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# Studying of factors influencing vegetation composition, distribution and production of Elsemeih rangeland of north Kordofan state, Sudan

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**Abstract:** This research was conducted at Elsemeih area during the period (2013-2014). The objective was to study the factors influence vegetation composition, distribution and production of the range land of area. The vegetation measurements were carried out using loop and quadrate methods. Systematic random samples techniques were used. The number of line transects were identified according to point of diminishing return method. Accordingly, (40) lines transect (20 lines for each season) were made. Each twenty lines were further divided in to ten lines transects for the sandy soil and (10) line transects for the clay ones for both seasons (2013 and 2014). The results showed that, there was no significant difference (p 0.35) in mean percentage of species composition, no significant difference (p 0.39) in mean average percentage of litter and there was no significant difference (p 0.0064) in mean bare soil percentage between sandy and clay soil. Results show that there was significant difference (p 0.05) in mean biomass productivity, significant difference (p 0.0001) in vegetation cover between sandy and clay soil. The average percentages of species composition were 63% and 68.95% in the sandy and clay soils in 2013 and 2014, respectively. The vegetation cover was 50% and 62.5% for sandy and clay soils, respectively. Whereas the average biomass productivity were 0.553 tan/ha and 0.615 tan/ha for sandy and clay soils, respectively. These differences were attributed to the open grazing practices, heavy grazing and time of grazing associated with climatic factors. It was concluded that under the stress of harsh environmental sequences in the two types of soils (sandy and clay) of the area, annual herbs are the only species that are able to survive because of their efficient utilization of the available soil surface water moisture, and the fact that annuals usually mature and shed their seeds well ahead before the incidence of soil moisture stress and seasonal fires out-break.

**Keywords:** Influence, rangeland, vegetation composition, production.

## I. Introduction

In the management and improvement of grasslands, the administrators and the grassland managers are faced with certain pertinent questions, where grassland is producing up to the capability of the particular site, if not, what is the highest ecological level would be, which the site might eventually produce, what ecological status of the present cover is in relation to the optimum, how the optimum may be achieved and what visible criteria may be used in judging whether a particular grass cover is undergoing a change in a desirable direction or otherwise?. The reconnaissance of grasslands, therefore, aims at studying the various grasslands communities as occurs in varied climatic conditions and recording these changes in relation to the ecological factors of the environment (whether natural or introduced by man) [1].

Assessments help to identify areas where problems occur and areas of special interest. Land managers can use this information and other inventory and monitoring data to make management decisions, which, in turn, affect soil quality. When assessments or comparisons are made, the rangeland ecological site description is used as the standard. For the soils associated with a given ecological site, the properties that change in response to management or climate are used as indicators of change [2]. Physical factors determine the kind of vegetation available, the manner and degree of possible use. Physical features include climate, soil and topography. Together they cause grass to grow in the plain, forests to grow in the mountains and shrub to grow in the deserts. Plant communities have constantly changed through geological time. At any particular time, the flora available to constitute the vegetation is a product of the climate, soil, and organisms available. The composition of the vegetation, however, is determined by grazing pressures from major herbivores. Soil is produced by the action of climate and vegetation upon the parent rock materials [1].

Rangelands health and soil quality are interdependent. Rangelands health is characterized by the functioning of both the soil and the plant communities. The capacity of the soil to function affects ecological processes, including the capture, storage, and redistribution of water; the growth of plants; and the cycling of

plant nutrients. For example, increased physical crusting decreases the infiltration capacity of the soil and thus the amount of water available to plants. As the availability of water decreases, plant production declines, some plant species may disappear, and the less desirable species may increase in abundance [3]. Changes in vegetation may precede or follow changes in soil properties and processes. Significant shifts in vegetation generally are associated with changes in soil properties and processes and/or the redistribution of soil resources across the landscape. In some cases, such as accelerated erosion resulting in a change in the soil profile, this shift may be irreversible, while in others, recovery is possible [2], [4] and [5].

