AN ANALYSIS OF THE EFFECTS OF LANDUSE/LANDCOVER CHANGES IN ASHAKA AREA, GOMBE STATE

BY

AMOS BITRUS BAMINDA

DEPARTMENT OF GEOGRAPHY
AHMADU BELLO UNIVERSITY, ZARIA
NIGERIA

DECEMBER,2009

AN ANALYSIS OF THE EFFECTS OF LANDUSE/LANDCOVER CHANGES IN ASHAKA AREA, GOMBE STATE.

BY

AMOS, BITRUS BAMINDA B.Sc (Jos 2004)

M. Sc/SCIEN/02658/06-07

A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL,

AHMADU BELLO UNIVERSITY, ZARIA

NIGERIA

IN PARTIAL FULFILMENT FOR THE AWARD OF MASTERS IN GEOGRAPHY

DEPARTMENT OF GEOGRAPHY

AHMADU BELLO UNIVERSITY, ZARIA

NIGERIA

DECEMBER, 2009

DECLARATION

I declare that the work in the thesis entitled 'An Analysis of the Effects of Landuse/Landcover Changes in Ashaka Area, Gombe State' has been performed by me in the Department of Geography under the supervision of Prof. E.O. Iguisi and Dr. A. L. Bello.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

Name of Student	Signature	Date

CERTIFICATION

This thesis entitled : "An Analysis of the Effects of Landuse/Landcover changes in Ashaka area, Gombe State" by Amos, Bitrus Baminda meets the requirement governing the award of the degree of Master of Geography of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

_____ **Date** 5-12-09

Prof. E.O Iguisi
Chairman, Supervisory Committee

_____ **Date** _____

Dr. A. L. Bello
Member, Supervisory Committee

_____ **Date** 5-12-09

Prof. E. O. Iguisi
Head of Department

_____ **Date** _____

Prof. S. A. Nkom
Dean, Postgraduate School

DEDICATION

This piece of work is dedicated to the glory of God. Secondly, my Mum Mrs. Nibram Ibrahim for denying all pleasures of life to ensure that I am what I am.

ACKNOWLEDGMENT

I wish to express my honest and sincere thanks to God for granting me all the resources and moral support to actualize my dream despite all odds. Similarly, express my profound gratitude to my team of supervisors Prof. E. O. Iguisi and Dr. A. L. Bello for guiding my feets and lighting my paths to appreciate independent research and add to a body of knowledge.

Secondly, my appreciation goes to all the geography staff for their professional guide in one way or the other. To mention a few my father Professor Ariyo for putting me through the Research Problem, Professor Jayeoba for guiding me into the use of prediction models and their limitations and Dr. Ati for his moral advice. The two Liberians, Mr. Lawal Mohammed and Ezekiel Bamaiyi for providing me with textbooks and other relevant materials related to the thesis work. Also, Mrs. Moore, departmental secretary for her motherly role played to ensure smooth completion of this piece of work.

Thirdly, I earnestly thank Mr. Leke my GIS expert for the assistance rendered to me in the field work and his time to travel all that long from Kaduna to Ashaka Cement in Gombe State, first for reconnaissance survey and secondly for the groundtruting aspect of the research work. This journey

almost claimed his life when he was caught up by the Jos crises that was erupted in 2008. I also thank all staff of the department of Remote Sensing/GIS Federal Ministry of Land Resource, Mando-Kaduna for their kind support and meaningful contributions. I wish to thank Mr. Bako for assisting me with hand GPS-Garmin 72 for the purpose of the groundtruthing.

This piece of work wouldn't have been possible without the assistance of Prof. Adefila (Chemical Engineering Department) for his technical advice and for providing me with Ashaka Environmental Auditing Report. Similarly, I appreciate Mr. Mustapha (Computer Expert), Adeola (Computer typist), Mr. Mohammed (Ashaka Statistician), all for the assistance rendered to me in one way or the other.

I appreciate my room mates; Mr. Sarki, Mr Muno, and Mr. Bitrus for their brotherly love and concern. I say thank you to Postgraduate Fellowship where constantly my strength was renewed. Sincere thanks goes to all my friends: Dr. Jasini, Dr Shalangwa, Mr. Balogun, Mr. Christoper, Mr. Abaje, Mr Billy to mention a few. Lastly, I warmly and sincerely appreciate my Dads, Mr. Ibrahim Hamman and Amos Baminda. My siblings; Dr. Innocent, Ladidi and Alhamdu. Also, my dear friend Gloria.

TABLE OF CONTENTS

Title Page	Page No.
Declaration	i
Certification	ii
Dedication	iii
Acknowledgment	iv
Abstract	v
Table of Content	vi
List of Tables	vii
List of figures	viii

Chapter One: Introduction

1.1 Background to the Study	1
1.2 Statement of the Research Problem	6
1.3 Aim and Objectives of the Study	10
1.4 Hypothesis	10
1.5 Scope of the Study	10

Chapter Two: Literature Review

2.1 Introduction	11
2.2 Landuse/Landcover	11
2.3 Geographic Information System and Remote Sensing	15
2.4 Landuse and Landcover Studies in Nigeria	15
2.5 Sources of Data for Landuse and Landcover Studies	19
2.6 Development of Mining in Nigeria	20
2.7 Development of Cement Industries in Nigeria	22

2.8 Nature of Limestone Mining and its Mineral Accessories - - 25
2.9 Effects of Landuse and Landcover Changes - - - - 26
2.10 Environmental Audit of Ashaka Area - - - - - 28
2.10.Materials Input into Cement Production- - - - - 29
2.10.2Environmental Impact of Cement making process - - - 30
2.10.3 Effects of Noise pollution - - - - - - 31
2.10.4 Water Consumption and Effluent Discharges - - - 31
2.10.4.1 Water Supply Sources - - - - - - - 31
2.10.4.2 Surface Water - - - - - - - - 33
2.10.4.3 Wastewater Quality - - - - - - - 34
2.10.4.4 Groundwater Quality - - - - - - - 34
2.10.5 Soil Study - - - - - - - - 35
2.10.6 Ecological study - - - - - - - - 36
2.10.7 Socio-Economic Impact Assessment - - - - - 37

Chapter Three: The Study Area and Methodology

3.1 The Study Area- - - - - - - - - 39
3.1.1 Location, Position and Size- - - - - 39
3.1.2 Geology and Topography - - - - - - - 39
3.1.3 Climate - - - - - - - - - - 41
3.1.4 Soils and Vegetation - - - - - - - 42
3.1.5 People, Occupation and Economics activities - - - - 43
3.2 Methodology - - - - - - - - - 43
3.2.1 Types and Sources of Data Collected - - - - - 43
3.2.2 Methods and Procedure of Data Collection - - - - 44
3.2.3 Development of a classification Scheme - - - - 46
3.2.4 Change Detection - - - - - - - - 49

3.2.5 Data Analysis - - - - - - - 51
3.2.6 Limitation(s) to the Study - - - - - - - 53

Chapter Four: Results and Discussion

4.1 Introduction - - - - - - - - - 55
4.2 Landuse/Landcover classes - - - - - - - 55
4.3 Landcovers Changes - - - - - - - - 64
4.4 Landuse/Landcover conversions - - - - - - 65
4.5 Environmental Problems - - - - - - - 70
4.6 Causes of Landuse/Landcover Changes - - - - - 71
4.6.1 Population - - - - - - - - - 71
4.6.2 Poverty - - - - - - - - - 72
4.6.3 Settlement Growth - - - - - - - 73
4.6.4 Technological factor - - - - - - - 75
4.6.4.1 Quantification of Impacts - - - - - - 76
4.6.4.2 Ambient Air Qualities - - - - - - - 77
4.7 Observed Effects of Mining Activities on the Environment - - 79
4.7.1 Resettlement - - - - - - - - 79
4.7.2 Damage of Vegetation - - - - - - - 80
4.7.3 Ecological Disturbance - - - - - - - 81
4.7.4 Geological Hazards - - - - - - - 82
4.7.5 Degradation of natural landscape - - - - - 83
4.7.6 Implications of Environmental and Landuse/Landcover changes for sustainable Development - - - - - - - - 83

Chapter Five: Summary, Conclusion and Recommendations

5.1 Summary - - - - - - - - - 87
5.2 Conclusion - - - - - - - - - 89

5.3 Recommendation - - - - - - - - 90
5.4 Suggestions for further Studies - - - - - - 91
References - - - - - - - - - - - 93
Appendices- - - - - - - - - - - 99

LIST OF TABLES

Table	Page
1.1 CO_2 Emissions from various Sources	7
1.2 Atmospheric Dust Deposition	8
2.1 Remote Sensing Images and their Resolution	19
2.2 Some Solid Minerals found in Nigeria	22
2.3 Materials used in Cement Production, their quantities consumed and associated environmental impact environmental impact	29
2.4 Impacts Due to Manufacturing Process	30
2.5 Potable water quality-	32
2.6 Surface Water Quality	33
2.7 Waste Water Quality	34
2.8 Ground Water Quality	35
2.9 Community projects Executed in the year 2001-2001	38
2.10 Community projects Executed in the year 2002	38
2.11 Approved community projects for 2004	38
3.1 Study Site Description by Coordinate	46
3.2 Ashaka Area Population Figures	53
4.1 The Extent of Landuse/Landcover classes	55
4.2 Overburden (tons) 2000-2008	59
4.3 Landuse/Landcover Changes	64
4.4 Built-up Land Consumption Rate and Absorption Coefficient	74
4.5 Quantification of Gaseous Emissions	76
4.6 Ambient air Qualities	78

LIST OF FIGURES

Figure Page

2.1 Spatial Distribution of Cement factories in Nigeria - - - 24

3.1 The Study Area - - - - - - - - - 40

3.2 A simple Classification Scheme Model - - - - - - 47

4.1 Landuse/Landcover changes of Ashaka Area:(1970-2005) - - 56

4.2 Overburden Excavated From :2000-2008- - - - - 59

4.3 Landuse/Landcover of Ashaka Area:1970 - - - - 60

4.4 Landuse/Landcover of Ashaka Area:1987 - - - - 61

4.5 Landuse/Landcover of Ashaka Area:1994 - - - - 62

4.6 Landuse/Landcover of Ashaka Area:2005 - - - - 63

4.7 Landuse/Landcover Composite Map:1970/1987 - - - 67

4.8 Landuse/Landcover Composite Map:1987/1994 - - - 68

4.9 Landuse/Landcover Composite Map:1987/2005 - - - 69

4.10 Population of the Communities around the factory site over the years - -

- - - - - - - - - - - 72

4.11 Noise Exposure Limits - - - - - - 82

LIST OF PLATES

Plate — Page

4.1 New Resettlement Site - - - - - - - 80

4.2 Open Pits - - - - - - - - - 83

4.3 Ashaka Quarry Reclaimed Site: Mining mounds with treeless surface - - - - - - - - - - - 99

4.4 Ashaka Quarry: Exposed limestone prior to blasting - - - 99

4.5 Ashaka Quarry: Overburden , Exposed Limestone and Mining pond - - - - - - - - - - - - 100

ABSTRACT

This study was conducted to assess the effects of Landuse/Landcover changes in Ashaka area of Gombe State. Remote Sensing and GIS techniques and ground-truthing involving field observations using HandGPS Garmin 72 were employed for the data collection. Landsat imageries and Spot Xs for four epochs i.e Landsat MSS, 1970, Landsat TM, 1987, Spot Xs 1994, and Landsat ETM, 2005 were used for digital data analysis and interpretation of the Landuse/Landcover of the area. Results of the analysis show that the most extensive landuse was agriculture which covered 65.18% of the area, in 1970, 68.36% in 1987 and 71.16% in 2005. Forestland recorded a decline in both spatial and temporal coverage from 46.06Km in 1970 to 26.18Km in 2005. The coverage of baresurfaces/gullies increased, partly because of decreased grassland and partly due to mining activities and deforestation. Grassland which covered 37.7KM^2 constituting 12.17% of the Landuse/Landcover classes in 1970 was decreased to 9.59KM constituting only 3.33% of the landuse/landcover classes in 2005. Mineland which was the focus of this study occupied 1.14Km indicating 0.38% of the classes in 1987 and slight increase of 0.14% in 2005 covering an area of 1.84KM^2 was revealed. Demographic pressures due to increasing population, poverty, industrial activities and intensification of agriculture was identified as the major causes of Landuse/Landcover changes in the area. Hence, overgrazing, overcultivation, increasing baresurfaces/gullies and deforestation were the environmental problems deduced from the results of the analysis of Landsat and SpotXs Imageries. Recommendations were therefore made to maximize the benefits of landuse activities and sustained economy and minimize the harmful effects of industrial activities and landuse/landcover changes. Suggestions for further study were also made.

