Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.23, 2015
www.iiste.org

Assessment of Vegetation Composition and Productivity of Rangeland as Affected by Altitude and Grazing Pressure in Kuraz District of South Omo Zone, South Western Ethiopia

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Abstract
The study was conducted in Kuraz district of south Omo Zone, South nation nationalities and people regional state of Ethiopia (SNNPRS), with the objectives of identifying effect of altitude and grazing pressure on vegetation composition and biomass yield of rangeland. Accordingly, a total of 19, 1, 2, 7 and 21 species of grasses, legumes, sedges, other herbaceous plant and woody species were identified in the district, respectively. A. adscensionsis, C. dactylon and S. consililis were the common/dominant species in the communal grazing lands, whereas A. hirtglama, E. choloacolonum, P. geminatum and S. spicatus were common/dominant species in the riverside. In the enclosure grazing sites, E. ch.roxbarghiana, C. dactylon and P. maximum and S. pyramidalis were the common and/or most frequent species. Furthermore, Acacia. sengal, A. mellifer, A. seyel, C. glondelosa and G. erythraea were the common and/or dominant woody species in the communal grazing area, whereas A. seyel, G. erythraea, A. senegal and A. millefera in the riverside. G. villosa, C. africanus, A. oerfota and Mede (local name) were the common and/or dominant species in the enclosure. Almost all the plant species existed in both altitudes. The mean woody density in communal, riverside and enclosure sites of the study district were 2,175, 1963.7 and 1725.5 plants per hectare, respectively. Thus, the wood species density indicated that communal and riverside grazing sites have shown higher number of woody vegetation than enclosure. Total dry matter biomass (DM), DM of grass, and DM of highly desirable grass species were significantly ($P<0.05$) higher in enclosure (1042, 832 kg/ha and 362 Kg/ha) followed by communal (756.5, 412.5 kg/ha and 47kg/ha) and riverside (621, 355 kg/ha and 50.5 kg/ha). The study indicated that as there was bush encroachment in the study district which resulted in decrease of palatable herbaceous species. Hence, there has to be different interventions on rangeland management practices like bush clearing, paddocking and rotational grazing.
Keywords: Biomass, grazing, herbaceous composition, chemical composition, invaders

Introduction

Semi-arid rangelands are complex ecosystems characterized by erratic rainfall and a high rate of vegetation dynamics. Vegetation dynamics is change in composition and stand structure of plant species over time (Herlocker, 1999; Dahdouh-Guebas et al ., 2002) and it affects biological diversity and rangeland productivity (Herlocker, 1999). This change in composition of vegetation is the result of continuous and complex interactions of plant communities with their environment. Vegetation is an important source of food, medicine, forage, firewood and construction. For a pastoral community, plants are key resources on which livestock production depends. For sustainable livestock production, development workers or rangeland managers need to know the existing plant communities of a given site, changes in plant communities as a result of certain management interventions, the relative value of each plant community for wildlife and livestock production and what factors or combination of factors will change the vegetation (Herlocker, 1999).

In arid and semi-arid rangelands, prolonged intense grazing eventually lead to shift in species composition (Skarpe, 1992) and reduction in grass biomass especially when soil nutrients are depleted (van Auken, 2009). Overgrazing affect the botanical composition and species diversity by depressing the vigor and presence of dominant species, which then enables colonization by less competitive, but grazing tolerant plant species (Sternberg et al., 2000). Selective grazing of palatable herbaceous plants by livestock enhances the growth of annuals and unpalatable herbaceous plants as well as woody plants (Skarpe, 1992) resulting in the decline of palatable species (Fensham et al., 2010). The increase in bushy vegetation in rangelands threatens livestock production in the savannas because encroaching woody species suppress palatable grasses and herbs (Scholes and Archer, 1997) through competition for soil moisture and nutrients. Uneven grazing intensity associated with livestock watering points has effects both on vegetation and the physical environments (Todd, 2006). This induces over utilization of rangeland resources (Pringle and Landsberge, 2004), permanent degradation (Kidane, 2005) and losses in vegetation biodiversity (Brooks *et al.,* 2006) in rangeland areas around watering points.

Quantity and quality of grazable material to pasturelands are affected by biotic and a biotic environmental factors including soil type, climatic regime, botanical composition, and management (Vázquez-

de-Aldana et al 2000; Pérez-Corona et al 1998). At landscape scale, topographic factors such as slope, aspect and altitude, together with soil characteristics such as nutrients, structure and texture which largely depend on underlying geology, influence the biomass production and quality of grazable material of pasturelands (Mutanga et al 2004).

In Kuraz Woreda of the study area 68% of the pastoralists are solely dependent on livestock and livestock products for their livelihood. This indicates that grazing and browsing are the dominant source of livestock feed in the area. Despite of such a huge dependency on rangelands, no studies/development interventions has been conducted in the study area. So, it needs generation of scientific information in order to design and promote appropriate development interventions and management systems. Hence, the purpose of this study was to generate information on: effect of altitude and grazing pressure on vegetation composition and productivity of rangelands, and to come up with appropriate recommendations.

