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RANGELANDS VEGETATION UNDER DIFFERENT MANAGEMENT SYSTEMS AND GROWTH STAGES IN NORTH DARFUR STATE, SUDAN (RANGE ATTRIBUTES)

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Abstract

This study was conducted at Um Kaddada, North Darfur State, Sudan, at two sites (closed and open) for two consecutive seasons 2008 and 2009 during flowering and seed setting stages to evaluate range attributes at the locality. A split plot design was used to study vegetation attributes. Factors studied were management systems (closed and open) and growth stages (flowering and seed setting). Vegetation cover, plant density, carrying capacity, and biomass production were assessed. Chemical analyses were done for selected plants to determine their nutritive values. The results showed high significant differences in vegetation attributes (density, cover and biomass production) between closed and open areas. Closed areas had higher carrying capacity compared to open rangelands. Crude protein (CP) and ash contents of range vegetation were found to decrease while Crude fiber (CF) and Dry matter yield (DM) had increased with growth. The study concluded that closed rangelands are better than open rangelands because it fenced and protected. Erosion index and vegetation degradation rate were very high. Future research work is needed to assess rangelands characteristics and habitat condition across different ecological zones in North Darfur State, Sudan.

Keywords: rangelands, Management system, Growth stage

Introduction

Sudan has diverse agro-climatic zones ranging from desert in the north to humid equatorial in the south, that contain vast and large natural rangelands suitable for grazing for all kinds of animals. Pastoral and agro-pastoral systems are the mainstay of the economy of the region. Livestock and its products are the primary source of income for over 60% of the population.

North Darfur State is unique in its natural rangelands; being homeland for many nomadic tribes, capable of sustaining all kinds of livestock; and many livestock routes cross the area. Rangelands face many problems; these include seasonal fluctuation in feed quantity and quality, land degradation and desert encroachment, erratic rainfall and expansion of both traditional and mechanized rainfed cultivation. In addition to cutting of browse trees and fodder plants for fuel and houses construction, water shortage and diseases prevalence resulted in range deterioration and movement of animals.

The balance between animals and feed does not exist in North Darfur State for the time being, and the number of animals is by far exceeding what the land is offering. Therefore, with the prevailing systems of production, the negative impact on the land and the environment would be expected to continue. These constraints may be reflected in severe deterioration in both quality and quantity of rangelands and consequently reduced livestock productivity. Therefore, detailed evaluation of vegetation is necessary to describe the current status of rangelands in North Darfur State, comparing these measurements over time to detect the change that has happened to rangeland, using ground measurements. Such monitoring would enable setting up strategies and measures aiming at alleviating constraints and improving productivity.

Study area

This study was conducted at Um Kaddada, North Darfur State, Sudan, located in the eastern part of North Darfur State of western Sudan (167 km from Elfasher - Capital of North Darfur State (Figure 1), covering an area of about 15000 km^2 (Ministry of Agriculture, Animal Resources and Irrigation 2006). The study area is part of what is called sedentary zone, located between zones of camel-owning nomads to the north and cattle owners to the south. The area is dominantly inhabited by Barti tribes accustomed to a sedentary life and is more attached to their lands, representing indigenous pastoralism for livelihoods than other tribes of the region.

Yousif (2005) designates the area as part of the Sudan arid zone, Annual precipitation is ranging between 100 – 170mm.

Since 1980, there have been only four occasions where the rainfall has exceeded 200mm at Um Kaddada locality. That was in 1986, 1992, 1994 and 2000. In almost all other years during this period up to 2009 total annual rainfall has been below 160 mm, (Table 1). The mean annual relative humidity is 24.3% which decreases to 13% in the drier months of winter and summer and increases to 51% in the wet season (July – September). The mean, minimum and maximum temperatures are 17C^{o} and 35C^{o} respectively; temperature can reach up to 40C^{o} during the hot summer months (Elfasher metrological station, 2009).

