AN ASSESSMENT OF THE MAGNITUDE AND RATE OF DESERTIFICATION IN YOBE STATE, NIGERIA (1970-2005) USING REMOTE SENSING/GIS APPROACH

BY

BILLY, *Justin*

MSC/SCIEN/04307/2006-07

A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA, IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTER OF SCIENCE (MSC) IN GEOGRAPHY

DEPARTMENT OF GEOGRAPHY

FACULTY OF SCIENCE

AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

JUNE, 2011

CERTIFICATION

This thesis entitled: *"An Assessment of the Magnitude of Desertification in Yobe State, Nigeria Using Remote Sensing/GIS Approach"* by BIILY, Justin meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria and it is therefore approved for its contributions to knowledge and literary presentation.

Dr. O. F. Ati — **Date**
Chairman, Supervisory Committee

Professor E. O. Iguisi — **Date**
Member, Supervisory Committee

Dr. O. F. Ati — **Date**
Head of Department

Professor A. A. Joshua — **Date**
Dean, Postgraduate School

DEDICATION

To my children Jane J. Billy and Judith J. Billy

ACKNOWLEDGEMENT

I am most grateful to my patient supervisors, Prof. E. O. Iguisi and Dr. O. F. Ati (Head of Department), for painstakingly going through this work and making corrections where necessary despite their tight official engagements within and outside the country. They did not only supervise me but exposed me through publications. May God reward you for your labour.

Special thanks to all the staff of the Department of Geography ABU Zaria for their various contributions during the period of my studies. I would like to especially thank Prof. M. Mammam, Dr. A. L. Bello, Dr. I. M. Jaro, Mr. R. O. Yusuf and Mr. I. I. Abass. Without their guidance and encouragement, I would have been unable to complete this study. A special thank to Dr. J. G. La'ah the P. G. coordinator for his encouragement. I also thank the librarians, Mal. Lawal and Mr. Ezekiel for their cooperation and concern.

The data for this study were acquired on CD-ROM from Federal Department of Agriculture and Land resource, livestock House in Mando-Kaduna, processed and interpreted at Dynamic Digital Technology Consultants limited, 4 Agric quarters, Egypt road, Barnawa Kaduna through the assistance of Mr. D. Leke. I appreciate his contributions, encouragement and support. I am very grateful to

Mr. B. Daniel of National Library Kaduna, for providing me with some of the materials on Desertification and Desert encroachment.

I would like to express my sincere and profound gratitude to members of my family especially my beloved wife Mrs. Grace Justin Billy, this achievement would not have been possible without her support. My heartfelt thanks go to my beloved mother Mrs. L. Billy for her moral support and encouragement throughout the course of this study. The support and encouragement I got from my younger ones, Jonah Billy, Kenneth T. and Zachariah Yayock, is highly appreciated. I am highly indebted to my in-laws, Mr. and Mrs. S. Leo, Mrs Veronica T. and Mr. and Mrs. D. Leo. I thank you all.

True friends are hard to find, which make me appreciate special relationship I shared with members of Peace House Fellowship, Bethel MPCS, Uzak Oegworock MPCS, VIBB MPCS and Advocating Network. To all Postgraduate students of Geography Department for their cooperation and support especially Mr. B. Amos (Chairman), Mr. N. Doka. Mr. B. Abaje, Mr. P. Tanko, Mr. J. Abu and Mr. Tanko P. Others are Mr. S. Joshua, Mr. O. Aina, Mr. Y. Madaki and Mrs. C. Tyoden. How can I forget my friends/colleagues for standing for me in my absence, most especially Mr. L. Kabir, Mrs. A. Ambi, Miss. A. Ahmed, Mr. A. Suleiman, Mr. M. Yakubu, Mr. S. Abdulrhaman and Mr. B. William. Thank you all out there that time and space will not permit me to mention all your names.

Above all, my utmost gratitude goes to God Almighty in whom I live, move and have my being. Without whom I could not have done anything. My father I appreciate you for being my help and strength from the beginning of the course to the very end.

TABLE OF CONTENTS

Title Page		i
Declaration		ii
Certification		iii
Dedication		iv
Acknowledgement		v
Table of Contents		viii
List of Tables		xii
List of Figures		xiii
List of Plates		xiv
Abstract		xv
CHAPTER ONE: INTRODUCTION		
1.1.	Background to the Study	1
1.2.	Statement of the Research Problem	4
1.3.	Aim and Objectives of the Study	7
1.4.	Research Hypothesis	7
1.5.	Scope of the Study	7
CHAPTER TWO: LITERATURE REVIEW		
2.1.	The Concept of Desert and Desertification	8
2.1.1.	The Desert	8
2.1.2.	The World Deserts	10
2.1.3.	Desertification	12

2.1.3.1. Causes of Desertification 14

2.1.3.2. Impact of Desertification 19

2.1.4. Desertification Frontline States 27

2.2. Measures Taken to Combat Desertification in Nigeria 28

2.3. Review of Previous Work on Desertification 31

2.3.1 Review of key Words 33

CHAPTER 3: THE STUDY AREA AND METHODOLOGY

3.1. Location 37

3.2. Physical Setting 37

3.2.1. Climate 37

3.2.2. Soil 40

3.2.3. Geology, Relief and Drainage 42

3.2.4. Vegetation 43

3.3. Human Setting 45

3.3.1. People and Population 45

3.3.2. Agriculture 48

3.3.3. Commerce and Industry 49

3.3.4. Tourism 50

3.3.5. Infrastructures 50

3.3.5.1 Education 50

3.3.5.2 Health 51

3.3.5.3 Electricity Supply 51

3.3.5.4 Transportation and Communication 52

3.3.5.5 Water Supply 53

3.2. Methodology 53

3.2.1. Sources and Types of Data Collected 53

3.2.2. Image Processing and Procedures 54

3.2.2.1 Mosaicking 55

3.2.2.2 Sub Set 55

3.2.3 Image Analysis 55

3.2.3.1 Image Interpretation 55

3.2.3.2 Normalized Different Vegetation Index (NDVI) 56

3.2.4 Gis Analysis 56

3.2.4.1 Polygonization 56

3.2.4.2 Overlay 57

3.2.4.3 Re-Class 57

3.2.5. Data Analysis 57

3.2.6. Limitation(s) to the Study 58

CHAPTER 4: RESULTS AND DISCUSSION

4.1. Introduction 59

4.2. The Movement of Dunes 59

4.3. The Vegetal Cover 67

4.4. Observed Phenomenon 77

CHAPTER 5: SUMMARY AND RECOMMENDATION

5.1. Summary 81

5.2 Conclusion 83

5.2. Recommendations 84

5.3. Suggestion(s) for Further Study 85

REFERENCES **86**

LIST OF TABLES

Table 2.1: Largest Deserts in the World (Non Polar Deserts) 11

Table 2.2: Desertification Frontline States in Nigeria. 28

Table 3.1: Yobe State Local Government; Population, Area and Population Density. 47

Table 4.1: The Extent of Dunes 59

Table 4.2: Two LGA'S affected by Dunes (Yusufari and Yunusari) 61

Table 4.3: Land Use Remote Sensing Data (NDVI)/Desertification Classification areas of Yobe state 76

LIST OF FIGURES

Fig. 2.1: World Desert Map (non-polar deserts) 11

Fig. 3.1: Location of Yobe State 38

Fig. 3.2: Yobe State; Local Government Areas 39

Fig. 3.3: Yobe State; Rainfall Distribution 41

Fig. 3.4: Yobe State; Vegetation Belts 44

Fig. 3.5: Yobe State; Population Density 46

Fig. 4.1: Yobe State; Dunes in 1970 63

Fig. 4.2: Yobe State; Dunes in 1987 64

Fig. 4.3: Yobe State; Dunes in 2005 65

Fig. 4.4: Yobe State; Composite of Dunes 66

Fig. 4.5: Yobe State: Reclassified NDVI, 1970 68

Fig. 4.6: Yobe State: Reclassified NDVI, 1987 69

Fig. 4.7: Yobe State: Reclassified NDVI, 2005 70

Fig. 4.8: Yobe State; Vegetal Cover in 1970 72

Fig. 4.9: Yobe State; Vegetal Cover in 1987 73

Fig. 4.10: Yobe State; Vegetal Cover in 2005 74

LIST OF PLATES

Plate 4.1: Vast Extent of Sand Dunes 77

Plate 4.2: Green Leaf Vegetation amidst Undulating Sand Dunes 78

Plate 4.3: Abandoned Settlement 79

Plate 4.4: Shelter Belts Established by North-East Arid Zone Development Programme (NEAZDP) 80

Plate 4.5: Sand Dunes Threatening a Settlement 80

ABSTRACT

Past studies and reports have shown that desertification is slowly but steadily encroaching from the Sahara into the southern latitudes. Research studies have also found out that sand dunes movement and deforestation is usually a prelude to desertification. A combination of Remote Sensing imageries of three different date 1970 (LANDSAT MSS), 1987 (LANDSAT TM), and 2005 (LANDSAT ETM) and Geographical Information System (GIS) techniques were used to analysed desertification in Yobe state. Results show that areas covered by sand dunes increasesd by about 1,323.74 km^2 (2.89%) during the study period (1970 - 2005), from 3,124.99 km^2 to 4,448.73 km^2. From NDV1 analysis non vegetal Cover increased too from 9,310 km^2 to 10,002 km^2 representing about 582 km (1.09%). Different efforts have been made to stabilize sand dunes encroachment by the settlers, State Government, North-East Arid Zone Development Programme (NEAZDP) and NGO's, but there is little or no results to combat the adverse effect of desertification. Some of the recommendations include the establishment of shelterbelts in order to counteract adverse ecological condition and the establishment of national desertification commission should be a priority issues.

CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND TO THE STUDY

Desertification is a term used to describe the severe degradation of land to a point where it resembles a desert condition resulting from "over-use" by man and in combination with variations in climate (Penolope, 1995). Desertification is common on the margins of the world's largest desert like the Sahara desert. It is also found where high population densities and poor land use practices have stripped land bare (Paul, 1995). Kaboré and Reij (2004) describe cases where this idea seems to be working, in places such as Kenya, Fumakaye area in Gombe state and the Central Plateau of Burkina Faso. Currently desertification is probably taking place much faster worldwide than in the past and as increased populations in marginal lands or desert fringes demand for more land to grow crops and graze animals. A major impact of desertification is biodiversity loss and loss of productive capacity (Wikipedia, 2007).

Desertification comes about by a complex interaction between the natural environment and human activities ("WERI Foundation", 2008). Desertification encompasses a wide range of processes of physical and biological nature, although many studies use the term in a narrower sense,

often influenced by the author's discipline. Thus the geomorphologists may focus on erosion processes, soil scientists on physical and chemical properties, ecologists on productivity of natural vegetation and botanists on changes in species composition and loss of biodiversity. This implies that land degradation may be seen to have taken place in the view of a geomorphologist, yet not with the eyes of botanists or vice versa (Ramussen, Band and Madsen 2001).

Desertification spreads outward from any where excessive abuse of the land occurs and far from any climatic desert and does not occur in linear, easily mappable patterns. Droughts do increase the possibility of desertification if the carrying capacity of non-irrigated land is exceeded. Combining drought with land abuse sets the stage for desertification ("WestMUNC", 2008). It is now recognized that desertification is one of the central problems in sustainable development of the dryland ecosystems. Rainfall variability both in time and space, coupled with inherent ecological fragility of the drylands weakens the resilience of the ecosystem and its ability to return to its original conditions.

World wide, desertification has claimed about 9 million square kilometer of the globe, an area nearly as large as the entire United States. Unless this trend is halted, at least one-third of the earth's arable land will be lost within the next 25 years. It was estimated that every year about 810 square

kilometer of usable land were being added to the desert while reforestation reclaimed only 22 square kilometer (Microsoft Encarta, 1986).

Africa is widely seen as a "devastated continent," where desertification is claiming a massive scale of land. In Africa today over 10,000 square kilometer of land is affected by desertification (Aina, 1996). This view of Africa has greatly influenced academic research agenda and international aid programmes, as well as public perceptions of the continent.

While the extent and severity of desertification in Nigeria have not been fully established, nor has the rate of progression been properly documented, there is a general consensus that desertification is by far the most pressing environmental problem in the dry-lands parts of Nigeria (Federal Republic of Nigeria, 2000). According to Salami and Balogun (2006), Nigeria depends on international organizations such as FAO and World Bank for information which are sometimes conflicting (depending on the source) and generally do not reflect the reality on ground in different parts of Nigeria. With the advent of NigeriaSat-1 and their potential for environmental management, Nigeria is now in a better position to monitor the trend of deforestation and provide data on land use feedback which are crucial for developing reliable climatic change models. The visible sign of this phenomenon (desertification) is the gradual shift in vegetation and sand dunes movement which is operating on a

time scale of several years or decade from grasses and occasional trees to expansive areas of desert-like.

One of the greatest challenges confronting Yobe State is desertification and desert encroachment. Its fertile land, though able to sustain crops under minimal rainfall conditions, is unable to fend off the approaching desert (Barsky, 1999). A major government priority was to curb the process of desertification and regain lost land. Yobe state government plans to raise millions of seedlings for distribution across the state during this year's tree-planting season campaign to be in tune with the Federal Government Greenwall Sahara Project under the Millennium Development Goals (MDGs) (Sani, 2008). Recently the Federal Government sign MoU with a German company (Hagens Engineering) on ₦ 300 billion Desert Control Project. The shelterbelt project is aim at combating desertification and mitigating drought in 11 frontline states (Onyebuchi, 2008).

1.2. STATEMENT OF THE RESEARCH PROBLEM

In reality, the nature and extent of desertification varies greatly throughout Africa and much of it is unrelated to human activity (Stock, 2006). The term desertification became very popular in Nigeria during widespread and debilitating Sahelian drought of 1968-1973. It is estimated that, Nigeria is presently losing about 351,000 km2 representing 38% of its total land mass to desert advancing south-ward ("FEPA", 1992). According to Oladipo

KASHIM IBRAHIM LIBRAR

(1993) about 15% (140 000km2) of Nigeria is prone to severe desertification, particularly areas north of latitude 12° N. According to Abaje (2007), there are different opinions concerning the rate of desertification in Nigeria. While some say desertification is progressing fast, others say it is serious, a few others admit that it is difficult to measure and yet others claim that it is occurring of between 0.5km and 0.8km a year.

When drastic changes occur to the vegetation around us, our health, economy, and environment are all affected. In 1974, for instance, thousands of people starved when the vegetation in the Sahel region of Africa dried up during an extended drought (Weler & Herring, 1999). As Nigeria ponders over the best way to tackle the menace, the situation in Kebbi, Borno, Sokoto,Yobe and other desert-prone states is not getting better as sand dunes are rapidly taking over many villages in those states (Sani, 2008). These areas can be described as Desertification Frontline States in Nigeria (Adamawa, Yobe, Kano, Bauchi Borno, Gombe, Jigawa, Katsina, Kebbi, Sokoto, and Zamfara) and altogether, they have a total land mass of 393,000km2 and form grazing area for about 90% of cattle population in the country. These areas are characterized by a short and erratic or uncertain rainfall period and long dry season. The annual precipitation in these areas could be as low as 200mm while the peak is about 600mm (Otegbeye, 2004).

There is also evidence to show that the effect of desertification is already taking its toll on humans, animals and plants in some of these frontline states. Indeed there is a vivid problem in these frontline states and particularly in Yobe state. Yobe state is one of the state most affected by desertification with consequences on environment, on health and on social and economic activities of inhabitants of the state with little effort to combat it yielded no reasonable result. The Yobe State Ministry of Environment says that more than five million livestock are being threatened by desertification. Also in about eight local government areas there is a severe threat by the drying up of surface and under-ground water sources. Worried by the socio-economic effects of such a devastating phenomena, Yobe deputy governor recently called on the Federal Government to "act urgently" help mitigate the situation (Sani, 2008).

From these observations it is clear that there is a need for thorough study of the desertification of Yobe state of Nigeria, which would be of great importance to the settlers, farmers and states of the country and also to meet the need and aspirations of National Economic Empowerment and Development Strategy (NEEDS) in reducing all forms of environmental degradation by 30% by the year 2007 and subsequently (NEEDS, 2005). In view of this, the emerging question is "to what extent has desertification affected Yobe state of Nigeria"?

1.3. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to assess the magnitude of desertification in Yobe state of Nigeria.

This aim will be achieved through the following objectives:

i. Determine and map the areal coverage of desertification in the state between 1970 - 2005.

ii. Estimate the rate of migratig sand dunes in the state between 1970 – 1987 and 1987 - 2005.

iii. Evaluate the extent of decline in vegetation cover in the state.

1.4. RESEACH HYPOTHESIS

There is no significant increase in the desertified area of Yobe state of Nigeria from 1970 - 2005.

1.5. SCOPE OF THE STUDY

The study will only cover three set of imageries of three different dates of Yobe state (1970, 1987 and 2005).

CHAPTER TWO

LITERATURE REVIEW

2.1.0 THE CONCEPT OF DESERT AND DESERTIFICATON

2.1.1. THE DESERT

There are different definitions of a desert. The American Heritage Science Dictionary (2002) defines desert as a large, dry, barren region, usually having sandy or rocky soil and little or no vegetation. Water lost to evaporation and transpiration in a desert exceeds the amount of precipitation; most deserts average less than 25 cm of precipitation each year, concentrated in short local bursts. Encarta dictionary (2007) defines desert as an area of land, usually in very hot climates, that consists only of sand, gravel, or rock with little or no vegetation, no permanent bodies of water, and erratic rainfall. According to Mabbut, J. A. (1985) the term desert carries at least three (3) related connotations; "empty life", waterless and unproductive.

Deserts seem to be an elusive phenomenon associated with varying view points. The Geologists see deserts as being both geophysical and ederphic in character. The Climatologists see desert in relation to synoptic weather patterns of wind, precipitation and temperature. The Ecologists understand a place to be desert environment in terms of biotic communities and the intricate system that function to keep the delicate infrastructure of nature in

balance. The common thing about all this kind of deserts definitions is simply lack of moisture. There could be too little moisture subjected by evaporation due to extreme high temperature or locked up in ice by extreme cold. Therefore, descriptively desert could be hot, cold, windy or dry.

