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Evaluation of Range Condition in Relation to Altitude and Grazing Type in Kuraz District of South Omo Zone, South Western Ethiopia

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Rangeland condition assessment was conducted in the Kuraz district of south Omo lowlands, south Western Ethiopia to determine the current status and future trend of the grazing land with emphasis on comparing different functional land use units as communal, riverside and enclosure. An approach that integrated data from herbaceous, woody plants and soil was followed. Density and canopy cover of woody plants were determined in 123 plots of 500m2. Scores of grass species composition, basal and litter cover; number of grass seedlings, grass age distribution, soil erosion and compaction were recorded from 615 subplots of 0.25m2. Mean total range condition score in the communal, enclosure and benchmark grazing sites of the study district were 19.22 ± 1.46, 23.40 ± 1.35 and 39 ± 1.35 respectively. Thus, communal, riverside and enclosure grazing sites were classified poor, fair and good condition respectively. Furthermore, relationships between rangeland condition score and herbaceous biomass production, percent bare soil, and density, frequency and percent cover of woody plants were determined by applying multivariate analyses. The overall rangeland condition appeared to be in a transitional state from good to poor with a downward trend. Therefore, rangeland rehabilitation, rotational grazing, fencing /paddocking and selective clearing of woody plants are recommended as a result of this study.

Key Words: Range condition, invaders, soil compaction, grazing, drought

Introduction

In Africa, drylands constitute about 43% of inhabited surface and are mainly used for pastoral and agro-pastoral activities to support 268 million people (IIED and SOS Sahel, 2010). In East Africa, grassland or savanna ecosystems cover extensive areas of the dry land surface, which account more than 60%of the total land area of the region (Neely and Bunning, 2008) and are a basis for livestock industry. In Ethiopia, pastoral and agro-pastoral areas support about 40% of the cattle, 50% of the small ruminants, and almost all camels (Hogg, 1997). Livestock production largely carried out in dry areas provides foods and incomes for an estimated 12 - 15% of the Ethiopia's pastoral and agro-pastoral population and also constitutes 20% of total growth domestic product (GDP) of Ethiopia (Aklilu, 2002).

The savanna ecosystems are highly dynamic, characterized by erratic rainfall and high rate of vegetation dynamics (Herlocker, 1999; Dahdough-Guebas et al., 2002), soil nutrient levels, fire and herbivore (Sharpe, 1992). But, livestock management systems can exert a considerable change on the diversity, composition, structure, and development of native plant communities (Popolizio et al., 1994; Vavra et al., 2007) in rangelands. Most savannas are degraded and dominated by unpalatable and annual herbaceous plant species and encroached by woody plants (van Vegten, 1984; Abule et al., 2005). The change in the composition of plant species in savanna ecosystems has a significant influence on the sustainability of livestock production (Sankaran et al., 2005). Proper understanding of effects of grazing management systems on savanna ecosystem dynamics is therefore essential in maintaining productivity and biodiversity (Sternberg et al., 2000; Mohammed and Bekele, 2010). In arid and semi-arid rangelands heavy grazing pressure and agro-ecological factor such as elevation can influence forage production and shift composition (Amsalu and Barrs, 2002; Gemedo-Dalle et al.,2006), soil erosion and rangeland degradation (Kassahun et al.,2008b), increase bush density (Angassa and Oba, 2008). Such changes will influence the productivity, sustainable utilization and management of rangelands ecosystem.

In the past in the rangelands of Ethiopia some attempts have been made by many researchers to determine rangeland condition. However, compared with the vast rangeland areas of the country, there are only very limited studies; for example, in south Ethiopia (Ayana, 1999; Gemedo-Dalle et al., 2006; Solomon et al., 2006b) in middle Rift valley (Amsalu and Baars, 2002; Abule et al., 2007a), in East Ethiopia (Amaha, 2006)) and South East (Teshome et al., 2010). Even though, these studies have been conducted, there is narrow information regarding to rangeland condition in Kuraz district South Western Ethiopia. Therefore, the objective of this study was to evaluate rangeland condition, through use of herbaceous cover, woody vegetation density and soil status as measuring parameter in different elevation belts and along grazing gradient in Kuraz rangelands.