Materials and methods

Description of study area

The study was conducted in Kuraz Woreda, which is found in South Omo Zone of SNNS, and it is bordered by Kenya in the South, Salamago Woreda in the north, Illime triangle in the west and Hammer Woreda in the east. It is (5^0.14'N latitude, 36^0.44'E longitude) 1000 km from Addis Ababa; 725 km from regional capital Awassa and 225 km from Jinka, the Zonal capital and generally the area is located in the south west of Ethiopia. The temperature of the area ranges from 25-40^{o}C and rainfall is 350-600 mm with bimodal rainfall and erratic distribution. The first rain starts from mid of March to the end of June main rain season and the second rain starts from September to end of November short rain season (BoA, 2007). Altitude of the study area is in the range of 350-900 m.a.s.l. spacious range of the area is with plane, and slight increase in altitude without surging scenery. Average livestock data from the Zone (BoA) indicated that the livestock population in the area was estimated to be 184,688 cattle, 81,065 goats, 15, 569 sheep, 250 camels and 540 donkeys (BoA, 2008). Crop cultivation is a recent practice for most pastoralists in the district.

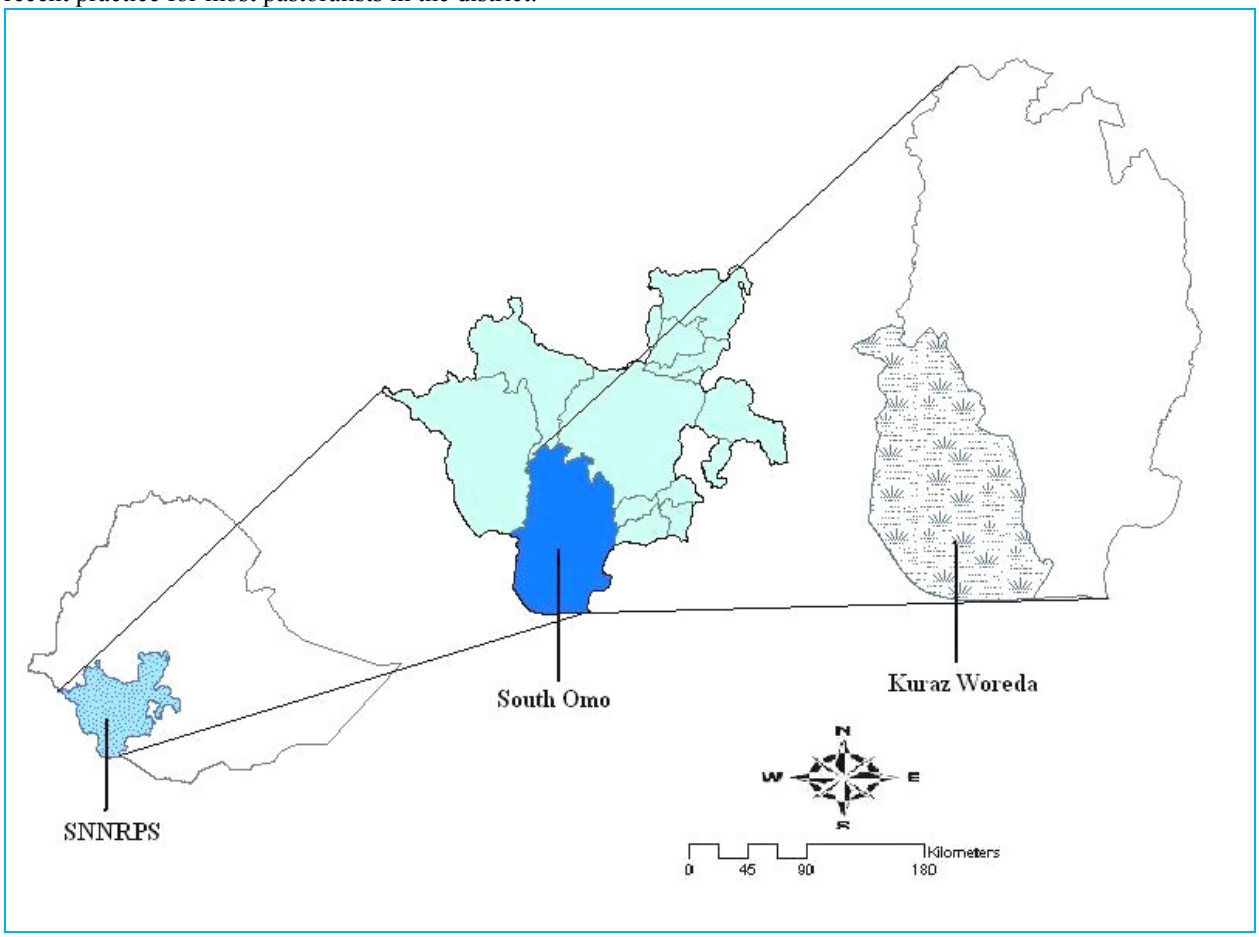

Figure 1. Location of the study district

Data collection

To select the range sites for the study, discussions were apprehended with the community members, elders in the kebeles and agricultural experts in the office about the major grazing areas and their location. Besides this, the researcher attempted to combine the ideas forwarded by the participant through observation of the kebeles with short visit. The numbers of sites in the district were decided on the proportional basis of the available grazing land in the district.

