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Comparison of Different Range Types in Terms of Vegetation Attributes and Carrying Capacity, Kadugli locality, South Kordofan State, Sudan

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Abstract: The study was conducted in Kadugli locality, South Kordofan state, during 2009-2011. The objective of the study was to make comparison between different range types. The rangelands were divided into four range types according to their soil types by using Global Positioning System (GPS). Parker loop method was used to determine the ground cover along transects of 100m length. A quadrate of 1m² sizes was used to determine density, frequency, range productivity and carrying capacity. The results obtained explained that rocky and clay soil range sites were the best rangelands concerning plant cover, biomass production and carrying capacity. The other two types of soils, sandy and gardoud soils rangelands were found poor for the same parameters. Species diversity was found poor in clay soil than the other types of soils.

Keywords: Rangeland, plant density, vegetation composition, species frequency**.**

Introduction

Range constitutes an important land based resource for several reasons, the most important of which may be their wide distribution, (Heady and Child, 2000). Rangeland is land supporting indigenous or introduced vegetation that is either grazed or has the potential to be grazed and is managed as a natural ecosystem, (Barry *et al.,* 2005). The Rangeland provides significant environmental and agricultural services to people though climate change amelioration, clean water, wildlife habitat, recreational use, livestock grazing, and many others when they are managed properly, (SRM, 2008).

The rangelands in Sudan varied from poor to rich according to the ecological zones, specially in south kordofan in Western and central regions, specifically in semi-arid regions of kordofan, including Nuba Mountains area, (Bashir and El Tahir, 2006).

Increase efforts are needed to achieve a comprehensive evaluation of the rangeland resources where a clear data invalid exists, including an evaluation of suitability for sustained long range productivity of goods and services. Future of rangeland resources development and management is dependent upon increased scientific capability, and extensive nature of these resources needs to develop data collection and analysis. (Matthew *et al.,* 2001).

There are many types of rangelands in Kadugli locality according to the soil types; these rangelands need more research to investigate their capabilities and achievement of the animal wealth. The study was conducted during 2009-20011 to determine the most vegetation attributes and range carrying capacity across different range types. Measurements techniques in rangelands are varied, different sample size and sample

intensities are required to fulfill certain management objectives, on the other hand the rangelands in the area located in harsh environments, which are complicated in using other techniques. The problem is how to do an economical inventory that will detect ecologically important change over extensive land areas with acceptable error rates. Measurement of grazing must be a continuing and flexible process by using the proper sampling methods and size to provide appropriate decision.

The inventory and monitoring of rangeland give good information about the land cover and other attributes, to assess current condition and the repeated measurement yearly tend to know about the range trend and other changes in rangeland uses.

The study was conducted in South Kordofan State, Kadugli locality, in area lies approximately between latitudes 9º 50" and 12º N and longitudes 27º 05" to 32ºE. It covers an area about 135000km², the average altitude of 600m above sea level, (Annon, 2007).

The climate of Kadugli locality is between semi-arid and sub-humid zone. Based on rainfall and according to the ratio of humid months and arid months and the length of growing season, Kadugli locality classified as sub-humid agro climate zone. The temperatures range from 42C° to 24C° in the May, and 31C° and 13C° in January. The two peaks are about 40.1C° in April and 36.5C° in November, (IFAD, 2006).

This study will try to compare between different range types in terms of ground cover, plant density, frequency, plant composition, and productivity. The study aims to determine the vegetation composition and biomass production in kadugli locality in order to determine the carrying capacity.

