International Journal of Current Research in Life Sciences
Vol. 06, No. 07, pp.697-704 2017

ISSN: 2319-9490

IJCRLS

www.ijcrls.com

Full Length Research Article

CONDITION OF MAJOR GRAZING AREAS IN THE RANGELANDS OF GAMBELLA, ETHIOPIA

*,[1]Ketema Tilahun, [2]Lisanework Nigatu, [3]Solomon Mengistu and [4]John Barnabas

[1]Gambella University,, Department of Animal Production and Health, Gambella, P.O. Box 126, Ethiopia
[2]Haramaya University, Department of Plant Science, Dire Dawa, P.O. Box 138, Ethiopia
[3]Ethiopian Institute of Agricultural Research (EIAR), Holeta Agricultural Research Centre, Holeta, Ethiopia
[4]Gambella University, Department of Plant Science, Gambella, P.O. Box 126, Ethiopia

Accepted 13th June, 2017; Published Online 31st July, 2017

ABSTRACT

A research exercise was undertaken in Nuer pastoral area of Gambella, southwestern Ethiopia, with the objectives of evaluating the condition of the major grazing areas of the rangelands. For the vegetation survey the pastoral area was stratified by districts namely: Itang and Jikawo and each district further divided into major grazing types (less, seasonal, communal grazed and river basins). Data were collected on grass species composition, basal cover, litter cover, number of seedlings, age distribution, soil erosion, soil compaction; woody species composition, density and height. There were a highly significant ($p<0.05$) differences in the total range condition scores among the major grazing areas of the districts. In Itang district, the mean condition scores of less, moderately, communally grazed and river basins were: 36.23±0.10, 28.78±0.20, 21.76±0.16 and 15.82±0.16, respectively. Whereasthe corresponding values in Jikawo district were: 34.91±0.10, 27.20±0.10, 18.69±0.16 and 13.58±0.16, respectively. In general, the present study confirmed that the condition of the communally grazed areas were in precaution and has deteriorated. To this end, an attempt to employ appropriate management systems along with monitoring of the grassland condition might be needed to promote the productivity of the grassland of the study areas to the level of the carrying capacity to ensure its sustainable utilization.

Key words: Condition, Deterioration; Grass species, Grassland, Range.

INTRODUCTION

Rangelands dominated by grass and grass-like species with or without scattered woody plants, occupy between 18-23% of the world land area (Blench and Sommer, 1999). In Africa, rangelands constitute about 65% of the total land area (Friedel*et al*., 2000).The range lands of Ethiopia are located around the peripheral or the outer edge of the country, almost surrounding the central highland mass (Alemayehu, 2004), constituting 62% of the country's land area (EARO, 2000; PFE, 2001; BLPDP, 2004). These areas are mainly found in the northern, northwestern and along the Baro River basin in the extreme western part of the country (Coppock, 1993). Most of these areas are below 1,500 m.a.s.l (EARO, 2000), characterized by arid and semi-arid agro-ecologies; experienced a relatively harsh environmental condition of unreliable, low and erratic rainfall with annual range of 200 to 700 mm, a regularly high temperature, between 15 and 50^{0}C, and low human population density (Beruk, 2003; Alemayehu, 2004; PFE, 2004), varied markedly in terms of the number of plant growing days per year, forage production, common plant associations, livestock and human carrying capacities and incidences of important livestock diseases (Coppock, 1993).Pastoral production systems have evolved under high-risk conditions in dry land regions. Traditionally, the pastoralists had a rich indigenous knowledge, which enabled them to adapt successfully to the highly variable natural resources (Niamir, 1999; Sabine and Rischkowsky, 2005; Sabine *et al*., 2004). Their adverse cultural setting is the result of centuries of adaptive knowledge (PFE, 2001). They have evolved a number of strategies, which have proven so successful over centuries, and are still followed to varying degrees, today; enable them to adapt to the vagaries of the rangeland environments (Herlocker, 1999; Sabine and Rischkowsky, 2005). The pastoralists keep diverse livestock species adapted to their ecosystem (PFE, 2001). Most herds are mixed as a means of adaptation to changing environment, to supply food for the family and to act as a cash reserve in the time of shortage, during droughts and disease problems (Niamir, 1991).The pastoralists identified distinct ecological

Corresponding author: Ketema Tilahun,
Gambella University, Department of Animal Production and Health, Gambella, P.O. Box 126, Ethiopia.

zones in accordance with the characteristics of the natural resources (Sabine and Rischkowsky, 2005), means use of high potential grazing areas (Herlocker, 1999). Traditionally, they manage risks by moving their livestock on a daily and seasonal basis to follow changes in the quality and quantity of pasture (IFAD, 1995; Sabine and Rischkowsky, 2005). The pastoral areas of Ethiopia have a rich resource potential (PFE, 2001) despite the fact that, the country has not yet benefited from these resources. This could be attributed to various constraints (Coppock, 1994). Of the immense constraints, livestock feed scarcity resulting from rangeland degradation and productivity deterioration is known to be the prime and common features of the pastoral areas. For efficient and sustainable utilization of the highest livestock potential from rangeland resources, ultimately, it is invaluable to understand the available resource base and the associated challenges that the pastoral communities have faced.Like other pastoral areas of the Ethiopia, in Gambella Regional State (GRS), extensive pastoral production system is experienced, predominantly in areas where the Nuer Pastoral communities inhabit. Various range research and development works were conducted in the Southern and Eastern rangelands of Ethiopia (Coppock, 1993), in Borana by Ayana (1999), Oba (2001), Gemedo (2004), Middle Rift Valley by Russel (1984) and Amsalu (2000), part of the Somali region by Ahmed (2003), Belayenesh (2006) and Amaha (2006). However, in the Gambella Regional State in general and the Nuer pastoral areas in particular, research and development interventions have never been done. Moreover, there are little or no researches and documentations made regarding range condition. It is, therefore, necessary to develop baseline scientific information on range condition of the major grazing areas. This would help to suggest ecologically sound and socio-economically feasible development and management interventions towards sufficient and sustainable use of the rangeland resources. To this effect the study aimed at evaluating the present range conditions of the major grazing areas based on the status of the vegetation cover and soil variables.

