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Assessment of Rangelands in Semi Arid Areas of Sudan - South Kordofan State (Eldebeibat Area)

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ABSTRACT

Rangelands are basically one of the main feed resources for livestock. Therefore, it's necessary to be known rangelands existing situation for their improvement and management. Vegetation measurement was conducted on the rangelands of South Kordofan at Eldebeibat area in two periods 2008 and 2012. Sampling for herbaceous cover was based on locating twenty transects 100 m. Length each along the main road in the whole study area which linked with Elobeid and Edalang locality. The herbaceous assessments included cover, composition, density and biomass. The equipments used for data collection were Loop, 1 m^2 quadrate, compass, and 100-m. Tape. Within the two quadrates 10 X 20 m., trees and shrubs density was determined using the direct count method. The results of the present study showed that overgrazing was considered as the major factor responsible for the low vegetation cover in the study area due to the concentration of high numbers of animals during the rainy season. The result indicated that continuous intense grazing causing vegetation changes such as the replacement of palatable grasses by less palatable plant species. The most dominant herbaceous species in the area were *Zornia glochidiata* and *Sida cordofolia* both are less preferred by animals, indicating intensive selective grazing and hence disturbance in rangeland. Results showed that there was considerable variation in tree density in two periods. Human activities and heavy browsing are the main factors influencing the distribution of tree cover and can also affect the woody species density. The *albizzia amara* and *Guiera senegalensis* are the most dominant tree species in the area and it is less preferred by animals. Sound management and suitable improvement techniques should be implemented for these rangelands.

Keywords: *Semiarid areas, Natural rangeland, plant compositions, Plant cover, Biomass production, Plant density*

1. INTRODUCTION

About 35% of the land surface is covered by arid and semi-arid lands, however, these areas are widespread and constitute a vital component of the total land area of the world and its characterized by low erratic rainfall of up to 700mm per annum, periodic droughts and different associations of vegetative cover and soils. The most common vegetation pattern found in semi-arid areas are usually referred to as spotted or stippled and consists of dense vegetation clusters that are irregular in shape and surrounded by bare soil (Ludwig *etal*, 1999). Seasonal vegetation dynamics are largely regulated by the availability of water so vegetation in these areas is scarce and spatially heterogeneous. In the republic of the Sudan, rangelands form an immense natural resource, occupy an area of 110 million hectares and provide about 86% of feed for livestock (Fadlalla and Ahmed, 1997). It is varied from poor to rich according to the ecological zones, especially in South Kordofan state in Western and central regions, including Nuba Mountains area. (Bashir and El Tahir, 2006). For example, during autumn camping "Makhraf", at Eldebeibat area, 65% of the State's livestock concentrated in this area. The high numbers of animals concentrate in a certain area could destroy the natural vegetation leads to overgrazing and hence deterioration of the pasture (Musa, 2001). Continuous overgrazing, through shrub removal and complete utilization of grasses and herbs, particularly before maturity, has resulted in an overall land degradation. The top soil surface is often crusted and resistant to water infiltration which may result in germination failure. The native vegetation is mostly composed of annual grasses and occasional shrub plant sparsely scattered in the area and some annual broad leaves, while the perennial range types had totally been destroyed (Abusuwar and Mohammed, 2011). Good management of rangeland resources requires many techniques of measurements and sampling used in range inventory and monitoring programs to determine the proper use of range resources. Because the inventory and monitoring are essential features of a range management process and plan. They can be as detailed as important to meet the objectives of the plan. (Holechek *etal*, 2004). The study area was conducted in Eldebeibat area - South Kordofan State. It is a part of South Kordofan State that was affected by desertification phenomenon, which spread from North Kordofan State up to the area under focus. The area lies between latitude 11° 45′ – 12° 49′ N and 25º 29′ – 30° 0 E. The area is about 5700Km^2 and constitute 7.3% of the total area of the State (Musa, 2001). The average maximum amount of rainfall in the Basin is received in August. It is about 140 mm in Edalang. The highest amount of rainfall recorded in one day in July and in August was about 74% of the average total rainfall for the month. The topography of Eldebeibat is flat with sandy soil occupying most parts of the area. The nomads prefer using the North parts of the State particularly in rainy seasons, because these areas are suitable for animal's movement, free from flies and rich by good plant species

