribution of plants is said to be regular, random and clumped or contagious when the value of A/F ratio is <0.025, 0.025-0.05 and > 0.05 respectively. The species distribution of this study shows that 9.09%, 18.18% and 72.73% in site1 while 7.14%, 42.86%, and 50% in site2 of the native tree species distribution were regular, random and contagious, respectively. This shows that in both study more than half of the tree species were distributed contagiously. In general preponderance of contagions distribution in natural vegetation has been reported by several workers (Eba 2017, A.S. Thakur, 2015, Devi et al.2006, Pandey 2001; Thakur 2003; Panchal and Pandey 2004; Kushwah et al.2002.

IVI of Top Five Species

IVI value is the total sum of relative density, relative frequency and relative dominance. It is used to determine the most ecologically significant species in a given community. Highest IVI of teak indicates its dominance and ecological success on account of its good power of regeneration and greater ecological amplitude. The detail of Relative Density**,** Relative Frequency**,** Relative dominance and Important Value Index of the study discussed in table 1(annex).

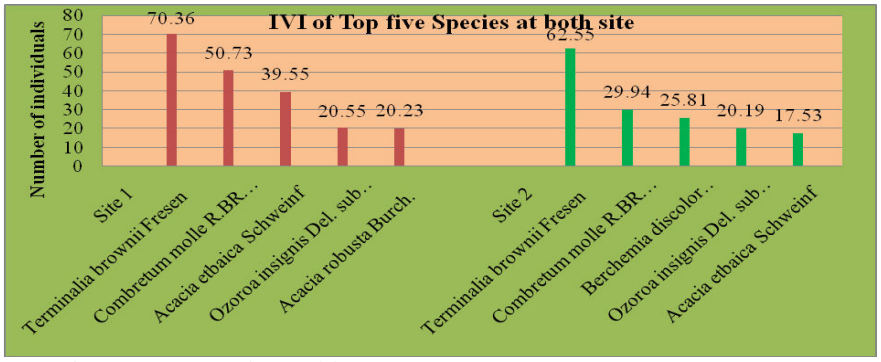

Fig 3: IVI Value of top five species**;** *Source: Author field survey, 2018*

Analysis of IVI provides information about the social status of a species and can be recognized as patterns of association of dominant species in a community.As Figure2indicates, in this study the analysis of IVI in the two study sites represented different combinations of species with different dominants. The most ecologically significant tree species in the study sites were Terminalia brownii fresen(70.36), followed by Combretum molle R.BR. ex G. Don (50.73), Acacia etbaica Schweinf (39.55), Ozoroa insignis Del. sub sp. Insignis(20.55) and Acacia robusta burch(20.23) in Anuba kebele (Site1), while at B/Oromia kebele (site2) Terminalia brownii fresen (62.55) was recorded highest IVI followed by Combretum molle R.BR. ex G. Don (29.94), Berchemia discolor (Klotzsch) Hemsl (25.81), Ozoroa insignis Del. sub sp. Insignis (20.19) and Acacia etbaica Schweinf(17.53). This study shows that in the study area (woreda) Terminalia brownii fresen ,Combretum molle R.BR. ex G. Don, Ozoroa insignis Del. sub sp. Insignis were the most highly dominate species. While A. Baleeshwar Reddy et al., 2016 in their study recorded the highest IVI value 54.29, 48.72 and 40.51 for Albizia amara, Prosopis juliflora, and Ziziphus jujuba tree species, respectively.

Species Area Curve

The species–area relationship or species–area curve describes the relationship between the area of a habitat, or of part of a habitat, and the number of species found within that area. Larger areas tend to contain larger numbers of species, and empirically, the relative numbers seem to follow systematic mathematical relationships

In this study as figure 4 Shows, the number of species increases as the size of the plot increase in both study sites. In every plot size the number of species in both of the study sites is closer, but the number of species at site2 (B/Oromia) is a somewhat greater compared to site 1(Anuba) at all plot size. The number of individuals recorded in both site in the minimum (100 m2) and maximum (900 m2) plot area were 6 and 15 at site1, and 7 and 17 at site2, respectively. Generally, the number of species increased steadily with increasing area

