

# ASSESSMENT OF BIOMASS, CARRYING CAPACITY AND HERBACEOUS COVER AT SAVANNAH RANGELAND AT ELSUKI AREA, SINNAR STATE, SUDAN



## Original Research Article

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## ABSTRACT

The study was conducted at Elsuki area about 50 km south of Sinnar town, with two consecutive seasons of 2012 and 2013. The aim of this study was to Assessment of Biomass, carrying capacity and Herbaceous cover at savannah Rangeland at Elsuki area, Sinnar State, Sudan. Five major transects were taken, each transect 3000m length and 10m width, their total area of the study is 150.000m<sup>2</sup> which it is about 10% of the total area. Herbaceous cover and biomass production, and carrying capacity were assessed. The results indicated that the variation in the herbaceous cover between the five transects as the result of variable transects. Results showed that in season 2011 the herbaceous cover percentage had a high significant effect in transect 5 for plants. Biomass in transect 2 and transect 4 had a significant effect, but transect 4 had a high mean compare to transect 2. The results show that in two seasons, transect 2 had a high significant effect of carrying capacity, while transect 4 had a high significant effect of carrying capacity in season 2011 only. The study recommended that rangeland should be managed and conserved by increasing the vegetation cover and decreasing the grazing pressure on the natural vegetation.

## Keywords:

Plant cover,  
 Biomass productivity,  
 carrying capacity

## I. INTRODUCTION

Plant ecology is a sub-descriptive line of ecology which studies the distribution and abundance of plants, the effects of environmental factors upon the abundance of plants, and the interactions among and between plants and other organisms (Keddy 2007). Examples of these are the distribution of temperate deciduous forests in North America, the effects of drought or flooding upon plant survival, and competition among desert plants for water, or effects of herds of grazing animals upon the composition of grasslands.

A global overview of the Earth's major vegetation types is provided by (Archibold 1995). He recognizes 11 major vegetation types: tropical forests, tropical savannas, arid regions (deserts), Mediterranean ecosystems, temperate forest ecosystems, temperate grasslands, coniferous forests, tundra (both polar and High Mountain), terrestrial wetlands, freshwater ecosystems and coastal/marine systems. This breadth of topics show the complexity of plant ecology, since it includes plants from floating single-celled algae up to large canopy forming trees.

One feature that defines plants is photosynthesis. One of the most important aspects of plant ecology is the role plants have played in creating the oxygenated atmosphere of earth, an event that occurred some two billion years ago. It can be dated by the deposition of banded iron formations, distinctive sedimentary rocks with large amounts of iron oxide. At the same time, plants began removing carbon dioxide from the atmosphere, thereby initiating the process of controlling Earth's climate. A long term trend of the Earth has been toward increasing oxygen and decreasing carbon dioxide, and many other events in the Earth's history, like the first movement of life onto land, are likely tied to this sequence of events (Keddy 2007).

One of the early classic books on plant ecology was written by Weaver and Clements (1938). It talks broadly about plant communities, and particularly the importance of forces like competition and processes like succession. Although some of the terminology is dated, this important book can still often be obtained in used book stores.

Plant ecology can also be divided by levels of organization including plant eco-physiology, plant population ecology, community ecology, ecosystem ecology, landscape ecology and biosphere ecology (Keddy 2007).

The study of plants and vegetation is complicated by their form. First, most plants are rooted in the soil, which makes it difficult to observe and measure nutrient uptake and species interactions. Second, plants often reproduce vegetatively, that is asexually, in a way that makes it difficult to distinguish individual plants. Indeed, the very concept of an individual is doubtful, since even a tree may be regarded as a large collection of linked meristems (Williams 1975). Hence, plant ecology and animal ecology have different styles of approach to problems that involve processes like reproduction, dispersal and mutualism. Some plant ecologists have placed considerable emphasis upon trying to treat plant populations as if they were animal populations, focusing on population ecology (Harper 1977). Many other ecologists believe that while it is useful to draw upon population ecology to solve certain scientific problems, plants demand that ecologists work with multiple perspectives, appropriate to the problem, the scale and the situation (Keddy 2007).

