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Assessment of woody species diversity, key drivers of deforestation and community perception; the case of Hotessa Forest, Bensa Woreda, Sidama Zone, Southern Ethiopia

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In Ethiopia, deforestation is a major challenge which leads to increased human encroachment upon wild areas and threats to biodiversity. In line with this, the aim of the current study was to assess woody species diversity and threats in Hotessa forest. Systematic sampling method was used to collect vegetation data. Accordingly, 100 plots each with 400 m^2 (20 m × 20 m) for woody species was laid along transect line. In each of these plots, all woody species were collected. Simple random sampling was used to identify target population and in-depth interviews were conducted with farmers living in close vicinity to the forest to identify challenges and threats on the forest. A total of 43 woody species distributed to 37 genera and 28 families were identified and documented. Fabaceae is the dominant families in terms of species richness. The Shannon-Wiener diversity index computed for the three different altitudinal gradients and showed that lower altitude is the most diverse and has more or less even distribution of species. In general, the diversity and evenness of woody species in the forest was 2.575 and 0.98 respectively. The result of analysis of the responses to human-induced factors responsible for deforestation in the study revealed that most of the respondents attributed population growth (80.82%) as the major factor responsible for deforestation in the study area.

Key words: Diversity index, Shannon-Wiener, farmers, interview, sampling.

INTRODUCTION

Different scholars in their study reported that in our world, the total global forest area has declined by 3%, from 4128 million ha in 1990 to 3999 million ha in 2015 (Keenan et al., 2015). Previous study by Reynolds et al. (2007) state that, the decline of vegetation cover is one of the most serious challenges facing humankind today. Same applies to country Ethiopia which also facing severe land degradation (Solomon, 2015). According to FAO (2016) land-use change is not necessarily the same as land-cover change. Land cover is the observed

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biophysical cover of the earth's surface, but land use reflects the actions of people and their intentions and the former is far more widespread than the latter, with deforestation occurring when people clear forests and use the land for other purposes, such as agriculture, infrastructure, human settlements and mining (FAO, 2016). Daniel (2016) in his study reported that land cover is constantly changing with different patterns and magnitudes in sub-Saharan Africa and the Sahel in particular. Currently in Ethiopia, the natural vegetation is highly affected by several factors such as, agricultural expansion, settlement, deforestation, land degradation, and increment in invasive species occurrence and logging practice which seriously damages the structure and composition of natural woody plant species and leading to the declining of forest biodiversity and agricultural yield in Ethiopia (Mohammed, 2011; Khumalo et al., 2012; Ariti et al., 2015; Gashaw and Dinkayoh, 2015; Bessie et al., 2016; Negasi et al., 2018) and with the present annual rate of deforestation 2% it continues (Moges et al., 2010).

Ethiopia is a mountainous country with great geographic diversity like rugged mountains, flat-topped plateaus and deep gorges incised river valleys and rolling plains (Teweldebrhan, 1988). This makes the country one of the largest forest resources in the horn of Africa and it owns a total of 53.1 million ha covered by woody vegetation which consists of 12.5 million ha of forest land and 40.6 million ha of woodland (FAO, 2016). The total forest area of the country has declined from 15.1 million ha in 1990 to 12.5 million ha in 2015. The annual rate of forest land decline is 104, 600 ha per year that is 0.8% of forest cover of the country (FAO, 2016). According to this report in total, Ethiopia lost 18.6% of its forest cover or around 2,818,000 hectare between 1990 and 2010.

Similarly, Stern (2006) the underlying causes of deforestation and degradation based on a framework analysis were identified as population growth, insecure land tenure, and poor law enforcement. The decline of forest capacity at the global and national level is a great problem that currently affects the livelihoods of people in different ways also reported by Asfaw and Fekadu (2018). However, there are evidences that indicate sustainable farming practices, like agroforestry. The same as in Bensa Woreda, there was high rate of agricultural expansion observed, especially in mountainous area which leads to deforestation and high rate of loss of woody species and sparsely diversified trees due to over population, logging and land fragmentations. Study has not been conducted before on floristic diversity and the threats of this area and has necessitated the qualitative and quantitative assessment of vegetation and threats on forest resources of the Woreda. Regarding this, systematic field survey of flora and fauna is a prerequisite for developing effective conservation programs and its implementation Kent and Coker (1992). The resulting information on vegetation is essential to solve ecological problems, for biological conservation and management purposes as indicated by Noriko et al. (2012). Thus, it is important to identify plant species diversity, species composition and drivers of deforestation of Hotessa forest. Additionally, the current study serves as spring border to narrow the gap on those forest management planners to use this information in their decisions on forest conservation and product use.

