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Current status and Future Prospect of *Olea europaea and Juniperu procera* on *Desa'a Afro Alpine forest*, North Ethiopia

Gebreslassie Teklay [1*], Hagos Gebreslassie[2]
1 Wukro Technical and Vocational Agricultural College, Wukro, Ethiopia
2 Natural resource management department, Adigrat University, Adigrat, Ethiopia
Corresponding Author; gslassie2002@yahoo.com

Abstract
Desa'a forest is a remnant forest on northern Ethiopia, Tigray. Although the forest has supposed to be protected area, it could not be free from illegal cutting and grazing, resulting reduction of forest cover and biodiversity loss. *Olea & Juniperus species were the* dominant tree species in the forest area and also the most exploited tree species. Hence, the study was intended to assess the sustainability of the two tree species *(Olea europaea & Juniperus procera)* in the forest area. Quantitative data (species biomass, rate of tree growth and rate of extraction) generated on non-destructive sample was applied. Allometeric equation and Mean annual Increment (MAI) were applied to estimate biomass and growth rate of woody species in the forest area respectively.
The rate of extraction by households was taken from the main outlets. Once the data generated, comparative analysis was done between the rate of the species growth and rate of extraction per annum. Accordingly, the woody vegetations O. europaea and J. procera were extracted more than their growing capacity. The mean annual increment (MAI) of O. europaea and *J. procera* were 3,307.304 and 678.7521 tone/yr respectively. However, the extraction of these two species was 8,227.475 tons/yr and 1,840.440 tons/yr through its main outlets respectively. From this, it was revealed that about 4,920.171 tons/yr (148.7 %) and 1,161.688 tons/yr (171.2 %) of fuel wood was extracted over the MAI of the two species, respectively. This shows there is unsustainable utilization of the two species in Desa'a forest which invite purposive intervention by concerned bodies.
Keywords: Desa'a, fuel wood, sustainability

1. Introduction

Forests are the principal sources of woody biomasses. Almost 2 billion people from low – income countries are dependent on biomass fuel (Anderson, 1996). However, regardless of the efforts made worldwide, the globe's woody biomass is declining in unimaginative rates and the trend seems irreversible. The consumption of biomass fuels such as fuel wood, charcoal, agricultural residue and animal dung has negative environmental, economic and health impacts (Mekonnen 2000, Anderson 1996). Increased use of firewood and charcoal leads to deforestation resulting ecological imbalance (Lopez 1997). The extent of forest degradation depends on the source of supply and demand, the nature of fuel wood and charcoal markets and household behavior (Arnold *et al*. 2003). Being one of the poorest countries in the world, Ethiopia, specifically Tigray's experience is not an exception (Mekonnen 2002, Badege 2005 and Gessesse 2007). The country including Tigray heavily depends on traditional energy consumption and is characterized by high dependence on biomass fuels. Thus, the extent of dependence on traditional fuels has had serious repercussion for the ecological balance and agricultural activities in general. The excessive deforestation, which led to the depletion of tree stock, caused a household energy crisis in Ethiopia and consequently the cost of fuel wood has continued to increase, thereby challenging the already staggering living condition.

Desa'a forest is a remnant forest of northern Ethiopia, Tigray, which is currently heavily exploited for fuel wood and charcoal processing. Although Desa'a forest is gazeted to be protected area, it is not immune from illegal cutting and grazing, resulting in reduction of forest cover, biodiversity loss and land degradation. Increasing demand for woody biomass by the rural household living near the forest area and the ever increasing of urban areas, the presence of road, the placement of the forest in between two regions and among different wereda's are believed to put more pressure on Desa'a forest and will lead to intensification of forest product collection. This will have, in all likelihood negative implication for the forest biodiversity and steadily losing biodiversity in the study area. The fuel wood from Desa'a forest is not only for domestic purposes, but its collection and sale is a major livelihood activity. Hence, the study intended to assess the species type and parts mostly preferred by the households.

2. Materials and methods

Area description

Desa'a forest is located between 130 20' and 140 10' North latitudes and between 390 32' and 390 55' East longitude (figure 1). It falls within two regions of Ethiopia, namely Tigray and Afar regions. In Tigray region, it covers three Woredas; Saesie Tsaeda Emba, Atsbi Wonberta and Enderta and the remaining part is falling in

Afar region's districts Shikhet, Berahle, and Dallol.