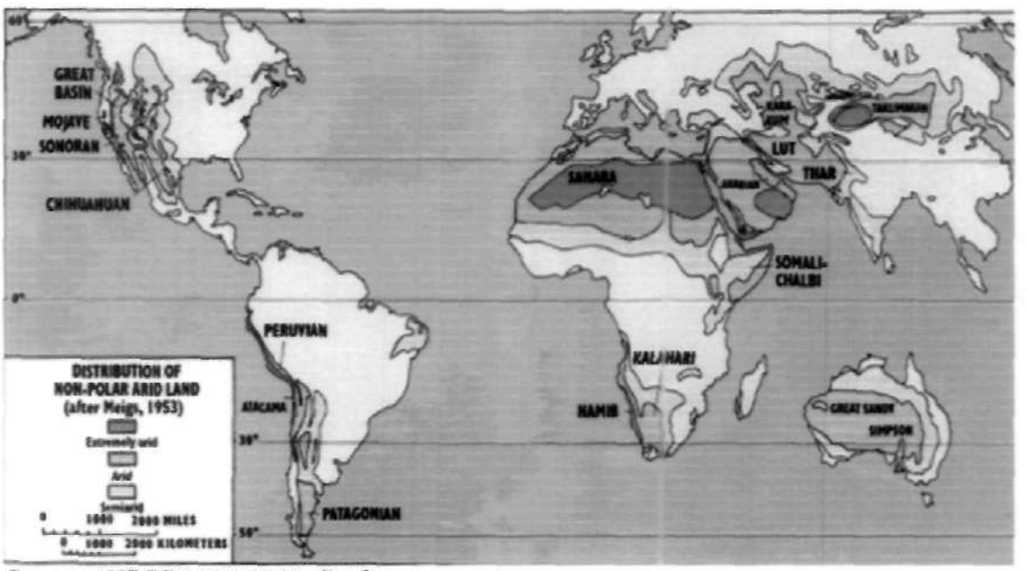
A desert , despite being a vast area of land that is extremely dry with little or no vegetation, comprises of one of the major ecosystems on this planet. It supports a wide range of plant and animal species that are attuned to survive in the harsh conditions. Nature has endowed desert vegetation with peculiar features to survive in desert climate. Some plant categories like Xerophytes do not have leaves, which help them reduce loss of water, while others have long roots (Phraetophytes) that help them fetch water from deep down the earth. Similarly, perennials and annuals have behavioral patterns that help them adapt to harsh conditions of the desert ("InfoBase", 2006).

The definition of Desert based on the purpose of this study is an area of the earth that is characterized by less than 250 mm of annual rainfall, an evaporation rate that exceeds precipitation, and, in most cases, a high average temperature. Because of a lack of moisture in the soil and low humidity in the atmosphere, most of the sunlight penetrates to the ground. Daytime temperatures can reach 55° C in the shade. At night the desert floor radiates heat back to the atmosphere, and the temperature can drop to near freezing (Smith, 2007).

2.1.2. THE WORL DESERTS

The world's great deserts were formed by natural processes interacting over long intervals of time. During most of these times, deserts have grown and shrunk independent of human activities. Paleodeserts, large sand seas now inactive because they are stabilized by vegetation, extend well beyond the present margins of core deserts, such as the Sahara. In some regions, deserts are separated sharply from surrounding, less arid areas by mountains and other contrasting landforms that reflect basic structural differences in the regional geology. In other areas, desert fringes form a gradual transition from a dry to a more humid environment, making it more difficult to define the desert border (Willem, 2007a).

The world's desert is basically divided into two: the Polar and Non Polar deserts. Desert regions cover 35% of the earth's surface which is approximately 1/3 of earth's land surface is a desert. The polar deserts are approximately 60 % of the world desert (Antarctica and Arctic) has total surface area of about 28.3 million square kilometers. The largest non-polar desert is the Sahara Desert of northern Africa, which has a surface area of 9 million square kilometers, and it stands as the largest non-polar desert in the world see fig 2.1 and table 2.1.



Source: USGS 2005-2008 Geology.com.

Figure 2.1 World Desert Map (non-polar deserts)

Table 2.1 Largest Deserts in the World (Non Polar Deserts)

DESERT	LOCATION	SQ KM
Sahara	northern Africa	9,100,000
Gobi	Mongolia/northeastern China	1,300,000
Patagonian	Argentina	670,000
Rub' al Khali	southern Arabian peninsula	650,000
Great Sandy	northwestern Australia	390,500
Great Victoria	southwestern Australia	390,500
Chihuahuan	Mexico/southwestern United States	360,000
Takla Makan	northern China	360,000
Sonoran	Mexico/southwestern United States	310,000
Kalahari	southwestern Africa	260,000
Kyzyl Kum	Uzbekistan	260,000
Thar	India/Pakistan	260,000
Simpson	Australia	100,000
Mohave	southwestern United States	52,000
Desert areas are very approximate, because clear physical boundaries may not occur		

Source: Microsoft ® Encarta ® 2006`. © 1993-2006 Microsoft Corporation.

49891

KHARTOUM IBRAHIM LIBRARY

2.1.3. DESERTIFICATION

Desertification is often confused with deserts because it is believed that "land once desertified has to look like a natural desert". Desertification irrevocably transforms productive land at some definite point in time into deserts". "Desertification can only occur on the fringes of deserts". "Climatic change is necessary for desertification to occur" and "deserts can expand on their own volition". Several authors and organisations clearly define desertification. The United Nations Conference on Desertification (UNCOD) held in Nairobi in 1977 defined 'desertification' as "the diminution or destruction of the biological potential of land that can lead ultimately to desert-like conditions under combined pressure of adverse and fluctuating climate and excessive exploitation" ("UNCOD", 1977).

Otegbeye (2004) reports that desertification is a process of turning a tract of land into an arid, barren one that can no longer support any considerable population without an artificial water supply. Hillel and Rosenzweig, (2002) observed that desertification is an environmental term that covers a wide variety of effects involving the actual and potential biological productivity of an ecosystem in the arid, semi-arid and dry sub-humid regions. According to Mortimore (1989), desertification is the diminution or destruction of the biological potential of the land, and can lead ultimately to desert-like conditions.

UNCED (1992) defined desertification as "land degradation in arid and semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities".Desertification is a phenomena, implying the extension of desert like conditions beyond its original limits into its marginal land (Yankunama, 1988). FAO (1993) also defined desertification as "the sum of geological, climate, biological and human factors which lead to the degradation of the physical, chemical and biological potential of lands in arid and semi-arid zones, and endanger biodiversity and the survival of human communities". The concept of desertification, the creation of desert like conditions where none had existed in the recent past was first mentioned in the study of dry forest in Sub-Sahara Africa region with mean annual rainfall between 700mm-1500mm (Kevin, 1992).

Most of the definitions emphasize three aspect of the problem: partial or total loss of biological productivity, climatic event and anthropogenic factors as causative roles; and the vulnerability of the ecosystems (environment). On this basis and for the purpose of this research, desertification can be defined as a gradual transformation of habitable land in arid, semi arid and dry sub-humid areas (rangelands, pastures, rainfed and irrigated croplands), resulting from various climatic variations, but primarily from human activities.

Therefore desertification is a process whereby the productive potentials of arid or semi arid land falls by 10% or more, this phenomenon results mainly from human activities (Tyler and Miller, 1998). According to Tyler and Miller (1998), 10%-25% drop in productivity is moderate desertification, 25%-50% drop in productivity is severe desertification and above 50% drop in productivity is very severe desertification.

2.1.3.1. CAUSES OF DESERTIFICATION

The cause may vary from region to region on account of different factors. The two main factors are physical (natural) and human (anthropological) factors.

I. Physical (Natural) factors:

1. Global climatic change or change in rain patterns; Large-scale climatic patterns can also cause desertification (Hulme, 1993). The Green House Effect permits incoming solar radiation to enter the atmosphere and increase amount of heat trapped in the atmosphere and oceans thus leading to rise in global temperature and change in precipitation pattern. For instance, global warming's effects are magnified in dry land climates (WestMUNC, 2008). Also, the rain pattern of the country is influenced by the moist tropical maritime monsoon air mass from the Atlantic Ocean and the dry tropical continental air mass from the Sahara desert. The boundary

between them is the inter-tropical discontinuity, ITD (Ayoade, 1982). The northern movement of the ITD bring wet season to all areas south of its location, while its southern movement brings dry season into areas north of its location. Desertification often result due to the failure of the rain bearing monsoon winds from the Atlantic ocean to penetrate enough into the northern region coupled with the solar radiation and high evaporation of the region.

2. Droughts are unique in that unlike floods, earthquakes, or hurricanes; during which violent events of relatively short duration occur, droughts are like a cancer on the land that seems to have no recognized beginning (Mather, 1985). Droughts covering a few hundred square kilometres do exist but these are usually of limited duration and modest severity. It is more common for droughts to cover relatively vast areas, a significant proportion of a continent or sub-continent approaching millions of square kilometers (Mather, 1985). Drought is a natural phenomenon that occurs when rain fall is significantly below normal recorded levels for a long time and often leads to desertification (Abaje, 2007).

3. Topography; the topography coupled with the sandy soil that is usually low in organic matter, nitrogen and phosphorus may

degrade rapidly under intensive rainfall and when over-used desertification sets in.

While Global climatic change or change in rain patterns, drought, topography are contributing factors, the root causes of it are all related to man's overexploitation of the environment.

II. Human (Anthropological) factors.

Desertification is induced by anthropogenic factors and the primary reasons for these are; overgrazing, over cultivation, deforestation and poor irrigation management.

1. Overgrazing: Overgrazing is the major cause of desertification worldwide and occurs when domesticated animals on farms consume all of the local plant life, thus destroying the local ecosystem. Ironically, locals depend on these animals as a source of subsistence or income (WestMUNC, 2008). It also results when livestock density becomes excessive and many animals are grazed on the same area of graze range land, leading to the degradation of vegetation, compaction and soil erosion.

   It account for almost 90% of desertified lands (Makama, 2008). It affects the vegetation, soil and even the health of animals. It can also lead to decline in animal production of rangeland vegetation and a change in species composition with a drop in the proportion

of potable grass species particularly perennials which are good at holding the soil together.

2. Over cultivation: This occurs when farmers try to crop their lands more intensively than permitted by its natural fertility and fail to compensate for the export of nutrient so that its fertility will regenerate naturally. It reduces soil fertility and damages soil structures and exposes it to erosion. Cultivation of marginal land especially the expansion of cultivated areas in years of good rainfall, which when followed by dry years exposes the land with very little vegetal cover and thus results to desertification ("FRN", 2000). Lands on which there is a high risk of crop failure and a very low economic return, for example, some parts of South Africa where maize is grown (Willen, 2007b).

3. Deforestation: Deforestation is the most dynamic indicator of desertification (Mabbut, 1985). The slash-and-burn agricultural technique is a typical cause of deforestation. Farmers in many areas slash and burn trees in order to clear out areas for farming. This may provide good acreage for domesticated plants, but it is ultimately detrimental to the environment. Direct overuse of resources is an obvious cause of desertification, as a rising population causes a rising demand for fuel wood and building materials (WestMUNC, 2008).

4. Poor irrigation management: Irrigation in dry land areas has been promoted by both government and non-governmental organisations. However, despite its advantages, incorrect irrigation practices in arid areas can cause salinization or alkalinization (the build up of salts in the soil) which can prevent plant growth (Willen, 2007b). This scenario is already a reality on a number of irrigation projects in Nigeria today, such as the Bakolori Irrigation, South Chad Irrigation and the Kano River Projects ("FRN", 2000).

5. Other factors which include Ignorance, error in choice of policies or technology and disaster such as war and national emergencies do contribute to desertification. Poverty contributes to desertification as poor people may be forced to overuse their environment in the short term, without the ability to plan for the long term effects of their actions (Willen, 2007b). The process of globalization both contributes to desertification and helps prevent it. Studies have shown that, in some cases, that trade liberalization, economic reforms, and export-oriented production in dry lands can promote desertification. (Xue, 1996)

As the land which is the basis for food production is degraded, local people have no choice but to exploit further natural resources such as forest and water. This leads to further land degradation which creates a downward spiral. When the practices described above coincide with drought, the rate of

desertification increases dramatically. Thus drought is a contributing factor, but the root causes are all related to man's overexploitation of the environment.

2.1.3.2. IMPACT OF DESERTIFICATION

Globally, desertification claims a Nebraska-sized area (200,346 sq km) of productive capacity each year. Desertification is a global problem occurring in many places but is prevalent along the margins of semiarid and arid lands in Asia, central Australia, portions of North and South America, and Africa. The two regions of the world most affected by desertification are Central Asia (China) and sub-Saharan Africa. In Africa, two thirds of the continent is desert or drylands. There are extensive agricultural dry lands, almost three quarters of which are already degraded to some degree ("WERI Foundation", 2008). Consequences of desertification include reduced biological productivity, reduction of biodiversity, a gradual loss of agricultural potential and resource value, loss of food security, reduced carrying capacity for humans and livestock, increased risks from drought and flooding, and in extreme cases, barren lands that are effectively beyond restoration ("Millennium Ecosystem Assessment", 2005).

I. ECOLOGICAL/ENVIRONMENTAL IMPACT OF DESERTIFICATION

The impact of desertification in arid and semi-arid regions is normally very severe due to the fragile nature of these lands (Charney *et al.*, 1977). Desertification has already occurred in a significant percentage of drylands, but in the near future it will become a threat that cannot be ignored (WestMUNC, 2008).

One-fifth of the world's population is currently threatened by the impact of desertification in Asia, Africa, the Americas, and even parts of southern Europe. It has been exactly 10 years since the United Nations adopted its Convention to Combat Desertification, calling attention to a problem that affects hundreds of million of people around the world (Bransten, 2004).

Desertification has been recognized as a major threat to biodiversity globally and locally. Numerous countries have developed Biodiversity Action Plans to counter its effects, particularly in relation to the protection of endangered flora and fauna. A number of solutions have been tried in order to reduce the rate of desertification and regain lost land (Glenn, Smith and Squires 1998).

The Sahel region of the Sahara Desert is growing at a rapid rate (WestMUNC, 2008). Africa has been significantly impacted by

desertification. Almost three quarters of Africa's agricultural drylands are already degraded to some degree. Dust from degraded ecosystems in sub-Saharan Africa is taken up and carried away by wind currents all the way to the Caribbean. The dust settles in coral reefs and leads to the degradation of reef ecosystem.

Desertification do have serious consequences on the available water resources, it affect level of upper ground water and stream flows, as well as the under ground water and large lakes, thereby affecting the riparian access as in lake Chad which has receded beyond the borders of Nigeria ("FRN", 2000). It has also caused destruction of habitat and loss of bio-diversity. The flora and fauna have badly depleted as a result of climatic variation and human mismanagement and /or over exploitation of the environment in Nigeria. Some fauna species such as the cheetah, Lion, Giraffe, Ostriches and the Bustard are endangered. With regard to floral, most of the indigenous plant species that were identified in the 1960's are now hard to come by especially those with medicinal value such as *Khaya Senegalisis* and *Mitrogina spp* (FRN, 2000).

Since the creation of Yobe State on August 21, 1991 desertification has become the most prevalent environmental problems facing the people living across the state. Environmental degradation in the low-laying

communities of Damaturu, Nguru, Ngalda, Gashua and Ngelzarma had claimed tens of thousands of farmlands and orchards (Musa, 2008)

The dunes are threatening life-supporting oasis, burying water points and in some cases engulfing major roads in the affected areas. The document, compiled by the Ministry of Environment in Yobe State, show that mass land occupied by the dunes has increased from 25,000 hectares to more than 30,000 hectares (Toye, 2002).

II. SOCIO-ECONOMIC IMPACT OF DESERTIFICATION

Desertification has been with us for over a thousand years, although it went unrecognized for a very long time. It only became well known in the 1930s, when parts of the Great Plains in the United States turned into the "Dust Bowl" as a result of drought and poor farming practices, although the term itself was not used until almost 1950 (Dregne, 2000). During that time, a considerable fraction of the plains population abandoned their homes to escape the unproductive lands.

The impact of desertification on the greatest number of people occurs in Asia. Degraded regions include the sand dunes of Syria, the eroded mountain slopes of Nepal, and the deforested and overgrazed highlands of Laos. The Northern Mediterranean region is the cradle of civilization and has borne the effects of poor agricultural practices (WERI Foundation, 2008). The Central Asian countries, Kazakhstan,

Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, and Uzbekistan, are also affected. More than 80% of Afghanistan's and Pakistan's land could be subject to soil erosion and desertification. In Kazakhstan, nearly half of the cropland has been abandoned since 1980. In Iran, sand storms were said to have buried 124 villages in Sistan and Baluchestan Province in 2002, and they had to be abandoned. In Latin America, Mexico and Brazil are affected by desertification (Public Agenda, 2007).

Not only is the destruction of an ecosystem harmful in and of itself, but degradation of the coral reefs directly hinders ecotourism, a large and important source of income for the Caribbean economy. Another example of an indirect result of desertification is urbanization, which has occurred near many dryland regions because of the dearth of dryland resources (WestMUNC, 2008).

In Africa, if current trends of soil degradation continue the continent might be able to feed just 25% of its population by 2025, according to UNU's Ghana-based Institute for Natural Resources in Africa. The areas which are known to have deteriorated this century are mainly on the edges of the southern Kalahari. The deterioration of the Karoo is less well established. It is possible that desertification of the Karoo began in the last century, when sheep were first introduced, and before good records were available for the area (willem, 2007a).

The African continent offers a stark example of the social and economic impact of desertification at its most extreme. Experts estimate that 60 million people will be forced to move from newly desertified areas of sub-Saharan Africa by the year 2020 if present trends continue (Bransten, 2004). Ghana and Nigeria currently experience desertification; in the latter, desertification overtakes about 3,510 km^2 of land per year.

Economic and social consequences of land degradation are undoubtedly a great concern for the country. One of the main social consequences is, in fact, an economic one, namely reduction of income for farmers.

Desertification has claimed properties valued at over N2.8 billion that have been destroyed over the last 15 years in Yobe state. In taming the environmental problems that continued to pose threats to the lives of residents and development processes of Yobe State, an environmental action plan was drawn up by Governor Mamman Bello Ali in conjunction with the Ministry of Environment. Desertification would be accorded top most priority, because it could frustrate us from addressing the problems in the agricultural, roads, education, health, commerce and tourism sectors said Governor Mamman Bello Ali (Musa, 2008).

One of the biggest problems posed by sand dunes is their encroachment on human habitats and threatens buildings and food/livestock production

(Toye, 2002). Considering a conservative production of five bags of 100 kg of grain of millet or sorghum per hectare in the area, it means the 30,000 hectares destroyed by the dunes is capable of producing over 1,500 bags of millet. With an average grain requirement of one bag of 100 kg of millet per family of four per month, it then follows that 150,000 bags can support 12,500 families of four or 50,000 people per year. The big question is how these 50,000 people survive in this area?" the document wonders (Toye, 2002).

The destruction of the 30,000 hectares of agricultural land has a negative impact on livestock survival in the state, which has a high concentration of animals in the vast West African country. Toye (2002) further reports that losing 30,000 hectares of grazing land annually means denying grazing land for 3,000 head of cattle annually.

III. POLITICAL/RESOURCE USE CONFLICT IMPACT OF DESERTIFICATION

Desertification encourages economic and social strife. This is often accelerated by lack of proper natural resource planning and management as well as diminishing environmental resource base. Conflict over land resources are focused on areas of high productivity which have competitive uses amongst the various rural users, notably farmers, herders and hunters ("FRN", 2000).

IV. ADVERSE CONDITIONS RESULTING FROM DESERTIFICATION

When desertification commences in an area, the area begins to witness some adverse conditions some of these (according to world environment day 2006) include the following:

1. Deterioration of the natural resources adversely affecting the socio-economic condition and livelihood support systems.
2. Reduction of irrigation potential.
3. Diminishing of the food security base of human beings and livestock.
4. Scarcity of drinking water extraction and depletion of ground water, interference with spacing of tube well, including hand tube well, shallow and deep tube well.
5. Health and nutrition status of the population, arsenic contamination in ground water, contamination due to disposal of waste and inadequate sanitation.
6. Reduced availability of biomass for fuel.
7. Loss of bio-diversity.
8. Impoverishment, indebtedness and distress sale of assets of production.