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Concept concerning land cover and Land use activity are closely related and in many cases have been used interchangeably (Keith, 2008) but are rather different. Landcover may be defined as the biophysical earth surface while land use is often shaped by human, socio-economic and political influence on the Land (Negendra, 2003). Landuse could also refer to man's activities on land utilitarian in nature, where as Land cover means vegetation and man-made constructions (Ronade, 2006). Land use could further be explained as human employment of the land (Turner II *et al.* 1995, Briassoulis, 2006) and Land-cover type(Skole1994,Briassoulis,2006).

Landcover and Landuse change means changes in structure and function (qualitative) and change in the areal extent (quantitative) of a given type of landuse or cover (Seto *et al.,* 2002). In case of landcover change, two types of changes can be distinguished (Turner 11 *et al.*,1995,Stole 1994, Briassoulis 2006): Conversion, which means a change from one cover type to another, and modification, which means alteration of structure or function without a complete change from one type to another; it could involve change in productivity, biomass, or phenology (Skole 1994, Briassoulis 2006).

Land cover change occurs as a result of natural process such as climatic variation, volcanic eruptions, change in river channels or the sea levels. However, most of the land cover changes of the present and the recent past are due to human actions – i.e. land utilization for production or settlement (Turner II *et al.* 1995, Briassoulis 2006). Similarly, land use change involves conversion from one type of use to another. Modification of a particular land use may involve change in the intensity of this use as well as alteration of its characteristics qualities/attributes.

The analysis of land use change revolves around two central and interrelated questions: "what drives/causes land use" and "what are the environmental and socio-economic impacts of land use change" (Briassoulis 2006). The precise meaning of the "drivers" or "determinants" of land use is not always clear (Gonzales,2009). However, there are two main categories widely accepted: biophysical and socio-economic drivers (Briassoulis 2006). The biophysical drivers include characteristic and process of the natural environment such as: climate variation, landform and geomorphic process, plant succession, soil types and process, drainage pattern(Carlos,2009). The socio-economic drivers comprise demographic, social, economic, technological, market, political and institutional factors and their processes (Briassoulis, 2006).

Identifying the causes of land-use change requires understanding both how people make land-use decision(decision-making processes) and how specific environmental and social factors interact to influence these decisions(Lambin, *et*

al.,2007). Drivers or causes of Landuse/Landcover has been identified to be both proximate (direct, or local) and underlying (indirect or root) (Lambin, *et al.*, 2007). Proximate causes operate at the local level (individual farms, households, or communities) and underlying causes tend to be complex, formed by interaction of social, Political, economic, demographic, technological, cultural and biophysical variables(Geist, *et al.*, 2002)

Vegetation changes are often the result of anthropogenic pressure (e.g. population growth) and partly natural factors such as variability in climate (Guerra et al., 1998; Janetos and Justice 2000).

Due to anthropogenic activities, the earth surface is being significantly altered in some manner and man's presence and his use of land has had a profound effect upon the natural environment thus resulting into observable pattern in the land use/land cover over time (Zubair,2006). Zubair (2006) also reports that there remain only few landscapes on the Earth that is still in their natural state.

Attention has been called to changes in Nigerian Landuse as inevitable facet of man-environment relationships in the country (NEST, 1992). Ademiluyi (2008) explained that the increasing concern for the management of natural resources in recent times has been necessitated by the increasing demographic pressures and its associated man-made activities, which have led to serious environmental stress and ecological instability.

The quest for industrialization and sustained development in Nigeria and the attendant improvement in the quality of life of the populace has taken its toll on

the environment (Aina, 1998). The effects of different industrial activities on the environment vary enormously but it is an incontrovertible statement that damage is being done to the environment worldwide (Emeka *et al,* 2008).

Lameed and Ayodele (2008) have also shown that the effects of technological development and urbanization are gradually negatively affecting forests and forest resources globally. The developmental efforts of the government and entrepreneurs in opening up the rural areas for access to basic necessities of life and attempts to industrialize have resulted in the removal of vegetation and the degradation of the environment.

Consequently there is an urgent need to address the issue of environmental degradation in order to enhance the sustainable utilization of natural resources. Conservation as noted by the world conservation strategy (Cunningham, 2001) is not opposed to development and rational use of natural resources.

The most serious risks from industrial production process (like in Ashaka cem) in Nigeria today come from water and air pollution. All the industries discharge their effluents, without prior treatment, into rivers, estuaries, lagoons, or the seas (Lameed and Ayodele,2008). Many of the effluent are toxic because they contain heavy metal such as mercury, aluminium and bromides among others. This is of great concern to the general environment. The danger which these heavy metals pose to the environment stems from the fact that not only are they toxic, but some have cumulative or synergistic effects when combined (Lameed and Ayodele, 2008).

The activities of cement producing industries such as in Ewekero, Nkalagu, Gboko and others are particularly notorious, although they are few and their physical impact is restricted to a maximum radius of about three kilometers (Iqbi and Shafig, 2001). Within this space, however, natural vegetation and crops are damaged, wildlife species are being destroyed or compelled to migrate, streams are extensively polluted, the soil is overcharged with chemicals and both man and livestocks are inconvenienced, by a dense and continuing coating of cement dust (Igbl and Shafig, 2001).

Zubair (2006) reports that the land use/land cover pattern of a region is the outcome of natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural, mining and demographic pressure. Thus, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use such as mining, agriculture, residential, etc.

Land use/ land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation mapping has greatly increased research on land use and land cover change thus providing an accurate evaluation of the spread and health of the world's forest, grassland, and agricultural resources (Zubair, 2006)

Remote sensing (RS) and Geographic information system (GIS) are now providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analysis of Earth-system function, patterning, and change at local, regional and global scales over time; such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity (Wilkie and Finn, 1996).

1.2 STATEMENT OF THE RESEARCH PROBLEM

AshakaCem PLC was incorporated in Nigeria in August 1974 as Ashaka Cement Limited, with the associated Portland Cement Manufacturers Limited [the Blue Circle Group] as its management partners to produce Portland cement. The company commenced production at Ashaka in 1979 using two identical Dry process pre-heater to produce 750, 000 tones of cement per annum. The raw materials, which include limestone, shale and sand stone, are locally sourced from separate quarries close to the Factory. The company changed its name to Ashaka cement PLC by special Resolution in July 1994(Environmental auditing, 2004).

There are two categories of air emissions associated with AshakaCem operations. These are gaseous and particulate (dust) emissions. Gaseous emissions are mainly combustion gases such as Co_2, Co, No_x, So_2 and H_2S. A summary of emissions from each source is presented on Table 1.1

Table 1.1 CO_2 EMISSIONS FROM VARIOUS SOURCES

EMISSION SOURCE	CO_2 EMITTED (tons)	CO_2 EMITTED/CEMENT PRODUCED (ton/ton)
Kiln oil	230,184	0.3275
Raw meal	350,998	0.4994
Generators	12,871	0.0183
Boiler	1,545	0.0022
Vehicles	1,224	0.0017
TOTAL	**596,822**	**0.8491**

Source: Ashaka Cement Environmental Auditing, 2004

Dust (particulate) emissions are generated from the quarry during blasting, crushing, raw mill, kiln, cement mill and during packing. The Federal Ministry of Environment (FMEnv) limits for dust emission is 600mg/nm^3 for the kiln and 500mg/nm^3 for the other sources.

This standard is rarely attained at Ashaka Cement factory due to problems associated with poor performance of the electrostatic precipitators (Environmental auditing 2004). Table1.2 provides details of the dust emissions monitored over a period of four years.

TABLE 1.2: ATMOSPHERIC DUST DEPOSITION

Sampling Stations	Approx. Distance From Source (km)	Atmospheric Burden (mg/m3)			
		Jun '04	Dec '03	Jul '03	Dec '02
Clinic	0.5	0.110	0.142	0.139	0.0314
CAB	0.3	0.147	0.155	0.154	
Workers' Village	1.5	0.122	0.148	0.142	0.025
Management Estate	4.0	0.06	0.013	0.008	0.003
Power House	0.1	0.137	0.023	0.016	0.006
Quarry Pit Office)	2	0.067	0.072	0.065	0.078
Jalingo	2	0.146	0.145	0.121	
Bajoga	10	0.08	0.120	0.098	0.0017
Badabdi	5.0	0.07	0.151	0.178	

Source: Ashaka Cement Environmental Auditing, 2004

The physio-chemical properties of the soil were studied within 10km from the plants to assess the impact of the cement dust on the soils. The result shows that the degree of impact of the cement dust on the soils has not reached the critical stage of soil degradation (Environmental Auditing, 2004).

Similarly, ecological studies have revealed that deforestation; removal of topsoil and quarry during limestone extraction has changed the ecology of terrestrial ecosystem and the biotic communities. The reclaimed areas are slow to re-establish in the natural regeneration or secondary succession patterns. This is further retarded in reforested areas being cut down illegally for fuel wood. The uncoordinated farming system around the area does encourage soil erosion.

Other aspects, which the auditing covered, include Noise and Vibrations measurement, Hazardous waste analysis, and socio-economic impact assessment.

The ultimate aim of environmental auditing is safe-guarding the environment and minimizes the risks to human health. Auditing alone is not sufficient to protect the environment from degradation but it is a powerful managerial tool. A successful environmental audit requires managers to establish a base line with which to measure future audit (Emeka, etal 2008).

An important aspect of the environment, which the Environmental Audit(2004) did not cover, is landuse/landcover change. The sourcing of raw materials for the factory is continually reflecting on landuse change. As the mines expand, more arable lands are converted to mines; abandoned mines are reforested. There is no previous study on landuse/landcover change around the neighbourhood of Ashaka Cement Factory. Landuse/Landcover auditing of the area is important for the purpose of assessing the nature of landuse conversions and their implications for sustainable development.

