Sudan University of Science and Technology
College of Graduate Studies

Assessment of The Environmental Impact of Natural Rangeland Management Interventions In Wad Omer Agricultural Scheme - Khartoum State

تقييم الأثر البيئى لتدخلات إدارة المراعى الطبيعية بمشروع

ود عمر الزراعي – ولاية الخرطوم

By:

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M. Sc in Range Science, 2012

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Dedication

To

My father and mother

To

My sister and friends

To

My all family

Samia

Acknowledgment

Foremost, all thanks to Allah who supports me in all my life and makes me strong to go on and gave me sistence, and patience to complete this work.

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LIST OF APPREVIATIONS

- (UNCCD)United Nations Convention to Combat Desertification
- (EIA) = Environment Impact Assessment
- (EFS) =Environment Feasibility Study
- (DM) = Dry Matter
- (PUF)= Proper Use Factor
- (SOM) =Soil Organic Matter
- (RPA) = Range and Pasture Administration
- (ENP)= Equatorial Nile Project
- (GDP)= gross domestic production

ABSTRACT

This study was conducted in Wad Omer agricultural scheme, Omdurman locality which was located between 16º 19′ 37″ -16º 27′ N and 31º 43′-31º 47′ E, in Khartoum state, during the period 2017and 2018. The study aimed to assess the environmental impacts of natural Rangeland management interventions in Khartoum State at Wad Omar Agricultural Scheme. Two range sites were selected in the study area; (sand soil and rock soil) 500m×500m plot was marked based on the criteria set .Eight transects of 100 m length were randomly distributed for vegetation measurements. Parker loop method were used to measure relative plants cover, of the rangeland using ¾ loop placed at ground level at one meter intervals, also quadrate of 1×1m was used to determine plant density, frequency and biomass production across line transect with interval of 20m between each other. The nearest individual method was used in each site to determine trees density. For soil seed bank and organic matter determination, 30 soil samples were taken in both range sites, collected from three soil depth (0-10, 11-20 and 21-30 cm) within area of 10×10 cm. All samples of the same depth were mixed of subsamples (250 gm). These subsamples were washed to separate the seeds, and also water and calcium chloride were used to separate dead and live seed. A questionnaire was designed to collect information from three villages which were randomly selected, represent 10% of total people. The standard equations of vegetation measurement were used for plant attributes and also SAS statistical program was used to analyze vegetation measurements and soil seed bank. The statistical package for social sciences (SPSS) was used to analyze socio-economic data. The results showed the average percentage of plant cover in the sandy soil was higher than the rocky soil site also the result showed that the plant density in sandy soil was 45/plant/m^2 and 35/plant/m^2 in rocky soil. The

productivity of the biomass had not affected by the soil types in grazing sites. The study found the dominate species composition at the sandy site were *Corchorus spp* (Khudra Baria) 61.1%, *Dactyloctenium aegyptium*(Abusabe) 59.2%, *Aristida adscensionis* (Gaw)53.7% and *Panicum turgidum(Tummam)*53.4%. While the dominated species composition of the rocky site were *Aristida adscensionis (*Gaw*)* 55.2%, *Eragrostis termula (*Banw) 54.3%, *Trinthema spp* (Rabaa) 48.5% and *Panicum turgidum* (Tummam) 44.2%. The study found that, the seed bank density decreases with the increase of soil depth and the lowest seed number in sandy soil. The study found that the main interventions of range and pasture Administration (RPA) to improve the rangeland status included broadcasting of seeds, planting forage, drilling wells, provide herbside and fertilizers and grow shelterbelts. The study concluded that the range management interventions in Wad Omer agricultural scheme had positive effects on crops protection and soil conservation. More interventions from Range and Pasture Administration in Khartoum State should be done. The seed bank, organic matter and vegetation attribute were good indicators can to be used to assess the impact of range improvement activities.

ملخص الدراسة

أجريت هذه الدراسة في مشروع ود عمر الزراعي بمحلية أم درمان والذى يقع بين خطى عرض 16° 19′ 37″ −16° 27′ N وخطى طول 31° 43′− 31° 47′ E ، في ولاية الخرطوم ، فى الفترة من 2017م−2018م. هدفت الدراسة الى تقييم التأثير البيئي لتدخلات إدارة المراعي الطبيعية بولاية الخرطوم بمشروع ود عمر الزراعي. تم إختيار موقعين رعويين (رملية−صخرية) مساحة كل منهما 500متر×500 متر. تمً وضع عدد ثمانية قاطعات طولية بطول (10) مترعشوائياً فى كل منهما , كما استخدم الإطار ذو الابعاد(1×1) متر وطريقة اللوب لدراسة الخصائص النباتية والتركيب النوعى, التغطية الارضية ,التردد والإنتاجية النباتية.

تم إستخدام طريقة اقرب مفردة لتحديد الكثافة الشجرية فى منطقة الدراسة. لتحديد المادة العضوية والمخزون البذرى فى منطقة مشروع ودعمر. تمً أخذ عدد (30) عينة فى الموقعين على ثلاثة أعماق مختلفة (0−10),(11−20),(21−30) في مساحة 10×10سم. كل العينات التي جمعت م نفس العمق تم خلطها وأخذت منها عينة(250) جرام. غسلت هذه العينات بالماؤ لفصل البذور من التربة. تم وضع البذور في الماء ومن ثم في محلول كلوريد الكالسيوم لفصل البذور الحية والميتة. تمً تصميم إستبيان لعدد ثلاث قرى أخذت بطريقة عشوائية تمثل المجتمع بنسبة(10%) من جملة السكان. تم إستخدام المعادلات القياسية لإدارة المراعى لإستخراج النسب المئوية , كما تم إستخدام برامج (SAS) الإحصائى لتحليل معلومات القياسات النباتية ومخزون البذور في التربة. المعلومات الإقتصادية والإجتماعية تم تحليلها بواسطة برنامج (SPSS). أظهرت الدراسة أن نسبة التغطية النباتية كانت أعلى في التربة الرملية عنها في التربة الحجرية. كما أن الكثافة النباتية كانت أعلى في التربة الرملية (45/ نبات/م^2) مقارنة مع الكثافة في التربة الحجرية (35/نبات/م^2). كما أن الإنتاجية النباتية لم تتأثر بنوع التربة. خلصت الدراسة إلى أن

التركيبة النباتية السائدة في الموقع الرعوى في الأراضى الرملية هى الخضرة البرية (*Corchorus spp*)61.1%, وأبوأصابع (*Dactyloctenium aegyptium*) 59.2% والقو (*Aristida adscensionis*) 53.7% والتمام (*Panicum turgidum*) 53.4%. أما في الأراضى الحجرية كانت السيادة للأنواع الأتية: القو (*Aristida adscensionis*) 55.2% , البنو (*Eragrostis termula*) 54.3%, الربعة (*Trinthema spp*) 48.5%, والتمام (*Panicum turgidum*) 44.2%. أوجدت الدراسة أن كثافة المخزون البذرى تتناقص مع زيادة العمق في التربة , وكان أقل عدد بذور وجدت في التربة الرملية. وجدت الدراسة أن التدخلات الرئيسية لإدارة المراعي والعلف (RPA) لتحسين حالة المراعي اشتملت على نثر البذور ، وزراعة الاعلاف ، وحفر الآبار ، وتوفير الأعشاب والأسمدة ، وزراعة الأحزمة الشجرية. خلصت الدراسة إلى أن تدخلات إدارة المراعي في مشروع ود عمر الزراعي ذات تأثير إيجابي على حماية المحاصيل وصيانة التربة. تعتبر خصائص مخزون البذور فى التربة والمواد العضوية والغطاء النباتي مؤشرات جيدة لتقييم آثار أنشطة تحسين المراعي. أوصت الدراسة بزيادة تدخلات إدارة المراعى والعلف في منطقة الدراسة, إستخدام معلومات المخزون البذرى والخصائص النباتية كمؤشرات جيدة لتقييم أثر تدخلات إدارة المراعى.

CHAPTER ONE

Introduction

1.1 General:

Sudan is the biggest counters in Africa, with an area of 1,882,000km^2 (Babeker, 2012). This area extends over different ecological zones including desert, semi-desert, low rainfall savanna and high rainfall Savanna, in addition to mountain regions. Sudan is located in the northeastern part of Africa between longitudes 49° 21'E-38° 34'E and latitudes 23° 8' N-8° 45'. It is known by its rich natural resources mainly, agricultural land (84,000,000ha) natural resources, livestock, water and forests (Babeker,2012).The population of Sudan estimated as 33.419,652 inhabitants after the separation of South Sudan (Babeker, 2012). The average rainfalls vary from less than 25 mm in the north to 800mm in the South. The main rainy season in central Sudan is between July and September. Mean daily temperatures vary from a maximum of more than 40°C in the north to a minimum of 6°C in Jebal Marra in the west. There are extensive plains of iron stone in the south, clay soils in the central plains, and sand in the north and west, with a few mountainous areas in the south, east and west. The River Nile runs through the country from south to north, a distance of 2258 km. In 1996, agriculture, which provides employment for about 75% of the population, contributed 48% of gross domestic production (GDP) and 73% of export earnings. Most important industries depend on agricultural products as raw materials (Fadlalla and Ahmed, 1999).

Before 1960, apart from small areas in Darfur and Kordofan, Sudan grew wheat only in the northern section of the Nile valley, and even there only on limited scale. a local land shortage, and because of the large cost of irrigation water in the north, the government then decided to grow wheat

in the Gezira scheme, although environmental and climatic conditions there are less favorable for wheat than they are in the north. Generally Sudan produces about 18.6 million tons of crop residues (AOAD, 1994) green fodder cultivation, however, is less than 126.000 ha. Rangelands provide about 86% of feed for livestock, crop residues and agricultural byproducts 10%and irrigation forage and concentrates 4%. The rangelands suffer from overstocking in some areas and under stocking in others, (Fadlalla and Ahmed, 1999).

Livestock herd in Sudan is estimated at (107,555,000) million heads of which (30,632,000) million are cattle (40,612,000) million sheep, (31,481,000) million goats and (4,380,000) million camels (Ministry of animal Resource, 2018).

Natural rangeland term includes all the land is suitable for grazing animals such as duty dry desert, which provides the plants, pastoral and forest areas and mountains suitable for grazing. The economic importance of pastures natural: The area of natural grassland in the world about 30% of the surface area of the ground, while in the Arab World was estimated to about 510 million hectares in 1980, equivalent to 36.3% of the total area of the Arab nation. The economic importance of pastures in the great contribution in the provision of food, livestock and return the proceeds of wealth in improving the living conditions of the pastoralists and conservation of biodiversity, (Dafaallah, 2001). Natural grassland is the safe place to keep wildlife as well as its importance in maintaining the biodiversity of the environment (Yaddi, 2006). Rangeland is land supporting indigenous or introduced vegetation that is either grazed or has the potential to be grazed and is managed as a natural ecosystem. Today there is a growing awareness of the important functions and values that rangelands provide to society, (Barry etal, 2005).

The Rangeland of the Sudan is a land that is dominated by grasses, forbs, managed as a natural ecosystem. Rangelands do, not only for low- input and renewable forage for grazing, but also serve as watersheds, recreational areas, and natural environments for native plant and wildlife (Mohammed, 2011).

Sudan natural rangelands which occupy two – thirds of the country area are the main source of feed for its livestock. This lead to desertification that is aggravated by frequent drought spells, (Abusuwar and Ahmed, 2003). Rangelands in the Sudan are diminishing due to the expansion of rain fed agriculture. The increasing demands on the world rangelands have led to concern over the sustainability of rangeland uses. Natural range in Sudan provides feed for a large number of livestock which plays a vital role in the national economy through provision of animal products for local consumption and foreign exchange (Mohammed, 2011). Rangeland deterioration a worldwide problem and a growing dilemma all over the world, Land degradation is a confusing term with multiple definitions usually relating to changes in vegetation and soil. The United Nations Convention to Combat Desertification (UNCCD) defines degradation as, reduction or loss of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest and wood lands resulting from land uses or from a process or combination of processes, as well as processes arising from human activities and habitation patterns, (Ho and Azadi, 2010), and Mathew and Scott Baggett, 2014).

The Sudan economy depends largely on agriculture , about 70% of the country's economically active population work in agriculture and about 90% of them live in rural areas .(Hassan, 2007). The agriculture depends on two main sources of water –rains and irrigation. The performance of Sudan agriculture has depended very heavily on weather condition.

Between 1985 and 1989 average of annual growth rate of agriculture was 5.5% with a decrease of 0.7 % annually in the GDP during the same period, (Gore, 1991).

In the Sudan, the area devoted for range and forestry is about 61.3% of the total area of the country. The total rangeland is about 68.6 million hectare (Ministry of Agriculture, 2015). Rangelands are the main source of food for domestic and wild animals. Most of the meat consumed locally and for export is produced from range animal. Moreover, other animal products such as cheese, milk and meet are produced from range animals, and assist in meeting pastorals living expenses. It is estimated that 30 to 40% of population in the Sudan are herders who depend totally on an animal to cover living expenses and 90% of livestock in the country is owned by these people, (Abu Suwar, 2007).

1.2 Problem Statement:

Wad Omer agricultural scheme located in arid and semi arid climatic zone with maximum temperature 46°C in May and June and relative humidity never exceeding 60% at any month (Ministry of Environment, 2018). The rangeland in the area faced many problems which led to declining quality and quantity of production of the natural resource like pasture, livestock, and agricultural crops. There are many rangeland management intervention were done by Range and Pasture Administration (RPA) in Wad Omer area, those interventions tried to stop the rangeland degradation in the soil, so these interventions necessitate the study of their impacts on the area and socio-economic aspects.

1.3 Objectives:

1.3.1 General objectives:

- To assess the environmental impacts of natural rangeland management interventions at Wad Omer Agricultural Scheme, Khartoum state.

1.3.2 Specific objectives:

- To investigate the environmental impacts on vegetation attributes.
- To assess soil stability and estimate biomass productivity
- To evaluate the socio –economic aspect of wad Omer Agricultural Scheme.

1.3.3 Research questions :

1. What the main interventions of natural Rangeland in Khartoum State to improve the situations of Wad Omer Agricultural Scheme?
2. What is the impact of rangeland degradations on the important rangeland plants?
3. How the rangeland management interventions affected the soil stability and biomass production?

CHAPTER TOW

Study Area

2.1 Location of Khartoum:

Khartoum is the capital of Sudan, in the east –central part of the country in the semi-desert zone of the junction of the Blue Nile and the White Nile (Ministry of information, 2011), Located between Latitude 15˚-8˚, 45˚-16' North and Longitude 36˚-31', 34˚-25' East. The area of 20,736m2 state equivalent to 4,937,142 acres , of arable land , about 36% of the total area of the state (Sumya , 2008) .with elevation of 380 meters above the sea level. Founded c.1821as on Egyptian army camp, it was destroyed by Mahdists in 1885 (Elkhalifa, 2008 and Ministry of information, 2011).

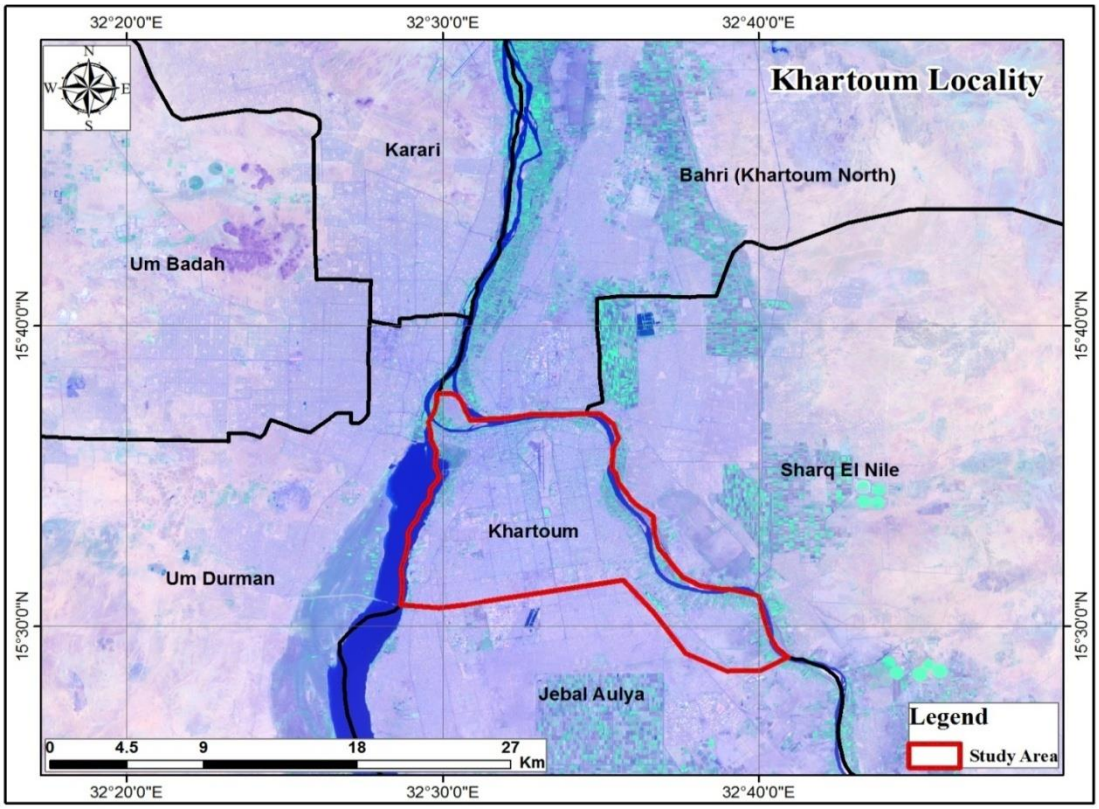

Fig (1) location map of Khartoum State, Hamza (2009)

2.2.1 Climate:

The area of Khartoum State lies in Semi-desert zone, with the main characteristics of which are: Hot summer with short rainy period (June-

September) and relatively cold, dry and relatively cold dry and windy winter (November-March) low rainfall (124mm) and high evaporation potential.