2.1.4. DESERTIFICATION FRONTLINE STATES

Latitude 12^0 N and 14^0 N and longitude 4^0 E and 14^0 E is an area prone for desertification in Nigeria which lies immediately south of the Sahara desert. The area cut through eleven states of the country (table 2.2), which are called the front line states (Oladipo, 1993).

Desertification frontline states in Nigeria have a total land mass of 393,000km^2 with 90% of cattle population of the country. These areas are characterized by short rainfall period and long dry season. The annual precipitation in these areas could be as low as 200mm while the peak is about 600mm (Otegbeye, 2004).

As vulnerable as it is, the zone has a high carrying capacity and is a home to over a quarter of the Nigerian population. It also played a dominant role in the agricultural modernization of the country; promotion of export crops such as cottons, groundnuts and gum Arabic and of food crops, most especially in the production of the import substitution crops, notably rice and wheat ("FRN", 2000).

Table 2.2 Desertification Frontline States in Nigeria.

STATES	LAND AREA KM^2	POPULATION
Adamawa	38,700	3,168,101
Bauchi	49,119	4,676,465
Borno	72,609	4,151,193
Gombe	17,100	2,353,879
Jigawa	23,287	4,348,649
Kano	20,280	9,383,682
Katsina	23,561	5,792,578
Kebbi	36,985	3,238,628
Sokoto	27,825	3,696,999
Yobe	46,609	2,321,591
Zamfara	37,931	3,259,846

Source: National Bureau Of Statistics and National Population Census 2006.

2.2. MEASURES TAKEN TO COMBAT DESERTIFICATION IN NIGERIA

The Federal government of Nigeria within the framework of protecting the environment has given prominences of the problems of desertification which formulate, coordinate, implement and monitor projections relating to desertification. Between 1954 when the first shelterbelts were established and 1985 about 2000km^2 of shelterbelt have been established, representing a small percentage of the area uncovered (Ojo, Oneyewoto and Ujah, 1987). The federal government of Nigeria sign as member of national action programme to combat desertification and mitigate the effects of drought toward the implementation of the convention to combat desertification (CCD) in Nigeria 1994 and been ratified same 1997 thereby qualify the country as a party to the convection.

The government also strengthens National and State institutions involved in desertification control programmes. For instance Federal Environmental Protection Agency founded 1988 with its State's Agencies (SEPR'S). Forestry Association of Nigeria (FAN) founded in 1970 to sensitise government and the public on conservative issues. It initiated the launching of the national tree planting campaign in the country. In 1889 Borno state government established a new ministry of animal and forestry resources to coordinate all desertification control project and launched ambitious forest and grass planting programmes including the distribution of over 20 million tree seedlings annually to various afforestation projects (FEPA, 1992).

The establishment of River Basin Development Authorities (RBAD'S) 1987 in Chad basin and National FADAMA Development projects to sustained agricultural practices and manage water resources has gone alone way in the fight of desertification.

Poverty alleviation is a major weapon to combat desertification. The North-East Arid Zone Department Programme (NEAZDP) founded by Federal Government of Nigeria with European Union Assistance commenced in February 1990 with the main objective of motivating, assisting the rural population to improve their standard of living through proper resource use and management which cover an area of about 25,000km^2 in the extreme northern part of Yobe. The Federal Ministry of Environment/ University of

Maiduguri initiated a model village project at Sabon Gari Nangere, Yobe state in 1995, to involve and encourage individuals and community participation in the establishment of community woodlots and roadside tree planting ("FRN", 2000).

The Federal Government of Nigeria has recognized that it cannot tackle the hydra-headed problem of desertification by itself, alone so it involves relevant international and Non-Governmental Organisation which play the role of advocating and educating the public on the danger of desertification. The Nigeria Conservation Foundation (NCF) was formed 1982 to raise awareness on conservation matters, protect threaten species and habitats and fond conservative research and projects ("FEPA", 1992).

The Nigeria Environmental Study/Action Team (NEST) formed 1987 with sole objectives of collecting and disseminating on the state of Nigeria environment. It is one of the major pressure group on all issues relating to the environment. The international Union for Conservation of Nature (IUCN) established the Hadija-Nguru Wetlands Conservation Project (HNWCP) in 1997 and was still supporting the implementation.

Result so far obtained from shelterbelt establishment in semi-arid areas of Nigeria indicate very bright prospects for the used of fast growing and drought resistance tree species in some localities ("FEPA", 1992).

2.3. REVIEW OF PREVIOUS WORK ON DESERTIFICATION

Hare and Ogallo (1993) estimate that over 400 million people are severely at risk as a direct result of the various processes of dryland degradation, and a further 700 million are either less severely affected or are at risk from the indirect repercussions of such degradation. Elhag (2006),UNEP (1992) and FRN (2000) estimated that roughly 70% of all agriculturally used drylands are degraded to some degree, especially in terms of their soils and plant cover, and up to 4 million hectares of rainfed croplands are being lost each year in the world's drylands, chiefly as a result of accelerated soil erosion and increasing urban growth.

Past studies and reports have shown that desertification is slowly but steadily encroaching from the Sahara into the southern latitudes ("FRN", 2000). Xue (1996) investigated on "the impact of desertification in the Mongolian and the inner Mongolian grassland on the regional climate" using biosphere model to test the impact of desertification and found out that desertification in the inner Mongolian grassland had dramatically increased during the past 40 years and has significant impact on the simulated climate by altering the water balance and surface energy balance. These lead to the weakening of the monsoon circulation and rainfall reduction in the area.

Shalaby, Ghar and Tateishi, (2004) in a study tittle, "Desertification impact assessment in Egypt, using low resolution satellite data and GIS", studied the

desertification processes and their impact on land cover changes in Egypt from 1992 to 2000. It was found that, parts of the agricultural lands have turned into degraded land due to desertification and urban expansion.

There have been attempts by Governmental, Non-governmental organizations and International Communities towards combating desertification in Nigeria which yielded little or no positive result. Medugu, (2007) in a comprehensive approach to addressing drought and desertification in Nigeria evaluate current government policies in addressing desertification and has found out that the reasons for the failure of current government policies are numerous including the government's top-down approach, inconsistency of government policies, neglect of indigenous knowledge, use of inappropriate technology, sectoral approach, inadequate funding, inadequate awareness. Makama (2008) assessed the effects of drought and desertification in Gada L.G.A, Sokoto state and observed that the control of drought and desertification in the state is more of theory than practical, inadequate funding and neglect by government officials hinders implementation.

Musa (2000) in this study "Quantifying Environmental Degradation in the Tropical Savanna with Remote Sensing and GIS Technology-A Case Study of Adamawa State" quantify the degraded areas in each local government of the state using Remote Sensing and GIS techniques. Satellite images covering the

study area for two time periods (1978 and 1995) are classified into various cover types. The quantified data are transformed into different indices which are then interpreted and discussed. The results, in terms of physical depletion of vegetation cover and vegetation vigor and biomass the northern parts (almost three quarters of the state – between lat. 08°30' and 11° 00') were the worst hit by land degradation and significant reduction in vegetation vigor when compared to the status ante in 1978 and only the southern part that is stable.

Yankunama (1988) also in the study "desert encroachment and settlement form in Borno State" observed that about 31.82% of the household in five (5) village settlements abandoned their houses and migrated to other areas due to the approaching sand dunes.

2.4. REVIEW OF KEY WORDS

MOSAICKING

Mosaicking is when the study area in which the user is interested on may span several scenes. In this case, it is necessary to combine the images to create one large file (Schrader and Pouncey, 1997). This is when individual scenes were stitched together to get one big image file for the date.

KASHIM IBRAHIM LIB

SUB SET

Sub setting refers to breaking out a portion of a large file into smaller files (Schrader and Pouncey, 1997). The useful portion of the big image file is extracted out for reason to conserved space in the machine and lightens the image.

SAND DUNE

Sand dune is any hill of loose sand shaped that is form by the wind. The active dunes constantly change form under wind currents and become inactive when stabilized by a vegetation cover or when pattern of wind or sand sources change. Dunes must be free from vegetation cover in order to form or move (Alan &Arthur, 2007). Movement of sand grains by the wind causes dunes to grow in height as well as to migrate. A growing dune may travel as much as 30 m in a year. Seen from the air, dune shapes vary from crescentic to ridgelike; however, all dunes are asymmetric in cross section. The side facing the wind is always longer and less steep than the side opposite (Microsoft Encarta, 2006).

The origin of sand dunes is very complex, but there are three essential prerequisites: (1) An abundant supply of loose sand in a region generally devoid of vegetation (2) a wind energy source sufficient to move the sand grains; and (3), topography whereby the sand particles lose their momentum and settle out (Armstrong, 1999).

NORMALIZED DIFFERENT VEGETATION INDEX (NDVI)

Normalized Different Vegetation Index (NDVI) was adapted to developed changes in the vegetation. Images provided an indirect measure of vegetation growth through the calculation of vegetation indices. The Normalized Difference Vegetation Index (NDVI) is one of the most generally used indices for vegetation monitoring (Hess, en at 1996). Nearly all satellite Vegetation Indices employ this difference formula to quantity the density of plant growth on the Earth — near-infrared radiation minus visible radiation divided by near-infrared radiation plus visible radiation. The result of this formula is called the Normalized Difference Vegetation Index (NDVI). Written mathematically, the formula is:

NDVI = (IR — I)/ (IR + I)

The formula of calculating the NDVI value changes from one satellite to another.

The NDVI values range from minus one (-1) to plus one (+1), where areas with vegetative cover have values greater than zero, close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves and negative values indicate non-vegetated surface features such as water, bare soil or the presence of clouds (Justice *et aL,* 1985)

IMAGE INTERPRETATION

Interpretation is a data reduction structure, reducing a list of numbers or descriptions to a manageable few (David, 2001). Interpretation could be done automatically or manually. On screen manual visual interpretation is done on the screen manually where by all the different signatures were delineated with there names for the purposed of understanding the signatures.

POLYGONIZATION

Polygon is an enclosed area, a 2D feature with at least three (3) sides and that has an area and perimeter, such as parcels of land, agricultural fields or political districts (David, 2001). The interpreted features are usually polygonised so the system will automatically generate an area statistics.

OVERLAY

Overlay is a major GIS operation for combining features and theme (David, 2001). It involve the placement of one map layer (set of features) A, on top of a second map layer, B, to create a map layer, C, that is some combination of A and B. C is normally a new layer, but may be a modification of B and A layers.

CHAPTER 3

THE STUDY AREA AND METHODOLOGY

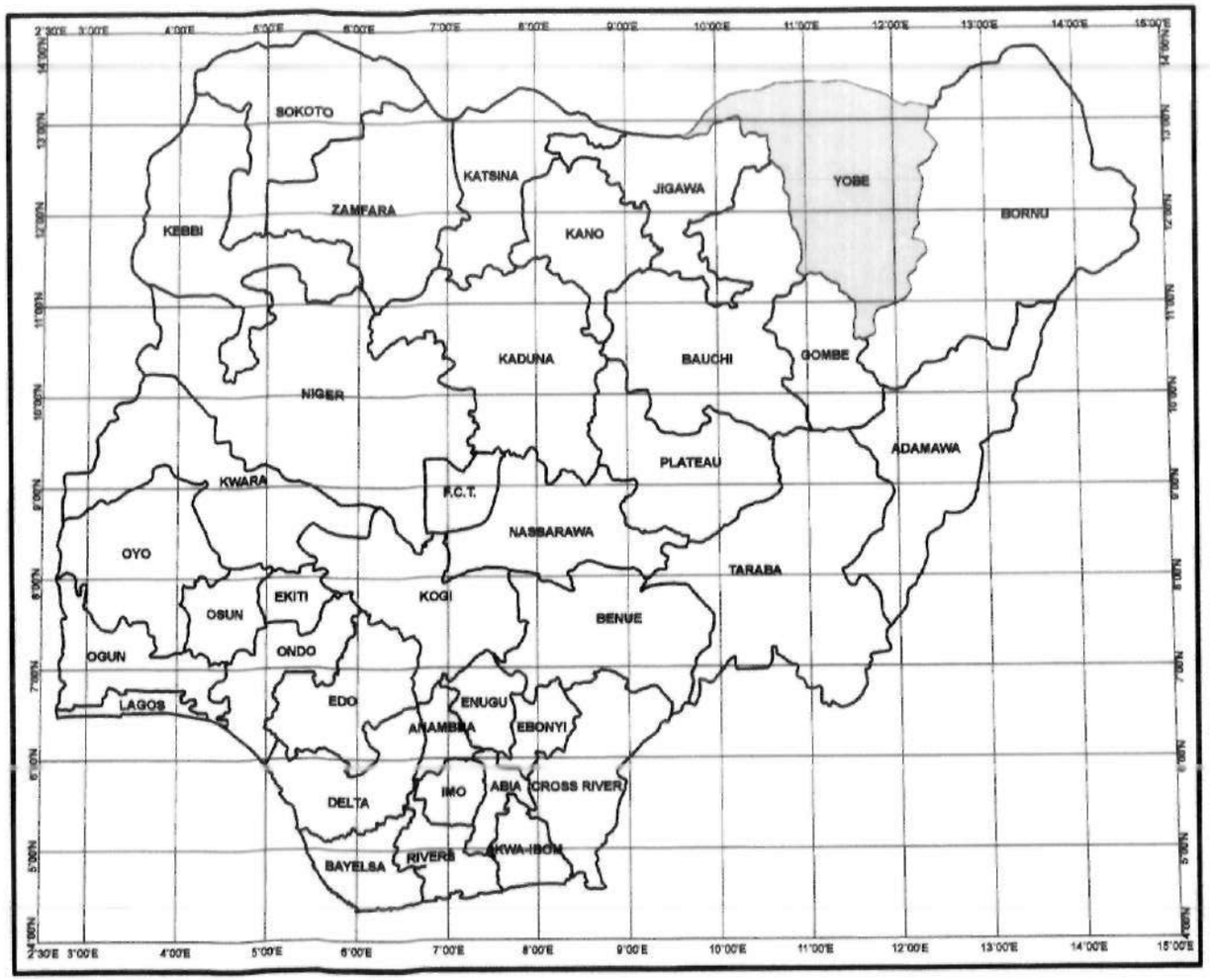
3.1. LOCATION

The study area (Yobe state) covered an area 47,153 sq km, is located in Northeastern Nigeria approximately between latitude 12°00' N and 13°22 N and longitude 9°40' E and 12°25' E, The state borders the fellow Nigerian states of Baucahi, Borno, Gombe and Jigawa and borders parts of Republic of Niger (Barsky, 1999) see fig 3.1. The state was created in 1991 from the then Borno state, it consist of seventeen Local Government Area (Ngex, 2006) see fig 3.2.

3.2. PHYSICAL SETTING

3.2.1. CLIMATE

The climate of Yobe state is tropical type which exhibits distinct wet and dry seasons, this type of climate represent a transition between humid and desert climates. The climatic pattern is determined by the wind system covering the area. These are the rain bearing South-West Trades (mt) blowing from the Atlantic Ocean and the dry dusty North-East Trades (ct) or Harmattan winds blow across the Sahara desert.



Source: Federal Surveys

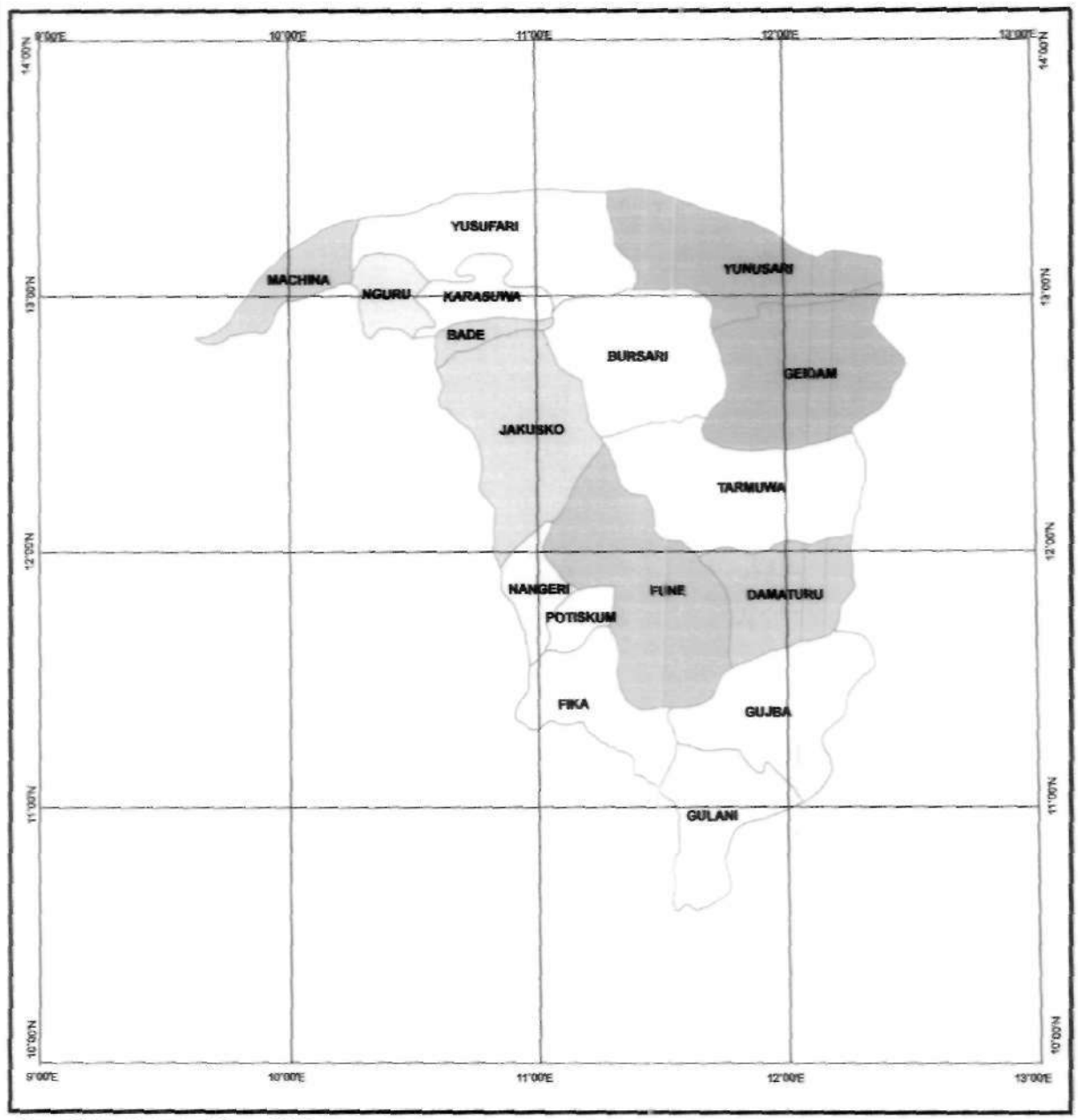
Scale:- 1 : 7500000

LEGEND

Study area

N

Figure 3.1: Location of Yobe State



Source: Yobe state land and Survey, 2005

Figure 3.2: Yobe State; Local Government Areas

Rainfall decreases northward both in duration and amount from place to place. It lasts for about 120 days in the northern part of the state and more than 140 days in the south (Mamman, Oyebanji and Petters, 2002) this duration follows the northwards movement of the Inter Tropical Discontinuity (ITD). There is a marked dry season of between 8 to 9 months and a wet season of only 3 to 4 months, the start of the rain is so gradual that it takes up to the middle of May to early June before proper setting is made and the peak of the rainy season is established in the month of August. Rainfall in the state is highly irregular in time and in space see figure 3.3. Therefore due to the irregularity, agricultural development depends on irrigation farming especially in the northern part of the state.