This study, therefore, focuses on landuse/landcover changes of the Ashaka area and ascertain the nature, extent and magnitude of landuse/landcover changes to establish their implications for sustainable development.

1.3 Aim and Objectives of the Study

The aim of this study is to assess the effects of landuse/landcover changes in Ashaka area of Gombe State from the time of its establishment in 1974 to 2005

This aim will be achieved through the following objectives

I. To map and determine the nature, trend, rate and magnitude of landuse/ landcover pattern between 1970 and 2005

II. To establish landuse/landcover changes between 1970 and 2005

1.4 Scope of the Study

This study covers Latitude 10^0 50′ to $10^0$60′ N and Longitude $11^0$25′ to $11^0$35′ E North of Gombe. Settlements considered include: Badabdi, Feshingo, Darumpa, Bulturi, Jajami, Ashaka Gari, Juggol, Gongila and Bajoga. These Settlements fall within the radius of 10km from the plant and constitute the major communities around the plant. No attempt was made in this study to assess the impact of the cement production on livelihood and related issues.

Chapter 2: Literature Review

2.1 Introduction

Land is our precious resource. We need land for constructing our homes, industry and infrastructure, to provide a soil for our crops to grow in, to provide open space and wild places for our recreation, and to allow natural terrestrial ecosystems to thrive and secure genetic resource for the future (James, 1996)

Human kind utilization of land has led to all areas of the Earth being modified. It is difficult to identify significant areas of the vegetation in the world that have not been so altered (James, 1996). Therefore human use of land has altered the structure and functioning of the ecosystem. Fabiyi (2006) reports that the most spatially and economically important human use of land globally includes cultivation in various ways, reserves, protected lands and timber extraction.

The literature review focuses on land use/landcover change and its implications for sustainable development. Other areas reviewed include the role of remote sensing in advance ecosystem management and the effects of mining on the environment.

HD
1027
Amo

2.2 Landuse/Landcover

Landuse/Landcover is about the biosphere and its entire content which is made up of the biota, soil, topography, water body, habitat. In recent times, monitoring and management of the vast resources therein has become a global issue because of its significant role in global sustainability (Oyinloye, Agbo, and Aliyu, 2008).

Turner *et al* (1995) described Landcover as the biophysical state of the earth's surface and immediate subsurface. Also, landcover is a material manifestation of natural, social and economic processes (landuse) on the Earth's surface. Landcover change has been described as the most Significant regional anthropogenic disturbance to the environments (Roberts et al, 1998). In essence both landuse and cover changes are products of the prevailing interacting natural and anthropogenic processes by human activities.

Landuse/ Landcover change and land degradation are therefore driven by the same set of proximate and underlying factor elements central to environmental processes, change and management (Desanker *et al.,* 1997; Verbug *et al.,* 2008; Fasona and Omojola, 2005). Proximate causes of Land-use change operate at the local level and underlying causes originate from regional or even global levels, though complex interplays between these levels of organisation are common. As a result, underlying cause tend to be complex, formed by interactions of social, political, economic, demographic, technological, cultural and biophysical variables(Lambin, *et al.*,2007)

Fasona and Omojola (2005) reported that studying landuse dynamics is essential in order to examine various ecological and developmental consequences of landuse change over a space of time. This makes landuse mapping and change detection relevant inputs into decision-making for implementing appropriate policy responses.

Landuse change detection allows for the identification of major processes of change and by inference, the characterization of land use dynamics. The reason for such consequence is as a result of over-dependence on primary resources with direct effect on biodiversity; landuse and landcover dynamics, terrestrial ecosystem and climate (atmospheric composition, vegetation, temperature changes and occurrence of extreme climatic events (Ademiluyi et al, 2008)

Ademiluyi, *et al* (2008) reports that to explain that landcover at global, national and local levels have characterized human-environment relationship. Indeed the growing human population has a huge potential for changing the face of the earth. Information on landuse and landcover is the basis on which the past and present human interactions and the impacts of such interactions with natural resources and the environment can be understood. One major consequence of the globally recognized rapid landcover change is the loss of biodiversity and ecosystem functioning.

The rate of biodiversity loss has been accelerating rapidly throughout the industrial era. According to the Global biodiversity assessment, species are now becoming extinct at 1,000-10,000 times the natural rate. The consequence of biodiversity loss is generally ecosystem degradation often measured using the Natural Capital Index (NCI) framework, which involves calculating the extent of natural area, and extent of the natural area is determined from land-use maps.

From the Industrial age through to this present information age, our environment is witnessing unchecked human activities, which invariably lead to social crises

characterized by accelerated degradation of natural resources, decline in agricultural productivity, rapid population growth, deterioration of quality of life.

A systematic understanding of changes in landuse and landcover is critical to the understanding of the ecosystem functioning and services and human welfare. A spatially explicit study of landuse and landcover changes will lead to a better understanding of the causes of change, and their consequence for the environment and society. Such an understanding will improve land and water management decisions to ensure that ecosystems and changing landscapes are sustainably managed (Oyinloye *et al*, 2007)

Sustainable development vis-a-vis environmental conservation is today recognized as the key to the present and future welfare and survival of the global community. There is no doubt that one of the most important prerequisites for sustainable development is the availability of accurate, reliable, up- to- date and standard data on natural and cultural resources. Such data /information is required at various levels for different purposes, for example demographers need information on the total number, distribution and composition of the population; industrialists needs to know the best location to establish an industry and policy makers and planners all need data and other vital information to find out the development activities and conservation strategies to achieve sustainable development.

2.3 Geographic Information System and Remote Sensing

Building a strong, reliable, accurate and easily accessible micro-level database system should form a major component of GIS database development. Such database infrastructure will facilitate participatory planning and decision-making at the grass root level. GIS, aided with remotely sensed data, Global Positioning System and other media for information collection and diffusion, can play an effective role in the storage, retrieval, analysis and sharing of data. GIS can play a major role as a media tool for gathering, storing, dissemination, reporting, analyzing and sharing of quantitative data, and other vital information about the natural and cultural resources.

In its most basic form, GIS refers to computer-based Systems for automation, storage, retrieval, analysis and presentation of geographically related information. It is the ideal tool for extracting the patterns and trends inherent in location-based information. GIS is a technology that manages, analyses, and disseminates geographic knowledge (Bonnie, 2005)

Peter Burrough defined GIS, as "a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world". Mark (1989), said the main objective of GIS is to allow the user of the Systems to interact vicariously with actual or possible phenomena of the real world.

2.4 Landuse and Landcover Studies in Nigeria

There has been an increasing worldwide awareness and studies on landuse and landcover change analysis in the last four to five decades. The importance of

such studies to sustainable development plan of nations has also been universally recognized (Ademiluyi, et al., 2008).In addition, there is still an extremely low level of recognition and research attention on landuse and landcover change studies in Nigeria(Okude, 2006).Some of the few prominent Landuse and cover analysis and change detection attempts include NIRAD project (1976/78), Areola(1977), FORMECU (1996) and Omojola (1997).Others include Landuse/Landcover mapping in Osun State using Nigeria Sat-1 Data (2007) (Oyinloye, *et al.*,2008) , Changing pattern of Landcover in the Lagos coastal Area of Nigeria(Okude, 2006), Urban Landuse Change Analysis of a Traditional City(Ibadan Metropolitan Area, Nigeria) (Fabiyi, 2006), Monitoring the growth of Settlement in Ilorin, Nigeria(Zubair, 2006) and Assessment of Landuse/Landcover changes in Kaduna metropolitan area (Ndabula, 2006).

Ademiluji et al (2006), reported that the NIRAD project was commissioned in 1976 and completed in 1978.It was based on imagery acquired through side Looking Radar (SLAR) to produce the first vegetation and Landuse maps of Nigeria.According to FORMECU (1976), the NIRAD project constitutes the first and only nation-wide database on the Nigeria environment as at 1976.The primary thematic purpose of the project was the inventory and mapping of vegetation types in Nigeria as well as the demarcation of forest reserves boundaries(Adeniyi,1984)

Areola (1977) carried out a study on land use types and terrain conditions in Lagos, in which he demonstrated the usefulness of aerial photo interpretation in

the identification or mapping of Landuse. The study which is localized was undertaken in 1977 at about the same time with the NIRAD National Project. The study used visual interpretation of infrared black and white photography which was flown aroud 1970 over the coastal areas of Lagos between the west of Ikorodu and Yewa River on the border with Republic of Benin. In the study, the major Landuse were morphologically determined, while the sub-divisions within each unit were based on differences in vegetation.

The Study carried out by Forestry management and Coordinating Unit (FORMECU) in 1996 was the second National and the most current nation-wide database on Nigeria landuse and vegetation. It was part of the Environmental Management Project (EMP), (Ademiluyi, 2008). The objective of the project was to assess and evaluate the available data; identify data gaps; develop programs for the production of current and reliable information on vegetation changes and degradation over time; develop and implement a GIS database for the country of Nigeria. These tasks were undertaken using a combination of multi-source and multi-date remote sensing data such as Landsat Multi Spectral (MSS-1976/78), SPOT Multispectral (1993/1995), Landsat Thematic Mapper(TM-1993), ERS-1 Radar-1994/1995), JERS-1 Radar-1995), and National Oceanic Atmospheric Administration(NOAA). Advanced very High Resolution Radiometer (AVHRR-1978, 1986, 1990, 1995).

Omojola(1997) carried out a Landuse and Landcover inventory and change assessment in a semi-arid region of Nigeria using remote sensing and GIS

techniques. The major contribution of the study was in the demonstration and evaluation of the integration of remote sensing and GIS techniques for Landuse and Landcover inventory and change assessment. To achieve the objectives set out in the study, aerial photographs for 1962 and 1977 and Landsat MSS and SPOT XS images for 1986 were used.

Zubair (2006) in monitoring the growth of settlements in Ilorin, Nigeria using GIS and remote sensing approach shows a rapid growth in built-up land between 1972 and 1986 while the periods between 1986 and 2001 witnessed a reduction in this trend. It was also observed that changes by 2015 might likely follow the trend in 1986/2001 all things being equal. In achieving this, Landsat data for three epochs were used in the study. Land consumption rate and Land absorption coefficient were introduced to aid in the quantitative assessment of the change.

A study carried out on Landuse/Landcover mapping in Osun State using NigeriaSat-1 Data by the Regional Centre for Training in Aerospace Surveys (RECTAS) in Nigeria's Land resources revealed that Land resources are changing at a rapid rate; at local to regional scales. The ecosystems on which Southwestern Nigeria societies depend are showing some signs of stress (Oyinloye, 2007). A systematic understanding of changes in Landuse and Landcover is critical to the understanding of the ecosystem functioning.

2.5 Sources of Data for Landuse and Landcover Studies

Space borne remote sensing has long been an appropriate and effective data source for Land cover mapping due to its wide coverage and repetitive observations (Haak and English, 1996; Lee *et al.*, 2002). This explains why satellite imageries have become very prominent in most Land cover and Land use studies carried out in Nigeria (Ademiluyi, 2008).

Table 2.1 shows the various data types, scale and their source. Parono (1996) has observed that small discrepancies may be detected when combining the Landsat data with SPOT data. However, he opined that such discrepancies may actually highlight the benefit of the combined use of different sensors in Landuse and Landcover studies, especially in terms of resolution.

