

**THE FORMS AND EFFECTS OF SOIL DEGRADATION ON
AGRICULTURAL LAND: CASE STUDY BOR TOWN,
JONGLEI STATE, SOUTH SUDAN**

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DECLARATION

I ATEM PUKA AROK, declare that no other researcher has written a similar report for any other university or academic institution, the completion of this research report has been my own investigation with maximum originality of data and information got from secondary sources or references.

Signature: 

Date: 24/08/2011

APPROVAL

This is to certify that this research report has been submitted for examination with my approval as a university supervisor.

Signature.....

Mr. Ammon Orashiba

Date.....

DEDICATION

I dedicate this dissertation to my God and parents especially mother Agoot Puka and Atem Arok for the care given to me when I was young and also towards my academic progress. I should not forget my brothers Amol Atem, Gomba Atem, and my sisters Alek Atem for great support given to me morally and financially throughout my entire three year course that was successfully done without failure through their commitment.

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LIST OF ABBREVIATION

UNDP	United Nations For Development Programmes
UNEP	United Nations For Environmental Protection
UNHCR	United Nations High Commissioner For Refugees
FAO	United Nations For International Education Children's Fund
UNICEF	Food Agriculture Organization
USAID	United Nations Agency For International Development
WHO	World Health Organization
WRI	World Resource For Institute
GOSS	Government Of Southern Sudan
NAS	National Academic Of Science
IOM	International Organization For Migration
MDFT	Multi- Donor Trust Fund
SPLM / SPLA	Sudan People's Liberation Movement / Army
WFP	World Food Programme
CPA	Comprehensive Peace Agreement
NGOs	Non Governmental Organizations
NPA	Norwegian People Aid

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ABSTRACT

The research on “The Forms and Effects of Soil Degradation on Agricultural Land” was carried out in Bor town Jonglei State, south Sudan. The major areas of the investigation were discussed to known the causes of soil degradation and adverse impacts on farming land and what solutions to be put in place to minimize the occurrence of soil degradation. Methods like photography, interviews, questionnaires, and observation were used for effective and efficient data collection.

At the period of study, the level of soil degradation was established in the following forms as shown bellow; massive deforestation 12.2%, monoculture 16.33%, climate change, 8.16% ,extensive cultivation / soil compaction 20.41%, overgrazing 24.49%, while advancement of Kidepo sand accounts for 6.2%, (over grazing taking great percentage of all the forms) .

Basing on the research findings, vital issues addressed include; information and measures to be put in place to stop people in the community to practice poor methods of farming, agro biodiversity conservation and enhancement, soil conservation management, proper use of agrochemicals ; sustainable pasture management, integrated pest management, agro forestry management and sustainable agriculture.

The research recommendation forwarded are among others; use of organic farming on agriculture land, proper soil management strategies, provision of leguminous viable seeds for soil conservation management, and agro-biodiversity conservation.

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.0 Back ground.

Soil degradation is defined as biophysical and chemical loss (erosion) and reduction in quality of topsoil associated with nutrient decline and contamination of soil; therefore it affects the soil quality for agriculture and has implication to the living community.

Physical degradation on farm land became a major problem in Bor town which is located in savannah grassland where unfriendly activities carried out by the communities to sustain living, especially subsistence farming and extraction of natural resources have led to agents of soil destruction that make it less productive for agriculture products. (According to World Bank report on human development index 2005), 73% of people globally are living by practicing primitive methods of farming carried out on cropland. This has encouraged all forms of soil deterioration through, deforestation, over grazing, poor agronomic practices and industrialization at 34.5%, 36.2%, 28.1% and 1.2% respectively, through (FAO, 1994) Surveillance on the causes of soil destruction.

Soil degradation in Greater Horn of Africa is known for lowering crop productivity due to frequent occurrence of the negative impacts of human activities. Land degradation has become a global priority issue that has affected agricultural land especially through destruction of biological habitat, physical and human environment (UNEP1987). Over all in sub-Sahara Africa, in the past half century approximately two billion hectares of land has been degraded through human activities for survival and 300 million extremely degraded with high level of soil erosion, nutrient depletion and desertification. This makes crop land infertile as frequently agents of erosion expose the land to denudation. (Pinstrup Andersen and Pandya-lorch, 1995).

International Federation of Social Workers (IFSW 2002) argues that political instability has dominated land in many parts of the world which caused some serious consequences to soil destruction. Bor town Jonglei state was the foundation of Sudan People's Liberation Army (SPLA) war that broke out in 1983 against Khartoum regime. This led

to agricultural land degradation through clearing of forest reserves and bombing by troops during raids that led to deterioration of the ecosystems in the rural setups. The accelerated soil infertility encouraged people to shift to fuel wood that reduced plant cover hence further land degradation. Soil degradation affected great horn of Africa especially Sudan, Ethiopia, Djibouti, Tanzania, Kenya and others, which frustrated livelihood in this region due low crop productivity (UNHCR Shortage of food report 2006).

Bor town is one of town existing in Jonglei state in southern Sudan with a population of about 50,000 people. The most of returnees and already existing communities according to population census 2007 report live under absolute poverty. Therefore this population encroaches on forests to earn a living which eventually leads to the natural resources exploitation through; daily collection of fuel wood and charcoal, subsistence growing of crops, and rampant settlement concentrated on farming land of a small geographical area that result to drastic soil degradation. Therefore most of vegetation around the farming land is burnt completely and exposed to erosion. (Ministry Of Agriculture, Forestry and Infrastructure, 2008)

1.1 Statement of the problem

There are many problems although soil degradation is evident in many parts of Jonglei state. The magnitude and severity of the problem in Bor town of Jonglei state South Sudan is extreme and with alarming rate on agricultural land. Population increase in settlements, growing of the crops by the returnees from East Africa countries, drought, less knowledge and skill of farming, demand for construction materials like timber and famine have contributed to more damage on the soil. The January 9/2005 Peace Agreement (CPA) led to the majority of exiled and internally displaced people to return home and start new life in Bor town, The majority if not all these people, earn a living through practicing traditional methods of farming and utilization of natural resources. The negative and unbearable consequences of all these practices like, soil erosion, loss of biodiversity, reduced soil fertility, acidity, salinity, floods and droughts among others, are felt by the land resource.

1.2 General objectives.

To find out the effects of soil degradation on agricultural land of Bor town Jonglei state

1.3 Specific objective

- a) To find out the forms of soil degradation on agricultural land resulting from human activities.
- b) To find out the effects of soil degradation on socio economic activities.
- c) To find out measures being taken to protect agricultural land from all forms of soil degradation
- d) To suggest recommendation on how to mitigate soil degradation on agricultural land.

1.4 Research questions.

- a) What are the forms of soil degradation on agriculture land of Bor town Jonglei state?
- b) What are the effects of soil degradation on socio economic activities of the people in the area?
- c) What measures are being taken to control soil degradation?

1.5 Scope of the study.

1.5.1 Conceptual scope.

The researcher studied the forms of soil degradation that exist on agriculture land of Bor town Jonglei state in relation to the community status. The research considered the different effects of soil degradation and further investigated the measures being taken to protect soil on agricultural land in order to address all forms of soil destruction. Suggestions and recommendations were made on how to manage the agricultural land. This research is thought to help various institutions and local communities to identify and manage different forms of soil degradation and their impacts on agricultural land.

1.5.2 Geographical scope

The study was conducted in Bor town Jognlei state located according to GTZ road Construction Company 2007, at a distance of about 150 km in the North East of Juba town. It is part of Bor County, bordering Pibor to the west and Pochala to the east. It covers an area of approximately 19 square miles.