2.2.2 Temperature:

In Khartoum State, the temperature at its maximum in may and June is (42.9◦c) and it is Minimum in December and January is 33◦c-28.6◦c).

Annual rainfall in Khartoum state is about 161mm. the rainy season extend from May to September. And the maximum rainfall has been recorded in (July and August).

Table (2.1) Maximum temperature C◦ (2010-2017) in the study,

YEARS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	33.9	36.7	37.4	41.2	42.9	42.2	37.6	37.4	39.0	40.7	37.5	33.2
2011	30.0	35.6	36.0	39.7	41.0	38.8	40.2	38.3	39.5	40.2	33.4	32.6
2012	29.9	35.6	36.5	39.2	42.8	41.4	38.2	36.3	40.0	39.8	36.0	31.7
2013	32.8	35.8	37.3	39.7	42.5	41.8	40.3	35.4	39.4	38.9	36.0	32.0
2014	31.6	32.4	37.4	40.9	41.0	42.0	36.9	34.7	37.2	38.0	34.7	33.3
2015	30.3	36.1	38.7	38.2	41.7	41.8	40.9	38.3	39.6	39.7	33.7	28.5
2016	28.5	33.1	39.6	40.2	42.0	41.2	37.7	36.2	38.7	39.7	36.7	33.0
2017	34.5	31.5	36.4	41.2	41.4	41.9	39.4	36.3	38.7	39.7	35.4	33.8

Source: Ministry of Environment, (2018)

Table (2.2) Minimum temperature C◦ (2010-2017) in the study area

YEARS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	17.0	18.8	20.3	25.3	28.3	29.2	27.0	26.2	27.1	28.3	25.2	19.6
2011	15.9	20.0	20.9	25.2	27.7	29.5	28.0	26.2	26.9	27.1	19.4	18.1
2012	15.0	20.0	20.4	25.5	29.0	29.0	27.1	28.7	27.7	27.5	23.3	18.3
2013	18.8	20.9	23.3	25.1	28.7	29.2	29.4	25.4	27.4	26.3	18.1	22.4
2014	17.3	18.4	23.1	27.4	28.4	29.0	26.1	25.5	26.3	26.5	22.1	19.3
2015	15.8	20.4	24.1	23.9	29.2	29.2	28.7	26.4	27.0	28.5	21.7	15.6
2016	14.9	17.9	24.3	25.9	29.4	29.2	26.7	26	26.8	27.1	23.4	19.6
2017	18.8	16.6	20.4	26.6	28.4	28.4	26.4	25.5	27.1	26.6	21.7	20.2

Source: Ministry of Environment, (2018)

2.2.3 Rainfall:

To show variation within the months and not just the monthly totals, Records show the rainfall accumulated over a sliding 31-day period centered on each day of the year. Khartoum experiences some seasonal variation in monthly rainfall. The rainy period of the year lasts for 2.8

months, from June 26 to September 20, with a sliding 31-day rainfall of at least 13 millimeters. The most rain falls during the 31 days centered on August 7, with an average total accumulation of 40 millimeters. The rainless period of the year lasts for 9.2 months, from September 20 to June 26. The least rain falls around January 2, with an average total accumulation of 0 millimeters (Elkhalifa, 2008 and Ministry of Environment, 2018), The average rainfall (solid line) accumulated over the course of a sliding 31-day period centered on the day in question, with 25th to 75th and 10th to 90th percentile bands. The thin dotted line is the corresponding average liquid-equivalent snowfall.

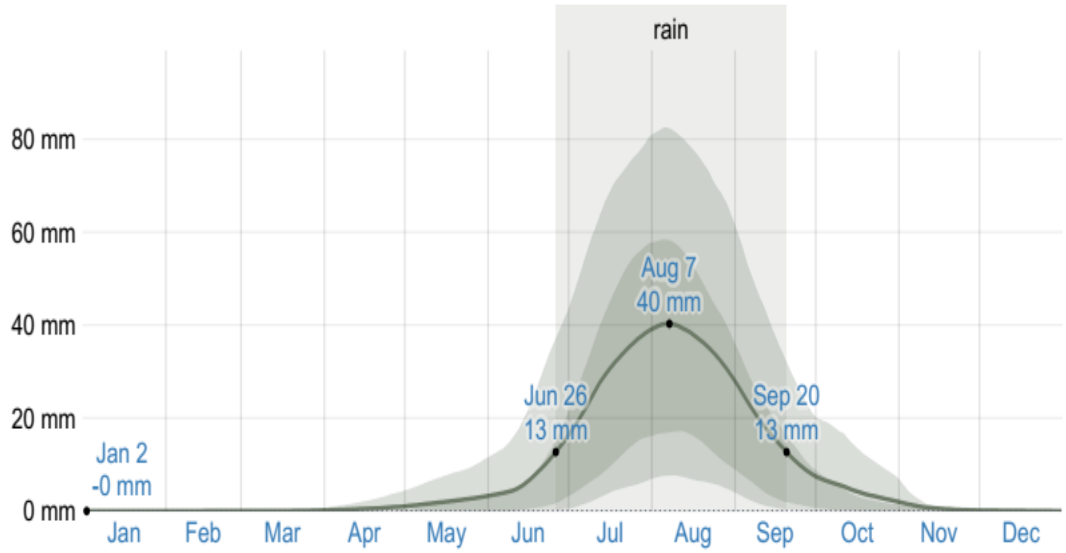

Fig (2) Average Monthly Rainfall mm (2010-2017), source: Ministry of Environment, (2018)

2.2.4 Relative humidity:

Khartoum State generally has low humidity, never exceeding 60% in any month, which reflects characteristics of dry climate, the mean is at its lowest during April 11%. The relative humidity along the Nite valley reaches much higher values 80% particularly during the period between June and September. RH in Khartoum State has low value thrush the year with mean of 29 % (Elkhalifa, 2008 and Ministry of Environment, 2018).

Table(2.3) Khartoum Monthly Relative Humidity In % for the period (2010-2017)

YEARS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	25	19	15	11	13	25	44	51	41	26	22	25
2011	24	15	12	19	12	17	33	49	39	30	24	30
2012	23	21	12	8	16	26	44	54	34	34	19	25
2013	24	17	10	8	11	22	28	56	40	24	22	28
2014	25	16	14	9	15	20	27	41	37	27	21	23
2015	25	16	14	9	15	20	27	41	37	27	21	23
2016	22	20	13	10	17	27	43	52	38	24	23	28
2017	24	16	11	11	23	24	38	49	38	18	22	30

Source: Ministry of Environment, (2018).

2.2.5 Geology and geomorphology:

The geological units in the study area are composed of superficial deposits, volcanic rocks, Cretaceous sedimentary rocks and Basement Complex, Basement rocks representing the considerable depth. They are poly metamorphosed and repeatedly deformed crystalline rocks of gneisses and schist types (Hamza, 2009). Volcanic rock is predominant with exposed and subsurface seated basaltic rocks at the extreme southwest of the area. Cretaceous sedimentary rocks, mainly Omdurman formation (Albian - Cenomanion) are dominant and well- exposed geological unit in the study area. It consists of sandstones, mudstones and conglomerates covered by superficial deposits .Most of the sandstones are coarse grained, poorly cemented, moderately to poorly sort characterized by relatively good permeability. Omdurman Formation, stratigraphically comprises Umm Bada subsurface member; and Merkhiyat upper member. Omdurman Sedimentary sequence is claimed to have been deposited in semi-arid or humid tropical climatic zone, under Fluvio-Lacustrine environment conditions where meandering stream, a braided channel activity do exist (Hamza,2009). Calcareous materials are very common as a matrix in sandy sediments and as nodules in clayey sediments. Their distribution

tends to increase towards the southwest. The calcareous materials were interpreted as products of successive processes of evaporation and leaching by floods in environments that were favorable for deposition of carbonates,(Hamza,2009) Superficial deposits are the uppermost units representing a thin cover of sand dunes and black cotton soil with Quaternary deposits consist of unconsolidated clay, silts, sands and gravels of considerable thickness (Fig.3) a long ephemeral braided and meandering water courses and river banks. Cretaceous sedimentary rocks is the main water bearing formation in the area where groundwater potentialities is proportional with the depths, and significantly affected by White and River Niles fluctuations. Intercalation of mudstones and clay layers forms more than one aquifer zones in the study area. Consequently, the artesian conditions are prevailing as a result of thick mudstones and clay beds confining the poorly cemented sandstones. The later constitute the main water bearing horizon with thickness increases to the west of the study area.

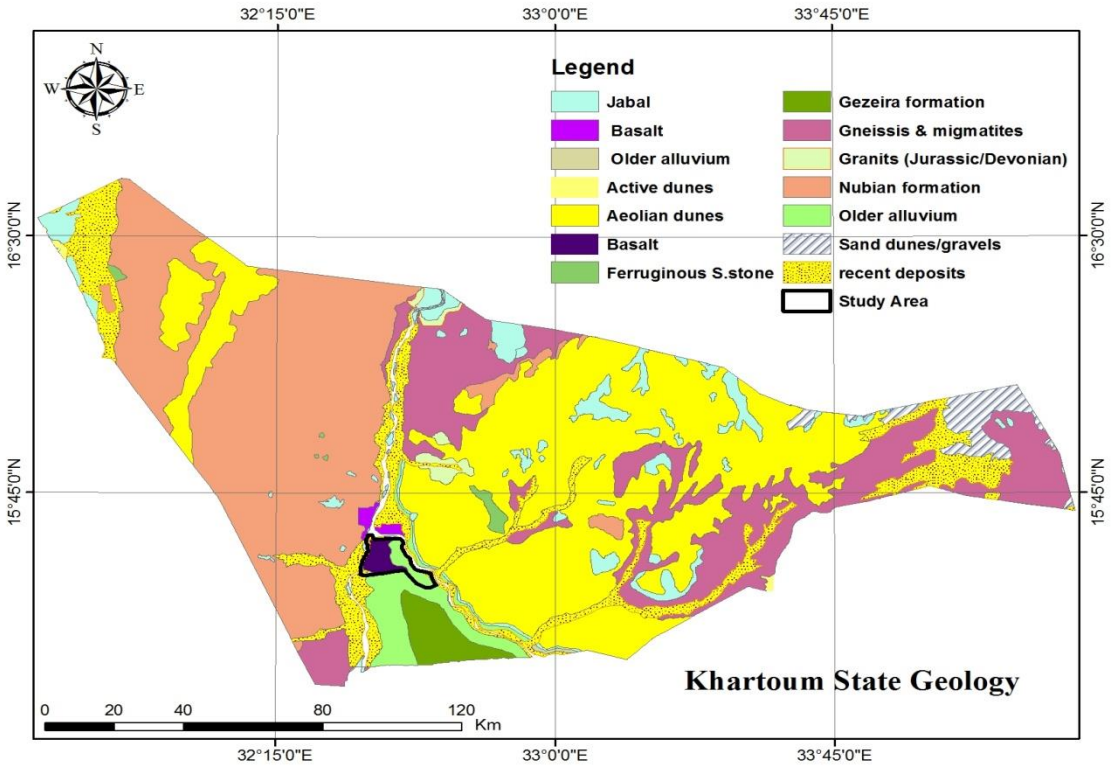

Fig (3) Geology of Khartoum State, Hamza, 2009

2.3 Land use in the study area:

The area is dominated by large mechanized agricultural schemes, although most of the rural population made up of subsistence farmers cultivating traditional rain-fed farms. The animal types owned by people are goats, some cattle and sheep, poultry and donkeys. Lack of veterinary services and poor pasture conditions are the main constraints for livestock herders in rural communities (WFP, 2010). Male family members migrate to large-scale mechanized and irrigated farms in search of work.

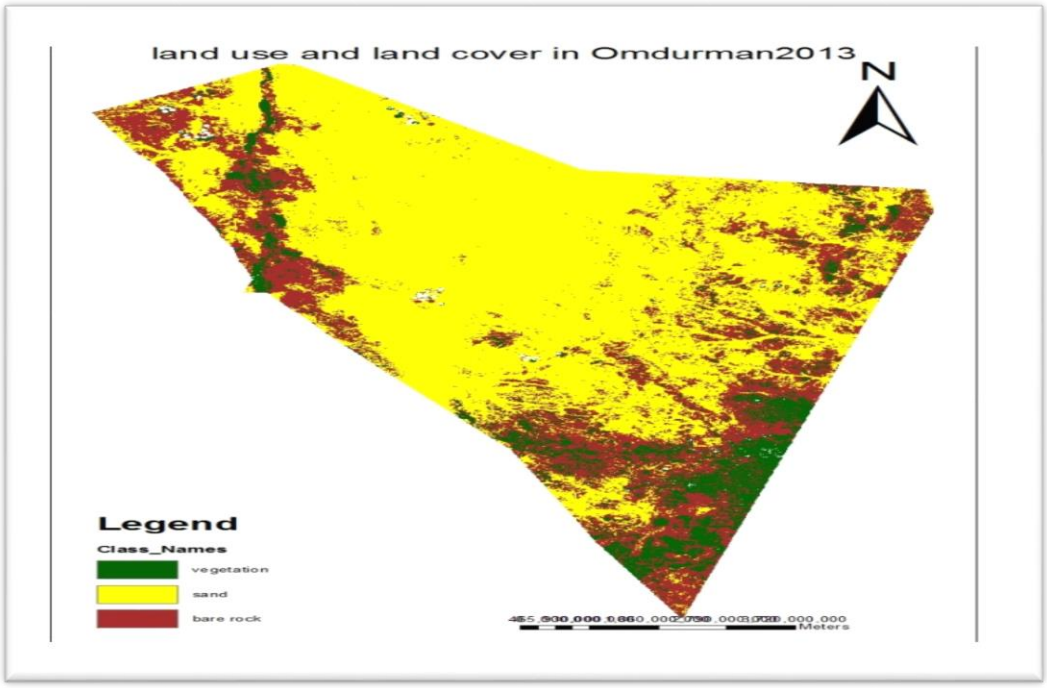

Fig (4) Land use in Omdurman area, Hamza (2009)

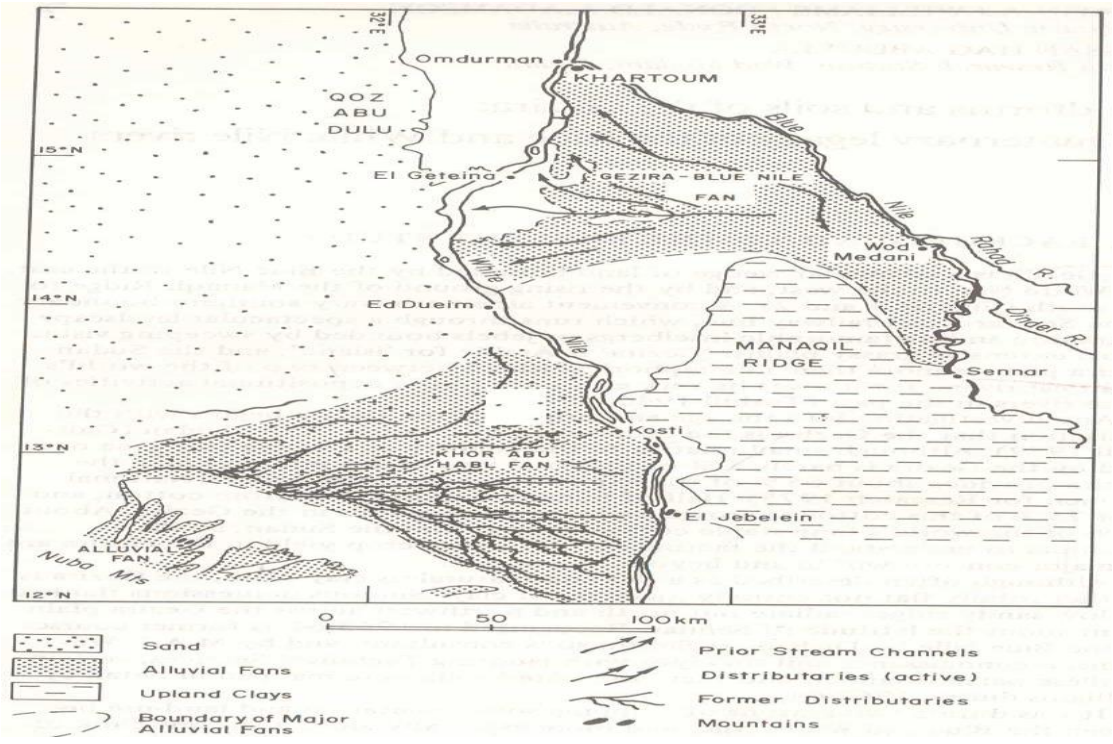

Fig :(5) Ajar Physical Features of the Central Sudan (Adamson etal, 1982)

2.4 Wad Omer Project:

The study area located in Khartoum state and Occurs on the northern part of Omdurman (at Elkilo 84, Khartoum–Dongla high way). Is located between latitudes 31˚ 43'E-31◦ 47'E and longitudes 16◦ 19'37 N-16◦27'N.The total area is (2000 fedden) and area covers 500 (Fadden) Wad Omer village surrounding with sough village at North (Farah, 2008).

