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Comparison of Vegetation Development of Closed Areas and ancient Forest in Tigray, Ethiopia.

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ABSTRACT

Several interventions have been tried to tackle environmental degradation in Tigray, Northern Ethiopia. One of which is the establishment of closed areas. Establishing closed areas is a method, by which an area is protected from human and livestock interference. This methodology of environmental improvement appears to be successful, but no substantive investigation has been attempted to quantify the improvement. This study tries to analyze the improvement of the vegetation in the degraded sites of a Juniper-Olea afromontane forest. This was achieved by comparing the vegetation of different aged closed areas, of 25 years, 5 years, a grazing land, and an ancient forest that has not been disturbed for at least 500 years. To achieve the intended objective, samples of 0.16 ha were taken from the above four sites. In these samples the number of trees, shrubs, grasses and herbs was counted, and their species was identified. From the information collected the species composition, abundance, dominance and frequency of trees was computed based on Lamprecht (1990). Moreover, species similarity indices were calculated using Weidelt's 1968 method. Finally species area curves were drawn for trees, saplings and shrubs, seedlings, and herbs and grasses following Lamprecht (1990). Based on these, the natural progress of development can be determined. It appears that the ancient forest is now in a degraded state. Both closed areas and the grazing land have very different species compositions as compared to the forest. Moreover, all land use types show very few tree seedlings, indicating a future problem in the development of the closed areas into a forest. The lack of seedlings in the ancient forest is also an indication that the forest has problems in regeneration. It is clear that intensive forestry and silvicultural activities are needed to managing and improving the productivity of the closed areas in such a way, that the conservation of biodiversity, environmental sustainability, and the demands of the local people can be met.

Key words: Vegetation improvement, closed areas, Ethiopia.

1. INTRODUCTION

The environmental degradation in the Northern part of Ethiopia, Tigray is a well-documented fact (TFAP, 1996). To tackle this problem several interventions have been tried, one of which is the creation of closed areas. Closed areas are land units protected from human and livestock interference. Many degraded forests and woodlands have been set aside and enclosed for rehabilitation. In 1996 there was a plan to establish 128,000 ha of closed areas by 2001, and until then about 143,000 ha of closed areas were established (TFAP, 1996). This methodology of environmental improvement appears to be successful (MUC, 1996), but no substantive investigation to quantify the improvements has been attempted. This study tries to quantify the degree of rehabilitation of the vegetation in a degraded site, with a potential natural vegetation of *Juniper-Olea* afromontane forest (Friis, 1992). This is done by comparing the vegetation in closed areas of different age, 25 years, and 5 years with an adjacent ancient forest and a grazing land.