1.5.3 Time scope.

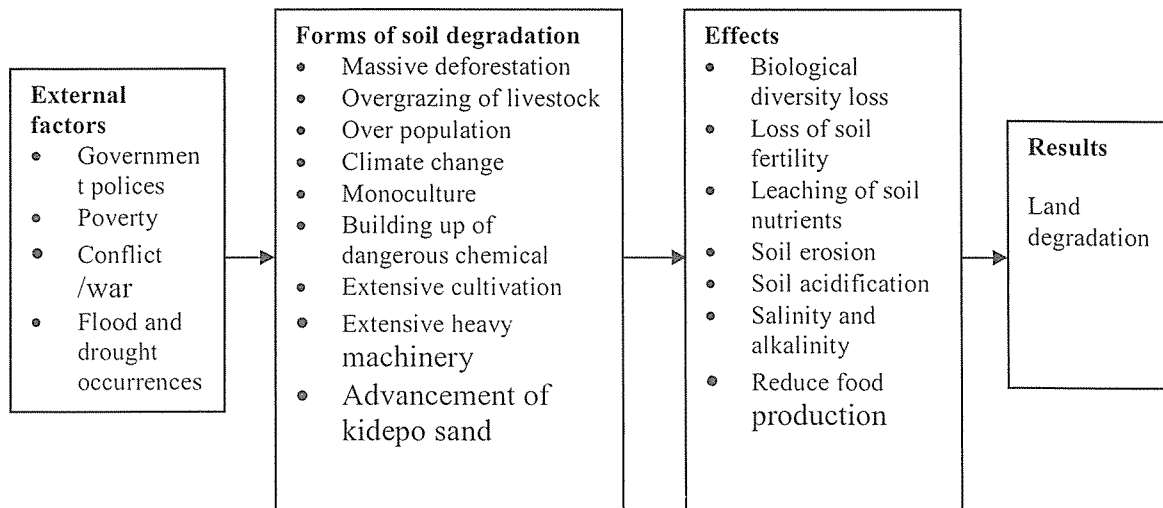
The study was carried out in two months due to time and funds available. A sample of 50 respondents was randomly selected from stake holders in the communities, elders, local chiefs and religious leaders, to have their opinion on soil degradation and its impacts.

1.6 The significance of the study.

- a) The findings will help to provide new knowledge and skill of identifying any form of soil degradation that affects cultivated land.
- b) The study finding will help in the evaluation and assessment of the causes of soil degradation.
- c) The study finding will help in the assessment of how the current time frame of soil degradation can be brought back to normal on agricultural land.
- d) The study shall help local communities and government officials to identify the gaps in soil conservation policies and suggest on how to address them.
- e) The finding will help in identifying the effects of poor farming activities on the agricultural land.

1.7 Conceptual framework.

The research demonstrates the relationship between the variables in the study. Thus the researcher has perceived the causes of soil degradation to be independent variable in the study, while the effects of soil degradation on arable land affecting crop production as dependent variable Bor town Jonglei state.



CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter discusses and presents the reviews of literature of the previous studies. It covers different authors' views that have been written in the subject area and includes several arguments from different fields of studies corresponding to the research problem.

Review of the literature.

Since the beginning of the world, most African and especially sub-Saharan countries depended on the natural resources in the environment to sustain a living. Subsequently agricultural land has been degraded due to increase in population. Population increase is coupled with; massive deforestation, overgrazing of livestock, over population, monoculture, building up of dangerous chemicals, extensive cultivation, extensive use of heavy machinery and poor conservation strategies on agricultural land among others. Various authors have written about the effects of soil degradation on crop productivity worldwide, but less if any, on Bor town Jonglei state.

By March 2006, the population in Bor town Jonglei state concentration was approximately 50.000 people mostly as returnees, struggling to settle and farm. This has been accompanied by several environmental negative impacts relating to; demand for arable land, firewood, timber and other resources in large quantities that the environment could not match.(UNHCR/IOM, 2006)

UNEP (1987) made an analysis and observed that the forms soil degradation are caused by poverty, illiteracy in the community, hence farming land destruction unknowingly due to overuse of natural resources such as fuel materials to sustain life. The war break out between Sudan People's Liberation Army and The Khartoum regime in 1983 caused much damage on the forest to expose combatants and destroyed crop lands that deprived farmers of their food supply as well as making soil bare exposed to agents of erosion. The extension of town due o increase in population settlements as well as increase in dumping sites of industrial wastes and sewage has disrupted the soils.

2.1 Forms of soil degradation on agricultural land.

Over population

Approximately 46% of population in sub Sahara has severity of food insecurity according to USAID 1994 report. This percentage is bigger than that of over all of Africa, Which was estimated to be 33% in 1990. Due to increase in population, the land is being degraded which leads to food production decline per unit land area. This does not exclude Jonglei state as part of the country in sub Sahara experiencing soil infertility.

Climate change on agriculture land

Climate changes become the top world issue threatening humanity. as it was suggested by global climate summit that warming are between 1.4 and 5.8 degree Celsius which exposed severe famine and drought to struck in this area of Jonglei state especially Bor town due to population increase has resulted from poor practices of bush burning hence climate variation struck the areas that make farming land to loss its fertility through frequent sunshine which make soil become loose as well as pest and diseases extremely attack vegetation and decreased livestock productivity directly (through high temperature) and indirectly through change in availability of feed and fodder and exposed evapo-transpiration make the soil loss it moisture contents which underlie food problems. The effects of climate change on agriculture is exacerbated by lack of adaptation strategies which increasingly limited due to lack of institutional economic and financial capacity to support such action(FAO,1999).The occurrence of drought and famine make agricultural land become less productive. The poorest woman and children make opportunity cost of destruction of forests due to lack of income ending to degradation (UNHCR IOM 2006).

Massive deforestation

This cutting down of trees in great number, as the returnees from camps went back to Bor town for settlement it has lead to disappearance of many trees from red-fed areas which has contributed significantly to soil degradation and deterioration of soil fertility. Forests are constantly being cut down for fuel and negligible replanting is carried out. As population grow and become concentrated in farming communities and villages, the treeless areas around the town where these settlements increase. The villagers have travel further to fetch firewood, this collection of wood ultimately becomes commercialized

with the men taking over the work from women this aid exposure of soil erosion at the onset of rain and offset to dry condition where evaporation, making soil to become infertile. Some of them are traditional farmers offer to cultivated the vast land, for crops through burning of grassland for easy cultivation which tended to decline organic matters and microorganism in the soil disappeared hence occurrence soil infertility resulted into soil degradation hence lowering productivity on cropland, this happen as much land being exposed to erosion agents . (Food insecurity and livelihood become hard (WRI 1996 FAO 1996).

Monoculture on agriculture land

The population of Bor town aiming for developments in agriculture has had far reaching effects on both ecological and economical status of the community. It was tradition in Bor communities as it designed to increased the productivity of farmland by growing only the best variety of crop to reduce labour cost .However it threat many part of Baidit farm ,making growth crops become yellowish due to lack of nutrients in the soil. This continuous single cropping it has hampered land yearly with out soil replenished it nutrients that are important for crops growth, this cause soil degradation, as it affected soil PH, organic matter, and microbial activities in the soil which resulted into loss of fertility and leaching, here is evidence from (ministry of agriculture forestry ,Jonglei state 2006)that crop yields reduced, due to monoculture of one type of crops like millet, sorghum, maize which can not fix nitrogen in the soil as they come out with training and work shop crop rotation program to improve soil fertility.

Overgrazing of livestock

Over grazing is a surplus of livestock population in Bor town on agriculture land is a big strain on grasses and fodder, it has contribute to the trend of cattle hardens the soil and prevents new shoots from emerging. Over grazing by goats is serious problem in certain stretches of the north East part of Bor town, the goats not only pull off leaves and branches, but also up root grass as opposed to sheet . According to (FAO 1994) explained that over grazing can degraded soil, because erosion destroyed grasses that acts to trap some particles, and reduce surface run off, and wind run off the top soil in the agricultural land hence fertility loss and soil also degraded than eventually, the crop yields become low. Over grazing become a problems as grazing land and agriculture land owned communally especially where people have settle in permanently around

water point, this has a tremendous lead to soil degradation and hence soil infertility as well as crops productivity reduced.

Extensive cultivation on cropland

In Jonglei state, Bor town rain-fed plays a very important role in socio-economic sector of the small scale farmers, providing a large and stable share of staple food. This rain-fed agriculture has contributed to a rapid increase of human and livestock population and necessitates a corresponding expansion of cultivated area. This automatically has led to over-utilization of land and thus causing soil degradation. Shifting cultivation is common tradition method where farmers move from one place to another when soil nutrients are exhausted. It involves tree logging and clearing of other vegetation cover. This is repeated year after year, resulting in destruction of primary vegetation cover, and ultimately in soil deterioration due to diminishing of soil physical and chemical properties such as organic matters, soil PH, micro-organism, and structure of the soil. This has reduced crop productivity on agriculture land. Ministry of Agriculture and Forestry, 2007 Report, indicates that most of the Baidit agriculture areas are suffering from erosion and flooding due to destruction of ecosystems and through uneconomical cultivation, like; bush burning. When land becomes scarce due to increased population, the fallow period is reduced in turn, and eventually the soils are exhausted without alternative land for growing crops.