Table2.1 Remote Sensing Images and their Resolutions

Data Type/Sensor	Year	Resolution
Multi-Spectral Scanner(MSS)	1970s	78m
Thematic Mapper(TM)	1980s	30m
SPOT(XS/Panchromatic)	1990s	30m-10m
Landsat	1980s	30m
Radarsat	1990s	12m(Variable)
Light Detection and Ranging (LIDAR)	1998	2m(Variable)
Compact Airborne Spectrographic Imagery(CASI)	Late 1990s	2m(Variable
Interferometric Airborne Synthetic Aperture Radar(IFSAR)	1990s	-
Polarimetric Synthetic Aperture Radar(PSAR)	1990s	
Ikonos	2000s	6m
Quickbird	2000s	1-4m

Source: Hwang and Ku, 2004; Webster, et al 2004

Remote Sensing provides information concerning the spatial distribution and the temporal variability of dynamics Landcover characteristics. Geospatial technologies are vital for performing analysis to aid decision makers in their difficult task of proving optimal and compromise solutions. GIS and remote sensing have shown active interests in both the operational scale and measurement scale of data. For instance in the field of remote sensing the 78m resolution Multi- Spectral Scanner (MSS) data of the 1970s has given way to 30m Thematic Mapper (TM) in the 1980s, SPOT in the 1990s and 1m IKONOS imagery in the 21st Century (Ademiluyi, 2008).

As shown in Table 2.1, such improvement in the spatial resolution/measurement scale allows for a new understanding of geographical phenomena that could not be measured at the previous scales (Hwang and Ku, 2004). The Nigeria SAT-1 data performed relatively well for Landuse mapping particularly vegetation mapping, but the radiometric qualities of the image need to be improved upon as linear features such as roads and rivers in particular cannot be discriminated.

2.6 Development of Mining in Nigeria

The Mining of solid minerals in Nigeria accounts for only 0.3% of its GDP, due to the influence of its vast oil resources. The domestic mining industry is underdeveloped, leading to Nigeria having to import minerals that it could produce domestically, such as salt or iron ore. Rights to ownership of mineral resources is held by the Nigerian government, which grants titles to

organizations to explore, mine, and sell mineral resources (Wikipedia, the free encyclopedia, 2008)

Organised mining began in 1903 when the mineral survey of the Northern Protectorates was created by the British Colonial government. A year later, the Mineral survey of the Southern Protectorates was founded. By the 1940s, Nigeria was a major producer of tin, Columbite, and Coal. The discovery of oil in 1956 hurt the mineral extraction industries, as government and industries both began to focus on this new resource. The Nigerian Civil War in the late 1960s led many expatriate mining experts to leave the country (Ministry of Solid Minerals Development, 2008)

Mining regulation is handled by the ministry of Solid Minerals Development, which oversees the management of all mineral resources. Mining law is codified in the Federal Minerals and Mining Act of 1999. Historically, Nigeria's mining industry was monopolized but State-owned public corporations. This led to decline productivity in almost all mineral industries. Some of the minerals that are found in Nigeria are summarized below in Table 2.2

Table 2.2 Some Solid Minerals found in Nigeria

Mineral	Date of Discovery	Location
Coal	1909	Enugu
Gold	1913	Maru, Anka, Malele, Tsohon, Birnin Gwari-kwaga,Gurmana, Bin Yauri, Oko lom-Dogon daji and Iperindo in Kwara State.
		Nassarawa State near the Plateau State and Southeast Nigeria
Columbite and Tantalite		Lagos State, Ogun State, Ondo State and Edo State.
Bitumen		Itakpe in Kogi State and others in Northeast and part of Northcentral
Iron Ore		
Uranium	1900	Cross river State, Adamawa State, Taraba State, Plateau State and Kano State.
Limestone	Early 1950s	Nkalagu in Enugu.

Adopted and modified from Ministry of Solid Minerals Development Report, 2008.

2.7 DEVELOPMENT OF CEMENT INDUSTRY IN NIGERIA

The first Integrated cement company in Nigeria was incorporated in 1954 and started production in 1954 at Nkalagu in Enugu State. This was in response to the increasing cement demand in the country and the presence of large Limestone deposits in the area (Ugoh, 1977). The establishment was the sole initiative of the federal Government of Nigeria in partnership with other indigenous investors. Prior to the establishment the Associated Portland Cement Manufacturers (APCM) were at the time accounting for more than half of cement imports to Nigeria.

To avoid losing Market, APCM hastened to install its own plant at Ewerero, agreeing to provide 51% of its initial capital and in partnership with the Western Regional Development Corporation and other investors incorporated the West

African Portland Cement Company (WAPCO). This Company started production in 1960.

In March 1967 the cement Company of Northern Nigeria started production in Sokoto and same year the Calabar Cement Company was established. The Ukpilla Cement Company started operations in 1971.At around this time, sizeable Limestone deposits of approximately Riln feed had been discovered around Ashaka village and the North eastern State government was holding discussions with APCM whose geologists carried out the Limestone explorations study of the area.

In 1974, Ashaka Company was incorporated at the initiative of the then north eastern State government; which owned about 25% of the Company, in partnership with APCM, the Federal Government and some other corporate investors.

In 1980 the Benue cement Company was established. This Company is also incorporated at the initiative of the former Benue-Plateau government, the federal government and a Swiss Company (Cementia Holdings A. G). In recent time more additional cement Companies are being established such as a Cement factory in Lokoja, Kogi State. The spatial distribution of Cement factories in Nigeria is shown in figure 2.1.

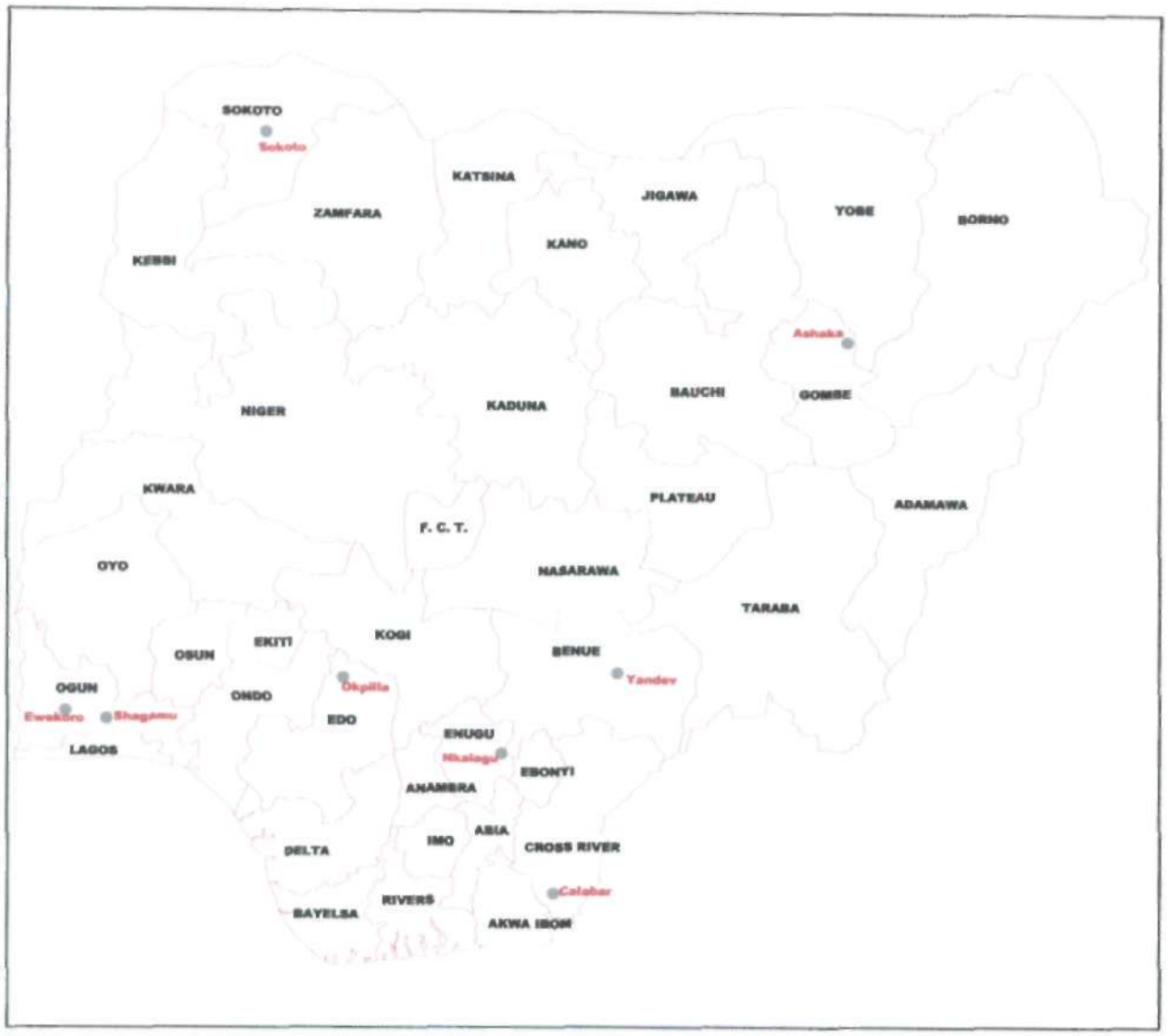


Figure 2.1: SPATIAL DESTRIBUTION OF CEMENT FACTORIES IN NIGERIA

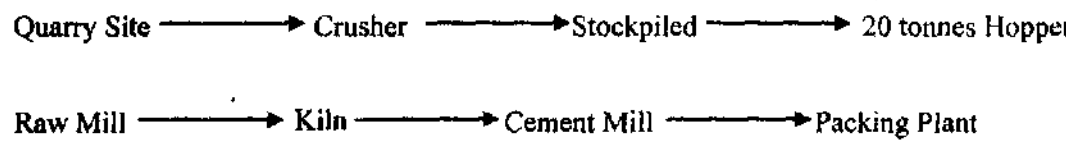
2.8 Nature of Limestone Mining and Its Mineral Accessories

Mining is the extraction of valuable minerals or other geological materials from the earth. Limestone is the principal raw material used in the manufacture of cement which is about 95% by composition of the total cement constituents. Other raw materials include Gypsum ($CaSo_4. nH_2O$) and Sand ($SiO_{2)}$ .These is sourced from the local area which constitutes the remaining 5%.

Technique employed for the quarrying of the mineral is OPEN CAST MINING a type of surface mining which involves removal of overburden (Top Soil) using heavy equipment, to reach the surface of the limestone layers usually 5 to 7m beneath the surface. Thereafter, drilling of hollows via which high explosives dynamites are introduce for blasting the limestone to enable the disintegration of compacted limestone to boulders.

These sizeable boulders are being transported by heavy duty machines to the crusher where is grinded and convey to the stockpiled. The stockpiled materials are further transported via the conveyor belt to the rawmills and subsequently transported to the kiln section. Here, the following reactions normally take place leading to the decomposition of calcium carbonate ($CaCo_3$) to clinker (CaO) and enormous release of carbon dioxide (Co_2) to the atmosphere. Furthermore, the clinker is mixed with hydrated calcium sulphate ($CaSo_4. nH_2O$) to produce cement. Finally, the cement is conveyed to packing plant where is been stored and packs in sacks.