MATERIALS AND METHODS

Description of the study area

The study was conducted in the Gambella Regional State which is located in the southwest part of Ethiopia, situated in the lowlands of the Baro-Akobo River Basin between latitudes $6^{0}22'$ and $8^{0}30'$ N, and longitudes $33^{0}10'$and $35^{0}50'$ E, and covers a total area of about 34,063 square kilometers (GRS, 2003). The regional state is characterized as mid, lowland and semi-desert agro-ecological zones. Itang and Jikawo districts are located in the semi- desert agro-ecological zone. Forests and woodlands are in existent except for some scattered bushes and shrubs, thus it is logical to defining the grassland as open grassland (GRS, 2003) with an extensive plaintopographic feature (PADS, 2004).The annual rainfall and mean annual temperature in the Regional State are 1,247 mm and 34.37 ^{0}C, respectively (IAR, 1990). The rainfall regime is unimodal, referred to as the "*Sudan Type*", occurs in the lowlands along the border with Sudan (Coppock, 1994). Poorly drained *vertisol* is the characteristic soil type of the grassland (GRS, 2003).The highest livestock population in Tropical Livestock Unit (TLU) is found in Jikawo district 156,168.5 (53%), followed by Akobo, 114,390.8 (39.3%). The lowest TLU in Gog, which is, 1,341.6 (0.5%)(PADS, 2004). The major breed is the Nuer (zebu) which is a very good performer in dairying and beef production provided proper management levels (GRS, 2003) and considered to have high tolerance to tse-tse challenges (Alemayehu, 2004).

Site selection and sampling procedure

A vegetation survey was conducted in the two districts (Itang and Jikawo), which are predominantly inhabited by the Nuer pastoral community. The sampling method used was 'Systematically Stratified Random Sampling Technique' (ILCA, 1990). Accordingly, each district was stratified into four range sites namely: communal grazing, seasonal grazing, river basins and less grazed areas, which represent the major grazing areas of the pastoral community. As a benchmark, the relatively less grazed areas were used for comparison with other grazing areas in their representative districts. A total of 11 range sites (3 from each of less grazed, communally grazed and river basins and 2 from seasonal grazing areas) were selected from Itang district. For each grazing types, from Jikawo district (3 range sites with a total of 12) were selected. Each range site was further divided into three randomly selected sample sites. Four samples from each sample site were grouped using 0.5 m x 0.5 m quadrat. Using GPS channel 12; the altitude, longitude and latitude readings of each range site were determined and recorded. From a randomly established reference points, samples were taken by radiating 30m to four directions. The random selection reference point was made using line coordination, for communal grazing lands, less grazed lands and seasonally grazed areas. Samples from river basin were taken on the flat side of the river within the range of 100 - 400 m from the river bank on non-water logged area. The assessment was carried out late in the long rainy season 2006, when most of the grasses were flowered.

Range condition assessment

The assessment was based on the species composition of the herbaceous layer (referred to as grass composition), basal cover, litter cover, relative number of seedlings, age distribution of grasses and soil condition (erosion and compaction). These factors were considered based on the criterion developed by Tainton (1981) and adopted by Baars*et al*. (1997). Scores for each criterion, 3 of the factors with a maximum score of 10 points and 4 with a maximum score of 5, were summed and the maximum possible score was 50 points. The rating was interpreted as follows: very poor (< 10); poor (11-20); fair (21-30); good (31-40); and excellent (41-50 points).

Grass composition (1-10 points)

The herbaceous vegetation samples from each site were classified into grasses, and forbs thereafter into different species. Three levels of species occurrence, based on the dry weight, were distinguished:present <5% of the dry matter of the herbaceous biomass;common 5 to 20%; anddominant >20%.According to the succession theory (Dykstehuris, 1949; Tainton, 1981) and based on the information aid to semi-arid South Africa (Ivy, 1969; Tainton, 1981), classification of grasses into desirable species likely to decrease with heavily grazing pressure (decreases), intermediate species likely to increase with heavy grazing pressure (increasers) and undesirable species likely to increase or invade with heavy grazing pressure (pioneers), was done. The opinion of pastoralists on vigor and palatability of a particular species was considered. In this study, decreasers and increasers were identified as palatable, whereas invaders as non-palatable grass species. The species composition score of the experimental unit was determined from the proportion of decreasers, increasers, and invaders in that experimental unit.