Build up dangerous chemical

Soil pollution from dangerous chemicals has become a major problem on agriculture land of Bor town, as it leads to soil degradation. Agrochemicals and wastes channeled from the development of industries, such as business wastes, domestic sewage sludge and town composts are carried by surface runoff, ending into farm land. The soils become toxic affecting their physical and biological properties as well as leaching of nutrient therefore reduced productivity of crops (Public Health Report, 2002).

Extensive use of heavy machinery

Soil degradation on agricultural land where heavy machinery are used for cultivation and other activities has occurred on vast land through; destruction of; soil structure, physical and chemical composition, soil textures, organic matter, aeration, water infiltration capacity and stability of aggregates relating from compaction and loosening of workable

layers. Thereafter, run off results to erosion with higher percentage of fine silt that seals crust hence forming more compact and brittle layer on the surface which does not favour crop production as it degrades and makes soil infertile for crop production and other species' disappearance on farm lands. (MDTF, 2008)

Advancement of Kidepo sand

Advancement of Kidepo sand occurs from the south east part of town where human activities become indiscriminate through forest burning. The sand also occurs in Ajahager swamp being eroded to Anyidi Payam during dry period and rainy season specially in August and September where most areas are flooded. The sand eroded by surface runoff to the agricultural land covers fertile soils and affect its fertility, hence reducing crop yields. Nutrient leaching is also accelerated, a problem particularly serious in areas adjoining to the desert. The desert expanded due to poor land use management like, over grazing, deforestation, bush burning across the region influencing negative impacts to crop production.

2.2 Effects of soil degradation on agricultural land.

Biological diversity loss

The Biodiversity that make up the soil and the habitant have been affected in Jonglei Bor town's agricultural land due to extreme traditional farming. Practices such as pastoralism lead to compaction of the soil making it very hard for crop roots to penetrate for absorption of nutrients and water for effective growth and production. Monocropping also increases soil infertility and loss of organic matter on top soil. these practices have influenced degradation and loss of nutrients over time which Jeopardizes food security and increase risks for local people (Worede 1992). Loss of soil nutrients are partly due to plantation cropping, a practice that has been promoted by development agencies like USAID program that supports conservation in Jonglei state.

Loss of soil fertility on agriculture land

The most serious cause of soil degradation on agricultural land is the loss of fertility especially through mismanagement of farm land hence depleting soil nutrients due to improper agronomic practices.

UN agencies like, UNDP, FAO and USAID in 2009 developed some land tenure laws and policies for sustainable agriculture to reduce practices threatening agricultural land

by reducing fuel wood extraction, tree planting to provide organic matter and hold soil firmly and act as wind breakers. Some trees can be planted as wood lot in farm so as to control soil erosion hence curb degradation. Increase in population in Bor town from the existing community and returnees have led to high fuel wood demand which resulted to soil degradation throughout this town and its surroundings, leaving soils bare and exposed to erosion hence increased soil infertility (Hutchinson 1991).

Leaching of soil nutrients

Man's activities on agricultural land in Bor town become deleterious of soil nutrients on the farming land which resulted from over leaching of nutrient due to the activities which make soil bare. During the month of august, when floods become severe, leaching of topsoil nutrients is highly evident. Unfortunately, this is the time when the communities need to derive maximum crop yields to satisfy needs. Leaching of crop nutrients on agriculture land in Bor town is also due to over irrigation of land which washes dip nutrients, ending up affecting soil fertility. For instance at stretches of south of Bor town, there is over clearance of vast land for rice plantation on the flat ground, (Ministry of Agriculture 2006). These farming practices with excessive use of machinery have compacted the soils which always keep stagnant water on the soil surface, hence water logging and salinity resulting to low crop growth, undermines food security and livelihood becomes threatened.(Sources Blaikie 1985 and WRI 1996).

Salinity / Alkalinity

This is a major problem in Bor town occurring in the month of August and September, due to high rain fall and during dry period when local farmers along river Nile bank over irrigate their crops. This problem comes as temporary incident of water surplus above the soil surface that nutrients percolate downwards and dissolve the lower layers. During dry period, accumulated salts are brought to the surface by capillary action. The water gets evaporated, leaving behind a crust of salts of sodium, Magnesium, and calcium which have a fluorescent appearance. This salt layer plays havoc with fertility of top soil and renders vast stretch of otherwise useful land infertile; this land is known by local names like *Tiop ci Goy* (Dinka language).

Soil erosion

Soil erosion is a common problem that leads to degradation of soil on agricultural land. This is though directly related to improper land use, when top soils detached from farm land either by runoff water or blown by wind. Productivity capacity of the soil is hindered, leading to declining crop yield which then contribute to food insecurity. Erosion in this town is encouraged by both poverty and shifting cultivation.

When food and alternative sources of income are unavailable, people tend to over cultivate without fallow periods which enable them to continue farming on marginal areas which result into soil degradation. Further more, high food production in this area is dependent on modern technology which involves the use extensive machinery and monoculture, both having negative impacts on soil components. (Cleaver and Schreiber 1994, Reardon and Sheikh 1995)

Soil acidification

The impacts of acidity on the agriculture land become severe due to frequent occurrence of the floods that encourage peat soils in the months of August and September making soils to become waterlogged. Soil acidity is an increase in the ratio of hydrogen ions in comparison to “basic” ions within the soil. This ratio is expressed as PH, on scale of 0-14 with 7 being neutral. The PH of soil has major effects on plant growth, as various nutrients become unavailable for crop use at different PH levels. Most crops like leguminous plants prefer slightly acidic soils, however an increase in soil acidity levels

being found in many farmlands in Bor town renders them unsuitable for others crops production hence deterioration in crop productivity.

Reduced food production

One of the most serious consequences of soil degradation in Bor town is decline in food production. The production of one type of crop like sorghum (Dura) in many parts of Payam has declined recently due to infertility of the soil as land is fragmented. Maize crop yields for example dropped from 1.3 tons per hectare to 0.8 tons in the same area.

2.3 Threats and challenges towards soil conservation strategies on farming land.

- a) Since the signing of (CPA) compressive peace agreement in 2005 /9/ 01, the community of southern Sudan went back to the previous home land and begun a new life. The mere return increased human numbers on a fixed land resource became the genesis of the threat.
- b) The challenges faced revolve around the establishment of their farming land and measures of soil conservation on the environment in the area. These include;
 - Lack of knowledge and skill of soil management particularly bio-intensive and regenerative methods for nutrient management on farm land e.g. mulching, cover cropping, intercropping, crop rotation and minimum tillage.
 - Lack of agro forestry development (aforestation and re-aforestation) stressing the integration of indigenous trees in to farming systems, and development of community tree nurseries.
 - Culture of community has constraints to soil conservation management. Culture is interested in keeping livestock and over cultivating of land on a large scale exposing it to soil to erosion.
 - Natural calamities especially drought and floods stress management of farming land and degrading the soils.
 - Poor farming activities such as monocropping, extensive machinery use, shifting cultivation among others, affect agricultural land.
 - Increased insecurity between the raiders community give limited time for soil conservation

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- Government policies of limited farming support finance affect agriculture and soil and water conservation projects.
 - Lack of organic farming like; compost manure, green manure, farm yard as fertilizers to improved soil fertility.

CHAPTER THREE

DESCRIPTION OF THE STUDY AND METHODOLOGY

3.0 Introduction

This chapter deals with research methodologies of the study, and discusses different aspects of geographical area in which the research was carried out. Other variables like; research design, study population, sample size, research instruments, sources of data, sampling technologies and data analysis are covered.

3.1 Description of the Study Area

Bor town, Jonglei state is located far north west of Juba capital of South Sudan with about 150 km from Juba and bordered with five counties as follows; Pibor to the far east of Ethiopia and Pocholla to the east whereas River Nile in the west, Twic in the north east and Baidit town in the south. The vegetation is savanna grassland with bio-modal rainfall between April and May as well as August to September.

