Deterioration of Biomass Productivity of a Rangeland Area in the White Nile State, Sudan.

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المستخلص:

تم إيجاد إنتاجية الكتلة الحيوية و سعة المرعى لثلاث مواقع في منطقة رعوية بولاية النيل الابيض بالسودان .

استخدم في البحث 126 مربعاً (1×1 م) بمساحة قدرها 16.5 متراً بين المربعات .

تم استخدام سبع تكرارات لتحديد الكتلة الحيوية (جم) لكل مربع ، و كان مجموع الكتلة الحيوية هو 33540.5 كجم/كم2 .

أظهرت النتائج انخفاضاً كبيراً في سعة المرعى من 26 وحدة حيوانية /كم2/السنة إلى 2.6 وحدة حيوانية / كم2/السنة .

يعزى التدهور في إنتاجية الكتلة الحيوية إلى موجات الجفاف و الضغط الرعوي في منطقة البحث .

Abstract

Biomass productivity and carrying capacity were determined at three sites in a rangeland area in the White Nile Statem Sudan . A total of 126 quadrates (1× 1m) wrer used white intervals of 16.5m in between . Seven replicates were used to determine biomass (gm) at each quadrate . The results of biomass and carrying capacity showed that there was a decline in the carrying capacity from 26 a.u./km2/year to only 2.6 a.u./km2/year . The total biomass of the study area was 33540.5 kg/km2. Deterioration in biomass productivity was attributed to drought spells and grazing pressure.

Introduction

Sudan is one of the largest country in Africa and the largest in the word with an area of 2.5 million square kilometers. It exhibits a wide range of variation in its topography, climate, soil, and hydrology . The study area (UM Rimmita) lies between latitiudes 14◦49′ N and longitude 32◦ 05′ and 32◦ 11′ E. It is bordered from the north by the White Nile and from the west by north Kordufan State, and from the north by Guetaina town about seventy kilometers north of Ed Dueim town.

Biomass is common vegetation measure that refers to the weight of plant material within a given area . Other general terms, such as yield or production are sometimes used interchangeably with biomass. Biomass is one of the most commonly measured attributes in range inventory or monitoring programs and the data may be collected on an individual species basis, as species groups, or as total weight for the vegetation.

Biomass can be determined using either direct or indirect sampling methods.

Direct methods involve techniques that weigh or estimate the actual biomass of plants in quadrates. Indirect methods are based on developing a relationship between plant and weigh and other attributes such as rainfall, or cover (Bonham, 1989).

The most suitable approach to determine biomass in an inventory or monitoring program depends on the type of vegetation, skills of observer and sample size requirements (Cook et al., 1986) .

Biomass of a given area is useful in determining its carrying capacity (C.C.) .There is a direct relationship between animal body weight, its food requirements and the carrying capacity.

Broady (1945) reported that body weight is used as a guide to establish food requirements of animals. He added that the energy requirements of an animal are directly correlated to its body size. He reported a food requirement of 0.66 – 0.73 of body weight.

Graham (1972) suggested a food requirement of 0.9 of body weight of sheep and cattle and a mean value of 0.75 for all animal species.

There are many definitions of carrying capacity which are primarily based on animal body weight and its food requirements.

Darag (1996) considered the carrying capacity as a term used to determine land use in terms of live stock 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) define the carrying capacity as the maximum number of aanimal units that a certain range can accommodate for a specific period on a asustainable basis .

The currently used and acceptable definition of carrying capacity is the maximum animal numbers which cangraze each year on a given area of range for a specific number of days without inducing a downward trend in forage production , forage quality or soil.

The carrying capacity is expressed as : animal unit/hectare/day i.e a.u./ha./day (Darag and Suliman,1988).

The carrying capacity is calculated by the following equation :

C.C. = total biomass production x 0.5 Where 0.5 = proper use factor i.e only half of the biomass production is considered to be available for grazing .

The carruing capacity is affected by many factors . Harrison (1955) stressed the effect of soil type on the carrying capacity . He reported a C.C. of 26 livestock units/km2 on basement complex and 18 livestock units/km2 on day soils. Kumar and Asija (2000) reported the following factors : population pressure , forage availability , rainfall, animal energy requirements and waste of grazable matter . They suggested that the society should change its life style and pattern of use of grazing lands in such a manner as to cause the least damage to the ecosystem. Similar ecological factors were reported by Barbour et al. (1987).

Continued heavy use (uncontrolled grazing) may inflict damage on the ecosystem and consequently may induce a change in vegetation with time due to change in abundance of grazable species, a phenomenon as vegetational dynamics (Austin, 1981). This leads to the disappearance of desirable species and domination of undesirable species. The overall result is rangeland deterioration.

Material and Methods

Determination of Biomass

Three sites (A,B,C) were randomly chosen at the study area and the biomass was determined for each side.