MATERIAL AND METHODS

Description of study area

The study was conducted in Kuraz Woreda, which is found in South Omo Zone of SNNPRS, 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 (50.14'N latitude, 360.44'E longitude) 1000 km from Addis Ababa; 725 km from regional capital Hawassa 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 25-40oC 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.

Selection of experimental sites

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. lower altitude and >600m.a.s.l higher altitude) with the participation of the district officers, 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 soil factors and one 20 m x 20 m for woody vegetation composition assessment.

Range Condition Assessment

The rangeland condition assessment was done by considering three layers (hrbaceous, woody and soil), based on the suggestions made by Friedel (1991). Five-plant factors (species composition of grass, basal cover, age distribution, hedging effect and canopy caver) and two-soil factors (soil erosion and soil compaction) was considered as criteria. Accordingly, two with a maximum score of 10 points (grass species and basal cover) and four with a maximum of five points (soil erosion, soil compaction, age distribution and canopy cover), and one with maximum score of 25 points (woody vegetation hedging effect) were summed up and the maximum possible total score was designated as 65 points. The rating for condition score were interpret as (0-13.5 very poor), (>13.5-27 poor), (>27-40.5 good), (>40.5-54 very good) and (>54 excellent). The details of the factors considered and criteria employed for the grass species and the soil layer was followed that developed by (Baars et.al., 1997) and woody vegetation condition score was rated according to Kuchar (1995).

Herbaceous species composition

Herbaceous species were divided into desirable species likely to decrease with heavy grazing pressure highly desirable (decreasers), desirable (increasers) and undesirable species likely to increase with heavy grazing pressure (invaders), according to succession theory (Dyksterhuis, 1949). Classification of grasses into decreasers, increasers and invaders was based on the vigor and the opinion of the herdsmen. Five observers and other experienced people on palatability participated in the condition evaluation. Herbaceous species were harvested from each experimental site of 1 m x 1 m area. Then the proportion of each class of herbaceous species was assessed by converting in to percentage composition (Appendix table 1).

Soil erosion and compaction

Soil erosion assessment was made by visual observation and five readings per sample site were taken. A scale of 0-5 points was considered. Soil erosion was rated based on the amount of pedestals (high parts of soil held together by plant roots with eroded soil around tuft), and in severe cases pavements (terraces of flat soil normally without basal cover with a line of tufts between pavement). The highest score 5 point was given for no sign of erosion, (4 points = slight sand mulch; 3 points= weak pedestals; 2 points = steep sided pedestal; 1= pavement, 0= gullies). Soil compaction (1 to 5 points) was evaluated based on the level of capping or crust formation of the surface soil. Soil compaction was assessed based on the amount of capping (crust forming). Five readings per sample site was taken and a range of points (1-5) was given as 5, 4, 3, 2 and 1 points for soil surface with no capping, isolated or scattered capping, > 50% capping, >75% capping and almost 100% capping, respectively.

Basal cover and age distribution

A representative sample area of 1 m x 1 m quadrates was selected for detail assessment of the basal cover. The surface of basal cover of tufted grasses and their distribution was assessed as follows. The 1m x 1m sample area was divided into halves, one of which was divided into 8 in order to facilitate the visual estimations. Only basal cover of live herbaceous plant parts were cut and put together in the prepared part were considered. Creeping grasses was encountered twice because no other system is developed and it was given maximum score because of abundance cover. It is excellent when the eighth is completely filled. Five readings per sample site was taken for age distribution assessment from an area of 1 m x 1 m and when all age categories, young, medium aged and old plants of the dominant species was present, the maximum score of 5 points was given. When there is only old, medium aged or young plants, the scores 3, 2 or 1 point, respectively was given. Young and medium-aged plants were defined as having approximately 20% and 50%, respectively of the biomass of old and mature plants of the dominant species.