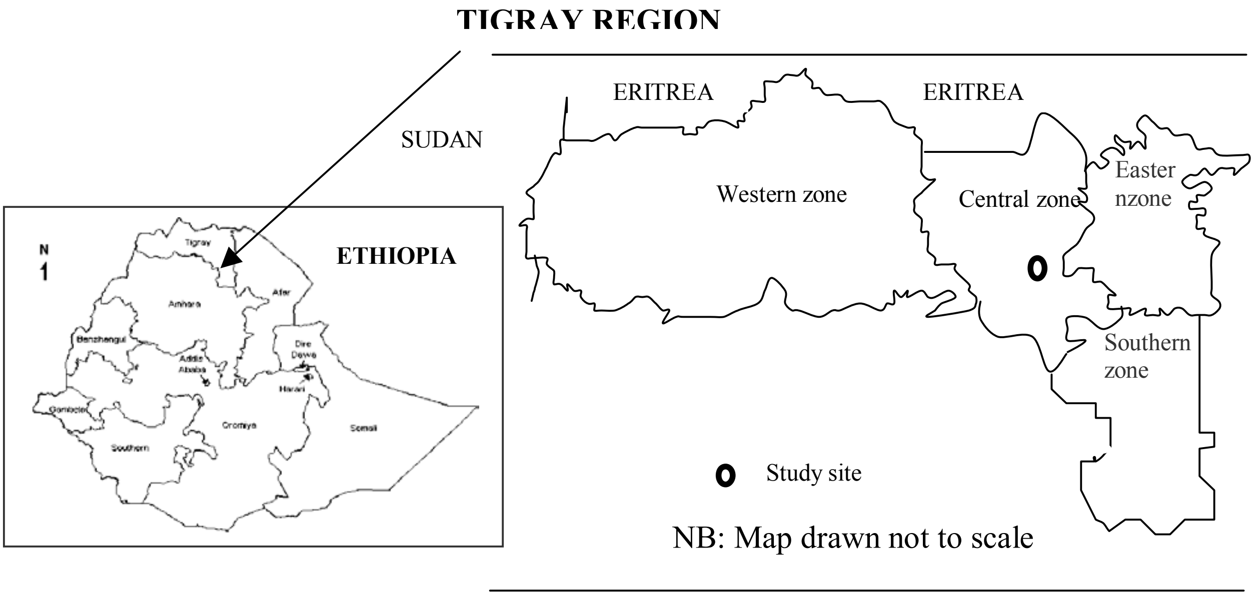


Figure 1, Map showing the study site, and the Tigray region in Ethiopia

2. METHODOLOGY

The study was undertaken in the highlands of *Degu'a Tembien* in Central Tigray, Northern Ethiopia (see figure 1). The bedrock of *Degu'a Tembien* is derived from volcanics of the Tertiary age, and consist of deeply weathered thick basalt flows (HTS, 1976 in MUC 1996). The climate of *Degu'a Tembien* is classified as *Dega* – according to the traditional altitudinal climatic classification. This means that the area lies between 2,200 m.a.s.l. and 2800 m.a.s.l. The average annual rainfall at *Hagere Selam*, which lies in the center of *Degu'a Tembien,* from 1973 to 1982 and 1992 to 1994, was 749 mm. The mean annual temperature during the same period was 15˚C. *Hagere Selam* lies 50 Kilometers southwest from Mekelle, the capital of Tigray region (MUC, 1996).

To achieve the intended objective, a sample of 0.16 ha was studied in each of the above four sites. A cluster sampling method using 8 strips of 10 meter width, and 20 meter length was used. The strips were arraigned pointing out in north, northeast, east, southeast, south, southwest, west, northwest directions out of a central point. Sampling was done in 3 compartments namely A, B and C. Where A is 10 meters by 10 meter; B is 5 meter by 5 meter; and C is 1 meter by 1 meter. Each of these is arranged in a concentric manner, with the smaller compartments falling within the larger ones. In compartment A the frequency, abundance and DBH of trees with a DBH greater than 10 cm were measured. In compartment B the frequency and abundance of shrubs and saplings were measured. In compartment C the frequency and abundance of seedlings, grasses and herbs were measured. For all the plants sampled the species were identified. Based on the collected data the species composition, abundance, dominance, frequency (Lamprecht, 1990), and importance value index (IVI) (Curtis and McIntosh, 1951, in Lamprecht, 1990) of trees were calculated. The IVI is a sum of relative abundance, relative frequency and relative dominance. Subsequently, a species similarity index was calculated using the method of Weidelt (1968) that considers both presence, or absence, and abundance of species. The formula used to calculate the similarity index is as follows:

$$Kd = \frac{2\sum ci}{\sum ai \sum bi} \times 100$$

Where: K_d = similarity coefficient modified by Weidelt
Σa_i = total number of individuals investigated in the first site
Σb_i = total number of individuals investigated in the second site
Σc_i = sum of the number of individuals of the species common to both sites

Finally species area curves were drawn for trees, saplings and shrubs, seedlings, and herbs and grasses following Lamprecht (1990).

3. RESULTS AND DISCUSSION

Table 1 shows the species composition, abundance, dominance and frequency of trees found in the ancient forest is presented. Table 2 shows a species comparison using Weidlt's similarity index to compare the different land use types. Figures 2-5 are species area curves drawn for the trees, saplings and shrubs, seedlings, and herbs and grasses. These curves show the differences in species area distribution for the different land use types. Photographs of the different land use types and one of the surrounding area are presented to give a visual appreciation of the vegetation under the different land use regimes.

Table 1. Abundance, dominance, frequency and important value index for the trees in the Ancient Forest.

Species	Total				Relative			IVI	Frequency Class
	Abundance N/ha	Dominance sq.m/ha	Average basal area	Frequency %	Abundance %	Dominance %	Frequency %		
Acokanthera schimperi	306.25	5.70	0.0186	75	43.36	24.54	26.09	93.99	IV
Rhus natalensis	106.25	4.65	0.0438	68.75	15.04	19.99	23.91	58.95	IV
Rhus glutinosa	56.25	3.58	0.0636	31.25	7.96	15.40	10.87	34.23	II
Euphorbia abyssinica	50	2.46	0.0492	25	7.08	10.57	8.70	26.34	II
Maytenus arbutifolia	87.5	1.22	0.0139	25	12.39	5.24	8.70	26.32	II
Olea europeae subsp. *cuspidata*	31.25	1.99	0.0637	31.25	4.42	8.56	10.87	23.86	II
Ekebergia capensis	25	2.42	0.0968	12.5	3.54	10.42	4.35	18.31	I
Grewia ferruginea	43.75	1.23	0.0281	18.75	6.19	5.28	6.52	17.99	I
Total	706.25	23.24	0.0329	287.5					

