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The Effect of Altitude Gradients in the Species Diversity of Woody Plants of the Natural Grazing Lands of West Shoa, Ethiopia

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Abstract
The study was conducted at Meta Robi district, west Shoa zone of Oromia Regional State in October 2015 with the objectives to assess the effects of altitudinal gradients woody species diversity along with different altitudinal gradients of meta-robi district. The latitudinal gradients were divided in to three as 2700msl as upper altitude, 2350 to 2700 as mid altitude and less than 2000 as lower altitude. The Vegetation assessment was conducted with transect walk with in 4-5kms of in 270 quadrat 90 from each three altitudes having 10mx10m (for trees layer) and 5mx5m (for shrubs layer) .The higher diversity species of woody composition appeared with decreasing altitudes. The shrub wood species composition showed higher species diversity than tree wood species composition. A total of 19 wood species belonging to 11 families were identified in the study area, of which eleven were trees (>cm dbh and > 5m height) whereas, the remaining rest eight were shrubs (<2cm dbh and less than 5m height). According to their acceptance by livestock (42.1%) were palatable, (21.1%) were highly palatable and the rest (36.8) were unpalatable.The nineteen woody species recorded from three altitudinal gradients were found to have importance value index of 24.74 to 77.25% for shrubs of woody composition at upper altitude, 29.97 to 75.25% for mid altitude and 11.3 to 92.13% for lower altitudes. Similarly the tree woody species found to have highest in importance value at upper altitude with the dominant tree species.
Keywords: Altitudinal-gradient Woody composition, Species diversity, Similarity Index, Importance Value, Upper altitude, Mid altitude and lower altitude.

Introduction

The presence and distribution of plant communities in rangeland ecosystems, but random factors of climate, terrain (topography) and earthy in their expanded role is fundamental physical and chemical properties of the soil, with vegetation, the diversity and the wide geographic distribution of plants are (Leonard et al. 1984).

In Ethiopia vegetation species diversity differs along altitudinal gradient in different layers at different scales in distributions pattern (Rathod 2014). This is because, altitude is a factor that determines the distribution of climatic factors and land suitability, this influences the crops to be grown, rate of crop growth, natural vegetation types and their species diversity.

According to Alemayehu (2006), in the lowlands browse and shrubs are dominant plants. The components of species diversity that determine the expression of traits include the number of species present (species richness), their relative abundance (species evenness), presence of the particular species (species composition), the interactions among species (non-additive effects) and the temporal and spatial variation in these properties. The higher the altitude is the lower the atmospheric temperature and higher precipitation, which is more likely to limit plant growth (Chollet et al., 2014).

Species diversity is made up of two components, the first of a number of species, and refers to the species richness. The second component is the variation of the uniformity of the distribution of species is concerned (Cocker and Kent 1996). Physiographic factors, the impact on soil moisture, chemical properties (nitrogen, potassium, etc), and physical (drainage, porosity, etc.), and other characteristics has an important role in the distribution of plant species and their diversity (Enright et al. 2005) .

Destruction of vegetation ecosystems (forest and pasture), and transforming them into monoculture farming systems, loss of biodiversity is, so that many species of fauna and flora, nature, faded areas, or general are endangered (Mesdaghi and Sadegh Nejad, 2000). Therefore, due to the destruction took place, measuring biodiversity and its related parameters, such as species composition, dominance, uniformity and number of species in ecosystems, ecological assessment, is of great importance (Goodman, 1975).

Even though feed assessment and dry matter yield per hectare obtained from the grazing land was identified by Yadessa et al (2016), the desirable species for livestock feeds in the study area were not identified and recorded. Therefore this study was undertaken to identify the woody species composition species diversity along with different altitudinal gradients.