The site was divided into two categories based on altitude (350-600 m.a.s.l. as lower altitude and >600m.a.s.l as higher altitude) with the participation of the district expertise, knowledge of elders, primary and secondary data where references are available, physical observation and field group discussions and GPS was used.

Each altitudinal site was further classified into three grazing sites as communal, riverside and benchmarks. In each of the grazing sites billed, a size of 200 m x 5 km dimension area of six, four and two communal, riverside and benchmark sites respectively were selected for lower altitude and then ten, four and two (communal, riverside and benchmark sites) respectively for upper altitude. Each of the 200 m x 5 km transect area was divided into five 200 mx1 km sub transect. Within each sub transect, five 1 m x 1 m quadrat was taken for herbaceous and one 20 m x 20 m for woody vegetation composition assessment.

Vegetation Composition and Identification

Identification of the species was undertaken at two levels. Plants that can be identified very easily in the field were identified right in the field. For those plants which cannot be identified in the field, vernacular names were given and sample of each species were pressed using plant press, labeled, and sent to the Haremaya University for identification.

Vegetation composition and dry matter (DM) yield were assessed by harvesting quadrates of size (1 m x 1 m) randomly at its 50% flowering stage. Harvesting was done at the ground level. After cutting, the samples were weighed immediately for biomass determination. Then each sample was sorted out into different species by hand. It was put in to airtight plastic bag and then after vegetation samples were sent to Jinka research center within 12 hours interval. Thereafter, each samples in the airtight plastic bag transferred to the paper bags. Finally, plant material inside paper bags were oven dried in Jinka Research Center at 105°c for 24 hours for DM determination. Based on the DM weights obtained, percent composition of each species of grass and other herbaceous plants for each quadrant was calculated and summarized to get the value for each sample site and finally total biomass production capacity of the area.

Biomass Yield

The herbaceous vegetation within 1m x 1m sample quadrat was harvested at ground level using hand shears. Vegetation samples from each site were classified into grasses of highly desirable, desirable, less desirable and forbs, thereafter into different species. The dry weights of each individual species were determined by using an electronic digital balance. Dry matter of each species was determined on dry weight basis dried in an oven at 105^0C for 24 hours. Total herbaceous dry weight, total dry weight of grasses, highly desirable grasses, desirable grasses and less desirable species of grass and forbs of the experimental unit were derived from the dry weight of each species in each sample.

3.8. Statistical Analyses

Biomass production from each range site composite samples of the 5 quadrates of 1 m x 1 m (1 m^2) was considered as an experimental unit. The composite samples were sorted out by altitude and major grazing types. Thereafter, the data was subjected to ANOVA. Accordingly, 60 samples fell in the altitude one and 80 in altitude two (a total of 140 samples) were used for the analysis. The data obtained from the vegetation variables were subjected to ANOVA using the GLM procedure of Statistical Analytical System (SAS) (2000) version 9-computer soft ware. Duncan's Multiple Range Test was used for mean comparison.

Result and discussions

Vegetation Dynamics of the Study District in Different Grazing Types

Communal grazing areas

Even though pastoralists confirmed that there is sweeping change in the vegetation coverage in study district, the current study has been evidence for relatively better contribution of grasses to total dry matter biomass. However, there is increase in quantity of less desirable grasses and other herbaceous species. The communal grazing areas in both altitudes were relatively lower in productivity and highly covered by less palatable grasses and forbs this is in line with studies (Kgosikoma, 2011, Sternberg et al. 2000 and Mphinyane et al. 2008) they reported that the biomass of herbaceous plants is highly responsive to grazing pressures. Woody vegetation has also pursued similar phenomenon, i.e. higher density of vegetation with lower palatability. Similarly, (Moleele and Perkins,

1998) reported overgrazing as one of the factors that facilitate the bush encroachment in communal grazing areas (annex table 1and 2).

Riverside grazing areas

The riverside grazing sites of the study district has equal proportion of unpalatable and palatable woody plant species by percent composition, which is in contrary to findings of (Landsberg *et al.,* 2003, Brooks *et al.,* 2006) it indicates that high grazing pressure, around watering points, disturb floristic composition and diversity of herbaceous layers which brings reduction in palatable species. In the current study balance is because of the lower level of grazing and browsing pressure during dry season. This less grazing around riverside is attached with movement of pastoralists to Island during beginning of dry season, disparate to other pastoral areas of Ethiopia. Studies conducted by Admasu (2006), Lishan (2007), Teshome (2006) and Ketema (2007) indicated that especially during the dry period of the year a huge number of livestock spend more time in riverside grazing areas due to their close proximity to watering points. However, this grazing sites are relatively over browsed due to high preference of the livestock to browse and graze near riversides during wet season, this is supported by the findings of (Ludwig, 2004, Fahnestock and Detling, 1999) frequent grazing near river side (watering points) enhance bush encroachments and reduction in vegetation cover (Annex table 1 and 2).