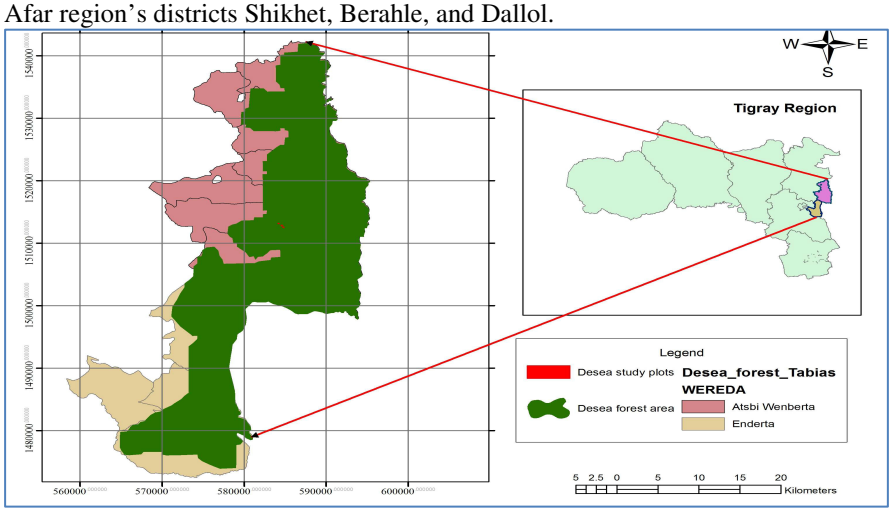

Fig 1 location of study area

The amount of rainfall during these months ranges from 116.3 up to 230 mm. This amount is very low when compared to that of the other parts of the region. Such an amount of rainfall is also marginal for the growth of trees. The mean minimum and the mean maximum temperature for the area vary in the range of 7.5 ^{0}C to 19.3 ^{0}C and 22.6 ^{0}C to 33.4 ^{0}C, respectively (Zenebe 1999). Topographically the area exhibits moderately gentle to steep slopes. The altitude of the area ranges from 1,500 m.a.s.l. at the lower limit to 2,500 m.a.s.l. at the plateau. According to the Aerial photograph interpretation and field observation report of the soil study team (Kebede and Admasu 1997), the entire forest area is composed of sedimentary rocks of Mesozoic age. Fine to medium grained crossed bedded red and white sandstone dominates the northern part, while limestone is the dominant rock type in the southern part of the forest. The soil types of Desa'a forest were classified as Vertic Phaeozem Antalo limestone, Calcaric Combisols Agulae shale, and the soils are clearly Pellic Vertisols (Abraham 2011).

2.2 Methodology used

A non-destructive sampling method was applied to estimate standing biomass of the main woody species (Alves *et al.* 1997; Brown, 1997; Schroeder *et al.* 1997; FAO, 1997 cited in Chavan *et al.* 2010). Total above ground biomass of the forest was estimated using allometric equation. $Y = Exp. \{-2.4090 + 0.9522 \ln (D_2 \times H \times S)\}$ where, Exp. {....} means the "raised to the power of {....}". Y is the above ground biomass (kg), H is the height of the trees (meter), D is the diameter at breast height in cm, and S the wood density (gm/cm3). The standard average value of wood density O.6 gm/ cm3 were taken (Patwardhan *et al* 2003 cited in. Chavan *et. al.* 2010).

Then the total biomass of Desa'a forest was estimated using the following formula. $Y_{tot} = \sum Y_i/P_i$ where: Y_{tot}=total biomass of the study area, Yi = biomass of each tree in each plot, Pi=selection of probability (n x a/A), where: A, a, and n denotes the total area of Desa'a forest, plot area and number of sample plots respectively. Then the total biomass per hectare is calculated by converting the biomass of each plot in per hectare terms. The mean annual increment (MAI) or mean annual growth refers to the average growth per year a tree or stand of trees has exhibited/experienced to a specified age (Husch *et al.* 1982). MAI is calculated as MAI=Y (t)/t .where Y(t) = yield at time t. Mean annual growth or increment (MAI) of the Desa'a forest especially the main species of fuel wood (O. europaea and J. procera) was done, by taking data from existing ongoing research (unpublished data). The mean annual increment of the two standing species was calculated by volume estimating using the parameters like diameter at breast height (DBH), tree height and basal area of the tree species. V=ghf adapted from Michael, (1998). Where, V=volume of the tree in m3/year, g=basal area ($\pi d2/4$), d=diameter at breast height, h=height of the tree and f =form factor of the tree usually used 0.5 as constant.

2.3 Statistical Data Analysis

Quantitative analysis techniques were used for data analysis. The quantitative analysis was done by using SPSS (version 16) soft-ware. Descriptive statistics were applied to analyze the data.

