VOL. 3, NO. 5, May 2013 ISSN 2225-7217
ARPN Journal of Science and Technology

http://www.ejournalofscience.org

The Influence of Range Sites Characteristics on Management Prescription of Different Rangeland Sites in Semi-arid Areas of Sudan - North Kordofan State

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ABSTRACT

Soil is an important aspect of rangeland greatly affects vegetation types and sites characteristics. These characteristics could help to understand the interactive relationships among the topographic, soil feature, vegetation composition for better management capacity. Factors that affect soil development are: climate, living organisms, topographic relief or landscape position, parent material and time (Roselleet al, 2011). This study was conducted in North Kordofan State in the semi-arid areas of Sudan to investigate the influence of range site characteristics on management prescriptions. The field data compared three rangelands sites in the study area, Jebel Kordofan, Um Glugi and Demokeya. The results of the present study showed that there were remarkable variations among selected sites in plant cover, biomass productivity and plant density during the growing season in the two study periods 2010/2011and these differences attributed to the influences of soil types as sites specific features as with the case of existence of some plant species that are more attractive to animals resulting in more intensive grazing (Cenchrus ciliaris and Aristida spp). Results indicated that Demokeya site exhibited highest plant cover and biomass production and Um Glugi had highest plant density in the two seasons. These results demonstrated that soil types in semi-arid region have an effect on distribution of moisture and nutrients resources, this effect also are expressed in vegetation attributes between rangeland sites and it is play an important role in range management to both the kind and amount of forage produced and the type of management options. This study provides baseline information regarding characteristics in these rangeland sites. Further investigations are required in-depth understanding these characteristics to progress toward sustainability.

Keywords: *Semi arid areas, Natural rangeland, soil type, Soil texture, Plant cover, Biomass production, Plant density*

1. INTRODUCTION

Arid and semi-arid regions cover approximately one-third of the world's land area and are inhabited by almost 400 million people. These areas are characterized by irregularity and shortage of rainfall, prolonged dry seasons, high temperature and high evaporation (Khiry and Csaplovics, 2006). The soils of arid and semi-arid regions are characterized by frequent water stress, low organic matter content and low nutrient content, particularly nitrogen (N) (Skujins, 1991). The vegetation supported by these soils ranges from barren or sparsely vegetated desert to grasslands, shrublands and savannahs, croplands and dry woodlands. Improper rangeland management practices and removal or loss of vegetation cover results in an increased risk of soil erosion and degradation because plants protect the soil surface from wind and water erosion and livestock is the major user of primary production in the semiarid and arid regions, so degradation has always been attributed to this sub-sector (Sidahmed and Yazman, 1994). Sudan lies within these areas and estimated as 602500 Km^2. Rangelands dominate these areas providing primary products of grasses, legumes and browse from shrubs and scattered trees associations in some depressed areas. These conditions create very harsh environments for rangelands, humans and livestock. However, the rangelands, which constitute a major renewable resource in highly vulnerable, diverse and difficult environment, were most affected by such change (Sidahmed, 1993). There is an urgent need for resource managers to know the state of the nation's rangelands, knowledge that is hampered by lack of reliable and continuous data especially over large regional scales. This information assists management decisions to make correct decisions and measure progress toward sustainability. The study area lies in North Kordofan state (Map1) at western Sudan between latitudes 12^o– 16^o N and longitudes 27^o– 32^o E. It covers an area of about 245,000 km^2, representing two third of the region. It has an average annual precipitation of about 250 mm and it characterized by great annual and seasonal variation in amount and distribution. Annual rainfall ranges from less than 50 mm on the northern border to more than 500 mm on the southern border. . In North Kordofan, the rainy season does not last for more than three months (ARC, 2007). The study area has diverse vegetation resulting from the variability in soils and rainfall. The grazing resources are composed of a number of grasses and browse species in addition to crop residues. The main grasses are: Cenchrus biflorus, Aristid amutabilis and Schoenefeldia graclilis while the browse species include Guiera sengalensis, Acacia Senegal, Boscia senegalensis and Leptadenia pyrotechnica (IIED and IES, 1989).The gardud soils are covered with broad-leaved savannah woodland Acacia seyal and Balanites aegyptiaca. The sandy soil cover with scattered upper storey vegetation characterized by grasses such as Cenchur sciliaris, Chloris gayana, Eragrostis spp., Panicum turgidum, Cyprus mundtii, Dactyloctenium aegyptium and Aristida spp. The main land use types in the study area are: the traditional crop production; range and livestock. The distribution of population within Northern Kordofan State is variable and follows rainfall density and distribution. The concentration of people results from the low soil productivity on one hand and the lack of water

during the dry season on the other hand (Gasimel seed, 2000). The goal of this study was to investigate the influence of range sites characteristics on management prescriptions of different rangeland sites in semi-arid areas of Sudan.