(IFAD, 2006). The study area (Fig 1) is characterized by relatively a sparse cover of trees and shrubs, but its southern parts is characterized by more thick cover of tall grasses, trees and shrubs. The dominant trees in the area are Higlig (*Balanites aegyptiaca)*, Siddr (*Ziziphus spina-christi*), Arad (*Albizzia amara),*Sarah (*Maeura crassifolia*), Talih (*Acacia seyal*) and Hashab (*Acacia senegal*) in addition to shrubs such as Kitter (*Acacia mellifer*), The understory is dominated by *Zornia glochidiata*, *Eragrostis spp*, *Digitariaspp*, *Dactylotenium aegyptium*, *Cenchrusspp*, , *Chloris gayana*, *Ipomoea spp*, *Abutilon angulatum*, *Fimbristyls dichotomo*, *Commelina subulata*, *Cyperus rotundus*, *Schoenefeldia gracilis.* Water sources in the area is mainly surface water which is collected in natural depressions "Ruhud" in the rainy season, this water is used for human and animal's consumption. But in summer the sedentary depend on wells and water yards "dounkys" sometimes within villages or in other locations, (IFAD, 2006). South Kordofan state had a wide area of rangeland, about 11,335,000 Fadden, 15% of the Sudan rangelands. These rangelands give about 23.6% with total fodders produce from Sudan natural rangelands, (RPA, 2011). The area accommodates 65% of the State's livestock during the rainy season (Musa, 2001). The high numbers of animals concentrate in this area due to presence of an autumn camping area "Makhraf". According to census in 2008the population of the area estimated at 22000 settled people and 2000 families of nomads which are grazing area in the rainy season. Eighty five of the resident population practice both agriculture and animal production. The objective of this study was to assess rangelands at South Kordofan in two periods (2008 and2012).