Enclosure/Benchmark site

Benchmark sites are underutilized and/or uninhabited areas due to fear of conflict between Dessentch and other tribes like Bume, Karo and mursi. This area is locally known as ("ililmeda", kumizilala). In addition to above mentioned situation, there is also not worth mentioning fear for tryponosomisis and some infrequent wildlife's as Lion and Python ("Zendo"). The area is located at the upper tip of lower altitude and lower tip of higher altitude. The percentage composition for highly palatable, palatable and less palatable species was impressive in this site. Hence, the palatable woody species dominate the enclosure areas and this result was aligned with the research findings of Admasu (2006), Teshome (2006), Lishan (2007), Ketama (2007) and Tesfaye (2008). The major reason for existence of palatable species in high percentage is that the area is well protected from being disturbed by livestock and other related human activities. It is under browsed and utilized than the other two grazing types *(*Annex table 1 and 2).

Vegetation Dynamics in Different Altitude Ranges

Herbaceous species composition

A total of 19, 2, 1 and 8 species of grasses, legumes, sedges and other herbaceous plants (forbs) were identified in the study district (Annex Table 1). Of the total herbaceous species recorded on DM basis, 66.9% were grasses of different species. Of the grass species, 28.34, 38.6 and 33.06% were highly desirable, desirable and less desirable, respectively. The increase in grasses composition is mainly due to higher contribution of enclosure/benchmark areas for increased biomass yield of grasses. Otherwise, lower biomass yield was obtained from communal and riverside grazing areas. Increase in less desirable grass species in the vegetation is due to over grazing and they are generally indicators of declining range condition (Vanoudtshoom, 1999; Yuvan and Tesema, 2005). Most of the identified species existed in both altitude zone. However, there was difference in percent composition of each species. This composition variation is effect of different biotic and abiotic factors. *Cynodo. dactylon* and *A.* adscensionsis, *S. spicatus were* some of the dominant and common grass species found in communal grazing areas while *P. geminatum, A. adscensionsis* and *C. dactylon* were among the dominant and common grass species found in riverside grazing areas. The enclosure areas were dominated by *C. ciliaris, C. dactylon,* and *P. maximum.*

Herbaceous species composition in altitude one (350-600m.a.s.l)

The lower altitude has relatively better contribution of grasses species to that of other herbaceous species than higher altitude. In this altitude range, there are 18, 1, 2 and 8 grasses; sedges, legumes and other forbs, respectively were identified. On dry matter basis, 50.07% were grasses of which 12.5, 36.2 and 49.8% were highly desirable, desirable and less desirable species respectively in communal grazing areas.

Contrary to this grazing area, benchmark grazing site has publicized high production capacity of grass biomass and lower amount of less desirable grass dry matter biomass. Even though the amount of benchmark area demarcated is low, when compared to communal and riverside grazing sites, its contribution to total dry matter biomass of grasses; and which indirectly contributed to increased DM biomass of highly desirable and desirable grass species in the current study. Accordingly, 71.19 and 28.81% grass and other herbaceous species DM biomass were registered. Furthermore, of the grasses 37.31, 33.16 and 27.2% highly desirable, desirable and less desirable species in dry matter biomass basis were branded.

Table 1. Common and dominant grass species in different grazing areas of the study district in altitude one (350-600)

Grazing type	Grass species	Category.	% Composition
Communal	*Chloris roxbarghiana*	DS	5.53
	Cynodon dactylon	DS	5.76
	Cynodon plectostchyum	DS	6.35
	Lecrisia hexandra	DS	5.61
	Aristida adscensionsis	LD	21.56
	Aristida hirtglama	LD	12.39
Riverside	*Eriochloa nubica*	HD	5.12
	Aristida hirtglama	LD	5.09
	Aristida adscensionsis	LD	21.4
	Paspulem geminatum	HD	5.23
Enclosure	*Bothriochola insculpta*	HD	6.5
	Cenchrus ciliaris	HD	23.4
	Cynodon dactylon	DS	11.5
	Eriochchloa nubica	DS	7.68
	Paspulem geminatum	HD	5.4

Cate. = Categories; HD = highly desirable, DS = Desirable, LD = Less desirable

Herbaceous species in altitude two (>600m.a.s.l)

A total of 19, 2, 1 and 7 species of grasses, legumes, sedges and other herbaceous plants (forbs), respectively were identified in this altitude range (Table 1). On this altitude, out of the total herbaceous species identified on DM biomass basis, 52.58 and 47.47% grasses and other herbaceous species respectively were documented; of the grasses, 10. 61, 36.87, 55.17 % highly desirable, desirable and less desirable grass species were identified in this altitude range. This increase in less desirable grass species in grazing areas is an indicator of poor range condition and which is well documented by other researchers (Amsalu and Baars, 2002; Admasu 2006; Teshome, 2006; Lishan, 2007). Similarly, to that of lower altitude, the communal grazing area is dominated by less desirable grass species like *A. adscensionsis* and some common desirable species as *C. dactylon.*

Table 2. Some of the common and/or dominant species in different grazing areas of study district in altitude two (>600 masl)

Grazing type	Grass species	Category	% composition
Ccommunal	*Cynodon dactylon*	DS	8.6
	Aristida adscensionsis	LD	21.5
	Sporobulus consililis	DS	12.3
	Cenchrus ciliaris	HD	4.95
River side	*Aristida hirtglama*	LD	22.4
	Echino choloacolonum	HD	5.5
	Paspulem geminatum	DS	6.7
	Sporbulus spicatus	DS	5.5
Enclosure	*Eriochloa nubica*	HD	7.3
	Panicum maximum	HD	5.5
	Chloris roxbarghiana	HD	6.5
	Cynodon dactylon	DS	23.6
	Aristida adscensionsis	LD	13.8

