Available online at http://www.journalijdr.com

International Journal of
DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 5, Issue, 02, pp. 3348-3358, February, 2015

Full Length Research Article

THE ROLE OF AREA CLOSURE ON THE RECOVERY OF WOODY SPECIES COMPOSITION ON DEGRADED LANDS AND ITS SOCIO-ECONOMIC IMPORTANCE IN CENTRAL RIFT VALLEY AREA, ETHIOPIA

[1]Mohammed Kasim, [2]Zebene Assfaw, [3]Abayneh Derero, [4]Mateos Melkato and [5*]Yosef Mamo

[1]Arsi University/College of Agriculture and Environmental Science Department of Natural Resources, P.O. Box, 193 Assela, Ethiopia
[2,4]Hawassa University, Wondo Genet College of Forestry and Natural Resources, P.O. Box 128, Shashemene, Ethiopia
[3]Ethiopian Environment and Forest Research/Forestry Research Centre, P.O. Box 30708 Addis Ababa, Ethiopia
[5]Hawassa University, Department of Biology, P.O. Box 05, Hawassa, Ethiopia

ARTICLE INFO

Article History:

Received 17th November, 2014
Received in revised form
23rd December, 2014
Accepted 31st January, 2015
Published online 27th February, 2015

Key words:

Area closure,
Density,
Diversity,
Population Structure,
Regeneration,
Socio-economic,
Woody species.

ABSTRACT

The study was carried out in degraded lands in Central Rift Valley area of Ethiopia in 2012. The main aims of the study were to assess the woody species composition, structure, regeneration, density and diversity in the area closures and in an open area; and to assess the socioeconomic importance of area closures to the local communities. Three area closures and one open area were considered. For vegetation survey, randomized sampling technique was used to locate the sample plots in each area. A total of 60 circular sample plots of each 314 m^2area were used. In each plot, heights, diameters and numbers of existing woody species were recorded. To assess socio-economic importance of the area closures, group discussion with 10 key informants, and 40 household heads survey were made using semi structured questionnaire. A total of 26 species belonging to 14 families were identified in the study area. The number of species recorded in an open area, and area closures of four-year, seven-year and 25-years were 13, 20, 23 and 15 respectively. The majority of the local people (85%) expressed positive attitude towards the benefits of area closures in rehabilitation woody species in the area. About 65% of the respondents confirmed that they had benefited from the area closures in one way or another. Thus, it can be concluded that, the area closures in the Central Rift Valley brought changes by rehabilitating degraded lands and eventually brought economic, social and ecological benefits to the local communities. In addition to what is covered with this study, further studies on dynamics of soils physical and chemical properties should be made to understand wide-ranging benefits of area closures. For sustainable maintenance of the rehabilitated areas and their contribution to the livelihood of to the local communities, setting tangible benefit sharing schemes from the closures, and diversify alternative sources of income are vital.

INTRODUCTION

The Ethiopian Central Rift Valley (CRV) is part of the Great African Rift. Varied topography, the mountain massifs, the CRV and the surrounding lowlands have given Ethiopia a wide spectrum of habitats and a large number of endemic plants and animal species (Zerihun, 1999). The CRV consist of a chain of lakes, streams and wetlands, and being a closed basin, the CRV is one of the environmentally very vulnerable areas in Ethiopia (Jansen *et al.*, 2007). Ethiopia has one of the largest driest landmass in developing countries in the world, which account for about 70 % of its landmass, of which it consists of 46% of the total arable land of the country (FAO, 2000).The vegetation in the central Rift Valley is characterized by Acacia open woodland, now extensively overgrazed, while deciduous forest occupy the ridges and slopes (Vallet-Coulomb *et al.*, 2001). Human pressure in the Rift valley is very high and the natural flora and fauna is disappearing rapidly (Feoli and Zerihun, 2000). The increased human

***Corresponding author: Yosef Mamo**
Hawassa University, Department of Biology, P.O.Box 05, Hawassa, Ethiopia

activities, such as clearance of forests for cultivation, livestock grazing and charcoaling have converted the area into open vegetation which is floristically poor and uniform (Hengsdijk and Jansen 2006). As a consequence of these changes in land use/cover, vulnerable sloping areas face increased erosion, degradation of vegetation and depletion of nutrients required for vegetative growth (Hengsdijk and Jansen 2006). Management of land and water resources in the CRV is complex due to increased competition for irrigation water, land and biomass. Moreover, climate change may affect the amount of rainfall and its distribution and requires policy development.

In this study 'area closure' is defined as area delineated to exclude human and livestock interferences. The importance of area closure to improve vegetation cover, composition, density, richness, diversity, and providing economic and ecological benefits to local communities around is widely documented (Emiru, 2002; Tefera, *et al.,* 2005; Emiru *et al.,* 2006; Ambachew, 2006). Area closure is also known to improve ground vegetation cover, which in turn enhance better soil conditions, microclimate conditions and water percolation (Emiru *et al.,* 2006). Longer time kept area closures can facilitate large numbers of woody species to grow in to higher height (Ambachew, 2006), and help woody species to have good population structure, inverted J-shape population growth with good regeneration (Kibret, 2008). Moreover, area closures are known that they provide forest products including trees that can improve the livelihoods of the rural poor though increasing incomes, improving food security, reducing vulnerability and enhancing well-being (FAO, 2001; Hengsdijk and Jansen 2006).

As in other parts of Ethiopia, deforestation and over-grazing in the central Rift valley area has resulted in increased erosion and run-off of rainwater, which may have affected the regional hydrology (Hengsdijk and Jansen, 2006), which in turn would decrease production of food production by the local communities, and worsening levels of poverty and malnutrition. However, there is a prospect of reverting vegetation degradation by taking proper vegetation restoration measures and incentives schemes to the local communities (Feoli and Zerihun, 2000), since the gene pool necessary for recovery of natural vegetation is still available in the area (Hengsdijk and Jansen, 2006). Although there is vegetation gene pool potential in the study area, so far limited studies, if any, were made to quantify the extent of vegetation recovery and their benefits to the local communities surrounding the areas.

There two notable examples of area closure in the Rift Valley area were those established by Wondo Genet Collage of Forestry and Natural Resources (WGCFNR) in Gubeta Arjo Peasant Association (PA); and the Abjata Shala National Lakes Park Head Quarters (ASLNP) in Arsi Negelle District. However, there are limited studies carried out on the role area closures in the recovery of woody species, composition, structure and density as well as their ecological and economical contributions to the local communities in the Central Rift Valley areas of Ethiopia. Therefore, the main aim of this research was to assess the role of these two area closures of different ages since established in the recovery of woody species composition, structure and density and their socio-economic importance to the local communities.