The dominant species in the ancient forest are the understory trees which include *Acokanthera schimperi, Rhus natalensis,* and *Rhus glutinosa* (table 1). The ancient forest is found in a degraded status, as the dominant species are understory species with lower basal area per tree. Moreover the few number of species, only 8, indicates the degradation level of the forest. From a total of 4.5 ha area, the land covered with trees is not greater than 2 ha (plate 2), the rest is highly disturbed forest. The disturbance of the forest had occurred as cattle were taken into the forest to drink from a spring. For this reason the water has now been diverted outside the forest, and made accessible to cattle. As can be seen from plate 1, the surrounding has very few trees to provide pollen and seeds for regeneration. The fragmentation, and lack of other isolated trees in the surrounding might as well have contributed to the species depletion of the forest.

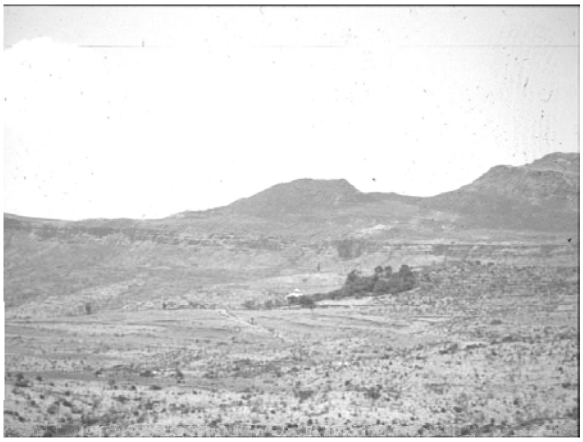


Plate 1. Top view of the study site

Plates 2. The surrounding in the dry season

Plate 3. Ancient Forest

Plate 4. 25 year old closed area

Plate 5. 5 year old closed area

Plate 6. Grazing land

Table 2. Species Similarity Index

Land use types compared	Weidelt (1968) 's index
Ancient Forest vs. old closed area	33.82
Ancient Forest vs. young closed area	16.65
Ancient Forest vs. Grazing land	1.97
Old closed area vs. young closed area	60.65
Old closed area vs. Grazing land	77.63
Young closed area vs. Grazing land	79.08

As can be seen in table 2, the species composition in the forest is very different from all the other land use types. However, the oldest closed area is the closest to the forest in its species composition with 33.82 % of the species in common between the two vegetation types. This indicates that even though the distances among all the sites are not that wide; the major regeneration source (tree seeds or vegetative material) for the other land use types might not be the forest. The old closed area, the young closed area, and the grazing land show very high similarities in species composition among themselves. This might indicate that these land use types are covered by pioneer species or by paraclimax species typical for grazing land.

The species area curves for trees, saplings and shrubs, seedlings, and grasses and herbs for the different land use types are shown in the following figures.

Figure 2. Species area curves for trees with DBH greater than 10 c.m.