MATERIALS AND METHOD

Description of Study Area

The study was undertaken between June to October 2015 during the 2015/16 growing season on communal grazing area of Meta Robi of western Shoa zone of western highlands of Ethiopia. Meta-Robi district is 110 km far from the capital Addis Ababa, and located at 13°59′ N, 38°28′ E at an altitude of 2473msl above sea level (figure1)

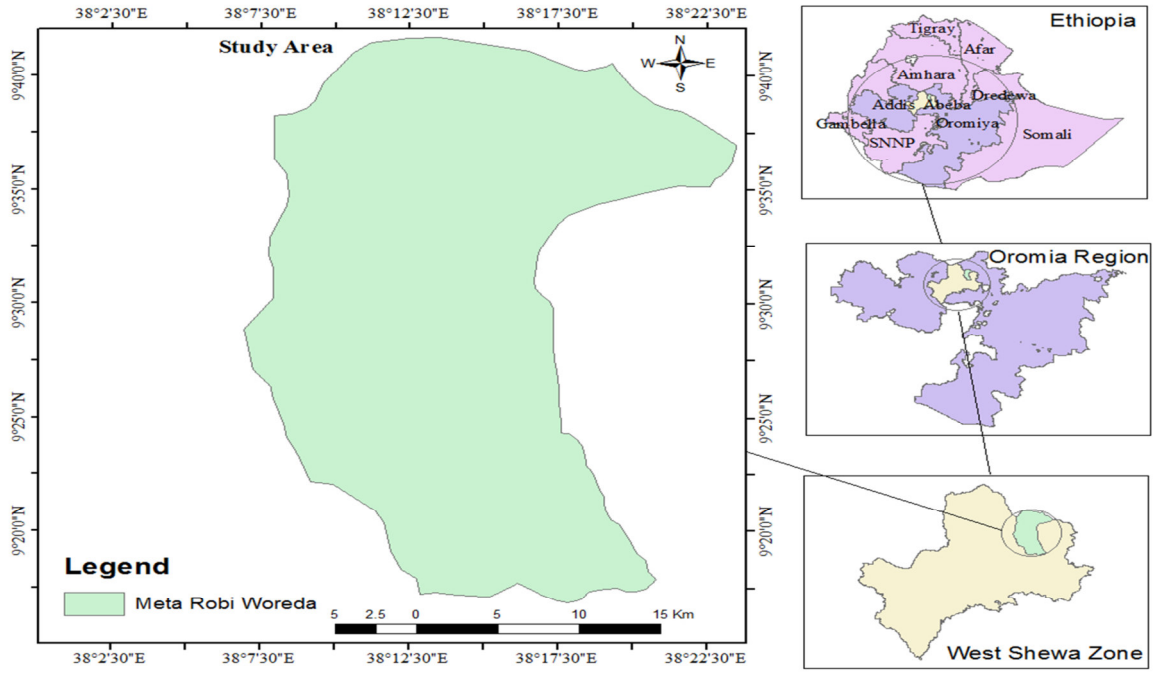

Figure1.location of the study area (EMA 2015)

The mean annual rainfall of the study area in 2015 (figure2) was in mm, ranging between 503.2 mm and 1573mm and was highly variable among years. The main rainy season was July to September. The mean annual minimum and maximum air temperatures of the experimental site were 15 °C and 31 °C, respectively (figure2). The experimental site was characterized by flat land, valley, mountains and rugged area estimated to be 60%, 8%, 9% and 23% respectively. The soil types of the district are classified into humic Nitosols (one of the best and most fertile soil, can suffer acidity and phosphorous fixation, and it becomes very erodible). The 0 to 20 cm soil layer of the experimental site was characterized by a pH of 4.94, a total N content of 0.296%, available phosphorus at (P) content of 1.16ppm/kg, organic carbon of 0.98% and 20.37ppm/kg of cations exchange capacity(Yadessa et al 2016). Visual observations in most parts of the grazing areas of the study site were conducted.