MATERIALS AND METHODS

Description of the study area

The study was conducted in the Central Rift Valley area about 210 km south of the capital city of Ethiopia within 7° 48′ 55′′ to 7° 53′ 01′′ Latitude and 38° 65′ 74′′ to 38° 68′ 43′′ Longitude. The altitude of the area ranges between 1648 and 1778m*asl.*Main rainy season occurs between July and October, with annual rainfall varies between 400mm and 700mm (Dagnew, 2006). The mean annual temperature varies between 19.6 ^{0}C and 25.6 ^{0}C (Tolcha, 2005). The soils of the study area were coarse–textured, alkaline (pH=7.6 - 8.2), silty, clay loam and rather infertile (Mekuria *et al.,* 1999). The area is categorized under *Acacia-commiphora* (small-leaved) deciduous woodland vegetation types of Ethiopia (Zerihun, 1999). The three study area closures initially were open sites and degraded due to anthropogenic pressures until these areas were closed away at different time from human and livestock interferences.

Data Collection

Vegetation sampling

To investigate the temporal effects of area closures on vegetation recovery, closures with different ages were considered. Accordingly, four-year and seven-years old area closures that were established by Wondo Genet College of Forestry and Natural Resources (WGCF and NR) and 25-yearsold area closure of the Park Head Quarters area by Abjatta-Shalla Lakes National Park (ASLNP) were considered in this study. As a control, one adjacent open area (common grazing land) to WGCF and NR was used, because of absence of open access grazing nearby 25-year old area closure.

Points denoting positions of sample plots were randomly marked on the topographic map of the area (scale 1:50,000) by means of square grids. The geographical coordinates of the points were fed in to the GPS. The points on the map were latter located on the ground using the GPS navigation system. Circular sample plots, (cited reliable by IFRI, 2007) each having 314 m^2 (10 m radius) area, were laid by locating coordinates at the centre of the circle (De Gier, 1989). In each of the four area closures including the control, 15 circular plots were established, having 60 sample plots altogether (4 x 15 plots = 60 plots) (Fig. 1). Pegs were used to mark the plot centers, and nylon ropes were used to demarcate the plot boundaries.

All individuals encountered vegetation types in the plots were categorized into three height classes: < 0.5 m (seedlings); 0.5-3 m (saplings/shrub) and >3 m (trees) (Demel and Granstörm, 1997). Those woody perennial plants that have one central stem, more than 3m in height and normally have a distinct head were considered as trees. However, woody, perennial plants that have a number of stems usually produced from near the soil surface which are less than 3m in height were considered as shrubs.

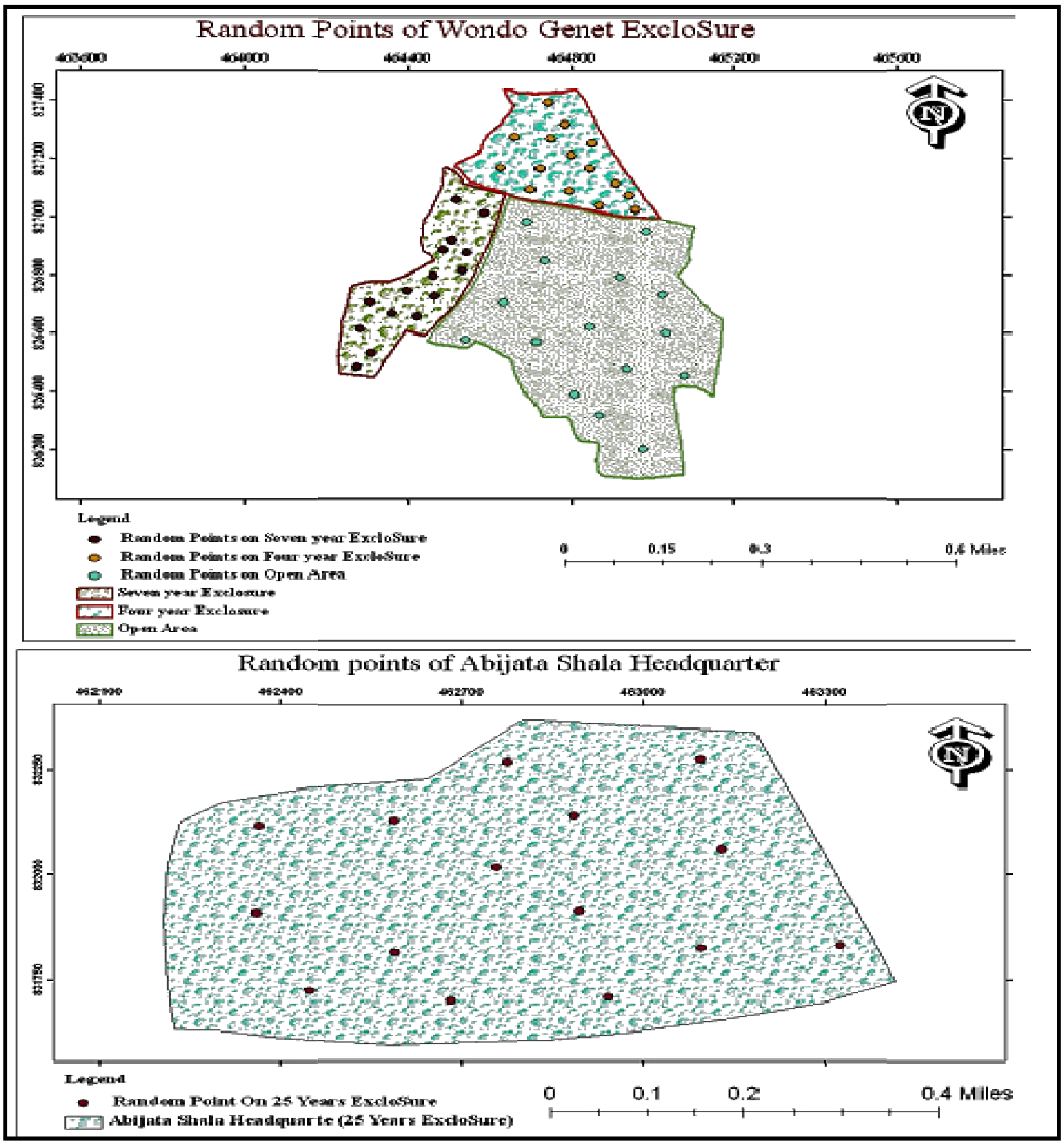


Figure 1. Random layout of points of plots in three area closures and an open area adjacent to two area closures

For trees and shrubs their diameters were measured using a diameter tape orcaliper, while their heights were measured using graduated wooden rod or hypsometer as found appropriate. No measurement was made for seedlings except counting. Shrubs diameters were measured at stamp height nearly 0.5cm above the soil surface. Trees heights were measured at breast height (1.3m above the soil) unless there were irregularities in the trunk in which diameter measurement was taken at the lower point (Tefera, *et al.*, 2005). All woody plant species encountered in the plots were identified on spot using vegetation identification guides or manuals (Cufodontis,1953-1972; Hedberg and Edwards, 1989; Edwards *et al.*, 1995, 1997, 2000; Hedberg *et al.*, 1995; Hedberg *et al.*, 2006).