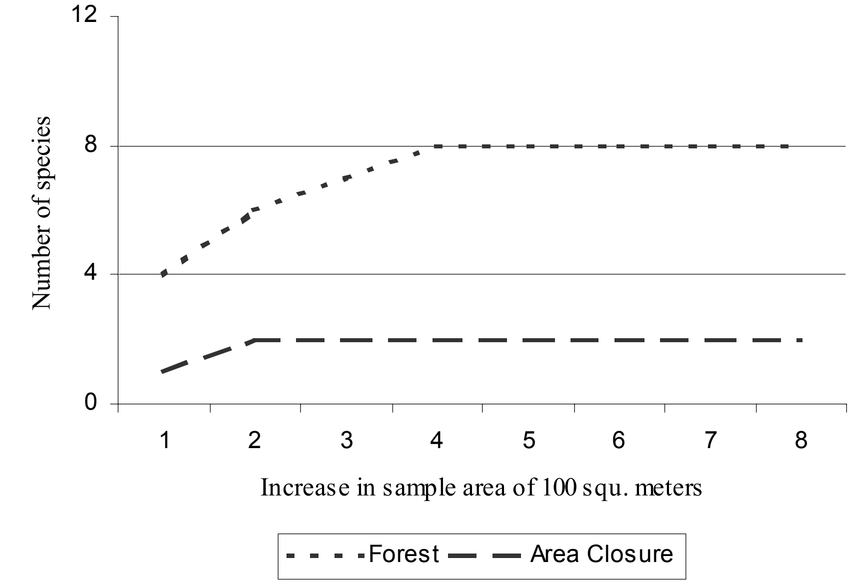


Figure 3. Species area curves for saplings and shrubs

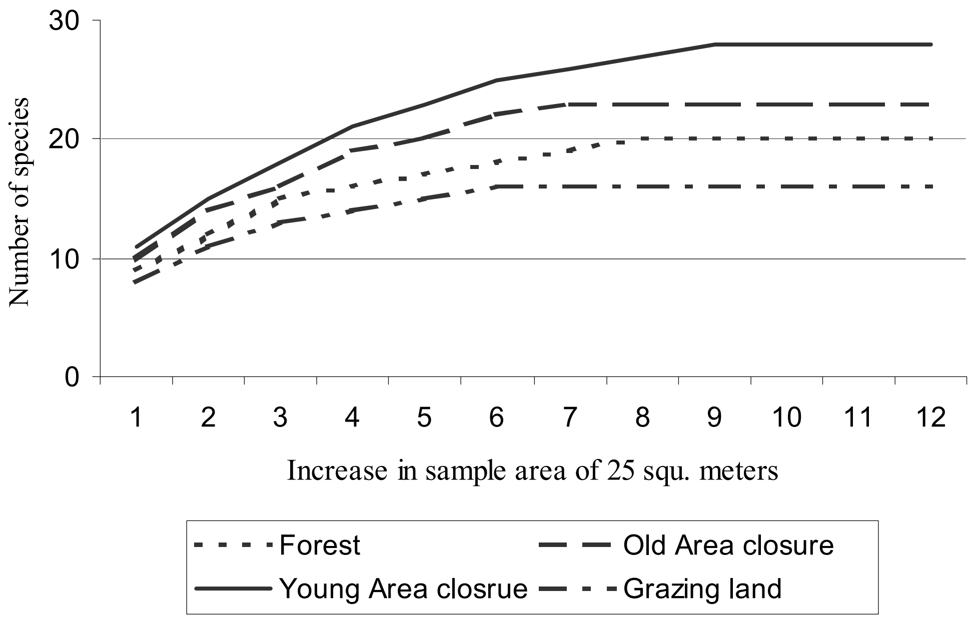


Figure 4. Species area curve for seedlings

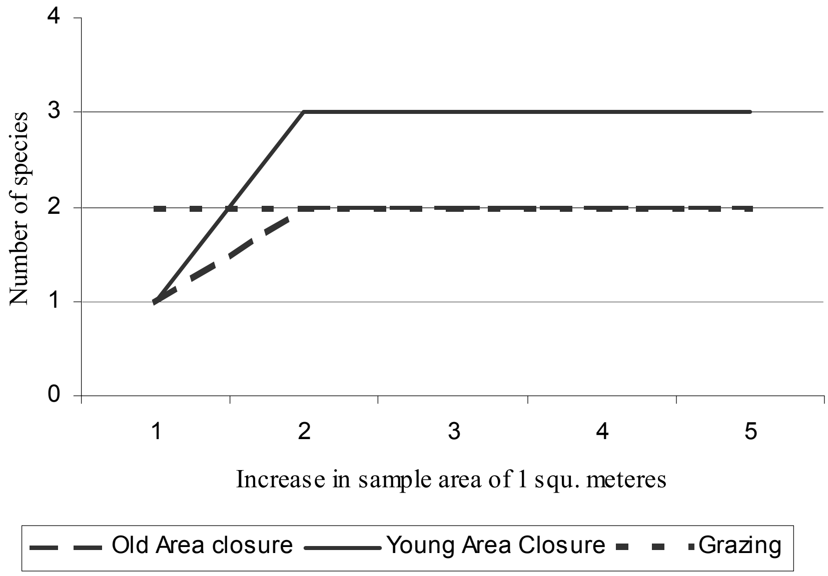
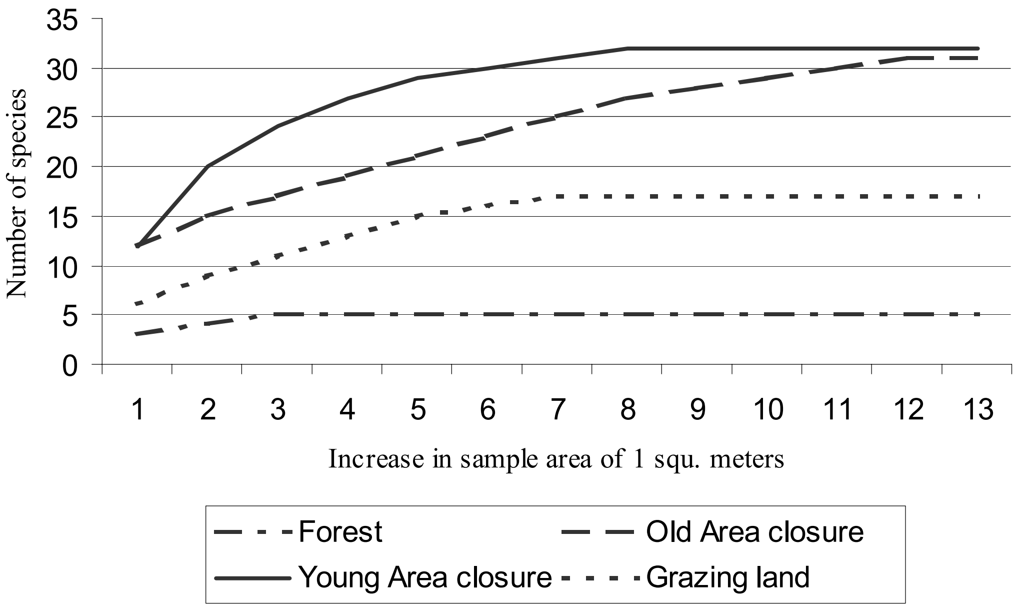