Soil quality is the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries, sustain plant and animal productivity, maintain or enhance the quality of water and air, and support human health and habitation. Changes in the capacity of soil to function are reflected in soil properties that change in response to management or climate. [6] and [2]. Changes in soil quality that occur as a result of management affect: the amount of water from rainfall and snowmelt that is available for plant growth; runoff, water infiltration, and the potential for erosion, the availability of nutrients for plant growth, the conditions needed for germination, seedling establishment, vegetative reproduction, and root growth and the ability of the soil to act as a filter and protect water and air quality [7], [6] and [2]. Soil quality on rangelands can affect plant production, reproduction, mortality, erosion, water yields, water quality, wildlife habitat, carbon sequestration, vegetation changes, establishment and growth of invasive plants and rangeland health [8].

Rang vegetation ecosystem is characterized by many divergent environment resulting from action and interaction of soil. These actions and interactions resulted in the country range Land major ecological zones- this ecosystem range from desert, Semi-desert, low rainfall Savannah in the north to high rainfall Savannah. It must be emphasized that there is inadequate information as to the original range vegetation composition and production of the various predominant ecological Zones. Since [9] dated 1958 no genuine work had been done with regard to the vegetation botanical composition, distribution, and production. To remedy this deficit of knowledge will require a systematic inventory and analysis of all parameters that maintain and influence vegetation composition, distribution and production. Adequate data must be collected and analyzed for the assessment of the current vegetation situation. The changes in vegetation composition must be correlated with the affect of seasonal fires, climatically sequences, as well as with the effect of grazing and all other parameters that may influence these changes [10].

Range lands in Sudan are facing many problems that hinder their use and development. Some are user oriented whereas others are resource oriented. Most rangelands lie in fragile environments and facing frequent drought periods, seasonal bush fires, changing in species composition, increasing pressure on the all species occur within a characteristic, limited range of habitat and within their range, they tend to be most abundant around their particular environmental optimum [11]. Thus successive species replacement occurs as a function of variation in the environment [12]. [13] Listed a set of measurable indices by which to appraise changed, as a foundation to reach a positive or negative judgment on the basis of the direction and magnitude of change. There are essential two components of concern, namely those dealing with the resource base for its intrinsic value, and those pertaining to the risk of reduced secondary production, and therefore lower economic returns from the land. Vegetation composition has undergone remarkable changes. Most of what was classified by [14] as belonging to *Acacia senegal* formation may have once been *Acacia senegal Combretum cordifanum* association. The replacement of *Terminalia brownii* by *Dalbergia amara* sup species was reported by [15] to take place within the low rainfall Savannah. Most of the *Acacia tortillis* formation is now disappearing leaving room to the spread and domination of *Leptadenia pyrotechnica*. The understory herbaceous vegetation is also undergone remarkable changes due to overgrazing, seasonal fires. The herbaceous botanical composition has been altered from the domination of the highly productive perennials to the spread and domination of the inferior and less productive annuals species and the former were reported as decreasing [10]. This research is an attempt to study the Factors influencing vegetation composition, distribution and production in Elsiemih area of Western Kordofan State.

## II. Research Methodology

### A. Study area

This study was conducted during the years 2013-2014 at Elsemeih area of North Kordofan State which lies approximately between longitude ($27.05\text{-}32^0$) east and latitude ($11.15 - 16.45^0$) north. The average elevation is 149 m above the sea level [16]. The climate of Elsemeih area is low rainfall woodland savannah with an average rainfall of 380 mms, the high temperatures range from ($22\text{-}30^0$ c) and the low temperatures range from ($13\text{-}24^0$c).The average yearly evaporation is about (1800 mm).The moisture range from 30% to73%.

**B. Sampling procedure**

The sampling procedure for herbaceous cover was based on the species area curve method for the determination of the number of samples to be taken. In this method the number of line transects were identified according to point of diminishing return [17]. Accordingly, (40) lines transect (20 lines for each season) were made. Twenty samples in season 2013 (ten line transect for the sandy soil and ten line transects for the clay ones) and other twenty samples in season 2014 (ten line transects for sandy soil and ten line transects for the clay ones) were done. The number of species determined in each sample was recorded in the vertical axis of the curve. When the number of samples completed twenty no new plant species was appeared. This point called "the point of diminishing returns" after which no species was recorded.