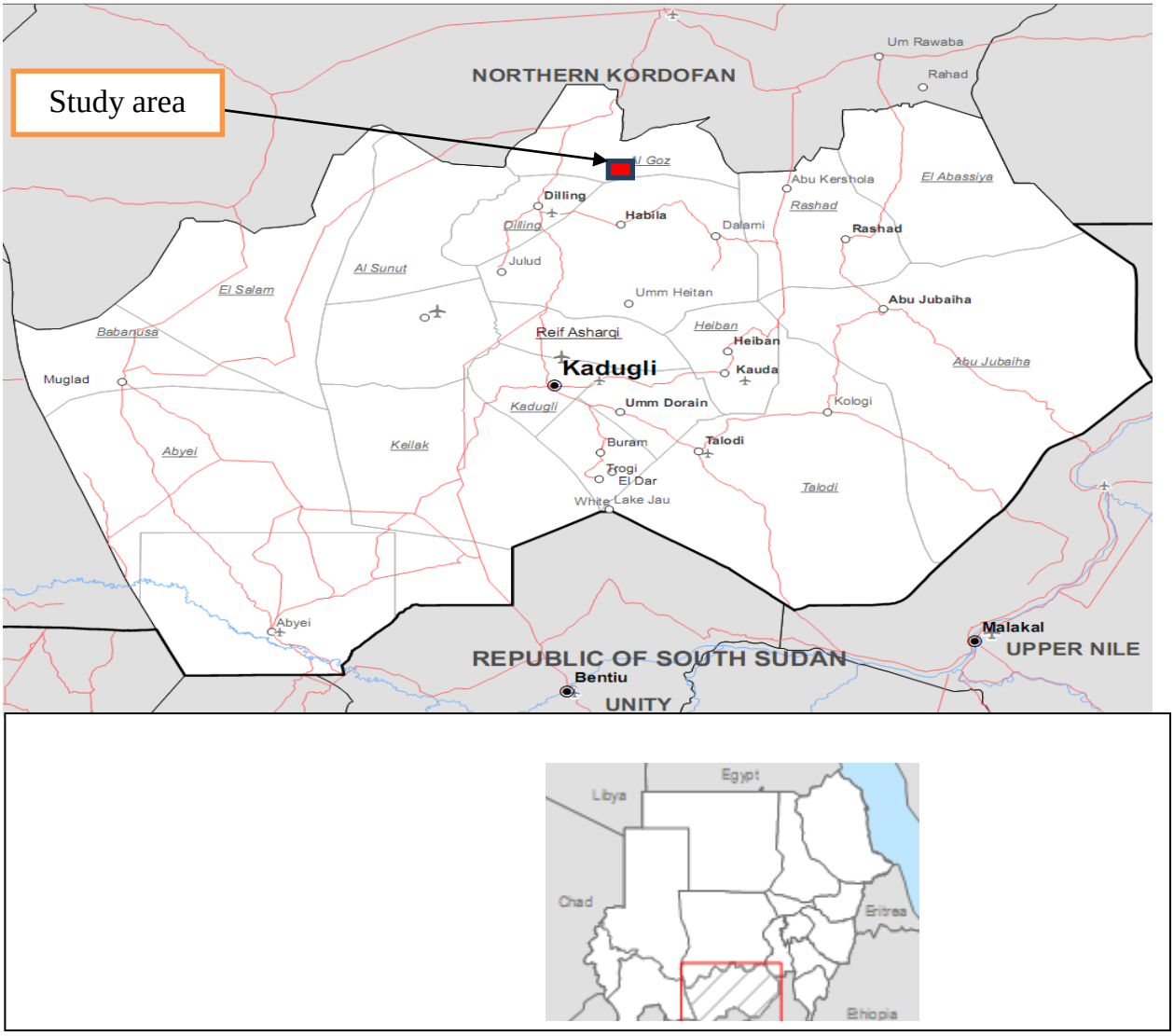

Figure 1. South Kordofan state administrative map illustrated the study area, source OCHA, 2013.

2. MATERIAL AND METHODS

The study was conducted in Eldebeibat area, South Kordofan State. The pattern of range resources utilization was assessed in a whole area in the rainy season of October 2008 and 2012. The assessment covered herbaceous cover and tree density.

2.1 Sampling procedure

The sampling procedure for herbaceous cover was based on locating twenty transects each of 100m length at the whole study area along main road which linked with Elobeid and Edalang locality. For trees and shrubs density, two quadrates 10 x 20m were distributed along each transect in the whole study area.

2.2 Measurements

- Herbaceous cover

To assess herbaceous cover, measurements taken included vegetation cover a composition, density and biomass. The equipments used were a Loop, 1 m^2 quadrate, compass, scissors and a 100 m tape.

The plant composition was measured along each 100m transect using loop, where plant species were recorded at ¾ inch loop (Parker, 1951) hit, and at one meter intervals where hundred observations were registered in a recording sheet for each transect. Percentages of plant composition, litters, rocks and bare soil were obtained by dividing total hits of each parameter along transects by total observations of individual factor and multiplied by 100%. The following equation was used to calculate the percentage of plant composition, bare soil, litter and rocks.

$$\text{Factor* (\%)} = \frac{\text{Total of hits of factor}}{\text{Total number of hits}}\ x100$$

Factor* = It represents the plant composition or bare soil or litter or rock

Plant cover percentage is the part of quadrate, which covered by plants. It was determined by locating 1X1m quadrate along the transects and at 20 m intervals. Plant cover percent was estimated for each quadrate and recorded, then the total estimation were summed and divided by the number of quadrates to give one average plant cover for one square meter (quadrate).