Cate = Categories; HD = highly desirable DS = Desirable, LD = Less desirable

Woody species composition indifferent altitude ranges

In the district, a 21 woody species were identified, of which 28.4% (6), 38.3% (8) and 33.3% (7) were highly palatable, intermediate and unpalatable, respectively (Annex table 2). The level of dominancy of each species varies depending on the grazing pressure of the rangeland. For example, highly palatable species dominated the protected areas, where as those species which are less palatable are dominating the communal grazing areas. Similarly, there is variation in percent composition of each woody plant species depending on the ability of each species to survive in limited resource allocation of the nature; hence, in the study district different species of acacia has dominated in composition, because of their ability to survive in limited nutrient supply and water stress area.

Somewhat less amount of woody vegetation, species were identified in this district when compared to reports from other research findings Lishan (2007) in Dembel and Shinel districts of Somale region, Admasu

(2006) for Hammar and Banna districts of South omo. On the other hand, less woody density per hectare was obtained from this district relative to Ketema (2007) for Nuer zone of Gembella region and Tesfaye (2008) Metama district of Amahara region. This variation might be allied by several factors like soil, temperature, altitude and rainfall of the area to support the life of large diversity of vegetation.

The dominant and/or common woody species in the communal grazing areas of the district were different species of *Acacia,* for example, *A. senegal* A. *millifera* and *A. seyel*. In the same way, *G. villosa*, *A. nubica and A. oerfata* are some of the species dominating benchmark areas; whereas *A. millifera A. seyal and mede* (local name) are some of the dominant species in riverside grazing neighborhood of the study district (Table 1).

Most of the woody species identified in the study district are good browse sources for browsing livestock. Most of the woody plants, which are brought into being in the study district, can be exploited effectively by most of the browsers. The height of most plant was in the range of 1 to 2m (Annex Table 3) this is mainly due to the scenery of topography, soil and rainfall not to prop up large long growing trees or browse species. Increasing the number of goat per house hold will increase effective utilization of the range browse feeds.

Woody vegetation in altitude one

In this altitude range of the study district, a total of 17 woody species, comprising 23.5% (4) highly palatable, 52.9% (9) palatable and 23.5% (4) (unpalatable) were identified and the woody vegetation density and the type of plants dominating the communal and river side grazing area are almost similar (Table 23). Relatively lower number of woody vegetation density has been listed in this altitude; this might be due to presence of camels. Camel is unambiguously effective browser of woody plant species so; this may go in front to decrease in density and/or extinction of certain plant species. A slight disparity has been pragmatic in terms of woody species composition between the benchmark sites and the other two grazing types. This is mainly due to less probability for growth of unwanted woody plants and it is associated with low chance to be overgrazed by livestock and/or disturbed by human activities.

Table 3. Common woody species and their percentage composition in different grazing areas in altitude one

Grazing type	Woody plant spp	Catogory	%age composition
Communal	*Cadaba glondelosa*	LP	10.84
	Acacia seyel	P	13.25
	Yorch.	LP	6.02
	Acacia Senegal	P	9.6
	Macrea macranata	LP	12.4
River side	*Acacia seyel*	LP	10.52
	Mede	P	9.71
	Acacia Senegal	P	10.52
	Solonum dubium	P	7.89
Enclosure	*Comicarpa africanus*	Hp	14.6
	Mede	P	17.93
	Grewia villosa	HP	8.95
	Acacia oerfota	HP	16.5
	Acacia sengal	P	10.4

Hp = highly palatable; P = palatable; LP = less palatable

Yorch and Mede- local name which couldn't be identified in the herbarium.

Woody vegetation in altitude two (>600m.a.s.l)

Due to natural factors like soil type and amount of rainfall, the area has less diversity of woody vegetation and limited chance for growth of larger stemmed trees. Twenty-one species of woody plants were identified in >600m.as.l altitude category. Consisting of 6 (28.6%) highly palatable, 7 (33.3%) intermediate in palatability and 8 (38.04%) unpalatable woody species (Annex Table 24). Disparity have been observed among different grazing types both in quality and quantity of woody vegetation they contain, as a result, the enclosure areas restrain high composition of highly palatable woody vegetation next of kin to riverside and communal grazing areas. The most dominating woody species in this altitude range of enclosure area are *Acacia oerfata*, mede where as the communal grazing areas are dominated by *Acacia senegal and Cadaba glondelosa.*

Table 4. Common and/or dominant woody species and their percentage composition in different grazing types of altitude two

Grazing type	Woody species	Category	%age composition
Communal	*Abutilon figrinum*	P	10.98
	Accacia Senegal	P	12.08
	Cadaba glondelosa	LP	10 51
	Zizyphus martiana	LP	7.69
Riverside	*Acacia senegal*	LP	22.4
	Acacia millefera	P	5.5
	Indigofera shemipher	HP	12.5
	Comicarpas africanus	P	8.5
Enclosure	*Mede l.name*	HP	10.8
	Acacia millefera	HP	22.5
	Acacia oerfota	HP	15.5
	Comicarpas africanus	P	10.5
	Grewia villosa	HP	13.8