MATERIALS AND METHODS

Description of the study area

This study was conducted in Bensa Woreda, Sidama zone in Southern Nations Nationalities and Peoples' Region (SNNPR) of Ethiopia. Bensa Woreda is one of the 19 districts in Sidama zone that extends into the Oromia region of Bale Zone or Borana-like peninsula. Bensa Woreda is bordered on the south and north by the Oromia Region, with Bona Zuria on the west, Arbegona district on the northwest, Chere district on the east, and Aroresa district on the southeast. Daye, the capital of Bensa Woredat, is located at 420 km southeast of Addis Ababa and 135 km northeast of Hawassa city, the SNNPR capital city. Bensa Woreda is located at altitude which ranges from 1452 to 3129 m above sea level. The two rainy seasons are the *belg* (short rainy season), which covers from late February to May, and the *kremt* (main rainy season), which extends from late June to early October. The average annual rainfall of the area is 1208.5 mm. The average annual temperature of the Woreda is 19°C. The Woreda has three major agro ecologies, with 50% were moist weyna dega (mid-altitude), 36% moist dega (highland) and 14% moist kola (lowland) (Bensa woreda pilot Learning Site diagnosis and program design, LIVES, 2012) (Figure 1).

The dominant soil type in the study area is loam soil. During the reconnaissance survey together with Woreda agricultural office expert informal communication, from the total area of the study site about half was covered by dense forest before one or two decades. However at present, the forest cover has diminished and the hazard of soil erosion and land degradation has increased. The cause for diminishing forest cover is increasing agricultural land expansion, fuel wood demand and timber production. As learned from the local elders, indigenous tree species like *Olea europea, Hygeia abyssinica, Podocurpus falcatus* and Bamboo (arborescent grass) were dominant before two decades. Nonetheless, currently *H. abyssinica* and *P. falcatus* has totally disappeared from the forest area. The total population of the study area is estimated to be 342,545 (Bensa Woreda Administration office, 2018).

Sampling design, sampling size determination and data collection

Bensa Woreda was purposively selected based on its floral diversity and unstudied area. A reconnaissance survey was made to obtain an impression on the general physiognomy of the vegetation and to identify sampling sites. Twenty transect lines was systematically laid to ensure that sample sites were cover representatives of major vegetation types occurring in the study area based on altitude gradient: namely, upper altitude (3 transect lines), middle (10 transect lines) and lower (7 transect lines) proportionally to their size. A total of 100 quadrants, Plots size of 20 × 20 m (400m2), were used for collection of floristic data at 100 m distance interval