Materials and Methods

The general concept of the study was to make comparison between different range types at the study area according to their vegetation attributes. The sites had been selected using the stratified sampling design, and choose the starting point using GPS. Proper selection of study sites is critical to the success of a range inventory program. A reconnaissance survey was conducted to assess, identify and select an appropriate site to represent the rangeland in the study area. Range sites are the principal units of rangeland classification that are based on categorizing vegetation according to site potential. According to the soil types the study area was divided into four range sites, sandy soil at Tillo village, clay soil near Tillo village, rocky soil near Kadugli air port and gardoud soil in Haffera Hammra at the North of the air port. The optimum sample unit size for rangeland sampling depends on the attribute being described (Muir and McClaran, 1997). The area of each site was one squire kilometer. Five transects of 100 meters length were selected, and four quadrates of size 1x1m were distributed in the middle of each transect, with interval 25 meters along the transects. The Parker loop ¾", was used to determine plant composition. At each one of the five transects, plant species, litter and bare soil were recorded at one meter interval using loop. Data was recorded in a specified sheet. A quadrate of 1m² was used to determine the needed attributes as follow:

Biomass

Biomass is a commonly measured vegetation attribute that refers to the weight of plant material within a given area. Other general terms, such as 'yield' or 'production', are

sometimes used interchangeably with biomass, and it expressed as (Ton/DM/Unit area). Herbaceous production generally is measured at the end of the growing season, (Christopher *et al.*, 2007). Biomass data collected as a total weight for the vegetation present in the quadrate, all plant materials harvested above 3cm of the ground from the quadrate. The plant materials were collected in paper bags, oven dried at 104C° and weighted. Range productivity was calculated by using the following formula:

$$\text{Range productivity} = \frac{\text{average biomass/m}^2 * 10000 * 0.5}{1000000} = \text{(ton/h/year)}$$

0.5 is a proper used factor.

Plant Composition

Species composition refers to the contribution of each plant species to the vegetation; it is generally expressed as Plant species (sp.). Dead plants or litter (L). Bare soil (Bs) percentage. Measured observations along transect line will were usually three types of observation which are the following:
Plant composition and other attributes were calculated using the following formulas:

1) $\text{Species composition} = \frac{\text{Total hits of each species}}{\text{Total hits of all species}} * 100\%$

2) $\text{Percent of bare soil} = \frac{\text{Total hits on bare soil}}{100} * 100\%$

3) $\text{Percent of plant litter} = \frac{\text{Total hits on litter}}{100} * 100\%$

The data analysis was done by using SAS statistical package version 6.12 and Microsoft Excel 2007.

Frequency

Frequency is the percentage of total quadrates that contain at least one rooted individual of a given species. It was determined by recording the species names which appear in quadrates. The frequency calculated by using the following formula:

$$\text{Frequency of the species} = \frac{\text{Number of the occurrence of the species}}{\text{Total number of samples}} * 100\%$$

Density

Density is a number of individual plants per unit area expressed as (plant/unit). It determined by counting all plants rooted in quadrates.

Carrying Capacity

Carrying capacity describes the number of grazing animals as management unit is able to support without depleting rangeland vegetation or soil resources.

Determining carrying capacity is a fundamental component of rangeland evaluation, because it is an important management tool that connects forage supply and forage consumption. A straightforward approach to determine the number of animals the management unit can support over a period of time is to divide the total forage biomass (ie., forage supply) by the total amount of forage consumed by a grazing animal during the grazing period (ie., forage demand). Calculations based on long term average forage production provide an appraisal of carrying capacity, whereas existing forage levels give an estimate of shorter term stocking rates.

Carrying Capacity = available forage per unit area/ tropical animal unit consumption. Express an animal units /area/season.

Results and Discussion

Ground Cover

Cover provided by a combination of plants, litter and bare soil. Ground cover is the most often used cover measurement to determine a site's watershed stability.

Parker loop was used to determine ground cover along transects, the distance between hits was1m. Five transects were located in each site of the rangeland which were divided into four range sites. The results in table (1), explain that, high significant differences between bare soils in the four sites as 28%, 5.4%, 0.6% and 22.6% in sandy soil, clay soil, rocky soil and gardoud soil correspondingly. This result explained that sandy and gardoud soils were very close together due to the similarity of their properties and origin. Through this result we see that the bare soil close in sandy soil range site and gardoud soil range site which is 28% in sandy soil and 22.6% in gardoud soil, this result due the similarity of these soil in terms of properties and origin. Also there are highly significant differences between plant cover, in different range sites, see table (1).