Um Kaddada Locality

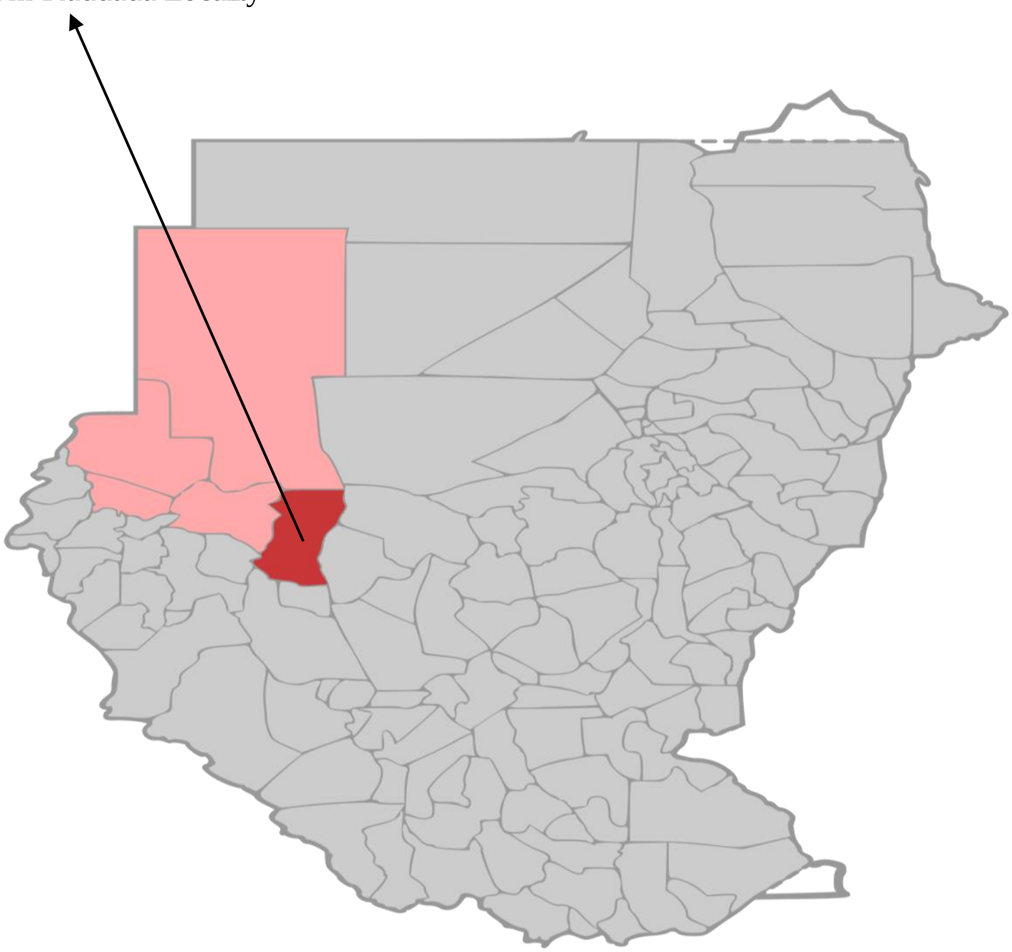

Figure 1: Location Map of the study area. North Darfur State, Sudan

Source: UN Cartographic Section, (2004)

Table 1. Rainfall in Um Kaddada locality (2008 and 2009)

month / period	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Total
2008	3.3	7	-	31.4	18.9	80.9	141.5
2009	-	-	-	38.3	61.8	47	147.1
Average	1.7	3.5	-	34.9	40.4	64	144.3

Source: Um Kaddada Meteorological Station (2009)

Materials and methods

The field work was carried out during onset of rainy season (Flowering stage) and end of rainy days (Seed setting stage) (late August and late October) for two consecutive years (2008 and 2009). The samples were collected from two sites (protected and open area) at Eastern part of Um Kaddada town. According to Khatir (2006), two points were chosen at each site. Within each point eight transects of 100m length were laid in a radiating manner, two quadrates in each transect were chosen, total of quadrates in each point were sixteen (Figure 2).