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

$$\text{Frequency\%} = \frac{\text{Number of quadrats with plants species occured}}{\text{Total number of quadrats}}\ \text{X}\,100$$

Density is defined as the number of individuals in a given unit of area. It was determined by counting of plants rooted within each quadrate (Bonham, 1989) as follows:

$$\text{Density} = \text{No. of individuals in each quadrat}$$

$$\text{Relative Plants Density} = \frac{\text{Density of species b}}{\text{Total density of all species/quadrat}}\ \text{X}100\%$$

To determine the dry matter production (DM) a 1x1 meter (quadrate) was placed along each transect at 20m intervals (five quadrate/transect). The plant species in each quadrate were clipped at 3cm above the ground level, as this represents grazing level using scissors. The harvested plant materials were placed in paper bags, partially dried under sunlight to reduce the moisture contents of plants and to protect them from decaying, because when the samples were taken the moisture was high. The plant materials were oven dried at 105ºC for 17 hours (overnight) at Seeds Center in Soba area. The oven dried materials were weighed. The dry matter per quadrates was obtained by dividing the total weight of all quadrates by their number to obtain one average of weight (g/m^2). Then the dry matter (ton per hectare) was obtained.

- Tree density

Density in vegetation measurement refers to the number of individuals per unit area. Trees and shrub density was determined using direct count methods. Two quadrates 10 X 20 m was distributed along each transect in the whole study area. In each quadrate the number of trees and shrubs was recorded. The number of species (trees and shrubs) was summed and divided by their number of all quadrates to come on average.

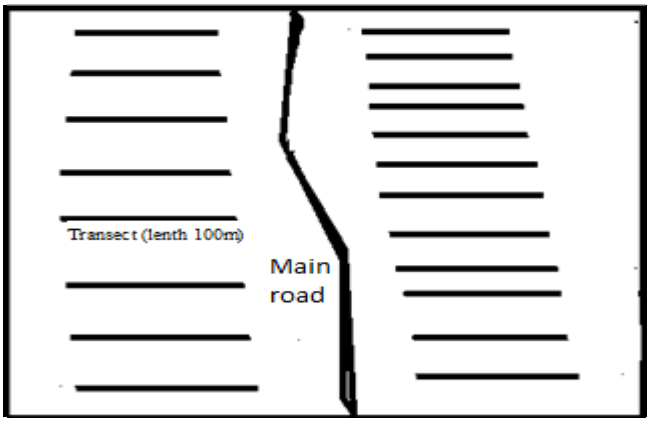

Figure (1) Layout of Transects Distribution in the study area beside the main road linked the study area with Elobeit and Aldalang. Source: (Authors, 2012).

3. RESULTS AND DISCUSSION

This study investigated the rangelands in semiarid areas, through assessment of vegetation attributes in two periods 2008 and 2012.

3.1 Herbaceous cover Assessment

- Cover:

The results showed that, the average cover percentage was higher in the period of 2008 compared with the period of 2012, 32.3% and 29.4% respectively (Table 1). This could be explained by the effect of trees shade on grass layer, because the period of 2012 recorded high tree density represented the lowest cover percentage. The variations in the vegetation cover between the two periods were caused by fluctuated precipitation, because rainfall is one of the most important variables that characterize arid and semi-arid environments. Rebeca *et al* (2011) stated that, the amount and seasonality of rainfall is also reflected in the amount of vegetation cover within the increase of vegetation (surface and canopy).As well as overgrazing was considered as the main biotic factor responsible for the low vegetation cover, because the high numbers of animals concentrated in this area during the rainy season. While the bare soil was higher in the period 2012 compared with the period 2008 (20.1% and 8% respectively). The high bare soil percentage may be due to low rainfall. The spatial variations in bare soil may be caused by topographic features, overgrazing and agricultural practices. Litter is any dead plant material that is in contact with the soil surface. Results in table (1) illustrate litter percentage was lower in the period of 2008 compared to 2012 (0.38% and 2.5% respectively). The very low litter percentage in 2008 may be due to intensive grazing in this period, while the increase litter percentage in 2012 may be due to un grazed by reason insecurity situation caused by civil war in this area. This result confirmed the findings of Jensen and Gutekunst, (2003) who indicated that the standing and fallen litter mass generally decrease with increased grazing intensity.