Dry savannas are generally complex systems (Westoby et al., 1989), alternating between woodland and grassland states (Van De Koppel and Prins, 1998). Savannah

ecosystems are globally important and cover about 20 % of the Earth's land surface area (Bond and Midgley, 2000; Sankaran et al., 2005) and 50 % of Africa (Wang et al., 2010). The savanna biome is characterized by scattered trees and continuous layer of herbaceous plants (Knoop and Walker, 1985; Sankaran et al., 2005; Wiegand et al., 2006). In terrestrial biomes, species diversity tends to correlate positively with net primary productivity, moisture availability, and temperature (Pidwirny, Michael 2006). Biomes are climatically and geographically defined as contiguous areas with similar climatic conditions on the Earth, such as communities of plants, animals, and soil organisms (The world biomass 2008) and are often referred to as ecosystems. Some parts of the earth have more or less the same kind of abiotic and biotic factors spread over a large area, creating a typical ecosystem over that area. Such major ecosystems are termed as biomes. Biomes are defined by factors such as plant structures (such as trees, shrubs, and grasses), leaf types (such as broadleaf and needleleaf), plant spacing (forest, woodland, savanna), and climate. Unlike ecozones, biomes are not defined by genetic, taxonomic, or historical similarities. Biomes are often identified with particular patterns of ecological succession and climax vegetation (quasi-equilibrium state of the local ecosystem). An ecosystem has many biotopes and a biome is a major habitat type. A major habitat type, however, is a compromise, as it has an intrinsic inhomogeneity. Some examples of habitats are ponds, trees, streams, creeks, under rocks and burrows in the sand or soil.

The biodiversity characteristic of each extinction, especially the diversity of fauna and subdominant plant forms, is a function of abiotic factors and the biomass productivity of the dominant vegetation. In terrestrial biomes, species diversity tends to correlate positively with net primary productivity, moisture availability, and temperature (Pidwirny 2006).

Eco-regions are grouped into both biomes and eco-zones:

- A fundamental classification of biomes is:
  1. Terrestrial (land) biomes
  2. Aquatic biomes (including freshwater biomes and marine biomes)

Biomes are often known in English by local names. For example, a temperate grassland or shrubland biome is known commonly as steppe in central Asia, prairie in North America, and pampas in South America. Tropical grasslands are known as savanna in Australia, whereas in southern Africa it is known as certain kinds of veld (from Afrikaans).

Sometimes an entire biome may be targeted for protection, especially under an individual nation's biodiversity action plan.

Climate is a major factor determining the distribution of terrestrial biomes. Among the important climatic factors are:

- Latitude: Arctic, boreal, temperate, subtropical, tropical
- Humidity: humid, semi-humid, semiarid, and arid
- Seasonal variation: Rainfall may be distributed evenly throughout the year or be marked by seasonal variations.
- Dry summer, wet winter: Most regions of the earth receive most of their rainfall during the summer months; Mediterranean climate regions receive their rainfall during the winter months.
- Elevation: Increasing elevation causes a distribution of habitat types similar to that of increasing latitude.

The most widely used systems of classifying biomes correspond to latitude (or temperature zoning) and humidity. Biodiversity generally increases away from the poles towards the equator and increases with humidity. Sinnar State is considered as one of the important livestock production areas in the country under rangeland conditions. The livestock production systems in the State are nomadic, transhumance and sedentary. Nomads and transhumance usually move with their animals from northern to southern parts of the State (KhourElagalien, Eldindir park boarders ...etc) in the dry season. The rangelands there witnessed a pronounced decrease in natural vegetation in both quality and quantity as a result of over-grazing and bad human practices (Abusuwar, and Azza 2010). Darag (1996) considered the carrying capacity as a term used to determine land use in terms of livestock grazing. He consequently defined the carrying capacity as the number of livestock that can graze on a definite size of rangeland for a limited period of time. Mustafa et al. (2000) defined the carrying capacity as the maximum number of animal units that a certain range can accommodate for a specific period on a sustainable basis. The aims of current study is assessment of biomass, carrying capacity and cover herbaceous at savannah rangeland at Elsuki area, Sinnar State, Sudan.

**II. MATERIALS AND METHODS**

The study was conducted at Elsuki area about 50 km south of Sinnar town at the eastern bank of the Blue Nile under rain fed condition, (Latitude 12°5'14.7' N and longitude 32°53'-35°58' E) Figure 1. The study area falls within the second division where the climate is described as typically continental dominated by the annual movement of the boundary between the dry northerlies and the moist southerlies with which the rains are associated. Most of the rain convictional and has a market diurnal maximum in the afternoons and evenings. According to (Ireland 1948) the variability or reliability of rainfall in the study area is 20-25%. The climate can thus be summarized as hot, tropical and semi-arid with a rainy season from May to October, followed by a spell of a cool dry winter during which the dry northern winds predominate (El Tom, 1974). The Northern part of the State lies within the low rainfall Savanna zone, where the average annual rainfall is between 400-600 mm, while the Southern part lies in the high rainfall Savanna zone, with the average annual rainfall of about 800mm . The mean temperature ranges from 35° C to 40° C in summer and from 20° C to 25° C in winter. ( Abdelaziz A.A 2010).