The vegetation biomass of the study area was determined by 126 (1×1m) systematic quadrates with intervals of 16.5m between the quadrates. Two transects were chosen for each site and these were subdivide into three quadrates each. Seven replicates were used to determine biomass (gm) at each quadrate. Plants at each quadrate were harvested at a level of 2-2.5cm above ground level using scissors . The harvested materials were put in labeled paper bags and oven-dried at 105◦C for 24 hours. Sample dry weights were obtained by using a sensitive digital balance. The biomass (gm/m2 and kg/km2) was determined by using the following formula:

$$\text{Biomass} = \frac{w1 - w2}{W1}$$

Where :

W 1= Fresh weight of plant sample.

W 2 = Dry weight of plant sample.

Determination of carrying capacity :

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

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

Where :

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

Daily animal unit requirement =10.5 kg/day

Biomass production was statistically analyzed using F- test for multiple comparisons.

Results and Discussion

The result of biomass determination have been presented in table 1,2 and 3

These biomass determination were later used to calculate the carrying capacity of the whole study area.

Table (1): Biomass (gm) at site (A):

Transect 1					**Transect 2**				
Sample No.	**1 Biomass (gm)**	**2 Biomass (gm)**	**3 Biomass (gm)**	**Total**	**Sample No.**	**1 Biomass (gm)**	**2 Biomass (gm)**	**3 Biomass (gm)**	**Total**
1	14.7	14.2	10.2	39.7*	8	22.5	22.0	21.9	66.4*
2	4.8	8.8	10.7	24.3*	9	2.2	0.9	5.8	8.9*
3	33.3	22.0	26.9	82.2*	10	15.9	16.2	4.7	36.8*
4	18.2	22.3	7.6	48.1*	11	80.7	24.0	22.9	127.6*
5	14.3	29.0	71.4	114.7*	12	52.2	8.8	38.1	99.1*
6	20.3	11.9	22.9	55.1*	13	33.4	43.9	11.0	88.3*
7	14.6	17.4	0.9	32.9*	14	2.6	5.7	2.5	10.8*
Total				397					437.9

*= significant at P› 0.05

Biomass determination

Total biomass (gm) =834.9 gm

Total biomass (kg) = 834.9 = 0.839.9 kg

Proper use biomass =0.5×0.8349 =041745 kg

$$\text{Biomass /m2} = \frac{0.41745}{42} = 0.009939 \text{ kg/m2}$$

Biomass/km2 = 0.009939 × 1000000 = 9939 kg/km2

According to Darag and Suliman (1988) the animal unit consumption was 10.5 kg/day

Determination of carrying capacity for site A

Carrying capacity of site (A) = 9939 = 2.6 a.u. /km2/year.

Where :

315= total monthly animal units consumption.

12= months of the year .

Table (2): Biomass (gm) at site (B):

Transect 1					Transect 2				
Sample No.	1 Biomass (gm)	2 Biomass (gm)	3 Biomass (gm)	Total	Sample No.	1 Biomass (gm)	2 Biomass (gm)	3 Biomass (gm)	Total
15	25.8	23.2	24.1	73.1*	22	24.6	19.1	4.0	47.7*
16	14.9	22.2	20.4	57.5*	23	6.2	4.5	0.1	10.8*
17	38.4	13.2	5.4	57.0*	24	55.2	27.4	7.1	89.7*
18	37.8	12.4	19.6	69.8*	25	22.6	20.6	21.6	64.8*
19	46.2	31.9	12.3	90.4*	26	22.2	12.3	17.1	51.6*
20	74.8	49.6	25.7	150.1*	27	20.2	26.3	32.5	79.0*
21	23.3	16.9	22.4	62.6*	28	42.5	73.8	66.0	182.3*
Total				560.5					525.9

*= significant at P› 0.05

Biomass determination

Total biomass (gm) = $\frac{1086}{1000}$ = 1.0864 kg

Proper use biomass = 0.5×1.0864 = 0.5432 kg

Biomass /m2 = $\frac{0.5432}{42}$ = 0.0129333 kg/m2

Biomass /km2 = 0.129333×1000000 = 12933.3 kg/km2

Determination of carrying capacity for site (B) =

$\frac{12933.3}{315\times12}$ = 3.4 a.u./km2/year

Table (3): Biomass (gm) at site (C):

Transect 1					Transect 2				
Sample No.	1 Biomass (gm)	2 Biomass (gm)	3 Biomass (gm)	Total	Sample No.	1 Biomass (gm)	2 Biomass (gm)	3 Biomass (gm)	Total
29	13.0	7.3	3.6	23.9*	36	22.0	29.7	20.9	72.6*
30	0.7	10.9	16.8	28.4*	37	39.1	25.7	26.9	91.7*
31	25.5	9.8	10.8	46.1*	38	25.9	75.4	27.2	128.5*
32	12.8	23.6	5.7	42.1*	39	51.3	23.3	23.1	97.7*
33	25.0	2.6	9.7	37.3*	40	43.2	296	28.5	101.3*
34	12.1	23.4	24.8	60.3*	41	16.6	2.4	31.4	50.4*
35	11.0	31.5	6.8	49.3*	42	22.0	8.9	35.6	66.5*
Total				287.4					608.7