- Plants Composition:

Results of plant composition of the two periods were demonstrated in Table (1). Quite similar values were scored in 2012 and the 2008 (77.4% and 76.1%respectively). The low plant composition may be due to both variable soil properties and grazing intensity. According to Yates *et al*., (2000) they stated that, grazing by domestic livestock has been considered as a main degrading factor because it changes vegetation structure and composition as a result of which some species increase in abundance and others decrease. The plant composition is changing continuously in space and time due to some factors, such as grazing, fire, and rainfall which differ in intensity, duration, and timing. O'Connor (1991) found that rainfall variability over 1 or 2 years could induce substantial changes in composition. The species relative compositions of the most dominant species in 2008 and 2012 were shown in Table (2) and (3). There was spatial variation in species relative composition in two periods. The increases of unpalatable plant species in 2012 were observed. These plants were; *Zornia glochidiata, Sida cordofolia* and *Oldenlandia senegalensis.* These differences in plant relative composition, may be due to the intense grazing. Moreover, the unpalatable plants often invade the areas. Also the reduction in more palatable plant species in the area such *as Dactyloctenium aegyptium.* The results in Table (3) showed the *Echinocloa colonum* and *Chloris Guyana* were absent in 2012; this may be caused by selective and early grazing of this species.

- Frequency

The results showed that, *Echinocholoa colonum* scored the highest frequency 67.6% in 2008 (Table 2), and *Zornia glochidiata* showed the highest frequency 69% in 2012 (Table 3). The overgrazing for a long time and overstocking may be change the dominant species in the area with other species such as *Zornia glochidiata* is considered less preferred by animals. The study area was dominated by different species in the two periods this may be due to the differences in the amount of rainfall and grazing intensity. As well as, competitions and utilization. Stoddart *et al*, (1975) stated that physical factors determine the kind of vegetation available, the manner and degree of possible use. Physical factors include climate, soil and topography also affected by type of vegetation.

Also the results showed that, *Dactyloctenium aegyptium* and *Zornia glochidiata* found in the area at two periods, this could be attributed to the fact that, the frequency has almost remained the same for the two periods again this result may show that this species is tolerant. It is clear that, *Dactyloctenium aegyptium* is to be known palatable, though it is an annual that soon disappears after the end of rainy season, but *Zornia glochidiata* not palatable for livestock in the area, particularly at milk stage it causes diseases of animals, the change dominant species by *zornia glochidiata* and *Sida cordofolia* is an indicator of deterioration of rangelands in the study area. The limited presence of *Echinochloa colonum* may indicate early or intensive grazing as this species is known to be relatively preferred.

Table.1 Average plant composition, cover, bare soil, and litter percentages for the periods 2008 and 2012

Period	Plant composition (%)	Cover %	Bare soil (%)	Litter (%)
2008	76.1%	32.3%	8%	0.38%
2012	77.4%	29.4%	20.1%	2.5%

Table.2 Percentages of species composition and frequency in (2008)

Composition		**Frequency**	
Species	**%**	**Species**	**%**
Dactyloctenium aegyptium	17.5	*Echinocholoa colonum*	67.6
Vossis cuspidata	14.7	*Zornia glochidiata*	60
Echinocloa colonum	13	*Dactyloctenium aegyptium*	57.5
Chloris gayana	11.7	*Chloris gayana*	47.6
Zornia glochidiata	11.4	*Digitaria gayana*	32.4

Table.3 Percentages of species composition and frequency in (2012)

Composition		**Frequency**	
Species	**%**	**Species**	**%**
Zornia glochidiata	22.8	*Zornia glochidiata*	69
Eragrostis spp	14	*Eragrostis spp*	61
Sida cordofolia	11.9	*Oldenlandia senegalensis*	50
Dactyloctenium aegyptium	8.9	*Sida cordofolia*	46
Oldenlandia senegalensis	8.7	*Dactyloctenium aegyptium*	42