There were significant differences between litter was found11%, 8.4%, 5% and 21.8% in sandy soil, clay soil, rocky soil and gardoud soil in that order, and the plant cover found that 61%, 86.2%, 94.4% and 55.6% in sandy, clay, rocky and gardoud soil respectively.

Generally, the rocky and clay soils rangelands were better than sandy and gardoud soil rangelands in terms of plant cover and bare soil.

Table (1): The ground cover:

Attributes	Sandy soil	Clay soil	Rocky soil	Gardoud soil	Sig.
Bare soil	28	5.4	0.6	22.6	**
Litter	11	8.4	5	21.8	*
Plant cover	61	86.2	94.4	55.6	***

* P<0.05
** P<0.01
*** P<0.001

Vegetation Composition

The data obtained through the Parker loop in the different range sites see in table (2). The dominant plant in sandy and gardoud soil range sites was *Schoenefoldia gracils* (Danab Elnaga) 83.3% in sandy soil and 40% in gardoud soil, and the co-dominant species was *Celosia argentea* (Um kenaitillat) in sandy soil 5% and *Pennisetum sp.* (Dokhn Eltir) 12.7% in gardoud soil rangeland. But the dominant species in clay soil rangeland was *Sorghum vercicolor* (Bigil) 69% and the second species was *Schoenefoldia gracils* (Danab Elnaga) 10.3%, while the dominant plant species in rocky soil rangeland was *Hyparrhenia confinis* (Um raggo) 53.7% and the other one was *Schoenefoldia gracils* (Danab Elnaga) 33.6%. Also the results found indicated that, good distribution of *Schoenefoldia gracils* (Danab Elnaga), was found in all range sites (sandy, clay, rocky and gardoud soil).This result lead to the good adaptation of this species in different soil types. There are high species diversity in rocky and gardoud soil, (13 plant species) compared to sandy soil, (9 plant species) and clay soil, (6 plant species). The poorest species diversity in clay soil were due to the pure stand of specific plant species which was *Sorghum vercicolor* (Bigil) in different part of this site.

Table (2) Vegetation composition (%):

Scientific name	Local name	Type of plant	Sandy soil	Clay soil	Rocky soil	Gardoud soil
Schoenefoldia gracils	Danab Elnaga	Grass	83.3	10.34	33.68	40
Celosia argentea	Um kenaitillat	Forbs	5	-	3.16	-
Echinocloa colonum	Difra	Grass	1.66	-	1.05	5.45
Zornia diphylla	Shilini	Forbs	1.66	-	5.3	-
Pennisetum pedicellatum	Um dofofo	Grass	1.66	-	-	-
Eragrostis sp.	Bano	Grass	1.66	-	2.1	1.8
Ipomoea sp.	Tabar	Forbs	1.66	-	-	7.27
Commicarpus africanus	Lessaig	Forbs	1.66	-	-	-
Aristida sp.	Humra	Grass	1.66	-	2.1	-
Sorghum vercicolor	Bigil	Grass	-	69	-	1.8
Cymbopogon nervatus	Nal	Grass	-	4.6	-	-
Aristida sp.	Gao	Grass	-	2.3	-	10.9
Pennisetum sp.	Dokhn Eltir	Grass	-	2.3	1.05	12.72
Ocimum sp.	Rehan barey	Forbs	-	1	-	-
Hyparrhenia confinis	Um raggo	Grass	-	-	53.68	7.27
Aristida stipoides	Agage Elbagar	Grass	-	-	3.16	-
Euphoebia sp.	Malbiena	Forbs	-	-	2.1	-
Clitoria ternate	Erg Elghazal	Forbs	-	-	1.05	-
Chloris gayana	Afan Elkhadeem	Grass	-	-	1.05	3.64
Requenia obcordata	Adan Elfar	Forbs	-	-	1.05	-
Sida cordofolia	Neyada	Forbs	-	-	-	1.8
Sesbania sesban	Sorieb	Forbs	-	-	-	1.8
Corchorus olitorius	Khodra bareya	Forbs	-	-	-	1.8
Dactyloctenium aegyptium	Abu asabi	Grass	-	-	-	3.64