The Climate of Yobe state is hot and dry for most period of the year. The mean temperature for most stations in the state is about 37°C. the highest temperature 42°C is normally experienced in April, while minimum temperature (about 30°C) are normally recorded in December (Iloeje, 1977). Wind speeds, especially in the early part of the rainy season have harmful effects on the plants and animals in the state; evapo-transpiration is equally high too.

3.2.2. SOIL

The soil in most Yobe state is derived from different materials which vary in textural characteristics, but are mainly silt clay or clayey. The profile of the

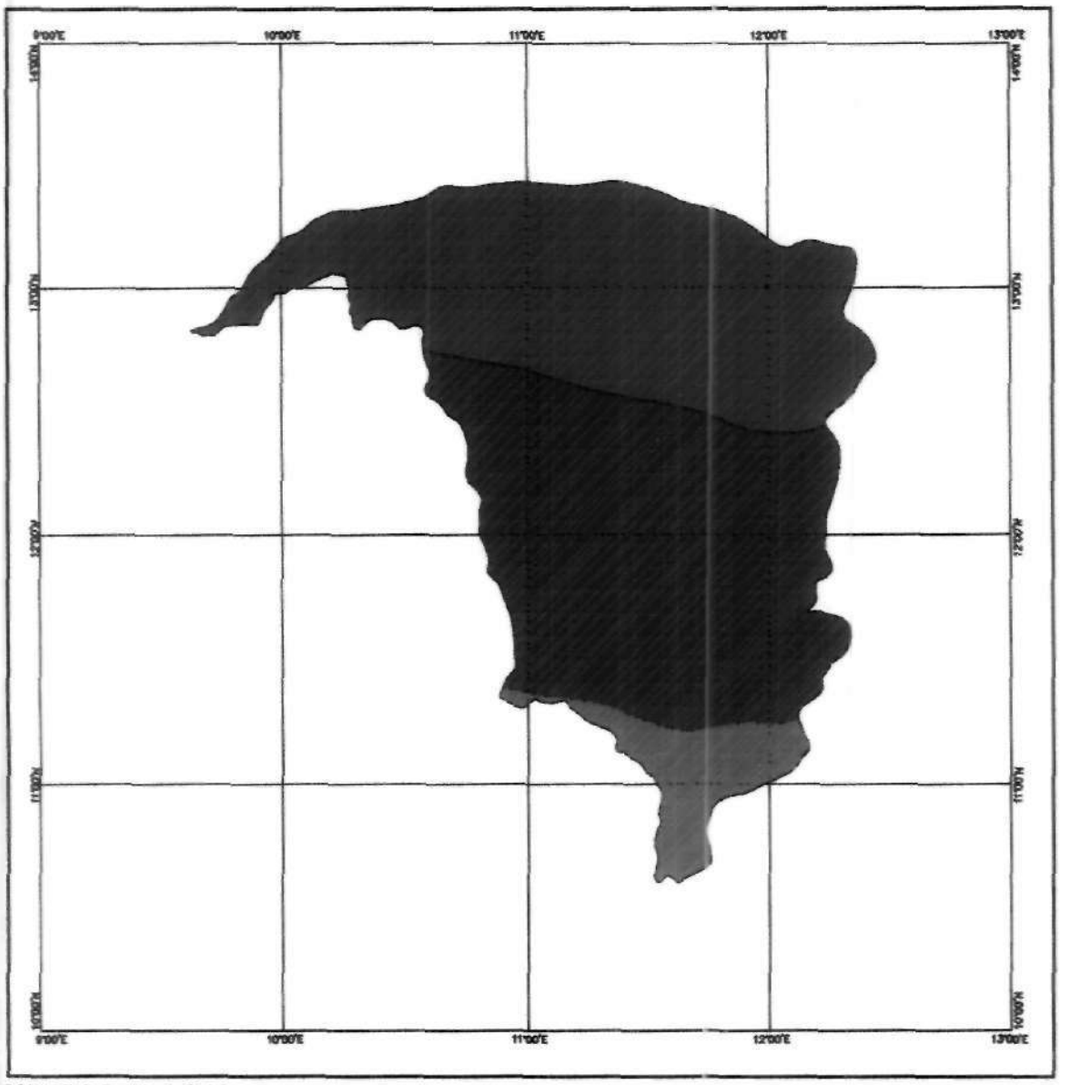


Fig. 3.3 YOBE STATE ; RAIN FALL DISTRIBUTION

soil is poorly developed and it has a low water retention capacity (Price, Justice and Los, 1990).

It has been observed that the wind-blown fine soil particles have nutrients essential for plant growth. Alluvial soils are also found in the major river valleys and are suitable for the cultivation of crops like rice and wheat, around Gashua. The productivity of the soil is greatly affected by lack of adequate vegetation cover to supply organic matter.

3.2.3. GEOLOGY, RELIEF AND DRAINAGE

Yobe state is principally comprises crystalline and sedimentary underlain by basement complex rocks. The entire area is characterized by the Chad formation which stretched into Jigawa and Borno states. It consists of sandy, clay, silk and sandy clay with average thickness of 300 meters.

Yobe State is generally flat, except for the southern parts of Gujba and Fika Local Government Areas where the land is generally rocky. The dominant relief of the Northern parts of the State is the fixed dune system of the ancient Hausa land. The rock formation also contains water-bearing aquifers of the Chad basin types, from which much of the water supply in the state is derived. The aquiver are of three layers, the upper, middle and lower aquiver which are arranged in zones. The River Yobe, from which the state is derived its name, is the biggest river in the state that flows east-wards and drain into Lake Chad. River Alkalam is one of the few tributaries of River

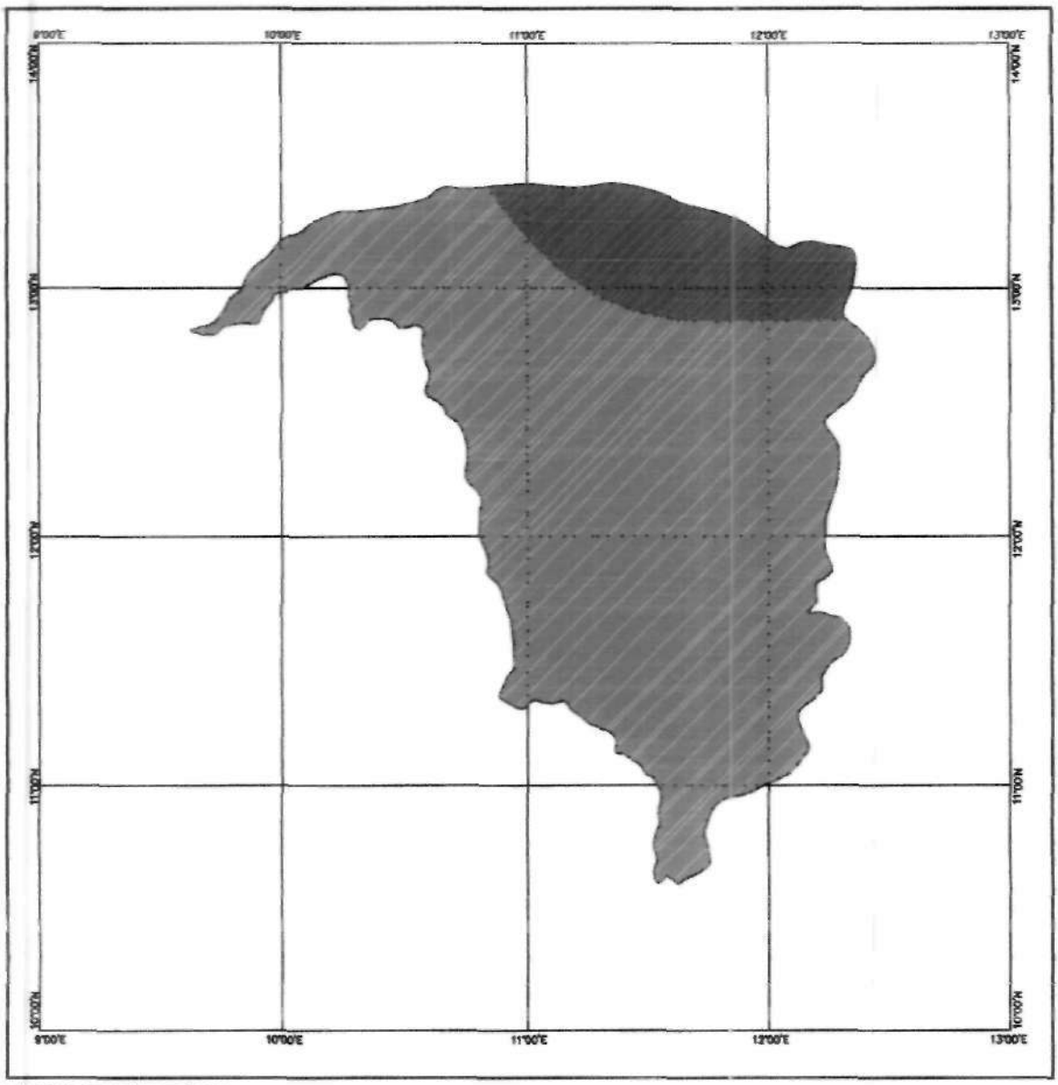
Yobe, where the famous yearly Bade fishing and cultural festival takes place (Mamman *et al.*, 2002).

3.2.4. VEGETATION

There are two (2) vegetation zones in the state. These are Sahel in the north and the Sudan savannah in the south. Vegetal cover is sparse as the grass grows closely at the base leaving bare surfaces in-between see figure 3.4.

The grasses in sahel are short, about 0.5m-1.0m in high and are interspersed with sand dunes. The trees are wide apart with the acacia and Dum palms as the most common types here. The acacia is a thorn, narrow leafed tree, fairly short and sometimes umbrella-shaped. The vegetation of the Sudan savannah is made up of short grasses 1.5m-2.0m high and stunted trees. Typical trees include the acacia, dum palm, silk cotton and baobab. The baobab stores water in the trunk like a sponge and draw water from this source during the dry period. The dum palm has tall straight branches and fan-shaped foliage. Silk cotton tree is the tallest of the group and grows to a height of 9m-15m.

The vegetation is exploited for a number of medicinal and other purposes like fuelwood, roofing and mat making which now make the environment vulnerable to desertification.



SOURCE: Online Nigeria Portal

SCALE :- 1:2,750,000

LEGEND

Sahel Savannah

Sudan Savannah

Fig. 3.4 YOBE STATE ; VEGETATION BELTS

3.3. HUMAN SETTING

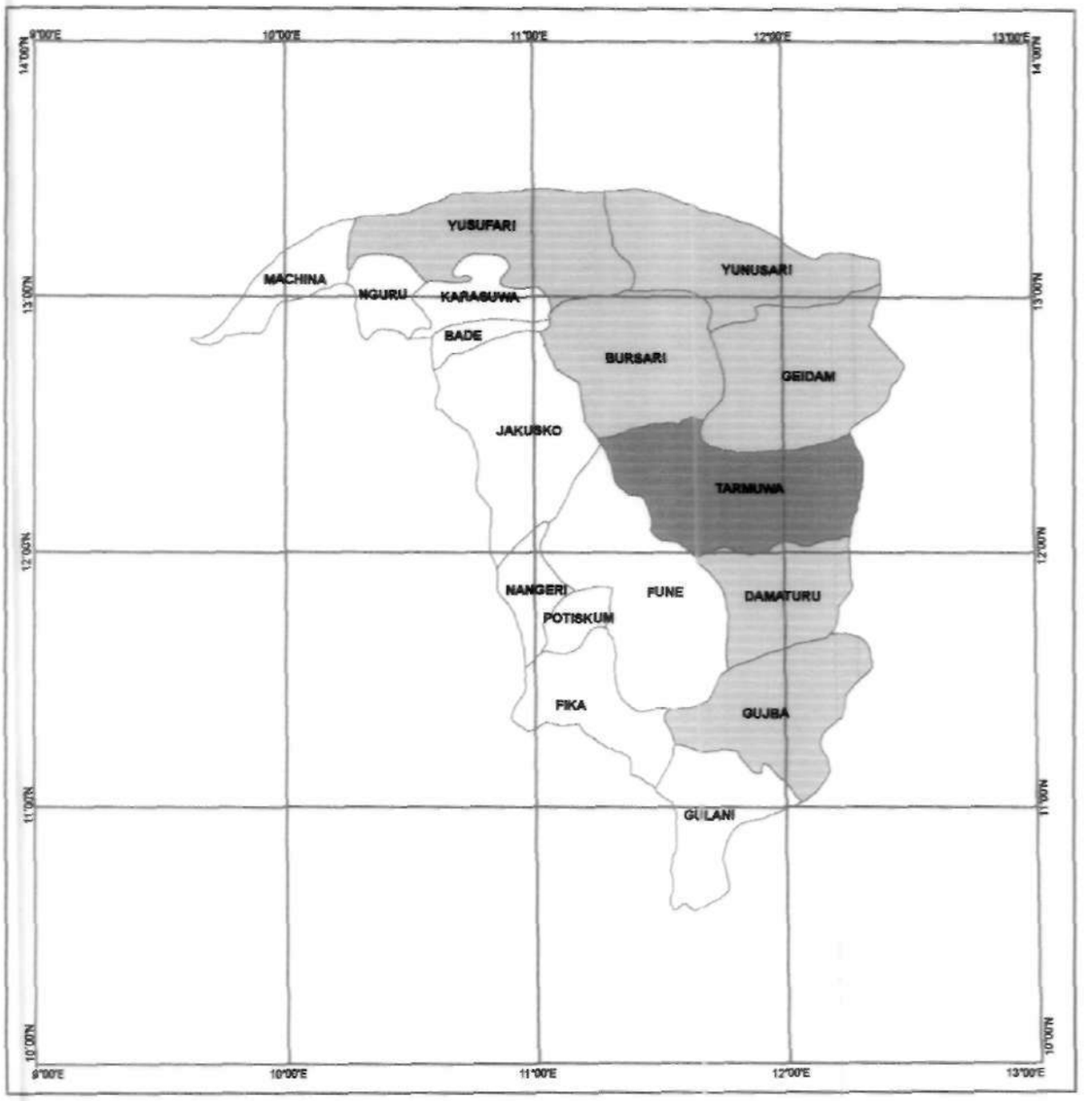
3.3.1. PEOPLE AND POPULATION

There are five major ethnic groups in the state. These are the Kanuri, Fulani, Kare-Kare, Bade and Hausa. The official language, as in every state of the country, is English. However, Hausa has gained wide acceptability as a medium of communication.

Yobe state, with a land area of about 44,881 sq km, has a total population of 2,321,591 according to the 2006 final population census results. It has an average population density of 52 persons per square kilometer. However density level varies from one local government area to another (table 3.1) the pattern of population distribution in Yobe state can be divided into three density levels as follows (figure 3.5);

1. Sparsely populated areas with density less than twenty people per sq km.
2. Moderately populated areas with densities of between twenty - forty people per sq km.
3. Densely populated areas with densities of over forty people per sq km.

The density populated areas are found in the west-central and southern part of the state while the sparsely populated areas are found in the extreme northern part of the state (Census, 2006).



Source: Author's analysis, 2009

Figure 3.5: Yobe State; Population Density

Cultural activities in the state include fishing and traditional wrestling competitions between villagers, after harvest. This competition involves all the local ethnic groups. Another popular cultural activity is called *sharo,* which is for testing the endurance of young men who want to get married. The *sharo* involves flogging one another's chest with cane in an organized competition (Ngex, 2006).

Table 3.1 Yobe State Local Government; Population, Area and Population Density

S/N	L G A	POPULATION	AREA (KM^2)	POPULATION DENSITY
1	Barde	139,782	772	181
2	Bursari	109,124	3,818	29
3	Damaturu	88,014	2,366	37
4	Fika	136,895	2,208	62
5	Fune	300,760	4,948	61
6	Geidam	157,295	4,357	36
7	Gujba	130,088	3,239	40
8	Gulani	103,510	2,090	50
9	Jakusko	229,083	3,941	58
10	Karasuwa	106,992	1,162	92
11	Machina	61,606	1,213	51
12	Nangere	87,823	980	90
13	Nguru	150,632	916	164
14	Potiskum	205,876	559	368
15	Tarmua	77,204	4,594	17
16	Yunusari	125,821	3,790	33
17	Yusufari	111,086	3,928	28
	Total	**2,321,591**	**44,881**	**Average 52**

Source; Census 2006

3.3.2. AGRICULTURE

Agriculture is the mainstay of the state economy. It is endowed with vast farming, livestock rearing and fishing development potentials provides employment to over 80 percent of the two (2) million populations in the state. Arable farming which is mostly at subsistence level can be categorised into two (2) types, namely upland farming and lowland (fadama) farming within the flood plains (Ngex, 2006).

The types of crops cultivated in upland farming are rain fed crops such as Millet, sorghum and cow pea, others are melon and groundnut. This provides the dominant staple for the people of the state. Virtually every household grows them. Low land (fadama) crops include wheat, rice, and vegetable such as tomatoes, onions and garden eggs. The cultivation of these crops starts from October, during this time rainfed farming activities have almost come to an end. These crops are mostly grown for sale, only little is used at home. Produce is mostly taken down south of the country for sale.

Livestock rearing is another very important activity in the state. Animals such as cattle, shape, camels, goat and donkey are kept by both the sedentary farmers and the nomadic herders. Pastorialism is mostly fadama areas during the dry season to take advantage of the rivers to water and graze the animals on fresh grass and shrubs of the flood plains. The nomads usually move upland during the rainy season when both water and pasture are

available everywhere to graze their animals. The state is one of the largest producers of cattle accounting for forty (40) percent of the products (Barsky, 1999).

The livestock rearing especially cattle, camels, and goats provide cash, meat, transport and milk. The rearers depend on sale of milk for daily income. Trading in livestock, smoke meat, hide and skin is a very important activity among the people in the state. The state have one of the largest cattle markets in West Africa located in Potiskum and other markets have been established in all the major towns in the state, where by trunks from far and near load the animals to places like Lagos, Onisha, Port-Harcourt, Enugu and Kaduna.

The state also possesses one of the richest fishing grounds in the north-eastern region of the country. It is practice especially among those who live close to the rivers. Smoke and dried fish trading is taken by local people and people from other Nigerians cities. Both men and women participate in catching and selling of fish. The fishing is carried out during the dry season mostly and it is regarded as a part-time activity, however, some group engaged in full time fishing.

3.3.3. COMMERNCE AND INDUSTRY

Research has shown the existence of commercial quantities of gypsum, limestone, dialomite, trona, quartz, gum arabic and potash. This makes the state an ideal location for industries such as cement, glass, chalk, soap,

detergent and adhesives as well as pharmaceuticals (Barsky, 1999). Lather works and the export of hides and skins to neighboring country also represent a significant opening for potential investors. The existing industries in Yobe state can be classified into the traditional local craft and the modern factories. The major local craft industries include leather works, pottery and weaving, while the major factories include Nguru oil mills, Nigerian food company limited, Yobe Flour and feed mills company limited (Mamman *et al,* 2002)

3.3.4. TOURISM

Yobe state has numerous tourist attractions among which are the following; Dokshi spring water in Gulani, Dagona birds sanctuary in Bade, Old Gorgaram city in Jakusko, Birnin Gazargamo in Gaidam, Tulo-tulowa village in Yusufari, Old Daniski settlement and Goya valley in Fika, 8000 year old Dufuna canoe in Fune, Grave yard of past Emirs of Fika, wetlands and Bade fishing and cultural festival in Jakusko (Yobe state, 2008).

