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Assessing the Current situation of Rangeland in Elbaja Area, White Nile State

تقييم الوضع الحالي للمراعي بمنطقة الباجا، بولاية النيل الأبيض

Dissertation Submitted for Partial Fulfillment of the Requirement of M. Sc. Degree in Range Science

By

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B. Honor. Range Science 2017

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2021

DEDICATION

To my parents

To my siblings

To my friends

To most important teacher

Dr. Mohammed Ibrahim Abdelsalam

Hafsa

ACKNOWLEDGMENT

I would like to express my special thanks of gratitude to my supervisor Dr. Mohammed Ibrahim for helped me to do this research

Secondly, I would also like to thank my parents and friends who helped me a lot.

I appreciate all the support I received from the rest of my family

Abstract

This study was conducted in Habeela area, in EI Duim locality in White Nile State, in 2019. The aim of this study was to assess the current situation of Habeela rangeland thorough the determination the vegetation attributes and soil seed bank. Tow site were selected randomly (grazed and un-grazed) area located by using GPS (Global Positioning System). Transect of length (100m), quadrate size (1×1m) and parker loop3/4 were used to determine vegetation attributes. Soil sample was taken form three depths (0-5, 6-10 and 11-15 cm) to assess soil seed bank. Soil subsamples were washed to separate the soil from seeds and soak in water 40 minutes for dead seeds separation. Lives seed were soaking in Calcium Chloride for 40 minutes. The data were analyzed using SAS statistical program, Duncan procedure for mean separation. The results of this study showed that, the biomass production was low, and also low carrying capacity of rangeland. In addition, the study found that *Schoenfeldia gracilis* was a high species density reached about 75 plant/m^2 and high species composition of the rangeland which made it dominant species. The study concluded that the low percent of these plants consider a strong indicator of the deterioration of this range site. This study recommended that to reseeding palatable plants and avoid over grazing.

الملخص

أجريت الدراسة في منطقة هبيلا، بمحلية الدويم في ولاية النيل الأبيض في العام 2019. هدفت الدراسة إلى تقييم الوضع الحالي للمرعى من خلال السمات النباتية والمخزون البذري. تم إختيار موقعين رعويين بالمنطقة (موقع مرعي وموقع غير مرعي) وتم تحديدها بواسطة جهاز (GPS). استخدم القاطع بطول 100 متر والإطار المربع (1*1) متر وحلقة باركر (3 /4 بوصة) لتحديد السمات النباتية. تم أخذ عينات من التربة على ثلاثة أعماق (0-5 و6-10 و11-15 سم) لتقييم المخزون البذري. أخذت عينة من كل عمق وتم غسلها بالماء لفصل التربة من البذور، وتم نقع البذور في لماء لمدة 40 دقيقة لفصل البذور الميتة من الحية كما تم نقع البذور الحية في محلول كلوريد الكالسيوم لمدة 40 دقيقة لفصلها. تم تحليل البيانات باستخدام برنامج (SAS) بطريقة دنكان (Duncan) للفصل بين المتوسطات. توصلت النتائج إلى أن انتاجية الكتلة الحية والحمولة الرعوية كانت قليلة في المراعي. بالاضافة إلى ذلك وجد أن نبات ضنب الناقة (*Schoenfeldia gracilis*) كان أعلى كثافة وصلت إلى 75 نبات/م^2 وأعلى تركيب نوعي في المرعى مما جعله النبات السائد. خلصت الدراسة إلى أن إنخفاض نسبة النباتات يعتبر مؤشر قوي لتدهور هذا الموقع الرعوي. أوصت الدراسة بإعادة إستزراع النباتات المرغوبة وتفادي الرعي الجائر.

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CHAPTER I

INTRODUCTION

1.1General:

Rangelands are grassland, shrubland, woodland, wetland, and deserts that are grazed by domestic livestock or wild animal, (FAO, 2007). Range constitutes an important land based resource for several reasons, the most important of which may be their wide distribution. Rangelands ecosystem are a complex set of interactions between soil, water, air, plant, and animal resources; temperature; topography; fire, and humans. Rangeland covered vast area of the globe and is considered a major source of cheap feed for livestock and wildlife habitat, depending upon the management applied, some of the benefits and services that are derived or directly obtained like (water for domestic) livestock products, flood protection, recreation, wood products minerals, and ecological continuity. The rangeland contributes the goods and services of human (Holechek *et al*, 2010). The Sudan rangeland are estimated to the income and subsistence of a large sector of the population and in addition provide more than 80% of the total feed requirements of the national herd, (Abusuwar, 2007). The type of vegetation in the Sudan starting from North to South included Desert, Semi-desert, Low rainfall woodland savannah (Low rainfall woodland savannah on clays, Low rainfall woodland savannah on sands, Low rainfall woodland savannah on special areas), High rainfall woodland savannah, Flood plain, Montane vegetation. Each of the above divisions, except the desert, is broken down into several plant communities and associations (Abusuwar, 2007). Rangelands dominate these areas, providing primary products of grasses, legumes and browse from shrubs and scattered trees in some area. Inventory and monitoring are essential part of range management process; they give good information about the land cover and other attributes, to assess current condition and the repeated measurement yearly tend to know about the range trend and other changes in rangeland uses. Plant inventory usually involves an assessment of vegetation resources at point in time (Holechek *et al*, 2004). Increase efforts are needed to achieve a comprehensive evaluation of the rangeland resources where a clear data invalid exists, including an evaluation of suitability for sustained long range productivity of goods and services. The Sudan rangelands were degraded and facing many problems which were affected the range condition and satiability of the resources. Land degradation leads to unfertile soil, unavailable water, reduction in net primary production, and change of plant cover and biodiversity. Continuous overgrazing, through shrubs removal and complete consumption of grasses and herbs especially before maturity, has resulted in an overall land degradation, (Abdelsalam, 2016). Mobility of the pastoralists, deterioration of natural rangeland in the El-Baja area, in addition, conflicts between farmers and postural communities, open grazing system is dominant system in rangeland in Sudan practice for a long time. However, in resently because of increased the number of population has increased due to the expansion of the agriculture and some population activities (Abusuwar, 2007).

1.2 Problem Statement

The importance of the rangeland resource it provides about 80% of the different vegetation zones in Sudan keeping them in ecological balance, in addition protects the soil and watershed areas against erosion (Abusuwar, 2007). The rangeland plays a vital role in providing human with the goods and services; they give multiple products according to their energy, innovation (Holechek *et al*, 2011). In El-Baja area vegetation and rangeland around the villages, they have many problems as well as overgrazing, deforestation, water scarcity, seasonal fire, effect on rangeland. In addition, mobility of pastoralists, shortage of rainfall, and misuse of land caused deterioration of natural rangeland in Habeela rangeland of El-Baja area. All these problems affected negatively on rangeland condition, trend and reflect the current situation of rangeland resources. This study comes to assess the current situation of rangelands according to their vegetation attributes and the stock of soil seed bank.

1.3 Objectives

1.3.1 General Objective:

To assess the current situation of rangeland in Habeela area to provide some effective management to improved rangeland situation.

1.3.2 Specific Objectives:

-To determine the vegetation attributes at Habeela area.

-To determine the soil seed bank at Habeela area.

1.4 Research Questions:

-What the importance of the vegetation attributes determination?

-What the importance of soil seed bank?

1.5 Study Area:

1.5.1 Location:

This study was conducted in “El-Baja” area near Habeela village North West of El Duim town, in the White Nile state, and it extends between latitude 14° 04 19” North and longitude 032° 01 ‘45” East, (Abdelsalam, 2008).