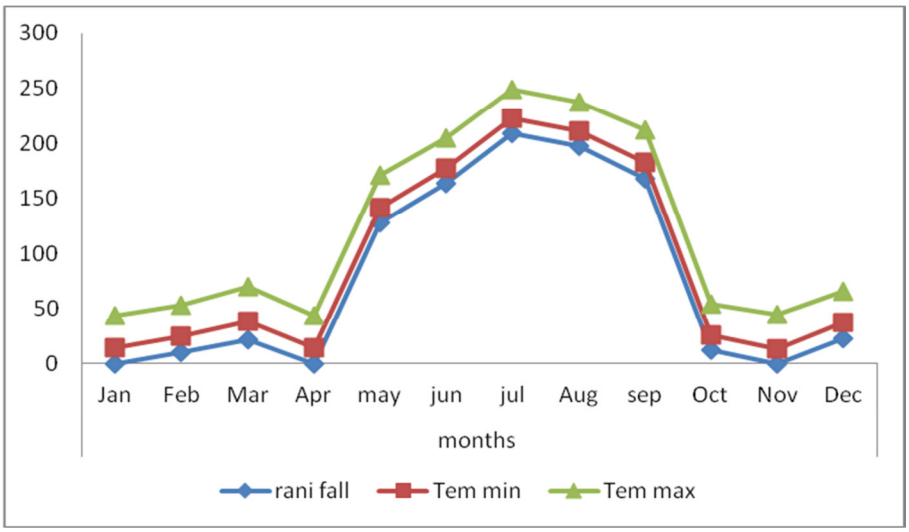

Figure 2.Rain fall and temperature of the study area: Source (EMA 2015)

Site Selection and Field Layout

Site selection of vegetation assessment was conducted with discussions apprehended with the community members, elders in the kebeles and agricultural experts in the office who know about the major grazing areas and their locations. The numbers of sites in the district were decided based up on proportional basis of the available grazing lands in the district. The study district was divided into three based on altitude variations using geographical point system (GPS) 1650-2000msl, lower altitude, 2000-2350msl, as mid altitude and 2350-2700msl as higher altitude (Holechek et al., 1998), as it is widely argued, altitude has an important influence on the distribution, growth, and diversity of rangeland plants (Gemedo. 2004; Getachew et al., 2008). However the classification of altitudes are not on the basis of Ethiopian agro ecological classification (Alemayehu, 2006).

Each altitudinal site was further classified in to the three grazing sites, moving from four to five Kms, considering the vegetation status of the study area discussing with district livestock agency further each altitudes classified in to three locations or sites. A 200 m x 50m at 4kms interval transect area was divided sampled using 1m x 1m, 5mx5m and 10mx10m quadrat for herbaceous species, shrubs and tree species (Karami et al., 2015).

Experimental Design and Treatments

The study was conducted using a three altitudinal gradient variations with 350msl as (1650-2000msl, 2000msl-2350msl and 2350-2700msls (Holechek et al., 1998). The design of this experiment was factorial experiment arranged as randomized complete block design with three replications. Altitudinal gradients variations, transects and quadrat numbers were considered as treatments replications and plots.

The transects was laid out with 200m x50m at 4kms interval. The total number of treatments during the study were three treatments (three altitudinal variations).

Data Analysis

The species diversity and similarity index were calculated by using a mathematical measure of species a species diversity in a community Shannon winner index was used to determine the diversity index (Eshaghi et al., 2009). Species richness, diversity and evenness were summarized using PAST soft ware (Koleff et al., 2003).

Vegetation attributes of grasslands were calculated to sum up and obtain importance value index and can be specified as:

Importance value(IV)= Rci + RDi + RFi

Where, Abundance (Ai) = Total number of individual species i

Cover(Ci)= Total % cover of specie i

Relative cover (RCi)= cover of species i/Total plant cover

Density(Di)=Ai/Area

Relative Density(RDi)= Di/Total plant Density

Frequency(Fi) number of Quadrats with species i/ Total number of quadrats sampled(Baxter, 2014).