The main objective was to investigate the possibilities of growing different crops in 1991 by irrigating an area of 38 ha. The first phase started in 1995 bore holes to irrigate 130 ha. The objective of first phase rehabilitates the environment. Wad Omer project activities also covered an area of 12.5 ha with an objective to improve food security and reduce sand dunes movement. Phase two started in July 2004 by visiting team of different disciplines to the area to identify the features and nature of the area and vision for the design of the installation process that is suitable for mechanical and dynamic (Aleheemer, 2008). This project is a partnership between FAO and the ministry of Agriculture, Livestock and irrigation. The activities performed included agriculture, grazing and agricultural extension. The area is open desert areas that influence the desert crawl and intense storms and sand movement in the form of buttoning repting .The region suffers from the deterioration of pasture, forest and the proportion of fire wood collection and use of trees in fuel and the lack of rainfall, (Ministry of Agriculture, 2008). Wad Omer agricultural scheme is one of the sites it is located in the country side west of Omdurman - locality Umbada, along the artery 84 Kilometer north in the direction of the east .The area is open desert areas that are affected with desertification and intense storms and sand movement which led to the formation of sand dunes and ripples form which indicates the transport and movement of

sand, which is active in the direction of the north east during the winter and south –west in the autumn.

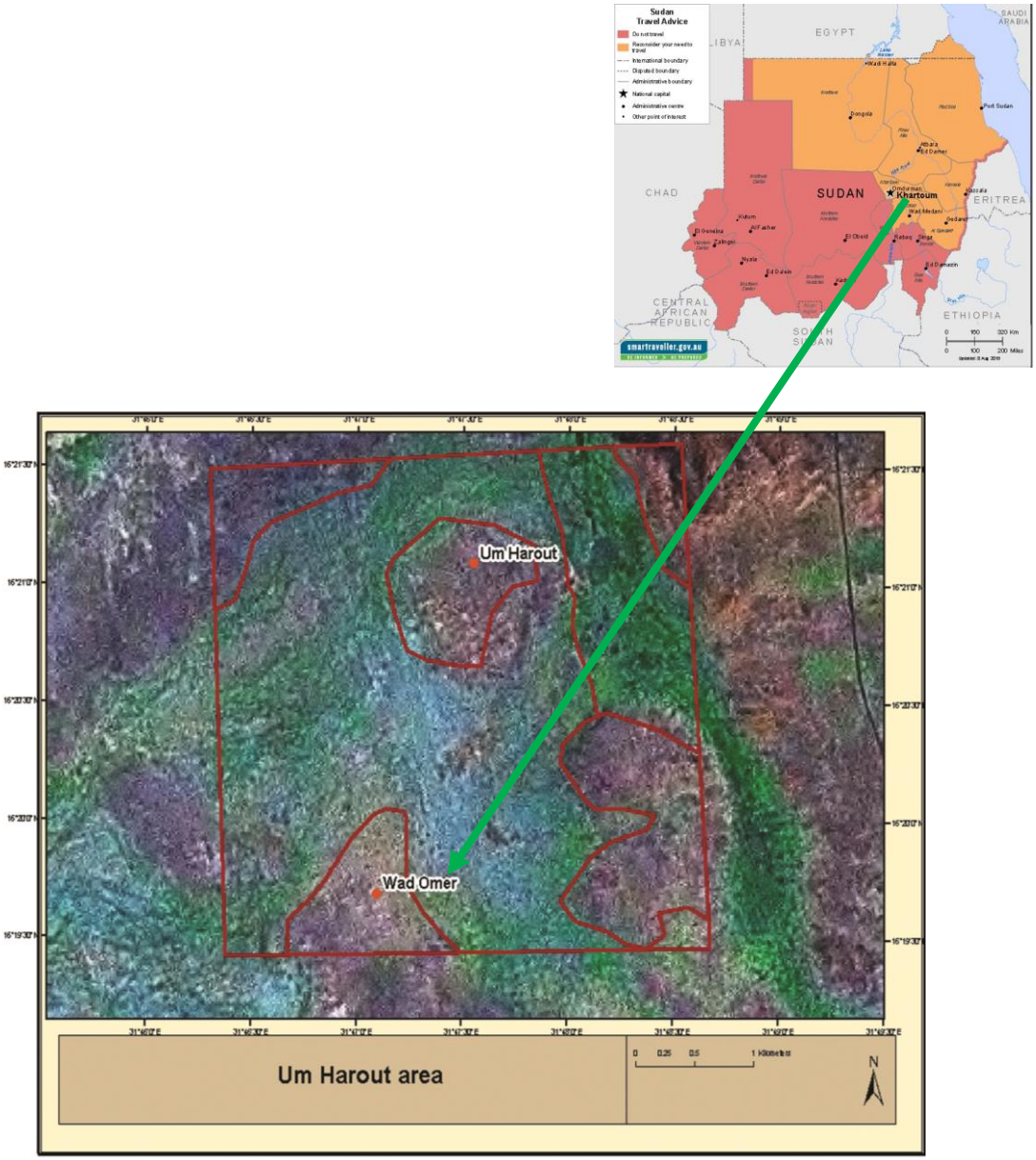

Fig (6): Map of Sudan, Source: http://sledgehammer.gov.auto (2019)

2.4.1Population:

The inhabitants of Wad Omer area is 805 persons , Hassanyia and Hwoaweer at 2008, 300 Family, The Hassanyia ,who are pastoralist , lost most of their livestock ,and some of them migrated to any places in the Northern state .The people in the study area were depend on range depending on seasonal grasses, shrubs and some trees in the some wade's

near of the study area .Generally the population of the study area is depended on agricultural and range all the year ,(Loeser *et al*, 2007).

2.4.2Topography:

The topography of the study area is wavy in nature (high and low) interspersed with rocky hills.

2.4.3 Geology, soil and water situation.

The area is flat plain with some rock outcrop like Merkhiyat hills**.** The There are several Wadis like Elmugadam. Nubian sandstone is an important geological formation store groundwater and where many artesian wells are can be dug (Mahmoud, 2013). Sand soil is dominating (Aridisoles) and clay soil (vertisoles) in the pockets of the Wadis.

2.4.4Climate:

The climate is characterized by desert to semi desert zone, which are known for its hot to very hot summer, short rainy season and warm to cold and dry winter. Rainy season extends from July to October (Mahmoud, 2013).The rainfall range between 75-150 mm. the area characterized by wind storm in the summer, the climate of the area is semi-desert according to the climate zones of kevie (1973). The mean daily temperature is 29.9C◦ and mean daily maximum of 45.9C◦in May while the minimum is 12.6C◦ in January, the total annual rainfall is 121.4mm and reaches a maximum of 48.3 mm in august. The highest recorded annual rainfall is 50mm/y.

The annual potential evapotranspiration is 2065 mm and the annual water deficit is about 1944 mm. The mean relative humidity is 28% and ranges from 15% in April to 48% in august. The sunshine duration ranges from 63% in July to 91% in November (Farah, 2008).

2.4.5 Vegetation Cover and Land uses:

According to (Farah, 2008) the project area is located in semi-desert belt.(Harrison and Jackson, 1958) mentioned that , its natural vegetation consist of *Acacia trotilies* (Samur), *Maerua crassifolia* (Sareh), *A-trotillisuar-radiana(*sayal*),Balanites aegyptica* (Higlig) *Ziziphus Spina-christi* (Sidir), *Capparis deciduas*(Tundub), *Acacia nilotica (Sunt)* and *Acacia seyal* (Talih). The most suitable and adapted tree is *Acacia tortilis* (Seyal, Acacia sub radiana), with other scattered trees such as *Acacia mellifera* (Kitter) and *Boscia senegalensis* (Mokhate) (Farah, 2008). There are plants appear in the water sites and in the autumn , such as *Tribulus Spp* (Deresa), *Aristida spp* (Gaw) ,*Zeylia pentandera* (Rabaa), *Corchorus spp* ,*Farestia spp* (Dahyaan)….ect . The region is currently used for grazing and browsing from plants growing in the village and there are limited activities for the transfer of sand and rocks for construction purposes to the capital (Ministry of Agriculture, 2008).

Plate (1): The Vegetation Cover in wad Omer area, field Survey, 2017®

Plate (2): Samr, Kitter and Sareh, Trees in wad Omer area, Field survey, (2017) ®

2.4.6 Soil:

The soil of the study area is sandy to alluvial soil, soil transported by wind, an addition to Nubian sand stone. The mean annual soil temperature than more 22C° and means winter temperature is more than 8 degree centigrade at 50 cm soil depth (Farah, 2008). Soils are as deep as 180 cm with clay content between 48-50% with yellowish-brown color in the top70 cm and dark yellowish-brown profile at the bottom. Generally, the soil of the study area was good for agricultural purposes, but due to aridity, nitrogen is deficient and Organic matter is low (Mustafa, 2003).

Plate (3): Show the sand movement in the study area, Field survey, ® 2017.

2.5 Water Sources:

The main water source in the study area are seasonal Wadies and in addition to wells. This water is used for human and animals consumption beside agriculture (Farah, 2008).

Plate (4): Water sources in study area in the past, Field survey, 2017®

Plate (5) Modern water source in the study area, Field survey, 2017®

2.6 Livestock:

The Sudan has a large livestock population (107,555,000 million heads) (Ministry of Animal Resources, 2018) The livestock herds, which include camels, sheep and goats (raised in desert and semi-desert zones) and cattle (bred in the medium rainfall savannah and in the Upper Nile flood plain) are owned mainly by pastoral and agro-pastoral groups. Livestock

is raised under semi-nomadic and nomadic systems with traditional movements occurring between wet and dry season grazing areas. The livestock sector is exposed to several risks including decreasing pasture as a result of drought and desertification, the expansion of crop growing, the shortage of cattle routes and lack of water for animals. Livestock raising and animal rearing is dominant throughout the area. Remarkably the veterinary service stations are few compared to the huge number of animals found in the state and specially the northern part of it. Insufficiency of drugs and lack of facilities are always constrains. Literate livestock herders used to contact the veterinary nurses or sometimes buy their needed drugs themselves to treat their animals, (Farah, 2008).

Table 2.4 Estimates of livestock population in Khartoum State

TYPES	**2007**	**2008**	**2009**	**2010**	**2011**	**2014**	**2015**	**2016**	**2017**
Cattle	232.175	239.356	246.759	254.390	262.258	247666	249083	251182	253593
Camel	6.600	6.634	6.668	6.701	6.735	6709	6733	6762	6790
Sheep	499.195	511.995	525.123	538.588	552.398	450387	454501	459045	460628
Goat	600.103	621.869	644.424	667.797	692.018	666106	659286	664649	668407

Source: Livestock in Sudan, Ministry of Animal Resource, IT (2018)

Livestock rearing Constitute an important livelihood activity in Wad Omer area where there was about 1500 goats, 1000 sheep, 300 Camels in the study area, providing milk and constitute source of income due to selling of animal to others, and families interested in raising chickens municipal houses to take advantage of eggs and chicken meat and sale of chicken as source of income for families (Farah, 2008).

2.7 Grazing Resources:

The natural grazing resources were estimated as 24% of the total area in Khartoum State. It contributed in livestock balance with 13% in addition there is feed gab of 40% it reels work in the area of rangeland rehabilitation to increase the average forge production (Drag,2004).

Plate (6) animals grazing in study area, field survey 2018 ®

CHAPTER THREE

Literature Review

3.1 **General:**

Sudan natural rangelands which occupy two – thirds of the country area are the main source of feed for its livestock. This lead to desertification that is aggravated by frequent drought spells, (Abusuwar and Ahmed 2003). Rangelands in the Sudan are diminishing due to the expansion of rain fed agriculture.

3.1.1 **The Rangeland:**

The terms range and rangeland have often been misused in the sense that they are often equated with livestock use and production alone. An important distinction is that range is a kind of land with many uses - it is not a land use. The multiple values of rangeland include forage for domestic and wild animals, water, wood fuels, and wildlife cover. There are many competing uses for rangelands - uses that are increasing with population growth, increasing urbanization and interests in preservation (Heady and Child, 1994).

Rangelands are defined as the areas of the world which by reasons of physical limitations-low and erratic precipitation, rough topography, poor drainage, or cold temperatures- are unsuited for cultivation and which are a source of forage for free ranging native and domestic animals, as well as a source of wood products, water and wildlife (Miller, 1997). Their historic climax vegetation was predominantly grasses, grass-like plants, forbs, or shrubs (Butler *et al.*, 2003). It account for about 70% of all land surface (Fuhlendorf and Engle, 2001 and Holechek, 2001). Rangeland supports different vegetation types including shrub lands such as deserts, steppes, temporarily treeless areas in forests, and whatever grows on land today, sandy, rocky, saline, or wet soils, and steep topography for

commercial farm and timber crops (Grice *et al.,* 2008). Rangeland vegetation may be naturally stable or temporarily derived from other types of vegetation, especially following fire, timber harvest, brush clearing, or abandonment from cultivation (Heady and Childs, 1994) and it managed, typically, for livestock production (Holechek *et al.,* 2004).

Rangelands are essentially large tracts of native vegetation used to support livestock production. The increasing demands on the world rangelands have led to concern over the sustainability of rangeland uses.

Natural range in Sudan provides feed for a large number of livestock which plays a vital role in the national economy through provision of animal products for local consumption and foreign exchange. Future of rangeland resources development and management is dependent upon increased scientific capability, and extensive natures of these resources need to develop data collection and analysis. (Matthew *et al*, 2001).

Rangeland deterioration a worldwide problem and a growing dilemma all over the world, Land degradation is a confusing term with multiple definitions usually relating to changes in vegetation and soil. The United Nations Convention to Combat Desertification (UNCCD) defines degradation as, "reduction or loss of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, as well as processes arising from human activities and habitation patterns, (Ho and Azadi, 2010 and Matthew and Scott Baggett, 2014).

3.1.2 Rangelands in arid and semi arid areas of the Sudan:

Rangelands in the Sudan forms a huge natural resource; it constitutes various types of grazing lands vary from open grasslands to seasonal water courses, flood plains, river banks and associated islands, woodlands, hills and mountain slopes (Zaroug,2000).

In arid zone the natural vegetation was virtually absent except on water courses, consists essentially of ephemeral grasses and herbs known as ‘gizu’. These succulent plants provide grazing, mainly for camels, during the dry period from November to February (Harrison and Jackson, 1958). The sparse thorn scrubs provide a period of good grazing for sheep, goats, cattle and camels besides the ephemeral grasses and herbs (Ayoub, 1998).

3.2 Range assessment:

Range assessment is very important for making proper decisions for range management process. Assessment process can take the following forms based on the objectives:

3.2.1 Rangeland evaluation:

Rangeland evaluation is the process of determining the status of natural rangeland resources. Historically, data describing vegetation attributes is located by sampling in an inventory and monitoring program. From this information, the status of rangeland vegetation can be rated. Repeated measurements over time provide an indication of whether the vegetation is improving or declining compared to predetermine standards or goals, (Muir, and McClaran 1997).

3. 2.1.1 Rangeland condition:

The rangelands in state suffer from desertification erosion, deforestation and overgrazing. The trend of rangeland from 2000 to 2007 shows degradation in rangeland area and productivity. The carrying capacity is 20-30 AU/fed/year (Mohamed and Suliman, 2008).

3.3 Rangelands Inventory:

Inventory: The process of gathering information about the resources and features of the land being managed and monitored. Completing an inventory is useful for planning management and monitoring programs,

(Mohamed and Suliman, 2008). Inventory and monitoring is essential part of range management process. Plant inventory usually involve an assessment of vegetation resources at point in time. The primary purpose of an inventory is to provide accurate representation of existing condition, (Holechek *et al*, 2004).