It is important to note that each stage of the cement making process release considerable amount of particulate matter into the environment which in turn affects the equilibrium and performance of the ecosystem. A schematic model is demonstrated below:



2.9 Effects of Landuse and Landcover Changes on the Environment

In the ecological context, Landuse and Landcover changes, besides affecting the current and future supply of Land resources, are important sources of many other forms of environmental change. They are also linked to them through synergistic connections that can amplify their overall effects.

Loss of plants and animal biodiversity is principally traceable to land transformation, primarily through the fragmentation of natural habitat. Worldwide trends in landuse and landcover change are important source of the so-called greenhouse gases, whose accumulation in the atmosphere may bring about climate change. As much as 35% of the increase in atmospheric Co_2 in the last 100 years can be attributed to Landuse change, principally through deforestation (William, 1995).

Landuse practices at all local and regional levels can dramatically affect soil condition as well as water quality, and water supply. Also, vulnerability or

sensitivity to existing climate hazards and possible climate change is very much affected by changes in Landuse and cover (Williams, 2008)

In most of the world, both fossil-fuel combustion and land transformation results in a net release of carbon dioxide to the atmosphere. In the United States, by contrast, present landuse and landcover changes are thought to absorb rather than release Co_2 through such processes as the rapid growth of relatively youthful forests which reduces fossil fuel combustion by 10% (William, 2008).

The loss of cropland to development aroused considerable concern during the 1970s and early 1980s in USA in connection with the1981 National Agricultural Lands study, which estimated high and sharply rising conversion. Experts regarded the conversion of cropland to other landuse categories as representing something short of a genuine crisis, likely moreover to continue at slower rather than accelerating rates into the future.

Patterns and trends in Landuse and Landcover significantly affect the degree to which countries and regions are vulnerable to climate change or to some degree can profit from it. The sectors of the economy to which landuse and landcover are most critical-agricbulture, Livestock, and forest products are, along with fisheries, among those most sensitive to climate variation and change.

These three climate-sensitive activities have steadily decline in importance a long time ago in the Nigerian economy. In the period shortly before and after the civil war, agriculture accounted for more than a third of the Nigerian gross

domestic product, or GDP. With the discovery of the oil in 1956 and exploration in the 1970s had affected the agricultural sector in turn affects the ecosystem of the affected areas. Perhaps this can be extended to areas such as Jos-plateau, Enugu where the mining activities has resulted to some ecological problems such as Land degradation.

Shifting patterns in human settlement are another form of Landuse and Landcover change that can alter a region's vulnerability to changing climate. As is the case in most other countries of the world, a disproportionate number of Americans live within a few kilometres of the sea. In the United States, during the world war period, the coastal States and countries have consistently grown faster than the country as a whole in population and in property development. The consequences is an increased exposure to climatic hazards such as hurricanes and other coastal storms (Williams, 1995)

2.10 Environmental Audit of Ashaka Area

Raymond and Dan (1973) defined social and environmental audit as a commitment to systematic assessment of and reporting on some meaningful, definable domain of the companies' activities that have social, health and environmental impacts. Welfort and Strachan (2005) adopted the concept of environmental performance of an organization. It should measure how well organizations, management and equipment are performing with the aim of helping management to safeguard the environment. It also provides information which can be used in the control of environmental practices and in assessing

compliance with organization policies, which include meeting regulatory requirements (Emeka, 2008).

Ashaka cement Environmental audit commence functioning in 1999 to assess the environmental impact of Limestone mining. This assessment is done every four years. Basically, the life cycle of mining activities is considered. These include-input, process and output.

2.10.1 Materials Input into Cement Production

The primary raw materials used in the manufacture of Portland cement are Limestone (about 95%), sandstone (2.0%), and gypsum (3.0%). The production line consists of continuous units namely: rock quarry and stockpile, raw mills, kilns, cement mills and packaging. In addition paper and plastic sacks, fuels, electricity, office stationery, machinery and equipment are all inputs required to make up cement. The summary is presented in table 2.3

Table 2.3 Materials used in Cement Production, their quantities consumed and associated environmental impacts.

Input	Quantities	Impacts
Limestone Quarried	1,048,744 tons	• 1,226,989 bcm of overburden was removed. • Affect soil organisms and vegetation • Temporary loss of farmland
Gypsum used	39,751 tons	• Affect soil organisms and vegetation • Temporary loss of farmland
River Sand	20279 tons	• Affects aquatic habitat, may causes soil erosion.
Paper sack	13,717,828	• Paper is made from forest resources • The manufacturing process generates effluents and emissions.
Office papers	n/a	• 50 rims of paper is equivalent to one standard tree
Kiln oil used	70,935.29 tons	• 2,360 truck-loads, used to convey kiln oil, generating emissions & waste oil in the process • Impacts associated with oil mining and refining
Petrol used	828,477 liters	• 25 truck-loads used, with impacts similar to that of kiln oil.
Diesel used	3,421,212 liters	• 100 truck-loads used, with impacts similar to that of kiln oil.

Ashaka Environmental Audit Report, 2004.

2.10.2 Environmental Impact of Cement Making Process

The cement making process as illustrated above involves five basic steps; crushing of limestone, milling of crushed material in raw mills, calcinations of limestone to clinker in the kilns, clinker milling and packing. River sand is added to the crushed material before raw milling and gypsum is added to the clinker before milling (Ashaka Environmental Audit, 2004). Table 2.4 presents a summary of the impacts of each step in the process.

Table 2.4: Impacts Due To Manufacturing Process

Process	Quantities	Impacts
Raw-Milling (limestone milled)	1,069,025 tons	Raw mills operated for 2,000 hours. 27,600MWh of electricity consumed. 3,700 tons CO_2 emitted by generators in generating 30% of the electricity. High noise levels and vibrations and dust emissions
Kiln Operations (ground raw meal used)	1,028,904 tons	Consumed 70,935tons of oil Consumed 22,350 MWh of electricity Cumulative CO_2 emission over 580,000 tons Thermal stress to the environment (kiln operates at 1,500^{0}C). High dust emissions from stacks
(clinker made)	668,251 tons	Product of the kiln
(clinker used)	659,717	Clinker used + gypsum used = cement mill feed (cement ground).
Cement Milling (cement ground)	700461 tons	28,180MWh of electricity consumed. 3,780 tons CO_2 emitted by generators in generating 30% of total electricity. High noise levels and vibrations and dust emissions
Cement Dispatched	702860 tons	About 20,000 truck-loads used for dispatch, generating emissions and waste oil in the process and dust emissions during loading and off-loading.
Others	Boilers supplying steam, compressors, workshop, maintenance, etc.	Gaseous emissions, noise, waste oil, etc

Source: Ashaka Environmental Auditing Report, 2004.

2.10.3 Effects of Noise Pollution

Noise is generally defined as any unwanted sound, and when this is emitted into the environment it becomes a pollution of sort. The hazards associated with noise of high intensity can cause acute or chronic effects. Either acute or prolonged (chronic effects) the damage can either be temporary or permanent.

Federal ministry of Environment require that workers shall not be exposed to noise levels of 90BA (ducibels) and above, for duration of 8 hours daily, five working days a week without adequate protection. The Environmental Audit Report, reported some measures taken by the management to ensure adherence to these regulations. These include wearing of Ear plugs that reduce the intensity of the noise to the receptor (ear drum).

2.10.4 Water Consumption and Effluent Discharges

2.10.4.1 Water Supply Sources

There are two sources of water supply; boreholes and River Gongola, for both domestic and industrial uses. Water samples were collected from nine different locations and analysed for quality. Results of the analyses are presented along with FMEnv standards on Table 2.5, 2.6 and 2.7 for portable, surface and wastewater respectively.

Results of analyses of the portable water samples presented in table 2.5 show that the gallery water as well as those collected directly from the tap in the chemical laboratory, Worker's village and Management estate are not fit for consumption, except when it is boiled and filtered. This is evidenced by the high

coliform count of the sources other than control samples, which were boiled and filtered. Iron levels were also higher than the acceptable standard. However, WHO guidelines for portable water does not prescribe health based limits of Iron drinking water because is an essential mineral required by the body. The limit of 0.1mg/liter specified by FMEnv is probably for protection against colouration and fouling of distribution systems.

Table 2.5: Potable Water Quality

PARAMETER	METHOD	FMEnv Standards	RESULTS (mg/liter unless otherwise stated)					
			PW 1	PW 2	PW 3	PW 4	PW 5	PW 6
Temperature °C	Electrometric	NS	24	25	26	27	26	25
Colour (appearance)	Spectrometric	Clear	Clear	Clear	Clear	Clear	Clear	Clear
pH	Electrometric	6.5-8.5	6.9	6.8	6.7	6.9	6.8	6.7
Conductivity		0.07	0.05	0.03	0.02	0.06	0.02	0.03
Hardness		NS	45	43	36	48	44	63
Dissolved solids	Gravimetric	600	87	82	79	88	127	147
Suspended solids	Gravimetric	NS	35	48	35	36	9	5
Calcium	AAS	0.5	0.15	0.23	0.31	0.33	0.35	0.34
Cadmium	AAS	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	AAS	NS	0.12	0.17	0.14	0.14	0.16	0.15
Copper	AAS	2.00	0.02	0.01	0.01	0.01	0.01	0.01
Iron	AAS	0.1	1.25	1.44	1.67	2.10	1.12	1.32
Magnesium	AAS	50.12	2.34	2.35	2.23	2.28	2.29	2.42
Manganese	AAS	0.05	0.24	0.21	0.22	0.27	0.27	0.24
Potassium	AAS	NS	2.52	2.35	2.36	2.34	2.44	2.30
Silver	AAS	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	AAS	200	8.73	7.30	6.67	6.60	6.40	7.40
Zinc	AAS	3	0.22	0.24	0.23	0.26	0.23	0.21
Alkalinity	Titremetric	NS	47.00	74.00	68.0	68	70	80
Chloride	Hach	200	5.25	7.45	6.33	5.35	5.28	5.67
Nitrate-N	Hach	1	0.05	0.07	0.08	0.12	0.05	0.05
Phosphate-P	Hach	NS	3.1	2.6	2.2	2.3	2.8	2.9
Sulphate	Hach	150	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sulphide	Hach	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dissolved oxygen	Electrometric	NS	8.0	8.2	8.20	8.3	8.2	8.2
COD	Hach	NS	9.2	8.6	9.40	8.00	4.5	5.50
BOD_5 20 °C	Hach	NS	2.1	1.4	2.00	3.5	1.5	1.0
Oil & Grease	Gravimetric	0	0	0	0	0	0	
Phenols	Argentometric	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: Ashaka Environmental Auditing Report, 2004.

2.10.4.2 Surface Water

Nine samples of surface water collected and analysed revealed that all sources met the FMEnv standard except for suspended solids. The results are presented in Table 2.6.