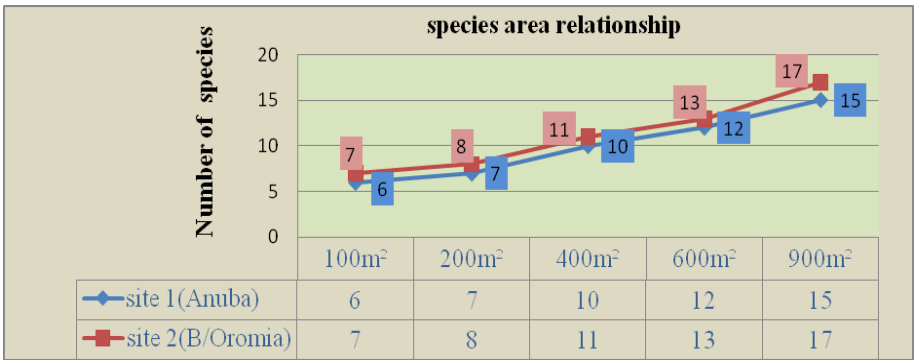

Fig 4: Species Area Relationship**;** *Source: by author, 2018.*

Cause of Deforestation

According to Ibid, (2003), Deforestation is caused by what human beings do to the forests and can be accentuated by drought. Generally deforestation occurs when people clear forest for their personal need such as, for fuel, grazing, when they need the land to grow and harvest crops, for building houses, and for income generation. It conclude that the main causes of deforestation in Ethiopia are agriculture land expansion, livestock production and fuel wood in drier areas

a.Tree Deforested for charcoal and fuel wood b. Tree Deforested for livestock and pond fencing

Photo 1: Photo of trees deforested for different purpose

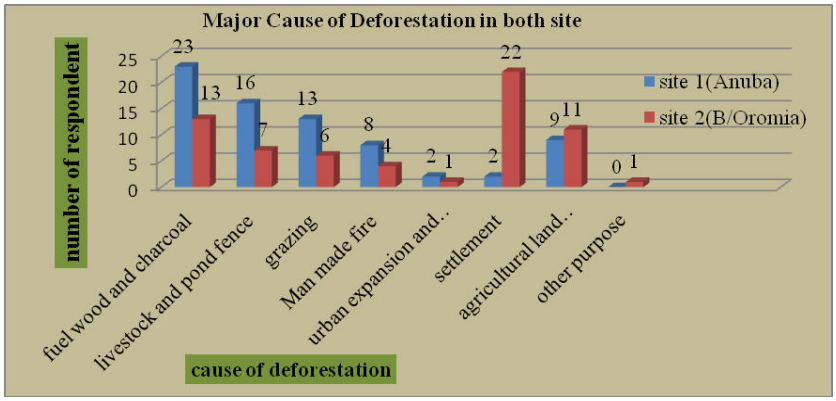

Fig 5: Cause of deforestation in the study area**;** *Source: author field survey, 2018.*

In the study area as the above figure4 shows, different cause of deforestation were identified during the field survey data. Among the major cause of deforestation in the study area fuel wood and charcoal production, livestock and pond fencing, settlement, grazing and agriculture land expansion are the major cause of deforestation. According to FAO, (2015) Forests conversion involves removing natural forests to meet other land needs, such as plantations, agriculture, pasture for cattle settlements and mining. This process is usually irreversible. The conversion of forests into agricultural plantations is a major cause of deforestation. The target house hold of this study respond that they have access to the forest resource of their area; they use forest for different purpose like grazing, livestock and pond fence construction, fuel wood and charcoal production. All of the respondents conclude that in the area there was deforestation. From the focus group discussion and in depth interview with the woreda experts in the study area the deforestation rate was increased through time as the needs of the population increased. During interview of key-informants, they perceived that in the study area lack of alternative energy sources was one of the challenges which aggravate deforestation; this was due to total dependency of the all households on fuel wood consumption rather than use of other alternative energy sources. They said that the cause of deforestation varies from site to site, for example they compare both of the study sites. In site1 (Anuba kebele) since there was no resettlement program the cause of settlement was low, while in site 2 (B/Oromia) there was settlement program that leads to deforestation to the area compared to site1. The field survey data from the target house hold also shows that site 2 is highly affected by settlement program.

According to the focus group discussion and key informants, due to population growth in the study area increased demand for more agricultural land, grazing land, charcoal production, fuel wood consumption and other uses, in the past years the tree cover was reduced, so the stock of tress diminishes as the forest resource was overly exploited rather than being managed on a sustainable basis, they said that in the area on their was a practice of having more than one wife (polygamy) which leads to the increasing of the population in the area and indirectly cause deforestation through increasing needs of fuel wood, grazing land, agriculture land and so on. Parry, 2003).also conclude that Growing populations are increasing forest degradation which is leading the country to famine. As the population continue to grow the need of the people increase and the country has lost 98% of its forested regions in the last 50 years.

Management systems undertaken and role of community participation to rehabilitate the degraded resource

Different management activity like watershed management, plantation, area closure and bush clearing has been undertaken and somewhat reduce the impact of deforestation on native tree species. During the management activity the consideration given for native tree species was not satisfactory because of the plantation and conservation activity focused on non-native one. The community participates in these management activities through different time and there was also some change observed in the area through community participation.