The total area of the state is about 40860 kms<sup>2</sup>. Five major transects were taken, each of 3000m length, 10m width within a total area of 150.000m<sup>2</sup> to collect data for total plant cover (T.P.C), Bare soil cover (B.S.C), litters of plants (L.P), biomass and state of species growth were recorded. For all the five transects a total of 75 quadrates after every 200m were sampled to represent all of the area.

**Determination of Biomass productivity:**

The formula used for determine the biomass was:-

$$\text{Biomass} = \frac{W1-W2}{W1}$$

Where: -

W1 = Fresh weight of plant sample.

W2 = Dry weight of plant sample.

**Determination of Carrying Capacity C.C:**

According to Darag and Suliman (1988) the carrying capacity of the study area was determined as follows:

$$C.C = \frac{\text{Allowable matter production/ ha}}{\text{Daily animal unit requirement}}$$

Where:

Allowable matter production/ha = Present Biomass Product of the study area /ha.

Daily animal unit requirement = 10.5 Kg/day.

**Data Analyses:**

SPSS analyses program was used to analyse the data of soil cover, biomass and carrying capacity only, the other data analysed by formulas.

**III. RESULTS AND DISCUSSION**

**Plant cover assessment :** In season 2011 the cover percentage of the study area had a high significant effect in transect 5 for plants, in transect 1 for litters and in transect 3 for bare soil, while there is no any significant effect for stones in all transects (Table 1). In season 2012 the cover percentage of the study area have no any significant effect for all parameters in all transects, but transect 5 recorded highly mean for plants, transect 2 had a highly mean for litters and transect 1 for per soil (Table 1).

**Biomass:** In season 2011 biomass of the study area in transect 2 and transect 4 had a significant effect, but transect 4 had a high mean compare to transect 2 (Table 2). In season 2012 biomass of the study area have no any significant effect for all transects, but highly mean was recorded by transect 2 (Table 2). From the results above, it can be seen that the five transects differed in the total biomass production this may be attributed to many factors such as floristic composition, growth rates, the ability of moisture utilization, intensity of grazing, erosion impacts and rainfall distribution within the sites and the seasons. Le and Hoste (1997) reported that biomass production depends on various factors such as climate, nature of soil, botanical composition and vegetation structure.

**Carrying capacity:** It was found that the carrying capacity was differ from transect to other. The results show that in season 2011, transect 2 and 4 had a high significant effect of carrying capacity, while in season 2012 transect 2 had a high significant effect of carrying capacity (Table 3). It is not easy to control the carrying capacity in the open range land but its determination is essential for correct utilization of the range resources to avoid overgrazing and range deterioration.

**IV. CONCLUSION**

The study has also highlighted the spatial variability of plant cover and biomass in the savanna rangeland at study area. It is to be concluded that, Range carrying capacity of the natural rangelands of the Elsuki area, Sinnar State 2011 and 2012 years. This indicated that the carrying capacity of the natural rangeland in this area are typical to that reported within the high rainfall woodland savannah. This Rangeland should be managed and conserved by increasing the vegetation cover and decreasing the grazing pressure on the natural vegetation.

**V. RECOMMENDATION**

It is to be recommended that rangeland should be managed and conserved by increasing the vegetation cover and decreasing the grazing pressure on the natural vegetation.

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Table (1): The ground vegetation cover% in the study area in the two seasons

Season	Measurements	T1	T2	T3	T4	T5
2011	Plant	78.80 ±10.48 <sup>b</sup>	88.80 ±11.19 <sup>ab</sup>	83.80 ±16.25 <sup>ab</sup>	89.27 ±8.71 <sup>ab</sup>	94.93 ±7.03 <sup>a</sup>
	Litters	21.200±10.476 <sup>a</sup>	9.267±6.766 <sup>b</sup>	11.267±11.190 <sup>b</sup>	9.600±7.799 <sup>b</sup>	4.400±5.642 <sup>b</sup>
	P.S	0.000±0.000 <sup>b</sup>	1.933±6.408 <sup>ab</sup>	4.933±8.075 <sup>a</sup>	1.133±2.031 <sup>ab</sup>	0.667±1.799 <sup>ab</sup>
	Stones	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>
2012	Plant	82.87 ±29.03 <sup>a</sup>	73.67 ±31.3 <sup>a</sup>	86.53 ±17.80 <sup>a</sup>	81.20 ±21.70 <sup>a</sup>	89.07 ±10.28 <sup>a</sup>
	Litters	15.33 ±28.26 <sup>a</sup>	25.47 ±30.55 <sup>a</sup>	12.27 ±16.70 <sup>a</sup>	18.80 ±21.70 <sup>a</sup>	10.20 ±9.25 <sup>a</sup>
	P.S	1.800 ±4.678 <sup>a</sup>	0.867 ±1.727 <sup>a</sup>	1.200 ±2.513 <sup>a</sup>	0.000 ±0.000 <sup>a</sup>	0.800 ±1.146 <sup>a</sup>
	Stones	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>	0.000±0.000 <sup>a</sup>