Table 2.6 Surface Water Quality

PARAMETER	METHOD	FMEnv Standards	SAMPLING LOCATIONS								
			SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9
Temperature (°C)	Electrometric	40.00	27.00	26	27.00	27.00	27.00	27.00	27.00	27.00	27.00
Colour	Spectrometric								Clear		
pH	Electrometric	6-9	7.5	6.6	7.3	7.2	6.7	7.2	7.1	7.3	6.9
Hardness		NS	104.00	45.00	53.00	72.00	64.00	116.00	89.00	76.00	82.00
Dissolved solids	Gravimetric	2,000.00	235.0	270	132.0	135.0	141.0	132.0	490.0	189.0	135.0
Suspended solids	Gravimetric	30.00	65.00	44	114.0	74.0	105.0	114.0	65.00	105.0	114.0
Calcium	AAS	200.00	12.60	13.5	5.20	6.20	3.80	5.20	12.60	3.80	5.20
Cadmium	AAS	1.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	AAS	NS	0.13	0.15	0.15	0.10	0.24	0.13	0.10	0.13	0.15
Copper	AAS	1.00	<0.001	<0.001	<0.001	0.02	<0.001	<0.001	0.02	<0.001	<0.001
Iron	AAS	20.00	4.78	2.43	2.43	3.45	2.40	2.20	3.45	2.35	2.43
Magnesium	AAS	200.00	2.10	2.10	2.10	2.30	2.30	1.70	2.30	1.5	2.10
Manganese	AAS	NS	0.37	0.25	0.26	0.23	0.17	0.20	0.23	0.18	0.25
Potassium	AAS	NS	3.45	2.80	2.80	2.80	2.20	2.80	2.80	2.40	2.80
Silver	AAS	0.10	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	AAS	NS	6.89	6.30	6.30	7.20	5.35	4.22	7.20	5.1	6.30
Zinc	AAS	1.00	0.17	0.18	0.18	0.24	0.22	0.21	0.24	0.17	0.18
Alkalinity	Titre metric	NS	11.5	81.0	84.0	8.7	8.4	12.6	121.3	15.0	2.8
Chloride	Hach	600.00	56.40	48.00	47.00	42.00	49.00	38.00	42.00	47	7.00
Nitrate-N	Hach	20.00	2.6	0.91	0.92	1.40	5.3	2.4	0.40	2.8	4.8
Phosphate-P	Hach	5.00	48	1.56	1.90	60	130	50	Traces	32	175
Sulphate	Hach	500.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sulphide	Hach	0.20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dissolved	Electrometric	NS	6.5	8.2	7.1	1.5	3.3	9.5	3.0	7.0	1.5
COD	Hach	NS	7.02	8.28	7.82	8.90	5.28	8.13	8.90	7.82	7.23
BOD5 20 0C	Hach	50.00	1.5	2.3	3.0	2.20	3.0	2.30	2.20		3.0
Oil & Grease	Gravimetric	10.00	0.20	0.24	0.24	2.60	0.24	0.40	0.60	0.24	0.42
Phenols	Argentometric	0.20	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Coliform	MPN										

Source: Ashaka Environmental Auditing Report, 2004.

SW = Surface Water: SW 1=R. Feshingo (DS) SW 4 = R. Gongila (DS) SW 7 = Quarry Pit 2 SW 2 = R. Gongila (POD) SW 5 = Jalingo Pond SW 8= Quarry Pit 3 SW 3 = R. Gongila (US) SW 6 = Quarry Pit 1 SW 9 = Bajoga Pond

2.10.4.3 Wastewater Quality

The wastewater contained high suspended solids, due to mud accassioned by the rainy season. In addition, BOD is higher than the specified standard of 50mg/L for sample collected at the oxidation pond and Jalingo pond. Suspended solids are also high in all the samples. The results are shown in table 2.7 below.

Table 2.7: Waste Water Quality

PARAMETER	METHOD	FME Standards	SAMPLING LOCATIONS Concentration in mg/liter(unless otherwise stated)				
			WW 1	WW 2	WW 3A	WW 3B	WW 4
Temperature °C	Electrometric	40	26	27	28	27	28
Conductivity			0.33	0.26	0.26	0.16	0.26
Ph	Electrometric	6-9	7.2	6.9	6.7	6.8	6.6
Hardness	Gravimetric	NS					
Dissolved solids	Gravimetric	2,000	243	212	352	132	91
Suspended solids	Gravimetric	30	44	47	145	41	116
Calcium (Ca^{2+})	AAS	200	3.2	2.8	3.1	2.4	2.8
Cadmium	AAS	1	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	AAS	NS	0.21	0.31	0.44	0.32	0.36
Copper	AAS	1	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	AAS	20	3.5	4.7	3.9	3.7	4.4
Magnesium (Mg^{2+})	AAS	200	3.5	4.3	4.4	4.2	3.2
Manganese	AAS	NS	0.01	0.01	0.02	0.00	0.00
Potassium	AAS	NS	2.7	4.5	5.8	4.8	4.6
Silver	AAS	0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	AAS	NS	5.23	5.35	4.90	5.75	4.90
Zinc	AAS	1	0.23	0.21	0.41	0.27	0.41
Alkalinity	Titre metric	NS					
Chloride	Hach	600					
Nitrate-N	Hach	20	0.26	0.25	1.18	1.23	0.23
Phosphate-P	Hach	5	2.0	2.2	3.2	3.1	2.0
Sulphate	Hach	500	<0.001	<0.001	<0.001	<0.001	<0.001
Sulphide	Hach	0.2	<0.001	<0.001	0.021	<0.001	<0.001
Dissolved oxygen	Electrometric	NS	8.8	5.2	2.4	2.5	4.9
COD	Hach	NS	11.0	15.0	34.0	27.0	11.0
BOD_5 20 °C	Hach	50	23.2	9.5	67.4	64.7	12.8
Oil & Grease	Gravimetric	10	3.3	2.4	2.8	4.6	2.2
Phenols	Argentometric	0.2	<0.001	<0.001	<0.001	<0.001	<0.001
Total Coliform	MPN/liter	4,000					

Source: Ashaka Environmental Auditing Report, 2004.

WW = Wastewater: WW1Interceptor 2, WW 2 Interceptor1, WW3A Oxidation pond1,WW 3B Oxidation pond 2 WW4 Drainage from clinic/despatch gate

2.10.4.4 Ground Water Quality

Results of analyses of groundwater obtained from the borehole on table 2.8 shows that Iron and total coliform are higher than FMEnv standards for portable water.

Table 2.8: Ground Water Quality

PARAMETER	METHOD	FME STANDARDS	MEASURED VALUES (mg/liter)
Temperature °C	Electrometric	NS	25
PH	Electrometric	6.5-8.5	6.9
Conductivity			0.08
Hardness		NS	35
Dissolved solids	Gravimetric	600	76
Suspended solids	Gravimetric	NS	37
Calcium	AAS	0.5	0.25
Cadmium	AAS	NS	<0.001
Cobalt	AAS	NS	0.35
Copper	AAS	2.00	0.01
Iron	AAS	0.1	1.23
Magnesium	AAS	50.12	3.6
Manganese	AAS	0.05	0.01
Potassium	AAS	NS	2.10
Silver	AAS	0.1	<0.001
Sodium	AAS	200	5.50
Zinc	AAS	3	0.22
Alkalinity	Titremetric	NS	67
Chloride	Hach	200	5.3
Nitrate-N	Hach	1	
Phosphate-P	Hach	NS	1.7
Sulphate	Hach	150	23
Sulphide	Hach	NS	
Dissolved oxygen	Electrometric	NS	8.4
COD	Hach	NS	7.5
BOD_5 20 °C	Hach	NS	1.7
Oil & Grease	Gravimetric	0	0
Phenols	Argentometric	0.001	<0.001
Total Coliform	MPN	0	27

Source: Ashaka Environmental Auditing Report, 2004.

2.10.5 Soil Study

Limestone, the principal raw material for cement production contains calcium and other elements. The cement dust from the factory falling on the soils can affect the soil physical and chemical properties. These in turn will affect plant (crop) performance. The most important components of the dust that can affect soil properties are oxides of Ca, Mg, Na, and Al in order of significance. The impact of Ca has been significant on the properties such as pH and base Saturation.

S/No	Component	Wt%
1	SiO_2	14.24
2	NaO	0.06
3	Al_2O_3	4.11
4	Fe_2O_3	1.89
5	SO_3	0.54
6	MgO	0.54
7	CaO	41.71

Results of the soil analysis has shown that the highly impacted areas are found within 500m radius from the plant and slightly impacted areas are within 1km to 5km radius from the plant and non-impacted areas are within 5km to 10km radius from the plant (Ashaka Environmental Audit, 2004).

2.10.6 Ecological Study

Ecological studies involve the overall interaction between the abiotic (non living) and biotic (living) components of the environment. The distinctive features of an area are governed by its geology, hydrology, drainage patterns, climatic regime i.e seasonal variation, physiographic factors and above all human activities.

Habitat alterations through environmental changes (such as pollution) exerts influence In species composition distribution, abundance, and their diversity.The result of the ecological study shows that there is significant deterioration of the natural vegetation of the area. Gaseous and particulate emissions can change the overall environment of an area depending upon the extent of the impact. In

addition to the existing impact of high temperature and aridity, severe stress could also lead to stunted growth due to decrease in biomass accumulation and alteration of species composition and diversity.

The environmental Audit Report (2004) shows that in most of impacted areas severe physiological processes linked to blockage of carbon metabolism by plants were observed. Visible symptoms are selective injury and defoliation of leaf areas among the different plant species. Deforestation, removal of top soil in quarry sites during Limestone extraction has changed the ecology of the terrestrial ecosystem and the biotic communities.

2. 10.7 Socio-Economic Impact Assessment

The study evaluated both positive and negative impacts of Ashakacem's operations on the social, cultural and economic impacts of mining operations. This study employed both primary data and secondary sources of data.

The result of the analysis revealed that allmost everyone interviewed complained about vibrations associated with quarry blasts, which they say cause their walls to crack. There is also the issue of temporary loss of land for farming, when quarry activities are still going on. However, the company has a policy of immediately backfilling quarries when they are completed.

Positive impacts of the mining activity are summarized in a table 2.9, 2.10 and 2.11 respectively. The communities benefit from scholarship schemes and also there is an expansion and rapid growth of economic activities in a small level.

TABLE 2.9 COMMUNITY PROJECTS EXECUTED IN THE YEAR 2000-2001

S/N	PROJECT	LOCATION
1.	Community Computer Learning Centre (with ten workstation)	Workers Village
2.	Standard Pri. Sch. With furnishing, HM & Asst. HM office	Dayayi Village
3.	A block of 2classrooms, toilet block, 72 lockers &72 chairs	Wuro Yayaru
4.	A block of 2classrooms with 72 chairs & 72 lockers HM`s office	Gongila Village
5.	A block of 2classrooms with 72 chairs & 72 lockers, HM office fully furnished	Bajoga Village
6.	Standard Dispensary,4 waiting chairs, 2 full size cupboards and chairs with desk	Badabdi Village
7.	Standard Dispensary,4 waiting chairs, 2 full size cupboards and chairs with desk	Bungum Village
8.	Fencing of the entire house with entrance hall of ward head	Badabdi Village
9.	Drilling of 4 boreholes with hand pumps	Ashaka Village
10.	Drilling of a borehole with hand pump	Feshingo Village
11.	Drilling of a borehole with hand pump	Darumpa Village
12.	Drilling of a borehole with hand pump	Lariski Village
13.	Drilling of a borehole with hand pump	SabonLayi Vill.
14.	Drilling of a borehole with hand pump	Manawashi Vill.
15.	Drilling of a borehole with hand pump	Sangaru Village
16.	Donation of refurbished J5 Bus	GDSS Bajoga
17.	Donation of refurbished J5 Bus	GGSS Doma
18.	Donation of refurbished Land rover	GGSS Malala
19.	Donation of refurbished Land rover	GSS Nafada

TABLE 2.10 COMMUNITY PROJECTS EXECUTED IN THE YEAR 2002

S/N	PROJECT	LOCATION
1.	A block of 2classrooms with 72 chairs & 72 lockers, HM office fully furnished	Ashaka Village
2.	A block of 2classrooms, 72 lockers &72 chairs	Tongo Village
3.	A block of 2classrooms, 72 lockers &72 chairs	Jajami Village
4.	A block of 2classrooms, 72 lockers &72 chairs	Badabdi Village

TABLE 2.11 APPROVED COMMUNITY PROJECTS FOR 2004.