1.5.2 The Climate:

Most of El-Baja area lies within the semi-arid which is characterized by a dry tropical climate where the average annual rainfall is less than 600mm. The rainy season in El-Baja starts in July, becomes dominant in August and continues up to October. The temperature ranges between (38℃ to 16℃) as a minimum, (Abdelsalam, 2008).

1.5.3 Topography:

The topography of the West part of White Nile is generally flat, with gentle sloping ground away from river. The area of the study is almost flat and leveled except for few humps and depressions, (Abdelsalam, 2008).

1.5.4 The Vegetation:

The ground cover in Elbaja area dominated by “Bano” *Eragrostis spp, “Gaw” Aristida spp, “*Danab ELnaga” *Schoenefoldia gracils,* (Abdelsalam, 2008). Elbaja area is surrounded from

North and East by intensive cover of trees and shrubs dominated by Seyal (*Acacia tortilis*), Kittr (*Acacia melifera*), in addition to other trees such as Sidr (*Zizipfus app*), Laout (*Acacia nubica*), Hashab (*Acacia Senegal*), Talih (*Acacia seyal*) (Abdalla, 2008).

1.5.5 Soil and Water Resources:

The soil of the area is a mixture of sand and clay, but with more clay towards the riverbank. Water sources in the area are mainly from surface dug pools (*Hafir*), in addition to water collected in natural depressions (*Ruhud*). This water used for human and animal's consumption. The water normally finished early in the dry season and before the next rainy season. Therefore, there is usually water shortage during the dry season (Abdalla, 2008).

CHAPTER II

LITERATURE REVIEW

2.1General:

Rangelands are an important renewable resource, includes grassland, grazeable forestland, shrubland, pastureland and riparian (Holechek *et al*, 2011). Rangelands account for 16% of world food production compared to 77% for cropland, rangelands distinguished from pasturelands because they grow primarily native vegetation, rather than plants established by humans (Holechek *et al*, 2004). Rangeland is now more commonly defined as a kind of land with specific vegetation and climate, so range management is science and art of planning and directing range resources as to obtain the maximum sustained livestock production without deterioration the range or the natural resources. Proper management is essential for the sustainable production of food and fiber, as well as supporting a wide diversity of other uses (Abusuwar, 2007).

Economically, production limited by difficult climate or topography, so that communal pastoralism or extensive commercial grazing has been the norm in many countries. Rangeland also provide traditional living areas for non-pastoral people and can support a diversity of wildlife, which offers both a source of food and an attraction for tourists and recreational hunters (Bonham, 1989).

2.2 Range Assessment:

Assessment process can take the following forms based on the objectives:

2.2.1 Rangeland Inventory:

Rangeland inventory is information collected to document and describes the existing resource status within a management unit. Features included depend on the purpose of the inventory, but in rangeland, situations are likely to entail vegetation types, range sites, range condition, carrying capacity, soil types, utilization patterns, topography, streams, habitat assessments for wildlife, and improvements such as roads, watering points, and fences (Bonham, 1989).

Rangeland evaluation may be considered either in the context of current use or in terms of potential for alternative uses. For the most part, climatic and edaphic constraints prevent agricultural development except in parts of the humid north (Johnson, 1986**)**. The grazing industries themselves are all essentially sedentary so that no land use conflicts arise from cultural differences between various groups of rangeland users. Thus while some alternative or complementary uses are feasible, the major emphasis in land evaluation is on suitability of current use.

2.2.2 Rangeland Monitoring:

Rangeland monitoring is conduct to record changes in resource status, usually to assess the response to a management program at a site. Such changes can only detected by a series of measurements spanning time. Data collected from a range inventory provides a valuable baseline against which to compare responses, but monitoring can be conduct at the same level of detail as the information provided by an inventory, (Abdelsalam, 2008). Instead, monitoring is usually base on observations of key areas and key vegetation attributes carefully selected to meet the objectives of the program. For example, species composition can be measure in a riparian area to determine the impact of a certain grazing system, changes in mesquite (Prosopis spp.) density can be used to assess the effectiveness of herbicide control, or ground cover could be chosen to monitor the impact of tourism at a popular site in a National Park.

2.2.3 Rangeland Evaluation:

Rangeland evaluation is the process of determining the status of natural rangeland resources. Rangeland evaluation is primarily concerned with the assessment of productivity for current use and with the extent to which resource condition altered by grazing. Repeated measurements over time provide an indication of whether the vegetation is improving or declining compared to predetermined standards or goals, (Abdelsalam, 2008).

2.3 Vegetation Attributes:

Rangeland inventory and monitoring programs have traditionally focused on describing attributes of the vegetation to describe current rangeland status or detect changes over time (Holechek *et al*, 1995). The selection of attributes is an important consideration when planning a sampling program.

The following sections describe the vegetation attributes that are regularly used in rangeland inventory or monitoring programs and discuss the strengths and weaknesses for the many field sampling techniques that are available to measure these attributes (Glatzle et al, 1993).

2.3.1 Biomass:

Biomass is a commonly measured vegetation attribute that refers to the weight of plant material within a given area. Other general terms, such as 'yield' or 'production', sometimes used interchangeably with biomass. Units to express biomass should be selected so that actual plant weight is easy to visualize, such as lb/acre, kg/ha or g/m^2 according to vegetation abundance and objectives of the inventory or monitoring program (Holechek *et al*, 1995). Biomass data collected on an individual species basis, as species groups, or as a total weight for the vegetation. Species composition calculated as the contribution (percent by weight) that each species makes to the total biomass.

Biomass is regard as an important indicator of ecological and management processes in the vegetation (Pieper, 1988):

-*Ecological indicators* - biomass is a measure of species dominance within the vegetation, since the demand for resources by each species is largely determine by plant size. Biomass also reflects the amount of energy stored in the vegetation, which can indicate the potential productivity at the site.

-*Management indicators* - biomass provides a variety of indicators for rangeland management. For example, it is a valuable tool to assess range condition, the carting capacity of an area, or to make short-term stocking rate adjustments according to the amount of forage reserves and residual biomass.

Methods to Determine Biomass:

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 quadrats. Indirect methods are based on developing a relationship between plant weight and an easier-to-measure attribute such as plant height, rainfall, or cover(Johnson, 1986**)**.

The most suitable approach to determine biomass in an inventory or monitoring program depends on the type of vegetation, skills of observers, sample size requirements, and time and budgetary constraints.

1 Direct Method:

Biomass sampling is usually conducted using a sample unit with defined boundaries, for example, some type of quadrat, so that biomass can be expressed relative to a known area. With these techniques, the quadrats are directly evaluated to assess biomass. This type of sampling is best suited to areas dominated by herbaceous or shorter shrub species, that can be accommodated in relatively small quadrats (Glatzle *et al*, 1993).

The most common direct methods of determining biomass are:

A Harvesting methods:

Direct harvesting of vegetation from quadrats of a known size is the most straight-forward approach to determine biomass at a site. A wide variety of mechanized clippers, lawn mowers, vacuum collectors, etc. Have been invented in attempts to making the task less onerous, but plant material is usually painstakingly gathered using clippers. Data are usually collected from many quadrats located along a transect, so that the transect is the sample unit. Therefore, data must be collected from several transects to determine the precision of the sample, for statistical analysis of biomass data (Roberts, 1981).

B Estimation Approaches methods:

Estimation approaches involve techniques that require observers to visually assess biomass in quadrats, rather than harvesting to determine biomass. Three common estimation methods to determine biomass are commonly used:

B.1 Comparative Yield Method:

Comparative yield method can be used to describe biomass property. It can be applied to a wide variety of vegetation types, particularly grasslands and shrublands, but becomes more complicated in vegetation with a diverse array of species or life-forms.