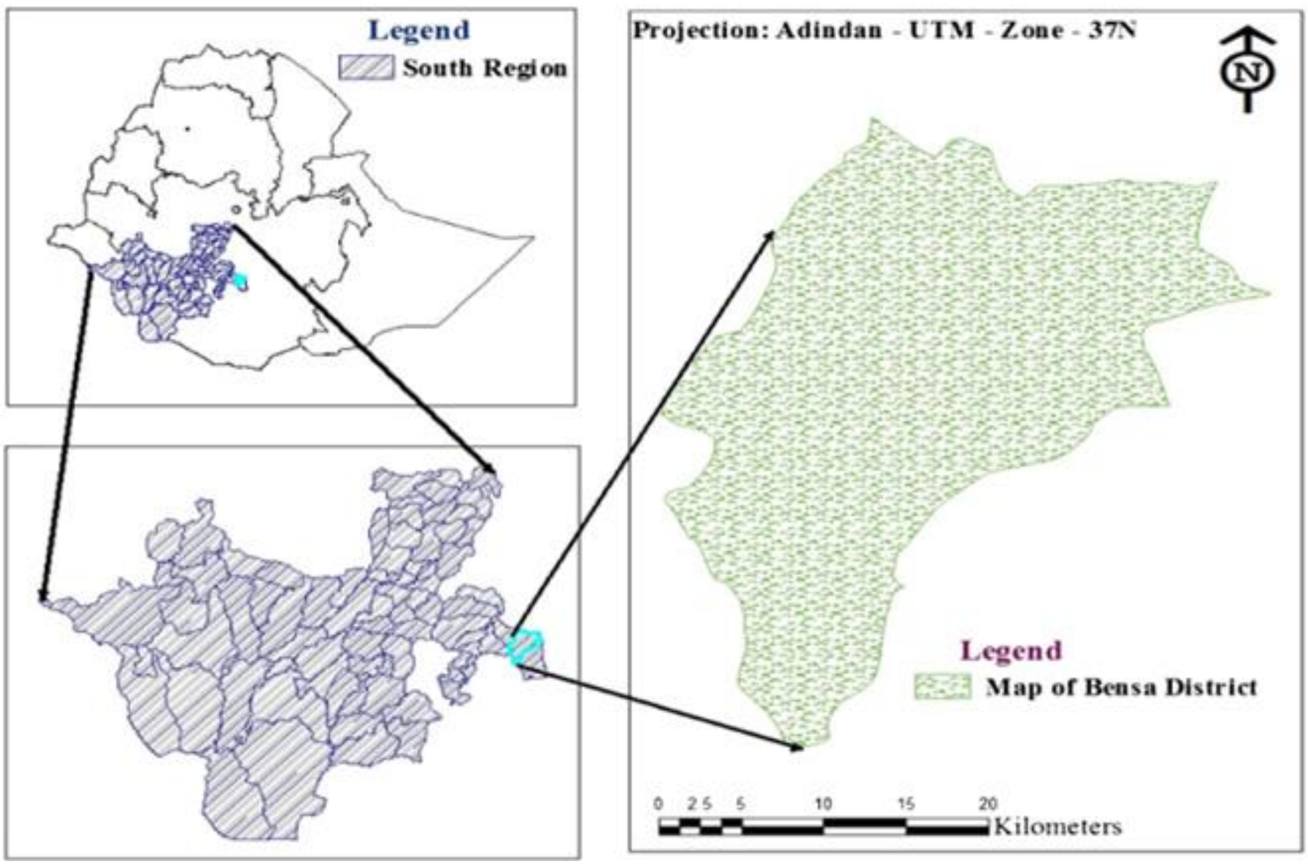

Figure 1. Map of the study area.

(Muller-Dombosis and Ellenberg, 1974). From each 20 x 20 m plot, a complete list of shrubs (woody plants having several stems 2 m tall and trees (woody plants having a dominant stem and more than 2m tall) was recorded. Plant identification was carried out at the field and confirmed at National Herbarium. Nomenclature followed the published volume of Flora of Ethiopia and Eritrea (Edwards et al., 2000; Hedberg et al., 2006, 2009) and Azene (2007).

Regarding the target population, the sampled population was identified using simple random sampling on the number of house hold leader to analyze the factors currently creating a threat to plant diversity. The questionnaire covered various socio-economic and demographic characteristics of the households, forest livelihood and forest land-use (Appendix 1). Socio-economic factors include age and education of the household head and land holdings (Appendix 1). The structure of the questionnaire was designed to meet the objectives of the study and pre-coded for ease of data collection and analysis. The questionnaire was semi-structured in and allowing for flexibility in responding to the questions (Appendix 1). The questionnaire was administered to all the household heads in selected villages. The criteria for village selection were based on agricultural practices and accessibility to forest. The sample size for the target population was determined using the following sample size determination formula (Kothari, 1985).

$$n = z^2pqN / E^2 (n-1) + z^2pq$$

Where n=sample size, E=Error (5%), N= Total population number, α = 0.05, q=1-p, p=estimated population element in the variable of interest (0.95), Z=95% - confidence interval (1.96). Therefore

$n = z^2pqN / E^2 (n-1) + z^2pq$

$= (1.96)^2(0.05)\ (0.95) \times 342545/\ (0.05)^2(342545-1) + (1.96)^2(0.05x0.96)$

$= 62506.24/856.54 = 73$

$n = 73$

Data analysis

Descriptive statistical methods were used to summarize and analyze the data. The raw data were from recorded woody plant species and data from focus group discussion, questionnaire survey, field observation and field work were entered an Excel spreadsheet. Then these data were transferred to various forms as table and chart with possible combinations. Descriptive statistics methods such as densities, frequencies, abundance, relative frequencies were applied. Shannon-Wiener diversity index, species richness and evenness were computed to describe the diversity of woody species of the area. These methods are among those of the most widely used approaches in measuring the diversity of species. Shannon-Wiener diversity index was calculated as follows.

$$H' = -\sum_{i=1}^{s} \text{Pi} \ln \text{pi}$$

Where, H'= Shannon Diversity Index, S= the number of species, Pi=the proportion of individuals.