Plant Density

Quadrates of 1m² size were located systematically along the transect, with interval of 25m. Density can be a good metric indicator that because it is clears of less variable from year to year than measures of cover and biomass. In table (3), the high density of species was *Schoenefoldia gracils* (Danab Elnaga), 36, 81, 42 plant/m² in sandy, rocky and gardoud soil rangelands respectively, while the high density in clay soil was *Sorghum vercicolor* (Bigil), 72 plant/m². The total species density was 67, 79, 232 and 68 plant/m² in sandy, clay, rocky and clay soil in that order. This result indicated that the rocky soil rangeland was rich in plant density, because of protection against wind and water erosion. On the other hand, *Schoenefoldia gracils* (Danab Elnaga) appeared in all range sites. This result may lead to an idea of good distribution and more abundance of this species in all types of rangelands in the study area. A strong recommendation can be given here when rehabilitation of degraded rangeland, is needed to choose the species of *Schoenefoldia gracils* (Danab Elnaga) as best species for reseeding of this native grass species.

Table (3) Plant density (plant/m²):

Scientific name	Local name	Type of plant	Sandy soil	Clay soil	Rocky soil	Gardoud soil
Schoenefoldia gracils	Danab Elnaga	Grass	36	2	81	42
Celosia argentea	Um kenaitillat	Forbs	23	-	24	-
Echinocloa colonum	Difra	Grass	2	-	13	-
Eragrostis sp.	Bano	Grass	2	-	2	-
Zornia diphylla	Shilini	Forbs	1	-	4	-
Indigofra sp.	Sharaya	Forbs	1	-	3	-
Farsetia longisclizua	Dahayan	Forbs	1	-	-	-
Aristida sp.	Gao	Grass	1	-	-	7
Sorghum vercicolor	Bigil	Grass	-	72	-	2
Cymbopogon nervatus	Nal	Grass	-	5	-	-
Hyparrhenia confinis	Um raggo	Grass	-	-	73	-
Aristida stipoides	Agage Elbagar	Grass	-	-	18	-
Pennisetum sp.	Dokhn Eltir	Grass	-	-	2	11
Sida cordofolia	Neyada	Forbs	-	-	1	1
Euphoebia sp.	Malbiena	Forbs	-	-	1	-
Chloris gayana	Afan Elkhadeem	Grass	-	-	-	4
Sesbania sesban	Sorieb	Forbs	-	-	-	1

Plant Frequency

Through the study of frequency in different range sites of Kadugli locality, it found that the highest frequency from sandy and gardoud soil rangelands was *Schoenefoldia gracils* (Danab Elnaga), 90% and 70% respectively, while the highest frequency in clay soil rangeland was *Sorghum vercicolor* (Bigil) 80% and the highest frequency in rocky soil was *Hyparrhenia confinis* (Um raggo) 65%.

Table (4) explained that *Schoenefoldia gracils* (Danab Elnaga) was abundant in all range sites from sandy to gardoud soil rangelands. This result may lead to recommend a given this species as the best one for improvement activities in the area, because it is a key species and good indicator for the area. Plant frequency alone may not be a sufficient basis for making land management decision because it is not directly related to more commonly applied vegetation attributes. But together with the plant density and vegetation composition can help the rangeland managers to make proper decisions to push up the rangelands toward the desired goals. On clay soil, it was found that only three plant species were frequent in the range site. This result support the previous result shown in table (2), that the pure stand of *Sorghum vercicolor* (Bigil) made this site poor in plant diversity. In future this site needs to introduce native plant species to enrich the species diversity in this area.

