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International Journal of Research Publications

International Journal of Research Publications

Assessment of Rangeland Health Attributes and Indicators in Sustainable Range Management (Northern Kordofan)

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Abstract

This study was conducted at "Abusonoon" Mountain, approximately 40 km west of Elobied town in Sheikan locality in North Kordofan State , central Sudan. The objectives are to assess rangeland health attributes and indicators. The study concept was based on addressing the main factors of integrated and sustainable rangeland management, including range health as an accumulative result of the different range management practices. Indicators tested in this study included vegetation composition and frequency, ground cover, biomass production, erosion hazards, seed bank and soil integrity such as organic matter. Three sites were selected to represent rangeland types in the study area including flat sand, relatively low land and sand dunes (goz) sites. Five transects were taken in each site based on releúe method and minimum area theory. In each site a plot of 1Km X 1km was selected and five transects were established inside to determine these indicators. The study revealed the following plant composition of each site: The sandy site was dominated by *Fimbristyls dichotomo*. The low land site was dominated by *Eragrostis tremula*, while in the goz site the dominant species was *Dactyloctenium aegyptium*. The species with high frequencies were *Cenchrus* spp in sandy site, while *Aristida* spp, had high frequency in both low and goz sites. Percentage of plant cover was affected by the pattern of the area, where flat sandy site scored 66.3%, low land site scored 71.4% while goz site scored 77%. The litter coverage scored 21.9%, 10.5 and 9% for the flat sandy, low land and goz repectively. No erosion hazard was identified since bare soil was less than 25 %. Productivity as indicated by biomass showed 0.824 ton/ha. for flat sandy site, compared to 1.207 ton/ha. for the depressions and 1.457 ton/ha. for the goz site. Carrying capacity was 109.87 AU/ha./day for sandy site, 160.93 AU /ha./day for the depressions site and 194.27 AU /ha./day for the goz site.

The study ascertained that vegetation cover is healthy in the area so there is only a need for activities of improvements and conservation. Replantation of trees in the area such as *Acacia tortilis* and, *Maerua carssifollia*, would be highly appreciated for more vegetation cover and sustainable land conservation.

Range Health Attributes; Range Health Indicators; Sustainable Management

1. Introduction:

Rangelands cover about 60 percent of Sudan, providing grazing for one of the largest concentrations of livestock in Africa. About 50 percent of rural nomadic people in Sudan depend on livestock to a significant degree. Range health is the sustainability of basic soil and ecological processes. Ranges are classified as healthy when there is no required change in management, but those classified as at risk may require a change in management to restore them to healthy conditions (Society for Range Management, 1989a).

Grazing areas have been severely affected by drought, land degradation and reduction in capacity to regenerate and provide sufficient fodder for livestock. Cultivation under arid conditions also leaves soil bare for most of the year and hence exposing it to more wind erosion. In addition, rural residents deplete forests to the ground for fuel wood and further harm the land and reduce its biodiversity.

Rangeland health ecological attributes can be evaluated through conversation with the assistance of land owners and managers. Appropriate description of plant communities that characterize the ecological site, could be used as key areas within their operating unit. Accordingly, Similarity index to the historic climax plant community or desired plant community will be determined. If appropriate, rangeland health ecological attributes evaluation will also be made based on experience and knowledge of the rangeland ecosystem to decide which rating techniques should be used on an individual rangeland unit (G.L.I, 2003). A rangeland health assessment provides information on the functioning of ecological processes relative to the reference state for the ecological site or other functionally similar unit for that land area. Such assessment provides information that is not available with other methods of evaluation. It gives an indication of the status of the attributes (Pellant, et al, 2005).

2. Materials and Methods

2.1. General

This study was conducted in North Kordofan state, “Sheikan“ locality near “Abusonoon“ Mountain, about 40 km west of Elobied town. The objectives of the study were to assess rangeland health attributes and indicators. The main study concept was based on addressing the main factors of integrated and sustainable rangeland management. The processes of integrated rangeland management are to be assessed and interpreted as indicators to promote integrated rangeland management, mainly focusing on vegetation attributes and soil integrity.

Range health, as an accumulative result of the different range management practices, was used as an indicator to assess the success of previous efforts.

The data collected from the study area was used for the following:

2.2. Rangeland health assessment

Range health is the sustainability of basic soil and ecology processes. Healthy ranges require no changes in management but areas classified at risk may require a change in management to restore its healthy condition.