The comparative yield method consists of three stages:

- Selection of Reference Quadrats.
- Assessment of Sample Quadrats.
- Collection of Calibration Quadrats.

B.2 Double Sampling Method:

The double sampling method is designed to determine biomass by sampling in quadrats. Depending on the objectives of the study, the double sampling method can be used to describe any biomass property. It can be applied to a wide variety of vegetation types, particularly grasslands and shrublands, but becomes more complicated in vegetation with a diverse array of species or life-forms (Friedel *et al*, 1988).

The double sampling method was developed as a modification of the weight-estimate method, to attempt to overcome the lack of precision among observers and the possibility of unchecked drift in an individual's estimate of biomass over time. In concordance with the weight-estimate method, data is collected by using defined weight-units for each species to visually estimate the biomass in each quadrat. However, a small second calibration data set is also collected, by clipping and weighing selected quadrats after estimation. Regression analysis is used to compare estimated and harvested values of the calibration samples, to determine if tended to underestimate or overestimate the visual estimation, and to provide the appropriate adjustments to be made to all field samples(Ahmed and Bonham,1982).

However, the observer's proficiency cannot be confirmed until after the calibration quadrats are clipped and weighed! Clipping one out of every 5 - 10 quadrats for inclusion in the calibration data set provides a reliable calibration in most situations.

Data is usually collected form multiple quadrats located along a transect, so that the transect is the sample unit. Therefore, data must be collected from several transects to determine the precision of the sample, for statistical analysis of biomass data.

The double sampling method is regularly used to determine biomass in range inventory or monitoring programs. It is a little slower than the weight-estimate method and still requires extensive training in the preliminary stages, but these disadvantages are well compensated by improvements in accuracy and precision. By only clipping a selection of quadrats, it is more efficient than harvesting to determine biomass(Riech *et al*, 1993).

2 Indirect Methods:

Indirect methods to determine biomass are based on developing a relationship between plant weight and an easier-to-measure attribute such as plant height, rainfall, or cover (Bonham, 1989).

A **Climatic Record:**

Climatic conditions have an obvious effect on plant growth, especially influencing the biomass of annual and perennial herbaceous species. A strong relationship between rainfall and herbaceous biomass has been developed for many rangeland types, including the semi-arid grasslands of southern Arizona, annual grasslands of California, the cold-deserts of the Great Basin, and the prairies of the Great Plains. In areas with distinctive seasonal rainfall patterns, precipitation during the growing season provides a better relationship than does annual rainfall (Bonham, 1989).

B Plant Dimensions:

Many different attributes describing plant dimensions can be used to determine plant biomass. Measurements on plant height, plant basal area, twig length and diameter, trunk diameter, canopy cover, or canopy volume, are all used as indirect methods to estimate biomass(Riech et al, 1993).

The method involves initially developing a regression relationship, by recording the appropriate dimensions and harvesting a small number of individuals that are chosen to encompass the range in plant size that will be encountered in the population. This step should be completed before further sampling commences, to ensure that the selected dimensions provide a good prediction of biomass ($r^2 > 0.70$, for example). The main sampling then proceeds by taking only dimension measurements, which are converted to biomass values using the regression equation (Bonham, 1989).

C Reference Unit Method:

Sampling is usually restricted to a key species, and can describe any biomass property depending on the objectives of the program. The reference unit method is most commonly used to estimate browse biomass of shrubs, but is equally applicable to herbaceous species with discrete growth forms such as bunchgrasses. For meaningful interpretation, the data must be converted from a biomass per plant to a biomass per area basis, requiring an additional estimate of density.

The reference unit method is a natural evolution of the weight-estimate method and the double-sampling method, in that a standard unit is selected as a biomass comparison for other plants during sampling.

2.3.2 Cover:

Cover is the vertical projection of plant material onto the ground when viewed from above; it is usually express as a percentage value. For example, 18% cover indicates a birds-eye-view would reveal 18% of the surface area as vegetative material with the remaining 82% as bare ground. In some forestry situations cover is expressed on an area basis, such as square meters/hectare or square feet/acre (Bonham, 1989).

Cover can be measured for the entire vegetation in an area, or can be applied to individual species. In many areas, overlapping plants can mean more than one species contributes to cover (Greig-Smith, 1983). Decisions involving which species to record depend upon the objectives of the study, and should be clearly describe as ground rules during the planning stage. Usually, if ground cover is the attribute of interest only the uppermost component is record, whereas basal cover is identify by the species occurring at the soil surface. Cover is regard as an important indicator of ecological and management processes within the vegetation, though many of the direct relationships still have to be quantify (Cooper, 1959):

-*Ecological indicators* - cover is a characteristic expression of ecological dominance, or the degree of influence a particular species exerts in the vegetation. Although ecological dominance is also a function of species biomass, cover values (eg, leaf area index) provide a close reflection of biomass rankings while being easier to determine. Furthermore, cover allows the species of various life forms to be evaluate together on a comparable basis, in contrast to other attributes such as density and frequency. Canopy cover is usually most meaningful when considering ecological processes, particularly when woody species are included, because measurements based on basal cover do not adequately reflect the extent of their influence within the vegetation.

-*Management indicators* - cover provides a variety of interpretations of direct concern to rangeland management, including erosion potential, the value of wildlife habitat, availability of forage, and trends in range condition. Ground cover is consider the best indicator of protection of the landscape against erosion, whereas canopy cover is commonly use to describe wildlife habitat or related to forage availability. Basal cover provides the most reliable measure for monitoring range trend (particularly when focusing on herbaceous components), because it is less sensitive to fluctuations caused by current seasonal conditions or immediate grazing history.

Methods to Determine Cover:

Much effort and imagination have been devoted to developing methods to estimate cover, reflecting its long tradition as an important attribute for rangeland inventory or monitoring purposes. The following techniques are the standard methods of determining cover:

1 Point Sampling:

Point sampling is one of the most common approaches to estimate cover of a site, since being conceived by New Zealand pasture scientists. It is based on placing a number of points within an area, and determining the proportion of the points that hit vegetation. In this manner, total cover can be calculated as the percentage of hits, relative to the total number of points sampled. Cover of individual species can also be estimated by recording the plant species when intercepted by a point. Species composition is the contribution of hits for each species and is expressed as a percentage of the total number of points where vegetation was recorded as a hit. Ground cover, basal cover, canopy cover, and leaf area index can all be measured by point methods, depending on the ground rules established to guide decisions regarding which species will be recorded when multiple hits are encountered if overlapping canopies are vertically intercepted (Hofmann and Ries 1990).

2 Line Sampling:

Another common approach to determine cover involves extending a line (usually a tape) across the site and recording the proportion intercepting plant material. In theory, line methods are a specialized form of point sampling to determine cover, where an infinitely large number of points are systematically arranged in a consecutive sequence (Hasel, 1941).

3 Sampling in Quadrats:

Although other approaches are generally preferred, a variety of methods are available to determine cover quadrats. Depending on the technique, measurements can be made for ground cover, basal cover or canopy cover. Species cover and species composition can also be estimated with most methods (Smith, 1944).

The general sampling principles involving sample unit shape, sample unit size, and sample size apply to these techniques, and need not be discussed with further. Because each quadrat represents a only a very small area of the site, sample variance is generally high, many quadrats must be taken to obtain a sample size that adequately represents the site (Smith, 1944).