Woody vegetation (hedging effect)

The composition, height and density, hedging effect of the woody plant species were recorded. In each quadrat (20 m x 20 m), all rooted live woody plants were identified by local name and recorded. The number of individuals of each tree and shrub species was counted to estimate woody vegetation density per hectare. The palatability and desirability of each of the woody plant to livestock as a source of feed were recorded by interviewing the herdsmen and elders of the study area. The response of pastoralists' was further confirmed with literatures. The highest score of 25 points was given for sample plot, when highly palatable (browseable) and palatable plants share dominance and most hedgeable plants were lightly to moderately hedged. The minimum point of 6.5 was given when the sample plot is dominated by less palatable, unpalatable and also when hedgeable plants are very heavily hedged and unhedgeable plants are less hedged. The rest estimates falling in between these limits. This was based on the method described (Kuchar, 1995) as given in Appendix Table 2.

Canopy cover

The percentage canopy cover was obtained by dividing the total linear length along the tape meter intercepted by the crown by the total length of the tape. The minimum score 1 point was given for less than 15% canopy cover and the maximum 5 point was given for cover that is more than 45% of the 20m transect length. Other points were considered between these limits (Kuchar, 1995) as given in Appendix Table 2.

Data analysis

Range condition assessment, from each range site composite samples of the 5 quadrates of 1 m x 1 m (1 m2) 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 and soil 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. Model was used for interaction effect of altitude ranges and grazing types in all range condition parameters i.e., grass composition, basal cover, age distribution, soil erosion, soil compaction and for woody vegetation factors. $Y_{ijk} = \mu + A_i + G_j + (AG)_k + E_{ijk}$

Where; Y_{ijk} = All range condition parameters, μ = Overall mean

Ai = Altitude ranges, i.e., between 350-600 m a.s.l. and between >601-900 m a.s.l.
Gj = Grazing types, i.e., communal, riversides and enclosure
(AG)k = Interaction between altitude ranges and grazing types Eijk = Random error.

RESULT AND DISCUSSION

Range Condition

There was a significant difference at ($p < 0.05$) among the range condition scoring parameters in different grazing types, except the woody species density. Herlocker (1999) mentioned that the degree of grazing strongly affects the structure, composition, quality and productivity of rangeland vegetation; this idea supports the result of present study. The benchmark areas had the highest values in grass species composition, basal cover, age distribution, low soil erosion and soil compaction and hedging effect values than the other two grazing types. However, there was no significant variation at ($p < 0.05$) in soil erosion and compaction between communal and riverside grazing areas of altitude one, this is mainly due to less susceptibility of the soil to water erosion in the lower altitude. Chronic overgrazing, drought and inappropriate cultivation have been most commonly alluded to as causes of deterioration in range condition in East Africa (Coppock, 1994; Herlocker, 1999). It is difficult to generalize about causes of change in range condition because of site-specific interactions among ecological features and human use (IPAL, 1984; Homewood and Rogers, 1987).High grazing pressure will influence the number as well as the composition of species of grasses (Friedel, 1997), age distribution and finally basal cover (Amsalu and Baars, 2002). The benchmarks/enclosures had a significantly better soil condition than the other two grazing types this is in line with findings of Abule (2003), Admasu (2006) and Lishan (2007).

There was no significant difference in wood vegetation density for all the grazing types, (Lishan, 2007) can shore up this upshot for Somali region but it is contrary to the findings of Admasu (2006) in Hamer and Bena-Tsemay districts. This might be due to climatic, soil and anthropogenic factors. In addition, it might be associated with less woody tree clearing from enclosure areas. Contrary to the findings of Lishan (2007), the communal grazing area has a significantly lower ($P \leq 0.05$) value in canopy cover than the benchmark grazing areas, this might be contributed by the presence of less number of browser animals during dry season, less tree thinning practice in bench marks/enclosure areas of the study district. However, animals most of the time graze and browse in communal grazing areas during summer season and migrate to Island (Desset) during dry season, animals are unruffled in the riverside grazing area in the early dry season this leads to reduction in vegetation coverage of riverside grazing areas. The enclosure areas showed higher total score for range condition than the communal and riverside grazing types (Tables 2 and 3). Similar to that of lower altitude, in the higher altitude the three gazing types fall in the categories of poor, fair, and good for communal, river side, enclosure/benchmark grazing types, respectively.(Gemedo et. al., 2006) stated that rangelands in poor or fair condition are those producing far below their potential or have lost productive potential. It might be suggested that the communal as well as the riverside grazing areas require some degree of range improvement practices in the district.