3.2 Research design

The study was both qualitative and quantitative, the quantitative data was acquired using structured questionnaires from different back grounds of people such as; Local Leaders, NGO Operating in the area and Religious and Cultural Leaders, to acquire information through assessment and evaluation on the effects of soil degradation on agricultural land in Bor town, Jonglei State - south Sudan. On the other hand, the qualitative data was acquired from key stakeholders through interviews and observations to get exact information from existing problems.

3.3 Population of the study

The approximate population in Bor town, Jonglei State is 50,000 people according to 2007 Population Census in South Sudan while the whole state population is one million people, with eleven counties, only about 60% are farmers and 40% business community.

It was not easy to acquire detailed information on the forms of soil degradation and effects, because Bor town is an agricultural as well as business centre. About one quarter of the population are not farmers.

3.4 Sample size

Due to limitation of time and finance, the researcher was not able to obtain information from large population at once in the town. Therefore a sample was drawn to represent the whole population. The sample used consisted of 50 respondents who were selected among local people, local leaders, including agricultural extension officers, cultural leaders and political leaders, conservationist that deal with conservation of soil which helped in identification of effects of soil degradation as a problem in conservation.

Table 1: The Table Shows Sample Used in the Study

Title Of Respondents	Number Of Respondents
Males	28
Females	22
Total	50

Source: Primary data

3.5 Sampling procedures

This study involved selecting a total of 50 respondents from the communities or population as targeted area of study; this was purposively selected from different communities and the population in the town. These included; local leaders, cultural and political leaders, conservationist individuals. At least counties like; Payams and Bomas were acquired from Town Council and Local Government and the respondents were chosen in relation to their specialization in the communities related to the effects of soil degradation on farm land.

3.6. Methods / Tools of Data Collection

Various methods were used to collect data from the field, these included; questionnaire, literature and interviews, observations, and photography, for qualitative research and interview guide of key informants were employed.

3.6.1 Questionnaires

The researcher developed logical sets of questions with the following variables such as; forms of soil degradation, effects and solution that have been put in place, closed and open ended question were used.

3.6.2 Observation

The researcher was involved in serious observation to obtain first hand information in order to help him prove whether the information that was given by the respondents was exact. This enabled the researcher to get information that related to the forms of soil degradation and their effects that existed.

3.6.3 Photography

The researcher photographed features in the field of specific interest. These photos reflected the forms of soil degradation and the effects of degradation on agricultural land in Bor town areas.

3.6.4 Interviews

The researcher asked respondents to get quick and flexible information from him with immediate problems without errors on the topic of the research specifically to the problem that could not easily be covered in the questionnaire.

3.6.5 Data Control and Measurement

The data collected was examined or tested and interpreted by the researcher. This was done by carrying out an additional research and applying other methods like; observation through ground truthing and literature check. All these sources were put together and measured for accuracy and correctness to determine the consistency of the data collected.

3.6.6 Data Processing and Analysis

The researcher made sure that the quantitative or qualitative data was successfully edited, coded and tabulated manually; this was done by observing and checking the questionnaires properly and after being filled by the respondent, the researcher corrected the questionnaires and singled out the useless information.

3.6.7 Ethical Procedures of Data Analysis

The use of questionnaire of data analysis guide was applied by the researcher to many respondents. The questionnaire was given to different people and their answers were useful to reduce chances of prejudice or minimizing errors.

The researcher physically and practically participated in literature search on the impact of farming communities due to loss of fertility in the farming land which resulted into food insecurity as crop production was reduced. With the help of check lists, the researcher corrected and recorded viable information provided as first hand from respondents in the community.

For genuine reason among the respondents, the researcher explained in details why he was carrying out the study and that was to interrogate the effects of soil degradation that came as a result of poor farming methods on agricultural land. The researcher gave a guarantee for respondents who wished their information and names to be kept confidential not to be exposed.

CHAPTER FOUR

PRESENTATION AND INTERPRETATION OF RESEARCH FINDINGS

4.0 Introduction.

This chapter discusses and interprets findings of the study carried out on the effects of soil degradation on farming land in Bor town Jonglei state. The major variables considered the following forms of soil degradation and their impacts on farming land, measure being taken and recommendation on how to manage soil on agricultural land.

4.1 Forms of Soil Degradation in Bor town

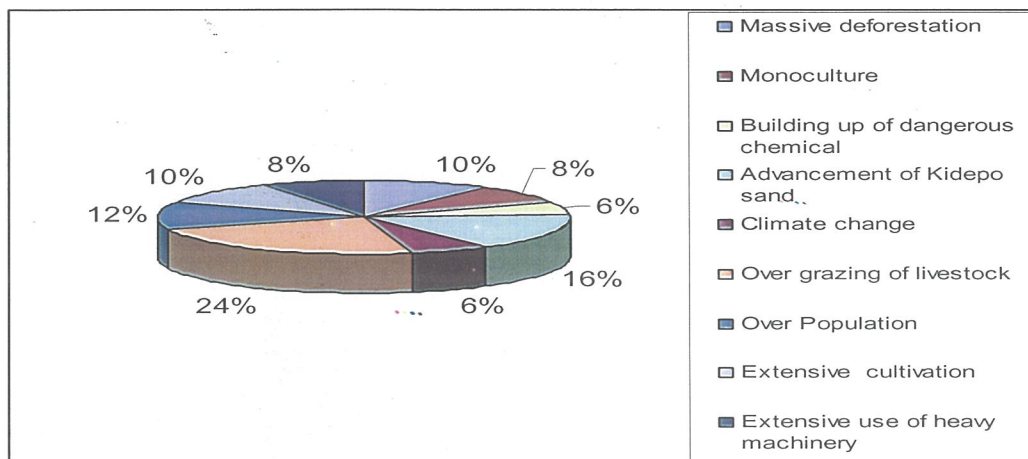
In Bor town state, there are various forms of soil degradation which occur due to agricultural activities and other activities and they include the following; massive deforestation, over grazing of live stocks, extensive cultivation, monoculture, over population, building up of dangerous chemical, climate change, and extensive use of heavy machinery.

Table 2: Showing forms of soil degradation

Forms of soil degradation	Number of respondents	Percentages
Massive deforestation	5	10.21
Monoculture	4	8.16
Building up of dangerous chemical	3	4.8
Advancement of Kidepo sand	8	16.33
Climate change	3	6.13
Over grazing of livestock	12	24.49
Over Population	6	12.24
Extensive cultivation	5	10.21
Extensive use of heavy machinery	4	8.16
Total	50	100.00

Sources: Primary Data

Fig 2: Showing forms of soil degradation



Sources: Primary Data

4.2. Massive Deforestation

This is massive cutting down of trees for many uses such as; timber to be sold for money, poles for construction of houses and cultivation of crops and threatening of soil productivity and land creation by people affected by cattle raiders tend to look for land with fertile zones along the river Nile. Almost 10 kilometers from town local communities, trees have cleared around town due to high demand for timber in households construction such as furniture and building materials, and high consumption of charcoal in Bor town among the homesteads as sources of energy for cooking. In this town, 10% of charcoal is used as source of energy every year. Such activities can easily affect vegetation which are essential to minimize severe erosion in the farm land, if they are not maintained sustainably, local people cannot travel to great distance to fetch fire wood in far ends as a result of soil degradation.

The majority of the communities in towns were refugees in East Africa which were repatriated under care of (UNHCR / IOM), underwent cutting down of trees for fuel to sustain a living due to lack of income, these activities in town has resulted to deterioration of the soil as the land is exposed to erosion hence less production of crops under arable land.

A majority of people in town live in severe poverty, this makes some of them demand for land to cultivate but unfortunately because of being poor, they adopt poor farming practices, which they use to cultivate the land during dry season and this is through clearing the land so that it is easy to prepare for cultivation. This temper with soil components which are important for fertility hence affecting, the biological, physical and chemical properties that make soil to lose its fertility therefore the extreme erosion by water and wind encouraging low crop yields. This is due to lack of capital for ploughing and clearing land and laziness to cultivate on the land. The local people in this area are pastoralists, they keep livestock to sustain living but the livestock is so many for them because they are poor, they don't have an alternative means of living, which leads to overgrazing of the agricultural land thus reducing grass cover by breaking soil through their hooves hence expose land to erosion and loss of fertility hence soil degradation becomes alleged to low crop production.