The equitability or evenness of abundance of woody species was measured as follows (Kent and Coker, 1992):

$$E = \frac{H'}{Hmax} = \frac{H'}{\ln S}$$

Where J= Evenness, H' = Shannon-Wiener diversity index and ln S **=** where **s** is the number of species.

Abundance is the number of individual plants per unit area. To measure of plant abundance, it requires the counting of individual plants by species in a given area which can be used to show spatial distribution and ranges over time. Relative abundance is calculated as follow:

$$\text{Relative abundance} = \frac{\text{Number of Individuals of tree species}}{\text{Total number of Individuals}} * 100$$

$$\text{Density (D)} = \frac{\text{Number of Individuals of species A}}{\text{Area sampled}} * 100$$

$$\text{Relative density (RD)} = \frac{\text{Di}}{\text{DN}} * 100$$

Where: Di=Number of individual of species A., DN=Total number of individual in the area.

RESULTS AND DISCUSSION

Woody species composition of the forest

A total of 43 species (26 trees and 17 shrubs) belonging to 28 families and 37 genera were recorded and identified from 100 quadrats examined from the study area (Table 1). Of all the families, Fabaceae, Anacardiaceae and Apocynaceae were the three most dominant families represented by 6, 2 and 2 genera, and 8, 3 and 3 species respectively. These three dominant families together constituted 14 (32.6%) of the total species richness in Hotessa forest. The next dominant families Acanthaceae, Asteraceae, Euphorbiaceae and Moraceae (each represented by 2 species or 18.6% together) and the remaining 21 families were mono specific (Table 1).

The study area is rich in species diversity and home for different plant communities. In this study, top seven families contributed to about 51% of all the 28 plant families recorded in the area. Other scholars studies conducted in woodlands of Ethiopia also reported similar findings. For instance Eba and Lenjisa (2017) identified 18 species; Zerihun et al. (2017) 15 species; Dagne and Tamru (2018) 15 species; Tesfaye et al. (2019) 5 species respectively in their study. In terms of species richness, the dominance of Fabaceae was reported from similar vegetation studies done by different scholars in the country such as Zerihun et al. (2017) and Tesfaye et al. (2019). The dominance of Fabaceae is also in line with the assessment results that show the dominance positions in the Flora of Ethiopia and Eritrea (Zerihun et al. (2017). This might have got the top dominant position probably due to having efficient pollination and successful seed dispersal mechanisms that might have adapted it to a wide range of ecological conditions in the past (Ensermu and Teshome, 2008; as cited by Zerihun et al. 2017). Some plant species like *Bougainvillea glabra, Casuarina equisetifolia, Coffee arabica, Melia azedarach, Euphorbia tirucalli* and *Dracaena steudneri* observed both in the forest and on the fence and farm lands of the marginal or adjacent villages of the forest. This might be easy to domesticate and local people used as ornamental plants (*Bougainvillea glabra, Coffee arabica* and *Dracaena steudneri*) and as a fence for ther farm land (*Euphorbia tirucalli*) and *Melia azedarach* and *Casuarina equisetifolia* as fodder for their cattle and fuel wood.

Species richness of the study area

According to Kent and Coker (1992) the Shannon Weiner index is the most frequently used index for the combination of species richness and relative abundance. With respect to this, the Shannon-Wiener diversity index was computed for the three different altitudinal gradients (Table 2). Lower altitude is found to be more diversified in species richness followed by middle and upper altitude. Pielou (1969) also stated that value of the index of Shannon-Weiner usually lies between 1.5 and 3.5; although in exceptional case, the value can exceed 4.5. Thus, the value of Shannon-Wiener Diversity Index of this study area occurs between 2.325 and 2.787. Here the analysis showed that the entire three altitudinal gradients were rich in species diversity. This might have due to the presence of sparsely distributed woody plant species compositions in all parts of the forest. During data collection the researcher observed that the local people still high contact with forest core zone (at middle and upper altitude) than the margin (buffer zone) of the forest. Equitability (evenness) is used to measures the relative abundance of different species. The higher the value of J, the more even the species is in their distribution. Thus, middle altitude has the highest even distribution whereas upper and lower altitude has the least even distribution respectively. In general, the diversity and evenness of woody species in the forest was 2.575 and 0.98 respectively. This is indicating that the diversity and distributions of woody species in the forest were relatively high.