- Density

The results of relative density of the most dominant species in the area for the period 2012 were demonstrated in table (4). *Side cordofolia* showed highest density 13 plant/m^2, but this type of species is not preferred by most livestock in the area particularly during the rainy season. Therefore, it considered invader plant in the area. The nomads and settled people said the main problem in rangelands in the area the existing of *Sida cordofoilia* in the area. The dominant plant species in the plant density are similar with dominant plant species in frequency such as *Sida cordofolia, Zornia glochidiata, Eragrostis spp, Oldenlandia senegalensis, Dactyloctenium aegyptium.*

- Biomass:

According to table (5), the results indicate that biomass productivity was nearly the same in both periods 2008 and 2012 (1.5 ton/ha and 1.3 ton/ha respectively). The variation in biomass productivity between two periods may be resulted from the variable and fluctuated rainfall characterizing this area. In addition to great differences exist in rangeland production across vegetation types may be due to species composition. Essentially, vegetation types differ in the rate of growth or primary production, per unit rainfall.

Table.4 The average relative density of the most dominant species at the rainy season of 2012

Species	Density/m^2
Sida cordofolia	19
Zornia glochidiata	13
Eragrostis spp	10
Oldenlandia senegalensis	6
Dactyloctenium aegyptium	3

Table.5 The average biomass productivity at rainy season of 2008 and 2012

Factor	2008	2012
Biomass production	1.5 ton/ha	1.3 ton/ha

- Trees and shrubs density

A result of the total density of woody species in the period of 2008 and 2012 is given in table (6). It was higher in the period 2012 when compared with the period 2008 (200 tree/ha and 71 tree/ha respectively). Highest density in 2012 may be due to the high density of *Guiera senegalensis* species which is less preferred by browse animals. In addition to, insecurity in the area. Human activities have the potential to influence the distribution of tree cover and heavy browsing can also affect the woody species density. As well as, utilization levels and moisture could be considered as main reasons of tree density variations.

The results of the relative density of woody species for the two periods were demonstrated in Table (7). The area was dominated by *albizzia amara* (43.13%) in 2008 and *Guiera senegalensis* (87.5%) in 2012. These types of trees are less preferred by browse animals. This may be an indication of the removal of other preferred species due to excessive browsing. As we know, the browse species are important in rangeland to cover the shortage of forage particularly in the dry season. According to (Le Houerou, 1980) stated that woody plants are a common component of the rangeland ecosystem of the world. The principal role of woody plants is providing forage for livestock and wildlife which is very important, especially in semi- arid and arid ecological zone.

Table.6 Total density of woody species during the rainy season of 2008 and 2012

Period	Total density tree/ha
2008	71
2012	200

Table.7 Density of woody species (tree / ha) at the rainy season of 2008

Species	Average density tree/ha
Albizzia amara	43.13
Acacia oerota	30.07
Balanites aegyptiaca	20.33
Acacia mellifera	17.43
Acacia nilotica	6.17

Table.8 Density of woody species (tree / ha) at the rainy season of 2012

Species	Average density tree/ha
Guiera senegalensis	87.5
Acacia Senegal	60
Acacia seyal	45
Acacia mellifera	42.5
Balanites aegyptiaca	40

4. CONCLUSIONS

Investigation of this study revealed the following conclusions:

-Vegetation cover was generally low in the two periods 2008 and 2012 due to the effect of trees shade on grass layer. Results indicated that, the concentration of high numbers of animals in the study area during the rainy season lead to rangeland deterioration. Results indicated that litter percentages were very low in the two periods 2008 and 2012.

-Results revealed that, there was spatial variation in species relative composition in the two periods due to continuous intense grazing causing vegetation changes such as the replacement of palatable grasses by less palatable plant species.

-The dominant herbaceous species in 2008 in South Kordofan were *Echinocholoa colonum*, while *Zornia glochidiata* ranked number one in terms of frequency in 2012. Dominance of *Zornia glochidiata* and *Sida cordofolia* species which are less preferred by animals, is an indication of intensive selective grazing and hence disturbance of rangelands in the study area.

- The results also revealed that, variation in biomass productivity could be attributed to varying and fluctuated rainfall characterizing this area and the differences in vegetation types as affected by soil moisture.