S/N	PROJECT	LOCATION
1.	Elevation of water tank & extension of pipe line 500mtrs	Jalingo Village
2.	Wall fencing of Government Day sec. School & gates	GDSS Bajoga
3.	Construction of 4 rooms & wall fencing of the palace	Bage V/H Palace
4.	Construction of a block of 2classrooms	JSS Ashaka
5.	Maintenance of toilets, soak away, construction of kitchen, purchase of mats & blankets	Bajoga satellite prison house
6.	Repair of Immunization Toyota hilux	Local govenment

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1The Study Area

3.1.1 Location, Position and Size

The study area is located approximately within Latitude $10^0$50'N to 10^0 60'N and Longitude $11^0$25'E to $11^0$35' which is some 112km North of Gombe. This makes the area within the northern part of the present Gombe State and close to its border with Yobe State. Figure 3.1 shows the location of the study area. The population of the area is about 236,087(National population Commission, 2006).

3.1.2 Geology and Topography

The geology of Ashaka area is part of the Cretaceous sedimentary formation. This was following the depression of the area by differential warping in the early cretaceau (or Albian) times; following the breakup of Gondwana land, which gave rise to the now popular Chad basin. The depressed area made possible a series of marine transgression and regression which led to the development of cretaceau sedimentary rocks in the area (Ashaka Geological Survey, 1978).

The parent rocks are of great diversity, the transitional formations consist essentially of thinly inter-bedded sandstones, mudstone and occasional shales and limestone, while the major formations are mainly build up shales and limestones. The dominant geology of shales and limestone give rise to shale

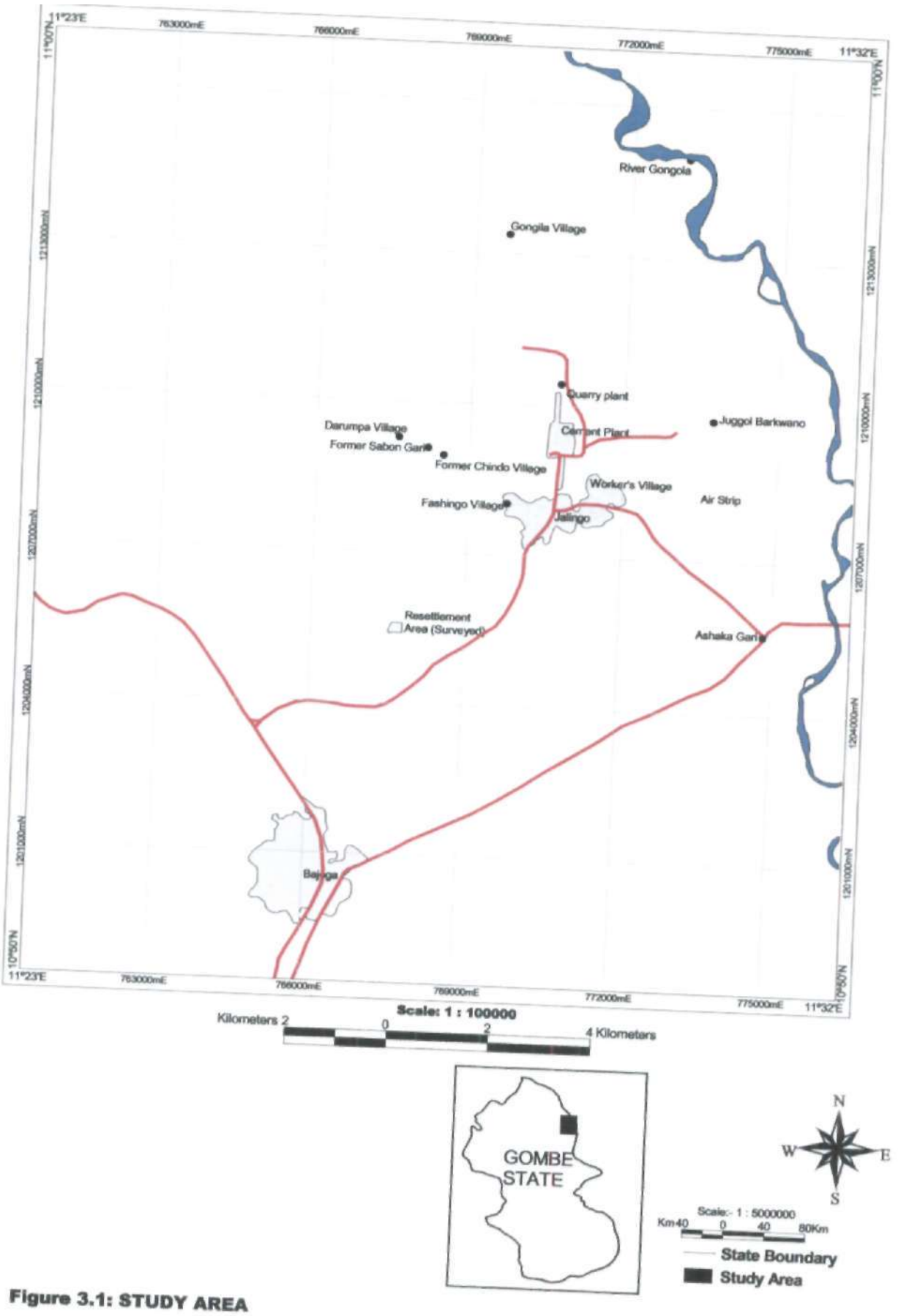


Figure 3.1: STUDY AREA

plain occupied by shales and transitional formation of sandstone and mudstone. The relief in the plain is gentle. There seem to be no strict relationship between topography and lithology. In some places the sandstone stands out, in others shale is found on higher parts (Ashaka Environmental Audit Report, 2004).

3.1.3 Climate

The climate is seasonally wet and dry. Like the rest of Nigeria, it is dominated by two air masses. These bring with them the rain bearing South-Westerly winds and the cold, dry and dusty North-easterly wind, locally known as the "harmattan". At different times of the year, one or the other of the winds prevail and the area experiences either rainfall or the dry harmattan depending on the advance or retreat of the other (Nyong and Kanaroglou, 1999).

Rainfall generally starts in early May and ends in late September. The annual rainfall could be as high as 800-900mm during the month of August and as low as 250-350mm during the first and the later period of the rainy season.

The relative humidity is low. However, it could reach 60-80 percent in the early morning hours during the rainy season.

Temperature is generally high throughout the year. It could be as high as 35-40^0C in the month of March and April, Minimum temperature is recorded during the rainy season and during the harmattan period. Yearly extremes in temperature range are 15^0C (harmattan) to about 40^0C during the month of March and April.

3.1.4 Soils and Vegetation

The types of soils in the study area are closely related to the parent rock. Where the parent rock is homogeous relatively simple soil association are recognised. The shale give rise to grey heavy loams and clay derived from homogeneous mudstones give rise to olive brown clay loam or loamy sand. The dominant soil type is grey mottled, sand and loams with some grey clay. The surface texture of the soils in the study area range from loamy sand (LS), loam (L), sand loam, sandy clay loam (SCL) and sandy clay (Ashaka Environmental Audit Report, 2004)

Hydromorphic soil of riverine and lacustrine type is also found in the study area along the flood plains of the nearby portion of the Gongola river. The soil contains recent alluvial deposits and is thus rich in nutrient. This soil is used in the area for the cultivation of rice and assorted horticultural crops.

The vegetation of the area is predominantly wooded scrubland. There is significant deterioration of natural vegetation of the area. The grasses are short and overgrazed with large exposed patches of bare soil susceptible to erosion. The large trees(7 to 20 meters high) are *Adonsonia digitata, Anogeissus leiocarpus, Sclerocaraya spp, Tamarindus indica* and *Balanaite aegyptica.* The small trees (2 to 6 meters high) with short boles are Combretum glutuism, Acacia seyal and other thorny shrubs. There are several woody climbers like *Combretum micranthum,* and *Capparis corymbosa.* Fuel wood collection is particularly intense within the area (Ashaka Cement Environmental Audit, 2004)

3.1.5 People, Occupation And Economic Activities

The study area consists of three major ethnic groups. These are the Karekare, Funani, and Kanuri. The major economic activities are agriculture and mining. To be specific, agriculture is the major economic activity in the area. However, with the picking up of activities at the area in 1979 and the subsequent linkages and multiplier effects, the economic activities of the study area have become more diversified with more dependence on the cement factory.

The establishment of the cement factory has attracted a number of small-scale businesses ranging from furniture making, mechanic services, trading of all sorts with the establishment of major business districts at Bajoga and Jalingo. This activity has also attracted some banks into the area. These include united bank for Africa, First Bank, First Inland Bank, Union bank, Zenith bank and First Monument bank.

Gypsum, one of the raw materials used in the production of limestone is also mined in the area with considerable number of the populace engaged in mining of the mineral. This activity could be said to have affected the ecosystem structure and functions (Amos, 2004)

3.2 METHOLOGY

3.2.1 Types and Sources of Data collected

In order to achieve the stated aim and objectives of this study, the following data were collected:

(i) Landuse/Landcover status of the study area in the 1970s, 1980s 1990s and 2005. These data helped in assessing landuse/landcover of the study area for these periods.

(ii) Overburden statistics. These data assisted in the prediction of landuse/landcover pattern

Four types of data were used in the course of this study. The satellite imageries include: LandSat imageries of the 1972, 1987 and 2005 and Spot Xs 1994.These were used for the landuse classification for the study periods. The LandSat imageries are of varied resolutions, thus, multispectral Scanner (MSS) 80m resampled to 50m of 1972, Thematic Mapper (TM) 30m of 1987 and Enhanced Thematic Mapper (ETM) 15m of 2005. The Spot Xs imagery used was 20m of 1994 (This imagery was mosaic with 1993 Spot Xs)

3.2.2 Methods and Procedures of Data Collection

Landuse/ landcover mapping of the Ashaka area was carried out by standard methods of analysis of remotely sensed data followed by verification, and visual interpretation of satellite data. For this purpose digital data on CD ROMs were procured from Federal Department of Agriculture and Land resource, livestock House in Mando-Kaduna, and National Space Research and Development Agency, Abuja. Digital image processing of the satellite data and the analysis of interpreted Landuse/Landcover maps were carried out at the department of Remote Sensing/GIS centre Mando, Kaduna using the basic softwares ERDAS

imagine 8.7, Arcview 3.2 and ArcInfo softwares. Figure 3.2 presented the simple model adopted in the analysis.