Important value index

Out of the 43 species recorded in the site *Carissa edulis* accounted, 11.45% of the relative abundance followed by *Buddleja polystachya* (11.01), *B. glabra, Sesbania*

Table 1. List of woody species recorded from Hotessa Forest with their scientific and family name: Habit (Ha): Tree (T), Shrub (Sh): Frequency (Fr): Relative frequency (Rf).

Species name	Family	Ha	Fr	Rf
Acacia abyssinica [Hochst.ex] Benth.	Fabaceae	T	20	2.88
Acacia albida Del.	Fabaceae	T	8	1.15
Acacia mearnsii De Wild.	Fabaceae	T	11	1.59
Acokanthera schimperi (A. DC.) Schweinf.	Apocynaceae	Sh	9	1.29
Adhatoda schimperiana Hochst*. ex.* Nees	Acanthaceae	Sh	12	1.73
Albizia gummifera (J.F. Gmel.) C.A. Sm.	Fabaceae	T	14	2.02
Arundinaria alpina K. Schum.	Poaceae	Sh	21	3.03
Bersama abyssinica Fresen.	Melianthaceae	T	22	3.17
Bougainvillea glabra choisy	Nyctaginaceae	Sh	23	3.32
Buddleja polystachya Fresen.	Loganiaceae	Sh	25	3.61
Calpurnia aurea (Aiton) Benth.	Fabaceae	Sh	17	2.45
Carissa edulis Vahl.	Apocynaceae	Sh	26	3.75
Carissa spinarum L.	Apocynaceae	Sh	19	2.74
Casuarina equisetifolia. L.	Casuarinaceae	T	15	2.16
Celtis integrifolia Lam.	Ulmaceae	T	13	1.88
Coffea arabica L.	Rubiaceae	Sh	14	2.02
Cordia africana Lam.	Boraginaceae	T	16	2.31
Croton macrostachyus Hochst. ex Delile	Euphorbiaceae	T	21	3.03
Dodonaea viscosa (L.) Jacq.	Sapindaceae	Sh	17	2.45
Dracaena steudneri Engl.	Asparagaceae	Sh	8	1.15
Entada abyssinica Steud.ex A. Rich	Fabaceae	Tr	10	1.44
Euclea schimperi (*A.DC*.) Dandy	Ebinaceae	T	20	2.88
Euphorbia tirucalli L.	Euphorbiaceae	T	18	2.59
Ficus sur Forssk.	Moraceae	T	16	2.31
Ficus vasta Forssk.	Moraceae	T	18	2.59
Juniperus procera Hochst. ex Endl.	Cupressaceae	T	15	2.16
Justicia schimperiana (Hochst. ex Nees) T. Anderson	Acanthaceae	Sh	9	1.29
Lannea schimperi (Hochst. ex. A. Rich.) Engl.	Anacardiaceae	T	13	1.88
Maytenus senegalensis (Lam.) Exell	Celastraceae	T	9	1.29
Melia azedarach Forssk.	Meliaceae	T	23	3.32
Millettia ferruginea (Hochs.) Baker	Fabaceae	T	20	2.88
Olea europea subsp*. cuspidate* (Wall.ex G. Don) Cif.	Oleaceae	T	6	0.87
Polyscias fulva (Hiern) Harms	Araliaceae	T	7	1.01
Podocarpus falcatus (Thunb.) R.Br. ex Mirb.	Podocarpaceae	T	15	2.16
Pouteria altissima (A.Chev.) Baehni	Sapotaceae	T	14	2.02
Prunus africana (Hook.f.) Kalkman.	Rosaceae	T	10	1.44
Phytolacca dodecandra L'Herit.	Phytolaccaceae	Sh	19	2.74
Rhus glutinosa Hochst. ex A. Rich.	Anacardiaceae	T	20	2.88
Rhus natalensis (Krauss).	Anacardiaceae	T	22	3.17
Sesbania sesban (L.) Merr.	Fabaceae	Sh	23	3.32
Syzygium guineense (Willd.) DC. *subsp. giuneense*	Myrtaceae	Sh	15	2.16
Vernonia amygdalina Del.	Asteraceae	Sh	21	3.03
Vernonia auriculifera Hiern.	Asteraceae	Sh	19	2.74