**C. Measurements**

**Plant composition**

The plant composition was measured along each 100m transect using loop. The ¾□ inch loop [18] used to measure vegetation every one meter along the 100 meter transects. Hits on species composition, litter, and bare soil were recorded. Resulting information listed on record sheet.

The measurement encountered the following:

- Plant species (sp1, sp2, ……etc)
- Litter (L)
- Bare soil (Bs)

The above parameters were calculated as the following:

Species composition = $\frac{Totalhitsofeachspecies}{Totalhitsofallspecies} \times 100\%$

Percent of bare soil = $\frac{\frac{Totalhitsonbalesoil}{100}}{} \times 100\%$

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

**Vegetation cover**

Vegetation cover was determined by locating 1X1m quadrate. It was estimated as a visual percentage of the quadrate covered by plant material [19]. Cover% = (the total sum of the estimated percent of the vegetation cover in all quadrates ÷ the total number of quadrates) × 100.

**Density**

Density is the number of plants recorded within each quadrate. The average density per quadrate of each species can be extrapolated to any convenient unit area [20]. Density is the number of individual plants per unit area [21]. Density has a considerable influence upon the number and kind of stock which can be introduced in to the grazing lands without endangering it [22].

**Total plant density**

Total plant density was determined by locating 1x1 quadrate. It was determined by calculating the number of individual species plant species /M2.

**Biomass production**

Biomass was determined using Quadrate (1m x1 m). All the above plants were clipped from the square meter quadrate at the grazing level (3 cm) and dried by an oven at 105 C° to get dry matter content, until the weight is obtained.

## III. Results and Discussions

Table: 1 Average percentages of species composition (2013, 2014).

| soil types | season | | Mean |
|---|---|---|---|
| | 2013 | 2014 | |
| sandy soil | 66 | 60 | 63 |
| clay soil | 71 | 66.9 | 68.95 |
| SE | | | 6.04 |
| p-value | | | 0.35 |
| significance | | | Ns |

ns= not significant, SE= standard error

Results of the study showed no significant ((p□ 0.05) difference in mean percentage of species composition between sandy and clay soil. In 2013 the species composition % was 66% in the sandy soil and it was 71% in the clay soil, while in 2014 the species composition was 60% in the sandy soil and 66.9% in the clay one (Table 1). However, the reduction of the mean of species composition percentages in both soils in 2014 may be due to the increase of the grazing of livestock that happens yearly to the area by different classes of animals. This agreed with [23] who stated that, different classes of domestic stock affect plant communities in different ways depending on growth forms and acceptability of the predominant plants, so pasture land managers should be well advised to consider:

- Whether undesirable changes in plant species composition have occurred as a result of the present kinds of grazing animals.
-Whether more equitable balance between the over story and understory plants may be attained by changes in the kinds and proportions of different types of grazing/browsing animals.

Results of the study showed no significant (p□ 0.39) difference in mean average percentage of litter between sandy and clay soil. In 2013 the litter species % was 9.6% in the sandy soil and it was 8.2% in the clay soil, while in 2014 the litter species was 11.8%in the sandy soil and 10% in the clay one (Table 2). However, the increase of litter percentages in both soils in 2014 may be due to the overuse of the plants that reduced the amount of surface plant materials and roots .Same observations was found by [4].