EFFECT OF ALTITUDE ON RANGE CONDITION AT DIFFERENT GRAZING TYPE

Communal grazing areas

There was a significant difference at ($p < 0.05$) in communal grazing areas of the two altitude ranges, in range condition scoring parameters like grass species composition, soil erosion, soil compaction (Table 1). The difference in grass species composition in both altitudes i.e. better in lower altitude is contrary to research conclusions of Gemado (2004) and (Teshome et al., 2010). Being inconsistent is associated with distance from Omo river. Overflowing effect of Omo river has optimistic impact for the growth of certain annual grasses in the lower altitude (350-600), which favors increased composition of grasses.

Table 1. Range condition score in communal grazing areas of the different altitudinal zone in Kuraz Woreda

Parameter	Mean±SE alt 1	Mean±SE alt 2
GSP	**3.28± 0.76^{a}**	**2.35 ± 0.28^{b}**
SE	**2.67± 0.52^{a}**	**2.35 ± 0.28^{b}**
SC	**2.70 ± 0.36^{a}**	**2.53 ± 0.29^{b}**
BC	**4.72 ± 0.73^{a}**	**4.564 ± 0.51^{a}**
AD	**1.70 ± 1.24^{a}**	**1.63 ± 0.33^{a}**

Continuation of Table 1

WV	**6.3 ± 000[a]**	**6.3± 0.0[a]**
CC	**2.02±0.24[b]**	**3.06 ± 0.44[a]**
Total	**20.26 ±3.85[a]**	**20.43±2.65[a]**
Status	**Poor**	**Poor**

Means with different letters in a row are significantly different (P<0.05). Grass species composition score; Bc= basal cover; Se = Soil erosion;Sc = Soil compaction; Ad = Age distribution of grasses;; Wv= Woody vegetation hedging effect; Ccs = Canopy cover score; Wd= Woody density; Cc%=Canopy cover%; SE= Standard error

In the communal grazing sites of both altitudinal ranges, the scores for grass species composition were low. The main reason for this could be overgrazing, drought, and bush encroachment. Studies made in different pastoral areas of Ethiopia (Ayana, 1999; Oba and Kotile, 2001; Gemedo, 2004; Ahmed, 2003; Belaynesh, 2006; Admasu, 2006; Teshome et al., 2010; Ketema, 2007; and Tesfaye, 2008) revealed that drought, overgrazing and bush encroachment were considered to be the major factors for the decline in rangeland condition and hence, leads to poor productivity of range land.There was no significant variation (P<0.05) in basal cover of herbaceous species in both altitudinal ranges, which is allied with low herbaceous species coverage and age distribution; which is also associated with poor management practices low rainfall and poor soil fertility of the rangeland. There was significant difference in soil erosion and soil compaction in both altitude i.e. soil which are in the higher altitude are eroded and compacted relative to lower altitudes this result was propped up by (Teshome et al., 2010). Soil erosion was high in lower altitude relative to its elevation and monotony of the area, during the group discussions with elders, they confirmed that wind is the major factor that give rise to erosion in the area rather rainfall. There was no significant variation in the woody vegetation density in both altitude ranges, however, there was significant variation in canopy cover at (p <0.05) this might be accredited by capacity of the upper altitude relatively to support larger trees and in addition to higher browser number in lower altitude. In general, the communal grazing areas are in poor condition hence, they are in need of better management practices like bush clearing, controlled burning, creating enclosure areas and feed conservation for dry period through community participation and interventions' of NGOs and GOs.