- The collected data was used to describe rangeland health indicators and criteria that can be used to characterize range health and functionality.
- A number of indicators were tested in this study which include vegetation composition and frequency, ground cover, biomass production, erosion hazard and soil integrity.

Parameters to assess rangeland heath include:

2.3. Vegetation attributes

Three sites were selected to represent rangeland types in the study area. These are the flat sandy, relatively low land areas and goz site. Five transects were established in each 1Km X 1km site based on releúe method and minimum area theory (Matthew and Robert, 1993). Along each transect of 100m the measurements were recorded at 1m intervals. These measurements include plant species, litter, bare soil and etc. to determine plant composition, the plant cover, litter and bare soil were estimated at 10 m intervals using a 1mX1m quadrant. Plants were listed, clipped and weighed to determine frequency and biomass productivity.

2.4. Measurements

- Species composition is the contribution of hits of each species expressed as percentage of total number of points where vegetation type was recorded. Measurements were taken at one meter interval. Observations were taken at one meter interval using the loop (¾″ diameter) along each 1 transect (Parker, 1951). Hits were recorded in the recording sheet for plant when any portion of it within the circumference of the loop is detected. Also hits were recorded for bare soil, litter and rocks.
    - Percentage of plant composition for each species was obtained by dividing its total hits by 100.
- Density was measured by actual count per unit area. Counts are averaged when more than one sample is taken. The total number of plants were determined by counting them inside the 1 m^2 quadrate at 10m interval along the transect.
- Frequency is the percentage of total quadrats which contain at least one rooted individual of a given species. Quadrats were placed along each transect as described above. The species frequency was obtained by dividing the number of quadrats in which the species is present by the total number of all quadrats taken and multiplied by 100.
- **The dominant species was obtained by** referring to the species of higher composition and frequency in the same area (Ahmed, 2004). It was usually predicted from the measurements of the frequency and composition. This may give a single rating on the reactions of these variables to a particular species.
- Total Cover is the percentage of all vegetation covering the ground surface inside the quadrat, or "Species Cover", is the percentage of the target species covering the ground surface inside the quadrat. Again, the one meter quadrat was placed along each transect for sampling. The vegetation cover percentages were calculated and recorded directly from the quadrate estimations in the field works.
- Biomass, the dry weight of the total vegetation or target species, was estimated using a 1m × 1m quadrant along each transect as previously mentioned. All the above ground vegetation (3 cm grazing level) was harvested from each quadrate, then put in labeled paper bags, dried at 75^o c for 48

hours and weighed. Then the dry weight was obtained using a sensitive digital balance. From this dry weight (g/m²), productivity per hectare (Kg or ton/hectare) was calculated (Darag and Suliman 1988).

- The carrying capacity was calculated according to tropical livestock requirement (7.5 kg). It was determined as hectare/ animal unit/ year (ha/Au/Y) according to (FAO, 1980).

3. Results and Discussion

3.1. General

This study has investigated the main elements of integrated and sustainable rangeland management process across three sites according to rangeland patterns (flat sandy site, low land (depressed) and sandy goz, to compare that with the role of stakeholders in the area, since they represent an interactive component of integrated rangeland management.

3.2. Rangeland health attributes

3.2.1 The five dominant species in composition & frequency

Table (4.1) shows the composition of the five dominant species in the three sites, the flat sandy site was dominated by *Fimbristyls dichotoma* (18%), *Cenchrus* spp (13.8%), *Zalya pentandra* (11.8), *Eragrostis tremula* (11.4%) *and Geigeria alata* (4.6%) they scored a total of 60% of the total plant composition of the site. The depressed site was dominated by *Eragrostis tremula* (25%) *Aristida* spp. (21.2%) *Dactyloctenium aegyptium* (14%) *Fimbristyls dichotoma* (10.6%) and *Cenchrus* spp (7%) and scored about 78% of the plant species in this site. In goz site, the five dominant species scored about 85% of the plant species namely, *Dactyloctenium aegyptium* (34.8%) *Eragrostis tremula* (22.8%), *Aristida* spp. (22%), *Cenchrus* spp (3.5%) and *Chrozophora senegalensis* (1.8%). Two species were common among all sites and other two species were common in the depressed and goz sites. while one species common in sandy and depressed sites. This may be due to peculiarity and suitability of the species to the three sites, that they have similar charasteristics, suggested by (RTLA 1999). The five species with high frequency (table 3.2) were *Cenchrus* spp (8.8), *Fimbristyls dichotoma* (8.2), *Eragrostis tremula* (7.2) *Zalya pentandra* (5.4), *and Euphorbia aegyptiaca* (5.4) in flat sandy site, while the species of *Aristida* spp. (9.6), *Eragrostis tremula* (9.6), *Fimbristyls dichotoma* (9.2), *Dactyloctenium aegyptium* (8) and *Cenchrus* spp (5.4) were high frequency in depressed site, and species of *Aristida* spp. (9.6), *Dactyloctenium aegyptium* (9.4) *Eragrostis tremula* (9.2), *Fimbristyls dichotoma* (5.2), and *Cenchrus* spp (4.8) with high frequency in goz site. Three species were shared between the sites and two were shared sites depressed and goz. This may be attributed to the patchy distribution and abundance of these species in area as suggested by RTLA 1999. Also *Zalya pentandra* and *Euphorbia aegyptiaca* were found in flat sandy site because of site charactristics as favourable for the growth of this species.