sesban and *M. azedarach (*10.13) (Table 3). According to Premavani et al. (2014) important value index values have helped to understand the ecological significance of tree species in community structure. Shamble (2011) also indicated that important value index of woody species were calculated either from relative density or relative

Table 2. Shannon-Weiner Diversity Index (H') and evenness (J) for the three elevation types of Hotessa Forest.

Elevation	No of species	H'	Evenness (J)
Lower	313	2.787	0.97
Middle	236	2.613	0.99
Upper	143	2.325	0.97

Table 3. Species distribution in the three altitudinal gradients.

Lower elevation	Middle elevation	Upper elevation
Prunus africana	*Dodonaea viscosa*	*Acacia albida*
Acacia abyssinica	*Cordia africana*	*Justicia schimperiana*
Bersama abyssinica	*Casuarina equisetifolia*	*Entada abyssinica*
Buddleja polystachya	*Juniperus procera*	*Olea europea*
Albizia gummifera	*Phytolacca dodecandra*	*Maytenus senegalensis*
Coffee arabica	*Croton macrostachyus*	*Euphorbia tirucalli*
Euclea schimperi	*Ficus sur*	*Carissa edulis*
Pittosporum abyssinicum	*Podocarpus falactus*	*Ficus vasta*
Bougainvillea glabra	*Rhus glutinosa*	*Rhus natalensis*
Acokanthera schimperi	*Arundinaria alpine*	*Sesbania sesban*
Acacia mearnsii	*Polyscias fulva*	
Adhatoda schimperiana	*Pouteria altissima*	
Calpurnia aurea	*Vernonia amygdalina*	
Dracaena steudneri	*Vernonia auriculifera*	
Celtis integrifolia		
Lannea schimperi		
Melia azedarach		
Millettia ferruginea		
Dracaena steudneri		

dominance or relative frequency. With respect to this, the important value index of woody species of Hotessa forest was calculated. As a result, ten most dominant tree species of Hotessa forest occupied 32.75% of the total important value index (Table 1). Those dominant species were *Carissa edulis*, Buddleja polystachya, *Bougainvillea glabra*, *M. azedarach*, Sesbania sesban, *Rhus natalensis*, *Bersama abyssinica*, *Arundinaria alpine*, *Croton macrostachyus* and *Vernonia amygdalina*. These trees were said to be tolerant and well adapted to the ecological interaction and the wider distribution shows their higher socio-economic and environmental role of the specific study site. From those species *Bougainvillea glabra* and *Melia azedarach* were found in the lower altitude and common in the forest and adjacent villages; whereas, *Sesbania sesban* is found in the upper altitude and important ecological role. In terms of abundance and distribution the contribution of *Carissa edulis* and *Buddleja polystachya* were the highest of all tree species; while Olea *europea* subsp. *cuspidate* had low relative frequency than the other. This might be due to over exploitation of the species for specific uses like timber, construction and firewood in the study area (Table 3). This indicates the species is under threat and needs immediate conservation measures from the concerned bodies. It has been well recognized through this study that different species has sparse distribution. The total density of woody plants was 551 individuals (stems) per hectare. Which means Density= number of individual tree /total sampling area (0.72 ha) and the relative density was 765/ha.

Socioeconomic characteristics of the interviewed respondents

As seen from Table 4, respondents were mostly males (71.2%) and aged between 41 to 50 (30.1%) with most of them having not attended formal education and some

Table 4. Distribution of respondents according to socio-economic characteristics.