Mede- local name, which had not been identified in the herbarium.
Palatability groups; HP = highly palatable; P = palatable; LP= Less palatable

Biomass Production

Biomass production in different grazing types

Communal grazing area

At landscape scale, topographic factors such as slope, aspect and altitude, together with soil characteristics such as nutrients, structure and texture, which largely depend on underlying geology, influence the biomass production and quality of grazable material of pasturelands (Mutanga *et al.,* 2004). The individual plant species, which make up the grassland plant communities, vary in their adaptive mechanisms and tolerance for grazing so the composition of the community will shift over time in response to different grazing intensities (Biondini and Manske 1996). The total DM biomass, DM biomass of grass species and highly desirable grass species were significantly affected at ($P<0.05$) by altitude in the study district. Hence, there was significant difference between the communal grazing sites located in the two-altitudinal ranges in terms of dry matter biomass, total grass and highly desirable grasses. On the other hand, there was no significant difference in dry matter biomass of desirable grasses, less desirable grass species and forbs in communal grazing areas of both altitudes (Table 5).

Table 5. The biomass yields of different herbaceous species in two altitudes of communal grazing area g/m^2

Parameter	Alt 1 Mean±SE	Alt 2 Mean±SE
TG	44.75± 6.59^a	37.7 ± 5.2 ^{b}
HDG	5.39 ±2.24^a	4.01 ± 1.7^b
DG	16.15± 4.24^a	13.87 ± 3.9^a
LDG	20.8± 4.07^a	22.27 ± 5.12^a
Forb	35.0±10.62^a	33.85± 6.18^a
TB	79.86± 8.66^a	71.3 ± 8.02^b

Means with different letters in a row are significantly different ($P<0.05$) (TB) toatal biomass (TG) total grass (HDG) highly desirable grass (DG) desirable grass (LDG) = less desirable grass forb = forbs SE= standard error

From the total biomass produced, the grass contributed the largest portion in both altitude ranges in all grazing types. Less desirable species contributed the largest part in communal grazing areas followed by riversides. Forbs covered highest percentage relative to each grass species composition in communal and riverside grazing areas. There is a decrease in grass species composition from enclosure to communal grazing areas. This was aligned with the reports of Amsalu (2000), Gemedo (2004), Admasu (2006), Lishan (2007) and Teshome (2006) who documented that the contribution of highly desirable grass species dry matter biomass was usually low in communal grazing lands.

Increase in the DM biomass of forbs and dry matter of less desirable grasses might be an evidence for poor range condition. High productivity of lower altitude in biomass base is in contrary to Teshome (2006), this mainly due to over flooding effect of Omo River.

River side grazing areas

There was a significant difference ($p<0.05$) in total herbaceous biomass, total grass biomass and highly desirable grass DM biomass in both altitudes (Table 6). The total biomass, total grass biomass, highly desirable grass

biomass and less desirable grass biomass has shown greater values in lower altitude than higher altitude this might be due to contribution of effect of Omo river overflow in altitude one area. Hence, which as it was mentioned in range condition discussions part facilitates growth of some annual species, as a result, it leads to increased total dry matter biomass production. The other factor might be pastoralists in higher altitude area are living relatively far from Island and they migrate overdue after heavy grazing in the area. Island (Desset) is area where most of the pastoralists in the lower altitude migrate during dry season lately and which in directly attribute to less utilization of range resources (forages). Increased biomasses production in the altitude one (lower altitude) of the study district is contrary to research findings in other pastoral areas of Ethiopia, Admasu (2006), Amha (2006), Ethiopia Lishan (2007), and Tesfaye (2008). They reported that as elevation increase rain fall increase, which then results in increased biomass.

Table 6. The biomass yield of different herbaceous species in two altitudes of river side grazing area

Parameters	Alt 2 Mean±SE	Alt 1 Mean±SE
TG	31.85 ± 4.52[b]	39.12 ± 4.55[a]
HDG	3.45 ±0.36[b]	5.39 ± 0.24[a]
DG	10.82± 2.71[a]	13.875 ± 2.13[a]
LDG	18.2 ±4.73[a]	18.89± 2.14[a]
Forbs	26.25 ± 6.9[a]	26.4 ± 9.89[a]
TB	57.55 ± 9.04[b]	66.62 ±11.55[a]

Means with different letters in a row are significantly different (P<0.05) (TB) toatal biomass (TG) total grass (HDG) highly desirable grass (DG) desirable grass (LDG) = less desirable grass forb = forbs SE= standard error

Enclosure areas

There was a significant difference in parameters like total grass DM biomass, highly desirable grass biomass and total biomass production in both altitude ranges; this is mainly due to variation in soil, management practices and other abiotic factors like flooding effect of Omo river. Total dry matter biomass, the dry matter biomass of grass and highly desirable grass biomass were significantly higher (P<0.05) in the enclosures located in the altitude one (Table 3). The total biomass production capacity of enclosure area is about 1.072 and 1.012 DM tone/hectare in lower and higher altitudes respectively. There was no significant variation (p<0.05) among variables of desirable, less desirable grasses and forbs dry matter biomass production in both attitudes, this is mainly due to equal chance of these species even not to be grazed by wildlife and increased probability of growth in both altitudes (table 7).