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River side grazing areas

There was no significant difference at (P<0.05) in all herbaceous and soil factors of range condition scoring parameters, except wood vegetation density (Table 2) in both altitude ranges. It has relatively better range condition than communal grazing areas. On the other hand hedging effect of woody vegetation has shown significant difference at (p <0.05) in both altitudes i.e. highly hedged in altitude one than two. Somewhat, there is greater woody density in altitude two than altitude one riverside grazing areas, the main reason for increase in woody vegetation might be associated with absence of camel in altitude two zone in comparative to altitude one. The other point is the capacity of altitude two to bear higher vegetations.

Table 2. Range condition score in riverside grazing areas of the different altitudinal zone in the study district

Parameter	**Mean ± SE alt 1**	**Mean ± SE alt 2**
GSCP	**4.37± 0.60[a]**	**4.57 ±0.68[a]**
SE	**2.53 ±0.23[a]**	**2.59 ± 0.219[a]**
SC	**2.58 ± 0.15[a]**	**2.72 ± 0.26[a]**
BC	**5.03 ± 0.4[a]**	**4.94 ± 0.43[a]**
AD	**2.26± 0.47 [a]**	**2.02 ± 0.37[a]**
WV	**6.79 ± 1.03[b]**	**7.46 ±1.02[a]**
CC	**3.08 ± 0.250[a]**	**3.35 ± 0.36[a]**
Total	**26.71±3.13[a]**	**26.38±3.34[a]**
Status	**Fair**	**Fair**

Means with different letters in a row are significantly different (P<0.05). Grass species composition score; Bc= basal cover; Se = Soil erosion sc = Soil compaction; Ad = Age distribution of grasses; Wv= Woody vegetation hedging effect; Ccs = Canopy cover score; =; Wd= Woody density; Cc%=Canopy cover; SE= Standard error

Benchmark site

There was significant difference in grass species composition, basal cover and canopy cover in both altitude zones at ($p < 0.05$). Contrary to (Teshome et al., 2010), the basal cover in the lower altitude showed higher value than that observed in upper altitude range, this might be related with better productivity of lower altitude due to overflow effect of Omo river. Woody vegetation density has no significant variation in both altitudes (Table 3). Then again, woody density, soil erosion and age distribution were not significantly different in both altitudinal ranges, rendering might be due to analogous management practices of enclosed areas and this result concurs with the findings of (Teshome et al.,2010) and Admasu (2006).

Table 3. Range condition score in enclosure grazing areas of the different altitudinal zone in the study district

Parameter	Mean ± Se alt 1	Mean±SE alt 2
GSC	**6.44 0.469[a]**	**5.37 ± 0.23[b]**
SE	**3.32 ±0.19[a]**	**3.20 ± 0.2[a]**
SC	**3.4 ± 0.26[a]**	**2.91± 0.41[b]**
BC	**6.86 ± 0.45[a]**	**6.11 ± 0.49[b]**
AD	**2.5 ± 0.16[a]**	**2.64 ± 0.32[a]**
WV	**13.02± 0.44[b]**	**16.7±1.08[a]**
CC	**3.52 ± 0.13[a]**	**3.64± 0.53[b]**
Total	**39.06±2.1[a]**	**39.57±3.26[a]**
Status	**Good**	**Good**

Means with different letters in a row are significantly different ($P<0.05$). Grass species composition score; Bc= basal cover; Se = Soil erosion Sc = Soil compaction; Ad = Age distribution of grasses;; Wv= Woody vegetation hedging effect; Ccs = Canopy cover score; =; Wd= Woody density; Cc%=Canopy cover; SE= Standard error