Socioeconomic characteristics	Number of respondents	Percentage
Gender		
Male	52	71.2
Female	21	28.8
Age (years)		
20-30	11	15.1
31-40	19	26
41-50	22	30.1
>50	21	28.8
Education		
Non formal education	31	42.5
Primary education	29	39.7
Secondary education	13	17.8
Post-secondary education	-	
Farm size (Ha)		
Below one	31	42.5
One to two	28	38.3
Two to three	9	12.4
Above three	5	6.8

attended primary school (42.5 and 39.7%) and possessed at least a hectare of farmland (57.5%). The dominance of the aged and youth population in this survey is an indication that agriculture has been abandoned, which is a challenge to food insecurity and the people are mostly limited to subsistence farming, with most of them adopting outdated and environmentally unfriendly agricultural techniques. This invariably contributes to deforestation and soil degradation. Again, the fact that most of them attained primary school (39.7%) is an indication that they may not be in tune with new farming techniques that lay more emphasis on conservation tillage, contour plowing to control erosion, and adoption of intensive farming rather than extensive farming to control deforestation and prevent loss of valuable species of economic and medicinal values.

Respondent opinion on causes of woody species diversity decrement

Understanding drivers of deforestation and degradation is fundamental for the development of policies and pre-request measures (Noriko et al., 2012). The result of analysis of the responses to factors responsible for deforestation in the study area is presented (Table 5) and it revealed that most of the respondents attributed population growth (80.82%) as the major factor responsible as a threat for deforestation in the study area. This is in line with Salafsky et al. (2008), who saw it as level 1 threat followed by Urbanization and infrastructure development and identified as level 2 threat (76.7%), logging as level 2 threat (76.7%), expansion of farming land as level 1 threat (75.34%) and fuel wood and charcoal as level 2 threat (71.23%). The implication therefore is that population growth is regarded as the overwhelming cause of deforestation in the study area.

According to Salafsky et al. (2008) threats are defined as the proximate activities or processes that have caused, are causing, or may in the future cause the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). For purposes of threat assessment, only present and future threats are considered. Similarly, in the study area, as a result of increment in population, people resort to clearing of forest to provide shelter and gate their basic needs. Increment of population in the rural areas has forced people to exploit forest resources in an unsustainable way and to clear the forests for agricultural purposes. This area expansion of agricultural land, logging, urbanization and infrastructure development has impacted negatively on the biodiversity and soil condition in the area. Clearance of forest for the purpose of agriculture has exposed the soil to erosion and

Table 5. The causes (threats) of woody species diversity loss.

	Factors for plant diversity loss	Factors with percentage	1	2	3	4	Total
1	Fuel wood and charcoal	Threats	29	23	11	10	73
		Percentage	39.72	31.51	15.07	13.67	100
2	Expansion of farming land	Threats	30	25	10	8	73
		Percentage	41.09	34.25	13.67	10.96	100
3	Logging	Threats	29	27	11	6	73
		Percentage	39.72	36.98	15.07	8.22	100
4	Urbanization and infrastructure development	Threats	31	25	18	21	73
		Percentage	42.46	34.24	24.66	28.77	100
5	Population growth	Threats	33	26	6	8	73
		Percentage	45.20	35.62	8.22	10.96	100

1= strongly agree (SA), 2= agree (A), 3 = disagree (DA), 4= strongly disagree (SD).

Table 6. Possible solution for conservation.

S/N	Way forwarded as a solution	Solutions with percentage	1	2	3	4	Total
1	Awareness related problem	Solution	27	25	15	6	73
		Percentage	36.98	34.25	20.55	8.22	100
2	Using alternative energy sources	Solution	28	21	14	10	73
		Percentage	38.35	28.77	19.18	13.69	100
3	Reforestation	Solution	33	23	9	8	73
		Percentage	45.2	31.5	12.3	10.96	100
4	Afforestation	Solution	26	29	10	9	73
		Percentage	35.6	39.7	13.7	12.3	100

1= strongly agree (SA), 2= agree (A), 3 = disagree (DA), 4= strongly disagree (SD).

leaching of nutrients. This has led to low farm productivity as complained of by most of the farmers. Low farm productivity in turn results in low farm income or poverty. The rapid construction works going on in the Woreda is an attestation to the rate of modernization and urbanization. This could be seen in the form of road construction, building of houses, hospitals and a host of others, all of which require the destruction of forest ecosystem. There is need to strike a balance between construction works and preservation of forest ecosystem. The human-induced problems/threats were encountered as major influencing factors/threats in the study area.

Similarly Negasi et al. (2018) as well as Dagne and Tamru (2018) in their study reported that human-induced threats were recorded as the major threats to forest degradation in Ethiopia.