Table 3.1. species with high composition values

Flat sandy site	No	Depressed site	No	goz site	No
Fimbristyls dichotoma	18	*Eragrostis tremula*	25	*Dactyloctenium aegyptium*	34.8
Cenchrus spp.	13.8	*Aristida* spp.	21.2	*Eragrostis tremula*	22.8
Zalya pentandra	11.8	*Dactyloctenium aegyptium*	14	*Aristida* spp.	22
Eragrostis tremula	11.4	*Fimbristyls dichotoma*	10.6	*Cenchrus* spp.	3.5
Geigeria alata	4.6	*Cenchrus* spp.	7	*Chrozophora senegalensis*	1.8

Table (3.2) Species with high Frequency

Flat sandy Site	No	Depressed Site	No	Goz Site	No
Cenchrus spp.	8.8	*Aristida* spp.	9.6	*Aristida* spp.	9.6
Fimbristyls dichotoma	8.2	*Eragrostis tremula*	9.6	*Dactyloctenium aegyptium*	9.4
Eragrostis tremula	7.2	*Fimbristyls dichotoma*	9.2	*Eragrostis tremula*	9.2
Zalya pentandra	5.4	*Dactyloctenium aegyptium*	8	*Fimbristyls dichotoma*	5.2
Euphorbia aegyptiaca	5.4	*Cenchrus* spp.	5.4	*Cenchrus* spp.	4.8

3.2.2. The cover percentage

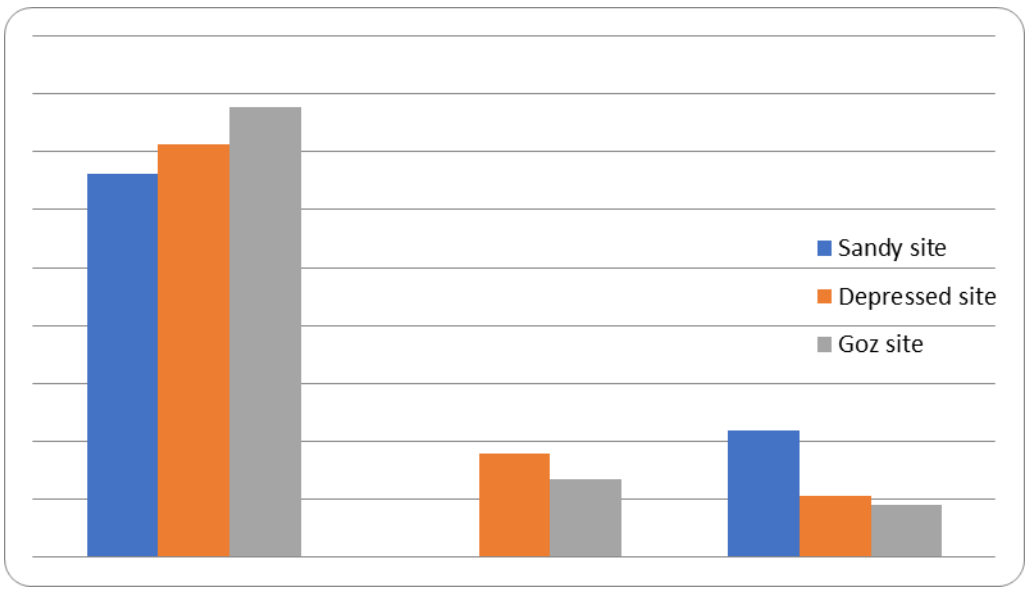
Table (3.3) shwos that the percentage of plant cover was affected by the pattern of the area. There was variation observed between the three sites, the flat sandy site scored 66.3%, the depressed site scored 71.4%, while the goz site scored 77%. This may be atrributed to similarity of the plant specices in composition between the sites and this was also suggsted by Bonham 1989. The bare soil coverage scored 11.8, 17.7 and 13.3 for the flat sandy, depressed and goz sites repectively. The less cover of bare soil may be related to more plants cover in the area and more organic matter, as suggsted by Barry et al 2005. Also the litter coverage scored 21.9%, 10.5 and 9% for the flat sandy, Depressed and goz sites repectively. Flat sandy site had more litter percentage than other sites. This may be due to the flat chatactistics of the site. This was suggested by Pyke et al 2003, average percentage of litter on both, top cover and depth are 20 – 25 % litter cover and 6mm depth.