4.3 Building up of Dangerous Chemical

Solid waste is defined as any discarded material that is not liquid or gas for instance polythene bags, cans, garbage, papers. Solid waste management in town is poor because the contracting company finds it difficult to manage the waste because many people dump waste around the edges of their farms in large heaps, where polythene bags are scattered in the agricultural land and some are non biodegradable wastes decomposed where leachate drain into the farm land and destroy the crops as well as it penetrates into the soil affecting microbial activities hence nutrients leached to the underground, therefore soil does not have potential to maintain its productivity.

4.4 Floods and Drought Occurrence

The farming land of Bor town began to experience heavy rains in month of July through August and September. The town is lying in low attitudes, such as areas like Makuach, Baidit are swampy. The nature of soil does not help in productivity, due to poor drainage soil, as leaching of nutrients highly occurs due to stagnant water which makes soil not favourable to the plant roots' zone to breath effectively. This degradation is caused by

frequent flooding as well drought make soil to be come loose and easily be eroded at dry period in the month of January to may, hence the top soil lose its nutrients which can be utilized by the plants in the growing season, therefore soil degradation exacerbated by this catastrophe has reduced soil fertility on arable land in town.

4.5 Extensive cultivation

The soil in Bor town lost its capacity of nutrients on farming land due to extensive cultivation, due to continuous rain-fed agriculture system every year, to maintain subsistence stability in the communities such crops are; sorghum and maize, sukuma, sesame, okra, egg plant, are grown along the Nile banks and swamp areas in Bor town at dry periods. These agriculture activities resulted due to increase in human and livestock which affects fertility of soil that makes soils to exhaust of crops nutrients, thus causing soil degradation, therefore low crop yields which encourage shifting cultivation leads to fragmentation of farming land in Bor town. This involves activities during land preparation, where removal of trees and uprooting of weeds and also use of herbicides ends up killing microorganisms presence in the soil as well degraded the components of soil thus lowering of moisture, and inhibited the aeration and soil structure, and organic matters through extreme compact of soil and the effects of chemicals used to control weeds. This has been repeated every year resulting to hampering vegetation covers and soil horizon. Therefore, ultimately soil degradation, existed through the activities which deteriorated the soil components which are essential for productivity. The most substantial convenient to increase soil fertility is by taking agricultural lands, fallow periods and pastures management whenever possible.

4.6 Extensive Use of Heavy Machinery

The mechanizing of agriculture began in late 2008 - Multi-Donor Trust Fund (MDTF) local NGO, fund micro-project benefited in Bor town with tractors has led to soil degradation after they have cultivated extensively four hectares of virgin land which currently left soil bare due to uprooting the large trees and vegetation cover on agricultural field for growing, sorghum and millet, maize, this activities increased extremes erosion in the areas since they have scattered trees and also semi-arid

characteristics, and the heavy rainfall in August causes water to be stagnant in the field hence compaction of soil due to water logging the soil which binds structure of the soil together as well removal of top soil by running water has reduce fertility. This has led to shifting of the same farms to a productive soil around the same land ending destruction of soil hence low crops yield.

4.7 Overgrazing of Livestock

The population of Bor town has been practiced keeping of livestock extensively for long period. These are cattle, goat, sheep, for multi-purpose in Dinka communities mainly for dowry payment, as well as source of food and income generation and even for prestige.

The Bor town communities specifically to livestock farmers has led to geographical change through shifting from one place to another has influenced soil degradation through agents erosion, due to the animals break soil through their hooves which has exposed soil erosion hence making farming lands compete for land due to destruction of soil fertility caused by movement of live stocks.

4.8 Advancement of Kidepo Sand

In agriculture fields of Bor town, the advancement of Kidepo sand became extremely as it reduced crop production at the month of August and September throughout the year due to frequent flooding which resulted to surface run off of top soil carrying away nutrients that is required by plant growth hence increase infertility of soil through changes of soil properties during dry season, where wind erosion swept off the loss soil when it dry hence soil components are destroyed therefore loses its status for production.

4.9 Monoculture on Farming Land

The most communities in Bor town are uniformly cultivators of one type of crops. For example among Dinka communities, their staple food being cultivated every year is sorghum, become most wanted in their history since genesis. In this modern agriculture, the adopted use synthesized fertilizers which have great impact on the land which their needs to produce much crops yield. This standardization of farming results in much waste of land and inefficient harvesting which has made farmers do shift from one land to

another leading to land degradation. Due to bush burning, the fertility of soil has been inhibited because of exhaustion of nutrients as soil becomes compacted; it develops colloid extensive due to over digging of the same land, creating hardpan and affect microbial activities in the soil as well as soil properties deteriorated. The infestation of weeds and pests management has reduced fertility of the soil through competition of nutrient in the fields by crops and weeds and use of inorganic fertilizers has contributed to leaching of nutrients to the layers which cannot be reached by plant roots zone, hence soil loss its natural appearance.

4.10 Effects of soil degradation on agricultural land

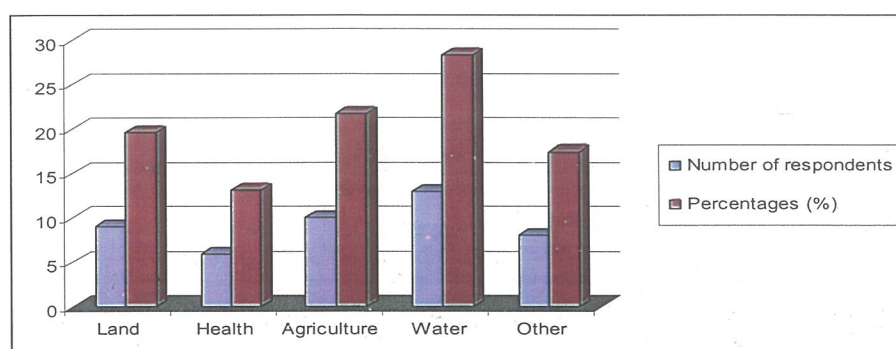
The presence of the Bor town soil degradation on arable land has caused by many activities as showed below;

Table 3: Effects of Soil Degradation

Activities affected	Number of respondents	Percentages (%)
Land	9	19.57
Health	6	13.04
Agriculture	10	21.74
Water	13	28.26
Other	8	17.39
Total	46	100

Source: Primary Data

Fig 3: Effects of soil degradation



Source: Primary Data

Biological Diversity Loss

Biodiversity - refers to the variety and viability of living things which can be measured at the genetic, species and ecosystem level. The genetic disappearance and species loss is greatly indicated by the disappearance of the *crane and ibis* which were common dominated birds in Bor town since 1980s before the country ran into war and soil degraded by over cultivation with the use of shifting cultivation and massive cutting of trees by people to meet high fuel wood for cooking and charcoal burning for domestic used as well as commercial activities to earn a living became a major cause of biodiversity loss, such destruction of habitat for wildlife species enhance them to migration meanwhile exposed land to erosion hence fertility loss which local communities could not access high crops yield. The deforestation of trees and burning of charcoal, over cultivation, monoculture and other causes of biodiversity loss, all of the above mention came to an existence as population in Bor town concentrated on farming land which resulted into soil degradation due to insufficiency of microbial activities in the soil leading to presence of an unanimous human induce factors.

Loss of Soil Fertility

The change in land management in Bor town is due to cutting down of trees and overuse of shifting cultivation to improve their crop yield has contributed to impacts of biological diversity loss and degradation of soil as well as catastrophes contributed to erode away the fertile topsoil through leaching of nutrients downward by infiltration of water from the surface into underground. The diffusion of chemical from domestic wastes and agriculture input has also contaminated the soil from farms land which dispersed soil nutrient and washed away by the rainfall into river Nile and swamps. This occurred as biodiversity and organic matter decline in the soil exposed to erosion and contamination increase in the soil through the absence of organic matter which acts as a buffer zone of the soil, the plant remains and animal manure contain carbon, nitrogen and phosphorous which are potential for soil fertility when they are to reduce on the arable land then degradation hampered soil components function such as water holding capacity, aeration, PH of the soil. *The Ministry For Agriculture, Food And Poverty Affairs (2006)* is currently funding projects that aim to develop a forestation programme as indication of

soil fertility, and soil degradation management as to monitor crop productivity through soil, survey so that to maintain soil biological functions hence soil degradation can be minimize in town on farming land through conservation strategies like construction of trash line, terraces, to reduce movement of runoff water during raining seasons since runoff water eroded the topsoil all over the farms and to the swamps around the town .