Effect of grazing type on range condition

Some studies have found that grazing to be the primary determinant of plant community composition (Fuhlendorf and seims, 1997). Grazing type highly affects both the quality and quantity of the vegetation coverage of the area, hence significant variation have been observed in different range condition scoring factors. There was a significant difference ($p < 0.05$) in GSC, BC, AD and WV composition in the three grazing types. The enclosure areas have got highest score followed by riverside and least score was chronicled in communal grazing areas (Tables 4 and 5).The difference in these parameters among the grazing types could be fond of with the poor range condition, high grazing pressure, bush encroachment associated with recurrent drought in communal grazing lands. Studies conducted in the rangelands of Borena and Jijiga have revealed that species composition, basal cover and age distribution depended on a number of factors such as types of gazing management, drought frequency, rainfall, human and livestock populations (Ayana 1999; Ahmed, 2003). Overgrazing due to high livestock population and prolonged drought may lead to a reduction in herbaceous species composition and diversity. Moreover, this aggravates the rangeland deterioration. Other researchers (Baars et al., 1997; Abule et al., 2005b; Admasu, 2006; Belaynesh, 2006; Teshome et al, 2010) reported the same idea. On the other hand, lower pressure of livestock grazing and trampling in enclosure site relatively resulted in highest species composition, basal cover, age distribution than riverside and communal grazing sites.

Effect of grazing types on range condition in altitude one

Even though the level of elevation and amount of rainfall does not smooth the progress of erosion in the area, there is significant variation in three grazing types. The main grounds for variation in soil erosion and compaction is the difference in management activities i.e. over stocking or over utilization of communal and riverside grazing sites. Hence, this situation escorted to less biomass production, basal cover and poor age distribution. The enclosure site was in enhanced soil condition than the other two grazing sites, which is in line with conclusions of (Teshome et al.,2010; Amaha, 2006; Admasu, 2006; Ketema, 2007)

Table 4. Range Condition Score (Means ± Se) In The Different Grazing Types Of The Lower Altitude

Parameter	CM	RS	En
GSC	3.28± 0.76[c]	4.37± 0.60 [b]	6.44 ± 0.469[a]
SE	2.67± 0.52[b]	2.53 ± 0.23 [b]	3.32 ±0.19[a]
SC	2.70 ± 0.36[b]	2.58 ± 0.15[b]	3.4 ± 0.26[a]
BC	4.72 ± 0.73 [b]	5.03 ± 0.4[b]	6.86 ± 0.45[a]
AD	1.70 ± 0.24[b]	2.26± 0.47[b]	2.5 ± 0.16[b]
WV	6.3 ±000[c]	7.59 ± 1.03[b]	13.02 ± 0.44[a]
CC	2.02 ± 0.24[b]	3.35 ± 0.250[ab]	3.52 ± 0.13[a]
Total	22.99±3.85[b]	27.71±3.13[b]	39.06±2.1[a]
Status	Poor	Fair	Good

Means with different letters in a row are significantly different (P<0.05). Grass species composition score; Bc= basal cover; Se = Soil erosion' sc= Soil compaction; Ad = Age distribution of grasses;; Wv= Woody vegetation hedging effect; Ccs = Canopy cover score; =; Wd= Woody density; Cc%=Canopy cover; SE= Standard error.

Effect of grazing type on range condition in altitude two

Management has unswerving impact on quality of rangeland, that is why there was significant difference at (p <0.05) with in the same area; in grass species composition, basal cover, soil erosion, soil compaction and age distribution. Poor range condition, overgrazing and recurrent drought might be conscientious for the increased level of soil erosion and compaction, for the lowest value of grass species composition, basal cover and age distribution (Teshome, et al.,2010).

Table 5. Range condition score (mean+ se) in the different grazing types of the higher altitude

Parameters	Cm	RS	En
Gsc	3.24 ± 0.87 [c]	4.57 ±0.68[b]	6.37 ± 0.23[a]
Se	2.35 ± 0.28[c]	2.59 ±0.219[b]	3.20 ± 0.2[a]
Sc	2.53 ± 0.29[b]	2.72 ± 0.26[b]	2.91± 0.41[a]
Bc	4.56 ± 0.51[b]	4.94 ± 0.43[b]	6.11 ± 0.49[a]
Ad	1.63 ± 0.33[c]	2.02 ± 0.37 [b]	2.64 ± 0.32[a]
Wv	6.30 ± 0.0[c]	7.46 ±1.02[b]	16.7 ±1.08[a]
Cc	3.06 ± 0.44 [a]	3.08 ± 0.36[a]	3.64± 0.53[a]
Total	21.67±2.27[c]	27.38±3.67[b]	40.57±3.14[a]
Status	Poor	Fair	Good