4 Plotless Sampling:

Cover estimated by plotless methods has the advantage of integrating large areas within a single sampling point. Early range assessments relied on the ocular reconnaissance method to estimate cover, where observers traversed the site before subjectively assigning a cover value. This technique generally provided consistent results when practiced by experienced observers, and large areas were surveyed in one day; but extensive training is required and personal bias is difficult to quantify (Bonham, 1989).

2.3.3 Density:

Density describes the number of individual plants in a given area, is an attribute that is tedious to measure but easy to interpret. It is most often apply to larger plants, such as trees, shrubs, and more forbs. Density is often use as a baseline inventory of the structure of rangeland or forest vegetation, by quantifying different species or various ages within a single species (Laycock, 1985).

Density data is also gathering to monitor the effect of various land use treatments, such as plant survival following burning or herbicide application, particularly for woody species. Density measurements are sometimes unsuitable for the herbaceous layer, especially when there are numerous plants to count or identification of individuals is difficult. Nonetheless, density is regularly use to evaluate seedling emergence and survival in a rangeland-reseeding program. Density is also commonly describe in autecological studies that trace the demography of herbaceous or woody populations. Density can provide useful indicators in an inventory and monitoring program to determine range condition and range trend because it remains relatively stable from year to year, regardless of changes in biomass that result from rainfall fluctuations or short-term grazing patterns.

2.3.4 Frequency:

Frequency is the number of times a species is present in a given number of sampling units. It is usually express as a percentage. Frequency is the vegetation attribute that describes the probability of finding a species within a particular area. The probability is based on the occurrence of that species in a series of sample units. For example, if a species has a frequency of 75%, we expect it to occur in three out of every four quadrats examined

Frequency is simple vegetation attribute to measure because it only requires identification of the species in each quadrat, and does not require that individuals are distinguish, measured, or counted. Therefore, data collection is usually a more rapid procedure than for other vegetation attributes such as biomass, cover, or density, which involve counting or subjective quantification. This advantage is most apparent in rangeland vegetation characterized by relatively low species richness, but diminishes in vegetation with complex species composition (Despain *et al*, 1991).

Frequency values are determined for individual species because an overall frequency for the entire vegetation cannot be obtained, in contrast to other attributes such as biomass, cover, or density. Likewise, it is not possible to obtain a meaningful expression of species composition from frequency data because the absolute abundance is not measure, only the presence of a species is measured

Frequency can be a sensitive method to detect vegetation changes at a site. Its ease and speed of data collection means that frequency is suited to large areas, so it is sometime adopted by State and Federal agencies for descriptive rangeland inventory or monitoring programs.

2.3.5 Species Composition:

Species composition refers to the contribution of each plant species to the vegetation. Botanical composition is another term used to describe species composition. Species composition is generally express as a percent, so that all species components add up to 100% (Barbour *et al*, 1987).

Species composition is a commonly determined attribute in rangeland inventory and monitoring. It is regard as an important indicator of ecological and management processes at a site.

-*Ecological indicators* - species composition provides the essential description of the character of the vegetation at a site. Certain images are readily understood when major species are mentioned, eg, pinon (*Pinus* sp.) - juniper (*Juniperus* sp.) woodland, and other common species are also presumed to be present as one becomes familiar with the vegetation. These distinctions form the basis of rangeland mapping and the delineation of range site boundaries.

The relative contribution of a species also signifies its dominance in the vegetation and its ability to capture resources. Slightly different inferences of competitive ability are suggest .if species composition is express based on cover, density, or biomass measurements.

-*Management indicators* - most objectives in rangeland management are directly concerned with the assessment or manipulation of species composition. For example, carrying capacity is influence by the relative abundance of desirable forage species at a site. Wildlife habitat is also influence by the relative contribution of various species that provide sources of shelter and food. Species composition is use to determine range condition and range trend, which are valuable tools to judge the impact of previous management and guide future decisions (SRM, 1989).

2.4. Range Health:

Rangeland health is the degree to which the integrity of the soil, vegetation, water and air as well as the ecological processes of the rangeland ecosystem is balance and sustained (USDA, NRCS, 1997).

2.5 Range Condition:

Range condition describes an evaluation of the status of rangeland vegetation. Condition assessments provide the framework to register information obtained by range inventories on the basic status of existing vegetation, and to gauge changes or range trend through monitoring **(**Friedel, 1991). In addition, range condition is use as a guide to ensure sustainable land capacity use, to determine carrying and adjust stocking rates, to identify potential responses to range improvement programs such as brush control or reseeding, and to evaluate the best locations of fences and water facilities to improve utilization within a pasture (Friedel, 1991).

The best-known procedure to assess range condition is the Quantitative Climax Method, used by the Soil Conservation Service (now Natural Resources Conservation Service) since the 1950s. This method compares species or species groups in the existing vegetation with that expected in the climax vegetation, to give a percentage reflecting the similarity between the two. A value close to 100% indicates that species composition of the existing vegetation closely reflects the composition of the climax vegetation, whereas lower values indicate a greater level of departure from perceived climax conditions. Although range condition is evaluate on a continuous scale from 0% to 100%, arbitrary classes are generally reported to illustrate range condition (Table 1).

Table 1. Range condition classes used in the Quantitative Climax Method

Range Condition Class	**Percent of Climax**
Excellent	100-76
Good	50-75
Fair	26-50
Poor	0-25

Source: Darag, 2006 sited by (Abdelsalam, 2008)

2.6 Range Trend:

Range trend refers to the change in the status of resources at a site detected by monitoring and is usually expressed as *improving*, *declining,* or *stable*. It originally pertained to any goal defined by management such as changing vegetation cover by adjusting stocking rates or grazing practices (Vallentine, 1990). The general association of range trend with data describing any vegetation attribute in a monitoring program is still theoretically valid, but today the term carries a more specific interpretation relating to the comparison of consecutive assessments of range condition in a monitoring program (Holechek *et al*, 1995).

2.7 Range Utilization:

Utilization refers to the amount of plant material that has been removed by animals during the grazing period. It can be based on individual plants, key species, or an assessment of the entire management unit. However, most commonly the current year's production of accessible forage plants is considered when assessing utilization. Utilization is usually expressed as a percentage, that is calculated on a total biomass basis (SRM, 1989). Livestock distribution patterns across the management unit can be classified into utilization zones that become the basis for management decisions concerning the location of additional range improvements, such as water points, salt grounds, and fencelines. Utilization also acts as an useful index to compare the impact of different stocking strategies such as season of grazing (Vallentine, 1990).

2.8 Range Management:

Range management is defined by as the "manipulation of rangeland components to obtain optimum combination of goods and services for society on a sustained basis, it deals with the human, plant, animal and soil together (Holechek *et al*, 2011).

Range management's focus has been expanded to include the host of ecosystem services that rangelands provide to humans world-wide. Key management components seek to optimize such goods and services through the protection and enhancement of soils, riparian zones, watersheds, and vegetation complexes. Sustainably improving outputs of consumable range products such as red meat, wildlife, water, wood, fiber, leather, energy resource extraction, and outdoor recreation, as well as maintaining a focus on the manipulation of grazing activities of large herbivores to maintain or improve animal and plant production (SRM, 2016).

2.9 Range Improvement:

Range improvements are changes made by managers to purposefully change the vegetation with the intent to improve and increase forage quantity and quality. Through the range management planning process, producers will have identified their problems and the opportunities for correcting them. Some form of range improvement probably will be considered.