Rangeland monitoring is the observing or measuring changes in the health of the land over space and time, (Mohamed and Suliman, 2008). Monitoring on the other hand, is an evaluation process usually conducted to determine the response to a management program, and usually is conducted several times over a fairly long time span (Holechek *et al*, 2010). Rangeland monitoring is conducted to record changes in resource status, usually to assess the response to a management program at a site. Such changes can only be detected by a series of measurements spanning time. Monitoring is the orderly collection, analysis, and interpretation of resource data to evaluate progress toward meeting management objectives. This process must be conducted over time to determine if management objectives are being met, (Swanson *et al*, 2006). Data collected from a range inventory provides a valuable baseline against which to compare responses, but monitoring can rarely be conducted at the same level of detail as the information provided by an inventory. Rangeland evaluation is the process of determining the status of natural rangeland resources. Repeated measurements overtime provide an indication of whether the vegetation is improving or declining compared to predetermined standards or goals. Rangeland assessment is the process of interpreting data and making value judgments about it (Swanson *et al*, 2006).

3.4 Importance of Rangeland:

Rangeland ranks as a major land type whether measured by size, support for animal –based industries, or source of stream flow. Substance

Partition of all major continents is rangeland. Worldwide, 30% of the worlds land area is grassland, 10% is classed as forest, and 27% is cropland. Amore useful measure of the importance of rangeland is the contribution they make to animal production (Arthur and Smith, 2012).

3.4.1 Importance of Livestock in Rangelands:

The main use of rangelands is grazing by wild and domestic animals on its natural vegetation. This form of rangeland use provides the cheapest source of nutrients for ruminants in Uganda. Therefore the improvement of rangeland management is fundamental for improved livestock and game production in the country. Most of the livestock in Sudan are kept under extensive management system and feed almost exclusively on rangeland resources (Arthur and Smith, 2012).

3.4.2 Rangelands in arid and semi-arid areas:

Arid and semi-arid areas are defined as areas falling within the rainfall zones of 0-300 mm and 300-600 mm, respectively (FAO, 1987). It cover one third of earth's land surface (UNCCD, 2004). Arid and semi-arid areas are characterized by low annual mean but extreme fluctuations in rainfall (Sullivan and Rohde, 2002). Droughts are an intrinsic part of arid and semi arid system (Müller, 2005). In the Sudan, the arid and semi-arid lands cover an area cover an area of 1.78 million km^2, which represents about 72% of the total area of the country (Sudan National Action Programme, 2006).

3.5 Environment Impact Assessment (EIA)

The environmental assessment of projects, scientific methodology to identify the implications for the activities of development projects, Therefore, the environmental impact assessment of projects is not considered an end in itself, but is a tool or a means to help improve decision-making in development. It was the beginning of the legislation in

the environmental assessment of the projects in the United States of America in 1969 and has since introduced legislation in the environmental assessment of projects in a number of developed countries and the developing world (Nagamani and Ph, 2017).

Evaluation always requires a wide range and substantial efforts, which should be directed to the following: determine the potential effects - analysis and evaluation of large and distinctive. There are several areas must be taken in the process of environmental assessment, including: human health, living organisms, different settings of the environment - the biosphere - Agriculture - Climate and Biosphere - Natural Resources - the relocation of residential communities - geographic area - the social consequences (Nagamani and Ph, 2017) .

3.5.1 The definition of environmental impact assessment (EIA):

Defined as the systematic examination of the multiple effects that result from project or development program in order to reduce or mitigate the negative effects and maximize positive impacts. In practical terms, this means studying and analyzing the environmental feasibility of the proposed project as the implementation of the project or operation may affect the integrity of environment and natural resources or human health, or both. The purpose of the environmental impact assessment is to ensure the protection of the environment and natural resources and preserve them (Anjaneyulu, *et al* 2017).

3.5.1.1 The concept of environmental impact assessment:

Environmental impact assessment of intended actions or systematic process designed to determine the environmental impact of development activity and signed on the environment and on human health and exchange information on those effects. The environmental impact assessment is an important part of planning and pieces of legislation, policies and environmental programs, and thus include assessment of environmental

impacts of those changes, useful to some people or classes of society, but harmful to others and environmental effects can be classified to the effects of initial occur directly by the project or intervention in the middle and secondary effects of environmental germbacrp, and the consequent development project inputs to the initial environmental impacts, while difficult to measure secondary effects (Ajith,2015).

E IA is such as evaluation of technical and financial, economic and social is part of project preparation, the environmental assessment on several levels, namely: the level of specific projects in the fields of irrigation, drainage and construction of dams and so forth. Regional level and global level, Stages of the environmental impact assessment of agricultural projects **:** There are several important stages of the commitment and include **:** Stage of the selection of the study group. Phase of the project description characterization of the initial phase of the project environment, the screening stage. The process of identifying preferences and effects, phase of preparing the document the environmental impact assessment, review stage, decision-making stage, follow-up and evaluation phase.

3.5.1.2 Timing of EIA:

Begin the steps to assess the environmental impact immediately in the preparation of feasibility studies, project and customize the site, and before his final designs, and are in the initial phase limited to the region's natural wealth and knowledge of the neighboring land uses, and to identify environmental problems and priorities (Anjaneyulu, *et al* 2017).

3.5.2 Environmental impact assessment is as follows:

1. The design of the environmental impact assessment, taking into account input from the environmental elements affected by the project.
2. Description and comprehensive analysis and detail to intervene in the

proposed project and a description and comprehensive analysis of environmental media, highlighting the environmental elements that will be affected by the project or the proposed Intervention and evaluation.

3. Recommend protective measures, evaluate and then view the results of the study and recommendations (Ajith, 2015).

3.5.3 Methodology for assessing environmental impacts:

The methodology for assessing the environmental impacts is a part of the planning process and decision-making on intervention, activity or development projects proposed on the environmental impacts of the project.

The decision is either to implement the project, or stop the project or modify the project, the process of environmental impact assessment is a continuous process that starts before a final decision on any project or intervention, and continue even after implementation of the project where it is monitoring the project after its completion to ensure that the emergence of negative environmental impacts affecting environmental media, has developed several approaches to assess environmental impacts in developed countries (such as the United States, Canada, Britain, Australia, and others), (Ajith,2015).

Consistent these approaches to focus on three axes in the process are: -

1. Knowledge of human activities and changes that occur in the center of those activities by the environmental (population growth development projects intensive use in the exploitation and management of resources).
2. Recognition on the environment and in particular the relations between the activities and characteristics of the environment.
3. Albiibp special awareness of the effects of negative and indicators of the deteriorating environmental quality, pollution and degradation of environmental resources, knowledge and distribution of environmental

impacts and environmental changes (Ajith,2015).

EIA refers generally to a positive or negative change in the environment as result of various human activities, the assessment and identification of environmental impact should be an integral part of planning policy, environmental impact assessments hands-on approach designed to identify and interpret and predict potential environmental impacts of development projects and programs has become Environmental Assessment, a practical tool is widespread in many countries of the developing world and developed to provide information, natural, economic and social are all sound basis for decision-makers and policy makers. Approaches and methods aimed at evaluating and assessing environmental impacts

- Estimating the size of environmental effects
- Damage and benefits - programs and new development projects, as projects or a list of the agricultural industry
- Evaluation of policies and procedures meet the environmental problems (Ajith, 2015).

3.5.4 Environmental Impact Assessment in Sudan:

A history of EIA in Sudan shows that the report of the Equatorial Nile Project (ENP) of 1954 is probably the first ever environmental impact assessment endeavor carried out in the developing world (Anjaneyulu, *et al* 2017). That was an EIA in function but not in name. Recent environmental and socio-economic evaluations were also carried out.

3.5.5 Features of the Process of EIA in Sudan:

As most of the developing projects in Sudan legislation are sponsored and implemented by overseas donors, it is the donors who require and usually supervise the implementation of particular ElAs. Sudan itself has not legislated for EIA as a mandatory requirement as is the case, for example, in the German Act on the Assessment of Environmental Impacts

(Anjaneyulu, *et al* 2017). Instead, there are over 150 natural resources laws and sectoral regulations dealing with health, water supply, land tenure, game, protected areas, fisheries and marine resources and other sectors of natural resources. More recently, Sudan has taken a remarkable step towards promulgating comprehensive environmental legislation, the Environmental Protection Policy Act, awaiting the signature of the President before being implemented, which states that, Any large developmental project, which construction might negatively impact the quality of the environment should undergo an Environment Feasibility Study (EFS).

Stipulated in the EFS is the requirement for the following information:

- Effect of proposed project/action on the environment;
- Any unavoidable negative environmental impact; and
- Available alternatives for proposed actions.)

3.6 Vegetation attributes:

3.6.1 **Plant cover:**

Cover means the projection of plants on to the soil surface measurements of cover can be expressed either as the percentage of the soil surface covered by the plants or plant parts or can be broken down into the spices. Plant cover is defined as the area of ground that is occupied by the above-ground parts of each species when viewed from above (Kent and Coker, 1992). All methods of plant cover estimation depend on the interception of the plant by a quadrat of a known area (Bonham, 1989). Cover measurements are commonly used to evaluated soil protection, watershed, health, rangeland ecological condition, and range trend (Holechek *et al,* 2004). Arial or canopy cover refers to the area covered by vertical projection of the crown of plant on the soil surface (Broun, 1954).

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 considered the best indicator of protection of the landscape against erosion, whereas canopy cover is commonly used 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 (Bonham, 1989).

Three methods that appear to meet time requirement for inventory and monitoring purposes are estimation, the step point method (Evans and Love, 1957) and line intercept procedures estimation procedures usually involve estimation cover by species in relatively small plots. The point step method was developed as a rapid, objective method of determining the cover and species composition of large range area (Evans and Love, 1957). The method involves cutting a notch or marking spot on the observers boot. The observer paces across the range area, recording whatever is directly beneath the notch or mark of his or her boot. Individual species, Litter, bare ground, rocks and so on can be recorded. Other devices, such as a fine rod or tripod, can be used to make placement of the point more objective.

3.6.2. Plant Composition:

Species composition refers to the contribution of each species to vegetation. Botanical composition is another term used to describe species composition (Bonham, 1989). It is generally expressed as a percent, so that all species components add up to 100% Species composition can be expressed as on either an individual species basis, or

by species groups that are defined according to the objectives of inventory or monitoring program (Bureau, 1996). Species composition is a commonly determined attribute in rangelands inventory and monitoring. It is regarded 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. These distinctions form the basis of rangelands 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. Management indicators - most objectives in rangeland management are directly concerned with the assessment or manipulation of species composition. For example, carrying capacity is influenced by the relative abundance of desirable forage species at a site. Wildlife habitat is also influenced by the relative contribution of various species that provide sources of shelter and food. Species composition is used to determine range condition and range trend, which are valuable tools to judge the impact of previous management and guide future decisions (Bonham, 1989).

3.6.3 Plant Frequency

Frequency is the number of times a plant species is present in a given number of quadrats of a particular size or at a given number of sample points. Frequency is usually expressed as a percentage and sometimes called a Frequency Index. The concept of frequency refers to the uniformity of a species in its distribution over an area. No counting is involved just a record of species present (Bohnam 1989).

3.6.4 Density:

Plant density measurement is commonly used to determine plant survival in responses to grazing and drought, plant establishment, and range trend (Holechek *et al*, 2004). Density is defined as the number of individual plants in a given area It is often used as a baseline inventory of the structure of rangeland or forest vegetation. In situation where identification of individuals is ambiguous, density measurements may be based on some other count units such as culms (Bonham, 1989).

Two general approaches can be adopted to determine density. The first approach, density is directly determined by counting plants within a defined sample unit, the second approach is a plot-less method based on measuring the distance or spacing between plants (Bonham, 1989).

3.6.5 Biomass:

Since aboveground vegetation must be clipped in some quadrats, circular quadrats should be avoided because of the difficulty in cutting around the perimeter of the circle with hand shears, and the non sampling errors that will likely result. It is impractical in the field to estimate and clip biomass in long, narrow quadrats. For this reason, we recommend you use square quadrats.(Krebs, 1989). 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', are 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/m2 according to vegetation abundance and objectives of the inventory or monitoring program.

Biomass is one of the most commonly measured attributes in range inventory or monitoring programs. Biomass data may be collected on an individual species basis, as species groups, or as a total weight for the

vegetation. Species composition may also be calculated as the contribution (percent by weight) that each species makes to the total biomass. Biomass is an attribute that is time consuming and laborious to collect, but easy to interpret. Biomass is regarded as an important indicator of ecological and management processes in the vegetation.

1. Ecological indicators - biomass is a measure of species dominance within the vegetation, since the demand for resources by each species is largely determined by plant size. Biomass also reflects the amount of energy stored in the vegetation, which can indicate the potential productivity at the site.
2. Management indicators - biomass provides a variety of indicators for rangeland management. For example, it is a valuable tool to assess range condition, the carrying capacity of an area, or to make short-term stocking rate adjustments according to the amount of forage reserves and residual biomass(Muir and McClaran,1997).

3.6.6 Soil organic matter:

Soil is defined as the dynamic, natural body of the surface of the earth in which plants grow Soil organic matter represents an accumulation of partially decayed and partially synthesized plant and animals residues. It makes up relatively small part of the soil (<1%- 6%) (Holechek *et al*, 2004).

3.7 Soil seed bank:

A seed bank is a reserve of mature viable seeds located in fruits (or cones) on the plant (aerial seed bank), on the soil surface or buried in soil. Soil is a major component of the earths ecosystem, is has a tremendous range of available niches and habitats. It is as an engineering medium, habitat for soil microbes, recycling system for nutrients and

organic wastes, regular of water quality, and a modifier of atmospheric composition (Nagamani, and Ph, 2017).

According to (Fayez, 2013) 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. Level of the seed reserve depend on the level of seed input from the sward, rate seed loss by predation or any other means, incident of germination, and probability of successful establishment. This reservoir is potentially capable of replacing the annual adult plants, which had disappeared by natural death or not, and perennial plants that are susceptible to plant diseases, disturbance and animal consumption, including man (Baker, 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 prop gules like tubers, rhizomes and stolons (Fernandez *et al.*, 1991).

3.7. 1 Characteristics of the soil seed banks:

The weed species have survived throughout time, because of their ability to resist to several adverse climatic conditions, tolerating high and low temperatures, dry and humid environments and variations in oxygen supply. The fundamental point in the success of weed survival is their persistence capacity in certain areas. This capacity is a consequence of a great number of seeds produced, long term viability, continuous germination, phenotypic and genetic plasticity (Freitas and Dinâmica, 1990).

The composition of seed banks is variable, and is classified as temporary or persistent, when modifying the regeneration of the vegetation during different time of the year. Temporary banks are composed of seeds of short life, which do not present dormancy and are dispersed in time for short periods during the year. Persistent seed banks are composed of

seeds that have more than one year of age and reserves of seeds remain in the soil (Garwood, 1989).Year after year, generally buried into the soil. Temporary banks are composed of seeds of short life, which do not present dormancy and are dispersed in time for short periods during the year. According to (Carvalho *et al.* 1995), 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. The longevity of seeds represents a major mechanism of survival of certain weed species, and this leads to a continuous source of emergency. The seed longevity in the soil varies among species, characteristics of the seeds, burial depth, and climatic conditions (Carmona, 1992).

The seed dormancy is another characteristic that affects the seed bank reservoir. The seed populations of several vegetable species behave in different ways with respect to germination; the weeds produce polymorphic seeds, with a certain proportion that is dormant and another not (Gore**,** 1991).

Several internal and external factors prevent seeds of germination. Among the internal factors are: the presence of a seed coat, which is a barrier to the penetration of water and oxygen; presence of a biochemical inhibitor in the seed; and immature embryo. Among the external factors, the most common are soil water content and temperature (Fernandez *et al*, 1991).

(Carmona, 1992) used the term innate dormancy (primary) and induced dormancy (Secondary) to characterize the development of the dormancy in the mother plant and after the dissemination in space, respectively. The term enforced dormancy, has been used for the inability of the seeds to germinate due to an environmental restriction, like water deficit, low temperature and poor aeration. However, some seed physiologists do not

consider the induced dormancy as an actual dormancy since the seed does not germinate because of the absence of environmental conditions and characteristics of the seed, since the seed does not need break dormancy but responds only favorable conditions for germination. This situation is more conveniently refereed as a case of quiescent seeds.

The dormancy represents a main mechanism of species preservation in the seed bank, distributing the germination through the year. It can guarantee the species survival in the form of seeds, under adverse conditions, even when the population of plants is completely eliminated (Carmona, 1992).

3.8 Wind erosion

Wind erosion is a common cause of land degradation in the arid and semi arid grazing lands of inland Queensland. It is one of the processes leading to desertification. Significant wind erosion occurs when strong winds blow over light-textured soils that have been heavily grazed during periods of drought. Wind erosion is also a natural process.

Wind erosion in Khartoum State, Khartoum is one of areas affected by land degradation, and the main process of land degradation in Khartoum State is wind erosion (Farah, 2003).

The large parallel sand dunes in south-west Queensland, including the Simpson Desert National Park, are the result of wind erosion and deposition over thousands of years. These dunes are constantly moving and roads and tracks can be covered by drifting sands in only a few hours. Understanding wind erosion is important as it provides a foundation for developing appropriate and effective land management and erosion control processes. To control wind erosion, derm encourages the adoption of sustainable management practices in the grazing and cropping industries.