Table: 2 Average percentages of litter species (2013, 2014).

| soil types | season | | Mean |
|---|---|---|---|
| | 2013 | 2014 | |
| sandy soil | 9.6 | 11.8 | 10.7 |
| clay soil | 8.2 | 10 | 9.1 |
| SE | | | 1.34 |
| p-value | | | 0.39 |
| significance | | | Ns |

ns= not significant, SE= standard error

Results in table (3) showed no significant ((p□ 0.0064) difference in meanbare soil percentage between sandy and clay soil. In 2013 the bare soil% was 13.4% in the sandy soil and it was 11.1% in the clay soil, while in 2014 the bare soil was 16.9%in the sandy soil and 14% in the clay one. However, the increase of the mean of bare soil percentages in both soils in 2014 may be due to the increase of the high grazing of livestock that happens yearly to the area. Same results were mentioned by [4] who reported that, the high increase of average bare soil around water points may be attributed to high grazing pressure as a result of high temperature and evaporation rates.

Table: 3 Average percentage of bare soil (2013, 2014).

| soil types | season | | Mean |
|---|---|---|---|
| | 2013 | 2014 | |
| sandy soil | 13.4 | 16.9 | 15.15 |
| clay soil | 11.1 | 14 | 12.25 |
| SE | | | 6.90 |
| p-value | | | 0.0064 |
| significance | | | Ns |

ns= not significant, SE= standard error

Results of the study showed highly significant ((p□ 0.35) difference in mean vegetation cover percentage between sandy and clay soil. In 2013 the vegetation cover% was 55% in the sandy soil and it was 65% in the clay soil, while in 2014 the vegetation cover was 45%in the sandy soil and 60% in the clay one (Table 4).

Table: 4 Vegetation cover percentages/$m^2$ (2013, 2014).

| soil types | season | | Mean |
|---|---|---|---|
| | 2013 | 2014 | |
| sandy soil | 55 | 45 | 50 |
| clay soil | 65 | 60 | 62.5 |
| SE | | | 6.04 |
| p-value | | | 0.35 |
| significance | | | *** |

***= significant (p□ 0.0001)

However, the reduction of vegetation cover percentages in both soils in 2014 may be due to the increase of the grazing of livestock that happens yearly to the area and varying animal combinations which affects largely on the soil type especially the sandy one. This agreed with [24] who related the reduction of plant cover to sacrifice areas along livestock routes, around water points and homestead.
Results of the study (Table 5) showed no significant ((p□ 0.84) difference in mean plant density percentage between sandy and clay soil.

Table: 5 Average total plants density/$m^3$ (2013, 2014).

| soil types | season | | Mean |
|---|---|---|---|
| | 2013 | 2014 | |
| sandy soil | 103 | 87 | 95 |
| clay soil | 118 | 107 | 113 |
| SE | | | 15.8 |
| p-value | | | 0.84 |
| significance | | | Ns |

In the year 2013 the six dominant species at the sandy soil were *Zornia spp, Dactyloctenium aegyptuim, Sida cordifolia,Cenchrus spp,Requtenia obeordate and Echinochola colona*, respectively. While in the clay one the six dominant species were *Zorina spp*, Dactyloctenium aegyptuim , *Requtenia obeodate, Aristida mutabilis , Cenchrus spp* and *Echinochola colona*, respectively. In the year 2014 the six dominant species in the sandy soil were *Dactyloctenium aegyptuim, Echinochola colona, Aristida mutabilis, Sida cordifolia, Indigofora aspera* and *Zornia spp*, respectively. While the six dominant species in the clay one were *Dactyloctenium aegyptuim, Ergrostis spp, Echinochola colona, Trinthema pantandra, Requtenia obeordate* and *Cassia spp*, respectively (table 6). The reduction of average total plants density in the two types of the soils (sandy and clay) from103 and 118 in 2013 to 87 and 107 in 2014 respectively, may be attributed to heavy and permanent grazing which hinder the natural rehabilitation of grasses, as a result of open grazing practices. [25] reported that this system (open grazing practices) leads to degradation.