2.10 Carrying Capacity:

Carrying capacity describes the number of grazing animals a management unit is able to support

without depleting rangeland vegetation or soil resources (SRM, 1989). Evaluating carrying capacity is an important application of rangeland inventory and monitoring programs, because it represents the key management tool to ensure sustainable use of natural resources. Although carrying capacity is a concept that typically relate to rangeland grazing for livestock production, wildlife considerations are equally relevant under the objectives of conservation and multiple use (Holechek *et al*, 1995). The primary complication in interpreting carrying capacity involves the incorporation of spatial and temporal variability. That is, both forage and animal intake are dynamic factors that vary according to site selection, time of sampling, species composition of the vegetation, utilization patterns, dietary preferences, livestock nutritive requirements, and resources available to the manager. Therefore, treat an evaluation of carrying capacity as a preliminary gauge to animal numbers for the management unit that will be revised in the light of monitoring information and immediate forage conditions.

The simplest and most reliable way to determine carrying capacity is to obtain past stocking rates and grazing management information for a piece of land and then assess the ecological status or condition of the rangeland. If the condition is good or improving, the current stocking rates are below carrying capacity. If the condition of the rangeland is declining, carrying capacity has been exceeded, and grazing management practices or stocking rate may have to be adjusted (Holechek *et al*, 1995)

2.11 Stocking Rate:

Stocking rate expresses the actual number of animals on a management unit throughout the time of grazing (Jasmer and Holechek, 1984). Therefore, stocking rates are the management interface that relate livestock consumption to forage supply. Stocking rate decisions have important ramifications on rangeland vegetation, livestock and economic responses. Although stocking rates may vary from year to year, average long-term stocking rates should closely reflect carrying capacity to ensure the optimal and sustainable grazing of range resources. For this reason, stocking rate considerations form the interpretative basis of many inventory or monitoring programs.

2.12 Grazing Management:

Grazing management is the total process of organizing livestock to make the best use of the pastures grown, or managing the frequency and intensity with which livestock graze pasture. Pastures respond differently to grazing, and by understanding the growth characteristics of a particular pasture, grazing can be used to encourage plant growth and maintain productivity. Grazing management is also an important factor in the management of soil, water and nutrients. If not managed well, grazing can lead to severe natural resource degradation.

Some pastures may naturally become less productive as they mature or at different stages of their production cycle. It is important to recognize this and adjust stocking rates accordingly. Overstocking at critical stages may result in irreversible damage to range.

2.13 Soil Seed Bank Assessment:

Seed bank is the seed reserve in soil, which comes from either plant species in the site or seeds transferred from elsewhere through dispersion or other means. According to the Matthew, and Robert, (1993) term soil seed bank has been used to designate the viable seed reservoir present in a soil. All the viable seeds present in the soil or mixed to soil debris constitute the soil seed bank (Simpson *et al*., 1989). The soil seed bank is the life cycle origin for the annual species, being fundamentally the cause of its persistence; in perennials, besides the seed bank, there is a bank of vegetative propagates (Garwood, 1991). Natural storage of seeds in the leaf litter, on the soil surface, or in the soil of many ecosystems, which serves as a repository for the production of subsequent generations of plants to enable their survival. Soil seed bank can be used to describe the storage of seeds from a single species or from all the species in a particular area. Given the variety of stresses that ecosystems experience such as cold, wildfire, drought, and disturbance seed banks are often a crucial survival mechanism for many plants and maintain the long-term stability of ecosystems. The success of a seed bank depends on the seed density ready to germinate, when replacement of a plant is necessary and when the environmental conditions for establishment are favorable (Carvalho *et al*, 1995).

Abdelsalam *et al* (2017b) concluded that the seed found in the soil samples at onset of the rainy season came from the plant of pervious rainy season or dispersal from the outside the areas.

2.14 Seed Bank Sampling and Estimation:

The depth to which samples should be taken will depend on the type of vegetation and the purpose of the study (Abdelsalam *et al*, 2017b). Flotation and subsequent viability determination, and those, which rely on, direct assessment of seedlings arising from soil samples. The germination technique, although by useful, may by less efficient than extraction methods.

Determination of proportion of dead seeds present in the soil seed bank is important in studying population dynamics, and a method of determining viability has been developed (Matthew, and Robert, 1993). Seed numbers are normally expressed as a number of seeds per m2 related to a certain soil depth.

CHAPTER III

MATERIALS AND METHODS

3.1 Study concept:

The mean idea of this study to identify the current situation of rangeland resources, in terms of vegetation attributes carrying capacity and soil seed bank. The study was conducted near Habeela Village at El-Baja area, White Nile State, Sudan, after rainy season at December 2019. The rangeland of the study area was heavily grazed by grazing animal.

3.2 Sampling procedure:

The measurements were taken in El-Baja area which was located in White Nile State. The sampling in vegetation attribute was selected randomly located by using GPS (Global Positioning System), random sampling is considered effective only if the population to be sampled is homogenous. Transect of length 100m was used to distribute samples systematically across the distance tape. Parker loop method was used to determine ground cover components with interval of 1 meter between each hit. Quadrate of size (1×1m) was placed along line transect at 25 meter interval between each other for biomass, density and frequency determination. The soil seed bank sampling was distributed according to quadrate distribution (Abdelsalam *et al*, 2016).

3.3 Vegetation Attributes Measurements:

3.3.1 Biomass Assessment:

Biomass is the total weight of the dry matter on an area for a given period and expressed as Kg (DM/Unit area). In this study data were collected as total weight for the vegetation present in the quadrate (1×1m), all plant materials was harvested above 3cm. The plant material was collected in paper bags, and drayed at 104°C after that was weighted, (Abdelsalam *et al*, 2016). Biomass productivity was calculated by using the following formula:

Biomass productivity = $\frac{\text{Average biomass (m2)} \times 10000 \times 0.5}{1000000}$ = (ton/h year), (Abdelsalam et al, 2012).

0.5 is proper used factor

3.3.2 Frequency:

Frequency is the percentage of total quadrates that contain at least one rooted individual of a given species. It was determined by recording the species names which appear in quadrates. The frequency was calculated by using the following formula:

Frequency of the species= $\frac{\text{Number of the occurrence of the species}}{\text{Total number of sample}} \times 100\%$

3.3.3 Density:

Density is a number of individual plants per unit area expressed as (plant/unit).It determined by counting all plant rooted in quadrates.

3.3.4 Species Composition:

Species composition refers to the contribution of each species to the vegetation. In this study was used loop method to determined species composition of rangeland. Species composition was determined by using parker loop method and calculated as a following:

Species composition = $\frac{\text{Total hits of each species}}{\text{Total hits of all species}} \times 100\%$

3.3.5 Ground cover:

Ground cover elements encounter bare soil percentage, dead plant materials (litters), animal plates, rocks and plant species percentages. These elements were estimated along the line transect using parker loop method, (Abdelsalam *et al*, 2017a) it expressed as a percentage. These attributes were calculated by using the following formulas:

Percent of bare soil = $\frac{\text{T0tal hits of on bare soil}}{100} \times 100\%$

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

Percent of animal plated = $\frac{\text{Total hits on animal plates}}{100} \times 100\%$

Percent of rocks = $\frac{\text{Total hits on rocks}}{100} \times 100\%$

Plant cover = $\frac{\text{Total hits of plant species}}{\text{total number of hits}} \times 100\%$