Basal cover and litter cover (0-10 points)

A representative sample area of 1 m x 1 m (1 m^2) was selected for detailed assessments, and divided into halves. One of these was further divided into quarters, of which was again divided into eighths. All plant basal covers in the selected 1 m^2 were cut, transferred while kept together, and drawn in the eighth segment to facilitate visual estimations of basal cover of living parts.The rating of basal cover for the tufted species was considered 'excellent' when the eighth was completely filled (12.5%), or 'very poor' when the cover was less than 3%. In this study, creeping grasses like *Cynodondactylon* were encountered twice and gave the maximum score. Similar procedure was followed for the rating of litter cover. It was considered 'excellent' when the cover exceeds 40% and 'poor' at less than 10% litter cover.

Number of seedlings (0-5 points)

The numbers of seedlings were counted using three areas chosen at random with a distance of approximately 10 m between the areas, each equal to the size of A4 sheet of paper (30 cm x 21 cm). The sheet was dropped from the height of 2 m above the ground. The category of 'no seedlings' was given 0 point, and 'more than 4 seedlings' was given the maximum score of 5 points with the rest fell within these range of classes (i.e., 0-5 points).

Age distribution (1-5 points)

Alike the number of seedlings, age categories of the herbaceous species was recorded from three randomly identified plots, each the size of an A4 sheet of paper (30 cm x 21 cm). When all age categories, young, medium aged and old plants of the dominant species are present, the maximum score of 5 points 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. When there are only young plants, the minimum score of 1 point was given.

Soil erosion (0-5 points) and soil compaction (1-5 points)

In each quadrat of the study areas, the extent of soil erosion and compaction were evaluated by visual observations and a corresponding score was assigned in each case. Soil erosion assessment was based on the amount of pedestals (higher parts of the soils, held together by plant roots, with eroded soil around the tuft), and in severe cases, the presence of pavements (terraces of flat soil, normally with basal cover, with a line of tufts between pavements). The maximum score (5 points) was given for no sign of erosion, while the following points 4 for slight sand mulch, 3 for weak pedestals, 2 for steep sided pedestals, 1 for pavements and 0 for gullies, respectively.Soil compaction was assessed based on the amount of capping (crust formation), following the suggestion of Baars*et al.* (1997). Thus, a range of points (1-5) were 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.

Statistical analysis

From each range site composite samples of the four quadrates of 0.5 m x 0.5 m (0.25 m^2) was considered as an experimental unit. The composite samples were sorted out by districts and major grazing types. Thereafter, the data was subjected to ANOVA. Accordingly, 33 samples fell in the Itang district and 36 in Jikawo (a total of 69 samples) were used for the analysis. For the woody vegetation, from each range site, 20 m x 20 m (400 m^2) quadrat was used as an experimental unit. Accordingly, a total of 46 samples (22 from Itang and 24 from Jikawo) were used for data analysis. The data obtained from the vegetation and soil variables were subjected to ANOVA using the GLM procedure of Statistical Analytical System (SAS) (1999) computer software. Duncan's Multiple Range Test was used for mean comparison. To determine the relationship of biomass with grazing types, districts and range condition rating, linear regression procedure was used.

RESULTS AND DISCUSSION

Effect of grazing on range condition at different district levelsRange condition in Itang district

Range condition of major grazing areas of Itang district is presented in Table 1. There was significant difference ($p<0.05$) among the major grazing areas found in the district in terms of grass species composition, number of seedlings, age distribution, soil erosion and compaction and total score. These parameters were highest in the relatively less grazed areas followed by the seasonally and communally grazed areas. The least scores were recorded in the river basins. The most likely reason for the highest score of all vegetation and soil attributes in the relatively less grazed areas of Itang district could be due to the lower livestock density associated with reduced grazing impacts.Among the major grazing areas of the district, there was highly significant ($p<0.05$) difference in their graminoids' species composition.

The grass species composition of relatively less grazed areas dominated by decreasers (48.1%) such as *Pennisetumadoense* and climax increasers (39.6%) like *Hyparrheniarufa*, were highest of all other major grazing areas of Itang district. In terms of their grass species composition, the moderately (seasonally) grazed areas which was also dominated by increasers (48.7%) such as *Hyparrheniafilipendula* and decreasers (33.5%) like *Brachiariaxantholeuca*, were significantly ($p<0.05$) higher than the communally grazed areas and the river basins. Among the major grazing areas in Itang district, the river basins, which were heavily grazed, exhibited low species composition and these were dominated by less palatable increaser (60%) such as *Echinochloapyramidelis* and undesirable invaders (32.1%), like *Pennisetumglabrum* and *Setariaverticillata.*

Table 1. Range condition score (LSM ï SE) of major grazing areas in Itang district

	Grazing areas					
Parameters	LG	SG	CG	RB	CV	CR
Gsc	5.61 ± 0.04^{a}	4.61 ± 0.05^{b}	3.22 ± 0.04^{c}	1.72 ± 0.04^{d}	6.79	0.260
Bc	9.72 ± 0.04^{a}	8.46 ± 0.05^{b}	8.25 ± 0.04^{b}	7.97 ± 0.04^{c}	2.78	0.245
Lc	2.86 ± 0.02^{a}	2.42 ± 0.03^{b}	0.00 ± 0.02^{c}	0.00 ± 0.02^{c}	11.77	0.147
Ns	4.79 ± 0.06^{a}	2.72 ± 0.08^{b}	2.00 ± 0.06^{c}	1.04 ± 0.06^{d}	14.47	0.389
Ad	4.71 ± 0.06^{a}	3.06 ± 0.07^{b}	2.26 ± 0.06^{c}	1.48 ± 0.06^{d}	11.76	0.344
Ser	4.33 ± 0.05^{a}	3.83 ± 0.06^{b}	3.11 ± 0.05^{c}	1.97 ± 0.05^{d}	8.82	0.249
Scp	4.22 ± 0.05^{a}	3.54 ± 0.06^{b}	2.92 ± 0.05^{c}	1.64 ± 0.05^{d}	9.66	0.300
Ts	36.23 ± 0.16^{a}	28.78 ± 0.20^{b}	21.76 ± 0.16^{c}	15.82 ± 0.16^{d}	3.69	0.956
Rc	Good	Fair	Fair	Poor		