Table: 6 Average species plants density/$M^2$

| NO. | Species Name | Sandy soil | | Aver-age | Clay soil | | Aver-age |
|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | | 2013 | 2014 | |
| 1 | *Zornia sp* | 7 | 6 | 7 | 6 | 5 | 7 |
| 2 | *Dactyloctenium aegyptium* | 0.18 | 4.41 | 9 | 6 | 7 | 7 |
| | *Sida cordifolia* | 1.22 | 1.06 | 7 | 3 | 4 | 4 |
| 4 | *Aristida sp* | 0.31 | 0.80 | 7 | 5 | 3 | 4 |
| 5 | *Erogrostis tremula* | 6.13 | 6.68 | 5 | 4 | 7 | 6 |
| 6 | *Indigofora aspera* | 5 | 7 | 6 | 3 | 3 | 3 |
| 7 | *Cencherus spp.* | 0.18 | 0.26 | 6 | 5 | 3 | 4 |
| 8 | *Brachiaria obtusiflora* | 4 | 4 | 4 | 3 | 3 | 3 |
| 9 | *Trianthema pantandna* | 4 | 5 | 5 | 5 | 5 | 5 |
| 10 | *Requtenia obeordate* | 7 | 5 | 6 | 6 | 5 | 6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | *Echinochloa colona* | 7 | 8 | 8 | 5 | 6 | 7 |
| 12 | *Cassia spp* | 5 | 5 | 5 | 3 | 5 | 4 |
| 13 | *Euophorbia spp* | 4 | 6 | 5 | 4 | 4 | 4 |
| 14 | *Tophrosia gracilis* | 4 | 4 | 4 | 2 | 3 | 3 |
| 15 | *Ipomea cardiofolia* | 3 | 3 | 3 | 3 | 2 | 3 |
| 16 | *Ruellia patual* | 3 | 2 | 3 | 4 | 2 | 3 |
| 17 | *Chorchorus olitoruis* | 2 | 2 | 2 | 4 | 3 | 4 |
| 18 | *Arstochlaena lachnospermum* | 2 | 1 | 2 | 3 | 2 | 3 |
| 19 | *Ocimum spp* | - | - | - | 3 | 4 | 4 |
| 20 | *Justica schimperi* | - | - | - | 3 | 5 | 4 |
| 21 | *Cassia tora* | 4.29 | 2.94 | - | 3 | 4 | 4 |
| 22 | *Cyperus mundtii* | | - | - | 1 | 1 | 1 |
| 23 | *Commlina spp* | - | - | - | 1 | 1 | 1 |
| 24 | *Pennisetum pedicellatum* | - | - | - | 1 | 2 | 2 |
| 25 | *Acanthospermum hespidum* | 0.06 | 0.80 | - | 2 | 1 | 2 |
| 26 | *Aristolchia bracteolate* | - | - | - | 1 | 1 | 1 |
| 27 | *Leptadenia hastate* | - | - | - | 1 | 1 | 1 |
| 28 | *Ipomea repens* | - | - | - | 1 | 1 | 1 |
| 29 | *Eorghum purpureosiceum* | - | - | - | 1 | 1 | 1 |

The variations in the dominances of the different species in the area in the two seasons and between the two types of the soils may be attributed to the type of soil and the rainfall parameters. This agreed with [26] who stated that plant populations change under the reduced native animal's impact and increased grazing pressure of domestic animals especially in the wet season. [14] Observed the high grazing pressure upon *Blepharis linarifolia*. He related this palatability to the high protein content, especially during the wet season.

Following the assessment of Range Vegetation within Kordofan special fund area [15] concluded that the major factors causing eradication of perennial species are over-grazing, fire, and the seasonal short-run fluctuation in soil moisture. He concluded that causes of denudation of natural vegetation include drought, wind, flood, bush, fire and over-grazing. It was concluded that under the stress of harsh environmental sequences, annual herbs are the only species that are able to survive because of their efficient utilization of the available soil surface water moisture, and the fact that annuals usually mature and shed their seeds well ahead before the incidence of soil moisture stress and seasonal fires out-break.

Results of the study (Table 7) showed significant ((p□ 0.05) difference in mean biomass productivity between sandy and clay soil. In 2013 the biomass productivity was 0.600 ton/ha in the sandy soil and it was 0.635ton/ha in the clay soil, while in 2014 the biomass productivity was 0.525ton/ha in the sandy soil and 0.585 ton/ha in the clay one.