3.3.5. INFRACSTRUCTURES

3.3.5.1 EDUCATION

Any genuine developmental programmed has to tackle, first and foremost, human capital and resource development. The state has been making serious effort over the years at providing educational facilities for learning and scholarship/busary awards to her teeming youthful population. There were a

total of 705 primary schools spread across the 17 Local government Areas of the state, 38 post primary schools and 4 tertiary institutions among which are the State College of Education, Gushua; the Federal Government College of Technical Education and the State Institute of Management Studies, both located at Potiscum; and the Federal Polytechnic, Damaturu. However Yobe state is currently classified as one of the educationally disadvantaged state in Nigeria (yobe state, 2008).

3.3.5.2 HEALTH

Yobe state has one Specialist Hospital, located in the state capital, seven General Hospitals, forty-five Health Centre, forty-six Public Health offices and one Primary Health Care Centre at Damaturu. In addition, there are a number of privately owed Clinics in the major towns of the state. There are a total number of 406 health personnel in the Government-owned health institutions, only 23 are doctors, 280 nurses, 5 well trained Pharmacists and 98community health officers. The state is grossly under-staff in this sector especially the medical doctors (Mamman *et al.*, 2002).

3.3.5.3 ELECTRICITY SUPPLY

Almost all major towns in Yobe State are fully connected to the National Grid for their electricity and power supply needs. Major towns as: Damaturu, Potiskum, Gujba, Nguru, Gashua and Fika are currently on the National Grid. Other smaller towns are fully supplied with electricity by the State

Rural Electrification Board (REB) (Yobe state, 2008). Considering the availability of electricity supply across the length and breadth of the State, Government is set to actualise its industrialisation dream.

3.3.5.4 TRANSPORTATION AND COMMUNICATION

Yobe state is served by two major means of transportation, the road and railway. All the local government council headquarters are connected to the capital as well as other parts of the country with a network of tarred roads, except three (3) namely Machina, Yusufari and Kanamma constantly moving sand dunes appear to be the main obstacle to the construction of tarred roads in the above mentioned Local Government. A railway line also links Port-Hacourt-Enugu-Jos-Gombe – Ashaka - Buni- Yadi, in Gujba Local Government to the south and Lagos - Kaduna - Kano - Nguru to the North. These railway networks are considered adequate for the transportation of Raw Materials and Finished Products to and from all parts of the Country (Yobe state, 2008).

Interms of communication, a number of places are provided with telecommunication facilities which are available in all the major urban centres. Yobe State Television (YTV) is also view in all parts of the state.

3.3.5.5 WATER SUPPLY

In terms of fresh water supply, there is little water for domestic and industrial uses. Since the creation of Yobe State in August, 1991, the State Government has succeeded in reactivating all existing, but dormant boreholes across the State sinking new ones have been drilled all over the State. In the long run, the state plans to construct Dam at Katorko, about 21 kilometres from the State Capital, along the Damaturu - Biu road. When completed, it is expected that about 250 million litres of water would be conserved annually. In addition to providing industries with their water requirements, the Dam is expected to facilitate irrigation farming and supply of portable water to the State Capital (Yobe state, 2008).

3.2. METHODOLOGY

3.2.1. SOURCES AND TYPES OF DATA COLLECTED

To fulfil the set objectives of this study, two (2) sources of data are used namely primary and secondary data. The primary data is from the ground-truthing that was carried out using Garmin 76 (handheld GPS, 15m accuracy) Global Position System (GPS) receiver. This gives the co-ordinates of some features signatures were observed on the images but which identities were not obvious. Field verification revealed them to be abandoned settlements, dunes and some form of vegetation.

The secondary source of data were the satellite images which were acquired on CD-ROM from Federal Department of Agriculture and Land resource, livestock House in Mando-Kaduna and other relevant documents from internet, government agencies and library. To determine movement of dunes and quantify changes in vegetal cover the following three (3) sets of remotely sensed data for the area were used.

1. LandSat Multi-Spectral Scanner (MSS) 80m resampled to 50m of 1970.
2. LandSat Thematic Mapper (TM) 30m of 1987.
3. LandSat Enhanced Thematic Mapper (ETM) 15m of 2005.

Though these images are of different resolutions they are still suitable for the present study.

The digital images were processed and interpreted at Dynamic Digital Technology Consultants Limited, 4 Agric quarters, Egypt road, Barnawa Kaduna.

3.2.2. IMAGE PROCESSING AND PROCEDURES

Earth Resources Data Acquisition System (ERDAS) Imaging was the software used in processing the images. The acquired images were pre-processed images that came in six (6) scenes which are in Universal Transverse Mercator (UTM) projection. The wide extent of the study area spanned across two (2) UTM zones namely zone 32 and 33. It was not

possible to stitch the scenes together; because they were in two (2) different zones therefore they were re-projected to Transverse Mercator (TM) Projection which allows the scenes together as a contiguous coverage in one projection.

3.2.2.1 MOSAICKING

The entire scenes of each date were stitch together in one contiguous image, a process called mosaicking. This now give us three (3) big images for the each date (1970, 1987 and 2005) larger than the study area, thereby occupying very large memories capable of retarding the processes.

3.2.2.2 SUB SET

The out line of the study area (Yobe State) was used in a subset operation to trim the mosaic images to the extent of the state. The useful portion of the big images of each date was extracted out using the border of the study area, for reason to conserved space in the machine and the image to be lighter.

3.2.3. IMAGE ANALYSIS

Arc GIS was the software used for analyzing the images.

2018

3.2.3.1 IMAGE INTERPRETATION

Dunes movement is one of the major indicators of desertification process. The extent of dunes for the three dates of study was determined by on-screen

KASHIM IBRAHIM LIBRARY

visual interpretation. Field observations on dunes were matched with corresponding image features to establish the spectral signatures of dune. This enabled the delineation of dunes area on the image.

3.2.3.2 NORMALIZED DIFFERENT VEGETATION INDEX (NDVI)

Normalized Different Vegetation Index (NDVI) was adapted to study changes in vegetation. The image data of the study dates were subjected to an NDVI analysis and nine (9) vegetation classes, ranging from -1 to +1 were obtained. For better appreciation of this result a GIS analysis was further performed.

3.2.4. GIS ANALYSIS

3.2.4.1 POLYGONIZATION

In order to automatically generate areal statistics for dunes, the delineated areas of dunes were converted to polygons. Area statistics obtain for various dates were used to determine changes in area of dunes coverage. Likewise the NDVI results for each date were also converted to polygons so as to calculate the area statistic of each vegetation class of the dates.

3.2.4.2 OVERLAY

The delineations of dune areas for the three (3) dates under consideration were put together in a spatial overlay process to visually display the movement of dunes over the three dates.

3.2.4.3 RE-CLASS

The NDVI result obtain was reclassified into nine (9) vegetation classes by the machine and later re-group to three (3) final classes for appropriate descriptions and clear understanding of the desertification process taking place within the study area.

3.2.5. DATA ANALYSIS

Descriptive statistics such as percentages, tables and mean were used for both analyses and presentation of data. A comparative analysis was made with the different imageries of different dates; it becomes necessary to identify the changed on the actual ground over time.

To achieve objective ii, the Rate of Change formula is used for a date.

$$RC = (ACET - ACBT / ACBT) \times 100 \text{ ---------- (1)}$$

Then, the Average Rate of Change of the dunes movement is calculated.

$$ARC = \frac{(ACET - ACBT / ACBT) \times 100}{YI} \text{ ---------- (2)}$$

Where; RC - Rate of Change

ACET- Area Coverage at End of Time

ACBT- Area Coverage at Beginning of Time

ARC- Average Rate of Change

YI- Years Interval (McDaniel, 2008)

3.2.6. LIMITATION(S) TO THE STUDY

The limitations of the study are summarized as follows: The availability and affordability of recent remotely sensed data of the present period (2009) and unavailability of data within the ten (10) years interval of the required dates.

HASHIM IBRAHIM

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. INTRODUCTIOIN

This chapter presents the result and discussion of the study on magnitude of desertification in Yobe state base on the stated objectives. The assessment of desertification was based on the movement of dunes and vegetation changes using remote sensing and Geographical Information System techniques.

4.2. THE MOVEMENT OF DUNES

The extent of dunes for the three (3) different dates were determined and mapped as shown in figure 4.1, 4.2, 4.3. the status of dunes for the period of study, was defined by area coverage as presented in table 4.1.

Table 4.1: The Extent of Dunes

YEAR	DUNES AREA COVERAGE		UNCOVERED AREA BY DUNES		TOTAL		CHANGE IN DUNES AREA (%)
	KM^2	%	KM^2		KM^2	%	
1970	3,124.99	6.78	43,300.03	93.22	46,425.02	100	-
1987	4,241.13	9.22	42,183.89	90.78	46,425.02	100	2.44
2005	4,448.73	9.67	41,976.29	90.33	46,425.02	100	0.45

Source: Author's Analysis 2009

Table 4.1 shows the extent of dunes for three different dates (1970, 1987 and 2005) of 46,425.02 km^2 area of Yobe state. In 1970 dunes cover 3,124.99

km^2 representing 6.78 percent of the total area of the state. The dunes cover 4,241.13 km^2 in 1987 which is 9.22 percent of the state after 17 years with a percentage change of 2.44 percent and 18 years later, in 2005 the dunes area increases to 4,448.73 km^2 representing 9.67 percent of the total area of the state with percentage change of 0.45 percent. The percentage change between 1970 and 1987 (2.44%) was high when compared to 1987 and 2005 (0.45%). This might be due to the occurrence of drought in the region which started late 1960's and lasted until about the mid 1980's which was recorded as the worst drought of 20^{th} century. Between, 1987–2005 the percentage changed dropped probably as a result of the rigorous campaign and fight against drought and desertification.

The figures 4.1, 4.2 and 4.3 indicate that dunes are not found all over the State. A look at the Local Government Area (LGA) map of the State reveals that only two LGA's are worst hit by the dunes in the north-central of the State, they are Yusufari and Yunusari Local Government Areas. The composite map fig.4.4 depicts the south-ward movement of the dunes.

From the statistic in table 4.2 the area coverage by the moving dunes account for more than 50 percent of the total of the two LGA's (Yusufari and Yunusari) which have a total surface area of 7718 km^2. In 1970, 40.49 percent of the Yusufari and Yunusari Local Government Areas were already being covered by the sand dunes. 1987 the sand dunes cover 4,241.13 km^2 of

the total area of the two (2) LGA'S which represents 54.95 percent and by 2005, the dunes cover 4,448.73 km^2 representing 57.64 percent.

Table 4.2: Two LGA'S affected by Dunes (Yusufari and Yunusari)

YEAR	DUNES AREA COVERAGE (KM^2)	YUSUFARI AND YUNUSARI LGA (KM^2)	PERCENTAGE OF AREA COVER BY DUNES
1970	3,124.99	7718	40.49
1987	4,241.13	7718	54.95
2005	4,448.73	7718	57.64

Source: Author's Analysis 2009

The Rate of Change 1970 to 1987

$$ARC = \frac{(ACET - ACBT / ACBT) \times 100}{YI}$$

ACET- 4241.13

ACBT- 3124.99

AARC - ?

YI- 17

$$ARC = \frac{(4241.13 - 3124.99 / 3124.99) \times 100}{1987 - 1970}$$

$$ARC = \frac{(0.3571) \times 100}{17}$$

ARC = 2.10

This means that for 17 years at the rate of about 2.10, land is swallowed by sand dunes reflecting the proportion of area cover by a desertification agent.

The Rate of Change 1987 to 2005

$$ARC = \frac{(ACET - ACBT/\ ACBT) \times 100}{YI}$$

ACET- 4448.73

ACBT- 4241.13

AARC - ?

YI- 18

$$ARC = \frac{(4448.73 - 4241.13/\ 4241.13) \times 100}{2005 - 1987}$$

$$ARC = \frac{(0.048949) \times 100}{18}$$

ARC = 0.27

This means that for 18 years at the rate of 0.27, land is swallowed by sand dunes reflecting the proportion of area cover by a desertification agent.

The period 1970 to 1987, the rate of change of sand dunes movement was high, this further buttress the occurrences of drought in the region while 1987 to 2005 was low when compared to the first period which is as a result of mitigation measures and fight against desertification and drought that were adopted by both international organizations and various tiers of government through afforestation programmes.

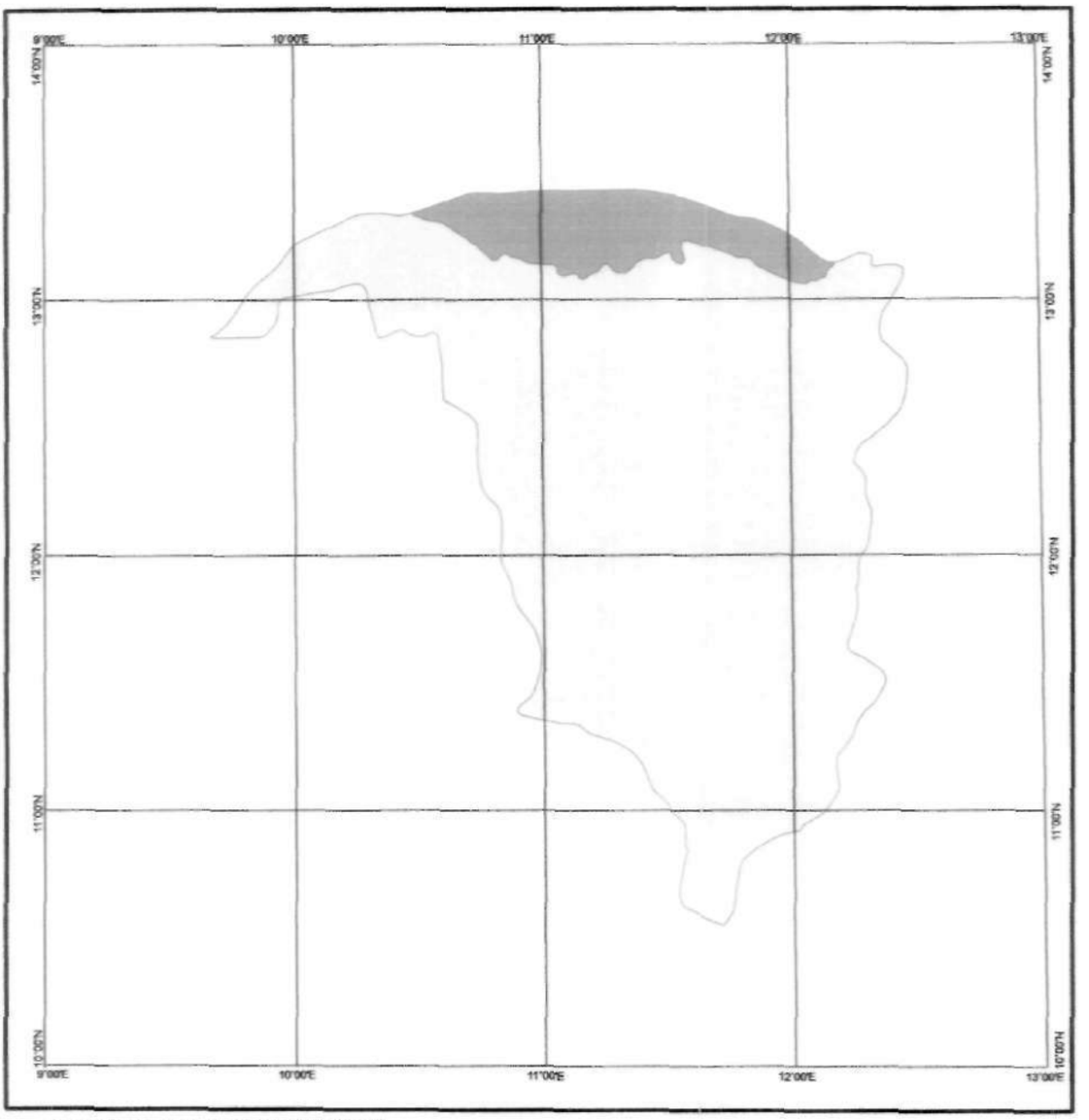
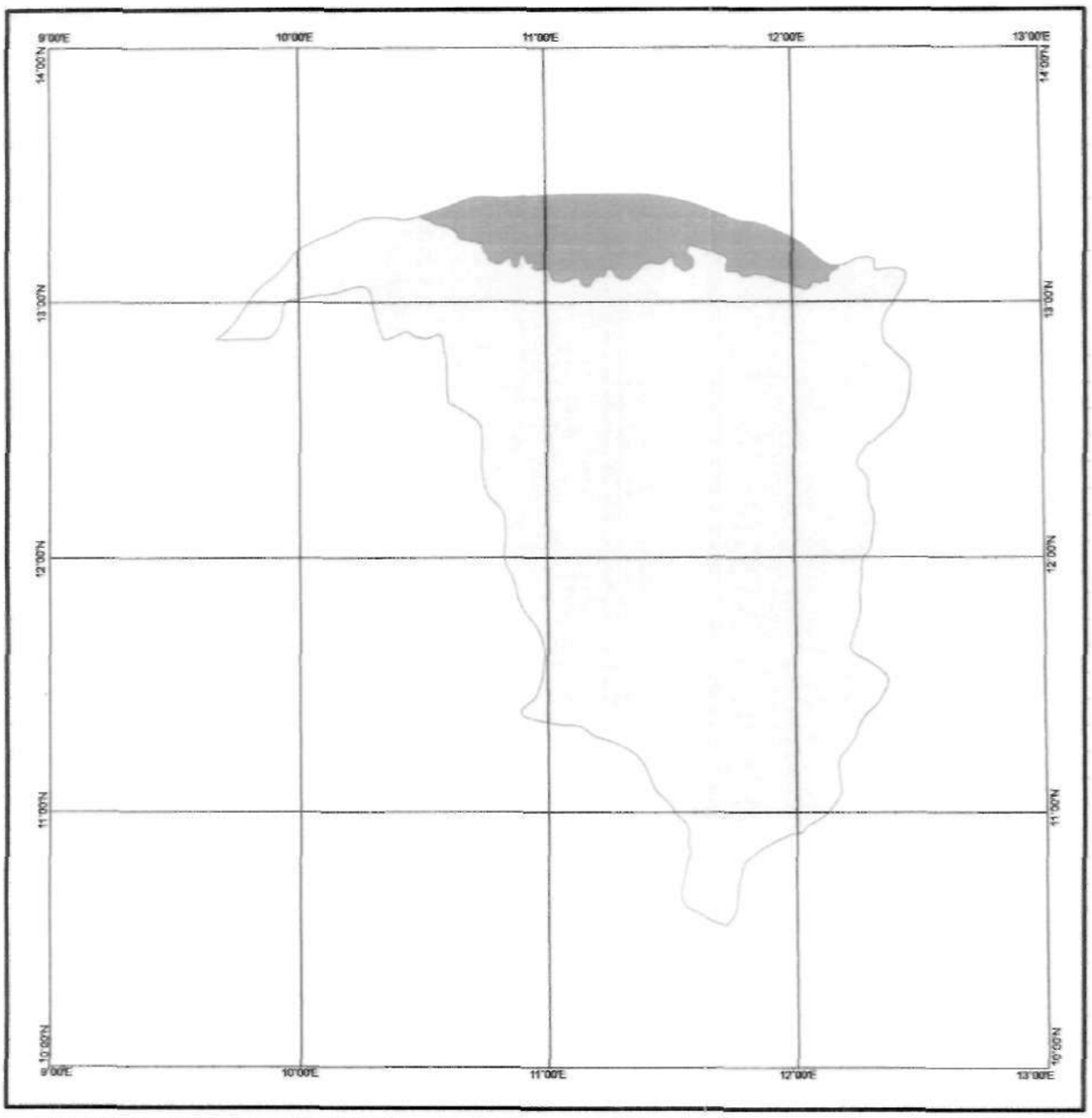


