The Effect of Some Range Site Characteristics on Rangeland Vegetation Attributes at Altadamon Locality- South Kordofan State, Sudan

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Abstract:

The study was carried out at South Kordofan State, East Abu Gebiha town, Southeast Alabasseya town. The study aimed to determine the effect of soil types on the rangeland vegetation attributes, to help the decision makers in making sound plans and management strategies. Three range sites were chosen according to their soil types namely; clay soil, *Gardoud* Soil and sandy soil range sites. For vegetation measurements the starting point was chosen randomly, then ten transects of length 100m established at each range sites systematically with interval 100m between each other, in order to establish these transects in the same direction used the campus for determining the desired direction of the line transect. Using the distance tape and Parker loop methods to determine the ground cover and botanical composition of each range site, also the quadrate of $1m^2$ was used across the line transects to find out the plant density, frequency, range productivity and carrying capacity. There was a significant difference in bare soil and plant litters between two seasons. The clay soil range site record high plant cover % and plant density compared to the sandy and *Gardoud* range sites. The study found the good distribution of plants in the clay soil range site. Also the clay soil recorded high biomass production and carrying capacity. The study concluded that the clay soils range site has potential in all aspects of production and environment, and able to maintain soil moisture.

Key Words: Soil types, Vegetation measurements, Transects, *Gardoud* soil.

Introduction:

Natural rangeland covers large areas of land, including various plant environments and climate zones in Sudan, (Abdelsalam, 2017). These rangelands exposed several problems negatively affected the natural resources in terms of vegetation composition, quantity and quality of fodder, soil conservation and watershed protection. The most important of these problems are drought, desertification and destructive human activities that accompany unbalanced development processes. Despite of all these constraints, rangelands are adaptable, produce, feed in the most fragile environments and play an important role in reducing the effects of climate change. According to Abdelsalam et al, 2016, the determination of range plant attributes it can helps the range

managers in making sound strategic plans and management decisions, so as to sustain the resources for uses and users. The rangelands differ in terms of vegetation attributes, according to the ecological factors affecting the plant growth and distributions; one of these factors is the soil types, which had a clear effect on plant communities and its distribution. These types of rangeland need more researches and studies to examine their capabilities and reaching of the animal wealth, (Abdelsalam, 2012). The spatial differences in natural rangeland are inevitably followed by differences in the plant species that form the vegetative community in the region. Therefore, these plants differ in their response to natural variables such as climate factors and human activities in the study area, depending on the type of soil they grow on and their physical and chemical properties. The soil in this area was exposed to erosion and driffeting the surface layer due to climatic factors, mainly wind and rainwater. These factors pose a danger and threat to the growth of plants in natural rangeland, especially erosion, which leads to loss of soil fertility. Therefore, this study trying to explain the range site characteristics influences on natural rangeland in the study area and their relation to the plant attributes such as productivity, frequency, density, vegetation composition and vegetation cover of these rangelands. The study aimed to explain the effect of soil type and its relation to plant characteristics in the study area and try to understand this relationship in order to use them in decision-making in rangeland management.

Research Methodology:

The area of the study was located in the South Kordofan State east of Abogbeha town and in the southeast of the Abbasid-Taqli town and west of Al-Maqinis town. This area lies approximately between 31º 20″-32º 08″ longitudes and 11º 50″-12º 22″ latitudes. The area is located within the savanna belt and the rich savanna climate region, the annual rainfall rate is between (500-900mm), (Ali, 2000).

The concept of this study was to determine the effect of soil type on the plant attributes of the natural rangeland in Eltadamon locality, South Kordofan State. In order to understand the relationship between vegetation cover and soil type through the selection of three range sites according to the type of soil such as clay soil, sandy soil and *Garduod* soil (*Gardoud soil is the hard clay soil mixed with sand*). To get some information that helps in the management of these rangelands within the sustainability concept and increase productivity and environmental efficiency.

This study will try to find some management implication for different range types by found the relationships between rangeland vegetation attributes and range site

characteristics. In the homogeneous rangeland, the sampling process is easy and small and representative of the community from which it is taken. However, most of the grazing land is characterized by diversity in the natural plant, some of which are available while the other is rare and the plants are distributed in different areas of rangeland. In this case more effective samples must be chosen to cover all differences in these rangelands, (Abdelsalam, 2008). In order to ensure a good representation of all rangelands, three range sites were selected in the study area according to soil type for range measurements. The study of rangeland in terms of quantity was not done to study all plant species or plant communities because this is not feasible in view of the large area of grazing area in the region, so it is enough to take samples of small areas identified randomly, to be studied and results can be obtained to represent all rangeland, (Alani and Rashid, 1986). The Releve method, (Barbour et al., 1987) was used to determine the optimum sample size for measuring the vegetation attributes of these range sites. Ten lines transects of 100m length established in each range site distributed systematically with interval 100m between each other.