Socioeconomic survey

Structured questionnaire was used to inquiry randomly selected household heads (HHs) in the study area. Depending on the data obtained from Peasant Association offices (PAs) there were about319 registered HHs surrounding the study sites. A total of 402.5%) HHs, 20 from WGCF and NR (16 from Gubeta Arjo and four from Hadha Boso PAs), and 20 from ASLNP (19 from Gale and Kelo and one from Hadha Boso PAs) were randomly selected. These HHs in the village had been classified as poor, medium and rich based on the size of farm, livestock number and grazing fields, according to the criteria given by the key informants (Table 1). Accordingly 18, 14, and 8 Respondents were randomly selected from poor, medium and wealthy Hs based on good wealth score from each category. The wealth ranking was done according to a field manual prepared by Grandin (1988) later modified by Crowley (1997). Wealth ranking was carried out for the purpose of identifying the household heads on the basis of criteria set for wealth or poverty, as well as their insight into differences in wealth amongst household heads (HHs) in their area. The result of the ranking exercise indicated that livestock size was an important determinant for separating farmers according to wealth status. In addition to random house hold survey, semi structured questionnaires were used to query Key Informants from the area about socio-economic importance of area closures in their surroundings. The selection of key informants was done by adapting techniques used by Den Biggelaar (1996). The key informants were defined in this study as individuals who were knowledgeable about local vegetation history, farming system, changes in social and economic conditions in their villages; and those who have lived continuously at their respective villages for25 years and longer. A total of ten key informants were selected, five from ASHLNP-HQ and the rest five from WGCF and NR surrounding area closures.

Data Analyses

Vegetation data analysis

The abundance, density, dominance and diversity of each species were calculated based on the total number of individual woody species recorded in all circular plots. The species diversity, richness and evenness were estimated using Shannon Diversity Index, Shannon Evenness Index, Simpson Diversity Index, and Sorensen Similarity Coefficient (Taylor, 1978; Krebs, 1985; Maguran, 1988; Kent and Coker, 1992; Krebs, 1999. The importance value index was estimated to evaluate the importance of individual woody species found in common among the different ages of area closures (Kent and Coker, 1992). Moreover, tests of Analysis Of Variance (ANOVA) were made to test variations of different vegetation parameters among different ages of area closures. Plant nomenclature follows: (Cufodontis, 1953-1972; Hedberg and Edwards, 1989; Edwards *et al*., 1995, 1997, 2000; Hedberg *et al*., 1995; and Hedberg *et al*., 2006).

Socioeconomic data analysis

The socio-economic data were analyzed using SPSS-19.0Software. Qualitative data were coded to enable analysis using the software.

RESULTS

Species composition and diversity of woody species. A total of 26 woody species representing 14 families were recorded in all area closures and from an open area as well. Of the total species recorded, 25 were indigenous and only one species, *Leucaenaleucocephala* was exotic, which was identified in the four-year-old area closure (Table 1).The Shannon Index value ranges from 0.26, lowest being recorded in an open area, to 1.96 for seven-year-old area closure. The value of Shannon Index for an open area was significantly different from the three closures ($p < 0.05$), while no significant difference was observed among the three area closures. The value of Evenness Index ranged from 0.00for four-year-old area closure to 0.99 for 25-years-old area closure, whereas Simpson Index value ranged from 0.14 for an open area to 0.97to the 25-year-old closure ($P < 0.05$) (Table 2).

Density and frequency of woody species

The densities (individual numbers/hectare) of woody species in the area closures were higher than the adjacent open area (Table 3). Among all woody species measured *Acacia etbaica, Acacia senegal, Acacia tortilis, Clutiaabyssinica, and Balanitesaegyptiaca* had the highest density of individuals in almost all area closures. *Clutiaabyssinica* was the most densely populated species in almost all area closures and the open area except in the 25-year-old area closure which was dominated by *Acacia tortilis* followed by *Acacia senegal, Balanitesaegyptiaca* and *Acacia seyal.* In terms of frequency, *Clutiaabyssinica, Acaciaetbaica, Acaciatortilis and Acacia Senegal* were the most frequently recorded species in an open area, the four-year-old and seven-year-old area closures whereas *Balanitesaegyptiaca* and *Acaciaseyal* were frequently recorded in the 25-year-old area closure (Table 3). Important value indexes of woody species in different area closure.

Table 1. List of woody species recorded in the study area

Scientific Name	Family name	Vernacular or local name	life form
Acacia etbaica. Schweinf 52864	Leguminosae	Doddota	Tree
Acacia senegalvar Senegal L. Wild	Leguminosae	Qarxafaa	Tree
Acacia seyal	Leguminosae	Waaccuu	Tree
Acacia tortilis (forssk.) Hayne	Leguminosae	Ajoo	Tree
Acokanthera schimperi (A.D C.) Schweinf	Apocynaceae	Qaraaruu	Shrub
Albiziagummifera (J.F. Gmel.) CA. Smith	Leguminosae	mukaarba	Tree
Balanitesaegyptiaca	Balanitaceae	Baddana	Tree
Carissa spinarum (C. edulis)	Apocynaceae	Agamsa	Shrub
ClutiaabyssinicaJaub. &Spach.	Euphorbiaceae	Uleefoonii	Shrub
Cordiaafricana Lam.	Boraginaceae	Waddeessa	Tree
CordiaovalisR.Br.ex.Dc.	Boraginaceae	Mandheera	Tree
Dichrostachyscinera (L.) Wight &Arn.	Mimosaceae	Geetoo	Tree
Dodoneaangustifolia L.F	Sapindaceae	Ittacha	Shrub
Euphorbia abyssinica	Euphorbiaceae	Hadaamii	Tree
Flacourtiaindica (Burm. f.) Merr.	Flacourtiaceae	Hudhaa	Shrub
GrewiabicolorJuss	Tiliaceae	Harooressa	tree/shrub
Grewiaferruginea	Tiliaceae	Dhoqona	Shrub
Lantana camara L.	Verbenaceae	Xoxxoqqee	Shrub
Leucaenaleucocephala(Lam.) De Wit.	Leguminosae	Lucinia	shrub/tree
LonchocarpuslaxiflorusGuill. &Perr.	Papilionaceae	Qalqalcha	Tree
Maytenussenegalensis (Lam) Exell	Celastraceae	Kombolcha	Shrub
Oleaeuropea var. africana	Oleaceae	Ejersa	Tree
PremnaschimperiEndle	Verbenaceae	Qarxaaxummee	Shrub
Pterolobiumstellatum (Forssk.) Brenan	Leguminosae	Gorta	Shrub
Rhus natalensis Benth. ex Krauss.	Anacardiaceae	Xaaxessaa	tree/shrub
Ziziphusmauritiana	Rhamnaceae	Qurquraa	Tree

Table 2. Least square differences (LSD) for species mean indices (Shannon, evenness and Simpson) in area closures and an open area.