The population in town has suffered from critical food in security as some land loss fertility due to lack for fallow period. There are workshops being conducted to local communities every month to trains them on proper methods of farming and soil management strategies.

Reduction of Food Production

The Bor town population suffers from food insecurity due to major impacts of soil degradation on arable land.

This happens through several factors as explained below.

Floods and drought occurrences, the frequent occurrences of floods and drought during dry periods and wet season has degraded the soil and claimed a lot of food reduction being subsidized by the provision of small ration by (NGO) W.F.P to local communities several respondent suggested that due to loss of soil fertility is through over cultivation of land coupled with frequent of floods and drought that lower agriculture output which has taken up a certain percentage. This is because small land around the town get degraded and become infertile due to lack of management or practices of sustainable agriculture like crop rotation mulching, farmyard manure application. This is because people are illiterate in this town on the use of any soil management strategies to improve crop yield. The problems of food insecurity is manifested by soil infertility on agricultural and which is characterized by compacted soil, bare soil, lose soil, water logged soil, this indicated lack of food production due to infertile soil depreciated yield of crops. One respondent explained that, *“due to infertile soil the yield of sorghum after harvest is less than twenty bags produced by every farmers, because soil is exhausted on farm land.”*

Soil erosion

Soil erosion is a common problem throughout the agricultural land in Bor town which has affected the production capacity of the land because the natural vegetation has been diminished through shifting cultivation and expansion of cultivated land which results to poor quality soil and lead to declined crops yield, the infertility is exacerbated by surface runoff and wind carrying away soil that is rich in nutrients and deducted in facilitation of microbial activities, this has impacted on soil quality which then contributes to food insecurity due to barrenness of soil hence unsuitable for plants growth.

Around water wells, there are many farms during dry periods the cattle drinks at evening and morning when they are derived for grazing the stumped on the land which has drastically broke the soil particles and soil becomes loose. This has accelerated effects of soil degradation in such area around town, the farming lands are overcrowded than heavily overgrazing leave the soil vulnerable to erosion at the same time leads to food insecurity as well poverty can lead to soil over use resources, that results to many ultimate causes of soil degradation on farming land through their contribution and determination for their survival, but nevertheless and hopefully he has also the ability to prevent and overcome these problems through management.

Salinity and alkalinity

Salinization is the accumulation of the salt on the arable land that is caused by flooding and irrigation which results to accumulation of salt on the fields especially during the dry periods where temperatures are extremely high thus evapo-transpiration is increased making soil lose its moisture. High concentration of salt level in the soils hampered the production as it reduces the ability of plants that are less in saline to grow or even survive. This is caused by natural processes but much occurs as a consequence of human action. Salinity acts like AIDS disease affecting the soil fertility in Bor town in arable land as it influences and deteriorates the components that makes up the soils, particularly in rural communities where crops production has been seriously affected which causes economic hardship, salinity problems soil components have been grouped into two types.

Dry land salinity in town is caused by the charge of saline accumulate of the surface of the soil that results to disappearance of nutrients on the surface. This is through burning of the soil hence reducing moisture due to large scale clearing of forests since Dinka repatriated communities settlement increased high demand for land to be cultivated and many activities led to degradation of fertile farming land.

Wet land salinity in Bor town occurs due to frequent flooding which transports materials that are picked up by surface run off into agriculture fields hence reducing soil fertility when water evaporates heaving salt deposits in the soil hence a celebrate degradation of nutrients therefore low crop yields obtained by the farmers.

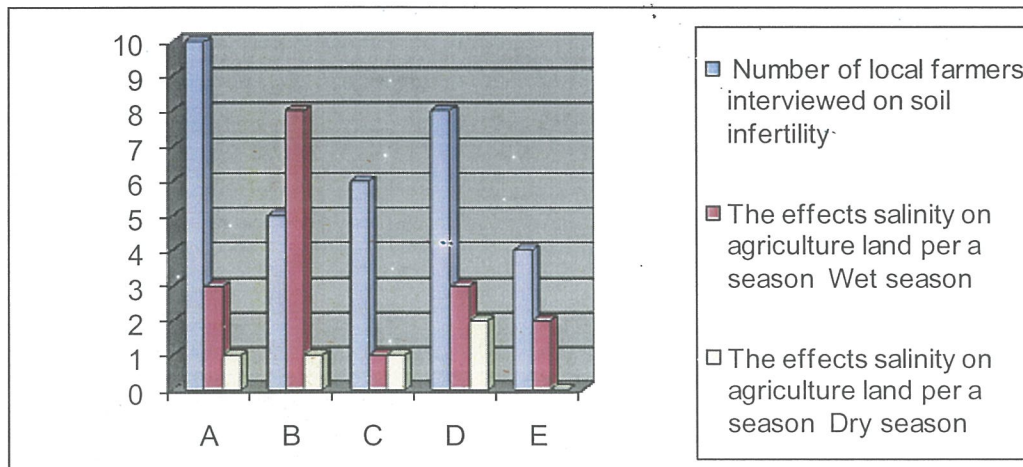
The dry salinity and wetland salinity in town has contributed to soil degradation due to frequent floods and over irrigation along the Nile bank which hampered soil management in town. The irrigation of the fields along the bank were thought to be good by the residents but it favored agents of the erosion in agriculture land between wet season (*May and September* and dry season in *November – April*) for example; the soil erosion in the month of May to August 2010 due to frequent flooding affected vast crop land in Bor town

Table 4: The comparison of soil degradation caused by dry land salinity and wet land salinity in different seasons

Level of soil degraded cause by dry land salinity and wetland salinity in different zones	Number of local farmers interviewed on soil infertility	The effects salinity on agriculture land per a season	
		Wet season	Dry season
A	10	3	1
B	5	8	1
C	6	1	1
D	8	3	2
E	4	2	0

Source: Primary Data

Figure 4: The comparison of soil degradation caused by dry land salinity and wet land salinity in different seasons



Source: Primary Data

Soil acidification

This is problem becomes increasing and more common in cultivated soils along the Nile banks due to several number of agricultural practices have expanded the degradation of such a soil. The main causal factor is the growth of plants that use large amount of basic ions (e.g. legumes); particularly when fertilizers that leaves acidic residues (such as super phosphate) are used. Subsequently soil acidification is the increase in the ratio of hydrogen ion comparison to basic-ions within the soil. This ratio is expressed as PH on the scale off on 0 – 14 with 7 being neutral. The PH of the soil can have more effects on plant growth, as various nutrients become unviable for plant use at different PH levels” most plants prefer slightly acidic soils, however and many areas of cultivated land is being found in many areas of farming land in Bor town, Jonglei state render soil to degraded it nutrients that make agriculture land unsuitable for crops productivity. This requires extensive management to be undertaken to improve soil components.

CHAPTER FIVE

DISCUSSION OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter deals with discussion of the findings, draws the conclusions as well as making recommendations to the research carried out. After a brief presentation of the general information of the respondents, the conclusions are presented basing on the five objectives of the study set to establish the impact of soil degradation and agricultural land of Jonglei state, Bor town district – southern Sudan. Specific recommendations emanating from the findings follow at the end of the chapter.

5.1 Measures Being Taken to Minimize Soil Degradation on Arable Land

The government and stakeholders as well as Non Government Organization have tried to put some of mitigation measures to conserves soil from existing forms of soil degradation as explained below;

Government and local as well as international NGO, in Bor town established, environmental sound development practice including Environmental Impacts Assessment (EIA) to monitor and evaluated the large scale agricultural practices such as mechanized agriculture which invoices conventional tillage that uses tractors' conservationist have been trained in soil conservation a major at Boma levels to local farmers, especially the soil management strategies in agricultural training centre, this work was facilitated by the government to revitalized through NGOs support, the training dealt with agricultural practices as human induce factor that have adverse effects on soil conservation, therefore, the conservation agricultural practices was to be introduced.

The government officials and local NGOs workers have been trained in soil conservation practices so that to promote environmental sound practices on arable land hence to increase high yields. At the beginning of 2009 in Bor town, the (USAID) supported

conservation of arable and through biodiversity conservation program, aim at conserving the soil from losing its fertility, to ensure the farming communities to benefit from sustainable agriculture due to respects of soil management strategies like crop rotation.