Gsc = Grass species composition; Bc = Basal cover; Lc = Litter cover; Ns = Number of seedlings; Ad = Age distribution; Ser = Soil erosion; Scp = Soil compaction; Ts = Total score; Rc = Range condition class; LG = Less grazed; SG = Seasonally grazed; CG = Communally grazed; RB = River basins; CV= Coefficient of variation; CR= Critical range; Means with different letters in a row are significantly different ($p<0.05$).

Table 2. Range condition score (LSM ï SE) of major grazing areas in Jikawo district

	Grazing areas					
Parameters	LG	SG	CG	RB	CV	CR
Gsc	4.83 ± 0.05^{a}	4.53 ± 0.05^{b}	2.89 ± 0.05^{c}	1.39 ± 0.05^{d}	8.33	0.273
Bc	9.69 ± 0.04^{a}	8.42 ± 0.04^{b}	7.61 ± 0.04^{c}	7.08 ± 0.04^{d}	3.13	0.247
Lc	2.75 ± 0.04^{a}	2.33 ± 0.04^{b}	0.00 ± 0.04^{c}	0.00 ± 0.04^{c}	17.73	0.216
Ns	4.67 ± 0.05^{a}	2.67 ± 0.05^{b}	1.26 ± 0.05^{c}	0.22 ± 0.05^{d}	14.55	0.308
Ad	4.52 ± 0.05^{a}	2.93 ± 0.05^{b}	1.93 ± 0.05^{c}	1.33 ± 0.05^{d}	12.30	0.316
Ser	4.25 ± 0.05^{a}	3.25 ± 0.05^{b}	2.47 ± 0.05^{c}	1.94 ± 0.05^{d}	9.43	0.270
Scp	4.19 ± 0.06^{a}	3.08 ± 0.06^{b}	2.53 ± 0.06^{c}	1.61 ± 0.06^{d}	11.66	0.319
Ts	34.91 ± 0.16^{a}	27.20 ± 0.16^{b}	18.69 ± 0.16^{c}	13.58 ± 0.16^{d}	4.15	0.940
Rc	Good	Fair	Poor	Poor		

Gsc = Grass species composition; Bc = Basal cover; Lc = Litter cover; Ns = Number of seedlings; Ad = Age distribution; Ser = Soil erosion; Scp = Soil compaction; Ts = Total score; Rc =Range condition class; LG = Less grazed; SG = Seasonally grazed; CG = Communally grazed; RB =River basins; CV= Coefficient of variation; CR= Critical range;Means with different letters in a row are significantly different ($p<0.05$).

Table 3. Range condition score (LSM ï SE) of relatively less grazed areas of the study districts

	Districts			
Parameters	Itang	Jikawo	CV	CR
Gsc	5.61 ± 0.09^{a}	4.83 ± 0.09^{b}	7.00	0.365
Bc	9.72 ± 0.05^{a}	9.69 ± 0.05^{a}	2.05	0.202
Lc	2.86 ± 0.07^{a}	2.75 ± 0.07^{a}	10.02	0.281
Ns	4.79 ± 0.08^{a}	4.67 ± 0.08^{a}	7.06	0.333
Ad	4.71 ± 0.09^{a}	4.52 ± 0.09^{a}	7.89	0.364
Ser	4.33 ± 0.08^{a}	4.25 ± 0.08^{a}	7.43	0.319
Scp	4.22 ± 0.09^{a}	4.19 ± 0.09^{a}	9.67	0.407
Ts	36.23 ± 0.25^{a}	34.91 ± 0.25^{b}	3.03	1.077
Rc	Good	Good		

Gsc = Grass species composition; Bc = Basal cover; Lc = Litter cover; Ns = Number of seedlings; Ad = Age distribution; Ser = Soil erosion; Scp = Soil compaction; Ts = Total score; Rc = Range condition class; CV= Coefficient of variation; CR= Critical range; Means with different letters in a row are significantly different ($p<0.05$).

Table 4. Range condition score (LSM ï SE) of seasonally grazed areas of the study districts

	Districts			
Parameters	Itang	Jikawo	CV	CR
Gsc	4.75 ± 0.05^{a}	4.53 ± 0.04^{b}	3.32	0.175
Bc	8.64 ± 0.05^{a}	8.42 ± 0.04^{a}	2.15	0.206
Lc	2.42 ± 0.09^{a}	2.33 ± 0.06^{a}	11.47	0.309
Ns	2.72 ± 0.12^{a}	2.67 ± 0.09^{a}	14.92	0.457
Ad	3.06 ± 0.10^{a}	2.93 ± 0.08^{a}	13.24	0.449
Ser	3.83 ± 0.09^{a}	3.25 ± 0.08^{b}	9.19	0.365
Scp	3.54 ± 0.05^{a}	3.08 ± 0.04^{b}	4.67	0.174
Ts	28.78 ± 0.25^{a}	27.20 ± 0.21^{b}	3.13	0.991
Rc	Fair	Fair		

Gsc = Grass species composition; Bc = Basal cover; Lc = Litter cover; Ns = Number of seedlings; Ad = Age distribution; Ser = Soil erosion; Scp = Soil compaction; Ts = Total score; Rc = Range condition class; CV= Coefficient of variation; CR= Critical range; Means with different letters in a row are significantly different ($p<0.05$).