Parameters	Shannon index(H)	Evenness index(J)	Simpson index
Open area	0.906 ^{b}±0.08	0.677 ^{b} ±0.06	0.579± 0.05
Four year	1.359 ^{a}±0.07	0.657 ^{b} ± 0.02	0.643 ± 0.02
Seven year	1.445 ^{a}±0.09	0.741^{b}± 0.03	0.687± 0.03
25 year	1.261 ^{a}±0.06	0.852 ^{a} ± 0.03	0.694 ± 0.01
F-value	9.58**	5.47 *	2.34
P-value	<0.0001	0.0023	0.0827

Note: *Significant (F-test) at P< 0.05, **significant at P<0.01. Different letters in the same column indicates significant difference (P< 0.05)

Table 3. Woody species' Density (D/ha) and Frequency (Fr %) in area closures and an open area

Species	Open area		4 years		7 years		25 years	
	Fr%	D/ha	Fr%	D/ha	Fr%	D/ha	Fr%	D/ha
Acacia etbaica.	67	131	100	1060	100	731	13	42
Acacia senegal	33	108	87	252	80	172	80	485
Acacia seyal	7	2	27	34	33	59	53	212
Acacia tortilis	53	172	100	411	100	273	100	543
Acokantheraschimperi	-	-	7	2	-	-	7	8
Albiziagummifera	7	17	47	4	-	-	20	25
Balanitesaegyptiaca	27	102	47	53	73	189	73	271
Carissa edulis	7	2	13	4	13	11	-	-
Clutiaabyssinica	100	829	100	2432	93	1552	13	21
Cordiaafricana	-	-	-	-	7	4	7	4
Cordiaovalis	-	-	7	4	7	2	-	-
Dichrostachyscinera	27	21	40	25	7	2	-	-
Dodoneaangustifolia	-	-	40	23	7	6	-	-
Euphorbia abyssinica	-	-	-	-	13	4	-	-
Flacourtiaindica	-	-	13	4	7	8	13	13
Grewiabicolor	13	6	53	138	73	36	-	-
Grewiaferruginea	20	11	33	49	7	8	13	23
Lantana camara L.	-	-	7	2	-	-	-	-
Leucaenaleucocephala	-	-	27	66	-	-	-	-
Lonchocarpuslaxiflorus	7	2	60	102	53	108	13	21
Maytenussenegalensis	7	21	-	-	7	6	13	21
Oleaeuropea	-	-	13	4	13	4	7	15
Premnaschimperi	-	-	33	25	-	-	-	-
Pterolobiumstellatum	-	-	7	2	-	-	-	-
Rhusnatalensiss	-	-	60	140	47	98	20	66
Ziziphusmauritiana	-	-	27	13	20	13	-	-
Total		1424		4849		3286		1770

Note: (–) =denotes absence of species, Density (D/ha) = is number of individuals per unit area (e.g., trees per ha, or plants per m2) and Frequency (Fr) = expresses the number of occurrence or absence of a species per sample plots.

Table 4. IVI values of common woody species observed in area closures and in an open area

	Importance Value Index (IVI)				
Species	Open area	Four-year closure	Seven-year closure	25-year closure	Mean value
Clutiaabyssinica	128.8	95.5	91.8	4.2	80.1
Acacia etbaica.	46.3	84.0	79.2	5.6	53.8
Acacia tortilis	29.7	25.5	23.7	105.1	46.0
Acacia Senegal	19.5	19.2	25.1	65.1	32.2
Balanitesaegyptiaca	40.1	7.0	20.6	44.9	28.1
Acacia seyal	1.9	4.4	9.2	37.6	13.3
Lonchocarpuslaxiflorus	1.9	8.6	12.7	4.3	6.9
Grewiabicolor	4.0	8.8	10.9	0.0	5.9
Grewiaferruginea	6.8	4.6	1.1	4.4	4.2

Note: species are arranged in decreasing order of their average IVI

The importance value index (IVI) that gives a more realistic figure of dominance from the structural stand points (Curtis and McIntosh, 1951), in 25-year-old area closure, *A. tortilis* was the most important species followed by *A. senegal B. aegyptiaca, A. seyal* and *R. natalensiss.* The Important Value Index of *C. abyssinica* and *A.etbaica* was highly shown at open area, four year, and seven-year area closures whereas *B. aegyptiaca* had the highest Value Index in both open area and 25-year-old area closure. In all of the area closures and the open area, much of the IVIs' values were attributed to few tree species (Table 4).

Similarity in species composition

The total number of tree and shrub species observed at the three area closures and in an open area were not statistically different. About 9 species (35%) out of all 26 woody species recorded were common to all area closures and an open area.

However, about 12 species (46%) were common to the three different aged area closures (Fig. 2).

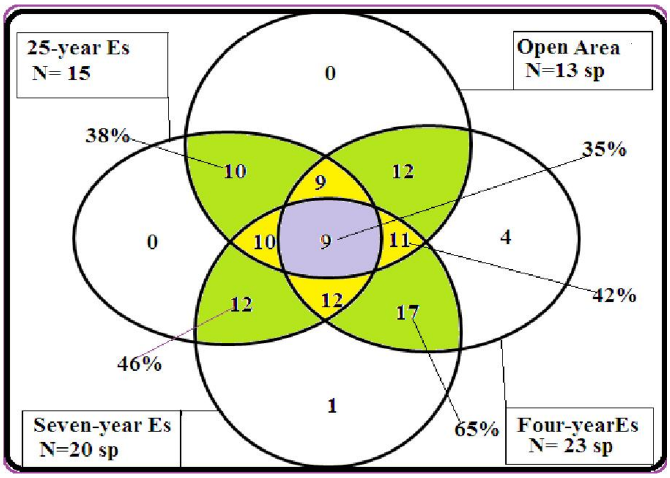


Figure 2. Venn diagram of the species richness pattern across area closures and in an open area

The Sorensen similarity index showed that as the age of area closures increases, species similarity increases (Table 5). The similarity percentage in species composition among the area closures and an open area ranges from 50% to 85%. The dissimilarity of tree species composition among the area closures was less than 50% presumably because of the study sites were found within in the same agro-ecology and catchment areas (Table 5).