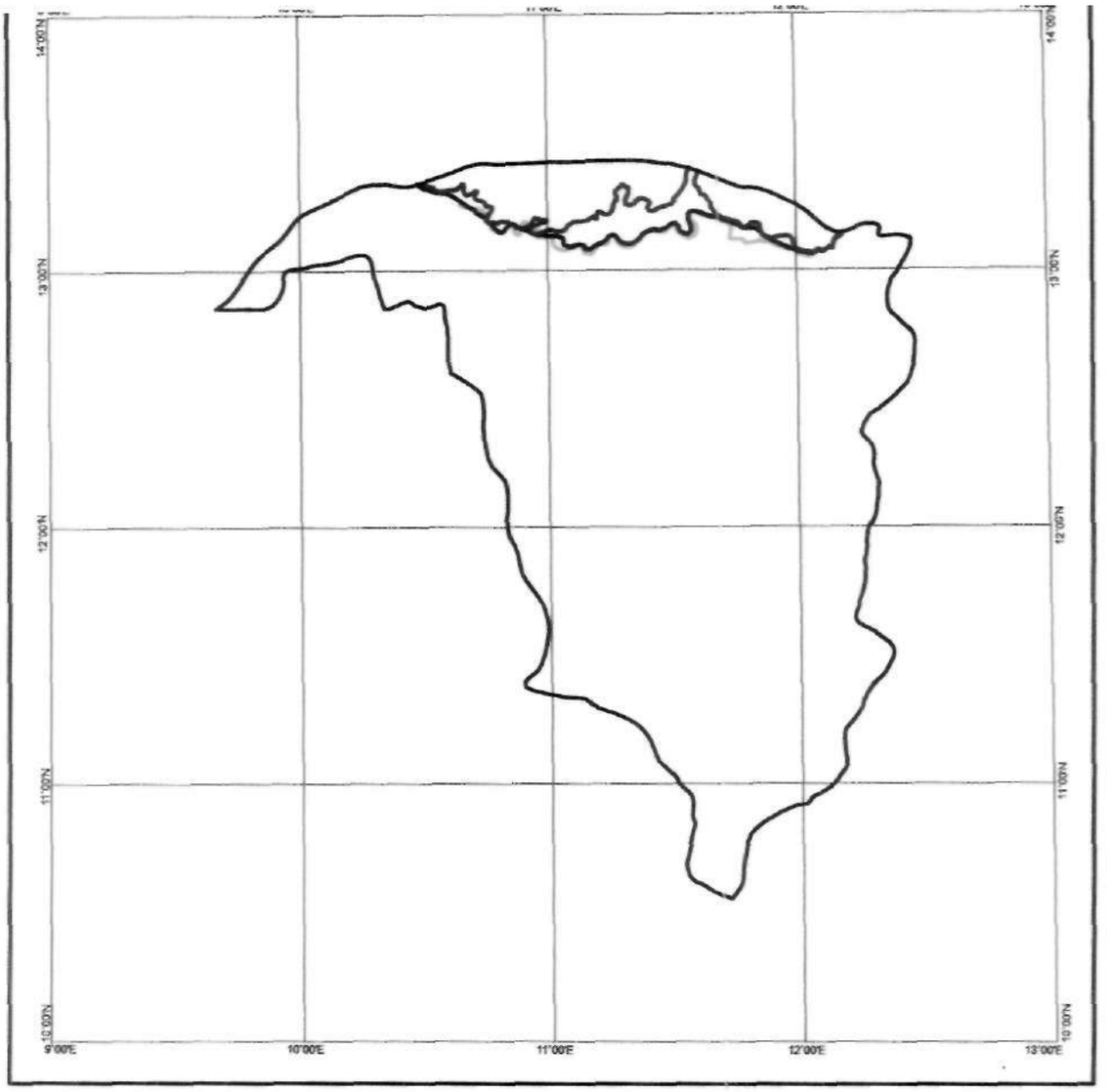
Figure 4.2; Yobe State; Sand Dunes in 1987



Source: Analysis of Landsat ETM (2005)

Scale:- 1 : 2750000

Figure 4.3: Yobe State; Sand Dunes in 2005



Source: Analysis of Landsat MSS (1970), Landsat TM (1987) and Landsat ETM (2005)

Scale:- 1 : 2750000

LEGEND

- Extent of dunes in 1970
- Extent of dunes in 1987
- Extent of dunes in 2005

N

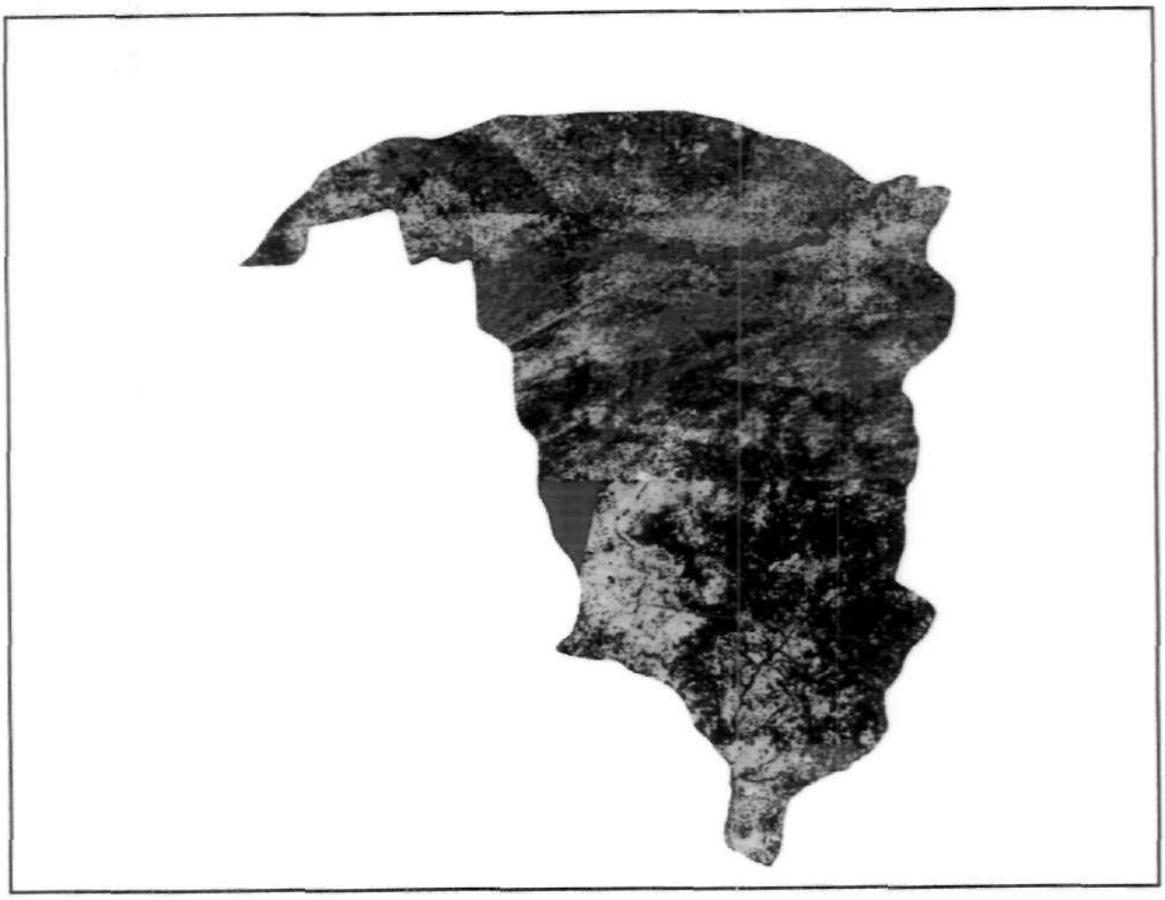
Figure 4.4: Yobe State; Composite of Sand Dunes

4.3. THE VEGETAL COVER

In order to assess vegetation change a Normalize Difference Vegetation Index (NDVI) analysis was performed on Landsat MSS of 1970, Landsat TM 1987 and Landsat ETM 2005. The output of the NDVI was a gray-scale image with stratification of values ranging from -1 to +1 which correspond to very low -1 to very high +1 vegetation values. In order to interpret the NDVI and quantify the various vegetation classes a reclassify operation was performed on the NDVI, the nine classes that resulted from the process are presented in figures 4.5, 4.6 and 4.7. From each of the NDVI map, the stratification follow the range of order as presented in table 4.3. To practically match these vegetation classes with reality, the nine classes were collapsed into three broad classes namely:

1. Non Vegetal Cover (bare soil, built up and water bodies).
2. Light Green-Leaf Vegetation (savannah shrub, scatter trees and minor grass components).
3. Green-Leaf Vegetation (riparian forest, Plantation and dominant savannah woodland).

The regrouped vegetal cover maps are presented in figures 4.8, 4.9 and 4.10 representing 1970, 1987 and 2005 respectively.



Source: Landsat MSS, 1970

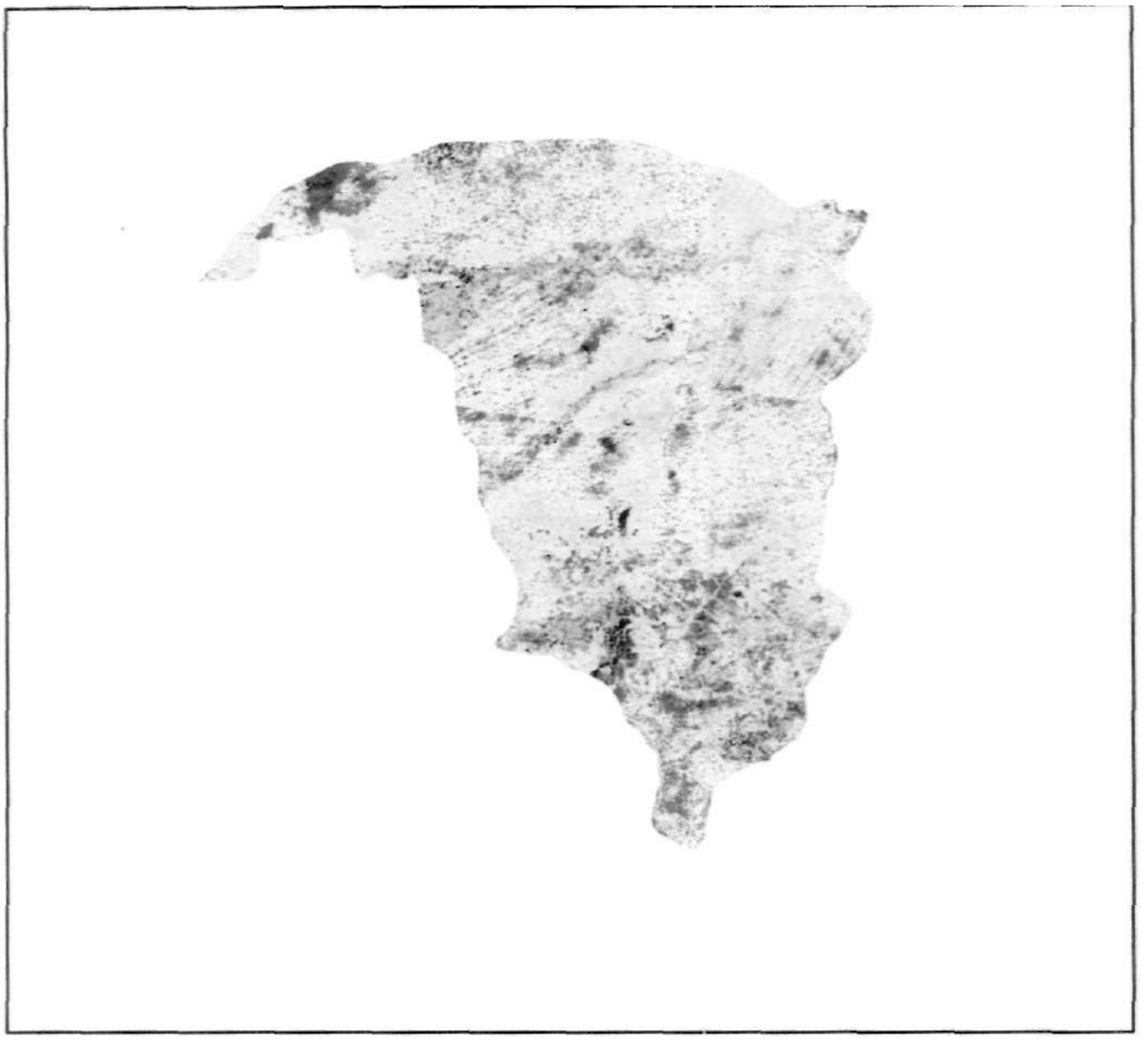
LEGEND

- -1–-0.74
- -0.73–-0.11
- -0.10-0.14
- 0.15-0.32
- 0.33-0.38
- 0.39-0.45
- 0.46-0.55
- 0.56-0.81
- 0.82-1

Scale :- 1 : 2750000

N

Figure 4.5; Yobe State: Reclassifed NDVI, 1970



Source: Landsat TM, 1987

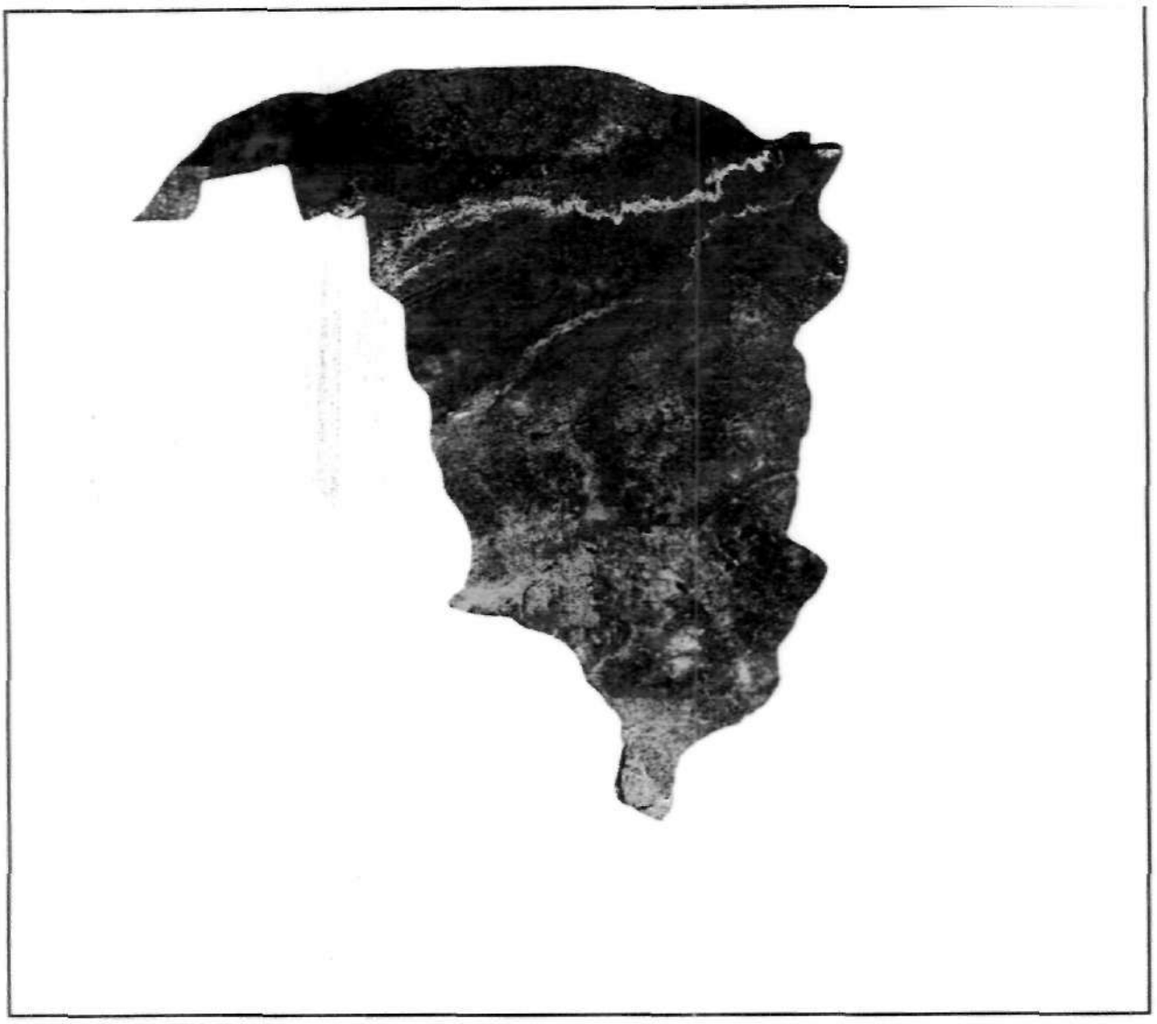
LEGEND

- -1
- -1--0.15
- -0.14--0.027
- -0.026--0.011
- -0.01-0.01
- 0.012-0.05
- 0.06-0.14
- 0.15-0.33
- 0.34-1

Scale :- 1 : 2750000

N

Figure 4.6; Yobe State: Reclassifed NDVI, 1987



Source: Landsat ETM, 2005

LEGEND

- -1--0.85
- -0.84--046
- -045--0.14
- -0.13--0.04
- -0.03-0.05
- 0.06-0.23
- 0.24-0.53
- 0.54-0.84
- 0.85-1