- Results indicated that there was considerable variation in tree density in the two periods. Highest total density scored in 2012. The *albizzia amara* was highest in 2008. While *Guiera senegalensis* was higher in 2012. The high density of these species is a fact of less desirable of these species by browse animals.

REFERENCES

[1] Abusuwar, A. O, Mohammed, S. A. A, (2011). Range inventory and evaluation of Zalingei area vegetation. Western Darfur State, Sudan. International journal of science and nature. VOL. 2 (2) 2011:248-253. ISSN 2229-6441. Society of Science and Nature. www.scienceandnature.org.

[2] Bashir, M and El Tahir, A. A (2006). Pastoral Production Systems in South Kordofan, Study 2. United Nations Development Programme in Sudan House 7, Block 5, Avenue P.O. Box: 913 Khartoum, Sudan. Sudan Currency Printing Press (SCPP.

[3] Bonham, C.D. (1989). *Measurements of terrestrial vegetation*. John Wiley & Sons, New York, NY. pp 11-202.

[4] Fadlalla, B. and Ahmed, F.A. (1997). Sudan country paper. In: Thomson, E.F., von Kaufmann, R., Li Pun H., Treacher, T. and van Houten, H. (eds). Global Agenda for Livestock Research. Proceedings of a Consultation on Setting Livestock Research Priorities in West Asia and North Africa (WANA) Region. ILRI (International Livestock Research Institute), Nairobi, Kenya, and ICARDA (International Center for Agricultural Research in the Dry Areas), Aleppo, Syria. 172 pp.

[5] Holecheck, J. L., Pieper, R. D. and Herbel, C. H. (2004). Range Management Principles and Practices. 5th ed. Pearson education, Inc., New Jersey.

[6] IFAD, (2006).Technical report about meteorological situations in south Kordofan State, South Kordofan office, Kadugli.

[7] Jensen, K. and Gutekunst, K. (2003) Effects of litter on establishment of grassland plant species: the role of seed size and successional status. *Basic and Applied Ecology*, 4: 579–587.

[8] Le Houerou, H. N. (1980). Conclusion and recommendations, in browse in Africa: the current state of knowledge (H. N. Le Houerou, ed). International Livestock Center for Africa Addis Ababa, Ethiopia.

[9] Ludwig, J. A. Tongway, D. J. and Marsden, S. G. (1999). Stripes, strands or stipples: modeling the influence of three landscape banding patterns on resource capture and productivity in semi-arid woodlands, Australia, Catena, 37, 257–273.

[10] Musa, A. Shasha, (2001). African green belt. Republic of Sudan.

[11] O'Connor, T.G. 1991. Influence of rainfall and grazing on the compositional change of the herbaceous layer of a sandveld savanna. J. Grassl. Soc. South Africa 8:103–109.

[12] OCHA, 2013. United Nations Office for the Coordination of Humanitarian Affairs. March 14 2013, 2:21.34 PM. http://www.unocha.org/sudan/maps-graphics/administrative-maps.

[13] Parker, K. W. (1951). A method for measuring trend range condition on national forest range. Administrative studies, U. S. Department of Agriculture, forest service, Washington, D. C. 26 pp.

[14] Rebeca, V. M. Eusebio, V. R. Klavdia, O. Luis, H. S. and Miguel, A. D (2011). Soil Erosion Processes in Semi arid Areas: The Importance of Native Vegetation. Soil Erosion Studies. Edited by Dr. Danilo Godone. ISBN 978-953-307-710-9.

[15] RPA, 2011. Range and Pasture Administration, 2011. The situation of fodder source in Sudan. Range and Pasture General Directorate. Khartoum East. P.O Box 2513. Sudan.

[16] Stoddart, L. A., D. Smith, and Box, T. W. Box, (1975). Range Management. 3rd Ed, Mc Graw – Hill Book Company, Inc, NY.

[17] Yates, C. J, Norton D. A and Hobbs, R. J, (2000). Grazing effects on plant cover, soil and microclimate in fragmented woodlands in south-western Australia: implications for restoration. Austral Ecology 25(1): 36-47.