Table 5. Sorensen similarity percentage in woody species composition for three area closures and in an open area

	Open Area	four year	Seven-Year	25-year
Open area	-	50	53	53
Four year	50	-	56	68
Seven-year	53	56	-	85
25-year	53	68	85	-

Population structure of woody species

Diameter and height distribution

In the open area there were no individuals with diameter class more than 5-7.5cm diameter.In four-year-old exclosure, the majority of individuals had a diameter in between 2.5-5cm. Few individuals had a diameter classes between 15-17.5cm and >17.5cm. Diameter class distributionsof trees with diameter greater than 5cm was presented for the five major species in the three area closures (Fig. 3). The diameter class distribution of some of the tree species in four and seven-year-old area closures showed an inverted J-shape population diameter structure (continuous recruitment of tree species), suggesting a normal population structure (Fig.3; b, cand e), where as the 25-year-old area closure showed a more or less J-shaped distribution indicating an interrupted regeneration pattern in the population. The frequency distribution of height class for woody species, reveals that woody species with height < 1.5 m constituted18%, 11% and 6% for four-year, seven-year, and 25-year area closures respectively , whereas in the open area theat accounted for 77%.

Regeneration status of selected major tree species

Rregeneration status of selected major woody species population were examined by counting the number of individual seedlings and saplings of that particular species. Accordingly, density ha^{-1} of seedlings and saplings for those selected five woody speciese (*A. etbaica A. tortilis, A. Senegal, B. aegyptiaca* and *A. seyal*) were 750 and 189 individuals for an open area, 736 and 729 individuals for four-year exclosure, 549 and 505 individuals for seven-year, and 541 and 78 individuals for 25-year area closures. Based on the comparison of the regeneration status of five selected tree species among themselves, *A. tortilis, B. aegyptiaca* and *A. etbaica* respectively were the top three species with better density of seedling and sapling at open area. From the three area closures, four-year old area closure represented better regenaration with *A. etbaica, A. tortilis,* and *A. Senegal* respectively were toping the lists.

Socioeconomic study results

Attitude of the local people towards area closures

About 80% respondents had similar understanding about their surrounding environment and had the opinion that the woodland in the area had been under serious degradation before area closure. The majority (85%) of the respondents had positive attitude towards the establishment of area closure, and 65% were felt they benefited from the area closures in one way or another. A little more than half (53%) of the respondents were participated during site selection for establishment of the area closures. The majority of respondents pointed out that the major causes for disappearance of forest and woodlands in their surrounding were illegal cutting of trees for charcoal making, fire and for construction materials (Fig. 4). Majorities of the respondents (87%) have agreed on the necessity and importance of establishing new area closures in their nearby degraded lands. However the remaining few (8%) respondents were against the idea. Out of all respondents, 58% of the respondents wished to protect and maintain the existing area closures, while 37% were had positive opinion in the expansion of area closures for future management of degraded land. Concerning the management and administration of the area closures, majority (63%) of the respondents thought that the government was responsible, while a quarter of the respondents (25%) felt that the local community was responsible, and the remaining 12% felt that both the government and community were responsible for the management of area closures.

45% and 38% of respondents were experienced shortages of fuel wood and grazing land in their localities respectively following the establishment of area closures. Moreover, nearly all of the respondents (93%) felt that wild animal damage to their crops and livestock increased after the establishment of area closures in their vicinity. With respect to availability of grazing lands, 58 % of the respondents were replied that they travelled to far places to overcome shortage of grazing land, while 38% of the respondents used the cut-and-carry system to overcome the shortages. Only very few respondent (1%) used rotational grazing, which they considered it as best strategy to overcome shortage of grazing lands in their locality.

Four year Es Seven year Es 25 year Es

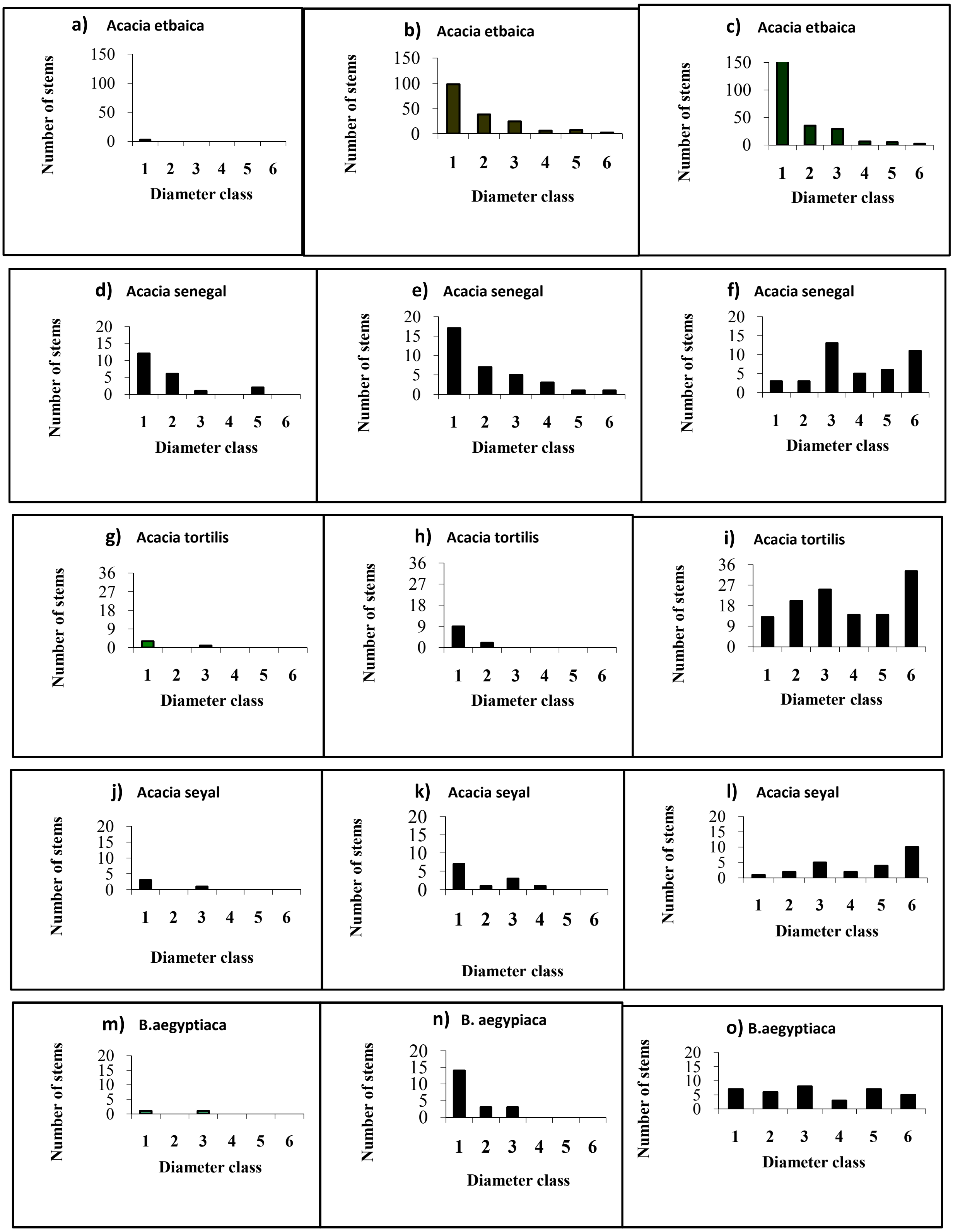


Figure 3. Diameter class distribution of some major tree species for the three area closures. (Diameter class: 1=5-7.5cm, 2= 7.5-10cm, 3= 10-12.5, 4= 12.5- 15 cm and 5= 15-17.5cm, 6= >17.5cm).