The above result agreed with the reports of number of researchers (Baars*et al*., 1997; Ayana, 1999; Amsalu, 2000; Abule*et al*., 2005) who stated that within plant communities, changes of vegetation composition resulted in an orderly and predictable way by grazing pressure. Furthermore, as grazing pressure continued, with the death of the most desirable species (decreasers), the relatively less palatable (increasers) dominate. Eventually, the climax vegetation could disappear and replaced by the undesirable invasive plant communities.The basal cover of relatively less grazed areas were significantly (p<0.05) highest of all other grazing areas, while the river basins scored the lowest. On the other hand, there were no significant differences among seasonally and communally grazed areas of Itang district in their basal cover scores. The litter cover of relatively less grazed areas were significantly (p<0.05) highest of all other grazing areas. Seasonally grazed areas, in their litter cover were significantly (p<0.05) higher than communally grazed and river basins. In terms of their litter cover, the communally grazed areas and river basins were similar.In the river basins, the soil erosion and compaction scores were significantly (p<0.05) least followed by the communally grazed areas. This indicated that the soil was relatively eroded and compacted. The most likely reason might be the use of the river basins as a major grazing area, besides being the primary sources of water throughout the year and across seasons. Consequently, trampling pressure became relatively highest in the banks as compared to the other grazing areas. In agreement with the study conducted by Amsalu (2000), in the mid rift valleys, the use of lake shores both for livestock grazing and watering sources resulted with the higher trampling effects in the areas.

Among the major grazing areas of Itang district, there were a highly significant (p<0.05) difference in the total range condition score. The relatively less grazed areas were significantly (p<0.05) the highest of all other grazing areas followed by seasonally (moderately) grazed areas. Based on the total range condition score of 36.2, the relatively less grazed areas were classified as ‘Good’, while the seasonally and communally grazed areas were both in ‘Fair’ condition class, with total score of 28.8 and 21.8, respectively. On the other hand, with an average mean score of 15.8, the river banks were significantly (p<0.05) the least of all other grazing areas and thus classified as poor ranges.The present study revealed that, the possible cause of variability in the total range condition of the grazing areas would be the difference in the degree of grazing pressure in the grazing areas. As grazing pressure decreased from heavily grazed river basins to relatively less grazed areas, the overall condition of the range increased from 15.8 (poor) to 36.2 (good). In agreement with the finding of Amsalu (2000), by which in the bottom altitude as compared to the relatively less grazed enclosures of the mid rift valley, the heavily grazed lake shores were in poor range condition.

Range condition in Jikawo District

Range condition of major grazing areas of Jikawodistrict is presented in Table 2. Among the major grazing areas of Jikawo district, there were significant (p<0.05) difference in grass species composition. The relatively less grazed areas, composed of decreasers (32.4%) such as *Pennisetumclandestinum* and *Eragrostispillosa* and increasers (51.4%) like *Hyparrheniarufa* and *Digitariaadscendense*, were significantly (p<0.05) the highest of all grazing areas. The moderately (seasonally) grazed areas were significantly (p<0.05) lower than those of relatively less grazed areas, but significantly (p<0.05) higher than the communally grazed and river basins. In terms of their grass species composition, river basins were significantly (p<0.05) the least of all grazing areas in the district.The most likely reason for this could be the dominance of invaders such as *Pennisetumglabrum* and *Setariaverticillata*, in the river banks, constituting about 53.4% of the total grass species composition, followed by the dominance of less palatable (increasers) such as *Echinochloapyramidelis* and *Erochloaprocera*, having 37.8% of the total grasses composition. The communally grazed areas of Jikawo district were also significantly (p<0.05) lower, in terms of their grass species composition, than those of the relatively less grazed and moderately (seasonally) grazed. The dominance of increasers (62.4%) such as *Erioachloaprocera* and invaders like *Eragrostistremula*, with 25.5% species composition of the total grasses, attributed for the lower score of the grass species composition of the communally grazed areas.In the communally grazed areas and river basins, there were high stocking rate. Under such situation, the less palatable (increasers*)* Hyparrhenia species, which were dominant in the relatively less and moderately grazed areas were replaced by Echinachloaspecies in the communally grazed areas and Eriochloaspecies in the river banks.The above result agreed with the reports of Harrington and Pratchett (1974) who stated that, under heavily stocking the Hypparhenia species dominated pasture had been changed to a pasture dominated by short grass species such as *Cynodondactylon, Digitariasetivalva, Heteropogoncontortus, Microchloacaffra*and*Brachiariadecumbens*, which are more palatable grasses.