Results and Discussions

Table 1 composition of woody species

No	Local Name	Botanical name	Family name	Functional group	Palatability
1	Ceekaa	*C. subdecandra*	Papiliondaeae	Tree	P
2	Gefeto	*D. einerven*	Mimosideae	Tree	P
3	Tatesa	*R. natalensis*	Anacardiaceae	Tree	UP
4	Iticha	*D. viscosa*	Sapindaceae	Tree	P
5	Miessa	*P. africana*	Rosaceceae	Shrub	P
6	Kombolcha	*M. Ovatus*	Celastraceae	Shrub	P
7	Agamsa	*C.edulis*	Apocynaceae	Shrub	P
8	Lafto	*A. siberiana*	Leguminaceae	Tree	P
9	Tadecha	*A. tortolis*	Mimosideae	Tree	HP
10	Ceekata	*G. temensis*	Tiliaceae	Shrub	P
11	Hebicha	*V. amygdalina*	Astraceae	Tree	HP
12	Rejii	*V. auriculifera*	Astraceae	Shrub	UP
13	Dodota	*A. etbaica*	Astraceae	Tree	HP
14	Wadessa	*C. Africana*	Borageanaceae	Tree	HP
15	Iddii	*S. incanum*	Astraceae	Shrub	UP
16	Bakkanisa	*C. megelocapus*	Euphhorbiaceae	Tree	UP
17	Inbuach	*R. usambarensis*	Polygonaceae	Shrub	UP
18	Iddii Saree	S. *nigrum*	Astraceae	Shrub	UP
19	Kosoru	*A. eminens*	Achantaceae	Shrub	Hp

A total of 19 wood species belonging to 11 families were identified in the study area, of which eleven were

trees (>cm dbh and > 5m height) whereas, the remaining rest eight were shrubs (<2cm dbh and less than 5m height). According to their palpability to animals (42.1%) were palatable, (21.1%) were highly palatable and the rest (36.8) were unpalatable (Table 1).

The major wood species recorded in the study area were, *Eucalyptus tree*, *Cordia africana*, *Croton megelocapus*, *Acacia siberiana*, *Acacia tortolis*, *Rhus natalensis* and *Vernonia amygdalina* and the major shrub functional groups recorded in the study area were *Carissa edulis, Calpurina subdecandra, Solanum incanum, Rumex usambarensis, Dodonaea viscosa, Maytenus ovatus ,cactus and Vernonia auriculifera. Vernonia amygdalina* was the dominant species in private grazing lands of the study area. This species dominated the upper and mid altitudes of the study area. Among the shrubs, the dominant species were *Maytenus ovatus, Carissa edulis, Solanum incanum and Calpurina subdecandra.* And *Solanum species* were the dominant species in mid altitude where there is higher grazing pressure which indicate degradation desirable vegetation species.

Species Diversity Index

The table for Shannon winner index disclosed that, altitudinal gradient had affected the woody species. The highest diversity index mean value was recorded at lower altitude (1650-2000msl) for shrubs and trees woody species(Table 2). This might be due to high soil organic matter and nutrient availability at lower altitude where as the upper altitude (2350-2700msl) soil was acidic due to high precipitation. The other factual evidence for lower existence of diversity might be the intensity of human activity impacted the woody species for livelihoods. The other justification fewer diversity at upper altitude the relationship of altitude and soil depth which probably acted upon decrease of species occurrence because of highest soil depth inhibited the species to utilize beneficial soil nutrients as with increased altitude (Zakir, 2014).

Similarity Index of Woody Species

Table 2.woody species diversity indices

Woody species	2350-2700msl	2000-2350msl	1650-2000msl
Shrubs	2.3	2.6	2.81
Trees	1.71	2.1	2.24

The computation from the vegetation analysis results of species across altitudinal gradients disclosed that the distribution of trees woody composition of the study the grasslands area were dissimilar (Table 3). Similarity index values in species composition were ranges from 18% to 85%. The adjacent ecological background of the area helped both upper and mid altitude to have more similarities and similarly mid and lower altitude to be similar in species diversities than upper versus mid altitude. In consequence of the adjucent location of the communities was enabled to have common environmental factors and additionally, these environmental factors such as aspects, slopes soil physical and chemical properties have sound effects to change the patterns of plants communities (Dereje, 2007). The comparison of altitudinal gradients disclosed that upper and lower altitudes had highest dissimilarity indices where as lower dissimilarity indices were observed between lower versus mid and mid versus upper altitudes. The sounding evidence for the similarity indices were the occurrence of most frequent and common species between two locations. Therefore altitudinal gradient played sound full role in determining the similarity indices.

The similarity indices of shrubs woody composition of the grasslands of the study area was within a range of 0.62 to 0.86 (Table 3). The current study showed that in tree woody composition the similarity indices was found to be highest between upper and mid altitudes 86% against upper and lower altitudes to be highest dissimilarity indices 18%. In case the shrubs the highest similarity indices was 86% found between uppers and mid altitudes. While the lowest similarity indices 62% was found between upper and lower altitudes. From the ecological points of view the grasslands of the study area showed highest similarities indices as long as they have adjacent locations and the highest dissimilarity indices as far as they have separated location, similar finding with (Getchew, 2015).