Scale :- 1 : 2750000

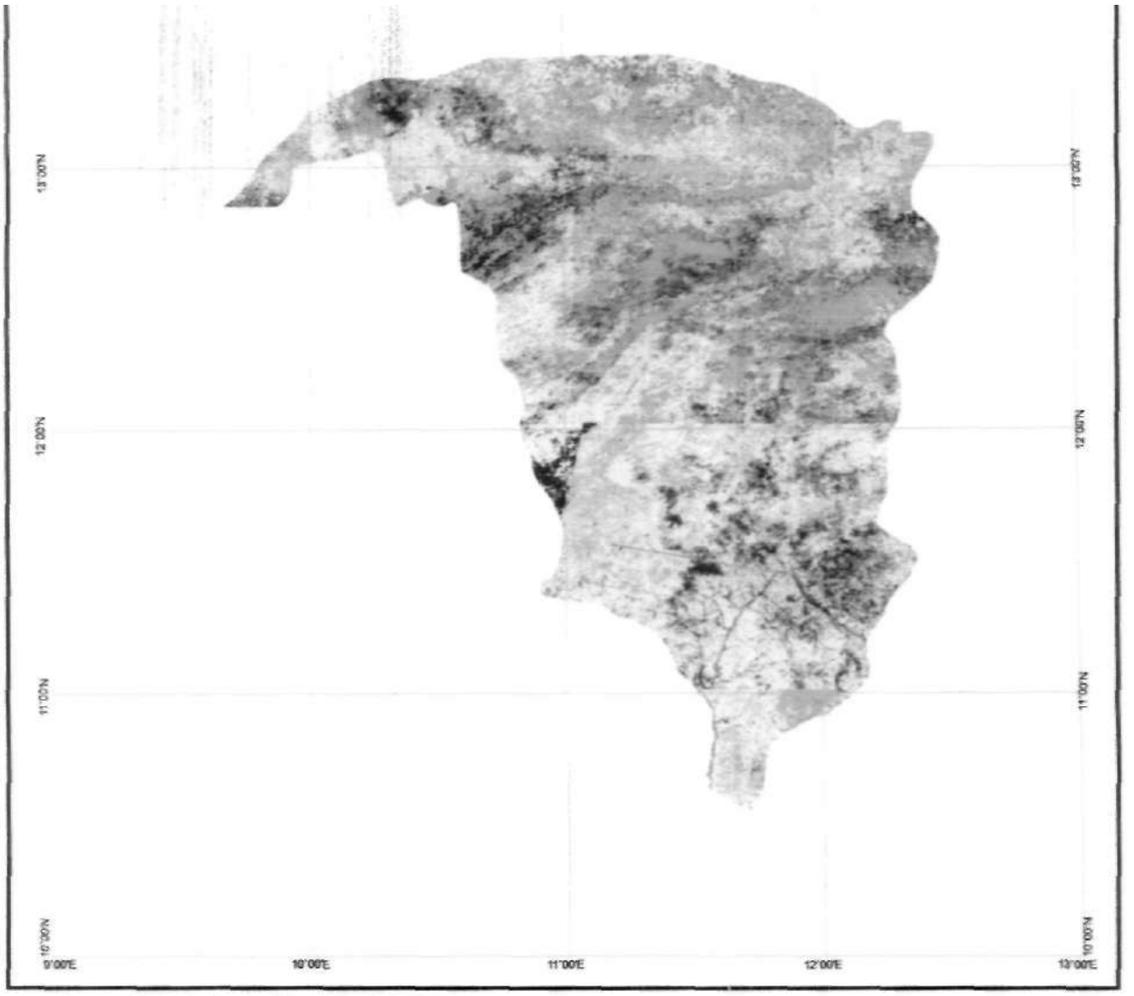
N

Figure 4.7: Yobe State: Reclassifed NDVI, 2005

Comparison of satellite data with ground survey shows that the results obtained by remote sensing GIS analysis regarding assessment of vegetation changes holds well with the actual ground vegetation in the study area. Desertification assessment depending on the NDVI values on tables (4.4) shows that the vegetation condition was deteriorating that is, high change was recorded in 1987.

The negative values were qualified to severe desertification, while positive values were qualified to moderate and light desertification/ undesertified. However, fig (4.8) - (4.10) indicated that the greatest desertification risk within the study area exist in the extreme North which advanced southwards since 1970 to 2005, though there were patches of desertified area in the southern part.

Based on the NDVI image value of the different dates results, it could be noticed that 9310 km^2 (20.05%), 9929 km^2 (21.39%) and 10002 km^2 (21.54%) of the area were severely lost to desertification in 1970, 1987 and 2005 respectively in an increasing order. 30514 km^2 (65.73%), 33227 km^2 (71.57%) and 33033 km^2 (71.15%) of the area were moderately affected by desertification in the said dates while 6601 km^2 (14.22%), 3269 km^2 (7.04%) and 33033 km^2 (7.30%) of the area were undesertified or slightly affected by desertification in 1970, 1987 and 2005 respectively see table 4.4.



Source: NDVI Analysis of Landsat MSS (1970)

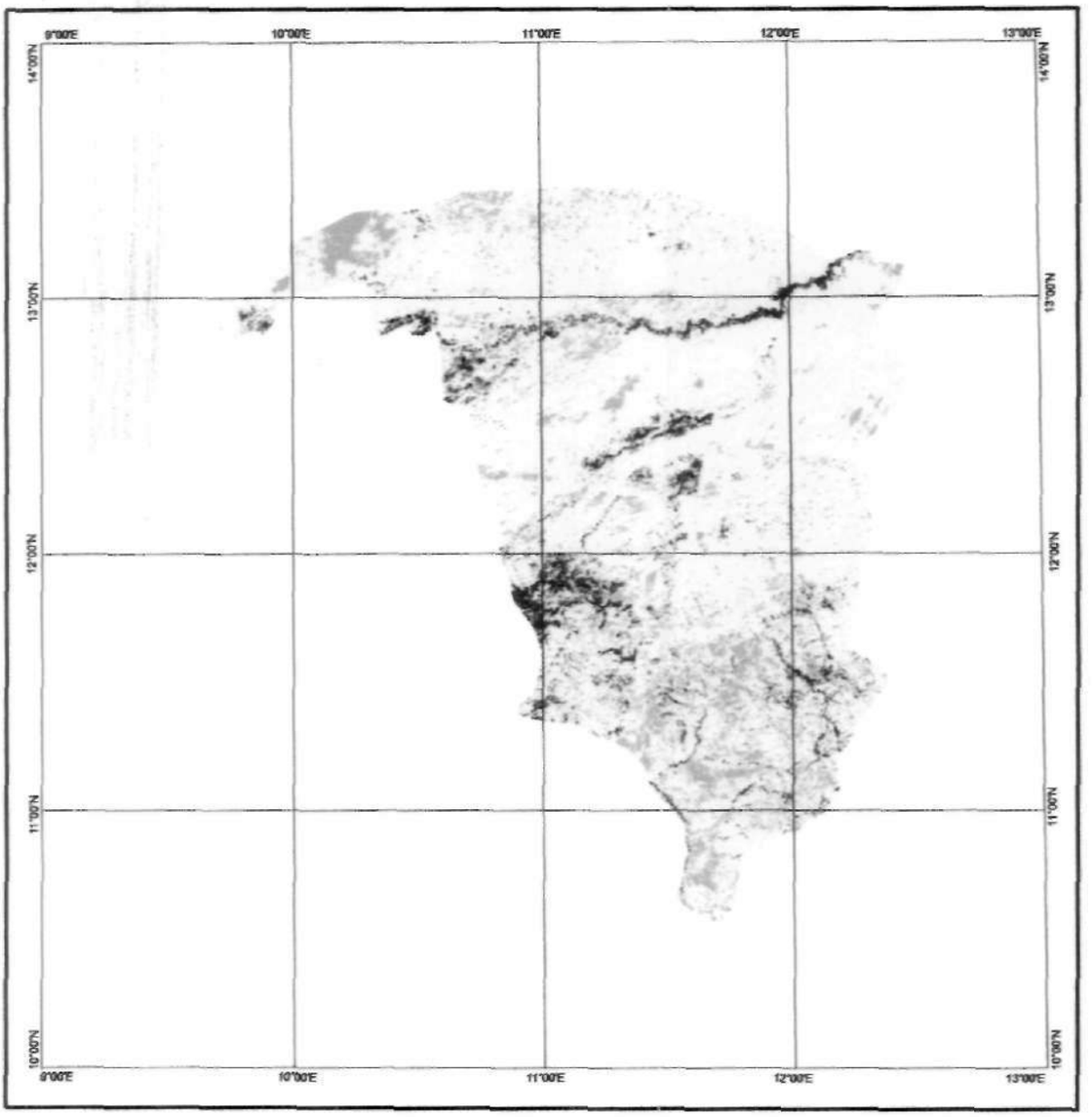
Scale:- 1 : 2,750,000

LEGEND

- Non Vegetal Cover (Bare surface/Build-up area/Water body)
- Light Green Leaf Vegetation (Discontinuous Savanna shrub/Scattered trees/ Minor grass component)
- Green Leaf Vegetation (Riparian forest/Plantation/Dominant Savanna woodland)

N

Figure 4.8; Yobe State; Vegetal Cover in 1970



Source: NDVI Analysis of Landsat TM (1987)

Scale:- 1 : 2750000

N

LEGEND

- Non VegetalCover (Bare surface/Build-up area/Water body)
- Light Green Leaf Vegetation (Discontinuous Savanna shrub/Scattered trees/ Minor grass component)
- Green Leaf Vegetation (Riparian forest/Plantation/Dominant Savanna woodland)

Figure 4.9: Yobe State; Vegetal Cover in 1987

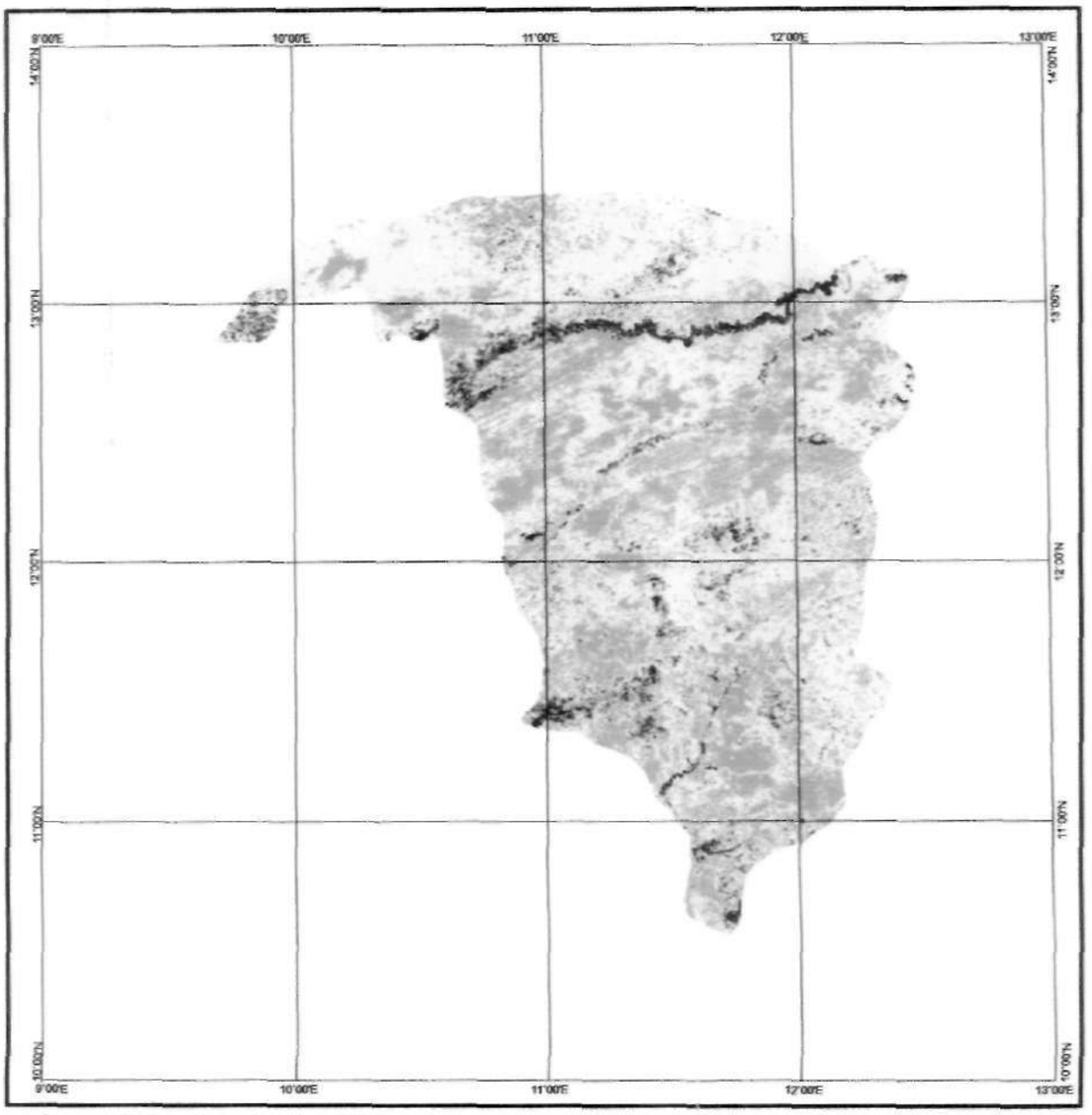


Figure 4.10: Yobe State; Vegetal Cover in 2005

Table 4.4 also indicate between 1970 and 1987 the severe desertification area coverage percentage change was 1.24% higher during the drought years when compared to 1987 and 2005 which was 0.15% when people are conscious of the adverse effects of desertification. The percentage change between 1970 and 1987 on moderate desertification area coverage was 5.84% while 1987 and 2005 negatively increase to 0.42, this indicate that before 1987 there was a level of ignorance on the effects of desertification. Between 1970 and 1987 the percentage change of undesertified area coverage decreases to 7.18% and increases between 1987 and 2005 by 0.26%. By 1987 Green Leaf Vegetation had drop drastically in quantity to almost half of 1970, but in 2005 it increased.

Table (4) Land Use Remote Sensing Data (NDVI)/Desertification Classification areas of Yobe state

Cover Type	Stratified NDVI Values	DESERTIFICATION CLASSIFICATION	1970		1987			2005		
			Km2	%	Km2	%	% Change	Km2	%	% Change
Non vegetal Cover; Bare Soil, Built-up and Water Bodies	-1 - 0.04	Severe	9,310	20.05	9,929	21.39	+1.34	10,002	21.54	+0.15
Light Green Leaf Vegetation; Scatter Trees, Savannah Shrub and Minor Grass Component	0.05 - 0.5	Moderate	30,514	65.73	33,227	71.57	+5.84	33,033	71.15	-0.42
Green Leaf Vegetation; Riparian Forest, Plantation and dominant savannah woodland.	0.51-1	Light/ Undesertified	6,601	14.22	3,269	7.04	-7.18	3,390	7.30	+0.26
TOTAL			**46,425**	**100**	**46,425**	**100**	**0.00**	**46,425**	**100**	**0.00**

Source: Author's Analysis 2009

+ denotes increase in percentage change of desertification classification
- denotes decrease in percentage change of desertification classification

4.4. FIELD OBSERVATTION

Plate 4.1 shows the vast extent of sand dunes encroachment around Yusufari and Yunisari villages with scatter or no vegetal cover. The sand accumulates into ridges which lie parallel along a north-to-south or northwest-to-southeast orientation, depending on the direction of the prevailing winds and shifting sand dunes are an indicator of desertification along with the erosion of soil. Accumulations of windblown sand are red, brown, or white in places which gives an interesting and beautiful scenario of the phenomena. As dry and vast the sand dunes fields were, there are cases and spots of natural green leaf vegetation illustrated in Plate 4.2.



Plate 4.1: Vast Extent of Sand Dunes in Yunisari LGA

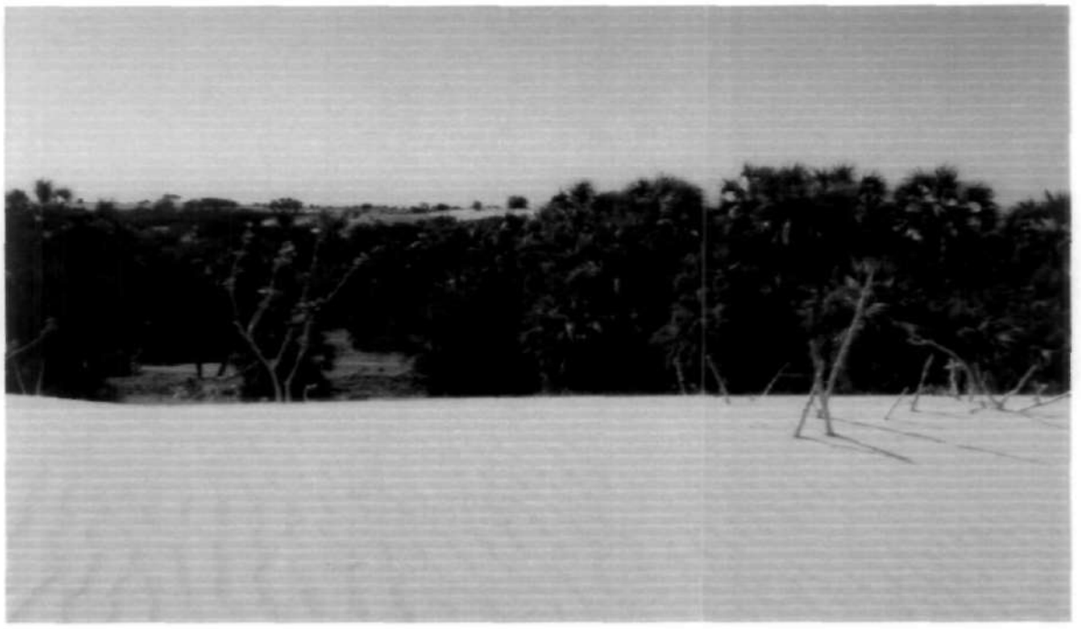


Plate 4.2: Natural Green Leaf Vegetation amidst Undulating Sand Dunes in Yusufari LGA

Sand dunes are potentially the most destructive elements which move in succession down wind and are capable of engulfing villages and burying fertile fields. Just as flood is destructive and displace settlers in other places in Nigeria, most especially the southern part of the country that is how sand dune and sand storm displace settlers, destroyed range land and buried highways as shown in Plate 4.3 were sand dunes swallowed part of Kaska village in Yusufari LGA of the State.



Plate 4.4: Shelter Belts Established by North-East Arid Zone Development Programme (NEAZDP) in Yusufari LGA

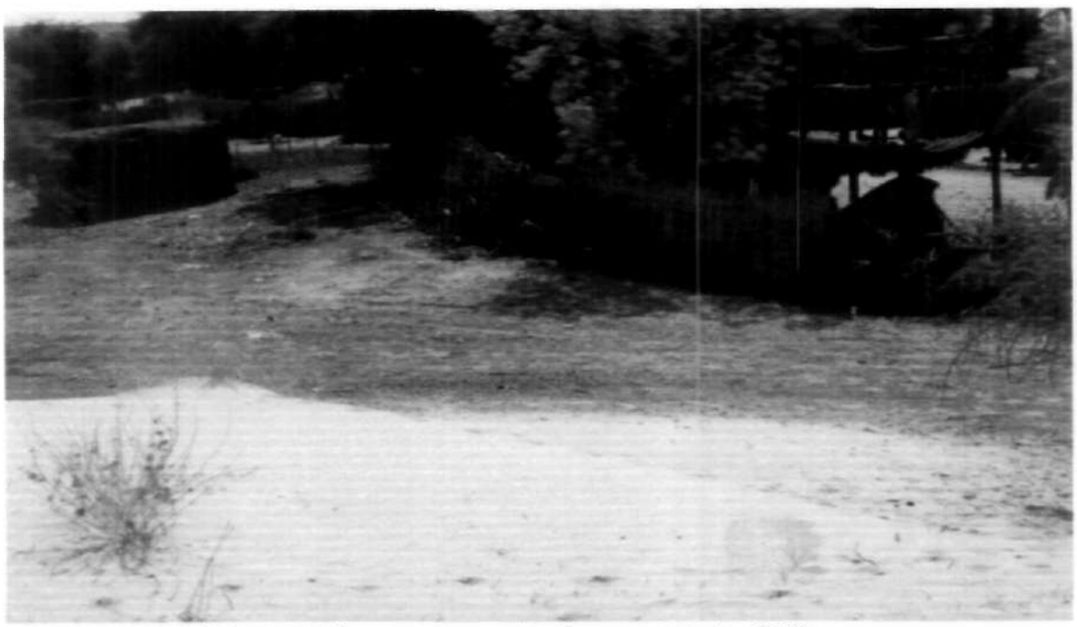


Plate 4.5: Sand Dunes Threatening a Settlement Kaska Village

CHAPTER 5

SUMMARY CONCLUSION AND RECOMMENDATION

5.1. SUMMARY

The study was conducted to assess the extent and magnitude to which desertification affected Yobe state of Nigeria and possible implications of on livelihood in particular and sustainable development in general.