Conclusion

In this study about 28 native tree species belonging to 15 families were identified and tree species was somewhat diversified while it is dominated by a few tree species; Terminalia brownii fresen, followed by Combretum molle R.BR. ex G. Don , Acacia etbaica Schweinf , Ozoroa insignis Del. sub sp. Insign and Acacia robusta burch were the dominant species in the study area and the community similarity of the area was highly similar. In the area the community similarity shows that there was high similarity of species between both sites, which have 22 species in common out of 28 native tree species recorded during the field survey. While the species area curve of the area was done between the range size of 100m2 and 900m2 and it shows that the species number increased as the size of the area increased. The major causes of deforestation are due to fuel wood and charcoal production, livestock and pond fencing, settlement, grazing, fire and agriculture land expansion which are the direct cause, while population growth, low income and lack of awareness are another cause of deforestation that was highly affecting the native species. The absence of alternative energy in the study area than fuel wood and depends of all the local community on forest resource of the area in order to meet their energy needs leads to depletion of the forest resource.

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Annexure-1

Table 1. Relative Density, Relative Frequency, Relative Dominance and IVI of both Sites

S. no	Species name	Site 2: Biftu Oromia kebele				Site 1 : Anuba kebele			
		RD	RF	Rdo	IVI	RD	RF	Rdo	IVI
1	*Salvadora persica* L.	1.06	1.52	0.60	3.18	0	0	0	0
2	*Grewia mollis* Juss.	1.06	1.52	0.86	3.44	0	0	0	0
3	*Pappea capensis* Eckl & Zey	3.19	4.55	4.49	12.22	0.93	1.79	0.98	3.69
4	Terminalia brownii Fresen	28.72	15.15	18.68	62.55	31.48	17.86	21.02	70.36
5	*Acacia nilotica* (L.) Willd. ex Del.	1.06	1.52	0.53	3.11	0	0	0	0
6	*Rhus tenuinervis* Engl.	2.13	3.03	1.61	6.77	0.93	1.79	0.65	3.36
7	Boswellia neglecta S.Moore	1.06	1.52	1.16	3.74	0.93	1.79	1.22	3.93
8	*Acacia tortilis* (Forssk.) Hayne	1.06	1.52	0.51	3.09	0.93	1.79	0.67	3.39
9	Acacia etbaica Schweinf	5.32	7.58	4.63	17.53	13.89	14.29	11.38	39.55
10	*Olea europaea* L. subsp. *cuspidata*	2.13	3.03	1.95	7.11	0.93	1.79	0.90	3.61
11	*Zanthoxylum chalybeum* Engl.	1.06	1.52	1.33	3.91	3.70	5.36	1.85	10.91
12	*Ozoroa insignis* Del. *sub sp. Insignis*	7.45	6.06	6.68	20.19	4.63	8.93	6.99	20.55
13	*Buxus hildebrandtii* Baill.	1.06	1.52	0.55	3.13	0.93	1.79	1.01	3.72
14	Acacia bussei Harms ex Sjostedt	3.19	3.03	3.83	10.05	0.93	1.79	0.54	3.25
15	*Commiphora africana* (A. Rich.) Engl.	1.06	1.52	0.86	3.44	0.93	1.79	0.35	3.06
16	*Ximenia americana* L.	2.13	3.03	2.14	7.30	4.63	5.36	2.07	12.06
17	Berchemia discolor (Klotzsch) Hemsl	6.38	7.58	11.85	25.81	1.85	1.79	9.82	13.46
18	Gardenia ternifolia Schumach. & Thonn.	1.06	1.52	0.45	3.03	0.93	1.79	0.37	3.08
19	*Euclea racemosa* Murr.	2.13	3.03	0.78	5.94	0	0	0	0
20	*Ficus sycomorus* L.	2.13	3.03	10.51	15.66	1.85	1.79	3.38	7.01
21	*Ficus vasta* Forssk.	1.06	1.52	3.21	5.79	1.85	1.79	2.54	6.17
22	*Ziziphus mucronata* Willd.	4.26	6.06	4.49	14.81	1.85	1.79	1.32	4.96
23	*Tamarindus indica* L.	2.13	3.03	3.87	9.03	2.78	3.57	3.33	9.68
24	*Combretum molle* R.BR. ex G. Don	11.70	9.09	9.15	29.94	20.37	16.07	14.29	50.73
25	*Ehretia cymosa* Thonn.	1.06	1.52	0.55	3.13	0	0	0	0
26	*Premna schimperi* Engl.	1.06	1.52	1.33	3.91	0.93	1.79	0.52	3.23
27	*Acacia seyal* Del.	2.13	1.52	2.00	5.64	0	0	0	0
28	*Acacia robusta* Burch.	2.13	3.03	1.37	6.53	1.85	3.57	14.81	20.23
	Total	100	100	100	300	100	100	100	300

Source: *Author field survey, 2018*

RD=Relative Density**, RF=** Relative Frequency**, RDo=** Relative dominance

IVI= Important Value Index