*= significant at P› 0.05

Biomass determination

Total biomass (gm) = 896.1 GM

Total biomass (KG) = $\frac{896.1}{1000}$ = 0.8961

0.8961 = 0.44805 kg×Proper biomass = 0.5

Biomass /m^2 = $\frac{0.44802}{42}$ = 0.016679 kg/m^2

1000000 = 10667.9 kg/km^2 ×Biomass /km^2 = 0.016679

Determination of carrying capacity for site C

Carrying capacity of Site (C) = $\frac{10667.9}{315}$ = 2.8 a.u./km^2/year

12×

Determination of carrying capacity for the study erea

The carrying capacity of the study area = $\frac{8.8}{3}$ = 2.9 a.u./km^2/year

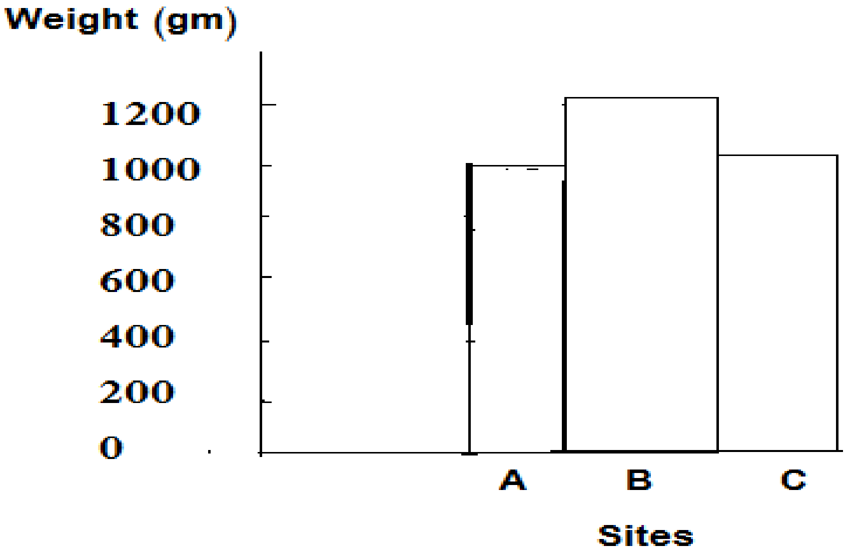

Fig (1). Histogram showing biomass (gm) at each of the three site of the area

The study area was located in the semi-desert region which covers 478000 km^2.The result biomass productivity for sites A,B and C have been shown in fig1 . The results statistical analysis showed that the three sites differed significantly (P› 0.05) in their total biomass production. This may be attributed to many factors such as florisity composition, growth rates , the ability of moisture utilization, intensity of grazing, erosion impacts and rainfall distribution within the sites and the seasons. Le Houeron and Hoste (1977) reported that biomass production depends on various factors such as climate , nature of soil, botanical composition and vegetation structure.

In the present study , the average carrying capacity was found to be 2.6 a.u./km^2/year.Arnold (1955) reported that the carrying of the region was 26 a.u./km^2/year . This big difference reveals a trend of distribution in the present situation of rangeland in the study area . The deterioration is probably due to a combination of biotic factors . The abiotic factors include drought spells and rainfall fluctuation, over-grazing , felling of woody species and increased human and animal population. All these factors together led to the complelet disappearance of some species and therefore the loss of seed source. Extinct herbaceous sepecies include
Blepharis linariifolia Chrysopogon aucheri, Trichodesma africanum, Tragus berternias and Bergia suffruticosa.

Abdallah (2008) found that pastures began to be invaded by unpalatable species such as *Calotropis procera.* They had been deterioration but no change to more desrt-like (less vegetated) condition.
The rangeland in the study area were deteriorated as compared to reduced plant diversity to the level which is regarded as damaging to the overall quality life and in the arid regions led to serve soil erosion and total loss of production potential .

The present study revealed that there are ecological problems as compared to Louis (1989) and Maxwell (1991). The major problem of the pastoeal regions is overstocking leading to certain ecological disaster and the quality of environment is deteriorating .
The study area has been affected by drought spells which have ecological importance as compared to Pears (1970). In time of drought, pressure on grazing land and water resources led to a marjed deterioration in range productivity.

Conclusions :

- The total biomass productivity (kg) for the whole study area was 0.834 kg.
- The total biomass/km^2 for the study area was 9939 kg/km^2 .
- The carrying capacity for site A was 2.6 a.u./km^2/year.
- The carrying capacity for site B was 3.4 a.u./km^2/year.
- The carrying capacity for site C was 2.8 a.u / km^2/year
- The carrying capacity for study area was 2.9 a.u./km^2/year.
- There was a marked deterioration in the biomass and the carrying capacity of the study area .

Recommendations

- Introduction of environmental education programs in curricula is a necessity in order to promote the general awareness of people .
- There is a crucial need for law enforcement in order to protect the soil and vegetation from destructive human activities .

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