2. MATERIALS AND METHOD

This study was conducted in North Kordofan State of Western Sudan covered three selected rangeland sites (Plates 1, 2, 3). These sites were selected representing the major rangelands types of Northern Kordofan State and were identified based on field survey and observation. Dependence on soil type as a main feature for identifying sites was a key process because soils play an important role in determining rangeland dynamics. Global Positioning System (G.P.S) was used to record the coordinates of the sites. Characteristics of these sites related to soil and vegetation are shown in table (1).

Table 1: General characteristics of the rangeland sites

Range type	Vegetation community	Soil type (%)			Organic matter ML/Litter
		Clay %	Silt %	Sand %	
Jebel kordofan	Woodland-Grassland	12	6	82	0.30
Um Gulgi	Shurbland- Grassland	4	2	95	0.17
Demokeya	Grassland- Woodland	6	4	90	0.35

2.1 Soil Sampling

Ten soil samples were taken at the three rangeland sites. Ten samples were used to represent each site. The samples were collected from the 0 – 30 cm horizon since the grass roots usually do not exceed 30 cm. Particles size distribution was determined by using the pipette method (Bouwer, 1986).Organic matter was determined as organic carbon ratio by using the Walkey method (Walkey, 1947).

2.2 Vegetation Sampling

At each site, data was collected for two seasons during the month of October in 2010 and 2011. The sampling area of 5 km x 5 km was marked in each site. Four transects were used each of 500 m length across each site. The same set of points was visited each year. At each site, 200 quadrates (1m x1 m) were located systematically at 10 m intervals resulted in 50 quadrate per transect to assess biomass production and plant cover.

2.2.1 Biomass Production

Biomass was determined in each site using Comparative Yield Method developed by Haydock and Shaw (1970). Quadrate (1m x1 m) was placed at each site (Bonham, 1989). All the above plants was clipped from these quadrates in the grazing level (3 cm) and dried by an oven at 105 C° to get dry matter content, until weight is obtained.

2.2.2 Plant Cover

Plant cover was determined by locating 1X1m quadrate at each site and plant material was estimated as a visual percentage into each quadrate along transect. Cover% = the total sum of the quadrate % x100 divided by the number of samples (quadrate).

2.2.3 Plant Density

Density for trees and shrubs and new natural regeneration was determined in each site by using nearest individual method reported by (Cottam and Curtis, 1956). A total of 80 measurements points were selected randomly for each site. At each point the closest plant is identified from the point is measured and recorded. Then the sample mean of the distance between plants for sample area is calculated. The relative density of specific species in each site was determined. The mean distance and density were calculated as follow:

$$D^{-} = \frac{\sum D^{-}}{n}$$

.

(where D^{-} = Mean Distances and n = Number of Samples)

Density per hectare was obtained as follow:

$$D = \frac{1000\ m2}{2\ (D^{-})\ 2}$$

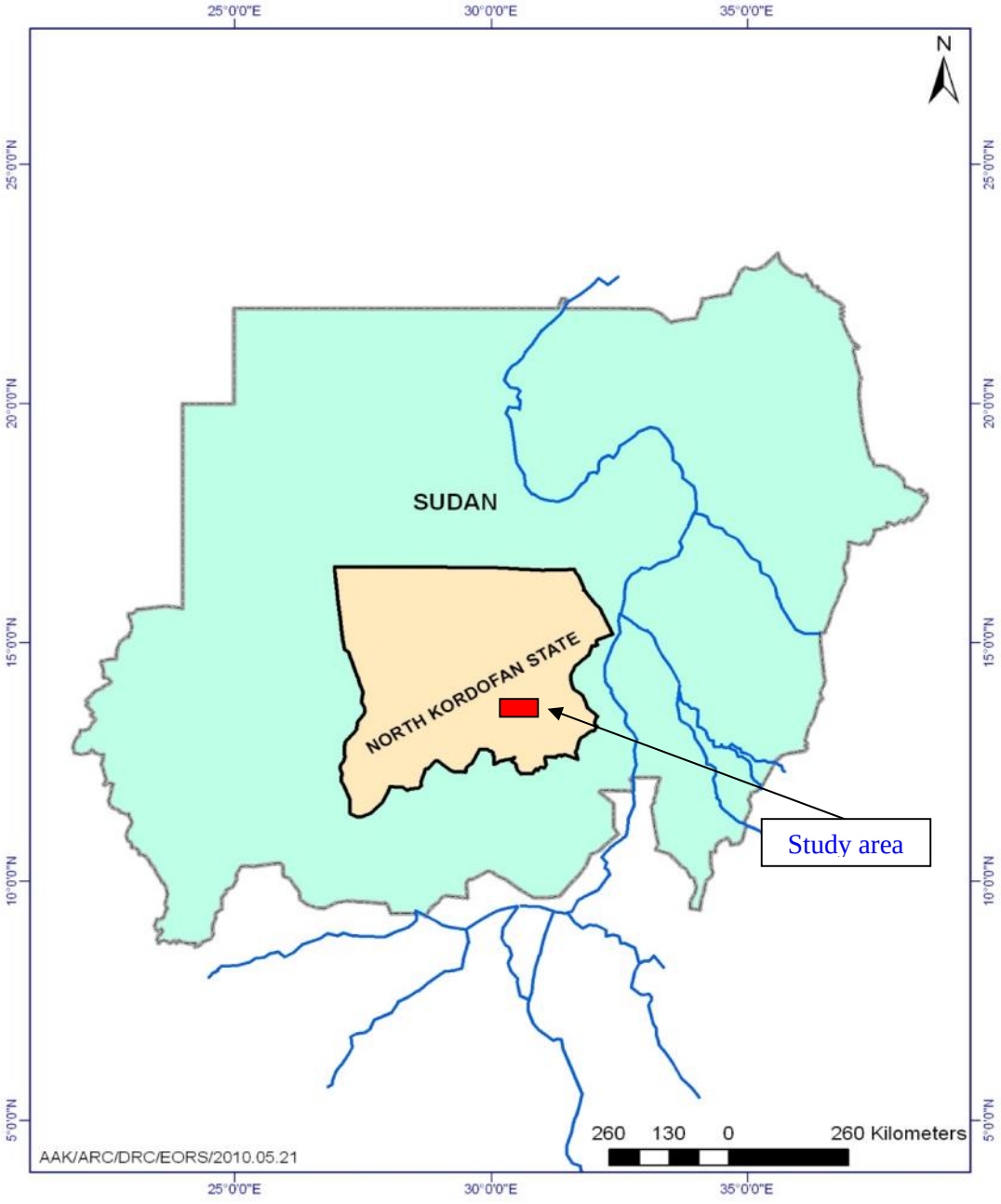
$$D(A) = \frac{N(A) \quad X \quad \sum D}{\sum N}$$

Where

N (A) = Number of individual of species (A),
∑ D= Total density
∑ N = Total number of individuals

2.3 Data Analysis

The data of vegetation attributes were analyzed. Descriptive statistics were used to compare variations between the different selected variables in each site.



Map 1: Location of the Sudan with study area – North Kordofan State

Plate 1: Jebel Kordofan

Plate 2: Um Glugi

Plate 3: Demokeya

Source: Field survey 2010

3. RESULTS AND DISCUSSION

3.1 Sites Characteristics

The results indicate that higher amount of sand found almost the same at UmGlugi and Demokeya (95%) and (90%) respectively. Low clay content (4%) and silt (2%) at UmGlugi (Table, 1).According to Gholinejad et al (2012) the results showed that soil texture including (clay, sand), organic matter content slope and altitude factors are the most influencing factors on plant communities' distribution within the sites .The chemical and physical characteristics of a soil determine: its ability to furnish plant nutrients; the rate and depth of water penetration; and the amount of water the soil can hold and its availability to plants (NRC, 1994).

The mean soil organic matter values were demonstrated in Table (1). Demokeya scored the highest value 0.35 followed by 0.30 in Jebel Kordofan and 0.17 in Um Glugi indicating the lowest organic matter. Low organic matter in Um Glugi could be attributed to intensive grazing because this site constitutes the main resting place for the nomads during their migration from the summer domains in south to the rainy season. Many management techniques attend to maintenance of soil organic matter for sustain production in rangeland, which can be strongly influenced by management. According to Zziwa et al (2012) pointed that Organic matter has also been identified as a major factor limiting rangeland production in many other ecosystems across the globe and increase in organic matter leads to an improvement in many other physical and chemical properties of soil.

3.2 Vegetation

Results of plants cover percentages at the different range sites were given in Table (2). A higher percentage (51.6%) of cover was recorded in Demokeya followed by 42.9% and 34.8% in the Jebel Kordofan and Um Glugi sites respectively. The differences in vegetation cover among selected sites were observed during the study period. Plant cover varied greatly associated with plant community. The spatial variation in vegetation cover reflects the combined influence of environmental factors including climate, soils and topography. Precipitations are the dominant control on soil moisture in the selected rangeland sites, where rainfall is higher and soil water storage capacity is greater. Rebeca et al (2011) pointed that the amount and seasonality of rainfall is also reflected in the amount of vegetation cover within the increase of vegetation (surface and canopy). The low plant cover in Um Glugi could be attributed to the reason that this site preferred by pastoralist because this site dominated by important species which considered palatable for animals like Cenchrus ciliaris and Aristida spp .Therefore, it is important range management should avoid the deterioration of the rangeland that caused by intensive grazing. Some procedures should be carried out to ensure the integration and balancing of the biosystem elements such as determining the suitable carrying capacity and stocking rate of the rangeland (Taha and Khidr, 2011). The soil of this site has low water holding capacity, and

has very low organic matter content. According to Pacheco (1976) the main limitation shown by this soil includes: low availability of moisture, low fertility and wind erosion hazards.