3.8.1 Measurement and calculation of wind erosion intensity:

The collected soil material by the vertical and horizontal sand traps was weighed and divided by the area through which sand particles entered the trap and the obtained weight per unit area was converted to soil loss in ton per hectare per day as **follows**:

$$= \frac{\text{Weight of soil per trap (g)} \times 100 \times 100 \times 10000 \text{ Area}}{\text{Of trap orifice (cm}^2\text{)} \times \text{number of day's} \times 1000 \times 1000}$$

$$\text{Ton hectare}^{-1}\ \text{day}^{-1} = \frac{\text{Wt of soil per trap (g)} \times 100}{\text{Area (cm}^2\text{)} \times \text{number of days,}}$$ (Toy, *et al* 2002).

3.8.2 The effects of wind erosion

Wind erosion may have the following impacts:

- Soil fertility is reduced because of the loss of the plant nutrients that are concentrated on fine soil particles and organic matter in the topsoil. This reduces the soils capacity to support productive pastures and sustain biodiversity.
- Erosion at the base of bushes and plants can result in the plant being isolated and ground cover being thinned out.
- The erosion of light-textured topsoil can expose dense clay sub soils. These smooth and bare areas, called clay pans or scalds can cover hundreds or even thousands of hectares. They are difficult to revegetate due to the lack of topsoil, low permeability and their often saline nature.
- The buildup of soil particles against obstacles may bury fences and roads.
- Sand grains transported by strong winds can damage vegetation in their path by sandblasting.
- Air pollution caused by fine particles in suspension can affect people's health and cause other problems (Toy, *et al* 2002).

3.8.3 Wind erosion processes

The three processes of wind erosion are surface creep, Saltation and suspension. Characteristics of each are outlined below (Toy, *et al* 2002).

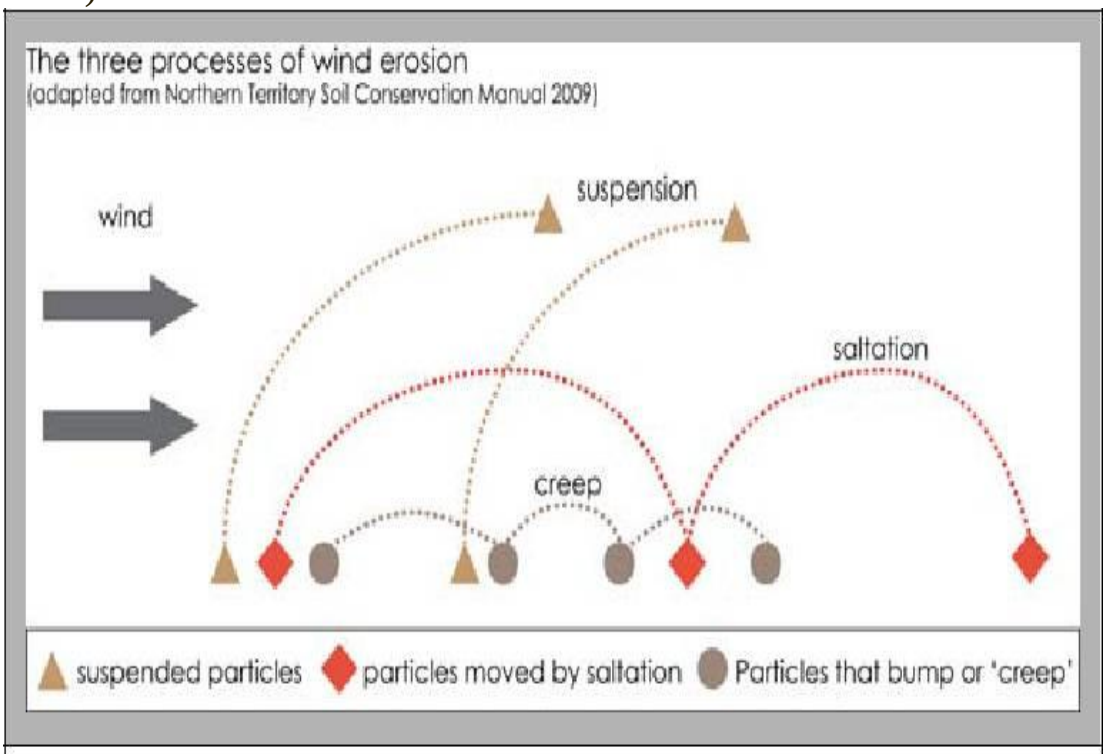

Fig (7) the three processes of soil erosion, (Toy, *etal* 2002).

Surface creep:

In a wind erosion event, large particles ranging from 0.5 mm to 2 mm in diameter are rolled across the soil surface. This causes them to collide with, and dislodge, other particles.

Surface creep wind erosion results in these larger particles moving only a few meters.

Saltation:

Occurs among middle -sized soil particles that range from (0.05 mm to 0.5 mm) in diameter, such particles are light enough to be lifted off the surface, but are too large to become suspended. These

particles move through a series of low bounces over the surface, causing abrasion on the soil surface and attrition (the breaking of particles into smaller particles).

Suspension:

Tiny particles less than 0.1 mm in diameter can be moved into the air by Saltation, forming dust storms when taken further upwards by turbulence. These particles include very fine grains of sand, clay particles and organic matter. However, not all dust ejected from the surface is carried in the air indefinitely. Larger dust particles (0.05 to 0.1 mm) may be dropped within a couple of kilometers of the erosion site. Particles of the order of 0.01 mm may travel hundreds of kilometers and 0.001 mm sized particles may travel thousands of kilometers. Through this process, Australian soil has been carried to New Zealand and beyond. Fine dust may remain in suspension in the air until it is washed out by rainfall (Cho, *et al* 2003).

3.9 Water Erosion:

Water erosion occurs when raindrops impact the soil surface and displace soil particles, and when water flowing over the land surface mobilises soil particles. It is a natural process often accelerated under agriculture, especially on cropped land. Water erosion can result in the loss of topsoil, reduced crop yields, damaged infrastructure, dispersal of weeds, eutrophication (algal blooms) and silting of dams and natural waterways. Water erosion causes loss of productivity and other damage, water erosion reduces agricultural, (Cho, *et al* 2003).

Productivity by:

- removing or moving nutrients
- removing valuable topsoil where there is a 'hostile' subsoil, reducing effective rooting depth and plant available water
- silting of dams, waterways and lowlands with sandy sediments, which can make flooding and water logging even worse
- reducing traffic ability of paddocks
- damage to tracks, fences and other infrastructure
- Reducing the risk of water erosion
- Water erosion can usually be minimized with a combination of mechanical, chemical and vegetative measures (Cho, *et al* 2003).

3.10 Soil Erosion:

Soil erosion is the process of wind and water moving soil particles from one location and transporting and depositing them elsewhere. Erosion is a natural occurrence, shaping sand dunes, creating river deltas, or carving out enormous rock features like the Grand Canyon. Humans, however, have dramatically accelerated this process through agricultural practices, mining, logging and clearing and grading for construction. The activities can cause detrimental effect on the environment, degrading water quality, soil compaction, limiting water nitration, removing vegetation, and exposing the soil surface, Erosion rates are higher on lands that are denuded and reshaped for urban development, than on agricultural land. Sedimentation is the gravitational deposition of transported materials in &owing or standing water (Toy, *et al* 2002). Sediment can carry polluting chemicals, destroys habitat, decrease the storage capacity of water bodies, and increase the risk of and wooding. Deposition of sediment on roads, and in stream channels, reservoirs, lakes, estuaries, and harbors, reduces recreational and municipal

usefulness and may require expensive removal operations. Soil erosion reduces the productivity of agricultural lands by removing top soil; Exposing less desirable subsoil "is results in a loss of organic matter and nutrients causing a reduction of fertility and plant-available, water-holding capacity. Soil degradation by accelerated water and wind-induced erosion is a serious problem and will remain so during the 21st century, especially in developing countries of tropics and subtropics. Erosion is a natural geomorphic process occurring continually over the earth's surface. However, the acceleration of this process through anthropogenic perturbations can have severe impacts on soil and environmental quality (Toy, *e t al* 2002). Soil erosion is a three stage process: (1) detachment, (2) transport, and (3) deposition of soil. Different energy source agents determine different types of erosion. There are four principal sources of energy: physical, such as wind and water, gravity, chemical reactions and anthropogenic, such as tillage. Soil erosion begins with detachment, which is caused by break down of aggregates by raindrop impact, sheering or drag force of water and wind. Detached particles are transported by flowing water (over-land flow and inter-flow) and wind, and deposited when the velocity of water or wind decreases by the effect of slope or ground cover (Toy, *et al* 2002).

Three processes dispersion, compaction and crusting, accelerate the natural rate of soil erosion. These processes decrease structural stability, reduce soil strength, exacerbate erodibility and accentuate susceptibility to transport by overland flow, interflow, wind or gravity. These processes are accentuated by soil disturbance (by tillage, vehicular traffic), lack of ground cover (bare fallow, residue removal or burning) and harsh climate (high rainfall intensity and wind velocity). However, soil erosion can be prevented by using remedial measures. Wind erosion can be prevented by planting trees to break the wind force (Abdalla *et al,* 2013).

3.10.1 Modeling Soil Erosion:

Field studies for prediction and assessment of soil erosion are expensive, time-consuming and need to be collected over many years. Though providing detailed understanding of the erosion processes, field studies have limitations because of complexity of interactions and the difficulty of generalizing from the results. Soil erosion models can simulate erosion processes in the watershed and may be able to take into account many of the complex interactions that affect rates of erosion (Farah, 2003).

CHAPTER FOUR

Materials and Methods

4.1General

This study was conducted in Khartoum state, north Omdurman area, around Wad Omer village as a main area covered by the project. The data was collected during the rainy season of September 2018. The objective of the study was to assess the environmental impacts for rangeland deterioration in Khartoum state.

4.2 Sampling procedure:

Sampling was done as relevant to two sites of the parameters identified, to assess the environmental impacts for rangeland deterioration in Wad Omer area, Khartoum State. Two range sites were identified as arange sites (sandy soil and rocky soil). The plot sample of 500m×500m criteria set by (Cottam and Curtis, 1956). Eight transects of 100 m each were randomly located in each site to measure vegetation attributes. Selection of the sites were based on releve' method and minimum area theory. Range measurements including plant cover, plant composition, plant frequency, trees density, biomass, organic matter and soil seed bank were conducted (Matthew and Robert in 1993).

4.3 Plant Measurements

Measurements were taken for the herbaceous cover included plant cover, plant composition, frequency, trees density, biomass, soil seed banck and organic matter. A Loop, 1 m^2 quadrate, a 100 m tape, and ranging roads were the major equipments used. The following measurements were taken within the sample plots and along transect.

4.3.1 Plant Cover:

Divided quadrate was used long line transect of length 100 with interval of 20 meters to estimate plant cover as a percentage. Also by using loop methods across the line transect with interval one meter.

$$\text{Plant cover} = \frac{\text{the total hits of plants}}{\text{All number of hits}} \times 100$$

4.3.2 Bare soil, Litters and Rocks:

Other ground cover components were determining using loop data as percentages, by using the following formulas:

$$\text{Bare soil} = \frac{\text{the total hits of bare soil}}{\text{All number of hits}} \times 100$$

$$\text{Litters} = \frac{\text{the total hits of litters}}{\text{All number of hits}} \times 100$$

$$\text{Rocks} = \frac{\text{the total hits of rocks}}{\text{All number of hits}} \times 100$$

4.3.3 Plant Composition:

Plant composition, was taken at each sites along eight transects using 3/4-inch loop hits. The total numbers of hits along each transect was equal 100 hits .The following equation was used to calculate the percentage of plant composition.

$$\text{Plant composition} = \frac{\text{Number of hits of each plant}}{\text{Total number of plant hits}} \times 100$$

4.3.4 Plant Frequency:

Frequency is the number of times a plant species is present in a given number of quadrats of a particular size or at a given number of sample points. Frequency is usually expressed as a percentage and sometimes called a Frequency Index.

It is calculated as follows:

$$\text{Species frequency} = \frac{\text{Number of Samples containing species}}{\text{Total number of Samples taken}} \times 100$$

4.3.5 Trees Density:

The nearest individual method was used in each site. Density for trees was determined in each site. A total of 30 points were selected randomly for each site at each point distance to nearest tree spp measured and the type of tree reported. Tree density was calculated as follow:

$$\text{Mean Distance} = \frac{\text{Sum of Distances measured}}{\text{Number of Samples Taken}}$$

Density per hectare was obtained as follow:

$$\text{Density} = \frac{10000\ m^2}{(\text{Mean Distance})^2}$$

$$\text{Relative trees density} = \frac{\text{No of species encountered}}{\text{Number of all trees}} \times \text{density of trees}$$

4.3.6 Biomass:

To determine the dry matter production (DM) a 1×1 meter (quadrat) was placed along each transects at 20 meter intervals, (eight transect). The plant species in each quadrat were clipped at (3) cm above the ground level, as this represent grazing level using scissors. Plant harvested materials were placed in paper bags, partially dried under sun light to reduce the moisture contents of plants and to proted them from decaying, because when the samples were taken the moisture was high. The plant materials were oven dried at 75C◦ for 48 hours , the oven dried materials were weighed .the dry matter per quadrate was obtained by divining the

total weighed of all quadrate by their number (35 quadrate per site) to obtain one average of weight (gm/m2). Then the dry matter (Ton/h) was obtained. Total forage production in ton/h was calculated after divinding the total biomass production by two (50% available forage), a proper use factor (PUF) as stated by Drag, 2004).

$$\text{productivi ty (Ton/ha/yr)} = \frac{\text{Average biomass } (g/m^2) \times 10000 \times 0.5}{1000000}$$

0.5= Proper used factor

4.3.7 Soil Organic Matter:

Soil is the dynamic, natural body of the surface of the earth, in which plants grow (Brady, and Weil, 2002). Soil organic matter represents an accumulation of partially decayed and partially synthesized plant and animals residues. It makes up relatively small part of the soil (<1% - 6%). The soil samples were taken randomly to determine organic matter at depths of (0-10 - 11-20 - 21-30 cm). Equipment used included muffle furnace, Balance, Porcelain dish, Spatula, Tongs. (15) Soil samples of 50gm were taken from each of the two sites to determine organic matter at the laboratories of the higher council of urban environment and promotion using the following steps:

- The mass of an empty, clean, and dry porcelain dish was determined.
- The part of entire oven-dried test.
- Dish as were placed in muffle furnace, for 24 hours at 400°C temperature (Brady, and Weil, 2002.
- The porcelain dishes were removed carefully using the tongs, and allowed it to cool to room temperature.
- The dish was emptied and cleaned.

4.3.8 Soil Seed bank:

Soil seed bank is a good indicator for assessing commutative effect of plant establishment along more than one year. To assess seed bank 30 soil samples (10cm×10 cm depth), were taken within each site randomly, and put in paper bags. The soils were mixed and sub-samples of 250/gm. each were prepared for washing and extraction.

Soil samples were washed using three sieves of (1.0- 0.5 and 0.25mm) put under each other at the laboratories of the higher council environment and promotion. Two hundred and fifty gram each sample of soil was placed in the upper sieve and washed using 250 ml of water for 10-15 minutes then put in tray and transferred into 500 ml beaker and stirred. The floating organic matter including dead seeds was filtered, using funnel with filter paper inside it, the funnel was placed into one conical flask connected to a vacuum pump to aid filtration. The filtered residue on the filter paper was transferred into petri-dish and the organic matter retrieved included mainly dead seeds. Samples remaining residues were washed using 250 ml of calcium chloride (12 gm /ml) to retrieve dead seeds from sample residues. The floated material after stirring included the live seeds, it is then added to the seeds remained in the flask for 40 minutes. Seen the highest seed solution of calcium chloride and filtered from the suppression of the flask (dead seeds) and left to dry under air. Seeds of the different species were identified under the microscope (MBC) Anatomy -10 by comparing them with a previously prepared colored image of seeds collected from the plants of study sites (Babeker, 2012).

4.3.9 Socio- economic Survey:

The socio economic survey was conducted to assess the involvement and response of Wad Omer community to the project activities and their impact in addition to their views for more improvement. Size of 105 households was taken represent about10% of population.

A questionnaire was designed to collect data and information required which covered, plant composition, activities such as agriculture and grazing, inputs of production, types of plants, types of crops, role of women participation, sources of water, irrigation system and vegetation aspects. In addition to the questionnaire a focused group discussion was conducted using checklist to collect group views and to cross check information provided by households.

4.3.10 Visits and Observations

Several visits to Wad Omar agricultural scheme were done to observe the following:

Sand dunce movement and desert encouragement, which led to degradation in vegetation cover and soil fertility lost. Also there is a diverse of plant such as *Dactyloctenium aegyptium* (abusabe), *Eragrostis termula (*Banw), *Trinthema spp* (Rabaa), and many types of trees such as *Capparis decidua* (Tundub), *Grewia tenax* and *Acacia tortilis sub-spp radiana* (Samur), this indicated that Wad Omar agricultural scheme was rich in terms of plant diversity.