Means with different letters in a row are significantly different (P<0.05). Grass species composition score; Bc= basal cover; Se = Soil erosion;Sc = Soil compaction; Ad = Age distribution of grasses;; Wv= Woody vegetation hedging effect; Ccs = Canopy cover score; =; Wd= Woody density; Cc%=Canopy cover; SE= Standard error

The mean canopy cover of woody plant in the study area was 28.4%, which is in ranges of Gemedo (2004) finding, he reported that 27 to 73% with a mean of 52% canopy cover values; high canopy caver implies increased woody vegetation density relative to the study area. Hedging or browsing effect was significantly affected (P<0.05) by grazing type. Communal and riverside had higher hedging effect or highly hedged difference at (P<0.05) than enclosures, this may perhaps be due to high browsing pressure on communal and riverside than enclosures. The overall range condition score revealed that communal, riverside and enclosures grazing sites were classified as poor, fair and good condition, respectively.

Interaction Effect of Altitude and Grazing on Range Condition

From the analysis of variance (ANOVA) (Appendix Tables 3-9) showed that there was significant interaction effect (P<0.05) between altitude and grazing type in soil compaction, canopy cover, woody vegetation hedging effect, On the other hand, there was no significant interaction in grass species composition, basal cover, soil erosion, age distribution in altitude and grazing types. The possible reasons for the interaction effect between altitude and grazing types could be partly due to the variation of grazing pressure between altitudes. But mainly it could be due to the natural plant community of a site might vary with altitude difference, as a result they could respond differently to similar grazing effect and this was also in agreement with the findings of Ayana (1999), Amsalu (2000), Admasu (2006) and (Teshome et al., 2010).

Conclusion

The rangelands in the study area are used both for grazing and browsing animals in such type of grazing land; the three layers in rangeland rating are essential. Heavily grazed site were poor while medium grazing site was fair whereas lightly/non grazed sites was good. The heavily and medium grazed rangelands were deteriorated and urgent action is needed. Nevertheless, the medium grazing sites were in transitional state from poor to fair condition while the light grazed sites need maintenance of their present condition. In overall, the higher and lower elevation sites were fair condition and need improvement interventions. This emphasizes the importance of stocking rates and proper rangeland management. To sustain the pastoral production systems in the area, the grazing sites need rehabilitation, conservation and proper management. This would involve resting of heavily and medium grazed sites, selective thinning of woody plants, and establishment of community-based grazing reserve in some key sites. To this end, pastoralists and all stockholders involving in rangeland utilization and conservation need to collectively develop a land-management strategy to ensure the recovery of degraded areas and bring to an end any further degradation.

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Appendix table 1. Criteria for the scoring of the different factors in order to determine range condition

Source (Baars *et al*, 1997)

Score	Grass composition	Basal cover	Litter cover	soil erosion	soil compaction
10	91-100% decreasers	.12%no bare areas	>40%		
9	81-90% decreasers	-	-		
8	71-80% decreasers	.9% evenly distributed	11-40%even distributed		
7	61-70% decreasers	>9% occasional bare	-		
6	51-60% decreasers	>6% evenly distributed	11-40%unevendistributed		
5	41-50% decreasers	>6%bare spots	-	no soil movement	no compaction
3	10-40% decreasers <30% increasers	>3% mainly annuals	-	slope sided pedestals	>50% capping
2	<10% decreasers ≥50% increasers	1-3%	3-10%weeds/tree leaves	steep sided pedestals	>75% capping
1	<10% decreasers <50% increasers	<1%	-	pavement	almost 100% capping
0		0%	<3%		

Appendix table 2. Criteria for the scoring of the different factors determining range conditions (woody vegetations).