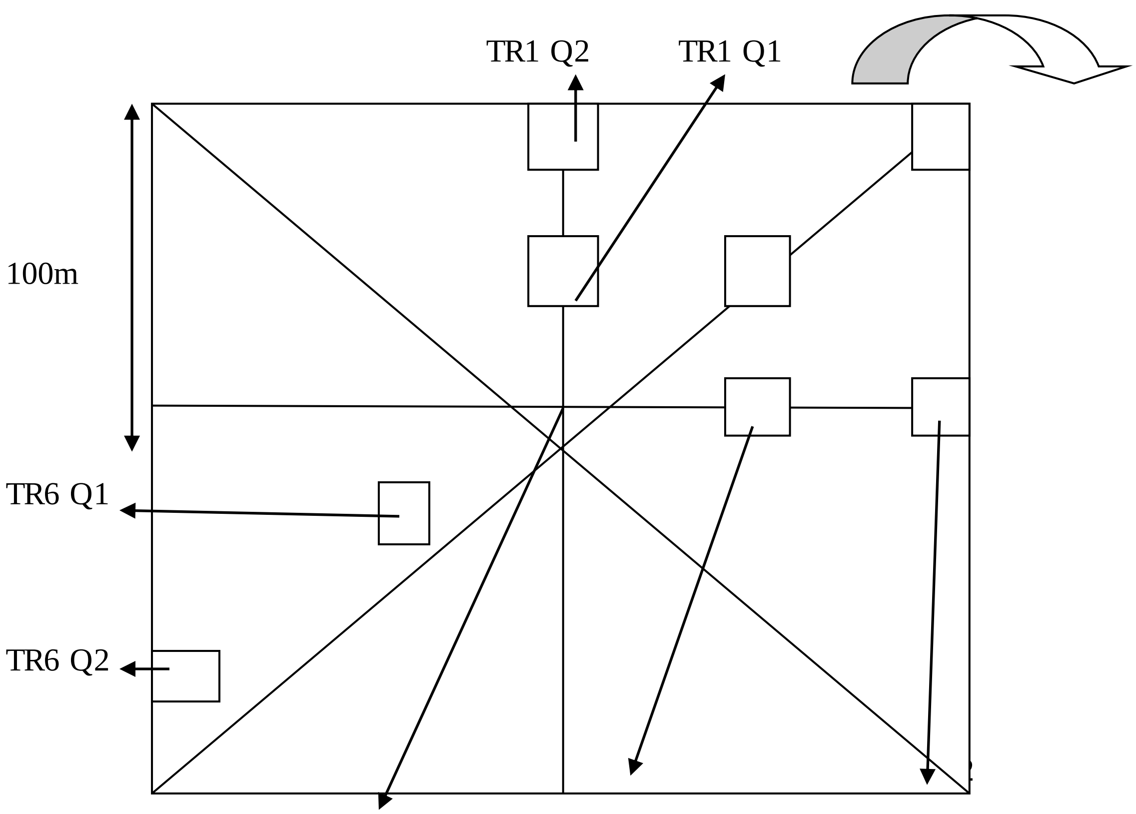

Figure 2. The layout of transects within the sampling area in each point

TR 1, 2,…. = Transect 1, Transect 2 ..etc
Q1, 2,… = Quadrate1, Quadrate2, …etc

Information used in the attainment of this study included both primary and secondary data. Primary data of vegetation measurements were collected from closed and open rangelands through intensive field surveys, and secondary data was obtained through various standard published and unpublished literatures.

The following data were collected:

Plant density (plants/m^2), %Vegetation cover, Carrying capacity and Range production (gram/m^2)

Measurement tools used include the following:

Measuring tape (100-meter), recording sheet, pair of scissors, quadrate (1mx1m), paper bags and sensitive balance

Statistical analysis

Data were arranged in split-plot design, taking ecological zone as main plot and the season as sub-plot (Steel and Torrie, 1980), growth stage was also taken as a factor and considered as a sub-sub plot. The data was first analyzed for each season separately then combined for the two seasons. SPSS software program was used for statistical analyses.

Chemical Analysis

Table (2) showed the contents of %dry matter yield (DM), %ash, %crude protein (CP) and %crude fiber (CF) for species Dactyloctenium aegyptium, Chloris prieurii, Blepharis linarifolia, Eragrostis aspera, Echinocloa colonum, Aristida sp., Cenchrus biflorus and Chloris virgata).