About 53% of the respondents conserve trees on their farmyard as fuel wood sources, whereas 23% bought charcoal and petrol gas as needed from the local market. About 18% of the respondents uses alternative energy sources such as cow dung and maize straw to overcome fuel wood shortages.

Attitudes of local communities towards the importance of area closures

Although thearea closure establishment was a newly introduced phenomenon, most (65%) of the respondents felt positive towards the area closures, because they have been seeing major improvements such as regeneration of trees and grasses, conservation of existing woodland and a reduction of soil erosion after establishments of area closures. Moreover 40% of the respondents benefited by harvesting grasses from the closures for their livestock feed and thatching or roofing their huts (Fig. 5).

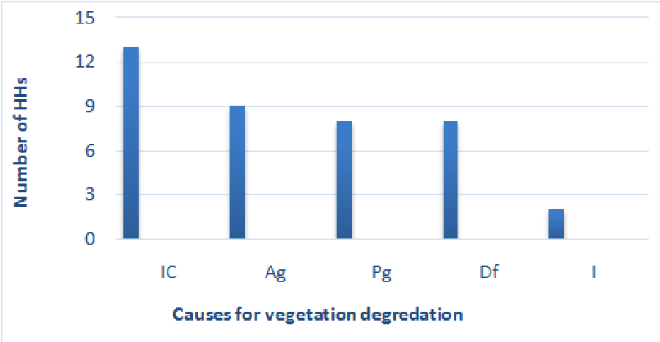
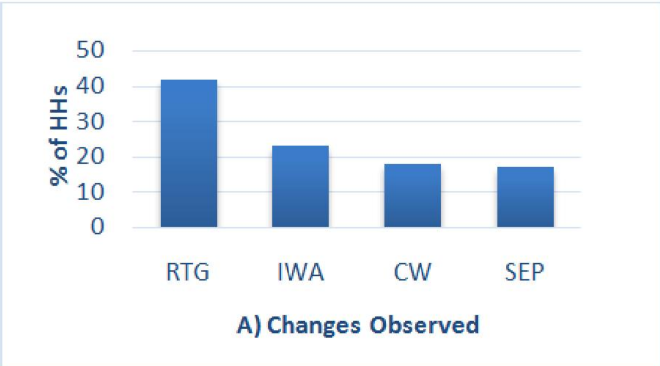


Figure 4. Major causes for degradation cited by respondents

Note: IC=Illegal Cutting; Ag=Agricultural expansion; Pg= Population growth; Df= Drought; and I= illiteracy.



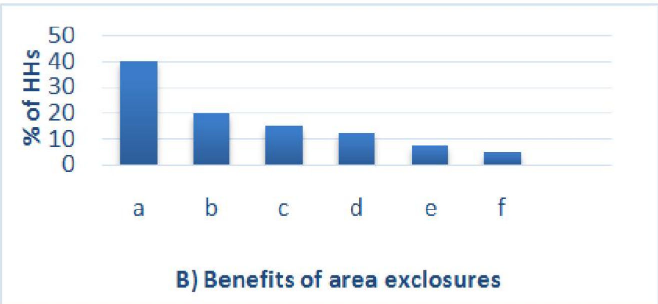


Figure 5. Major observed changes (Fig. 9a) and benefits (Fig. 9b) by the local community after the establishment of area closures

Note: RTG= Regeneration of Trees and Grasses; IWA= Introduction of Wild animals; CW=Conservation of existing woodlands; SEP= Soil Erosion Protection; a= Grasses harvesting; b= source of animal feed; c= source of fuel woods; d= traditional medicines; e= climate regulation; f= Natural beauty.

DISCUSSION

Woody Vegetation Rehabilitation

The comparison of results made between the three area closures and an open area in terms of woody species diversity, frequency and density revealed that area closures had higher values in these parameters than an open area. This finding is in line with other findings from elsewhere in the country (Ambachew, 2006; Kibret, 2008). However, the values recorded did not show linear increment with ages of the area closures. This presumably because woody species composition of recovered are closures might be influenced by several other factors than ages of the closures alone. These factors may include soil seed bank status, dispersal of propagules to the site from nearby sites (Ambachew, 2006) and past site history, and its management (Mulugetaa nd Demel, 2005). The species composition and density of the four-year area closure was higher than any other age classes. This might be as a result of its geographical position, in which it was located at relatively lower elevation with a greater advantage and possibility to accumulate eroded top soil sediments from the higher elevation sites. Such soils could transport seeds along with water erosion and improve soil conditions for regeneration. The 25 year old area closure of the Park Head Quarters area was in the Abjata-Shalla Lakes National Park, and this Park has been enduring devastation and destruction of its vegetation, wild animals and properties by the local people as the tragedy of commons during the change/overthrow of the previous government in 1991 (Tedla, 1995).

Hence, these destructions of vegetation and wild animals, and its relative isolation from other closure areas might be the causes for the observed lower woody species compositions and densities, which otherwise could have higher values due to its long ages of establishment than the other area closures. Emmiru's *et al.* (2006) finding supported this assumption that the 25-year-old area closure showed the least species richness may have to do with its past disturbance history, climatic and edaphic conditions that have an effect on the type of species appearing. In terms of life forms, shrubs had got the highest abundance at four-year and seven year area closures. The high abundance of shrubs and trees in the area closures implies importance of closures for the rehabilitation or restoration of woody species on degraded lands. Similar results have been reported from studies in the Northern (Kindeya, 1997; Kebrom, 1998 and Emiru, 2002), and in central part of Ethiopia (Tefera, 2001 and Ambachew, 2006).