Table: 7 Biomass productivity ton/ha (2013, 2014).

| soil types | season | | Mean |
|---|---|---|---|
| | 2013 | 2014 | |
| sandy soil | 0.600 | 0.525 | 0.563 |
| clay soil | 0.635 | 0.585 | 0.615 |
| SE | | | 4.718 |
| p-value | | | 0.05 |
| Significance | | | * |

*= significant (p□ 0.05)

The decrease of biomass productivity in 2014 in the two types of the soils may reflect the impacts of environmental factors which include climatic factors such as: rainfall, temperature, radiation and humidity etc which determine the quantity and the quality of forage. This agreed with [4] who stated that production is determined by environmental factors. It also may be due to the rainfall parameters. This agreed with [27]. He stated that growth is determined by rainfall parameters such as: distribution, number, amount and intensity of individual rains. [23] Stated that the inter-annual variations in forage production are caused by many factors, the major one being the effect of rainfall. In the Sahel, the coefficients of variation along the 200 to 600 mms

gradient are usually 20% to 30%. They also stated that in India, the results indicate that with adequate protection and controlled grazing the forage yield on the rangeland practically doubled in about 3 to 5 years. It has been estimated that during years of a normal rainfall, air-dried forage production in " very poor ", " poor ", " fair ", and " excellent" grassland is 200, 500, 750, 1000, and 1500 kg/hectare, respectively, when protected, fertilizer application and reseeding with better grasses, suiting different soil and rainfall conditions give increased yields of forage material, amongst the different soil and water conservation measures on rangelands. The variation in biomass productivity in the two seasons may be attributed to rainfall parameters, soil type and the impacts of the nomads arrival to wet season area, they enter the area with their animals before plants reach its full maturity stage, and this leads to the reduction of the growth in the coming years causing the degradation of the area, because the animals eat the plants before it produces the seeds. The same results were mentioned by [28] who stated that seed production is especially important to annuals, since it is the only way they reproduce. It has been shown that seed production in annual grasses can be greatly reduced by clipping, especially late in the growth season. It is unlikely thought that grazing can reduce seed production below the amount needed for production.

## IV. Conclusion

The study concluded that the open grazing practices, heavy grazing and time of grazing associated with climatic factors have an impact on vegetation composition, distribution and production. It was concluded that under the stress of harsh environmental sequences in the two types of soils (sandy and clay) of Elsemeih area, annual herbs are the only species that are able to survive because of their efficient utilization of the available soil surface water moisture, and the fact that annuals usually mature and shed their seeds well ahead before the incidence of soil moisture stress and seasonal fires out-break.