Biological and mechanical fixation of the sand dune has been carried out since 2004 by Range and Pasture Administration.

4.3.11 Data Analysis:

For vegetation measurements, data were analyzed according to standard range assessment indices as stated in the materials and methods, other measurement of vegetation soil data were analyzed using SAS statistical program. Socio- economic data were coded and tabulated in the computer and analyzed using SPSS and (Chi-squire) test was used as analytical tool in this study.

CHAPTER FIVE

Results and Discussion

5 . 1 General:

This chapter discusses the data and information collected during the present studies and tries to investigate and compare the results found with other relevant previous results. Including rangeland interventions mainly plant composition, plant cover, plant frequency, trees density, organic matter content, and biomass and soil seed bank assessment. Related socio-economic aspects of the project activities were also covered, in addition to main agricultural interventions in the surrounding area.

5.2 Plant Measurements:

5.2.1 Plant Composition:

According to results showed in table (5.1) the dominate species composition at the sandy site with the interventions were *Corchorus spp* (Khudra Baria) 61.1%, *Dactyloctenium aegyptium*(Abusabe) 59.2%, *Aristida adscensionis* (Gaw)53.7%*Panicum turgidum (Tummam)* 53.4% *Eragrostis termula (*Banw) 34.7% *Chrozophora plicata* (Turba) 33.3%, *Trinthema spp* (Rabaa) 26.1%,and *Crotalaria senegalensis* (Sefera) .

The dominated species composition of the rocky site were, *Aristida adscensionis (*Gaw*)* 55.2%, *Eragrostis termula (*Banw) 54.3%, *Trinthema spp* (Rabaa) 48.5%, *Panicum turgidum* (Tummam) 44.2% and *Corchorus spp* (Khudra Baria) 42.8%. It is observations *Stylosanthes flaricans*, *Schoenfeldia gracilis, Cenchrus biflorus, Forsskaolea tenactssima*, *Sarcopterium spinosum*, appeared in the area of the agricultural scheme interventions, but not on the other sites. This indicated the success of seed broadcasting activities with species preffered by animals. Also this was confirmed by local people during the focused group discussion.

Species less preffered by animals like *Corchorus spp* (Khudra Baria) found to have high percentage in plant composition in areas of activities which may explain their competitive advantage compared with preferred species as a result of selective grazing.

As shown in table (5.1) sixteen plant species have been recorded for the site sandy soil with activities, while thirteen have been found at the other site, indicated that plants under management conditions showed relatively high diversity.

Mohamed (2009) found that the tangible impact of management practices including improving the vegetation composition of the more potential sites at large scale. This can be done by grazing management (optimum season of grazing, stocking rate, appropriate species), also stated that the degree of grazing strongly affects the structure, composition, quality and productivity of rangeland vegetation. Continuous intensive grazing leads to vegetation changes such as the replacement of palatable grasses by less palatable plant species, replacement of perennial grasses by annuals, bush encroachment, lower standing biomass and reduced basal cover.

Table (5.1) Plant Composition % at the Two Sites (Sandy and Rocky Soil) In Wad Omer Agricultural Scheme:

Species	**Sites %**	
	Sandy soil	**Rocky soil**
Corchorus spp	61.6	42.8
Dactyloctenium aegyptium	59.2	36.4
Aristida adscensionis	53.7	55.2
Panicum turgidum	53.4	44.2
Eragrostis termula	34.7	54.3
Chrozophora plicata	33.3	10.6
Trinthema spp	26.1	48.5
Crotalaria senegalensis	18.2	9.4
Stylosanthes flaricans	12.9	-
Tribulus terrestris	11.6	27.7
Ipomoea cordofana	8.3	16.8
Schoenfeldia gracilis	7	-
Amaranthus spp	6.4	8.2
Cenchrus biflorus	5.7	-
Forsskaolea tenactssima	5.2	-
Sarcopterium spinosum	2.6	-
Echinocoloa colonum	-	8.5
Senna occidentalis	-	24.5

5.2.2 Plant Cover:

Result in table (5.2) showed the average percentage of plant cover at the sandy soil site was 51% and the average at the other site Rocky soil was 47.9%. Differences in cover could be attributed to different vegetation density at different sites, in addition to relative in

vegetation composition (Holechek *et al*., 2004), state that the plant cover measurements are commonly used to evaluated soil protection, watershed, health, rangeland ecological condition, and range trend.

Table (5.2) Average of plant Cover at the two sites (Sandy and Rocky soil) in Wad Omer agricultural scheme:

Sites	Rock	Litter	B.S	SP	Plant Cover percent %
Sandy soil	2	9	14	73	51
Rocky soil	6	11	18	63	47.9

Although cover percentage is an important variable in range assessment but it may not reflect the quality of range in relation to plants characteristics, which may indicate that project interventions contributed positively to area conservation and protection from soil erosion. Babeker, (2012) stated that rangeland management plans should include grazing management with the purpose of increasing the vegetation cover and decreasing the grazing pressure on the natural vegetation and controlling kinds and numbers of animals (Proper stocking). Also Abdalla, *et al*, (2013) stated that the plant cover in sandy soil was a higher at the other sites. When utilizing the rangeland it is absolutely essential to regulate the effects of grazing on vegetation cover. This is found to be realistic as the interview with villagers confirmed, since according to their views that before the project the cover was poor in the area for many years compared with recent years.

5.2.3 Plant Frequency:

Table (5.3) and table (5.4) showed that the frequency into two sites of *Corchorus spp* was 87.5% in the sandy soil site and 100% in the rocky soil site .Species with high frequency in the site sand soil site were *Corchorus spp* 87.5% *Eragrostis termula* 75% *Aristida adscensionis* 75%, *Dactyloctenium aegyptium* 62.5% *Panicum turgidum 50% Trianthema portulacastrum* 37.5% and *Amaranthus spp* 37.5%. This result agreed with (Barbour *et al*, 1987), who stated that the through the study of frequency in different range sites of the study area, it found that the highest frequency from sandy**,** while the highest frequency in rocky soil site**.** In addition to species with high frequency in rocky soil site were *Corchorus spp* 100%, *Trinthema spp* 87.5%, *Aristida adscensionis* 75%, *Crotalaria senegalensis*75%, *Dactyloctenium aegyptium* 62.5%, *Panicum turgidum* 62.5%, *Senna occidentalis* 50%, and *Tribulus terrestris* 37.5%. The density of plant in sandy soil site was 54/plant/m^2 while in the rocky soil site was 35/plant/m^2. This result is higher in sandy soil site than the rocky soil site. The results indicated that the plant in the area varies depending on the site characteristics. It is found that the frequency of *Eragrostis termula* and *Trianthema portulacastrum* in the sandy soil site with (75% and 37.5%) relectivey higher compared to their frequency (25%) in rocky soil site.

Table (5.3) Plant Frequency % and Density at the site (Sandy Soil) in Wad Omer agricultural scheme:

Species name	**percentage%**	**Density/ plant/m^2**
Tribulus terrestris	75	8
Dactyloctenium aegyptium	62.5	5
Eragrostis termula	75	8
Forsskaolea tenactssima	12.5	2
Trianthema portulacastrum	37.5	5
Aristida adscensionis	75	8
Amaranthus spp	37.5	2
Corchorus spp	87.5	12
Panicum turgidum	50	1
Stylosanthes flaricans	12.5	1
Ipomoea cordofana	12.5	1
Trinthema spp	12.5	1
Crotalaria senegalensis	12.5	-
Total		**54/plant /m^2**

Table (5.4) Plant Frequency % and Density at the site (Rocky Soil) in Wad Omer agricultural scheme:

Species name	**percentage%**	**Density/plant/m^2**
Trinthema spp	87.5	6
Aristida adscensionis	75	7
Tribulus terrestris	37.5	3
Senna occidentalis	50	3
Corchorus spp	100	6
Crotalaria senegalensis	75	2
Dactyloctenium aegyptium	62.5	5
Eragrostis termula	25	1
Panicum turgidum	62.5	1
Trianthema portulacastrum	25	1
Schoenfeldia gracilis	12.5	-
Amaranthus spp	12.5	-
Total		**35/plant/m^2**

5.2.4 Trees Density:

According to the results in table (5.5) the total of trees density in the sandy soil site was (112 tree) while in the rocky soil site only (23 tree/ha). This result reflects the variation of trees density between the two range sites. The higher tree density was found of *Ziziphus spina-christi,* about (47 trees, per hectare) in sandy soil range site, while this tree was not found in rocky soil range site. This may be due to the different location and the effect of soil type on the distribution of trees. The other trees at the sandy soil site were, *Salvadora persica* (Arrack) *Grewia tenax* and *Acacia radiana* (Seyal), while in rocky soil site were *Capparis decidua* (Tundub), *Boscia senegalensis* (Mokhate), *Maerua crassifolia*

(Sareh). Very little number of trees was observed at the rocky soil site compared to sandy soil site. The high tree density, which was found in the sandy soil range site, may be attributed to the management interventions adopted by the project. The presence of browse trees in the study area provides on important source of fodder during long dry season which occur in this area.

Table (5.5) Relative Density of trees (Tree/ha) at the two sites (Sandy and Rocky soil in Wad Omer agricultural scheme):

Species	**Trees density/ha**	
	Sandy soil	**Rocky soil**
Salvadora persica	2 5	3
Ziziphus spina-christi	4 7	-
Maerua crassifolia	1 6	4
Boscia senegalensis	-	7
Capparis deciduas	3	8
Grewia tenax	7	1
Acacia radiana	1 4	-
Total	**1 1 2**	**2 3**

5.2.5 Organic Matter:

5.2.5.1 The soil organic matter in range sites:

The results shown in table (5.6), explained that there were a high significant differences (Pr > F 0.001), in the amount of soil organic matter between two sites of rangeland in the study area. This result illustrates the differences in the soil properties in different range sites. According to the result represent in table (5.7), the rocky soil range site recorded high organic matter (3.22%) compared to the sandy soil range site recorded (1.77%). This result illustrates the poor organic matter in

sandy soil. The same results reported by (Abdelsalam *et al*, 2017), who found that the low organic matter in sandy soil attributed to lowest plant cover and grazing pressure in the range site. The soil organic matter is the key factor for assessing the range site stability and rangeland health. Also is a good indicator for rangeland sustainability (Abdalla *et al*, 2013) reported that many management techniques depend on the maintenance of organic matter to sustain rangeland production. Higher organic matter means in rocky soil more decomposition of organic plant materials produced at the site as a result of high amount of biomass.

Table (5.6) Effect of Sites in Organic Matter in Deferent Sites:

Source	DF	Mean Square	F Value	Pr > F
Soil	1	15.84	17.29	0.001**
Depth	2	2.71	2.96	0.07 NS
Rep	4	0.81	0.89	0.48 NS

**: high significant differences - NS: No significant differences

Table (5.7) Effect of Sites in Organic Matter of Rangelands in Wad Omer Area

Sites	Mean
Sandy soil	1.77 b
Rocky soil	3.22 a

Means with the same letter are not significantly different.

5.2.5.2 Effect of soil depth in organic matter accumulation:

The result represent in table (5.8) showed a significant difference with in the soil depths. There was a significant difference between the depth (21-30) cm and the depth (0-10) cm, were 2.84 % and 1.9 % respectively. On the other hand there was no significant difference among the depths (0-10) cm and (21-30) cm. The result reflects the negative effect of water

and wind erosion in rangeland site of the study area. Because the sandy soil more subjected to the erosion. These range sites were poor in vegetation cover, which lead to desertification. (Adam *et al*, 2010) found that poor plant cover subjected to wind and water erosion. Also (Fayez, 2013) found that poor plant and low organic matter in arid and semi–arid area.

Table (5.8) Effect of Depth in Organic Matter of Rangelands in Wad Omer area

Depth	Mean
0-10 cm	1.9 b
11-20	2.76 ab
21-30	2.84 a

Means with the same letter are not significantly different.

5.2.6 Biomass production in different range sites:

From the results represent in table (5.9), illustrated there were no significant differences among the range sites in the biomass production. Also transect and quadrate had not affected of the biomass in the study area. On the one hand the productivity of the biomass had not affected by the soil types in range sites, which the sandy soil range site recorded the same production of biomass compared to rocky soil range sites such as 4.16 and 4.13 respectively, see table (5.10). Generally the biomass production in two sites is poor, subjected to effect of desertification and sand dunes in this area (Abdelsalam *et al*, 2012), who found that the lowest biomass produced, sandy soil range sites. Also Abdelsalam (2017) reported that the sandy soil was less fertile. These rangelands need especial management to improve their capability and biomass productivity, and also need more protection against the soil loss from the wind and water erosion.

Table (5.9) Effect of sites in biomass of different sites

Source	DF	Mean Square	F Value	Pr > F
Site	1	0.004	0.00	0.97 NS
Transect	1	3.96	0.78	0.39 NS
Quadrate	3	4.73	0.93	0.46 NS

NS: No significant difference

Table (5.10) Effect of sites in biomass in Wad Omer area

Site	Mean g/m^2
Sandy soil	4.16 a
Rocky soil	4.13a

Means with the same letter are not significantly different.

5.2.7 Soil Seed Bank:

The results represented in table (5-11) showed that the soil types had not significantly affected on the seed density in the Wad Omer area. On the other hand, soil depth has a significant effect on seed density in the soil. The depth of 0-1 0 cm was the highest seed density per square meter in both soil types of live and dead seeds, followed by the depth 11-20 cm, while the depth 21-30 cm was recorded less seed density, see table (5-12). This result agreed with (Abdelsalam *et al* 2017), who stated that the soil depth had a highly significant effect on the seed density, while the seed density was not affected by the soil types. The high variability of the seed density among the soil depth reflects the occurrence of these seed in the different soil depths. The occurrence of the majority of the seed in the upper layer of the soil makes them able to grow the next growing season. Generally the seed density decreases with the increasing the soil depth, this agreed with (Elsafori and Abdallah, 2014), who found that the seed density decrease according to soil depth increasing.

As compared to the soil types the study showed in table (5-12) explained the rocky soil range site was a high number of live seeds (188/m^2, 140m^2 and 68 m^2) than the sandy soil range site (168 m^2, 100 m^2 and 44 m^2), in all soil depths. This result demonstrates that the seeds in the rocky soil range site were more able to regenerate the rangelands next years. The lowest seed number in sandy soil may be due to the grazing animal, because this range site affected by the early grazing in rainy season. (Abdelsalam, *et al*, 2017), reported that the early grazing affected the soil seed bank under the heavy grazing.

The higher number of plant species found in the upper layer of the soil into two range sites, which were 10 species in all, and it decreased with the increase of soil depth. Through the results presented in Table (5-12), there are about five more dominant plant species in terms of live seed density at the upper depth in the sandy soil range site, including, *Indigofera spp*, *Dactyloctenium aegyptium*, *Schoenfeldia gracilis*, *Amaranthus graecizans* and *Corchorus spp* respectively.

The results shown in Table (5-12) indicated that there were six plant species that were denser of live seeds than all the plants in the rocky soil range site at the upper depth such as, *Dactyloctenium aegyptium*, *Corchorus spp*, *Schoenfeldia gracilis*, *Panicum turgidum*, *Aristida spp* and *Amaranthus graecizans* sequentially. Among these plant species there are three species found in the two range sites (*Dactyloctenium aegyptium*, *Schoenfeldia gracilis* and *Amaranthus graecizans*), this indicates the widespread spread of these species and their ability to adapt to different soil types. The presence of plant diversity in the study area and differences in seed density may be due to some environmental factors in the area, Babeker, (2012), reported that the soil properties have a clear effect on the soil seed bank. All the plants found in the study area are annual plants, including forbs and grasses except *Panicum turgidum*.

Therefore, these rangelands need improved by introducing some seeds of perennial plants for the sustainability of range and soil conservation. As for the density of dead seeds, there was a clear difference between the range sites, where the *Indigofera spp* and *Amaranthus graecizans* had the highest plant density on the sandy soil range site, while the *Dactyloctenium aegyptium* and *Corchorus spp* were the highest density in the rocky soil range site, in the different soil depths.