USAID and UNDP have helped to mobilized the farmers and forestry sector in Bor town by training forestry officials in proper soil management, the agro forestry extension aiming at reducing the adverse effects of soil degradation on arable land UN agencies such as UNDP, FAO, and USAID are helping the Jonglei state government to develop the land tenures laws and policies through and extensive stakeholders, process as secure right for sustainable agriculture to reduced the effect that degraded the arable land in Bor town. These efforts are helping farmers and pastoralists to secure land right for easy soil management hence to improve land for sustainable agriculture production.

5.2 Suggestions and Recommendations

There should be construction of dike in order to minimized the overflow of water during the frequent of flooding along the bank on the onset of the rainfall and minimize on the movement of livestock hence little soil degradation on the arable land curb down.

The GOSS, Jonglei states government and NGOs, in collaboration with Bor town, town council should exercise massive education to farmers n the importance of soil conservation on arable land, this would reduce the agricultural land degradation. Farmers should be encouraged to voluntarily organize themselves to be cooperative societies and association aimed specifically at soil conservation objectives. The agricultural stakeholders should be the main target behind the establishment of organization in order to provide strategies and environmentally sustainable agriculture issues and forum through which large scale and local farmers group can share knowledge, and identify course of action and work toward solution in soil management to improving soil fertility.

Diking to isolate Bor farming areas near the river bank from frequent flooding, that washed away the top soil which is productive, the present dike along the river bank in the eastern of periphery of Bor town has minimized overflow of water for last few years since the construction began. The adverse soil degradation impacts caused by the floods

contributed to change in the fertility of the soil and agricultural land use related to over grazing has lead to soil exhaustion. The Ramsar convention Gross in November, 2006 at Juba denotes the Sudd wetland in Bor town has been encroached due to population increases. The International Convention ratified the cause of degradation as human activities, thus Ramsar sites standards, laws and regulations were to be implemented to minimize soil degradation and other biodiversity disappearance.

The farmers to regulate the agricultural activities along the wetlands through NGOs and local government should create awareness and campaign for sustainable and soil conservation to minimized forms of soil degradation impacts on crop production on Bor town arable land and, other vegetation covers. The existing systems of land ownership should be modified from land use policies either clan land or communal ownership to individual ownership. This will ease effects of soil degradation by reduce soil erosion, over grazing and infertility so that to increase crop production on arable land.

Alternative agricultural methods of farming system should be introduced in order to promote soil conservation of the arable environments. The methods of soil conservation such as crop rotation, rotational grazing, mulching, strip, intercropping, cropping, minimum tillage, should be encouraged to reduce loss of nutrients by increasing the fallow period.

A forestation and reforestation programme emphasized mostly by the local farmer and NGOs in order to rehabilitate frees that have been cut down to over cultivation and settlement, timber, charcoal and pasture improvement and to reduced soil degradation and worse impacts which reduce crop production.

Agroforestry should be agricultural practice that deserved to be used by the whole people/farmers due to multi-uses. Conservational functions, it is used to provide organic manure, wind break, reduction speed of rain drop, and minimized the loss of moisture and hold soil firmly to control erosion that degraded the soil. It is natural environmental conservation which attracts farmers to based most to increase fertility of soil on arable land.

Development of other sectors of economy which can reduced the used of land, tourism, transport and communication among others could reduced number of farmers over cultivated the arable land and reduced local dependency of agriculture as the only wealth based activities, hence reduce pressure that degraded the fertility soil on arable land.

Environmental impacts assessment should be best tool to monitor and evaluate for developing sustainable proper agricultural practices in Bor town either at large scale or local scale level.

There is needs for the local farmers to introduced irrigation schemes on the arable land during dry period to reduced the chances of soil drying up exposing the land to denudation which can resulted to loss of top soil hence in fertility increased.

Organic farming, mulching, agro-forestry, planting cover crops practice soil water conservation methods, like digging trenching for easy facilitation of surface run off that can eroded the soil hence degradation curbed it down.

The government should introduced soil conservation projects at rural levels that can address local harvest and early planting of resistant varieties to low nutrients soil.

The ministry of the agriculture and state government should set up agricultural projects that address improved soil management, improvement of crop yields and livestock management to reduce the soil breaking by the moving animals on the land at the grazing fields.

Government should provide capacity building of the farmers' communities in management of soil on agricultural land not to loss it fertility, by provision of incentive to the poor who can engage in wood fuel to get money for survival.

The government and local NGOs, should provide alternative mean for cooking to reduce the communities by practicing deforestation for the purpose of wood for domestic used, this local NGOs like FAO, UNEP must introduce the use of bio-gas for cooking and

lightening, especially from during of cattle, as trees to be conserves and hence helped to improved soil fertility by holding soil together and contribution of leaves on the soil to improve productivity of crops.

The local NGOs should also provide use of solar panels which provide solar lightening to the local communities which the wont demand for fire wood as source of light and fuel that will assist in soil conservation and land management. The local NGOs and government in the states should introduce the use of improved charcoal stores that consumes less firewood and charcoal can minimized soil plants destruction which shall increase fertility of soil rather than degradation. The use of solar cookers should be introduced by the communities to minimize the use of fire wood hence soil erosion agents can be control effectively.

Research should be encouraged in Bor town arable land to promote sustainable agriculture projects. The research should evaluate on farming systems designed to maximized use of marginal land that many small scale farmers should given chances to cultivate. It should be discuss and also investigate the use of alternative farming system such as integrated pest and soil conservation management through agro forestry on arable land to reduce soil degradation effects.

Government, international organizations, UN agencies such UNEP, FAO, UCN and local authorities, should invest in remote sensing and Geographic Information Systems (GIS) to monitor and evaluates agriculture activities that lead to soil degradation by use of soil sampling method to take soil to the laboratory soil analytically it fertility and therefore to enhance and recorded the differences in soil fertility on the sensitive arable land on wetland along river Nile bank.

Protection of wetland farmers set on fires for easy cultivation method to reduce the grasses, reads, papyrus which added less nutrients on Bor town arable land. If extremes fires are prevented it promote soil fertility by not destroyed the structure of the soil hence soil degradation reduce therefore crop production increase. Since the agricultural land in Bor town is degraded due to large population practicing farming, the land reduces in size.

Some of arable land gazette forest reserves which would promote soil conservation hence soil management become efficiency.

Goss and states authorities should provide security for the farmers in Bor town for easy monitoring and evaluation to avoid poor agricultural practices concentration on specific land.

There is need to register all the agriculturalist and training the farmers in better methods of farming. This vital to create awareness among the farmers by open up training institution near cultivated sites such as Bor town in order to enable them to practice sustainable farming in wetland.

The government and international NGOs should introduce exotic method of keeping livestock, like zero grazing to minimized soil degradation due to over stocking of animals must be abolished hence soil conserves for it suitability.

The local government should be adapted the strategy to curb climate change measures on soil to maintain its fertility by doing early planting, planting drought resistant varieties, reduction herd size, and planting high yielding crops and leguminous plants that can added nutrients into the soils.

The UN agencies like W.F.P, (CRS) NPA should solve the food insecurity by providing food items to local communities which depended on over cultivation of land for their satisfaction, as the (N.P.A) Norwegians provide aid by providing high breed seeds to enhance crops yields. They should provide agricultural advisory services through extension officers and farmers to equip them with knowledge and skills for proper land use and how soil and be managed without losing it components.

5.3 Conclusion

Agriculturalists and communities in Bor town are extremely being affected by the adverse effect of soil degradation on the arable land, have become tremendously increase food insecurity, this reduction of fertility of the soil nutrients cannot be leave in abandoned without mitigation measure to be taken to reduced the forms of soil degradation, if the rates of effects and forms accelerate on the arable land, therefore the deterioration of the soil components doubles if self hence fertility should loss in the soil.

The traditional methods of farming in Bor town has maximized production as well as minimization the cost of food production with regard to the impacts of soil degradation on the arable land and the services it provides to the community. The current traditional agricultural practices in Bor town will be unstable due to large population carried out poor farming systems on the arable land which invaded the soil fertility through a diverse effect of soil degradation that resulted to high incidences of low crop yields due to loss of nutrients.