C. abyssinica, *A. tortilis, A. etbaica, A. senegal and B. aegyptiaca* were the most abundant woody species. Such species known to maintain viability and regenerate from seed dispersal by wind and wild animals, and have ability to sprout from damaged stumps or roots (Kebrom, 1998, and Tefera, 2001). The highest proportion of individuals with more than 3m height class were encounteredin 25-year-old area closure (80 %), followed by the seven-year-old area closure (38%) and (29%) for four-year-old area closure. This result was reasonable since younger area closues naturally had small size woody species than older area closures.The higher densities of woody species across different ages of area closures as compared to lower density value in an open area could indicate occurrences of continuous disturbance in an open area, which suppresses the recruitment of seedlings and saplings of woody species. Composition and density of seedlings and saplings would indicate the status of the regeneration of a given population of tree (Mekuria *et al.,* 1999 and Kindeya, 2003). Instead the open area had higher density and dominated by *C. abyssinica,* which might be favored by the disturbance. Higher densities of woody species in area closures as compared to open areas were supported by other researches findings (Kindeya, 1997 and 2003; and Kibret, 2008).Analysis of Shannon diversity indices showed high value for area closures than the open area. The highest diversity value at seven-year old area closure may be explained by the influence of dominant and rare species present in the area. This is in line with finding of Ambachew (2006). Simpson index of diversity showed increasing trend diversity along increasing age categories of the closures. The species evenness also showed significant difference among age categories of area closures. This might indicate that the existence of variations in species diversity within different age categories of area closures was a result of heterogeneous distribution of species due to time factors. The higher evenness was encountered in the 25-year-old closure, which could partly be explained by difference in site condition (Ambachew, 2006). Population structure has been widely used to articulate the regeneration status of woody plants (Tefera, 2001; Emiru, 2002, and Ambachew, 2006). The analysis of population structure revealed more or less inverted J-shaped frequency distribution for four-year and seven-year area closures, suggesting that these closures had good regeneration status. This finding is in agreement with results from Tigray (Emiru, 2002) and Shewa (Tefera, 2001; and Ambachew, 2006).

Attitude of the local people towards area closures

Understanding peoples' attitudes and addressing their needs and priorities towards successful utilization and management of common resources such as forest/woodland resources is critical (Carena, 1985).This is particularly so important in areas where communities are highly dependent on local forest/woodland resources. Establishing area closure is one approach of managing degraded forest/woodland (Kindeya, 1997; Tefera, *et al.,* 2005; Emmiru, *et al*., 2006; and Kibret, 2008). In the present study area, a majority of the respondent had a positive attitudes and perceptions towards the conservation of woodland through area closures in their locality, which could indicate that there was strong local peoples' commitment to combat land degradation. Similar result was reported by Ambachew (2006). Local community members have a good deal of knowledge on the causes for the disappearance of forests and woodlands. Illegal cutting of trees for charcoal making, fire, and market sells, agricultural expansions, and human population increase were suggested as major causes for degradation of woodland areas. The study made by Alemeneh (1990) and Tefera *et al.* (2005) showed that participation of peasant associations leaders and members of the local community were so important for the success of area closure in the rehabilitation of degraded land.

Rehabilitated areas contribute to a good deal of annual income of local community (Muys *et al*., 2006). Most of the respondents (65%) in this study confirmed that they benefited from the nearby area closures. From wealth categories, 55% of poor, 64% of medium and 87% of rich household heads confirmed that they were benefited from area closures in one way or another. Due to their limited number of cattle population, poor households felt that there were less privileged from nearby area closure. Regeneration of trees and grasses, woodland conservation and a reduction of soil erosion were considered as the major positive changes observed after the establishment of area closures. Similar findings were reported by Emmiru, *et al*. (2006) and Ambachew (2006). Based on finding of this study, the benefits of area closure can be categorize into four: (1) use of grasses for house/ bee hive cover, and cattle feed during drought season by using 'cut–and- carry approaches, and sources of traditional medicine. (2) Rejuvenation of some tree species which did not exists outside the closure areas or found at a distance, which have importance as construction materials and uses for social welfare for instance leaves/fruits of *Cordiaafricana* is used during wedding ceremony by Oromo people. (3) Regeneration of different woody species and grasses have reduced soil erosions affecting the areas. (4) Direct economic benefits from tourists visiting Abjatta-Shalla Lakes National Park, where 25 year-old area closure was located, and from many resort lodges and hotels existing along lakes in the Rift valley area. Expanding of these direct and indirect benefits of area closures would encourage local peoples' commitment for supporting future area closure interventions. However, to achieve this, there should be clearly defined scheme for benefit sharing mechanism from area closures to the local communities.

Conclusions

Results of the present study clearly demonstrated that area closure can contribute to rehabilitation of degraded areas in a relatively short period of time, while contributing to improved livelihoods of local community. The comparison made between different age categories of area closures showed that composition, density, diversity, and population structure of woody species were better in the area closures than the open. Woody species composition and diversity were not only influenced by ages of area closures, but also affected by other factors such as altitudes and extent of disturbances in the closures before their establishment. The dominant tree species recorded were *Acacia etbaica, Acacia tortilis, Acacia senegal, Balanitesaegyptiacaand Acacia seyal.* Regeneration status these tree species was in the order of *A. tortilis> A. etbaica>A. Senegal > B. aegyptiaca> A. seyal.* Careful design of management strategy that integrates local needs and ecological rehabilitation are needed for sustainability of area closures. In addition to what is covered with the current study (vegetation and socioeconomic surveys), further studies on dynamics of soils physical and chemical properties should be made to understand wide-ranging benefits of area closures.

REFERENCES

Alemeneh, D. 1990. Environment, famine and politics in Ethiopia: A view from the village. Lynne Rienner. London.

Ambachew, W. 2006. Vegetation and soil property changes following degraded hillsides exclosure and its socioeconomic significance in east Shewa, Ethiopia. Masters thesis, Swedish University of Agricultural Sciences SLU.

Bedru, B., Muys, B. and Mathijs, E. 2006. Economic valuation methods of forest rehabilitation in exclosures. *Journal of the Drylands*, 1(2): 165-170.

Carena, M. (ed.), 1985. Putting people first: Sociological variables in rural development. A world bank reports publication.

Cufodontis, G., 1953–1972. Enumeratioplantarumathiopiae spermatophyta.Vol.2, Jardin Botanique National De Belgigie, Meise, Belgium.

Curtis, J. T. and McIntosh, P. R. 1951. An upland forest continuum in the prairie-forest border region of Wisconsin, Ecological Society of America. *Ecology*, 32: 476-496

Dagnew, Y. 2006. Population status of *Acacia senegal* (linne) willdenow and its gum quality in the central rift valley of Ethiopia. Masters thesis, Hawassa University, Hawassa, Ethiopia

De Gier, A. 1989. Woody Biomass for Fuel, Estimating the Supply in Natural Woodlands and Shrublands. International Institute for Aerospace survey and Earth Science (ITC), nschede, The Netherlands.

Demel, T. and Granstörm, A. 1997. Seed Viability of Afromontane Tree Species in Forest Soils. *Journal of Tropical Ecology*, 13: 81-95.

Den Biggelaar, C. and Gold, M.A. 1996. Development of utility and location indices for classifying agroforestry: the case of Rwanda. Agroforestry Systems 34: 229-246.

Edward, S. and Ensermu, K. (eds.). 1999. "Indicators to determine the level of threat to tree species." In forest genetic resource conservation: Principles, strategies, and actions proceeding of the national forest genetic resources conservation strategy development world.