In all grazing areas of the entire Nuer zone, the litter coverage was uncommon. This might be likely associated with the extreme aridity of the regional state in general and the grasslands of Nuer zone in particular that promotes rapid decomposition of the litter. Since, this explanation holds true with the argument of Oba et al. (2001), that, in arid environments, due to fast turn-over of materials, extremity of temperature and increased grazing pressures, accumulation of litter cover becomes highly dynamic. There was significant (p<0.05) difference among the major grazing areas of Jikawo district in the soil attributes. Soil erosion and compaction scores of relatively less grazed areas were significantly (p<0.05) the highest of all grazing areas. Seasonally grazed areas were higher (p<0.05) in their soil erosion and compaction scores than the communally grazed areas and river basins but significantly (p<0.05) lower than those of relatively less grazed areas.On the other hand, soil erosion and compaction were observed to be highest in the river basins followed by communally grazed areas. This implies that, in these areas, the stocking rate and grazing pressures were high. Most likely, as a result of high stocking rate and increased grazing pressure, trampling effects might exist and further resulted in an increased bulk density of the soil and reduction in infiltration of the soil. The range condition of relatively less grazed areas, with a total score of 34.9 and good condition class, were significantly (p<0.05) the highest of all grazing areas. With a mean total score of 27.2 and having a ‘Fair’ range class, seasonally (moderately) grazed areas were significantly (p<0.05) higher than those of communally grazed and river banks. The range condition class of communally grazed and river basins were poor with total scores of 18.7 and 13.6, respectively.In general, based on the range condition assessment and the present context of the district itself, as grazing pressure increases from less grazed areas to heavily grazed river basins as well as communally grazed areas, the range condition of the major grazing areas decreased from ‘good’ to ‘poor’ condition. Furthermore, in line with the explanation of Amsalu (2000), as range condition class improves from poor to good, species composition changes from less to highly palatable plant communities. Since, the study revealed that, species composition scores of the major grazing areas possess similarities in their trend to those of the range condition classes.

Effect of district on range condition at different grazing levels

Less grazed areas

Range condition of relatively less grazed areas in the study districts is presented in Table 3. Relatively less grazed areas of the two districts, constituted almost 95% of increasers and decreasers out of the grass species composition nearer to their climax stages. In rating this parameter, the relatively less grazed areas of Itang were significantly (p<0.05) higher than those found in Jikawo district.In basal cover, litter cover, number of seedlings, age distribution and soil condition parameters there were no significant difference between the relatively less grazed areas of the two districts. According to the total condition scores, the relatively less grazed areas in Itang were significantly (p<0.05) higher than those located in Jikawo, but all of them classified as ‘Good’.

Seasonally grazed areas

Range condition of seasonally grazed areas in the study districts is presented in Table 4.Grass species composition rating was significantly (p<0.05) higher in the seasonally grazed areas of Itang than those found in Jikawo. This could most likely be related with the relatively low livestock density along with relatively less grazing pressure and further less climax vegetation change in Itang district. Moreover, the prolonged in dating of flood in the dry season grazing (communally grazed) areas led the pastoralists in Jikawo to utilize their seasonal grazing areas intensively. Between the seasonally grazed areas of the two districts, there were no significant variations in basal cover, litter cover, number of seedlings per unit area and vegetation structures.Soil erosion and compaction scores of the seasonally grazed areas found in Jikawo district were significantly (p<0.05) lower than those located in Itang. The total range condition score of seasonally grazed areas of Itang recorded to be significantly (p<0.05) higher. The range conditions of these grazing types were in ‘Fair’ class.

Communally grazed areas

Range condition of communally grazed areas in the study districts is presented in Table 5.Except the litter cover there were significant (p<0.05) differences regarding other

Table 5. Range condition score (LSM ï SE) of communally grazed areas of the study districts

	Districts			
Parameters	Itang	Jikawo	CV	CR
Gsc	3.22±0.12^{a}	2.89±0.12^{b}	8.46	0.258
Bc	8.25±0.08^{a}	7.61±0.08^{b}	3.46	0.267
Lc	0.00±0.00^{a}	0.00±0.00^{a}	-	0.000
Ns	2.00±0.08^{a}	1.26±0.08^{b}	22.65	0.369
Ad	2.26±0.09^{a}	1.93±0.09^{b}	13.23	0.276
Ser	3.11±0.11^{a}	2.47±0.11^{b}	10.29	0.287
Scp	2.92±0.10^{a}	2.53±0.10^{b}	9.98	0.272
Ts	21.76±0.29^{a}	18.69±0.29^{b}	4.23	0.855
Rc	Fair	Poor		

Gsc = Grass species composition; Bc = Basal cover; Lc = Litter cover; Ns = Number of seedlings; Ad = Age distribution; Ser = Soil erosion; Scp = Soil compaction; Ts = Total score; Rc = Range condition class; CV= Coefficient of variation; CR= Critical range; Means with different letters in a row are significantly different (p<0.05).

