



(RESEARCH ARTICLE)



## Assessment of rangelands condition in low rainfall savannah of Sudan

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### Abstract

Vegetation measurement was conducted on the rangelands of Western Darfur State at Zalingei locality at late rainy season of 2015 and 2016. The purpose of the study was to assess range condition through determining forage production and herbaceous cover at western part of Zalingei town. The sampling procedure was based on locating random ten (10) transects and two quadrats in each transect were chosen, the herbaceous assessments included composition, species frequency, cover, density and biomass. The results showed that overgrazing was considered as the major factor responsible for the low vegetation cover and yield in the study area due to the concentration of high numbers of animals during the rainy season. The result indicated that continuous intense grazing causing vegetation changes such as the replacement of palatable grasses by less palatable plant species.

Further research works is needed to monitoring vegetation change and to assess the rangelands for their improvement and management

**Keywords:** Biomass production; Density; Frequency; Range composition; Vegetation cover

### 1. Introduction

Rangeland management as a discipline skillfully applies an organized body of knowledge accumulated by range science for two purposes: (1) protection, improvement, and continued welfare of the basic resources (soils, vegetation, endangered plants and animal species, wilderness, water, and historical sites) in a sustainable way, and (2) optimum production of goods and services in combinations needed by society in a more multiple fashions (the harmonious use of range land resources for more than one purpose, such as livestock, recreation, wild life, water production, and others) [1]. Grazing has been reported to reduce the diversity of herbs and shrubs in the rangeland. Due to overgrazing, the vegetation species composition, richness and productivity has changed over the past decades, some species have disappeared while others have survived through the use of morphological or other adaptations [2]. Good management of rangeland resources requires many techniques of measurements and sampling used in range inventory and monitoring programs to determine the proper use of range resources. Because the inventory and monitoring are essential features of a range management process and plan. They can be as detailed as important to meet the objectives of the plan [3].

Sudan has animal resources which reach approximately 106.6 million head with a goat population of 31.2 million head, and Central Darfur State hosts about 2.0 million head [4]. This large livestock herd of Sudan depends on natural rangelands and forests for most of their feed requirements which are estimated as 133 million tons of dry matter per year [5]. However, in many cases, natural rangelands fall short of meeting animal requirements. Several factors affect rangelands productivity and production such as impact of climate change and human activities. Ground vegetation cover

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measurements are commonly used for the evaluation of soil protection, watershed health, range land ecological condition and range trend [3].

Central Darfur State is located in the western part of Sudan between longitudes 22° - 20' and 23° - 40' E, and latitudes 12° - 30' and 13° - 30' N. The State is covered area about 41.25 thousand square kilometers, and covered by different ecological zones, low rainfall savannah, mediterranean climate and high rainfall savanna, different types of soil covered the state with various productivity potentials ranged from sandy soil to clay soil. Livestock in the state include cattle, sheep, goats and camels; animal production system is transhumance, nomads and sedentary livestock keepers, rainfall ranged from 250mm north - 800mm south. The location and physical characteristics of rainfall, soils and topography led to diversified vegetation which includes low rainfall in the north and high rainfall savanna in the south of the state [6].

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## 2. Material and methods

### 2.1. Study area

The study was conducted at Zalingei locality, at late rainy season of 2015 and 2016. The purpose of the study was to assess range condition through determining forage production and herbaceous cover at western part of Zalingei town.

### 2.2. Sampling procedure

The sampling procedure was based on locating random ten (10) transects and two quadrats in each transect were chosen.

### 2.3. Measurements

To assess herbaceous cover, measurements taken included vegetation cover, plant composition, density, species frequency and biomass production. The equipment's used were a Loop, 1 m<sup>2</sup> quadrat, scissors, paper bags and a 100m tape.