Table (5-11) Effect of Soil Types and Depth on the Variation of Soil Seed bank Density

Source	DF	Mean Squire	F. Value	Pr ≥F
Soil	1	261.3	0.22	0.65NS
Depth	2	12785.3	10.72	0.005**

NS: no significant differences, **: High significant differences at alpha ≥ 0.05

Table (5-12) Seed Density (seed/m^2) at the Sandy and Rocky Soil Range Sites

Depth 0-10 cm				
Botanical Name	**Sandy soil**		**Rocky soil**	
	Live Seed/m^2	**Dead Seed/m^2**	**Live Seed/m^2**	**Dead Seed/m^2**
Indigofera spp	36	68	8	0
Dactyloctenium aegyptium	32	8	36	32
Schoenfeldia gracilis	28	12	28	12
Amaranthus graecizans	24	36	20	8
Corchorus spp	24	12	36	20
Panicum turgidum	8	8	24	4
Tribulus terrestris	8	4	-	0
Crotalaria senegalensis	4	4	4	0
Ipomoea cordofana	4	0	-	0

Eragrostis termula	0	12	0	8
Sarcopterium spinosum	0	0	0	12
Aristida spp	0	0	24	0
Total	**168**	**164**	**188**	**96**
Depth 11-20 cm				
Indigofera spp	24	48	12	4
Dactyloctenium aegyptium	24	12	32	28
Schoenfeldia gracilis	16	8	0	0
Amaranthus graecizans	16	20	8	0
Corchorus spp	16	8	32	16
Panicum turgidum	4	8	12	0
Sarcopterium spinosum	0	4	20	0
Aristida spp	0	0	12	4
Ipomoea cordofana	0	0	8	4
Tribulus terrestris	0	0	4	0
Total	**100**	**108**	**140**	**56**
Depth 21-30 cm				
Indigofera spp	8	16	0	0
Dactyloctenium aegyptium	12	4	12	8
Schoenfeldia gracilis	12	8	0	0
Crotalaria senegalensis	0	4	0	0
Ipomoea cordofana	12	0	4	0
Sarcopterium spinosum	0	4	16	0
Corchorus spp	0	0	8	4
Panicum turgidum	0	0	4	0
Aristida spp	0	0	12	0
Amaranthus graecizans	0	0	12	4
Total	**44**	**36**	**68**	**16**

5.2.7.1 The Botanical Composition of Soil Seed Bank in Wad Omer Area:

The botanical composition of seed bank reflects the contribution of plant species in the future plant community in the study area. The result shown in table (5-13) illustrates the diversity of plants in the sandy soil range sites. There are five plant species found the highest percentage in terms of botanical compositions *Indigofera spp*, *Dactyloctenium aegyptium*, *Schoenfeldia gracilis* and *Corchorus spp*, into two depths (0-10 and 11-20 cm), while the species decreased in the last depth (21-30 cm) just only three species had a high species composition such as *Indigofera spp*, *Dactyloctenium aegyptium* and *Schoenfeldia gracilis* respectively. This result was confirmed that the *Indigofera spp*, records the highest percentage in all soil depths, including live and dead seeds, but the percentage of dead seeds exceeded the percentage of living seeds, 44.5% and 21.4% in depth 0-10 cm, 44.4% and 24% in depth 11-20 cm and 44.4 and 18.1% in depth 21-30 cm of dead and live seeds botanical composition respectively. From this result, it concluded that the seeds of the *Indigofera spp* lose a large percentage, making them vulnerable to loss of their seed bank in the soil and threatening their natural regeneration. Through the results represented in table (5-13), found that there are three plant species records the highest botanical composition in the rocky soil range site, *Dactyloctenium aegyptium* (19.1% and 33.3%), *Corchorus spp* (19.1% and 20.8) and *Schoenfeldia gracilis* (14.9 % and 12.5), for all live and dead seed, respectively in the upper soil depth. While the *Dactyloctenium aegyptium* and *Corchorus spp* were found the highest botanical composition percentage in the lowest soil depths, (11-20 cm and 21-30 cm). Species less preferred by animals like *Corchorus spp* found to have a high percentage in plant composition in this range site, which may explain their competitive advantage compared with preferred

species as a result of selective grazing. This site needs some management interventions to increase the proportion of desired plant species and reduce the competition between them and undesirable plants. (Babeker, 2012) confirmed that, the tangible impact of management practices including improving the vegetation composition of the more potential sites at large scale.

Table (5-13) Seed botanical composition % of the sandy and rocky soil range sites:

Depth 0-10 cm				
Botanical Name	**Sandy soil**		**Rocky soil**	
	Live Seed %	**Dead Seed %**	**Live Seed %**	**Dead Seed %**
Indigofera spp	21.4	41.5	4.3	0
Dactyloctenium aegyptium	19	4.9	19.1	33.3
Schoenfeldia gracilis	16.6	7.3	14.9	12.5
Amaranthus graecizans	14.3	22	10.6	8.3
Corchorus spp	14.3	7.3	19.1	20.8
Panicum turgidum	4.8	4.9	12.8	4.2
Tribulus terrestris	4.8	2.4	4.3	0
Crotalaria senegalensis	2.4	2.4	2.1	0
Ipomoea cordofana	2.4	0	0	0
Eragrostis termula	0	7.3	0	8.3
Sarcopterium spinosum	0	0	0	12.5
Total	**100**	**100**	**100**	**99.9**
Depth 11- 20 cm				
Indigofera spp	24	44.4	8.6	7.1
Dactyloctenium aegyptium	24	11.1	22.9	50
Schoenfeldia gracilis	16	7.4	0	0
Amaranthus graecizans	16	18.5	5.6	0

Corchorus spp	16	7.4	22.9	28.7
Panicum turgidum	4	7.4	8.6	0
Aristida spp	0	0	8.6	7.1
Tribulus terrestris	0	0	2.9	0
Indigofera spp	0	0	8.6	7.1
Sarcopterium spinosum	0	0	14.3	0
Ipomoea cordofana	0	0	5.6	7.1
Total	**100**	**99.9**	**100**	**100**
Depth 21-30 cm				
Indigofera spp	18.1	44.4	0	0
Dactyloctenium aegyptium	27.3	11.1	17.6	50
Schoenfeldia gracilis	27.3	22.2	0	0
Crotalaria senegalensis	0	11.1	0	0
Ipomoea cordofana	27.3	0	5.9	0
Sarcopterium spinosum	0	11.1	23.5	0
Corchorus spp	0	0	11.8	25
Panicum turgidum	0	0	5.9	0
Aristida spp	0	0	17.6	0
Amaranthus graecizans	0	0	17.6	25
Total	**100**	**99.9**	**99.9**	**100**

5.2.7.2 The Live and Dead Seeds in the Two Range Sites of Wad Omer Area:

According to the results shown in table (5-14) there were no significant differences in the percentage of live and dead seeds between sandy and rocky soil range sites, but there was a significant difference between the soil depths, especially the percentage of live seeds in the rocky soil where the last depth (21-30 cm), recorded the highest percentage of live seeds more than 80%, on the other hand the upper layer records lowest live

seeds percentage (58%). This result may reflect the impacts the soil erosion on the upper layer, which causes the seed to disappear as a result of wind movement.

Table (5-14) the percentage of live and dead seed of the sandy and rocky soil range sites.

Soil Depth/cm	**Sandy Soil**		**Rocky Soil**	
	Live Seed %	**Dead Seed %**	**Live Seed %**	**Dead Seed %**
0-10	50.6	49.4	58	42
11-20	48.1	51.9	71.4	28.6
21-30	55	45	81	19

Statistical Analysis

Source	Mean	Std Dev	Std Error	T	Pro ≥T
Live Seed	-18.97	9.62	5.56	-3.41	0.07NS
Dead Seed	18.9	10.05	5.80	3.25	0.08NS
Depth	-64.80	25.75	14.87	-4.36	0.04*
Soil	-1.18	22.57	9.21	-1.28	1.00NS

5.2.8 Socio- economic Aspect:

5.2.8.1 Livelihood Activities:

The results in table (5-15) showed that, there were highly significant differences at (P< 0.0001) within respondents' age in three villages. The majority of respondents age were between (20 – 40), in Wad Omer (40%), Soug (50%) and Umharoot (60%), followed by age (41 – 60) that wad Omer 40% Soug 35% and Umharoot 6.7, while the above 60 were gradually low. These results showed that the majorly of respondents in active age (20-40), this group of age is very important in agricultural activities in the study area, especially in Umharoot village. This results agreed with (Babeker,2012)who state that this indicates that livelihoods in the project area depend mainly on natural resources and age group

between (20-40) years and are important in the process of agricultural interventions in the agricultural scheme. Moreover a high percentage of youth found in the study area, helps in the implementation any activity to improve and rehabilitate to degraded rangeland, and they can also strongly contribute to all development activities.

Table (5-15) Age categories of responds in study area

Age	**Wad Omer**		**Soug**		**Umharoot**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**
20-40	12	40	10	50	9	60
40-60	12	40	7	35	1	6.7
Above 60	6	20	3	15	5	33.3
Total	**30**	**100**	**20**	**100**	**15**	**100**

NS= insignificant (p>0.5). *=significant (<0.01). **= high significant (p<0.001). ***= highly significant (p<0.0001).

5.2.8.2 Education level:

The result in table (5-16) showed that there are highly significant differences between three village (Wad Omer , Soug ,Umharoot) according to the education level (p<0.001). The majority of respondents (40%, 35%, and 33.3%) in the village, Wad Omer, Soug, and Umharoot respectively, were educated at Khalwa level, followed by primary school in Wad Omer 36.7%, Souge30%, and Umharoot 20%. While the illiterates just found Wad Omer (23.3%) and Umharoot (20%). This result indicated that may the formal education was not important in their society and they not continued their education. The low level of educations in these communities leads to lack of environmental awareness and miss management of their natural resources management.

Table (5-16) Result of Education level in wad Omer project

Education level	**Wad Omer**		**Soug**		**Umharoot**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**
Illiterate	7	23.3	0	0	3	20
Khalua	12	40	7	35	5	33.3
Primary	11	36.7	6	30	3	20
Intermediate	0	0	7	35	4	26.7
Secondary	0	0	0	0	0	0
University	0	0	0	0	0	0
Post graduate	0	0	0	0	0	0
Total	**30**	**100**	**20**	**100**	**15**	**100**

Sign**

5.2.8.3 Occupation of respondents in wad Omer agricultural scheme:

The results represent in table (5.17 and 5.18) showed that the majority of respondents were farmers, (70%, 65%, 60%), in wad Omer, Soug and Umharoot villages respectively. The high percentage of respondents as farmers may be due to encouragement, while were found from ministry of agriculture in Khartoum State food security project in (2004).

Table (5.17) Occupation of respondents in wad Omer and Soug agricultural scheme

Wad Omer							**Soug**							
	Farmers		**Grazing**		**Trading**		**Farmers**		**Grazing**		**Trading**		**Others**	
	freq	%	freq	%	freq	%	freq	%	freq	%	freq	%	freq	%
Yes	21	70	5	16.7	3	10	13	65	9	45	3	15	0	0
No	9	30	25	83.3	27	90	7	35	11	55	17	85	20	100
Total	**30**	**100**	**30**	**100**	**30**	**100**	**20**	**100**	**20**	**100**	**20**	**100**	**20**	**100**

Table (5.18) Occupation of respondents in Umharoot agricultural scheme

Umharoot								
	Farmers		**Grazing**		**Trading**		**Others**	
Yes	9	60	3	20	3	20	0	0
No	6	40	12	80	12	80	15	100
Total	**15**	**100**	**15**	**100**	**15**	**100**	**15**	**100**

5.2.9 Plant cover in Wad Omer agricultural scheme:

Table (5-19) indicated that most respondents opinions there are many types of vegetation in the three villages, with different percentages (76.7%) of respondents in Wad Omar, Suog village 75%, and Umharoot 40% said there are *Trianthema spp* was found in their villages, while other types of the vegetation within the three villages are *Aristida spp*, *Ipomoea cordofana* and *Dactyloctenium aegyptium* by 80%, and 76% respectively in Wad Omar, 55%, 35%, 25% while in Soug village 13.3% .20%, 6.7% either village Umharoot. This result indicated that there were many types vegetation in three villages, which reflects the good cover of the study area rangeland minerals.

Table (5-19) Types of plant cover in Wad Omer Agricultural Scheme:

Type of plant		**Rabaa**		***Aristida spp***		***Ipomoea cordofana***		***Crotalaria senegalensis***		***Dactyloctenium aegyptium***		**Haskaneet**	
Name of village	Wad Omer	Freq	%	Freq	%	freq	%	freq	%	Freq	%	Freq	%
Yes		23	76.7	24	80	24	80	14	46.7	23	76.7	13	43.3
No		7	23.3	6	20	6	20	16	53.3	7	23.3	17	56.7
Total		**30**	**100**	**30**	**100**	**30**	**100**	**30**	**100**	**30**	**100**	**30**	**100**
Name of village	Soug	Sign**											
Yes		15	75	11	55	7	35	2	10	5	25	3	15
No		5	25	9	45	13	65	18	90	15	75	17	85
Total		**20**	**100**	**20**	**100**	**20**	**100**	**20**	**100**	**20**	**100**	**20**	**100**
Name of village	Umharoot	Sign**											
Yes		6	40	2	13.3	3	20	1	6.7	1	6.7	1	6.7
No		9	60	13	86.7	12	80	14	93.3	14	93.3	14	93.3
Total		**15**	**100**	**15**	**100**	**15**	**100**	**15**	**100**	**15**	**100**	**15**	**100**

This result may be due to intervention of rangeland management for example of broadcasting of the important range plant seed. Generally the result of the type vegetation cover in the interview and the quadrate field were the same. The same result reported found by (Babeker, 2012) there are much vegetation in the study area.

5.2.9.1 The occurrence of palatable plant in study area:

The result showed in table (5-20) there are significant differences between the respondent's opinions about the occurrence of palatable plants in rangelands of the study area. The high palatable plant found in Soug village (75%), followed by Umharoot village (73.3%) and Wad

Omer (43.3%). These results may reflect the different awareness of range plant characteristics between the respondents.

Table (5-20) The respondents opinions about palatable plants in study area

Name of village	**Wad Omer**		**Soug**		**Umharoot**	
	Freq	%	Freq	%	Freq	%
Occur	13	43.3	15	75	11	73.3
Not occur	17	56.7	5	25	4	26.7
Total	**30**	**100**	**20**	**100**	**15**	**100**
Sign *						

5.2.9.2 Environmental impacts of plants disappearance in study area:

The results in table (5-21), illustrate that there are high significant difference between respondents about their awareness of the disappearance of plants from the rangeland in the study area. The majority of respondent in Souge village said the plant disappeared from the rangeland, followed by Wad Omer (53.3%), and Umharoot (40%). These results may reflect the rangeland detraction and forage shortage for livestock in this area.

Table (5-21) Environmental impacts of plants disappearance on livestock in study area:

Name of village	**Wad Omer**		**Soug**		**Umharoot**	
	Freq	%	Freq	%	Freq	%
Affect	16	53.3	11	55	6	40
Un affect	14	46.7	9	45	9	60
Total	**30**	**100**	**20**	**100**	**15**	**100**
Sign **						

5.2.9.3 Types of exotic plant species introduced by the Range and Pasture Administration in the study area:

The results in table (5.22) indicated that most of respondents said that are many types of exotic plants in three villages. The high frequent of

different exotic plant such as *Panicum turgidum* (Tummam) and *Leptadinia pirotechinica* (Marekh) about (63.3.7%,16.7%) respectively of respondents in Wad Omer village , Soug village (5%, 30%) and Umharoot (13.3% ,60%) respectively. The result indicated that there are a large number of exotic plant species in the three villages. The exotic plants are of economically significance to the soil conservation of the study area, which has led to the stop of sand. This result may be due to interventions of rangeland management, which were practiced in this area by introduced many exotic plant species and reseeding the degraded rangeland by this seed.

Table (5.22) Types of exotic plant species introduced by Rangeland management in the study area:

Name of village	Wad Omer				Soug				Umharoot			
	Panicum turgidum		*Leptadinia pirotechinica*		*Panicum turgidum*		*Leptadinia pirotechinica*		*Panicum turgidum*		*Leptadinia pirotechinica*	
	Freq	%	Freq	%	Freq	%	freq	%	Freq	%	freq	%
Yes	19	63.3	5	16.7	1	5	6	30	2	13.3	9	60
No	11	36.7	25	83.3	19	95	14	70	13	86.7	6	40
Total	30	100	30	100	20	100	20	100	15	100	15	100
Sign ***												

5.2.10 Rangeland management interventions to improve rangeland status:

According to the results in table (5.23) that the majority of respondents (90%) in the Wad Omar village said that there are reseeding in their villages. The results also showed that about 80% of the respondents in Soug village said that there are broadcasting, followed by Umharoot (26.7%), while (93.3%) from Wad Omer said they are planting fodder.

The respondents in Umharoot village (65%, 66.7%) said that there is fodder cultivation; moreover, the results showed that all the respondents in three villages said there are well drilling.

In addition to the results showed that provides funding were found in three villages, moreover the result showed that there are provides herbside and fertilizers in two villages (Wad Omer village and Umharoot village). This result may reflect to good indicators, good management activities, these interventions had a positive environmental impact in the study area reduce wind speed, sand dunes fixation, conserve the vegetation cover. The same result reported with (Babeker, 2012) which found that the rangeland management interventions in terms of growing crops and drilling wells.