## References

[1]. O. Amin, N., Nomadism versus sedenterization: An environmental choice in Western Sudan (The Case of Gerih elsarha). M.Sc. Thesis Institute of Environmental Studies. University of Khartoum, 1986.
[2]. D. Bonham, C. Measurements of terrestrial vegetation. John Wiley & Sons, New York NY. pp 11-202, 1989
[3]. G. Brown, D., Predicting vegetation types at tree line using topography and biophysical disturbance variables. Journal of vegetation science5, 1994.
[4]. A. Darag, A., Senior staff training lecture. Community based rangeland rehabilitation project. Gerigikh rural council Bara province. North Kordofan administration. Sudan, 1996.
[5]. N. Donkor,T; J. Gedir.V; .J. Hudson.R; W. Bork, .E.; D. Chanasyk S. and A. Naeth. M., Impacts of grazing systems on soil compaction and pasture production in Alberta,1Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada T6G 2H1; 2 Department of Agricultural, *Food and Nutritional Science*, University of Alberta, Edmonton, Alberta, CanadaT6G 2P5. Received 9 March 2001, accepted 12 September 2001.
[6]. S. Elwakeel, A., Rangeland surveys and analysis. Training manual. Forage and rangelands administration. Khartoum. Sudan, (2001.
[7]. FAO, Grazing and forest economy.Forest products study No4 .Printed in Italy, 1953.
[8]. G., Fashir, Integrated Rangeland management for Sustainable agriculture and animal production .Case study (Kadugli Locality), a dissertation Submitted in partial Fulfillment of Requirement M.Sc. Degree in Range Science, Sudan University of Science and Technology, 2008.
[9]. G. Fashir, Impacts Assessment of Open Grazing System on Some Rangeland Environmental Components- Case Study Dilling Locality South Kordofan State- Sudan.Thesis Submitted in Fulfillment of the Requirements for the Degree of PhD, 2014.
[10]. N. Harrison, M. and K. Jackson, J., Ecological classification of vegetation of the Sudan. Agricultural publications committee. Khartoum, 1958.
[11]. N. Harrison, M., Report on a grazing survey of the Sudan. Department of animal production. Khartoum University.*Technology*,19(2),47-53, 1955.
[12]. IASC (2010).Managing Range http://oneplan.org/Range%5CRangeSoil.asp.
[13]. L. Laude, J. and F. Robet, E., Tillering at the reproductive stage in Harding grass, *Journal of range management*. 21:148-151, 1968
[14]. PN De. Leeuw and C. Tothil J, The concept of range and carrying capacity in Sub-Saharan Africa-myth or reality. Addis Ababa. Ethiopia,1990
[15]. A. Leopold, A biotic view of the land. Jour. Forestry 37:729-730, 1939.
[16]. Ministry of information, Sudan the land of opportunities facts and figures, Khartoum, Sudan, 2011.

[17]. W. Parker, K., A method for measuring trend in range condition on national forest ranges. Administrative Studies, U. S. Department of Agriculture, Forest Service, Washington, D. C. 26 pp, 1951.
[18]. N. Ridder, Productivity of Sahelian rangeland, study of the soil, the vegetation and the exploitation of the natural resources. Wageningen agricultural University. The Netherland sperspective. A and M University. Texas, 1982.
[19]. M. Elkheir, S., Performance of Some selected natural range plant species at Babanousa area. Ph.D thesis. College of Forestry & Range Science. Sudan University of Science & Technology, 2008.
[20]. M. Elkheir, S.; G. Fashir. A.; and M. Ishsg.Y, The impact assessment of direct fence with some treatments on rangeland improvement in Semi-Arid area –Sudan. *Sudan Journal of Science and Technology*,19(2),16-21, 2019.
[21]. M. Shackleton, C., Examining the basis for perceptions of communal land degradation: lessons form the Central Lowveld. Communal rangelands in southern Africa. Dep. Of livestock and pasture science. University of Fort Hare. Alice. South Africa, 1998.
[22]. D. Stingsby, and I. Cook ,C.,. Practical Ecology Macmillan Educational LTD. London, 1986.
[23]. A. Stoddart,L. and W. Box,T., Range management. New York. Mc Grow Hill, 1975.
[24]. C. TerBraak, and I. Prentice, A theory of gradient analysis. Advances in Ecological Research. Vol. 18. Academic press. London, 1988.
[25]. USDA, The qualitative assessment indicators are from Interpreting Indicators of Rangeland Health, Natural Resources Conservation Service Version 3, 2000, TR 1734-6, BLM (http://www.ftw.nrcs.usda.gov/glti), 2000.
[26]. USDA, Rangeland Soil Quality, The Soil Quality Institute, Grazing Lands Technology Institute, and National Soil Survey Center, Natural Resources Conservation Service, USDA; the Jornada Experimental Range, Agricultural Research Service, USDA; and Bureau of Land Management, USDI),sheet 1, 2001.
[27]. P. Van Soest, and R. Wine, Estimation of true digestibility of forage by the in vitro digestion of cell walls. Proceeding. Xth. International grassland congress. Helsinki. Finland, 1966.
[28]. J. Wickns, Kordofan botanical measurement. Kordofan government. Kordofan special fund,1962.