T= TRANSECT

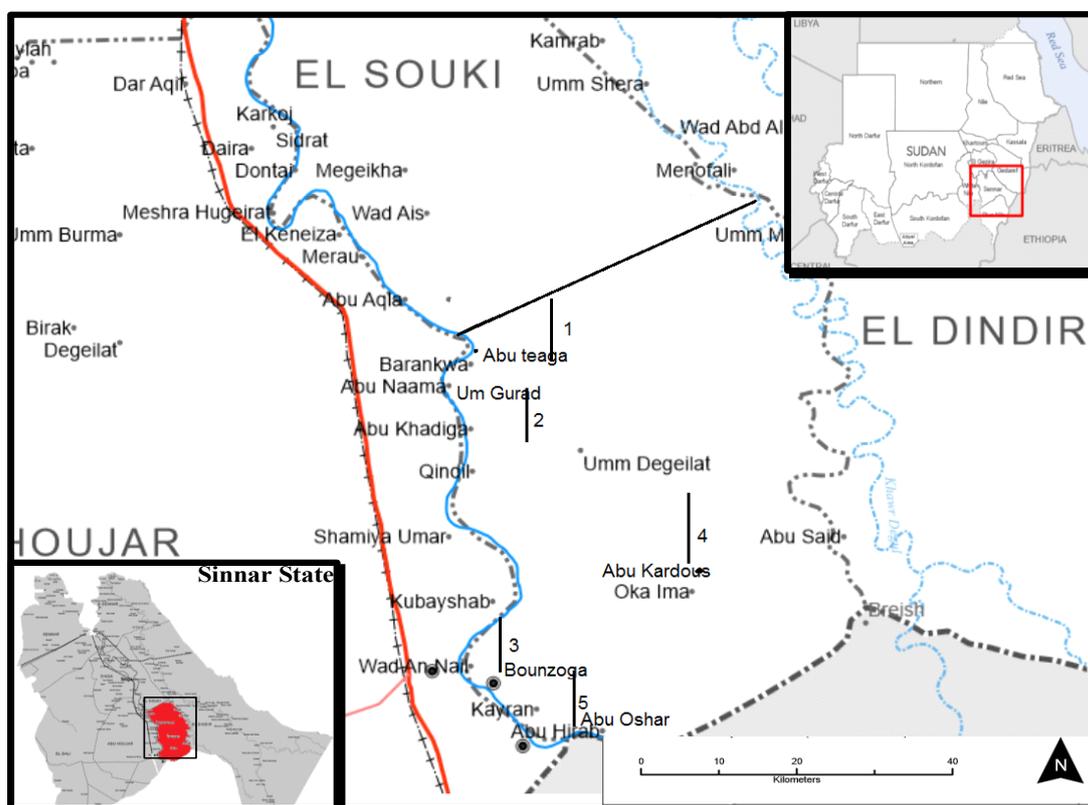
Table (2): Biomass in the study area at the two seasons

TRANSECT	Wight (kg/h)	
	Season 2011-2012	Season 2012-2013
1	84.33 ±33.16 <sup>b</sup>	41.80 ±31.86 <sup>b</sup>
2	96.47 ±61.35 <sup>a</sup>	46.47 ±29.09 <sup>a</sup>
3	63.27 ±38.70 <sup>c</sup>	39.27 ±27.04 <sup>c</sup>
4	96.60 ±37.42 <sup>a</sup>	38.87 ±18.25 <sup>d</sup>
5	44.13 ±28.10 <sup>d</sup>	30.33 ±16.17 <sup>e</sup>

Table (3): Carrying capacity (CC) ha/TLU/year at the two seasons

TRANSECT	carrying capacity /ha	
	Season 2011-2012	Season 2012-2013
1	8.02 ± 3.16 <sup>b</sup>	3.98 ± 3.03 <sup>b</sup>
2	9.19 ± 5.84 <sup>a</sup>	4.44 ± 2.79 <sup>a</sup>
3	6.03 ± 3.69 <sup>c</sup>	3.72 ± 2.57 <sup>c</sup>
4	9.20 ± 3.56 <sup>a</sup>	3.66 ± 1.74 <sup>d</sup>
5	4.20 ± 2.68 <sup>d</sup>	2.88 ± 1.55 <sup>e</sup>