The plant composition was measured along each 100m transect using loop, where plant species were recorded at ¾ inch loop [7] hit, and at one meter intervals where hundred observations were registered in a recording sheet for each transect. Percentages of plant composition, litters and bare soil were obtained by dividing total hits of each parameter along transects by total observations of individual factor and multiplied by 100%. The following equation was used to calculate the percentage of plant composition, bare soil and litter.

$$Factor = \frac{\text{Total of hits of factor}}{\text{Total number of hits}} \times 100$$

(Factor\* = It represents the plant composition or bare soil or litter)

Plant cover percentage is the part of quadrat, which covered by plants. It was determined by locating 1X1m<sup>2</sup> quadrat along the transects and at 50m intervals. Plant cover percent was estimated for each quadrat and recorded, then the total estimation were summed and divided by the number of quadrats to give one average plant cover for one quadrat.

A frequency which is the incidence of species occurrence was also calculated by counting species, which occur in a quadrat. The following equation may use to calculate the frequency.

$$\text{Frequency\%} = \frac{\text{The number of quadrats contain the species}}{\text{Total number of quadrats}} \times 100$$

Density is defined as the number of individuals in a given unit of area. It was determined by counting of plants rooted within each quadrat as follows:

Density = No. of individuals in each quadrat

To determine the biomass production or dry matter (DM) a quadrat was placed along each transect at 50m intervals (Two quadrat/transect). The plant species in each quadrat were clipped at 3 cm above the ground level, as this represents grazing level using scissors. The harvested plant materials were placed in paper bags and dried by air and

weighed. The dry matter per quadrates was obtained by dividing the total weight of all quadrates by their number to obtain one average of weight ( $\text{g}/\text{m}^2$ ), then the dry matter ( $\text{kg}$  or  $\text{ton}$  per hectare) was obtained.

### 3. Results and discussion

#### 3.1. Range composition

Table (1) showed the results of plant composition of the two periods, the values were scored in 2015 and 2016 (66.25% and 58.5% respectively). The low plant composition in the second season may be due to grazing intensity. According to [8] they stated that, grazing by domestic livestock has been considered as a main degrading factor because it changes vegetation structure and composition as a result of which some species increase in abundance and others decrease. The plant composition is changing continuously in space and time due to some factors, such as grazing, fire, and rainfall which differ in intensity, duration, and timing, this agreed with [9]. Also table (1) illustrate that litter percentages was low in the second period, the low litter percentage may be due to low rainfall characterizing the low rain fall areas, which resulted in low vegetation cover. [10] reported that litter in a pasture is a function of forage growth, senescence, harvest and decomposition. It may be also due to both the continuous grazing of the available sparse vegetation and the redistribution of litter by wind and water. [11] and [12] reported that the standing and fallen litter mass generally decrease with increased grazing intensity. The results of this study are in close agreement with the findings of [13] who observed that standing and falling litter mass generally decreased while amount of bare soil increased with increasing grazing intensity.

#### 3.2. Density

Results of plant density of the different periods were demonstrated in Table (2). The average plant density was 88.63 and 53.11 plants/ $\text{m}^2$  for season 2015 and 2016 respectively. The reduction of the vegetation density may be attributed to various factors including human induced activities. [14] mentioned that overuse and misuse activities such as heavy grazing and over cutting of trees and overpopulation of both human and animal have reduced the densities of plant species. The palatable species has been subjected to selective grazing by the huge number of animals reduces the number and densities of the palatable species. Results of density of the most dominant species were demonstrated in Table (3), *Eragrostis sp* scored the highest density while *Echinochloa colonum* scored the lowest density at different periods. The variation in species density may be attributed to grazing and human activities. [15] reported that human activities are accelerating functional changes on fragile rangeland ecosystems.

#### 3.3. Biomass production

The forage biomass production showed in Table (4) that season of 2015 had higher production. This reduction may be attributed to many different factors such as increase in livestock numbers above the carrying capacity of the range. The grazing intensity is another factor that affects the distribution of biomass production at the study area. Human activities mainly overgrazing and agricultural practices are responsible for decreasing biomass production in arid and semi-arid. Results of [16] indicated that with adequate protection and controlled grazing the forage yield on the rangeland practically doubled in about 3 to 5 years. So management plan can include grazing management (proper stocking rate), protection of some areas, application of fertilizer, reseeding with the adapted and palatable grasses and legumes can be applied to the protected areas, utilization of the appropriate rainwater harvesting technique and utilization of supplementary feeds to decrease the pressure on the over grazed areas. In order to reduce the chance of range resources deterioration and to carry out correct range management system only 50% of the annual biomass produced by the rangelands is considered available for grazing and accessible to animal consumption. The other 50% will be left as reserve, for wild animals and other unseen utilizations. [17] said that forage is the part of vegetation that is available and acceptable for animal consumption, whether grazed, destroyed by animals or harvested by the local community.