3.4 Soil Seed Bank Determination:

The soil seed bank plays a vital role in the natural environment and ecosystem, the intensity of stock of rangeland plant seeds differs greatly from one region to anther and depends on many factors. Soil seed bank is a good indicator for assessing the accumulative effect of plant establishment along more than one year, (Frahalour *et al*, 2019). To assess seed bank 9 soil samples (10cmx10) with depths 0-5, 6-10 and 11-15cm, were taken within each site randomly, and put them in paper bags. The soil was mixed and sub-sampled of 250 gm, and then were prepared for washing and extraction. After seeds extraction, were floated into 250mm water for 45 minutes, until the dead seed float in the water surface, and then filtered using filter papers. The live seeds, which were sec in the bottom of the beaker, were floated in Calcium Chloride $CaCl^2$ 12g/ml solution for live seed extraction, and were put in filter papers for drying. Seeds of the different species were identified under the magnifying glass, and comparing them with a seeds collected from the plants of study sites, then the percentages of live and dead seeds were calculated according to the following equation:

Percentage of live seeds = $\frac{\textit{The number of live seeds}}{\textit{All seeds number}} \times 100\%$

Percentage of dead seeds = $\frac{\textit{The number of dead seeds}}{\textit{All seeds number}} \times 100\%$

Seed density = $\frac{\textit{Number of seeds of depth} * 2 * 10000}{\textit{Quadrate area} * \textit{number of quadrate of soil depth}}$

3.5 Data Analysis:

For data analysis: The vegetation attributes data were organized tabulated and analyzed using standard range measurements equation and SAS. The soil seed bank data were analyzed by using

SAS statistical software, analysis of variance ANOVA procedure and DUNCAN multiple range tests for separating the means.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Vegetation Attributes Assessment:

4.1.1 Biomass Production and Carrying Capacity:

The annual production of biomass is an indicator of the energy captured by plants, and it is the availability for consumption given correct rangeland condition. According to results represent in table (4.1) the protected area (un-grazed) recorded high biomass production about (0.3 Tons/ha/year) compared with (0.04 Tons/ha/year) come from grazed area. Degradation becomes a serious problem as shown in Habeela area (Al-Baja rangeland) that means, the biomass production was low in both un-grazed and grazed area. These may be attributed to the fully utilized range by the grazing animals in different years. The carrying capacity of the un-grazed area was high about 0.11 TAU/ha/year, compared with the carrying capacity of grazed area 0.002 TAU/ha/year. Due to this result, continuous grazing affected negatively on the biomass and carrying capacity in the study area, this result agreed with Abdelsalam *et al* (2016) who stated that the continuous grazing had a negative impact on biomass production; it decreased the aboveground biomass in the rangeland. Low biomass productivity with low carrying capacity of rangeland is an important indicator that shows the extent of the deterioration that has occurred in the rangelands of Habeela area in the White Nile State. The current situation of Habeela rangelands is considered very deteriorating, which has negatively affected the forage productivity.

Table (4.1) Biomass production and Carrying capacity:

Attributes	Ungrazed area	Grazed area
Biomass production (Tons/ha/year)	0.3	0.04
Carrying capacity (TAU/ha/year)	0.11	0.002

*****TAU: Tropical Animal Unit

4.1.2 Frequency and Density:

Results shown in table (4.2) indicate the frequency of the plant species in Habeela (Al-Baja) area. *Aristida spp* scored the highest frequency of about 75%, while *Schoenfeldia gracilis and Eragrostis spp* was lower 55%, 5%. This result indicated that *Aristida spp* had a good adaptation in study area, which can be concern as a key species in this rangeland. Density can give valuable indicators in an inventory and monitoring program, because it remains quite steady from year to year. Results of plant density in table (4.2) indicated that the total plants density in study area were 81 plant/m²; found that *Schoenfeldia gracilis* was a high species density reached to 75 plant/m², followed by *Aristida spp* and *Eragrostis spp* recorded 2 and 4 plant/m² respectively. This result clearly indicates the extent of the degradation occurring in Habeela rangeland, through the disappearance of vegetation and its density. The high density of *Schoenfeldia gracilis* may be due to its high tolerance to grazing and its ability to adapt to the environment. This result agreed with Abdelsalam *et al* (2012) who reported that *Schoenfeldia gracilis* had a good distribution and ore abundance in all types of rangelands.

Table (4.2) Frequency and Density:

Scientific name	**Local name**	**Frequency %**	**Density (plant/m²)**
Schoenfeldia gracilis	Danab elnaga	55	75
Aristida spp	Gaw	75	2
Eragrostis spp	Bano	5	4
Total			81

4.1.3 Plant Composition:

The result shown in table (4.3) indicated that the vegetation of the study area was dominated by *Schoenfeldia gracilis and Aristida spp*, this constitutes about 93% of the total plants. These species is considered desirable for domestic animals. Low diversity of plants considered a strong indicator of the deterioration of this range site, also plant composition affected by the open grazing in the area. This result agreed with Abdelsalam *et al* (2016) who reported that high grazing pressure could change plants species composition and plant diversity. These results showed a clear negative on the range condition. Moreover, the high animal's number around study area may limit plant regrowth potential by causing soil surface compaction.

Table (4.3) Plant composition:

Scientific name	**Local name**	**Percentages %**
Schoenfeldia gracilis	*Schoenfeldia gracilis*	93
Aristida spp	Gaw	6

4.1.4 Ground cover:

The ground cover of rangeland plays a vital role of soil protection against the surface erosion. Ground coverage includes all the elements that have seen on the surface of rangeland such as bare soil, litters and vegetation cover. The results are obtained in Table (4.4) explained that there are significant differences between ground cover components. The effect of gazing pressure is clear through an increase of the litter and bare soil in Habeela area, which recorded about 37%, 30% respectively. The vegetation cover shown was about just 18% of the total area; this result makes clear that rangeland was used intensively by grazing animals. The high litter and bare soil percentage in the study area may be because of increased livestock number that decreases the available vegetation cover. This result reflects the negative impact of over stocking on vegetation cover and soil conservation. The continuity of grazing may lead to deterioration in the area as a result of overgrazing, this result was on line with Abdelsalam *et al*. (2017a) who found that the reason of high litter and bare soil may be due to animal grazing behaviors; it can eat part of plants and leave the other part which falling on the soil surface, in addition to other parts of plant crushed during animal grazing. Decreased vegetation cover and increased bare soil are main indicators of the decline and degradation of rangeland conditions. This is what happened to the state of the rangeland in the Habeela area, and it became more degraded. It is also considered that the continuous grazing practiced in these rangelands may be the main cause of the degradation of rangeland resources. Abdelsalam *et al*, (2017a) stated that the continuity of grazing may lead to deterioration in the area as a result of overgrazing.

Table (4.4) The means of ground cover

Measurements	**Percentages**
Litter	37.22 a
Bare soil	30.55 a
Plant cover	18.21 b
Rocks	15 b
Plant spp	13.89 b
Dung	1.44 c

Means with the same letter are not significantly different at alpha 0.05.

4.2 Soil Seed Bank Assessment:

4.2.1 Live and Dead seeds:

According to the results shown in table (4.5) there were significant differences between number of live seeds (Pr 0.01) and high significant between number of dead seeds (0.001) in grazed and un-grazed area of Habeela area. Among the results un-grazed area recorded high number of seeds about 8 live seeds compere with grazed area just obtained about 2 live seeds. On the other hand, un-grazed area had a highest number of dead seeds about 10 seeds compared with grazed area were only about 3 dead seeds. These results explain the negative impacts of rangeland degradation on soil seed bank. In addition, the misuse of natural rangeland may have led to the degradation of rangeland resources in Habeela area. This result agreed with Mohammed *et al*, (2020) who stated that the misuses of rangeland might increase soil erosion, loosed upper layer of soil, and attributed to decrease the live seed percentage. Reduced seed bank in rangeland soils are a bad indicator of declining vegetation cover and its incapability to regenerate naturally. The deterioration of the seed bank in the soil the deterioration of the vegetation cover above the soil surface, if reflects vegetation decreases, fewer seeds are produced accordingly.