Figure 1: Study area



Source: OCHA (2012)

## REFERENCES

- [1] **Abdelaziz A.A** (2010). The effect of some management practices on decertified range lands in Sinnar Sate. PhD Thesis, U of K: 33-34.
- [2] **Abusuwar, A. and Abdelaziz, Azza A,** (2010). Effect of Sowing Some Range Species on the Production of Decertified Rangelands in Sinnar State, Sudan. Desertification and Desert Cultivation Studies Institute, University of Khartoum, Sudan J. Des. Res. 2: 50-65, 2010.
- [3] **Archibold, O.W.** (1995). Ecology of World Vegetation. London: Chapman and Hall. pp. 510 p. ISBN 0 412 44290 6.
- [4] **Bond, W.J., Midgley, G.F.,** (2000). A proposed CO<sub>2</sub> - controlled mechanism of woody plant invasion in grasslands and savannas. *Global Change Biology* 6, 865-869.
- [5] **Darag, A.** (1996). In Service Training Senior Staff. Training between Community Based Rangelands. Rehabilitation Project, Geriegikh Rural Council, Bara Province, North Kordufan, Sudan.
- [6] **Darag, A. and M. Suliman** (1988). Training Course in Range Management and Range Improvement. Range and Pasture Administration. Sudan. 47 pp.
- [7] **El Tom M.A.** (1974) Sudan Climate (in Arabic). The Institute of Arab Research and Studies, Dar Nafee Printing and Publishing. Khartoum, Sudan. 133pp
- [8] **Harper, J. L.** (1977). Population Biology of Plants. London: Academic Press.
- [9] **Ireland, A.W.** (1948). The Climate of the Sudan. In J.D. Tothill "Agriculture in the Sudan" Oxford University Press. 62-83.
- [10] **Knoop, W.T., Walker, B.H.,** 1985. Interactions of woody and herbaceous vegetation in a southern African savanna. *Journal of Ecology* 73, 235-253.
- [11] **Keddy, Paul A.** (2007). Plants and Vegetation. Cambridge: Cambridge University Press. ISBN 13 978-0-521-86480-0 Check |isbn= value
- [12] **Le Houeron, H.N. and C.H. Hoste** (1997). Rangeland Production and annual Rainfall Relation in Mediterranean Basim in the African Sahelo Sudanian Zone. *J. Range Manag.* 30 : 3.
- [13] **Mustafa, H., El Goni, O., Mahmoud, A. and H. Idris** (2000). Manual for Range Management and Improvement. Dry land Husbandry Project, Sudan.
- [14] **Parker, K. W.** (1951). 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.
- [15] **Pidwirny, Michael** (2006). "Biomes". In Sidney Draggan. Encyclopedia of Earth. Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment. Retrieved 2006.
- [16] **Sankaran, M., Hanan, N.P., Scholes, R.J., Ratnam, J., Augustine, D.J., Cade, B.S., Gignoux, J., Higgins, S.I., Le Roux, X., Ludwig, F., Ardo, J., Banyikwa, F., Bronn, A., Bucini, G., Caylor, K.K., Coughenour, M.B., Diouf, A., Ekaya, W., Feral, C.J., February, E.C., Frost, P.G.H., Hiernaux, P., Hrabar, H., Metzger, K.L., Prins, H.H.T., Ringrose, S., Sea, W., Tews, J., Worden, J., Zambatis, N.,** (2005). Determinants of woody cover in African savannas. *Nature* 438, 846-849.
- [17] **The World's Biomes**, Retrieved August 19, 2008, from University of California Museum of Paleontology.
- [18] **Wang, L.X., D'Odorico, P., O'Halloran, L.R., Caylor, K., Macko, S.,** (2010). Combined effects of soil moisture and nitrogen availability variations on grass productivity in African savannah. *Plant and Soil* 328, 95-108.
- [19] **Weaver, J. E. and Clements F. E.** (1938). *Plant Ecology*. 2nd edition. New York: McGraw-Hill Book Company.
- [20] **Wiegand, K., Saltz, D., Ward, D.,** (2006). A patch-dynamics approach to savannah dynamics and woody plant encroachment - Insights from an arid savanna. *Perspectives in Plant Ecology, Evolution and Systematics* 7, 229-242.
- [21] **Williams, G. C.** 1975. Sex and Evolution. Monographs in Population Biology. No. 8. Princeton: Princeton University Press.

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