There are several methods for range measurements that can achieve the objectives of range management. The precision and accuracy of the measurement vary according to the objective of the study. Most of these measurements are closely related to the dynamics of plant growth, developed by those interested in the environment of plant communities. To achieve the objectives of this study, plant measurements were carried out as follows:

The parker loop (Parker, 1951) was used to determine ground cover elements and vegetation composition of all range sites of the study area. There are 100 readings of 3/4 ″ loop took along the single transect with interval 1 m between each reading.

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

$$\text{Percent of plant litter} = \frac{Total\ hits\ in\ plant\ litter}{100} \times 100\%$$

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

Using the quadrat method (Wilm *et al.* 1944), 40 quadrate of 1 square meter were distributed over the line transect of 2 km in each of the three range sites representing clay, sand and *Garduod* soils. Four quadrates per transect of the studied areas, were distributed systematically at an equal distance of 25m. Each quadrate is divided into four sections in order to facilitate the counting of plants and the estimation of coverage by looking through the quadrate. The density of the plants in the area was obtained

through direct counting. The frequency was determined by recording the species that are found within the quadrate. Then record the readings obtained in a special form and then calculated the averages of all readings of density and frequency according to the following formulas:

Species density = the number of individual species/given area (m^2)

Plant frequency = Number of the occurrence of the species *100%

Total number of samples

Plant productivity determines by harvesting all plants within the quadrate at a height of one inch and placed into paper bags. All plant materials were placed in an oven dry at 105º to dry completely and weighted. The rangeland productivity calculated by using the following formula:

Range productivity= average biomass $gm/m^2 \times 10000 \times 0.5$ = tonne/hectare/year
1000000

10000 = hectare

0.5 = proper use factor

To determine the carrying capacity, the proper use factor (Stoddard et al, 1975), was used to calculate the available forage, The standard animal unit used for determining the carrying capacity was TAU (tropical animal unit) with an average weight of 250 kg. TAU consumption about 2.5% of its the weight dry matter per day, yearly need about 2.7 tons of dry matter. The carrying capacity calculates by:

Available forage/ TAU consumption, expressed TAU/ha/year.

Data Analysis:

SAS statistical package version 6.12 was used for data analysis, means were separated by Duncan multiple range tests, and also Analysis of Variance (ANOVA) was used to analyze the collected data.

Results and Discussion:

Ground Cover:

The ground cover is one of the important attributes that can be measured in natural rangeland, and include; bare soil, plant litters and plant cover. The results shown in table 1 explain that there is a significant difference in bare soil and plant litters between two seasons, these differences found are due to the difference in rainfall in the two seasons. According to the results shown in table 2 was a significant difference in bare soil and plant litters between the two seasons, it may be due to the annual differences of precipitation in the area. According to Olom et al, (2015) the lower litter and bare soil

percentages might be attributed to the influences of rainfall amount and distribution. There was a significant difference between the three soil types in terms of a plant cover, in the result shown in table 3. The clay soil range site record high plant cover % compared to the other range sites. While the sandy soil site had a less plant cover %. This result compatible with Abdelsalam et al, (2012) stated that the sandy and *Gardoud* soil poor in plant cover. Also Abdelsalam, (2013) found that the sandy range site expose of wind and range erosion, which reduces the vegetation cover and increases the bare soil at these sites. According to Abdalla et al, (2013) the spatial variation of plant cover reflects the influences of environmental factors in different range sites. Carmona et al, (2013) stated that the habitat type of rangeland the main factor affected the vegetation cover. These variations in vegetation attributes play a vital role in range management strategies and planned, because the different range sites need different management strategies to achieve the desired goals of range management.