Possible solutions suggested on woody species conservation in the study area

Focus group discussion was implemented to triangulate the responses from household interview on possible solutions of threats of deforestation in the study area. From the analysis of informants suggestion as possible solution of deforestation, reforestation was taken as priority to cope up problems of threats (76.7%) and a major way to minimize the loss of plant diversity followed by afforestation (75.3%), awareness creation (71.23%) and using alternative energy (67.12%) in the community nearby to the forest (Table 6).

The control or reversal of deforestation can, therefore, be achieved by addressing the drivers identified to be currently contributing to deforestation in the study area.

The promotion of alternative energy sources (like biogas and solar energy) should be encouraged to reduce dependence on the use of firewood. Reducing deforestation would also require creating and strengthening reversal of deforestation such as awareness rising on consequences of deforestation (public education) and strengthening participatory forest restoration and protected area expansion programs. This is in line with the same recommendation from Asfawa and Fikadu (2018). It is vital therefore, that the Woreda natural resource administrative body or Forest and environment office to enhances the land use planning process in addition to identifying and implementing appropriate decision to mitigate harmful effects of development activities (like illegal agricultural expansion, urbanization and infrastructure development) on forest resources. During data collection session the researcher observed that, the nearby society still rely on the forest for their daily life activities and most people cut down trees for fuel wood and charcoal production. In general, the rural people in the country and Bensa Woreda get their basic needs from the nature gifted areas without sustainable utilizations and conservation. Wise utilization of natural resources and responsibilities must be considered.

Conclusion

Understanding the resources and process of forest degradation is vital for informing forest management and conservation policy and for an efficient conservation of interventions. This study has quantified the Hotessa forest woody species diversity and dynamics of forest resource degradation and its drivers in southern Ethiopia Sidama Zone Bensa Woreda. A total of 43 woody plants species were identified and recorded. The plant resource in the study area is considerable, the Woreda being relatively rich in plant diversity. Based on Shannon-wiener diversity index analysis, the distributions of species were natural with less human intervention. Socioeconomic characteristics of the respondents showed that mostly males and aged with most of them without any formal education and primary school education and possessed at least a hectare of farmland. Expansion of agricultural land, logging, urbanization and infrastructure development were recorded as a major challenges and negative impact on the biodiversity and soil condition in the area. In the course of this study, it was noticed that farming activities in relation with population growth were greater and a lot of pressure placed on natural resources. Forest might have been losing its diversity through above indicated threats. The long history of exploitation may result to unequal distribution of woody plant species in the forest, and woody plant species before reaching the seedling and sapling stage is under destruction. Hence, proper and integrated approach in implementing policies and strategies related to land resources management should be considered and future study on seedling regeneration status and LULC change is recommended.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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APPENDIX 1

Questionnaire on Drivers of deforestation and perception of the local community
Name of the interviewer --------------------------------- Date ------------------------Signature ---------
Survey area: District: ____________ Kebele: __________ Village: _________
Distance from the forest ________________
Personal information; Name of household head: ________________________
Gender of head M ---------------- F ---------------- Age of respondent ------------
Educational status --
Farm size in ha --
2. What are the major uses of forests in your area?
3. Do you think that deforestation is the major problem in your locality?
4. How is today's coverage of the forest when compared to the conditions before 2019?
A. Declined B. Increased C. No change
5. According to your knowledge, is severe and rapid forest cover change observed? A. yes B. No
6. If the answer to question number '5' is yes, what were/are the major causes of deforestation?
Rank the drivers; Population growth, Agricultural land expansion, Fuel wood, Charcoal production, Urbanization and infrastructure development and logging
7. What is your major source of income? A. Sale of cash crops B. Sale of wood and charcoal C. Other ___________
8. What types of fuel do you use for household needs (List them in order).
9. On the basis of your knowledge, what are the impacts of deforestation/forest cover change in the area? (Put in order).
10. Are there species of "trees" and wild animals, in danger of extinction due to forest cover change from the local region? Please mention if any?
11. What do you think about the possible solution to alleviate the current problem of deforestation and to use forest resources in a sustainable manner?
12. What are the existing efforts to reduce deforestation and forest degradation in the study region?
13. What are the challenges in implementing the efforts to reduce deforestation and forest degradation in the study region/area?