Source (Kuchar 1995)

Dependent variable. GSC

Appendix table 3. Analysis of variance for interaction effect of altitude and grazing on grass species composition

Parameter	**Value**	**Total point**	**Description**
Hedging	**3**	**25**	**Highly palatable woody shrubs share dominance Most hedgeable plants are lightly to moderately hedged Few or no decadent plants**
	2	**18.75**	**Palatable plants dominant. Hedgeable plants moderately to heavily hedged. Some plants decadent due to hedgeing**
	1	**12.5**	**Palatable and less palatable plants dominant Hedgeable plants heavily to very heavily hedged Considerable numbers of decadents' shrubs present Some may be dead due to hedging**
	0	**6.25**	**Less palatable and unpalatable shrubs dominant Some normally unedgeable shrubs are hedged Headgeable shrubs very heavily hedged the crowns often reduced to nubbins Many shrubs decadent and dead from hedging**
Canopy cover	**3**	**5**	**>45% cover**
	2	**4**	**36-45% cover**
	1.5	**3**	**26-35% cover**
	1	**2**	**15-25% cover**
	0	**1**	**<15% cover**

Source	**DF**	**SS type III**	**Mean Square**	**F Value**	**Pr > F**
gr	**2**	**327.5145281**	**163.715094**	**210.87**	**<.0001**
alt	**1**	**3.9619955**	**3.9619955**	**7.65**	**0.0064**
alt*gr	**2**	**0.0000000**	**0.0000000**	**0.00**	**1.0000**

R-Square	**Coeff Var**	**Root MSE**	**GSPC Mean**
0.820061	**16.58874**	**0.719522**	**4.337415**

Gr=grazing, alt= altitude

Dependent variable: soil erosion (SE)

Appendix table 4. Analysis of variance for interaction effect of altitude and grazing on soil erosion

Source	DF	Type III SS	Mean Square	F Value	Pr > F
gr	2	24.03	12.016	78.65	<.0001
alt	1	2.02	2.02	19.84	<.0001
alt*gr	2	0.00	0.00	0.00	1.0000

R-Square	Coeff Var	Root MSE	SE Mean
0.647739	11.87097	0.319143	2.688435

Dependent Variable: Soil compaction (SC)

Appendix table 5. Analysis of variance for interaction effect of altitude and grazing on soil compaction.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
gr	2	17.04	8.52	66.78	<.0001
alt	1	0.78	0.78	9.17	0.0029
alt*gr	2	1.23	0.41	4.85	0.0031

R-Square	Coeff Var	Root MSE	SC Mean
0.617146	10.54236	0.291672	2.766667

Dependent Variable: BC

Appendix table 6. Analysis of variance for interaction effect of altitude and grazing on basal cover.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
gr	2	155.25	77.75	182.92	<.0001
alt	1	6.78	6.78	23.98	<.0001
alt*gr	2	0.00	0.00	0.00	1.0000

R-Square	Coeff Var	Root MSE	BC Mean
0.801726	10.20477	0.531898	5.212245

Dependent Variable: AD

APPENDIX TABLE 7. ANALYSIS OF VARIANCE FOR INTERACTION EFFECT OF ALTITUDE AND GRAZING ON AGE DISTRIBUTION

Source	DF	type III SS	Mean Square	F Value	Pr >F
gr	2	52.38	26.196	43.33	<.0001
alt	1	2.14	2.144	5.32	0.0226
alt*gr	2	0.00	0.0000	0.00	1.0000

R-Square	Coeff Var	Root MSE	AD Mean
0.488811	30.80982	0.634850	2.060544

Dependent Variable: WV

Appendix table 8. Analysis of variance for interaction effect of altitude and grazing on woody vegetation.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
gr	2	2220.66	1110.33	1506.60	<.000
alt	1	4.04	4.04	8.24	0.0047
alt*alt	2	60.282	30.094	40.90	<.0001

R-Square	Coeff Var	Root MSE	WV Mean
0.970980	8.171175	0.700942	8.578231

Dependent Variable: CC

Appendix table 9. Analysis of variance for interaction effect of altitude and grazing on grass species composition

Source	DF	Type III SS	Mean Square	F Value	Pr > F
gr	2	2.83	1. 41	7.09	0.0002
alt	1	0.11	0.11	0.89	0.3463
alt*gr	2	8.88	4.49	28.18	<.0001

R-Square	Coeff Var	Root MSE	CC Mean
0.389543	17.99180	0.365344	2.030612