Table 3. Similarity index of woody species

Locations	Tree species		Shrubs species	
	Similarity	Dissimilarity	Similarity	Dissimilarity
Upper and mid	0.85	0.15	0.86	0.14
Upper and lower	0.18	0.82	0.62	0.38
Mid and lower	0.20	0.80	0.77	0.23

Upper= 2350 -2700msl, Mid=2000-2350msl and lower=1650-2000msl

Importance Value Index (IVI)

The importance value index is the combined results of the three parameters of relative frequency, relative density and relative dominance (Kent and Coker, 1992). Therefore the importance value index of this woody composition was calculated by adding all these three parameters. As displayed in (Table 4), the nineteen woody

species recorded from three altitudinal gradients were found to have importance value index of 24.74 to 77.25% for shrubs of woody composition at upper altitude, 29.97 to 75.25% for mid altitude and 11.3 to 92.13% for lower altitudes (Table 4).

Table 4. Importance Value index of Shrubs

Altitudes	Ni	Cover	Q	MC	RC	D	RD	F	FR	IVI
2350-2700msl	16263	1.2%	237	2.06	100	7.23	100	2.63	100	300
2000-2350msl	27463	0.9%	246	2.63	100	12.21	100	2.73	100	300
1350-2000msl	31783	0.7%	333	2.61	100	14.13	100	3.70	100	300

The dominant shrub species found to be recorded highest importance value in the three locations were *P. africana, S. nigrum* and *S. incanum* for upper altitude, *M. ovatus*, *R. usambarensis and P. africana* at mid altitude and *P. africana, C.edulis* and *M. ovatus* at lower altitude respectively (Appendix table 6). Similarly the tree woody composition of the grasslands of the study area found to be 15.44 to 64.12, 22.93 to 78.33 and 49.3 to 67.81 for upper, mid and lower altitudes respectively (Appendix table 5). The tree woody species found to have highest in importance value at upper altitude with the dominant tree species *C. subdecandra, D. einerven* and *C. megelocapus.* While the rest two altitudinal gradients were found to have dominant tree species *D. einerven*, *V. amygdalina* and *C. subdecandra* and *R. natalensis*, *A. siberiana* and *V. amygdalina* respectively (Table 5).

Table 5. **Importance Value index of Trees**

Altitudes	Ni	Cover	Q	MC	RC	D	RD	F	FR	IV
2350-2700msl	7761	3.5%	391	3.03	100	0.86	100	4.34	100	300
2000-2350msl	6618	4.1%	323	3.02	100	0.74	100	3.59	100	300
1350-2000msl	7547	3.2%	242	2.67	100	0.84	100	2.69	100	300

The highest importance value index recorded for the particular woody species show that the species is said to be dominant species in reference to other plant species within the same particular area (Curtis and McIntosh, 1951). Therefore *C. subdecandra ,D. einerven* and *C. megelocapus* were dominant tree species and *P. africana*, *S. nigrum* and *S. incanum* were dominant shrub species for upper altitude of the grasslands of the study area.

According to Simon and Girma (2004), similar report with Lamprecht (1989) and Tamrat (1994) in (Feyera *et al.,* 2007) the dominance and ecologically most importance of these species might be due to their good regeneration due to resisted from pathogens, adaptability to growth in the shade, competition with other trees, least preference by browsing animals, attraction of pollinators and due to seed predators that facilitated seed dispersal within the existing environmental conditions of the study area. In contrast the woody species with the least importance value may be due to adverse environmental conditions and selective disturbance of human for the available resource use and computation in the area.

Conclusion and Recommendation

The major findings of this study were the altitudinal variation had affected both shrub woody composition and tree woody composition. The species diversity for both shrubs and tree woody composition was recorded at lower altitude. The woody species diversity showed lower at upper altitude which indicate that most of the species lost due to economic importance and the community advised to proper management of wood species.

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