Figure 5. Species area curve for herbs and grasses



According to the species area curves, only the forest and the oldest closed area have trees with a diameter above 10 cm. Nevertheless, the two tree species in the old closed area have only one individual per species. 25 years is a long time to wait just to obtain two trees that could serve as a wood resource for a whole village community. As compared to the trees the sapling, shrub, grass and herb populations are doing better. What is astonishing rather, is the lack of seedlings in the forest, and the very few seedlings found in the other land use forms. Although further studies will be needed to verify this, the present circumstances in the forest and in the closed areas in terms of number of seed sources or success of germination and recruitment seem to be insufficient to produce enough seedlings for future forest regeneration.

4. CONCLUSION

The vegetation in the closed area is a long way from developing into a type of forest comparable to an ancient forest. 25 years is not a long time in terms of forest development and ecological succession, however it is a long time for land to be left for nature to heal itself. The significance of the cost of enclosing these areas can only be determined by looking at the opportunity values of the land. The ecological changes in increased species diversity have added to the value of the land. It is however clear that interventions are needed to improve the number of species, and seedlings of the species. In addition silvicultural management to improve the quality and status of the trees are needed. In this regard, silvicultural interventions should be oriented towards managing and improving the productivity of the closed areas, in such a way that the needs for conservation of biodiversity and environmental sustainability, and the demands of the local people for biomass resources and secondary 'forest' products like honey can be met.

5. ACKNOWLEDGMENTS

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REFERENCES

Friis, I. (1992) Forests and forest trees of northeast tropical Africa: their natural habitats and distribution patterns in Ethiopia, Djibouti and Somalia. Royal Botanic Gardens, Kew. London. 396 pp.

Lamprecht H. (1990) Silviculture in the Tropics. GTZ, Eschborn, Germany. 295 pp.

Million Bekele (2001) Country Report – Ethiopia; Forestry Outlook Studies in Africa. FOSA Working Paper. 39 pp.

MUC (1996) Base-line Survey, To Assess Opportunities and Constraints for Future Reforestation Activities in Tembien, Tigray. Green Promotion Project in Tembien, Tigray. 175 pp.

TFAP (1996) Tigray Forestry Action Plan. Tigray Bureau of Agriculture and Natural Resources Development, Regional Government of Tigray. Mekelle, Ethiopia. 122 pp.

Weidelt, H.-J. (1968) Der Brandhackbau in Brasilien und seine Auswirkungen auf die Waldvegetation. Diss. Forstwissenschaftlicher Fachbereich, Universität Göttingen, Germany. 163 pp.

WRI (2001) World Resource Institute. 2000/2001. Population and human development. P. 75-92. A guide to the global environment. Oxford University Press, New York..