Table 6. Range condition score (LSM ï SE) of river basins of the study districts

	Districts			
Parameters	Itang	Jikawo	CV	CR
Gsc	1.72±0.06^{a}	1.39±0.06^{b}	15.63	0.243
Bc	7.97±0.07^{a}	7.08±0.07^{b}	4.14	0.312
Lc	0.00±0.00^{a}	0.00±0.00^{a}	-	0.000
Ns	1.04±0.07^{a}	0.22±0.07^{b}	47.58	0.299
Ad	1.48±0.07^{a}	1.33±0.07^{a}	20.81	0.293
Ser	1.97±0.05^{a}	1.94±0.05^{a}	10.30	0.202
Scp	1.64±0.08^{a}	1.61±0.08^{a}	21.22	0.345
Ts	15.82±0.23^{a}	13.58±0.23^{b}	6.77	0.995
Rc	Poor	Poor		

Gsc = Grass species composition; Bc = Basal cover; Lc = Litter cover; Ns = Number of seedlings; Ad = Age distribution; Ser = Soil erosion; Scp = Soil compaction; Ts = Total score; Rc = Range condition class; CV= Coefficient of variation; CR= Critical range; Means with different letters in a row are significantly different (p<0.05).

vegetation and soil attributes between communal grazing areas of the two districts. The total condition score of communally grazed areas of Itang district was significantly ($p<0.05$) higher as compared to those of Jikawo. Jikawo district has been known for its highest livestock population in the regional state. Furthermore, from the pastoralists' perception it was understood that, shortage of grazing lands (communal grazing areas) has been a constraint. As a result, the available communal lands overstocked beyond their capacity to carry the maximum livestock number. Accordingly, the communally grazed areas of Jikawo district classified under 'poor' condition class, while those found in Itang were within a condition of 'fair' class.

River basins

Range condition of river basins in the study districts is presented in Table 6. In their scores of grass species composition, basal cover and number of seedlings, river banks in Itang district were significantly ($p<0.05$) higher than those located in Jikawo. There were no significant variation in terms of litter cover, age distribution and soil condition scores between the river basins of the two districts.Total range condition score of river basins in Jikawo was significantly ($p<0.05$) lower than those found in Itang district. However, their condition classified as 'poor' as those of Itang, indicating, the deterioration of these areas, which resulted from their use as a sacrifice.

Interaction effect of grazing and district on range condition

Two-way analysis of variance showed a significant ($p<0.05$) interaction existed between districts and grazing types, in terms of grass species composition, basal cover, number of seedlings per unit area, soil erosion and total range condition. Variability in the grazing pressure between the districts might be partly the possible reason for the interaction effect on the above parameters. In line with the reports of Ayana (1999) and Amsalu (2000), similar areas in similar condition will respond in same way to the same management strategies. Accordingly, in the present study, due to variability in the vegetation community structures resulted from the impacts of biotic and abiotic components within the ecosystem.

Conclusion

The present findings clearly showed that the current rangeland condition has deteriorated and highly affected by over grazing and invasion of unwanted species. The communal grazing lands and river basins have been over grazed due to overstocking. This situation has been a threat for the livelihood of the pastoral community in the districts and should be reverted through employing proper grazing systems (grassland management practices), rehabilitation and conservation. The range condition analysis in this study was based on a single season data where such parameters could be influenced by both spatial and temporal variations. Therefore, further studies need to be carried out on the basis of different deriving factors so as to finally produce unbiased information on the range resources and potentials.

Acknowledgements

The authors are grateful the Federal Agricultural ATVET and Extension Department of Ministry of Agriculture (MoA) for funding the research project. The supports of Haramaya University, GambellaPeoples Regional State Council, Gambella Bureau of Agricultural Development, Gambella Agricultural Research Institute and Gambella ATVET College are also acknowledged. The authors would like to extend their appreciation to the contributions of Nuer pastoralists.

REFERENCES

Abule, E., Snyman, H.A.&Smit, G.N. 2005. Comparisons of pastoralists perceptions aboutrangeland resource utilization in the middle Awash valley of Ethiopia. *J. Environ. Manage.*, 75, 21-35.

Ahmed, B.2003. Soil condition & vegetation cover in human impacted rangelands of Jijiga, Somali Regional State. M.Sc. Thesis.AlemayaUniver., Ethiopia.

Alemayehu, M.2004. Rangeland Biodiversity: Concepts, Approaches &the wayforward. Addis Ababa University, Faculty of Science, Addis Ababa,Ethiopia.80p.

Amaha, K.2006. Characterzation of rangeland resources &dynamices of the pastoral Production system in the Somali region of Estern Ethiopia. Ph.D. Thesis. The Free StateUniver., Bloemfontein, South Africa.

Amsalu, S.2000. Herbaceous species composition, dry matter production & condition of the major grazing areas in the mid rift valley. M.Sc. Thesis.AlemayaUniver., Ethiopia.

Ayana, A.1999. Range condition & traditional grazing management in Borana. M.Sc. Thesis.AlemayaUniver., Ethiopia.

Baars, R.M.T., Chileshe,E.C.&Kalokoni, D.M. 1997. Technical note: range condition in cattle density areas in the western province of Zambia. Tropical Grassland, 31,569-573.

Belaynesh, D. 2006. Floristic composition & diversity of the vegetation, soil seed bank flora & condition of the rangelands of the Jijiga Zone, Somali Regional State, Ethiopia. M.Sc. Thesis.AlemayaUniver., Ethiopia.

Beruk, Y. 2003.The declining pastoral environment & variability status & adaptation strategies. Pp. 155-164. Proceedings of the Challenges & Opportunities of Livestock Marketing. The 10th annual conference of Ethiopia Society of Animal Production, Addis Ababa, Ethiopia, 22-24 August 2003.

Blench, R. & Sommer, F. 1999. Understanding Rangeland Biodiversity. ODI (Overseas Development Institute), Portland house, stage plane, London. Working paper 121.