Table (3) and (4) indicate that there were differences in the mean biomass of the selected range sites. Demokeya site scored the highest biomass value in the two seasons of 2010 and 2011 (74.36 g/m2) and (264.32 g/m2) it followed by (35.35 g/m2) and (183.07 g/m2) in the Jebel Kordofan site and (21.87 g/m2) (126.19 g/m2) in Um Glugi respectively.

Differences in biomass productivity between range sites may be attributed to soil type, species composition and herbaceous cover density. Because the characteristics and the type of soil is important to both the kind and amount of forage produced and the type of management that is possible or appropriate. In addition to vegetation types differ in the rate growth or primary production, per unit rainfall. These variations in productivity might be attributed to the seeds were likely more protected and were enjoying better soil moisture.

The soils of these sites differ in soil type, Um Glugi is sand soil with largest particle size, loses moisture and nutrient quickly. Therefore, the characteristics of soil in each site play a big a part in the plant ability to extract water and nutrients. This could be supported by Holechek et al (2002) stated that moisture and nutrient retention by soils has more influence on vegetation productivity than rate of water infiltration. In arid and semi areas soils high in clay are more productive than those high in sand this agrees with Roselle et al, (2011) pointed that Clay particles have the greatest ability to hold both water and nutrients. Results from current study showed high values of biomass production in Demokeya. Because the best balance between moisture infiltration and retention is obtained with loamy soils, which have mixture of sand silt and clay. The high biomass production may be due to of limited degradation, high nutrients levels and limited competition for grass with woody species.

The average density of plants at the different range types is given in table (5). Um Glugi had highest plant density (176 tree ha^{-1}) as compared with Jebel Kordofan site (57 tree ha^{-1}) and Demokeya (11tree ha^{-1}) in the first season. In the second season Um Glugi also scored highest tree density (156 tree ha^{-1}) it followed by Demokeya (127 tree ha^{-1}) and Jebel Kordofan (122 tree ha^{-1}). Each rangeland site is associated with the density and species of woody vegetation, which is affected by the rainfall, temperature and soil type among other factors. The variations in plant density between the different rangeland sites might reflect the different range sites characteristics. These variations among sites are reported for many species, this may be an indication of the complexity of the tree's density environment during a growth season. Leptadenia pyrotechnica is the dominant shrub type in Um Glugi site may be due to the fact that this species are more adapted to sand soil and it is often a pioneer species in sand dune fixation. This agrees with Al-Amin (2011) the results show that Leptadenia pyrotechnica species have capability to capture sand and provide relatively good protection against consequences from erosion.

Table 2: Plant cover % in the different range sites

Statistics	Sites		
	Jebel kordofan	Um Glugi	Demokeya
Mean	183.07	126.19	264.32
Standard Deviation	74.38	41.82	89.35
CV%	40.6%	33.1%	33.8%
Std. Error	5.26	2.96	6.32

Table 3: Biomass of grasses (g/m2) in the different range sites during rainy season of 2010

Statistics	Sites		
	Jebel kordofan	Um Glugi	Demokeya
Mean	35.35	21.87	74.36
Standard Deviation	27.54	17.77	29.64
CV%	77.9%	81.3%	39.9%
Std. Error	1.948	1.26	2.097

Table 4: Biomass of grasses (g/m2) in the different range sites during rainy season of 2011

Statistics	Sites		
	Jebel kordofan	Um Glugi	Demokeya
Mean	183.07	126.19	264.32
Standard Deviation	74.38	41.82	89.35
CV%	40.6%	33.1%	33.8%
Std. Error	5.26	2.96	6.31

Table 5: Total plant density of the different range sites during the rainy season of 2010 and 2011

Sites	Total plant density/ha	
	Season 2010	Season 2011
Jebel kordofan	57	122
Um Glugi	176	156
Demokeya	11	127

4. CONCULOSION

The influence of soil types on range vegetation attributes was studied at selected rangeland sites in North kordofan. Differences were observed among range sites in soil characteristics, plant cover and biomass productivity for the two seasons 2010/2011. The study also found that there were variations in plant density between rangeland sites, where Um Glugi site showed highest plant density. The results suggested that site characteristics will greatly influence management prescriptions. Results demonstrate that management process should greatly consider sites characteristics to assist range managers in promoting sustainable management.

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