Table (4.5) Effects of grazing on Live and dead seeds:

Sites	Live seeds	Dead seeds
Un grazed	8 a	10 a
Grazed	2 b	3 b
Pr > F	0.01 *	0.001 **

Means with the same letter are not significantly different at alpha 0.05.

* Means there are significant differences.

** Means there are high significant differences.

According to the result represent in figure (4.1) illustrate that the percentage of dead seeds were higher than the percentage of live seeds in two range sites of Habeela area. The dead seeds reached about 60 and 55.6% in grazed and un-grazed area respectively, while the live seeds percentages were about 40 and 44.4% in that manner.

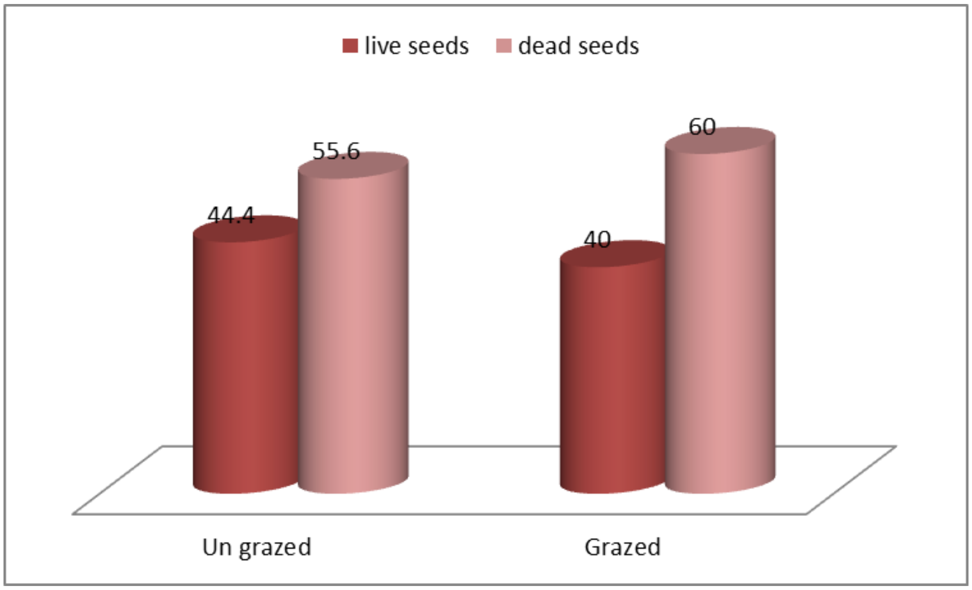

Figure (4.1): Percentage of live and dead seeds in range sites.

4.2.2 Seed Bank Composition:

The results in table (4.6) indicated that they were high significant differences (0.0006) and highly significant differences (0.0001) between percentage of plant diversity in the live and dead seeds range. The results found *Sechoenfeldia gracilis* recorded highest presence of seed (live 68.2% and dead 70.4%), while *Indogefera spp* and *Cyprus rotandus* recorded lowest presence of seed (live 4.5% and dead 3.7%) respectively. Among these results, there was no species diversity in Habeela area may be due to some environmental factors in the area. The area is considered to be a semi-arid climate which characterized by low rainfall and high temperatures that have a negative impact on the development of vegetation. The presence of *Sechoenfeldia gracilis* as the highest percentage in the botanical composition of the seed stock, as well as the species composition of the plants, indicates the plant's ability to adapt to arid and semi-arid environments. The species composition of the seeds in the soil helps to know the plant species that will form the future plant community. Frahalour *et al* (2019) reported that the botanical composition of seed bank reflects the contribution of plant species in the future plant community at the study area.

Table (4.6) Botanical composition of seed bank:

Species name	Live seeds	Species %	Dead seeds	Species %
Sechoenfeldia gracilis	15 A	68.2	19 A	70.4
Eragrostis spp	5 B	22.7	6 B	22.2
Indogefera spp	1 B	4.5	1 B	3.7
Cyprus rotandus	1 B	4.5	1 B	3.7
Pr > F	0.0006 **		0.0001 ***	

Means with the same letter are not significantly different at alpha 0.05.

** Means there are high significant differences.

*** Means there are highly significant differences.

4.2.3 Seeds Density and Depth:

The results in table (4.7 and 4.8) showed that, the soil depth had a significant affected on the seed density in the study area. According to results, the depth of 0-5 cm was the highest seed density per square meter, while the depth 11-15 cm recorded less seed density, these results agree with Abdelsalam *et al* (2017b), who stated that the soil depth had a highly significant effect on the seed density. In table (4.8) observed the highest seeds found in the depth 0-5, where recorded about 167 seeds/m² while the depth of 6-10 recorded about 67 seeds/m², but the depth 11-15 recorded lower amount of seed 33 seeds/m². Generally, the seed density decrease with the increasing of the soil depth, this agrees with Frahalour *et al* (2019), who found that the seed density decrease according to soil depth increasing.

Table (8) Seeds in different Depths:

Depths cm	Live seeds	Dead seeds
0-5	10 A	12 A
6-10	4 B	5 B
11-15	2 B	3 BA
Pr > F	0.03 *	0.001 **

Means with the same letter are not significantly different at alpha 0.05.

* Means there are significant differences.

** Means there are high significant differences.

Table (9) Seeds density (seeds/m²)

Depths cm	Seeds density
0-5	167
6-10	67
11-15	33

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion:

The study concluded that:

- The current situation of Habeela rangelands is considered very deteriorating, which has negatively affected the forage productivity.
- The vegetation of the study area was dominated by *Schoenfeldia gracilis* and *Aristida spp* these species is considered desirable for domestic animals
- The vegetation cover shown was about just 18% of the total area; this result makes clear that rangeland was used intensively by grazing animals.
- The deterioration of the seed bank in the soil reflects the deterioration of the vegetation cover above the soil surface, if vegetation decreases, fewer seeds are produced accordingly.
- The percentages of dead seeds were higher than the percentage of live seeds in two range sites of Habeela area. The dead seeds reached about 60 and 55.6% in grazed and un-grazed area respectively.

5.2 Recommendations:

This study recommended the following:

-Conserved the degraded rangeland of Habeela area.

-Reseeding palatable plants and rehabilitates the degraded rangeland.

-Avoid over grazing and early grazing.

-Increase species diversity.

-More research and studies in this area.

REFERENCES

Abdalla, N. I., (2008). Browsing and it is relation to rangelands Management in Sudan semi-arid area. M.Sc. Thesis, College of Forestry and Range Science, Sudan University of Science and technology, Khartoum- Sudan.

Abdelsalam M. I, Abdalla N. I, Abdelkreim M, Ibrahim M. E. A and Mohammed M. M (2017a). The Impact of Continuous Grazing on Natural Rangeland in Alazzazah area-Blue Nile State, Sudan. *Journal of Rangeland Science,* (7) 4. 309-315.

Abdelsalam M. I, Elsaer A. A Babeker S. El-S and Hassan H. A (2017b). Determination of soil seed bank and organic matter in different range sites of Altadamon locality- South Kordofan State- Sudan. *Agrica* (6) 2. 111-116.