BLPDP(Borana Lowland Pastoral Development Programme). 2004. Overview of Borana Pastoral Production Livelihood System. Extension-, PRA- and M+E- Concepts Networking &Policy Advocacy. BLPDP, Documentation on 7 years experience, Vol. I. December, 2004. Addis Ababa, Ethiopia.

Coppock, D.L.1993.Vegetation & pastoral dynamics in the southern Ethiopia rangelands: Implications for theory & management. Pp.42-61. In: Behnke, R.H.J., Scoones, I.&Kerven,C. (eds.). Range ecology at disequilibrium. New model of natural variability &pastoral adaptation in African Savanna. Overseas Development Institute, London, UK.

Coppock, D.L.1994.The Borana Plateau of Southern Ethiopia: Synthesis of pastoralresearch, development & change, 1980-1991. International Livestock Center for Africa (ILCA), Addis Ababa, Ethiopia.393p.

Dyksterhuis, E.J.1949. Condition & management of rangeland based on quantitative ecology. *J. Range Manage.*, 2,104-115.

EARO (Ethiopia Agricultural Research Organization), 2000. Dry land Agriculture Research Strategic Planning Document. Addis Ababa, Ethiopia. 66p.

Friedel, M.H., Laycock,W.A. & Basin, G.N. 2000. Assessing rangeland condition & trend. Pp.227-261. In:MannetjeL.T. & Jones,R.M. (eds.). Field Laboratory Methods for Grassland & Animal Production Research. CABI, UK.

Gemedo-Dalle, T. 2004. Vegetation ecology, rangeland condition & forage resources evaluation in the Borana lowlands, Southern Ethiopia. Ph.D. Dissertation. Georg-AudustUniver.,Gottingerg, Germany.

GRS (Gambella Regional State), 2003. Gambella Regional Land-use & Land Allotment Study. Amended Draft Final Report, Vol. II. Yeshi-Ber Consult (YBC). October 2003, Addis Ababa, Ethiopia.

Harrington, G. N.& Pratchett, D. 1974. Stocking rate trials in Ankole, Uganda: I. Weight gain of Ankole steers at intermediate & heavy stocking rates under different managements. J. Agric. Sci., 82, 497-506.

Herlocker, D.J. 1999. Rangeland Ecology & Resource Development in Eastern Africa. Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), Nairobi, Kenya. 393p.

IAR (Institute of Agricultural Research), 1990. Abobo Research Center Progress Report 1988-1989. IAR, Addis Ababa, Ethiopia.

IFAD (International Fund for Agricultural Development), 1995. Common property resources& the rural poor in sub-Saharan Africa. IFAD, Rome, Italy. p75.

ILCA (International Livestock Center for Africa), 1990. Livestock Research Manual. ILCA, Addis Ababa, Ethiopia. 2:31-54.

Ivy, P. 1969.Veld Condition Assessments.Pp.105-111. Proceedings of Veld Management Conference. Bulawayo, Zimbabwe, 27-31 May 1969.

Niamir, M. 1991.Traditional Africa range management techniques: Implications for rangeland management. Overseas Development Institute (ODI), London, UK.

Niamir, M. 1999. International aid for rangeland development: Trends & challenges. Pp. 147-152. In: Eldridge, D. & Freudenberger, D. (eds.). Proceedings of the 6th International Rangel and Congress, Towns-Ville, Australia, 17-23 July 1999.

Oba, G.2001. Indigenous ecological knowledge of landscape change in East Africa. International Association for Landscape Ecology Bulletin, 19(3): 1-3.

PADS (Pastoral Areas Development Study), 2004. Review of the past & present trends of the pastoral areas. Pp.1-34. Livestock Resources. PADS Report Phase I. Section I, Vol.II, Techniplan, MCE, Agristudio, Addis Ababa and Rome.

PFE (Pastoralist Forum Ethiopia), 2001.Poverty Reduction Strategy & Pastoral Development. Proceedings of the Second National Conference on Pastoral Development in Ethiopia. 22-23 May 2001, Addis Ababa, Ethiopia, Pastoralists Forum Ethiopia

PFE (Pastoralist Forum Ethiopia), 2004. Pastoralism & sustainable pastoral development. Proceedings of the Third National Conference on Pastoral Development in Ethiopia. 23-24 December 2003,Addis Ababa, Ethiopia,Pastoralists Forum Ethiopia.

Russell, A. 1984. The environment of Ethiopia Rift Valley compared to other areas of Africa. In: Richard Stewart, (ed.). ILCA Bulletin No. 17. ILCA. Addis Ababa, Ethiopia.

Sabine, H.& Rischkowsky, B. 2005. Integrating the indigenous knowledge of Borana pastoralists into rangeland management strategies in southern Ethiopia. June 2005. IKNotes 81.

Sabine,H., Dalle D. &Rischkowsky, B. 2004.Potentials & constraints of indigenous knowledge for sustainable range & water development in pastoral land use systems of Africa: A case study in the Borana lowlands of southern Ethiopia. Tropical Support Programme Publication (TOEB), GTZ, Eschborn, 123 p.

SAS (Statistical Analysis System), 1999. Institute of Applied Statistics & SAS Programming Language. Cary, North Carolina.

Tainton, N.M. 1981. The assessment of veld condition. Pp.46-55. In: TaintonN.M. (ed.). Veld management in South Africa. University of Natal Press, Pietermarizburg, South Africa.

****