Table 2. Chemical analysis for the dominant species

Species	DM%	Ash%	CP%	CF%
Dactyloctenium aegyptium	96.7	10.44	11.01	49.31
Chloris prieurii	97.72	13.90	6.66	35.04
Blepharis linarifolia	97.09	8.24	9.13	57.96
Eragrostis aspera	96.60	4.55	2.34	37.96
Echinocloa colonum	98.15	8.94	4.86	48.77
Aristida sp	97.04	5.98	3.32	53.14
Cenchrus biflorus	97.21	11.49	6.42	55.43
Chloris virgata	97.31	8.01	3.44	35.31

DM = Dry Matter, CP = Crude Protein, CF = Crude Fiber

Results

The effects of management and growth stage on range attributes during the first season (2008) are shown in Tables (3). Management had significant ($P<0.01$) main effects on density (plant/m^2), %vegetation cover and biomass production (kg/ha). Closed area had higher range attributes (density, cover and biomass production) in comparison with open rangelands (Table 3). Growth stage significantly ($P<0.01$) affected density and vegetation cover, ($P<0.05$) biomass production. The highest range attributes were during the flowering stage (Table 3).

Management x growth stage interaction ($P<0.01$) effects were significant on density, ($P<0.05$) cover and biomass production. Range attributes in closed area during seed setting had the highest density while the open area during seed setting had the lowest density. Closed area during flowering stage had highest vegetation and biomass production whereas open rangelands during seed setting had the lowest vegetation cover and biomass production (Table 3).

Table (4) shows the effects of management and growth stage on range attributes during the second season (2009). Management had significant ($P<0.01$) main effects on density (plant/m^2), %vegetation cover and biomass production (kg/ha). Closed area had higher range attributes (density, cover and biomass production) compared with open rangelands (Table 4).

Growth stage significantly ($P<0.05$) affected density where flowering stage resulted in higher density than seed setting stage. No significant ($P>0.05$) effects were observed on vegetation cover and biomass production (Table 4).

Table 3. Effect of management and growth stage on Range attributes (season 2008)

Factors		Density (plant/m^{2})	vegetation Cover%	Biomass Production (kg/ha)
Management:				
Close		91.83	32.50	645.00
Open		38.38	15.94	190.78
SE$\pm$		3.44**	1.64**	3.07**
Growth Stage :				
Flowering		77.09	29.30	468.91
Seed setting		53.11	19.14	366.88
SE$\pm$		3.44**	1.64**	3.07*
Interaction: Management x Growth Stage:				
Close	Flowering	91.03	34.53	647.81
	Seed Setting	92.63	30.47	642.19
Open	Flowering	63.16	24.06	290.00
	Seed Setting	13.59	07.81	91.56
SE$\pm$		4.86**	2.32*	4.34*

* significant at 0.05 level, ** significant at 0.01 level

Table 4. Effect of management and growth stage on Range attributes (2009)

Factors		Density (plant/m^{2})	vegetation Cover%	Biomass Production (kg/ha)
Management:				
Close		120.73	49.53	688.91
Open		25.75	14.38	179.53
SE$\pm$		3.48**	1.66**	2.67**
Growth Stage:				
Flowering		79.72	32.58	451.25
Seed Setting		66.77	31.33	417.19
SE$\pm$		3.48*	1.66^{ns}	2.67^{ns}
Interaction: Management x Growth Stage:				
Close	Flowering	121.34	47.66	645.00
	Seed Setting	120.13	51.41	732.81
Open	Flowering	38.09	17.50	257.50
	Seed Setting	13.41	11.25	101.56
SE$\pm$		4.93*	2.35*	3.78**

^{ns} not significant, * significant at 0.05 level, ** significant at 0.01 level

Table 5. Effects of different seasons, management and growth stage on Range attributes (Combined analysis)

Factors			Density (Plant/m^2)	vegetation Cover%	Biomass Production (kg/ha)
Season:					
2008			65.10	24.22	417.89
2009			73.24	31.95	434.22
SE +			2.45*	1.7**	2.04 ^{ns}
Management:					
Close			106.28	41.02	666.95
Open			32.06	15.16	185.16
SE+			2.45**	1.17**	2.04**
Growth Stage:					
Flower stage			78.41	30.94	460.08
Seed Stage			59.94	25.23	392.03
SE+			2.45**	1.17**	2.04*
Interaction (SE+):					
Season x Management:			3.46**	1.65**	2.88^{ns}
Season x Growth Stage			3.46^{ns}	1.65*	2.88^{ns}
Management x Growth Stage			3.46**	1.65**	2.88**
Interaction: Season*Management*Growth Stage:					
2008	Close	Flowering	91.03	34.53	647.81
		Seed Setting	92.63	30.47	642.19
	Open	Flowering	63.16	24.06	290.00
		Seed Setting	13.59	7.81	91.56
2009	Close	Flowering	121.34	47.66	645.00
		Seed Setting	120.13	51.41	732.81
	Open	Flowering	38.09	17.50	257.50
		Seed Setting	3.41	11.25	101.56
SE+			4.90*	2.33^{ns}	4.07^{ns}