Table 1. ANOVA table of ground cover:

Attributes	Source	DF	M S	F Value	Pr>f
Bare soil	Season	1	1179.26	6.4	0.01*
	Soil types	2	352.71	1.91	0.1 NS
	C. V	37			
Plant litters	Season	1	960	5.83	0.01*
	Soil types	2	1.05	0.01	0.9NS
	C. V	29.97			
Plant cover	Season	1	21.6	0.17	0.67NS
	Soil types	2	372.05	2.97	0.06NS
	C. V	54			

***means significant differences**

NS no significant differences

Table 2. DUNCAN multiple range test of ground cover % in two seasons

Attributes	Season	Means
Bare soil	1	41a
	2	32.23b
Plant litters	1	38b
	2	46a
Plant cover	1	20.1a
	2	21.3a

Means with the same letter are not significantly different

Table 3. DUNCAN multiple range test of ground cover % in different soil types

Attributes	Means		
	Clay soil	*Garduod* soil	Sandy soil
Bare soil	31.9a	38.05a	40.07a
Plant litters	42.5a	43a	42.85a
Plant cover	25a	19.45ab	17.15b

Means with the same letter are not significantly different

Botanical Composition:

The results in table 4 indicate that there is a huge diversity of vegetation in the study area, as each range site, these diverse plants its dominant plants that have adapted to the environmental requirements of the site. In the clay soil range site there is homogeneity in the specific composition of plants in the two seasons, due to the absence of differences in the percentage of plant composition in the range site. While there is a wide variation in the botanical composition of plants in the *Gardoud* soil range site, where *Aristida spp* formed about 41% and 63% of the overall plant species in the first and second seasons, respectively. This indicates that *Aristida spp* was the dominant of the plant in the *Gardoud* range site and the heterogeneity of the plant community on the site. It was found that the *Ipomea cordofana* appeared on all the range sites, indicating the good distribution of this plant and its ability to grow in different soil types in natural rangeland. Therefore, it can be considered as the *Ipomea cordofana* can be used as a key species for all broadcasting and re-seeding programs of degraded rangelands in this area. This study found that the soil type has a clear effect on the distribution of species composition, this agreed with Breuer, (2012) and Rubanza et al, (2006), stated that the distribution of vegetation types was partially dependent on the soil type and fertility.

Table 4. The Botanical composition % of different range sites in two seasons

Botanical name	Clay soil		*Gardoud* soil		Sandy soil	
	Season1	Season2	Season1	Season2	Season1	Season2
Ipomea cordofana	19.85	13.36	10.5	9.13	-	5.6
Indigofera spp	13.85	7.76	-	-	-	-
Fagonia cretica	13.48	-	-	-	7.7	-
Ocimum spp	7.11	-	3.92	-	-	-
Cymbopogon nervatus	5.42	18.6	-	-	-	-
Requienia obcordata	4.86	12.9	-	-	-	-
Abutilon spp	3.77	-	-	-	-	-

Xanthium brasilicum	-	8.63	-	-	-	-
Aristida spp	-	4.8	41.17	63	-	-
Amraranthus spp	-	-	10.5	-	7.7	16.6
Peristorphe bicalyeulata	-	-	3.92	-	-	-
Aristida adscensionis	-	-	3.92	-	-	-
Eragrostis spp	-	-	3.92	-	-	14.9
Sporobolus spp	-	-	-	6.9	-	9.2
Gynandropsis gynandra	-	-	-	5.5	-	6.5
Cucumis spp	-	-	-	5.5	-	-
Cenchrus spp	-	-	-	-	21.9	-
Cynodon dactylon	-	-	-	-	8.7	-
Trianthema portulacastrum	-	-	-	-	7.1	-
Senna alexandrina	-	-	-	-	6.1	-
Tribulus terristeris	-	-	-	-	6	-
Dactyloctenium aegyptium	-	-	-	-	3.8	-
Sporoblus pyramids	-	-	-	-	-	10.1
Elytropurus spicatus	-	-	-	-	-	5.6

Plant Density:

According to the results presented in Table 5, the plant density is higher in the clay soil range site compared with the other sites, Also the second season scored the highest intensity compared to the first season. This result clearly shows the effect of the range site characteristics on the density of natural vegetation cover. In the clay soil rang site, *Cymbopogon nervatus* was the highest density in the first season, followed by *Sporoblus pyramidls*, whereas in the second season the highest density was *Indigofera spp* followed by *Cymbopogon nervatus* and *Ocimum spp*. While in the other two sites found that the highest species density in *Gardoud* soil range site was *Aristida mutabilis* in the two seasons, but in the sandy lands was *Trianthema portulacastrum* and *Amraranthus spp* are the highest species density in the second season. The result indicated that the clay soil range site was more species diversity, followed by sandy range site and *Gardoud* soil range site, respectively. Fattahi and Ildoromi, (2011) stated that the significant effect of soil characteristics and aspects of plant diversity and clay was the most factor influencing the diversity. These differences in plant density reflect spatial variations of grazing sites and annual precipitation differences. This result agreed with Abdalla et al (2013), reported that the density affected by the soil types, rainfall

and temperature among other factors. The superiority of the clay soil compares to the sandy and *Gardoud* soil, range sites in plant density may be due to clay soil fertility and has the potentiality to retain moisture for a long time. This result supported to Hasanpori et al, 2014, found that increasing the fertility of the soil and the amount of clay in the soil led to increased plant density. Plant density information should be used to develop a natural rangeland management plan, taking into consideration the characteristics of each site to ensure continuity of the rangeland for future generations and sustain their production. Rajabov and Thorsson, (2009) stated that the application of such ecological concepts in rage assessment helps to understand the effective factors of vegetation changes and to provide the sound framework for sustainable natural resource management.

Table 5. the plant density plant/m² of the different range sites in the two seasons.

Botanical name	**Clay soil**		***Gardoud* soil**		**Sandy soil**	
	Season1	Season2	Season1	Season2	Season1	Season2
Cymbopogon nervatus	12	9	-	-	-	-
Sporoblus pyramids	10	7	-	3	-	-
Ipomoea sinensis	6	4	2	-	-	-
Sorghum sudanensis	6	-	-	-	-	-
Indigofera spp	4	15	-	2	-	-
Ipomea cordofana	3	-	-	-	2	1
Ocimum spp	-	9	3	-	-	-
Abutilon spp	-	8	-	-	-	-
Corchorus spp	-	7	-	-	-	-
Vernoni spp	-	7	-	-	-	-
Xanthium brasilicum	-	6	-	-	2	2
Dactyloctenium aegyptium	-	4	-	-	3	-
Aristida mutabilis	-	-	8	10	-	3
Setaria verticillata	-	-	4	-	-	-
Elytropurus spicatus	-	-	3	3	1	1
Fagonia cretica	-	-	2	3	1	-
Cenchrus spp	-	-	1	-	-	-
Sesbania sesban	-	-	-	3	-	-

Cassia tora	-	-	-	-	3	-
Tribulus terristeris	-	-	-	-	2	-
Trianthema portulacastrum	-	-	-	-	-	10
Amraranthus spp	-	-	-	-	-	8
Solanum dubium	-	-	-	-	-	1
Total	**41**	**76**	**23**	**24**	**14**	**26**

Plants Frequency:

The table 6 reviewed frequency results in the different range sites of the studied seasons. The study found that the most plants frequently of the first season in the clay soil range site were *Sporoblus pyramidls, Indigofera spp* and *Ipomea cordofana,* while in the second season the higher species frequency were *Cymbopogon nervatus, Ocimum spp, Xanthium brasilicum* and *Sporoblus pyramidls*. In the *Gradoud* soil range site, most plant frequency found in the first season was *Ocimum spp* and *Aristida mutabilis* in the second season. The sandy soil range site recorded low species frequencies in the first season less than 20%, while in the second season one plant was found reach 20% is *Trianthema portulacastrum.* Through this result, we found the good distribution of plants in the clay soil range site compared to the other two sites. This proper distribution of plants makes them grow homogeneously in rangeland and form a good mixture fodder for livestock. This indicates that clay soil characteristics played a major role in the distribution of range plants in the site. Azarnivand et al (2014) found that the vegetation distribution was mainly related to the soil characteristics. Abdelsalam et al (2012) reported the plant frequency alone may not be enough for making a sound range management decisions, but with the density to make the right decision in the range management.