#### 3.4. Vegetation cover

Result of ground cover percentages of the different periods was demonstrated also in Table (4). The ground cover was 51.96% and 45.44% in seasons of 2015 and 2016 respectively. One of the most important factors that influenced the range land particularly the vegetation cover is overgrazing. The vegetation in the study area suffers from an increase in livestock numbers that exceeds the carrying capacity of the area. Overgrazing became widespread and acute. According to [18] overgrazing caused about 46% of the soil degradation.

#### 3.5. Frequency

In table (5) The results showed that, *Aristida sp.* scored the highest frequency 80% in 2015, and *Eragrostis sp* showed the highest frequency 90% in 2016. The overgrazing for a long time and overstocking may be change the dominant

species in the area with other species such as *Aristida sp.* is considered less preferred by animals. The study area was dominated by different species in the two periods this may be due to the differences in grazing intensity as well as, competitions and utilization, this agreed with [9]. The limited presence of *Ipomoea sp* may indicate early or intensive grazing as this species is known to be relatively preferred.

**Table 1** Range component

Season	Plant	Litter	Bare soil
2015	66.25	23.50	10.25
2016	58.50	10.50	31.00

**Table 2** Plant density

Season	Density (plant/m <sup>2</sup> )
2015	88.63
2016	53.11

**Table 3** Species density

2015		2016	
Species	Plant/m <sup>2</sup>	Species	Plant/m <sup>2</sup>
<i>Eragrostis sp</i>	21	<i>Eragrostis sp</i>	13
<i>Aristida sp.</i>	18	<i>Aristida sp.</i>	11
<i>Dactyloctenium aegyptium</i>	15	<i>Dactyloctenium aegyptium</i>	7
<i>Commicarpus africanus</i>	13	<i>Commicarpus africanus</i>	12
<i>Echinochloa colonum</i>	10	<i>Echinochloa colonum</i>	4
<i>Ipomoea sp</i>	12	<i>Ipomoea sp</i>	6

**Table 4** Range Attributes

Season	Biomass (kg/ha)	Vegetation cover%
2015	981.19	51.96
2016	613.76	45.44

**Table 5** Relative frequency

2015		2016	
Species	%	Species	%
<i>Aristida sp.</i>	80	<i>Aristida sp.</i>	70
<i>Commicarpus africanus</i>	70	<i>Commicarpus africanus</i>	55
<i>Dactyloctenium aegyptium</i>	55	<i>Dactyloctenium aegyptium</i>	65
<i>Echinochloa colonum</i>	10	<i>Echinochloa colonum</i>	35
<i>Eragrostis sp</i>	45	<i>Eragrostis sp</i>	55
<i>Ipomoea sp</i>	10	<i>Ipomoea sp</i>	20

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#### 4. Conclusion

Based on the results obtained, it can be concluded that: The rangelands at the study area are subjected to overuse and depletion of vegetation cover, due to increase in human population, animal numbers and change in environmental conditions. Unwise utilization and exploitation of the range lands particularly by man causes range deterioration and serious reduction in range production in both quantity and quality, which fail to accommodate the increased numbers of animals and encourage the storage of dry grasses (hay) by sheep owners for the peak period. This activity increased the deterioration of rangeland and decreased the productivity, which caused land degradation. Grazing management is the first consideration in management plan to regulate the effects of grazing on vegetation cover and to minimize the severe erosion hazards.

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#### Compliance with ethical standards

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##### *Disclosure of conflict of interest*

The author declares that there is no conflict of interest regarding the publication of this article.

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