^{ns} not significant, * significant at 0.05 level, ** significant at 0.01 level

Management x growth stage interaction (P<0.01) effects were significant on biomass production, (P<0.05) density and cover. Closed area during flowering stage had the highest density followed by closed area during seed setting, while the open area during seed setting had the lowest density. Closed area during seed setting had the highest vegetation cover and biomass production whereas open rangelands during seed setting had lowest vegetation cover and biomass production (Table 4).

Table (5) shows the results of the combined analysis of range attributes for the two seasons (2008 and 2009). Years had significant ($P<0.01$) main effects on %vegetation cover, ($P<0.05$) density, but no significant ($P>0.05$) effect on biomass production. Range attributes were highest during 2008 and 2009.

Management significantly affected ($P<0.01$) range attributes (density, vegetation cover and biomass production. Closed areas had highest range attributes (Table 5).

Growth stage had significant ($P<0.01$) main effects on density and vegetation cover, ($P<0.05$) on biomass production. Range attributes had highest during flowering stage.

Year x management interaction had significant ($P<0.01$) effects on density and vegetation cover, but no significant ($P>0.05$) effect on biomass production (Table 5). Year x growth stage interaction effects on density and biomass production were not significant ($P>0.05$). However, management x growth stage interaction effects were significant ($P<0.01$) on range attributes. Range vegetation in closed areas during seed setting had the highest density and biomass production whereas closed areas during flowering stage had the highest vegetation cover (Table 5). Year x management x growth stage interaction effects were significant ($P<0.05$) on density, but no significant ($P>0.05$) effects were found on vegetation cover and biomass production. Range attributes during the season 2009 in closed area during flowering stage had the highest density while the season 2009 in closed area during seed setting had the highest vegetation cover and biomass production (Table 5).

Carrying Capacity

Table (6), shows that the average carrying capacity in the closed area for the season 2008 was 0.7 ha/Au/month, and 2.36 ha/Au/month in the open area, while for the season 2009, it was 0.65 ha/Au/month and 2.51 ha/Au/month in the closed and open area, respectively.

Discussion

The study investigated the effect of management and growth stages on rangelands vegetation through assessing the biomass production, vegetation cover, plant density and carrying capacity for two consecutive seasons.

Closed areas had higher plant density, vegetation cover and forage production compared with open rangelands; also flowering stage had higher range attributes than seed setting (Tables

3, 4 and 5). The differences in the dry matter productivity are mainly due to the fact that grazing sometimes negatively affects the plant communities, when not done in the right time or at proper stocking rate. This situation is related to the main problem associated with rangeland management where over-stocking lead to progressive reduction in biomass production and plant cover, and in the arid and semi-arid areas leads to soil degradation (Strang, 1980). Overstocking coupled with severe intermittent and prolonged drought further exacerbate the problem of low forage availability and therefore, poor animal production (RPA, 1993). HTS (1975), stated that grazing of dry material causes relatively little damage to growth in the following years, while grazing during the wet season when grasses are growing and seeding causes potentially permanent damage leading to reduced forage production.

Carrying capacity was affected by different years and management systems. Closed areas had higher carrying capacity compared with the open areas in both season (2008 and 2009) (Table 6). The carrying capacity of the study area is very low if we compare it with the total numbers of the animal units utilizing the area. These differences could be attributed to low and differences in forage production. General land misuses and frequent cyclic drought severely affect vegetation species composition and the overall biomass production per unit areas (RPA, 2006).

Table 6. The Carrying Capacity (ha/ AU/ period) for the seasons 2008 and 2009

	Closed		Open	
Year	Ha/AU/day	Ha/AU/month	Ha/AU/day	Ha/AU/month
2008	0.02	0.7	0.08	2.36
2009	0.02	0.65	0.08	2.51

Note:
Ha = Hectare. AU = Animal unit

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