Table 6. The plant frequency% of the range site in two seasons

Botanical name	**Clay soil**		***Gardoud* soil**		**Sandy soil**	
	Season1	Season2	Season1	Season2	Season1	Season2
Cymbopogon nervatus	12.5	25	-	-	-	-
Sporoblus pyramidls	22.5	20	-	-	-	-
Ipomoea sinensis	12.5	12.5	2.5	-	-	-
Sorghum sudanensis	10	-	-	-	-	-
Indigofera spp	20	7	-	5	-	5
Ipomea cordofana	20	-	-	-	7.5	-
Ocimum spp	-	25	22.5	-	-	-
Abutilon spp	-	15	-	-	-	-
Corchorus spp	-	15	-	-	-	-
Vernoni spp	-	17.5	-	-	-	-

Xanthium brasilicum	-	25	-	-	10	12.5
Dactyloctenium aegyptium	-	5	-	-	2.5	-
Aristida mutabilis	-	-	15	40	-	7.5
Setaria verticillata	-	-	12.5	-	-	-
Elytropurus spicatus	-	-	5	7.5	2.5	-
Fagonia cretica	-	-	5	5	10	-
Cenchrus spp	-	-	5	-	-	-
Sesbania sesban	-	-	-	7.5	-	-
Tribulus terristeris	-	-	-	-	8.5	-
Trianthema portulacastrum	-	-	-	-	-	20
Amraranthus spp	-	-	-	-	-	15
Solanum dubium	-	-	-	-	-	12.5

Biomass Productivity:

The result obtained in table 7 and 8 explained that was a highly significant difference between the two seasons in biomass production, in the same time there was no significant difference between the soil types. The highest yield obtained from biomass was in clay soil range site compared to other sites, thus confirm the efficiency of the clay soil site of both production and environmental services, this agrees with Abdalla et al (2013) and Abdelsalam et al (2012), mentioned that the clay soil rangeland more productive and a high value in biomass production. Clay soil rangelands are able to maintain soil moisture, which helps to grow range plants and sustain them for longer periods in range sites, it also more fertile than the sandy soil.

Table 7. ANOVA table of biomass production in gm/m² two seasons

Source	DF	M S	F Value	Pr>f
Season	1	4035.73	128.03	0.0001***
Soil types	2	0.76	0.02	0.97NS
C. V	78.75			

*****means highly significant difference**
NS means no significant difference

Table 8. DUNCAN multiple range test of biomass production in different soil types

Soil types	Means
Clay soil	7.24a
Gardoud soil	7.09a
Sandy soil	7.05a

Range Carrying Capacity:

Figure 1 indicated that the clay soil range site was better in term of carrying capacity compared to sandy and *Gardoud* soil range sites, this agrees with Abdelsalam et al (2012), reported that the clay soil range site was a higher carrying capacity than other range sites. Matthew et al (2012) stated that the climate factors, soil types and management strongly affect the system productive. The low carrying capacity in sandy and Gardoud soil range site indicates a potential degradation of range resources, this supported by Jadalla et al (2015), stated that the low value of carrying capacity will indicate general land degradation and over grazing.

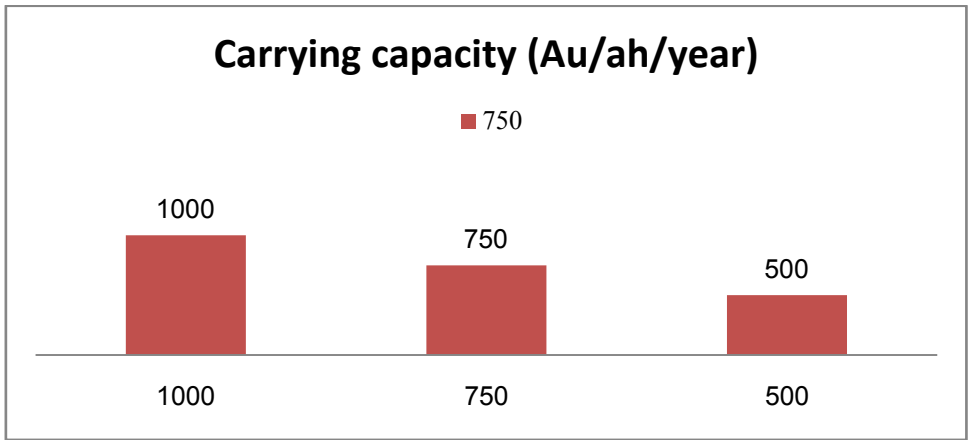

Figure (1) the carrying capacity in different range sites

Conclusion:

The study concluded that there are variations in vegetation attributes in the three range sites. The clay soils range site has potential in all aspects of production and environment, and able to maintain soil moisture. Sand and clay soil rangelands are more vulnerable to erosion and degradation. Hence the need to develop detailed management plans that take into account the specificity of each range site according to its potential to contribute to the sustainability of range resources.

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