3. Result and discussion

3.1 Biomass Estimation

O. europaea and J. procera are the most preferred woody species for fire wood, mainly *Olea* for cooking, heating, lighting and *Juniperus* for baking end use purpose. The study revealed that, about 20.72 tone/ha and 0.84 tone/ha with 139.78 kg/tree and 8.63 kg/tree biomass was found, respectively in forest.

Table 1. Biomass of the species

S. name	Average Kg/tree	Kg/plot	Kg/ha	Total Biomass in Kg
J. procera	8.634735087	33.57953	839.48813	74714443.88
O. europaea	139.781207	828.7029	20717.572	1843863886
Total	148.4159421	862.2824	21557.06	1918578330

3.2 Tree Growth Status

The MAI of *O. europaea and J. procera* is 3,307.304 tons/yr and 678.7521 tons/yr in the forest, respectively (Table 2).

Table 2. Tree growth

S.name	M^3/tree/yr	M^3/plot/yr	M^3/ha/yr	Total m^3/yr	MAI	
					M^3	Ton
O. europaea	0.019312482	0.043322595	1.083065	96392.785	4630.	3307
J.procera	0.010791301	0.009624674	0.240617	21414.913	950.2	678.7

3.3 Daily Supply of Fuel Wood

Most of the woody species extracted or supplied from the Desa'a forest for fuel wood are *Olea europaea, Juniperus procera, Cadia purpurea (selien), Tarchonanthus camphorates (Ebuk), Dodonaea viscosa (Tahses), Carissa edulis (Egam), Acacia etibyca (seraw), Psydrax schimperiana (Tsehag), Maytenus obscura (atat), Combretum aculeatum (korenet), Acokanthera schimperi (mebtie), Diospyrus mespilferms (tselimoy), Rhus vulgaris (atami).* However, Olea europaea and Juniperus procera, are the most dominantly extracted tree species from forest observed during the assessment. From the three sample outlets, averagely about 539.5 DL equivalents to 34.73 tones and 46 IL equivalents to 1.928 tons of fuel wood were extracted from the forest (Table 4.4). When we calculate a yearly basis 10,503,110.34 kg or 12,503.7 tons of fuel wood is extracted each year, of this amount about 76.29 % (8,457,048.49 kg or 10,069.91 tones) was supplied mainly from the species O. europaea and J. procera (Table 4.6) for fuel wood consumption as well as for selling purpose. This amount extraction hampers the status of the species because the growing habit of the two species is very slow and highly extracted above their potential. The sustainability of these two species was in jeopardy.

Even though a lot of species are extracted from the forest, variation in amount was observed among the species due to the species preference by the rural household as well as the urban households. Woody vegetation species like *O. europaea, J. procera* and *A. etibyca* were the most extracted species from the forest with 62.34 % (22.85 tons/day), 13.95 % (5.11 tons/day) and 10.12 % (3.71 tons/day) coverage, respectively (table 2).

Table 2 Average supply of wood by species in loads and Kg in both seasons

Outlet	*O. europaea*	*J.procera*
K	130.725	36.525
Dr	113.64	48.26
LK	103.1	0
TL	347.465	84.785
D	19197.44	4294.36
Y	6911078.85	1545969.7
%	62.34	13.95

Where: - OL=outlet, K=korha, Dr=Dearu, LK=Lewah-kewhi, TL=total load, D=daily extracted in kg, Y=yearly extracted in kg, Spp=species, *OE= Olea europaea, JP= Juniperus procera, AE= Acacia etibyca, CP= Cadia purpurea, TC= Tarchonanthus camphorates, RV=Rhus vulgaris, L-k=Lewah kewhi*

Conclusion

Olea europaea, Juniperus procera, Cadia purpurea (selien), Tarchonanthus camphorates (Ebuk), Dodonaea viscosa (Tahses), Carissa edulis (Egam), Acacia etibyca (seraw), Psydrax schimperiana (Tsehag), Maytenus obscura (atat), Combretum aculeatum (korenet), Acokanthera schimperi (mebtie), Diospyrus mespilferms (tselimoy) and Rhus vulgaris (atami) were among the woody biomass in Desa'a forest. From those, O. *europaea* and *J. procera were the* most dominant and most exploited woody species. These woody vegetations (O. europaea and J. procera) were extracted more than their growing capacity. The mean annual increment (MAI) of O. europaea and J. procera were 3,307.304 and 678.7521 tone/yr. However, the extraction of these two species were 8,227.475 tone/yr and 1,840.440 tone/yr respectively for fuel wood only from the forest through sample outlets which is about 4,920.171 tone/yr (148.7 %) and 1,161.688 tone/yr (171.2 %) of fuel wood was extracted over the MAI of the two species, respectively. This shows the unsustainable utilization the two species.

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