The encroachment of farming land by livestock and over farming the fertile land throughout will be solved and shaped by how farming population resolves the balance for animal food products and soil conservation services. Since the soils on arable land are finite, the huge expansion of livestock sector required to meet expanding demand must be finished while substantially reducing the effects of soil degradation on the farming land.

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APPENDICES

APPENDIX 1

QUESTIONNAIRES FOR SELECTED RESIDENTS, LOCAL FARMERS LEADERS IN BOR TOWN, JONGLEI SATE SOUTHERN SUDAN

Dear Respondent,

I am ATEM PUKA AROK, a student at Kampala International University offering a Bachelor's degree of Science in Environmental Management carrying out a research study on the, "*Effects Of Soil Degradation on Arable Land and Sustainable Conservation Of Soil.*". I'm privileged to have you as my respondent and the information given to me is purely academic and will be treated with confidentiality.

Instructions

Please tick the appropriate corresponding box necessary where you are provided with alternative

SECTION A

BIO DATA

1) Gender

- a) Male ☐
- b) Female ☐

2) Education background

- | | | | |
|---------------|--------------------------|--------------|--------------------------|
| i) None | <input type="checkbox"/> | | |
| ii) P1 – P4 | <input type="checkbox"/> | v) Tertiary | <input type="checkbox"/> |
| iii) P5 – P7 | <input type="checkbox"/> | vi) 0 level | <input type="checkbox"/> |
| iv) Secondary | <input type="checkbox"/> | vii) A level | <input type="checkbox"/> |

viii) Diploma ☐

ix) Others, Specify

3) Age

a) 18 – 25 ☐

b) 26 – 35 ☐

c) 36+ ☐

d) Others, Specify

4) Marital status

a) Single ☐

b) Married ☐

c) Divorced ☐

5) How long did you stayed in this Town?

.....
.....

6) What is your observation concerning the forms of soil degradation on arable land in this town?

.....
.....

7) What is your occupation?

.....
.....

8) Number of local farmers.

.....
.....

9) When are seasons for starting farming in this area?

.....
.....

10) What are the methods of cultivation by then?

.....
.....

11) Do you still carry out the same methods if any?

a. Yes ☐ No ☐

If Yes explain

.....

Thanks for your cooperation

APPENDIX II

INTERVIEW GUIDE FOR SELECTED GOVERNMENT OFFICIAL

Interview Guide for selected government official, local framers and conservation in Bor town, Jonglei State Southern Sudan

Dear Respondent,

I am ATEM PUKA AROK, a student at Kampala International University offering a Bachelor's degree of Science in Environmental Management carrying out a research study on the, "*Effects Of Soil Degradation On Arable Land And Sustainable Conservation Of Soil.*". I'm privileged to have you as my respondent and the information given to me is purely academic and will be treated with confidentiality.

Instructions

Please tick the appropriate corresponding box necessary where you are provided with alternative

SECTION B

Forms of Soil Degradation on Arable Land

1. (a) Is there any soil degradation that takes place here?

Yes ☐

No ☐

(b) If yes, list and explain them

.....
.....

2. Do the forms of soil degradation have effects to crop production?

Yes ☐

No ☐

(a) If yes, what impacts are they?

.....
.....
(b) If not explained ~
.....
.....

3. Do the people contribute to the above forms in any way?

Yes ☐

No ☐

If yes explain
.....
.....

4. Do you think farming practices carried out in this region degrade soil?

Yes

☐

No

☐

(a) If yes explain degradation
.....
.....

Thanks for your cooperation

APENDIX III
SECTION C

EFFECTS OF SOIL DEGRADATION

1. Does soil degradation affect you in any way?

Yes ☐

No ☐

If yes explain

.....
.....

If No, why?

.....
.....

2. Does soil degradation have effects on livelihood of people in Bor town?

Yes ☐

No ☐

If yes, who are the most affected group of people?

.....
.....

Thanks for your cooperation

APENDIX IV
SECTION D

MEASURE BEING TAKEN TO MINIMIZE SOIL DEGRADATION ARABLE LAND

3. Are there some solutions that have been done to reduced soil degradation on arable land in Bor town?

Yes ☐ No ☐

If yes, name them

.....
.....

2. In your attempt to solve the problem of soil degradation did you get help from any body agency?

Yes ☐ No ☐

If yes name them

.....
.....

Thanks for your cooperation

APPENDIX V

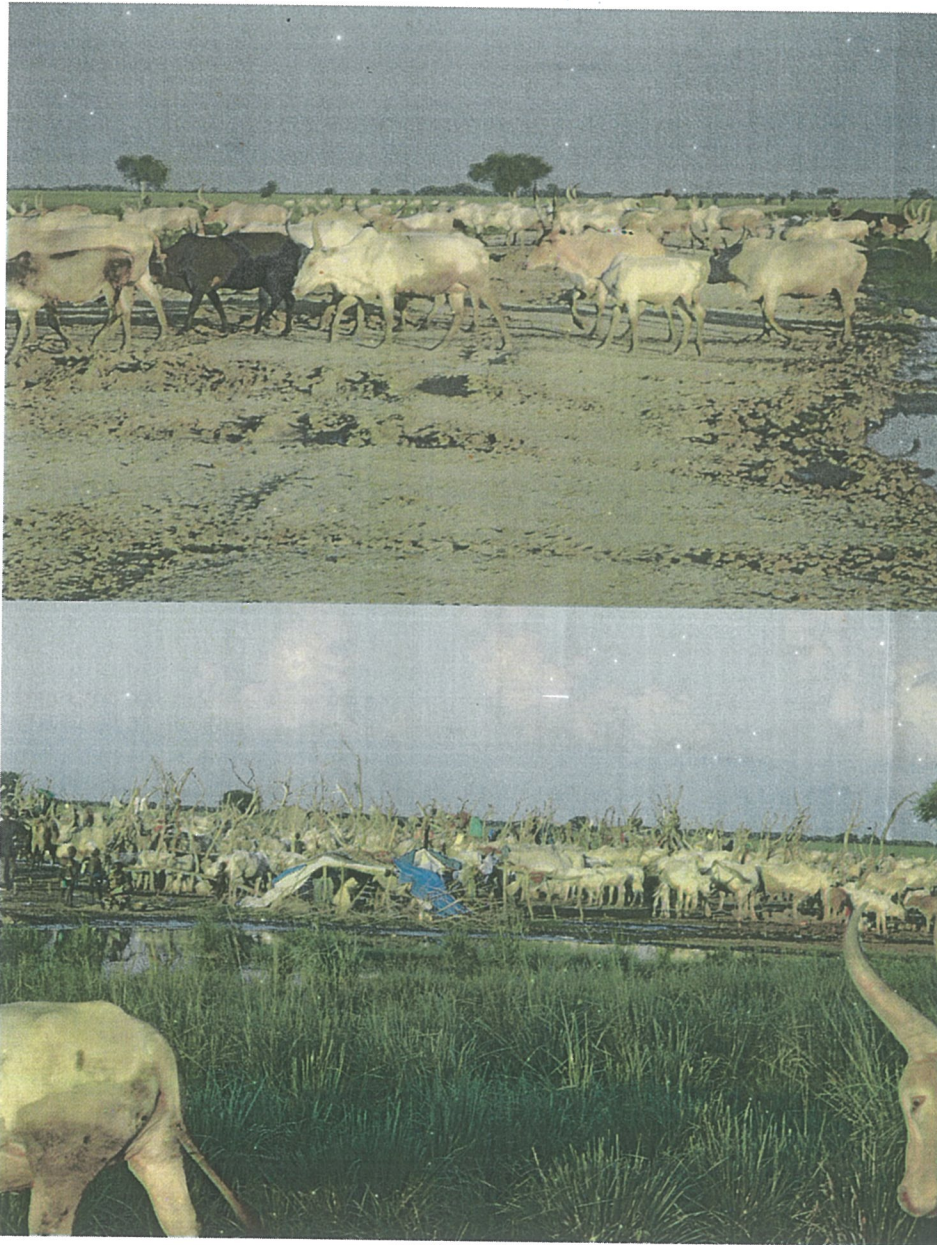
FORMS OF SOIL DEGRADATION



Monoculture



Dike method of control floods



Overgrazing of Livestock