For quantifying the areal extent of desertification, satellite imageries for three periods were employed to detect changes in sand dunes and vegetal covers of the area. Increase in sand dunes and reduction in vegetal covers are good indicators of desert encroachment. The satellite imageries that were used for the study comprise; LANSAT MSS, 1970, LANDSAT ETM 1987 and LANDSAT ETM 2005. Earth Data Acquisition Software (ERDAS imagine 9.2) was used to mosaic, subset and enhanced the quality of the satellite imageries while a specialized GIS world software, ArcGIS was used to interpreted and analysed the images. The Results of the analysis have indicated a progressive shift of sand dune in the direction of the prevailing wind and decreased in vegetal cover obtained through the Normalized Defference Vegetation Index (NDVI) results. Sand dune area coverage has recorded 3,124.99Km^2 representing 6.78% of the total area in 1970, 4,241Km^2 representing 9.22% of the entire area in 1987 and 4,448.73Km^2 of

KASHIM IBRAHIM LIBRARY

the entire area in 2005 representing 9.67%. This explains the fact that percentage change between 1970 and 1987 was 2.44% and subsequent periods 1987 and 2005 has recorded 0.45%. the decreased in percentage change was envisaged due to mitigation measures that were adopted by both international organizations and various tiers of government through afforestation programmes thereby creating shelter belts in various segment of the affected areas.

Similarly, the Normalised Difference Vegetation Index (NDVI) of the different periods has recorded severe, moderately and slightly lost of vegetation. It could be noticed that 9310Km^2 (20.25%), 9929Km^2 (21.39%) and 10002Km^2 (21.54%) of the area were severely lost to desertification in 1970, 1987 and 2005 respectively. 30514 Km^2 (65.73%), 33227 Km^2 (71.57%) and 33033 Km^2 (71.15%) of the area were moderately affected by desertification in 1970, 1987 and 2005 respectively. In addition, 6601 Km^2 (14.22%), 3269 Km^2 (7.04%) and 33033 Km^2 (7.03%) of the area were slightly affected by desertification in 1970, 1987 and 2005.

Therefore, results of these analyses have revealed desert encroachment through vegetal loss and progressive movement of sand dunes which is encroaching northwards and threatening settlements and claiming arable lands for agricultural purposes. There is need for more mitigation measures to be put in place in order to prevent or minimised the trends.

The increasing incidence of desertification is the most disturbing ecological problems faced in Yobe State. Wind erosion is found to aggravate the problem by creating sand dunes in the northern parts of the State, especially in Yusufari and Yunusari areas. Today, the lives of the people living in these areas are seriously threatened such that the trend in mitigation is southwards.

5.2 CONCLUSION

Desertification has now become a pressing issue on the world stage since the Sahelian drought started at the late 1960s. Desertification appears as land degradation under arid, semi-arid and dry sub-humid climates.

Remote Sensing and GIS techniques have proven to be a computable tractable indicator for detecting sand dunes movement and the vegetation zones. These are useful particularly where there is a lack of primary measurements of dunes movement and vegetation conditions over large area. It has been possible to calculate the areas coverage of land in Yobe state that has been lost to desertification, that is, been swallowed by sand dunes and has no vegetal cover.

Different efforts have been made to stabilize sand dunes encroachment by the settlers, State Government, North-East Arid Zone Development Programme (NEAZDP) and NGO's, but there is little or no results to combat the adverse effect of desertification.

5.2 RECOMMENDATIONS

Because desertification is a common problem in arid regions and goes beyond Yobe state in terms of extent and combating it, based on the findings of this study, the following recommendations are made:

1. Direct involvement of major land owners and farmers is necessary to create the necessary forest vegetation required to ameliorate the deserlification process.
2. Shelterbelts are to be established in order to counteract adverse ecological conditions. The selection of the shelterbelts species should be principally on biological considerations which include: 1. easy availability of good quality seeds, 2. adaptability to the environment, 3. fast growth and 4. Effectiveness in reducing wind velocity (consequently its physical and physiological damage) and to check the desert spread.
3. A national desertification commission should be established, desertification in Nigeria should be a priority issues.
4. Government policies should be enforced to ensure protection of trees to safeguard forest resources and reduce the increasing trees and grassland depletion in the study area
5. Finally, it is recommended that more Agro-meteorogical extension work in the form of information and education will be needed to raise the awareness of the settlers in the area about the severity and the sequences as well as the consequences of desertification.

5.4 SUGGESTION(S) FOR FURTHER STUDY

In this regard, a focus needs to be made on the following research aspects:-

1. There is a need to carry out a resource inventory of the affected parts of Yobe state in order to assessed the past, present and potentials hazard of migrating dunes and desertification, with the view to drawing up a priority list for sand dunes fixation and to decide on the most economical steps to be taken.
2. Studies should be carried out to combine the newly emerging technologies including the remote sensing/Geographic Information System (GIS) data with ground observed data and nomads perceptions to monitor and evaluate the magnitude of desertification in the state.
2. Studies should be carried out to explore information on the microclimate effects especially on the soil moisture regimes and the possibility of using the best shelterbelts composition (row of suitable trees) as windbreaks in some areas. Also to determine; species suitable for planting, nursery practices to be used, types and size of material to be planted, time of planting and spacing trials.

REFERENCES

Abaje, I.B. (2007). Drought and desertification in Northern Nigeria: Implication for sustainable development, *Journal of the school of art and social sciences* (1) 226 Kaduna State College of Education, Gidan Waya

Adel, S., Mohammed A. and Ryutaro T (2004) Desertification impact assessment in Egypt using low resolution satellite data and GIS. *An international journal on Environmental studies* Vol. 61 no. 4 pp 375-383

Aina, E. O. A. (1996). "Greening the Desert: The Implication of the International Convection On Drought and Desertification Control" University of Maiduguri Inaugural Lecture Series No 55

Alan, S., and Arthur, S. (2007) *Science and system of the human environment* (3rd ed) (p557) Boston: John willey and sons, Inc.

America Heritage Science Dictionary, (2002) *The American heritage dictionary of the English Language*, Fourth ed. USA: Houghton Mifflin Publishing Company.

Armstrong, W. P. [1999]. *Sand dunes: A phenomenon of wind Retrieved* August 6, 2008, from Wikipedia the free Encyclopedia

Ayoade, J. O. (1982) Climate ITD movements and ends in Barbour, K. M., Oguntoyinbo J. S., Onyemelukwe, J. O C. and Nwafor, J. C. (eds) *Nigeria in maps.* Ibadan: Nigeria Publishers Services limited.

Branstan, J. (2004, June 17) World: Desertification threatens one fifth of global population. *The international Herald Tribute.* Retrieved December 19, 2007, from http://www.rferc.org/archive/kazathstan/latest/html.

Barsky, J. (1999 September 30), Yobe state: the pride of a determined people. *The Washington Times Advertising Department* Retrieved October 23, 2008 from http://www.wikipedia.org/wiki/advertisement.

Census (2006) *List of Nigeria state by population* Retrieved October 5, 2007 from http://en.wikipedia.org/wiki/listofnigeriastatebypopulation.html.

Charney, J. G., Quirk, W. J., Chow, S. H. and Kornfied, J. (1977). A comparative study of the effects of albedo change on drought in semi-arid regions. *Journal of atmospheric science.*

David, B. E. (2001) GIS: A Visual Approach. New York: Onward press

Dregne, H. E. (2000). Drought and desertification exploring the linkages. In: D. Wilhite (ed) *Drought a Global Assessmen.t* Tayer & Francis Group, New York. Vol. **2**

Elhag, M. M. (2006) *Causes and Impact of Desertification in the Butana Area of Sudan* Unpublished PhD thesis, Department of Soil, Crop and Climate Sciences, University of the Free State, Bloemfontein, South Africa

Encarta Dictionary (2007) *Desert* Retrieved September 3, 2008, from Encarta 2006 © 1993-2006 Microsoft Corporation

Federal Environmental Protection Agency (1992) Achieving sustainable Development in Nigeria: N*ational report for the United Nations conference on environment and development* (pp 26-28).

Federal Republic of Nigeria, (2000) National action programmed to combat desertification and mitigate the effect of drought: *Toward the implementation of United Nations convention to combat desertification and mitigate the effect of drought* (pp 13-14)

FAO, (1993). Definition and general approach to the problem. In: Sustainable Development of Drylands and Combating Desertification. A Position Paper. FAO, Rome. Retrieved August 5, 2009, from http://www.fao.org/docrep/V0265E/v0265e01.htm

Glenn E., Smith M. S., Squires V. (1998). On our failure to control desertification implications for global change issues, and a research agenda for the future. *A journal of Environmental Science & Policy,* Volume 1, Issue 2, Pages 71-78

Hare, F. K. and Ogallo, L. A. J. (1993) *Climate variation, drought and desertification* WMO,Geneva, Switzerland. pp 45

Hess, T., Stephens, w. and Thomas, G. (1996) Modelling NDVI from decadal rainfall data in the North East Arid Zone of Nigeria *Journal of Environmental Management* 48, 249–261 Retrieved October 3, 2007 from http://www.faqs.org/abstracts/Environmental-issues/Modelling-NDVI-from-decadal-rainfall-data-in-the-North-East-Arid-Zone-of-Nigeria.html

Hillel, D. and Rosennzweig, C. (20002) Desertification in relation to Climate Variability and change.Advance Agron.

Hulme, K. (1993) Exploring the links between desertification and climate change. *A journal of Environment* Vol. 35(6):4-45

InfoBase (2006) *Desert of the world* Retrieved September 5, 2007, from http//www.mapofworld.com/geography/flora-fauna.html

Iloeje, N. P. (1977) A geography of Nigeria. Nigeria: Longman ltd

Justice, C.O, Townshend, J.R.G., Holben, B.N. and Tucker, C.J (1985) Analysis of the phenology of global vegetation using meteorological satellite data. Int. J. of Remote Sensing

Kaboré, D. and Reij, C. (2004). *The emergence and spreading of an improved traditional soil and water conservation practice in Burkina Faso.* EPTD Discussion Paper No. 114. Washington D.C.: International Food Policy Research Institute. Retrieved August 5, 2008, from http//www.ifpri.org/divs/eptd/dp/eptdp114.htm

Kevin, E. T. (Ed) (1992). *Climate system modeling* (pp.37-40) England: Cambridge University Press.

Mabbut, J. A. (1985) Desertification in Australia. Water research foundation of Australia Report no. 4 Canbera Australia.

Makama H. (2008). "*Assessment of the effects of drought and desertification in Gada LGA sokoto state"* Unpublished B URP Dissertation, Department of URP, ABU Zaria

Mamman A. B., Oyebanji J. O. and Petters S. W. (2002*) Nigeria: A people united, a future assured.* Nigeria: longman ltd.

Mather, J. R. (1985). Drought indices for water managers. *Publications in Climatology 38:1 Delaware Center of Climatic Research,* Department of Geography, Delaware, U.S.A.

McDaniel P. (2008). How to do just about everything, *eHow, Inc.* Copyright © 1999-2008. Retrieved January 18, 2009 from www.wikipedia.ehow.com.mht.

Medugu, I. N. (2007) *A comprehensive approach to addressing drought and desertification in Nigeria* Unpublished MSc Thesis, University of Technology Malaysia. Retrieved August 5, 2009, from http//www.wikipedia.cs.wisc.edu/ghost/goview/index.htm.

KASHIM IBRAHIM LIBRARY

Microsoft Encarta (1986) *Drought and Desertification* Retrieved September 3, 2008, from Encarta 2006 © 1993-2006 Microsoft Corporation

Microsoft Encarta (2006) *Sand Dunes* Retrieved September 3, 2007, from Microsoft Student Encarta 2006 © 1993-2006 Microsoft Corporation

Millennium Ecosystem Assessment, (2005) *Global desertification* Retrieved October 3, 2009, from http//www.ew.go.jp/en/earth/desert/leaflet_gb/index_1_1.html.

Mortimore, M. (1989) *Adapting to drought: farmers, famines, and desertification in west Africa*. Cambridge: Cambridge University press.

Musa A. A. (2000) *Quantifying land degradation in the tropical savanna of adamawa state, using remote sensing and GIS technology*. Unpublished PhD thesis, Department of Geography, Federal University of Technology, Minna.

Musa, N. (2008 September 22). Yobe commits 180m to desertification, flooding action plan. *Guardian online*. Retrieved January 2, 2009 from http//www.guardiannewsngr.coman/archives

National Bereau of Statistic (2006) *Land area by state* Retrieved July, 28 2008 from www.nigeriastat.govt.ng/

National Economic Empowerment and Development Strategy (2005) *Central Bank of Nigeria* (pg 44)

Ngex (2006) Yobe state. Retrieved July, 28 2008 from http://ngex.com/nigeria/places/states/yobe.htm

Nigeria Portal (2009) *Nigeria precipitation map* Retrieved September 5, 2008, from hppt://www.onlinenigeria.com/precipatation/

Nigeria Portal (2009) *Vegetation and Forest map of Nigeria* Retrieved September 5, 2008, from hppt://www.onlinenigeria.com/vegn.map/

Ojo, G. O, Oneyewoto, Z. O and Ujah J. E. (1987)Use and management of shelterbelts In: Sogua, V. O, Enabor, E. E, Kalu, A. E and Mortimore, M (ed) *Ecological disasters in Nigeria: Drought and Desertification.* (pp 251-258) Federal Ministry of Science and Technology, Lagos: Nigeria Publishers.

Oladipo, E. O. (1993). *A comprehensive approach to drought and desertification in Northern Nigeria "Natural Hazard"* (pp 215-216) Netherlands: Kluwer Academic Publishers.

Onyebuchi, E. (2008 December 16), FG, German Firm sign MoU on ₦ 300bn Desert Control Project. *Thisday news paper.*

Otegbeye, G. O. (2004). "Drought and Desertification: Challenges for aforestation in Nigeria Arid and Semi-arid region" *Savanna*: *A journal of environmental and social sciences.* Zaria: A.B.U. Press Ltd. Vol. 19, No. 1 pp 1-11.

Paul, W. E. (1995). *Geography; people and places in a changing World.* USA, National Textbook Company Contemporary Publishing Group Lincolnwood, Illinois.

Penelope, R. (1995). *The environment: Issues and choices for society* (pp.201-207) USA. Jones and Bartlett Publishers

Price, S. D. Justice C. O. and Los, S. O. (1990). Remote sensing of the sahelian environment. A review of the current studies and future prospects. Technical centre for agriculture and co-operation.

Public Agenda (2007) Ghana: Threats of Desertification must be taken seriously (*all Africa.com*). Retrieved September 5 2007 from http://www.wikipedia.org/wiki/desertification/htp

Rasmussen, K., Band F, and Madsen, J. E. (2001). *Desertification in reverse, Observations from northern Burkina Faso.* Global Environ. Retrieved October 3, 2008 from *www.wikipedia.org/wiki/observations.*

Salami, A.T. and Balogun, E.E. (2006) Utilization of NigeriaSat-1 and other satellite for forest and biodiversity monitoring in Nigeria. (pg 100) Abuja, National Space Research and Development Agency (NASRDA)

Sani, A. (2008, February 1), Combating Desertification in Nigeria. *Rivers State Newspaper Cooperation.* Retrieved October 3, 2008 from www.thetidenews.com/article

Schrader S. and Pouncey R. (1997) ERDAS imagine field guide 4th ed. USA: ERDAS inc

Shalby, A., Ghar, M. A. and Tateishi, R. (2004) Desertification impact assessment in Egypt using low resolution satellite data and GIS.

International Journal of environmental studies. Vol 61(4). Taylor and Francis group.

Smith, R. L. (2007) *Desert*. Microsoft Student. Retrieved December 8, 2008, from Microsoft Student 2008 [DVD]. Redmond, WA: Microsoft Corporation, 2007

Stock, R. (2006). *"Africa" Redmon, W A: Microsoft Corporation.* Retrieved January 3, 2008, from Microsoft Student Encarta 2006 © 1993-2006 Microsoft Corporation

Toye, O. T. (2002 August 26) Desertification threaten economy, food security. Retrieved March 3, 2008 from http://www.ipsnews.net/copying.ht.shtm

Tyler, G and Miller, J.R. (1998) *Living in the environment: Principles connection and solution* (pp.555-556) USA, Wadsworth Publishing Company.

UNCED (1992). Earth Summit Agenda 21: Programme of action for sustainable development.United Nations Environment of Public Information New York, USA. Retrieved August 5, 2009, from http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm

UNCOD (1977) Desertification: Its causes and consequences. (Nairobi: UNEP)

UNEP (1992). Status of Desertification and Implementation of the United Nations Plan of Action to Combat Desertification. Report of the Executive Director. Nairobi: United Nations Environment Program.

United State Geological Survey, (2008) *Desert* Retrieved September 5, 2007, from http//:www.geology.com/records/sahara-desert-map.gif

Weler, J., and Herring, D. (1999) *Measuring vegetation (NDVI &EVI)* August 6, 2008, from Wikipedia the free Encyclopedia

WERRI foundation (2008) *Desert and desertification; The causes, consequences and challenges.* Retrieved January 21, 2009 from http:/www.slideshare.net/weri/desert-and-desertification-the-causes-consequences-and-challenges-presentation

Westchester Model United Nations Conferences (WestMUNC) (2008) *Desertification.* Retrieved January 21, 2009 from http:/www.westmunc.com/intelligence/bgpapers/index.php.

Wikipedia (2007) *Desertification* Retrieved September 5, 2007, from www.wikipedia.org/wiki/desertification.

Willen V. C. (2007a) *Desertification: definition, problem, global monitoring, local remedies (USGS)* Retrieved September 21, 2007, from http//www.pubs.usgs.gov/gip/desert/desertification.

Willen V. C. (2007b) Desertification: causes effects, spreading, halting. Retrieved March 3, 2007, from http//www.bcb.uwc.ac.za/envfacts/desertification.htm.

World Environment Day (2006) *Bangladesh and desertification: Don't desert dry lands.* Retrieved January 19, 2008 from http//www.sdnbn.org/sdi/international_day.ned/200/index.htm.

Xue, Y. (1996) *The impact of desertification in the Mongolian and inner Mongolian grassland on regional climate.* Center for Ocean –Land-Atmosphere studies Calverton Maryland. Retrieved October 3, 2008 from http://www.scholargoogle.com/scholar:xue

Yankunama, B. (1988) *Desert Encroachment and settlement form in Borno state* Unpublished MSc Thesis, Department of URP, ABU Zaria

Yobe State (2008) Wikipedia the free Encyclopedia Retrieved September 5, 2008, from hppt://www.yobestate.gov.ng