Abdelsalam, M. I., (2008). Assessment of commonly used sampling and measurement techniques as related to natural rangeland management. M. Sc thesis, College of forestry and range science, SUST, Khartoum, Sudan**.**

Abdelsalam, M. I., Ibahim, G. A., Elmagbooland, A. H. and Fashir, G. A., (2016). Determination of range plant attributes in Kadugli Locality, South Kordofan State, Sudan. *International Journal of Innovative Research in Science, Engineering and Technology*, (5) 2. 1525-1529.

Abdelsalam, M. I., Mohammed, A. A. and Mahamadeen, M. S., (2012). Comparison of different range types in terms of vegetation attributes and carrying capacity, South Kordofan State, Kadugli Locality. Journal of Science and Technology 13, Agricultural and Veterinary Sciences, Khartoum, Sudan.

Abusuwar, A. O, (2007). Range management. University of Khartoum, Khartoum, Sudan.

Ahmed, J. and Bonham, C.D, (1982). Optimum allocation in multivariate double sampling for biomass estimation. Journal of Range Management 35:777-779. (*pdf*)

Barbour, M.G., Burk, J.H., and Pitts, W. D, (1987). *Terrestrial plant ecology*. Benjamin Cummins Publishing Co, Menlo Park, CA. 2nd ed. pp. 191-193.

Bonham, C.D. 1989. Measurements for terrestrial vegetation. John Wiley Sons, New York, NY. p 265.

Carvalho, P.C. de F. and Favrretto, V. (1995). Impact das reserves de sementes no solo sobre a dinâmica populacional das pastagens. Informative Abrates, v.5, n.1, p.87-108, 1995.

Cooper, C.F. 1959. Cover vs. density. *Journal of Range Management* 12:215. (*Pdf*).

Despain, D. W., Ogden, P. R., and Smith, E. L, (1991). Plant frequency sampling for monitoring rangelands. In: G.B. Ruyle. (ed). Some methods for monitoring rangelands and other natural area vegetation. University of Arizona, College of Agriculture, Extension Report 9043. pp. 7-25.

FAO, (2007). Forests and rangeland. Near east region facts and figures West, N.E., McDaniel, K., Smith, E.L., and S. Leonard. 1994. *Monitoring and interpreting ecological integrity on arid and semi-arid lands of the western United States*. Range Improvement Task Force, Las Cruces, NM. pp 1-15.

Frahalour, S. A., Abdalla, Y. Y., Gaiballa, A. K., and Abdelsalam, M. I, (2019). Variation of Soil Seeds Bank in Natural Rangeland of Wad Omer Agricultural Scheme, West Omdurman, Sudan. Sudan Journal of Science and Technology. (20). 2. 54-61.

Friedel, M.H, (1991). Range condition assessment and the concept of threshold: A viewpoint. *Journal of Range Management* 44:422-426.

Friedel, M.H., Chewings, V.H., and G.N. Bastin. 1988. The use of comparative yield and dry-weight-rank techniques in arid rangelands. Journal of Range Management 41:430-434. (*pdf*).

GARWOOD, N.C 1991. Tropical soil seed banks: a review. In: LECK, M.A.; PARKER, V.T; SIMPSON, R.L. (Ed). Ecology of soil seed banks. London: Academic Press.

Glatzle, A., Mechel, A., and M.E. Vaz Lourenco. 1993. Botanical components of annual Mediterranean grassland as determined by point-intercept and clipping methods. *Journal of Range Management*. 46:271-274. (*pdf*).

Greig-Smith, P. 1983. Quantitative plant ecology. Academic Press, New York, NY. pp 5-9.

Hasel, A.A. 1941. Estimation of vegetation-type areas by linear measurements. *Journal of Forestry* 39:34-40

Hofmann, L., and Ries, R.E, (1990). An evaluation of sample adequacy for point analysis of ground cover. *Journal of Range Management* 43:545-549. (*pdf*)

Holechek, J. L., Pieper, R. D., and Herbel, C. H (2011). Range Management: Principles and Practices (6th Edition). 6th ed. N.P.: Pearson, 2011. 5. Print. Upper Saddle River, New Jersey, 6th Ed.

Holechek, J.L., Pieper, R.D., and Herbel, C.H (1995). Range management principles and practices. Prentice Hall, Englewood Cliffs, NJ. 2nd ed. pp 159-176.

Holechek.J.L, Pieper, R. D., and Herbel, C. H (2004). Range Management: principles and practices, New Mexico State University, Las Cruces Rex D. Pieper, New Mexico.

Holechek.J.L, Pieper, R. D., and Herbel, C. H (2010). Range Management: principles and practices, Upper Saddle River, New Jersey, 6th Ed.

Jasmer, G.E., and Holechek , J.L, (1984). Determining grazing intensity on rangeland. *Journal of Soil and Water Conservation*.

Johnson, M.K. 1986. Estimating ratios of live and dead plant material in clipped plots. *Journal of Range Management* 39:90. (*pdf*).

Laycock, W.A. 1985. Density as a method for measuring rangeland vegetation. In W.C. Krueger (Chairman) *Symposium on use of frequency and density for rangeland monitoring*. Proceeding 38th Annual Meeting, Society for Range Management, Salt Lake City, UT, February 1985. pp 91-100.

Matthew, W. F. and Robert, T.F.M. (1993). Methods for Plant sampling, Restoration in Colorado Desert management. Notes, Biology Department Sant Diego state University Sant Diego

Mohammed F. S. Al, Abdelsalam, M. I, Ibrahim G. A and Babeker S Al-S (2020). Assessment the Effect of Gold Mining Activities on Soil Seed Bank at Al-Sobag Area of Butana Rangeland- Gedarif State- Sudan. Agrica. 9 (2). 119-124. DOI 1059582394448X2020000164.

Pieper, R.D. 1988. Rangeland vegetation productivity and biomass. In: P.T. Tueller. (Ed). *Vegetation science applications for rangeland analysis and management.* Handbook of vegetation science, Volume 14. Kluwer Academic Publishers, Dordrecht. pp 449-467.

Riech, R.B., Bonham. C.D., and K. Remington. 1993. Double sampling revisited. *Journal of Range Management* 46:88-90. (*pdf*)

Roberts, H.A. (1981). Seed banks in the soil. Advances in Applied Biology, Cambridge, Academic Press, 1981. v.6, 55p.

Simpson, R.L.; Leck, M.A. and Parker, V.T. (1989). Seed banks: General concepts and methodological issues. In: LECK, M.A.; PARKER, V.T; SIMPSON, R.L. (Ed). Ecology of soil seed banks. London: Academic Press, 1989. p.3-8.

Smith, A.D. 1944. A study of the reliability of range vegetation estimates. Ecology 25:441-448

SRM, Society for Range Management (2016). Society for Range Management. Universities and Colleges, 2016. Web. 22 Apr. 2016.

SRM, Society for Range Management (1989). *A glossary of terms used in range management.* Society for Range Management. Denver, CO. 3rd ed.

USDA, NRCS.1997. National range and pasture handbook. USDA, NRCS, Grazing lands Technol. Inst. 190-vi-NRPH, Washington, D.C.

Vallentine, J. F, (1990). Grazing management. Academic Press. San Diego, CA. pp. 294-320.

Darag A, (2006). Course of range practices, College of Forestry and Range Science (SUST) Khartoum, Sudan.

Appendices

Appendix :(1)

Sudan University of Science and Technology

College of Graduate Studies

Loop format:

Site:……………   Date:………….

NO:……………

Appendix: (2)

Sudan University of Science and Technology

College of Graduate Studies

Quadrate format:

Site: …….. Date: …….. Location: …… NO: ……..

NO	SPP name and number	Cover estimation%	NO	SPP name and number	Cover estimation%
1			3		
2			4		