Edwards, S., Mesfin, T., Sebsebe, D., Hedberg, I. (eds.). 2000. Flora of Ethiopia and Eritrea, Vol. 2 (1). The National Herbarium, Addis Ababa University, Addis Ababa and Department of Systematic Botany, Uppsala University, Uppsala.

Edwards, S., Mesfin, T. and Hedberg, I. (eds.), 1995. Flora of Ethiopia and Eritrea, Vol. 2 (2). The National Herbarium, Addis Ababa University, Addis Ababa and Department of Systematic Botany, Uppsala University, Uppsala.

Edwards. S., Sebsebe, D. and Hedberg, I (eds.). 1997. Flora of Ethiopia and Eritrea, Vol. 6. The National Herbarium, Addis Ababa University, Addis Ababa and Department of Systematic Botany, Uppsala University, Uppsala.

Emiru, B. 2002. Actual and potential contributions of enclosures to enhance biodiversity in dry lands of Eastern Tigray, with particular emphasis on woody plants. SLU (Swedish University of Agricultural Sciences), Sweden.

Emiru, B., Demel, T. and Barklund, P. 2006. Actual and potential contribution of exclosures to enhance biodiversity of woody species in the drylands of Eastern Tigray. *Journal of the Drylands*, 1(2): 134-147.

Ester Raventós Vilalta, E.R. 2010. Water resources management in the Central Rift Valley of Ethiopia.

FAO. 2000. Food and Agriculture Organization. Global Forest Resources Assessment. Main report. FAO Forestry paper 140. Food and Agriculture organization of the United Nations. Rome, 2001.

FAO. 2001. Food and Agriculture Organization. News and highlights: Forestry forum spotlights poverty alleviation. Rome, Italy.

Feoli, E. and Zerihun, W. 2000. Fuzzy set analysis of the Ethiopian rift valley vegetation in relation to anthropogenic influences. *Plant ecology*, 147: 219-225.

Grandin, B. 1988. Wealth ranking in smaller communities: a field manual, Nottingham, England: Intermediate Technology Publications Ltd. London, UK, 49pp.

Hedberg, I. and Edwards, S. (eds.). 1989. Flora of Ethiopia, Vol. 3. The National Herbarium, Addis Ababa University, Addis Ababa and Department of Systematic Botany, Uppsala University, Uppsala.

Hedberg, I., Edwards, S. and Sileshi, N (eds.). 1995. Flora of Ethiopia and Eritrea, Vol. 4 (1). The National Herbarium Addis Ababa University, Addis Ababa and Department of Systematic Botany, Uppsala University, Uppsala.

Hedberg, I., Ensermu, K., Edwards, S., Sebsebe, D. and Persson, E. 2006. Flora of Ethiopia and Eritrea Vol. 5. The National Herbarium, Biology Department, Science Faculty, Addis Ababa University, Ethiopia and The department of Systematic Botany Uppsala University, Sweden

Hengsdijk, H. and Jansen, H. 2006. Agricultural development in the Central Ethiopian Rift valley: A desk-study on water-related issues and knowledge to support a policy dialogue. Plant Research International B.V., Wageningen, Netherland.

IFRI. 2007. Field Manual. Center for study of institution, population and Environmental Change, Indiana University. Bloomington, Indiana 47 408 USA.

Jansen, H., Hengsdijk, H., Legesse, D., Ayenew, T., Hellegers, P. and Spliethoff, P. 2007.

Land and water resources assessment in the Ethiopian Central Rift Valley. Alterra rapport1587. Wageningen University, The Netherlands.

Kebrom, T. 1998. Ecological Rehabilitation of Degraded Hill slopes in South Wello, Ethiopia. Ph.D. Dissertation, Acta Universitatis Upsaliensis, Upsala, 363.

Kent, M. and Coker, P. 1992. Vegetation Description and Analysis: A practical approach. John Wiley and Sons, Chichester. 363 pp.

Kibret, M. 2008. Enclosure as a viable option for rehabilitation of degraded lands and biodiversity conservation: The case of Kallu Woreda, Southern Wello Ethiopia. Masters thesis, Adis Ababa University Faculty of Science, Environmental Science Program, Addis Ababa, Ethiopia.

Kindeya, G. 1997. Area enclosures as an approach in the management of dryland biodiversity: a case study in Tigray region, northern Ethiopia. Proceedings of the Workshop on management of Dryland Biodiversity. 30 July – 1 August, 1997, Nairobi, Kenya.

Kindeya, G. 2003. Ecology and Management of *Boswelliapapyrifera* (Del.) Hochst. Dry Forests in Tigray, Northern Ethiopia. Doctoral Dissertation George-August-University of Gottingen. Germany.

Krebs, C. J. 1985. Ecology: The Experimental Analysis of Distribution and Abundance. Harper and Row Publishers, New York. 800 pp.

Krebs, C. J. 1999. Ecological Methodology (2nd ed). Addison Wesley Longman, inc. Menlo Park, California. 454 pp.

Magurran, A.E.1988. Ecological Diversity and Its Measurement. Chapman and Hall, London.

Mekuria A, Demel, T, Olsson, M., 1999. Soil seed flora, germination and regeneration pattern of woody species in an Acacia woodland of Rift Valley in Ethiopia. *Journal of Arid Environments,* 43:411–435.

Muys, B., Kindeya, G., Aerts, R., Mitiku, H. and Deckers, J. 2006. Perspectives for the rehabilitation of dryland forests in Ethiopia. *Journal of the Drylands*, 1(2): 217-220.

Tedla, S. 1995. Protected areas management crises in Ethiopia. *Walia,* 16:17-30.

Taylor, L. R. 1978. A variety of diversities. In: Mound, L. A. and Warloff, N. (eds.). Diversity of Insect Faunas: Blackwell, Oxford. pp 1- 18.

Tefera, M. 2001. The Role of Area Closures in the Recovery of Woody Vegetation in Degraded Hillsides of Biyo and Tiya, Central and Northern Ethiopia. Masters thesis TISSN 1402-201X, SLU, Sweden.

Tefera, M., Demel, T., Hulten, H. and Yonas, Y. 2005. The role of Communities in Closed Area Management in Ethiopia. *Mountain Research and Development,* 25: 44-50.

Tolcha, R. 2005. An ecological study of vegetation around Lake Abijata. Masters thesis Addis Ababa University Addis Ababa, Ethiopia.

Vallet-Coulomb, C., Legesse, D., Gasse, F., Travi, Y. and Chernet, T. 2001. Lake evaporation estimates in tropical Africa (Lake Ziway, Ethiopia). *Journal of Hydrology*, 245: 1-18.

Zerihun, W. 1999. Forest in the vegetation type of Ethiopia and their status in the geographical context. In: The Proceedings of the National Forest Genetic Resources Conservation Strategy Development .workshop. June 22, 1999. PP. 1-36. Addis Ababa, Ethiopia

****