3.2.3. Erosion hazards

Table (3.4) shows the erosion hazards found in each site. The flat sandy site scored 11.8, the deperessed site scored 17.7, and the goz site scored 13.3. This may be related to the charactorsitics of sites or water may be flowing by this sites. Reid and Love (1950) suggused that 8 – 24 percent bare soil = slight erosion hazard.

Table 3.3. The Cover % along the three range sites

Site	CP%	BS%	L%
Flat sandy site	66.3	11,8	21.9
Depressed site	71.4	17.7	10.5
Goz site	77.7	13.3	9



Figre 2. The cover % along the three range sites

Table 3.4. Erosion Hazard along three range sites

	Flat sandy site	Depressed site	Goz site
Mean	11,8	17.7	13.3

3.2.4. Biomass production and carrying capacity

The biomass usually refers to the weight of organisms present at one time. Biomass estimates are used in determining grazing capacity, rangeland condition, range trend, watershed, and health and wildlife habitat quality. (Table 3.5) shows that biomass was different among the three sites, with significant differences at P (0.001). The average weight was 82.4 gm/m² in flat sandy site, 120.7gm/m² in depressed site and 145.7 gm/m² in goz site. The variation in biomass between the sites may be attributed to sites' characteristics and growth of species as suggested by RTLA (1999). Also, it may depend on the absolute availability of growth limiting

factor and may be influenced by the amount and distribution of precipitation and annual rainfall.
Productivity as indicated by biomass showed 0.824 ton/ha. for flat sandy site, compared to 1.207 ton/hac. for sandy site and 1.457 ton/ha. for goz site, as shown in table table (3.6). This may be due to different factors including influenced climate, nature of soil, composition, vegetation structure, and intensity of management (Le Houerou and Hoste, 1979). Also low quantities of water in area relates to few practices of livestock raising. Productivity in this area is considered normal as related to rainfall amount (Pyke *et al* 2003).
Carrying capacity was 109.87 AU/hac./day for flat sandy site while for depressed site was 160.93 AU /ha./day and was 194.27 AU /ha./day for goz site, as shown in table (3.6). The variation between sites may be related to different productivity and other factors that influenced it.

Table 3.5. Biomass production along the three range sites (gm/m²)

	Flat sandy site	Depressed site	Goz site
Mean	82.4	120.7	145.7

Table 3.6. Productivity & Carrying Capacity along the three range sites

	Flat sandy site	Depressed site	Goz site
Productivity ton/hac.	0.824	1.207	1.457
Carrying capacity AU /hac./day	109.87	160.93	194.27

4. Conclusions:

The Assessment of the rangeland health attributes and indicators, as an output of integrated rangeland management, in the study area revealed the following variations:

There was a variation observed in the percentage of plant cover between the three sites, but there was high plant cover in all of them and a lower bare soil cover. Flat sandy site had more litter percentage than the other sites.

The study revealed that there was no erosion hazard as a result of low bare soil cover. There was a variation also in biomass between the sites due to sites' characteristics and growth of the species. This indicated different productivity and carrying capacity due to different factors of influence.

In general, the study concluded that ranges are considered healthy enough and do not require any introduction for change. Management, so far, could be kept as such at this time, bearing in mind that continuous observations and measurements are essential to prevent destructive activities by the dwellers that can cause further deterioration.

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