The abundance and frequency found in the area in both rocky and sandy soil of the study area, explained the nature of mixed grass and forbs which may be very important as a balance feed for grazing animals and wildlife, so no supplementary feeding needed.

Table (4) Plant frequency (%):

Scientific name	Local name	Type of plant	Sandy soil	Clay soil	Rocky soil	Gardoud soil
Schoenefoldia gracils	Danab Elnaga	Grass	90	15	60	70
Celosia argentea	Um kenaitillat	Forbs	50	-	60	-
Eragrostis sp.	Bano	Grass	30	-	20	-
Farsetia longisclizua	Dahayan	Forbs	30	-	-	-
Zornia diphylla	Shilini	Forbs	20	-	45	-
Echinocloa colonum	Difra	Grass	15	-	30	-
Aristida sp.	Gao	Grass	15	-	-	25
Indigofra sp.	Sharaya	Forbs	15	-	30	-
Sorghum vercicolor	Bigil	Grass	-	80	-	10
Cymbopogon nervatus	Nal	Grass	-	25	-	-
Hyparrhenia confinis	Um raggo	Grass	-	-	65	-

Euphoebia sp.	Malbiena	Forbs	-	-	20	-
Pennisetum sp.	Dokhn Eltir	Grass	-	-	15	30
Sida cordofolia	Neyada	Forbs	-	-	5	30
Aristida stipoides	Agage Elbagar	Grass	-	-	5	-
Sesbania sesban	Sorieb	Forbs	-	-	-	25
Chloris gayana	Afan Elkhadeem	Grass	-	-	-	15

Biomass

Direct harvested method was used to determine biomass in four range sites. Table (5) showed that, there were a high significant differences between the biomass in range sites, such as 50.7g/m², 542.3g/m², 196.7g/m² and 94.3g/m, in sandy, clay, rocky and gardoud soil range sites. This result indicates that, there are different potentials across the range sites. Highly biomass was found on clay soil range site while the lowest biomass was found on sandy soil range site. This situation reflects the soil fertility which was different from soil to soil.

Table (5): Biomass g/m²

Range sites	Sandy soil	Clay soil	Rocky soil	Gardoud soil	Sig.
Average biomass	50.7	542.3	196.7	94.3	**

Range Productivity

The proper use factor, was used (take half and leave half) according to; Stoddard L. A et al (1975), a proper use factor of 50% indicates that, a plant will have half of total available annual production of vegetation will be removed by livestock at the end of growing season. Figure (1), showed that, the range productivity was different from site to site. There are high significant differences (according to biomass data, table (5)) between clay soil productivity and all of other soil types. The highest range productivity was found on clay soil range site, 2.7 ton/h/year, while the lowest productivity was sandy soil range site 0.26 ton/h/year.