Table (5.23) Rangeland management interventions to improve rangeland status

Name of village	Wad Omer				Soug				Umharoot			
	Yes		No		Yes		No		Yes		No	
	Freq	%	Freq	%	Freq	%	freq	%	freq	%	freq	%
podcasting seeds	27	90	3	10	16	80	4	20	4	26.7	11	73.3
Grow forge	28	93.3	2	6.7	13	65	7	35	10	66.7	5	33.3
wells drilling	14	46.7	16	53.3	8	40	12	60	3	20	12	80
saving investment	19	63.3	11	36.7	5	25	15	75	5	33.3	10	66.7
Provide herb sides and fertilizers	11	36.7	19	63.3	0	0	20	100	3	20	12	80
Sign **												

5.2.10.1 Reasons of rangeland degradation in study area

According to results in table (5.24) the majority of respondents (43.3%) in Wad Omer village said result there were broadcasting while Souge and Umharoot village said no over grazing. Also the results showed that about (13.3%) of respondents at Wad Omer village said there was soil erosion followed by Umharoot and Souge the same (40%), but the results showed

little rainfall. in Suog and Wad Omer village (40%, 40%) receptivity said that there were view rainfall, (Abdalla, 2006) stated that soils are most susceptible to wind erosion when they are dry and bare. The overgrazing that removes plant cover makes soils vulnerable to wind erosion. The hazard increases with length of time, when soil surface is bare and with the degree of soil dryness. Also, Abdalla *et al*, (2013) who stated that the wind erosion can be prevented by planting trees to break the wind speed.

Table (5.24) Reasons of rangeland degradation in study area

Name of village	**Wad Omer**				**Soug**				**Umharoot**			
	Yes		**No**		**Yes**		**No**		**Yes**		**No**	
	Freq	%	freq	%	Freq	%	Freq	%	Freq	%	freq	%
Desertification	13	43.3	17	56.7	2	10	18	90	2	13.3	13	86.7
Soil erosion	4	13.3	26	86.7	8	40	12	60	6	40	9	60
Over grazing	0	0	30	100	11	55	9	45	3	20	12	80
Little rainfall	18	60	12	40	12	60	8	40	3	20	12	80
Bad management	21	70	9	30	1	5	19	95	3	20	12	80
Others	14	46.7	16	53.3	0	0	20	100	0	0	15	100
Sign ***												

5.2.10.2 Pattern agricultural in study area

According to the results showed in table (5-25) there are significant differences between the respondent opinions within three villages. The majority of the people in Wad Omer village 86.7%, Souge 95% and Umharoot village 100% practiced agriculture, while just few peoples found in Wad Omer (13.3%) and Soug village (5%) were practiced grazing animals. This result may be due to population behavior such as agricultural through wells, population stability through food security. Generally the agricultural lead to decrease wind and water erosion in study area.

Table (5-25) Agricultural patterns in study area

Name of village	Wad Omer		Soug		Umharoot	
	Freq	%	Freq	%	Freq	%
Grazing	4	13.3	1	5	0	0
Agricultural	26	86.7	19	95	15	100
Total	30	100	20	100	15	100
Sign *						

5.2.11The environmental situation of Wad Omer area before establishing the agricultural scheme:

According to results in table (5.26) the majority of respondents (40%) in two villages (Soug and Umharoot) said there was pollution in farm soil, resulting from uses of fertilizers and pesticides, while the respondents at Wad Omer village said there was no soil pollution. Also the results showed that about (65%) of respondents at Soug village said there was air pollution followed by Umharoot (46.7%), while (96.7%) that there was at Wad Omer village said there are no air pollution. The results showed that there was no water pollution in Suog and Umharoot villages, while (43.3%) in Wad Omer village said that there was water pollution. The results showed there are many new diseases found in the study area such as Allergic reactions and fever with different percentages (53.3%, 30%, and 33.3%) respectively three villages. These results may attribute to environmental deterioration by human activities and climatic factors.

Table (5.26) environmental impacts assessment in study area

Name of village	Wad Omer				Soug				Umharoot			
	Yes		No		Yes		No		Yes		No	
	Freq	%	Freq	%	Freq	%	Freq	%	freq	%	freq	%
Soil pollution	1	3.3	29	96.7	8	40	12	60	6	40	9	60
Air pollution	1	3.3	29	96.7	13	65	7	35	7	46.7	8	53.3
Water pollution	13	43.3	7	56.7	0	0	20	100	0	0	15	100
New disease	16	53.3	14	46.7	6	30	14	70	5	33.3	10	66.7
Others	1	3.3	29	96.7	6	30	14	70	7	46.7	8	53.3
Sign ***												

***= very high significant

5.2.12The effect of shelter belts in Wad Omer agricultural scheme

The result in table (5.27) showed that the shelter belt in Wad Omer Agricultural scheme has significant differences within three sites according to respondent's investigation, that the shelter belts prevent soil erosion, soil protection and decreased sand dunce, that Wad Omer recording 40%, Soug village 30% and Umharoot village 60%. For the role of shelter belts in crop protection, the results revealed that 66.7% of respondents stated the shelter belts protect their crops in Umharoot, followed by Wad Omer village 63.3%, while 35% in Soug said the shelter belts protect their crops. This result may be due to good managements of shelters belts program and farmer's awareness about shelters belts role or environmental benefits of shelter belts to the study area. Abdalla, (2006) found that in arid zones the harsh conditions of climate and shortage of water are intensified by the strong wind. Living conditions and agricultural production can be often improved by planting trees and shrubs in protective wind breaks and shelterbelts will reduce wind speed and provide shade. Also found that shelterbelts reduce evaporation from the soil, reduce wind erosion, moderate extreme temperature, lower water table and increase soil fertility. Also shelterbelts make on essential conditions to food security by maintaining the environmental conditions needed for agricultural

protection. Wind break and shelterbelts provide shelter for livestock, particularly young animals against the demoing effects by both cold and hot.

Table (5.27) the role of shelter belt in Wad Omer agricultural scheme

Name of village	**Wad Omer**				**Soug**				**Umharoot**			
	Yes		**No**		**Yes**		**No**		**Yes**		**No**	
	Freq	%	freq	%	Freq	%	freq	%	Freq	%	freq	%
Protect soil erosion	12	40	18	60	6	30	14	70	9	60	6	40
Dehumidify the atmosphere	0	0	30	100	13	65	7	35	9	60	6	40
Noise reeducation	17	86.7	13	43.3	8	40	12	60	7	46.7	8	53.3
Reduce wind intensity	15	50	15	50	0	0	20	100	1	6.7	14	93.3
Crop protection	19	63.3	11	36.7	7	35	13	65	10	66.7	5	33.3
Source of crime and the spread of diseases	1	3.3	29	96.7	4	20	16	80	7	46.7	8	53.3
Others	15	50	15	50	0	0	20	100	1	6.7	14	93.3
Sign ***												

5.13 General Observations

5.13.1 The past situation:

- During the field visit in2012 the following were observed:
- There was environmental degradation in terms of sand dunce and wind erosion.

  There are a number of trees and forest diversity, also a lack of water for human consumption and for agriculture activities.
- Wad Omar area was affected by the desertification and it subjected to sandy dunes and wind erosion, most of the trees and shrubs were severely by wind and sand accumulation,

  Trees cover was low due to drought and natural degradation.

5.13.2 The current situation:

- The current status of Wad Omar agricultural scheme is good in terms of vegetation cover, tree density and plant diversity.
- Range and Pasture Administration had done several interventions to reduce sand dunes movement, including the planting of different types of trees to fix sand dunes and maintain the vegetation cover.
- Biological and mechanical fixation led to stop creeping of the sand and preserved the vegetation.

CHAPTER SIX

Conclusion and Recommendations

6.1 Conclusion:

Based on results found from this study it concluded that:

1. The sand soil range site was best than he rocky soil range site of plant cover and trees density, the higher trees density found in sandy soil site (112 trees/ha) compared to (23 trees/ha) in the rocky soil range site.
2. The presence of browse trees in the study area such as *Ziziphus spina-christi, Salvadora persica, Boscia senegalensis, Acacia radiana* and *Grewia tenax,* in the study area provides an important source of fodder during the dry season.
3. The rocky range site contents high amount of organic matter (5.7%) than sandy range site (1.77%), this reflects the soil fertility.
4. There are five dement plant species in terms of live seed density in sandy soil range site such as *Indigofera spp, Dactyloctenium aegyptium, Schoenfeldia gracilis, Amaranthus graecizans* and *Corchorus spp,* while there are six species recorded high density in rocky soil range site namely *Dactyloctenium aegyptium, Corchorus spp, Panicum turgidum, Sarcopterium spinosum, Aristida spp* and *Amaranthus graecizans*.
5. The main interventions of Range and Pasture Administration(RPA), to improve the rangeland situation in Wad Omer agricultural scheme, included reseeding, crop planting, drillings wells, provides of herbicides, fertilizers and planting of shelterbelts.
6. There are many positive environment impacts of the (RPA) intervention such as reduce wind speed, sand dine fixation and vegetation cover conservation.

7. Vegetation attributes, organic matter, soil seed banck with socio-economic aspects gave valuable information to assess the impact of (RPA) intervention in Wad Omer area.

6.2 Recommendations:

Based on the results and findings of this study the following recommendations are suggested:

1. Need more management interventions to importance rangeland especially in rocky soil range site to increase the vegetation cover and trees density
2. Improve sandy soil productivities by using organic fertilizers and planting shelterbelts.
3. Participation or local people in implementation of range important activities to insure success and sustainability.
4. Raise the awareness of people at Wad Omer area of the important role of wind break and shelterbelts establishment in providing environmental and socio-economic services.
5. Ongoing field research should be conducted to investigate the environmental impacts, including soil properties, climatic parameters and rangeland and pasture Administration and people of Wad Omer interaction.

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APPENDICES

Appendix (1) Questionnaire

Sudan University of Science and Technology

College of Graduate Studies

This questionnaire is about StudyThe Environmental Impact of Rangeland Management Interventions in Wad Omer Agricultural Scheme- Khartoum State for ph.D degree in Range science.

Please choose the best answer from the following and put assign ☐

1. **PRIMARY INFORMATION:**

   Name.....

   Date.....

   Age: less than 20 ☐ 21-40 ☐ 41-60 ☐ bove 60 ☐

2. Place or village.....
3. Position..... .....
4. Level of education:

   Illiterate ☐ Khalwa ☐ Primary ☐ Intermediate

   Secondary ☐ University ☐ Upper University ☐

5. Source of income : agricultural ☐ grazing ☐ trading ☐

   others ☐

6. How to income in Wad Omer agricultural scheme?

   Modern ☐ science 5 years ☐ 10 years ☐ 15 years ☐

   above ☐

7. Do you resident in the scheme area? Yes ☐ No ☐
8. What type of the plant cover in the study area?
9. Is palatable? Yes ☐ No ☐

10.If yes please mention.....

11.What is the impact of the disappearance of some species of palatable plants on the animals of the area.....?

12.What are the types of invasive plants that have emerged recently in the region now.....

13.What are Rangeland management interventions to improve rangeland status?

- Podcasting seeds ☐ Grow forge ☐
- well draining ☐ Provide herb sides and fertilizers ☐

14.What are the resons of Rangeland degradation in study area?

Desert crawl (sand) ☐ soil erosion ☐ overgrazing ☐

vew rainfall ☐ bad management ☐ other mention ☐

15.What the agriculture pattern in the study area ?

Meroitic ☐ Meroitic traditional ☐ Traditional rain ☐

Traditional Meroitic ☐ Grove ☐ Others ☐

16.What is the environmental impact of the use of fertilizers and pesticides in the project? Soil Pollution ☐ Air Pollution ☐

Water Pollution ☐ New Diseases ☐ Other ☐

17.What the mechanism of agricultural processing in the study area?

By family ☐ by employed ☐ other ☐ ention? ☐

18.What is the impact of shelter pelt in the study area?

Protect the soil from drifting ☐ moderate the atmosphere ☐

Reduce noise ☐ Reduce wind intensity ☐

Crop protection ☐ Source of crime and the spread of other diseases ☐

Appendix (2)

Loop method recording sheet

Date.....….Site.....:Sample plot….....

Observer…….soils…….….transect number……...

Summary of symbol:

Rocks(R)

Litter (L)

Bare soil (B.s)

Plant Species (P.s)

Appendix (3)

Data sheet frequency and density of plant

Date……Site……Sample plot:.....

Observer……soils……transect number…….....……

Quadrat No	Species name	Plant No	Q.No	Species name	Plant No
1			2		
3			4		

Appendix (4)

Types of species in study area

Species	Local name
Corchorus spp	Khudra Baria
Dactyloctenium aegyptium	Abuasabee
Aristida adscensionis	Gaw
Panicum turgidum	Tumam
Eragrostis termula	Banw
Chrozophora plicata	Tarba
Trinthema spp	Rabaa
Crotalaria senegalensis	Sefera
Stylosanthes flaricans	Sharaiya
Tribulus terrestris	Diraisa
Ipomoea cordofana	Tabar
Schoenfeldia gracilis	Danab alnaga
Amaranthus spp	Lesan alter
Cenchrus biflorus	Haskaneit
Forsskaolea tenactssima	Leseeig
Sarcopterium spinosum	Natash
Echinocoloa colonum	Defra
Senna occidentalis	Sanamaka
Eragrostis termula	Banw
Amaranthus spp	Lesan alter
Senna occidentalis	Sanamaka

Appendix (5)

One-Sample Test (Analysis)

Test Value = 0						
95% Confidence Interval of the Difference		Mean Difference	Sig. (2-tailed)	df	T	
Upper	Lower					
2.08	1.52	1.80	.000	29	12.953	Age
.51	.15	.33	.001	29	3.808	Function
1.42	.84	1.13	.000	29	7.999	education level
.47	.13	.30	.001	29	3.525	Source of income – Agriculture
.97	.69	.83	.000	29	12.042	Source of income –grazing
1.01	.79	.90	.000	29	16.155	Source of Income – Trade
1.01	.79	.90	.000	29	16.155	Source of income – Other
3.08	2.32	2.70	.000	29	14.468	In com to Wad Omar
.26	.00	.13	.043	29	2.112	Resident or roaming
.39	.07	.23	.006	29	2.971	- Four types of vegetation cover in the region
.35	.05	.20	.012	29	2.693	Types of vegetation cover in the region
.35	.05	.20	.012	29	2.693	Soil - types of vegetation in the region
.39	.07	.23	.006	29	2.971	Types of vegetation in the region
.62	.25	.43	.000	29	4.709	Saphira - the types of vegetation in the region
.75	.38	.57	.000	29	6.158	Haskneet
.72	.34	.53	.000	29	5.757	Whistle
.75	.38	.57	.000	29	6.158	Is palatable
.72	.34	.53	.000	29	5.757	Are there poisonous plants for animals?
.26	.00	.13	.043	29	2.112	If yes, state it
.66	.28	.47	.000	29	5.037	To what extent does the disappearance of some species of palatable plants affect the animals of the region?
.97	.69	.83	.000	29	12.042	What are the types of invasive plants that have emerged recently in the region - Al Marikh
1.55	1.18	1.37	.000	29	15.272	What are the types of invasive plants that have emerged recently in the region – Tumam
.21	-.01	.10	.083	29	1.795	What are the pasture and wellness management interventions in improving the status of natural pastures in the region - sowing seeds
.16	-.03	.07	.161	29	1.439	What are the pasture and wellness management interventions in improving the status of natural pastures in the region

.72	.34	.53	.000	29	5.757	What are the pasture and wellness management interventions in improving the status of natural pastures in the region - drilling wells
.55	.18	.37	.000	29	4.097	What are pasture and wellness management interventions in improving the region's natural pasture situation - providing funding
.82	.45	.63	.000	29	7.077	What are pasture and forage management interventions Improving the natural pasture situation in the region
.75	.38	.57	.000	29	6.158	What are pasture and forage management interventions Improving the natural pasture situation in the region
1.00	.74	.87	.000	29	13.730	What are pasture and forage management interventions Improving the natural pasture situation in the region
.59	.21	.40	.000	29	4.397	What are pasture and forage management interventions Improving the natural pasture situation in the region
.47	.13	.30	.001	29	3.525	What are pasture and forage management interventions Improving the natural pasture situation in the region
.72	.34	.53	.000	29	5.757	What are pasture and forage management interventions Improving the natural pasture situation in the region
1.00	.74	.87	.000	29	13.730	Agriculture pattern
1.03	.90	.97	.000	29	29.000	What is the environmental impact - soil pollution
1.03	.90	.97	.000	29	29.000	What is the environmental impact - air pollution
1.23	.57	.90	.000	29	5.572	What is the environmental impact - water pollution?
.66	.28	.47	.000	29	5.037	What is the environmental impact - the emergence of new diseases
1.03	.90	.97	.000	29	29.000	What is the environmental impact – others
.72	.34	.53	.000	29	5.757	Mechanism of accomplishing agricultural operations
.79	.41	.60	.000	29	6.595	Impact of tree belts - Protection of soil from erosion
1.24	.49	.87	.000	29	4.709	Impact of tree belts - noise reduction
.69	.31	.50	.000	29	5.385	Impact of tree belts - Reducing wind intensity
.55	.18	.37	.000	29	4.097	Impact of tree belts - crop protection
1.03	.90	.97	.000	29	29.000	Impact of tree belts - a source of crime and the spread of diseases
.69	.31	.50	.000	29	5.385	Impact of tree belts – Others