Table 7. The biomass yields of different herbaceous species in two altitudes of enclosure grazing area.

Parameters	Alt 1 Mean±SE	Alt 2 Mean±SE
TG	94.3 ±8.0 [a]	86.12 ±7.21[b]
HDG	16.8 ±4.038[a]	11.22 ± 4.87[b]
DG	34.4± 10.02 [a]	29.85 ± 4.18[a]
LDG	10.15 ± 3.15[a]	8.3± 4.06[a]
Forbs	16.8 ±3.038[a]	11.22 ± 4.87[a]
TB	107.15 ±10.75[a]	101.22 ± 10.92[b]

Means with different letters in a row are significantly different (P<0.05) (TB) toatal biomass (TG) total grass (HDG) highly desirable grass (DG) desirable grass (LDG) = less desirable grass forb = forbs SE= standard error

Biomass production in different altitude zones

Biomass production in altitude one

The current study indicated that total dry matter biomass and dry matter biomass of grass species were highest (P<0.05) in the enclosure areas followed by communal which was significantly higher (P<0.05) than in the riverside grazing sites. Significant difference (P<0.05) was observed in less desirable grass species and forbs production in different grazing site of altitude one (lower altitude) range. Accordingly, the DM biomass of less desirable grass and forbs was 222.7 and 350, 188.9 and 264.0, 83 and 112.2 kg per hectare in communal, riverside and enclosure areas, respectively. Therefore, the contribution of highly desirable grass and desirable grass to total dry matter biomass of grass was lowest in communal and highest in enclosure (Table 8).

Table 8. Biomass production in lower altitudes of different grazing types in kuraz woreda

Parameter	Communal (Mean±SE)	River sides (Mean±SE)	Enclosure (Mean±SE)
TG	44.75 ± 6.59[b]	39.12 ±12.[c]	96.12 ± 7.21[a]
HDG	5.39 ±2.24[b]	6.6 ± 1.01[b]	54.5 ± 7.43[a]
DG	16.15 ± 4.24[b]	13.875 ± 4.13[c]	29.85 ± 4.18[a]
LDG	22.27 ± 5.12[a]	18.89 ± 4.14 [b]	8.3 ± 4.06 [c]
Forbs	35.0 ± 10.62[a]	26.4 ± 9.89[b]	11.22 ± 4.87[c]
TB	79.86 ± 8.66[b]	66.62 ±12.55[c]	107.22 ± 10.92[a]

Means with different letters in a row are significantly different (P<0.05) (TB) toatal biomass (TG) total grass (HDG) highly desirable grass (DG) desirable grass (LDG) = less desirable grass forb = forbs SE= standard error

Biomass production in altitude two

Similarly, the same phenomena was observed like that of the lower altitude, there was a significant difference at (P<0.05) in biomass yield of total DM biomass, total grass DM biomass was obtained in enclosure areas followed by communal grazing sites and least was recorded from riverside grazing sites. The low productivity of riverside site is mainly attached with excessive over stocking of livestock near the rivers in early dry season, i.e., it is a preparation site for migration to Island (Desset). No significant difference was observed in DM biomass yield of highly desirable grasses in both communal and riverside grazing areas but significant (P<0.05) with that of enclosure areas. Higher DM yield of less desirable grass and forbs have been chronicled in communal grazing areas followed by riverside and least in enclosure areas (table 9)

Table 9**.** Biomass production in higher altitudes of different grazing types in kuraz woreda

Parameter	Communal Mean±SE	Riverside Mean±SE	Enclosure Mean±SE
TG	37.7±5.2 [b]	31.85 ± 4.[c]	84.3 ±8.0[a]
HDG	4.01 ±1.7[b]	3.45 ±2.36[b]	38.05 ±6.03[a]
DG	13.87 ±3.9[b]	10.82± 2.[c]	34.4± 10.02[a]
LDG	20.8± 4.07[a]	18.2 ± 4.73 [b]	10.15 ± 3.15[c]
Forbs	33.85± 6.18[a]	126.25 ± 6.9[b]	16.8 ±7.038[c]
TB	71.3 ±8.02[b]	57.55 ± 9.04[c]	101.15 ±10.752[a]

Means with different letters in a row are significantly different (P<0.05) (TB) toatal biomass (TG) total grass (HDG) highly desirable grass (DG) desirable grass (LDG) = less desirable grass forb = forbs SE= standard error

Conclusion

- From the current study it can be concluded that there increase in unwanted woody and herbaceous vegetation increase, and reduction in productivity of rangeland. Hence, the situation requires the definite commitment and full participation from the pastoralists, government and non- governmental organizations that are directly or indirectly involved in rangeland resources utilization, management and other related activities.
- The pastoral communities must be advised and trained on proper rangeland management and improvement measures (e.g., proper grazing management, resting of grazing lands, different methods of bush management including their economic use) suitable to the area.