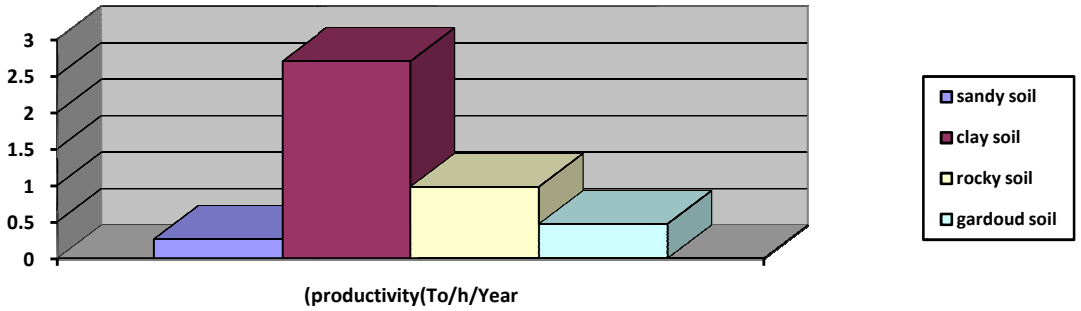

Figure (1) Range productivity

Range Carrying Capacity

The range sites were found different in terms of range carrying capacity. Figure (2) shows that, the clay soil range site was found the highest one (1Au/h/year), while the lowest range site found the sandy soil (0.1Au/h/year) and the other sites gave range carrying capacity, rocky soil range site 0.36Au/h/year and gardoud soil range site 0.17Au/h/year. This result indicated that, the clay range site was better than other range sites. It can satisfy one animal unit annually if managed properly.

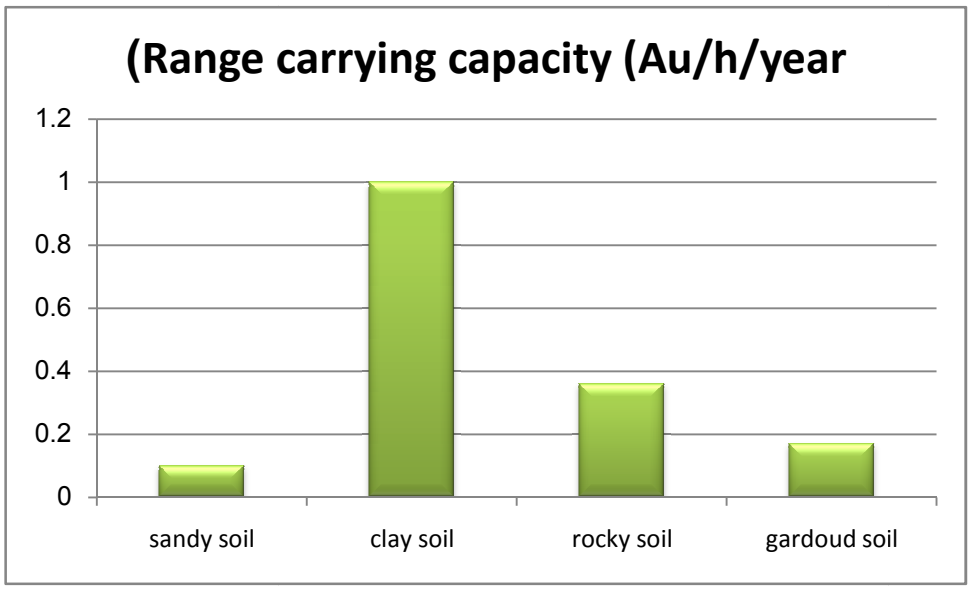

Figure (2), Range carrying capacity

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مقارنة بين مختلف أنواع المراعي من خلال العناصر النباتية وحمولة المرعى

محلية كادقلي – ولاية جنون كردفان – السودان

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جامعة السودان للعلوم والتكنولوجيا – كلية علوم الغابات

المستخلص:

أجريت الدراسة في ولاية جنوب كردفان، محلية كادقلي في الفترة من 2009–2011 م. هدفت الدراسة لإجراء مقارنة بين مختلف أنواع المراعي. قسمت المراعي الى أربعة أقسام بناءاً لأنواع الترب باستخدام جهاز تحديد المواقع العالمي (GPS) أستخدمت حلقة باركر لتقدير التغطية الأرضية باستخدام القطاع بطول 100م كما استخدم الإطار 1م² لتحديد الكثافة، التردد، الأنتاجية والحمولة الرعوية. النتائج المتحصلة وضحت أن مراعي الأراضي الصخرية والطينية أفضل من حيث التغطية، الإنتاجية النباتية والحمولة الرعوية.النوعين الأخريين من الأراضي، الرملية والقردودية، وجدت فقيرة فيما يخص نفس المعلومات. وجد أن التربة الطينية فقيرة في التنوع النباتي من الأنواع الأخرى من الترب.