Acknowledgements

The authors acknowledge, the South Agriculture Research Institute and rural capacity building project (RCBP) for financing the project, and Jinka Agriculture Research Centre for their logistical assistance during data collection and Haromaya University for use of their animal nutrition laboratory and Herbarium

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Annex table 1. Herbaceous species identified in different altitude categories and grazing types of Kuraz district

Grasses	Category	350-600			600-900		
		Cm	RS	En	Cm	RS	En
Aristida adscensionsis	LD	C	p	C	C	p	C
Aristida hirtglama	LD	C	p	-	C	C	-
Bothriochola insculpta	HD	-	-	D	p	-	C
Cenchrus ciliaris	HD	P	P	C	C	-	-
Chloris roxbarghiana	DS	p	-	C	p	p	C
Cynodon dactylon	DS	C	p	D	C	p	C
Cynodon plectostchyum	DS	C	-	P	P	-	P
Dactylocytenium aegypticum	HD	P	-	D	p	P	D
Hetropogan contrutus		-	-	-	p	-	P
Panicum maximum	HD	p	-	P	-	P	C
Echinocholoa colonum	DS	-	C	P	-	C	-
Eriochloa nubica	HD	p	d	-	-	p	C
Paspulem geminatum	HD	-	C	P	-	C	-
Microcholea kuntii	LD	-	-	-	p	-	-
Sporobulus pyramidalis	DS	C	p	P	-	-	C
Sporobulus consililis	DS	-	p	P	C	-	P
Sporbulus spicatus	HD	p	-	D	-	C	P
Lecrisia hexandra	DS	P	C	P	-	P	P
Sorghum verticilflorum	HD	-	C	P	-	p	-
Sedges							
Cyperus spp	DS	-	C	P	-	C	P
Legumes							
Pupalia lapacea	LD	-	-	P	-	p	P
Crotalaria alibculis	LD	P	P	P	p	C	-
Forbs							
Barleria quadrispina	UPL	D	P	-	D	-	-
Comicarpus verticilates	DS	D	P	-	P	p	
Datura stromonium	LD	C			p	-	-
Cucumis dipsaceus	LD	-	P	P	-	p	P
Cocinia spp	LD	C	-	P	C	-	P
Hewatia subulobata	LD	-	P	C	-	p	-
Aerva javanica	LD	p	-	-	p	-	-
Zeleya pentadra	LD	p	-	-	p	-	-
Tribulus terrestres	LD	C	-	-	d	C	

Cate = Categories, HD = highly desirable; DS = Desirable; LD = Less desirable; P = Present (<5% of DM); C = Common (>5% and <20% of DM), D = Dominant (>20% of DM), (Amsalu and Baars, 2002) CM = Communal grazing areas, Rs= Riverside grazing areas and en= Enclosure

Annex table 2. Woody plant species identified in different altitude categories and grazing types of Kuraz Woreda

Woody spp	Category	350-600masl			601-900			
		Cm	RS	En	Cm	RS	En	Remark
Abutilon figrinum	LD	P	P	-	C	-	C	
Acacia seyel	D	C	C	P	C	C	P	
Acacia millefera	D	P	C	C	C	P	P	
Acacia senegal	LD	C	C	P	C	C	P	
Acacia nubica	HD	-	-	-	P	-	C	
Acacia oerfota	HD	-	P	C	C	-	C	
Cadaba glondelosa	LD	C	C	-	C	C	C	
Clutia abysinica	D	P	P	-	C	P	-	
Cissus duandriangula	D	P	-	-	C	-	-	
Comicarpas africanus	HD	P	P	C		-	C	
Dobera spp	DS	P	-	-	P	C	-	
Ethretia spp	DS	-	-	-	P	-	-	
Grewia erythraea	LD	P	P	-	P	-	P	
Grewia villosa	HD	P	P	C	C	P	C	
Indigofera shemipher	HD	-	-	C	P	P	C	
Solonum dubium	D	P	C	-	P	-	-	
Marea macranatha	LD	P	P	-	P	-	-	
Mede l.name	HD	C	C	C	C	P	P	not
Withania somnifera	LD	C	P	-	C	C	-	
Yorch l.name	LD	C	-	-	C	-	-	Not
Zizyphus martiana	LD	P	P	-	C	-	-	

Pala. gr = Palatability groups; HD = Highly palatable; D = palatable; LD= less desirable P = Present (<10% of density), C = Common (>10% and <20% of density), D = Dominant (>20% of density), Cm = Communal grazing areas, RS= Riverside En=enclosure

Annex table 3. Height classes of woody vegetation species in the study district.

Woody spp	<1m	1-2m	2-3m
Abutilon figrinum	Y		
Acacia seyel		y	y
Acacia millefera		y	
Acacia senegal			y
Acacia nubica		y	
Acacia oerfota			y
Cadaba glondelosa	Y		
Clutia abysinica	Y		
Cissus duandriangula		y	
Comicarpas africanus		y	
Dobera spp	Y		
Ethretia spp	Y		
Grewia erythraea		y	
Grewia villosa		y	
Indigofera shemiper		y	
Solonum dubium	Y		
Marea macranatha		y	
Mede l.name		y	
Withania somnifera	Y		
Yorch l.name			y
Zizyphus martiana	Y		

Where y=class of height.