Ground-truthing was carried out using Garmin 76 (handheld GPS, 15m accuracy) Global Positioning System (GPS) receiver. This enabled the mapping of new mining lands that were not captured at the time the imagery was taken and some features which were obscured on the remote sensing images particularly tiny settlements, gullies and bare surfaces. Special attention was given to the features identified, their characteristic spectral signatures and their characteristic behaviours with an aim to quantifying them. Table 3.1 shows some of the locations.

Table 3.1:Study Site Description by Coordinate

Nortings	Eastings	Remark
0770735	1210439	Quarry Plant
0770735	1210414	Quarry Site (P1)
0770399	1210222	Quarry Site (P2)
0770456	1210000	Quarry Site (P3)
0770431	1209899	Quarry Site (P4)
0770412	1209710	Quarry Site (P5)
0770209	1209376	Quarry Site (P6)
0767318	1209463	Lariski
0766691	1210064	Northwestern Limestone Block
0766664	1210134	Northwestern Limestone Block
0766604	1210218	Northwestern Limestone Block
0766487	1210245	Northwestern Limestone Block
0766379	1210308	Northwestern Limestone Block
0766350	1210452	Northwestern Limestone Block
0766635	1210567	Northwestern Limestone Block
0767612	1209281	Darumpa Village
0768185	1209091	Former Sabon gari
0768485	1208960	Former Chindo Village
0769755	1208035	Feshingo Village
0769621	1213376	GongilaVillage
0773068	1214998	River Gongola
0773723	1209815	Juggol

KASHIM IBRAHIM IBRAH

Source: GPS Readings for some points in AshakaCem.

3.2.3 Development of a classification Scheme

Based on a prior knowledge of the study area for over a decade and a reconnaissance survey with additional information from previous studies, a visual interpretation scheme was developed for the study in line with the

objectives. The following steps were taken during the landuse/landcover category classification procedure as shown in figure 3.2

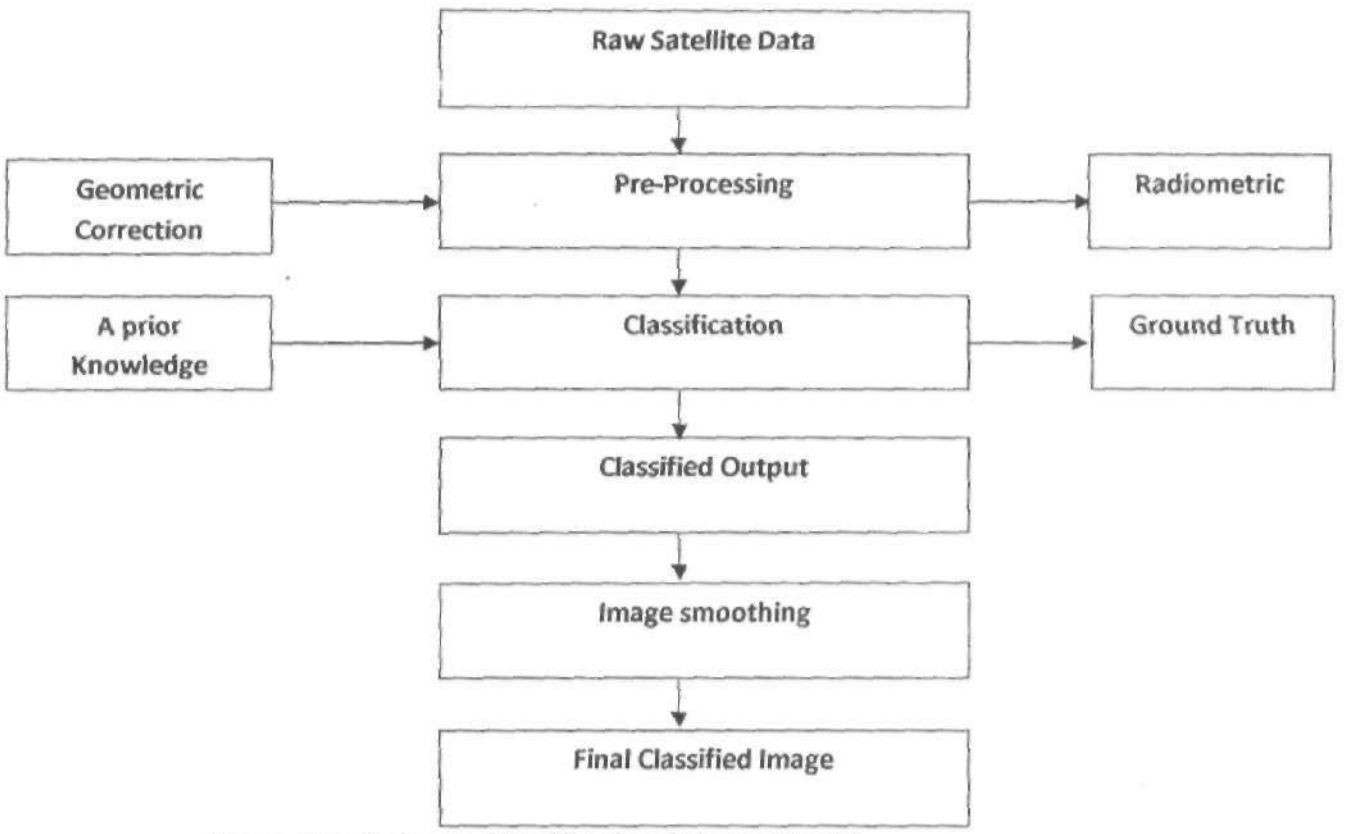


Figure 3.2: A simple Classification Scheme Model

Source: Adopted and Modified From Pushpam, 2008.

Firstly, Remote sensing software: Earth Resources Data Acquisition System (ERDAS Imagine version 8.7) software was used for the processing of the images. The raw satellite image was converted from Tag image file format (Tiff) to img format using ERDAS in order to be compatible with other ERDAS Imagine files. The layers were stacked and subset to delineate the study area for classification (Boakye et al., 2008). The UTM Zone coordinate was used to geocode the imported image. This was followed by georeferencing using the Traverse Mercator Projection with reference units in meters to allow compatible positioning of other meters.

Similar to the work carriedout in Ghana by Boakye, et al., (2008) the researcher made use of the visible portion of the electromagnetic spectrum. Band combination of red, blue and green was used to display the raw images in standard colour composites.

The spectral band combination for displaying images often varies with different applications (Trotter, 1998).This was necessary for the visual interpretation of the images. A band combination of red, blue and green (RGB) is often used to display images in standard colour composites for Land use and vegetation mapping (Trotter, 1998). In this study, the LandSat TM and ETM images and Spot Xs were displayed in a band combination of 1, 2 and 3 (red, blue and green) which is standard for visual interpretation of vegetation mapping in the tropics (Prakash and Gupta, 1998; Trotter, 1998)

Secondly, Arcview 3.2a software was used to open the subset image, altered the colour bands to enhance the image and subsequent interpretation of the various landuse/landcover classes.

Thirdly, Arcinfo software was used to correct the delineated landuse/landcover by eliminating "overshoot" and "undershoot". This was made possible after the shaped files have been converted to Arcinfo files. Then the converted files were "clean". The "clean" files were built as lines and polygon that resulted to establishing a topology. Finally, the built lines and polygon was returned to Arcview software to create a database.

The following operations were performed:

- Coding of the polygons and describing them
- Symbolizing the classes developed
- Composite map of the various years was laid for Landuse/Landcover change detection analysis.

The statistics of the various classes were generated using the Arcview 3.2a programme. Finally maps were composed; using Arcview (version 3.2a) programme and the maps were validated in the field to assess its accuracy. In carrying field validation, GPS coordinates reading of some sites were taken.

3.2.4 Change Detection

The most commonly used landuse change detection methods include (1) Image Overlay (ii) Classification comparison of landcover statistics (iii) change vector analysis (iv) principal component analysis (v) image rationing and (vi) the differencing of normalized difference vegetation index (NDVI) (Duadze, 2004). The method used in this research was that of classification comparison of landcover statistics. This method was adopted because the study sought to find out the quantitative changes in the areas of the various land cover categories. Using the post-classification procedure, the area statistics for each of the land cover classes was derived from the classification of the images for each date(1972, 1986, 1994 and 2005) separately, using functions in the Arcview and

Arcinfo software. The areas covered by each landcover type for the various periods were compared.

A total of Ten Landuse/Landcover categories were identified and classified in the study. These were: (1) Forestland (ii) Agricultural land (iii) Grassland (iv) Plantation (v) Riparian forest/ Flood plain (vi) Water body (vii) Mine land (Viii) bare surface/ Gully (ix) Airstrip (x) built up area.

Agricultural Land-This comprises of land used for production of food, fibre, crops except plantation. These were identified on the imagery by irregular shapes and their natural characteristics.

Plantations-This includes land having well defined boundaries and is in association with human settlement. They are man-made plantation features. Plantation tree crops include majorly mango trees plantations as observed from the field. Others include eucalyptus trees.

Forestland-This includes Land such as deciduous forests and degraded forests and shrubs. Also some pockets of sparse forests.

Built-upland-This comprises areas of land covered by structures mostly human settlements.

Mine Land: This includes excavated limestone land that is characterised by overburden tips resulting to formation of mounds which in turn produce landscape disturbance.

Grassland: This comprises of land with scrubs grasses as the dominant plant. Depicted grey spectral signature and dry grasses which indicates absence of chlorophyll content.

Bare surfaces/ Gully Land: This indicates an absence of trees and shrubs. This also means eroded areas of varied types such as sheet to rill erosion. Gully erosion is predominant in the North-eastern part of the factory between the plant and the management estates. This is shown on the imageries of 1987, 1994 and 2005.

Water Body: Areas persistently covered by water such as rivers and streams

Riparian Forest/ Flood plain: This means a forested area of land adjacent to a body of water where also there is a continuous seasonal flooding. Irrigation farming is being practice on the floodplain.

3.2.5 Data Analyses

Descriptive statistics such as percentages, tables, mean and graphs were used for both analyses and presentation of data.

First, Calculation of the Area (in kilometers) of the resulting Landuse/ Landcover types for each study year and subsequently comparing the results. The comparison of the Land use Land cover statistics was used to assist in identifying the percentage change, trend and rate of change between the decades.

In achieving this, the first task was to develop a table showing the area in Kilometer Square and the percentage change for each year measured against each Land use Land cover type. Percentage change to determine the trend of change was calculated by dividing observed change by sum of change multiplied by 100.

$$(Trend)PercentageChange = \frac{\text{Observed Change}}{\text{Sum of Change}} \times 100$$

Overlay operation was used to identify the location and magnitude of change.

The land consumption rate is a measure of compactness, which indicates a progressive spatial expansion of a Settlement land while land absorption coefficient, is a measure of change in consumption of new land by each unit increase in population. The formulas are given below;

L. C. R= $\frac{A}{P}$ A=areal extent of the mining land

P=Population

$$L.A.R = \frac{A2-A1}{P2-P1}$$

A1 and A2 are the areal extents (in km^2) for the early and Later years, and P1 and P2 are population figure for the

Early and later years respectively (Yeates and Garner,1976)

The population projection of the Ashaka area was obtained from the 1963 and 1991 census respectively. The formulae that was used to project the 1963 and

1991 population is presented below. The recommended National Population Commission (NPC) 1991 3.2% annual growth rate was used.

$TP = PV(1+r)^n$

Where,

PV= Present population

r=rate of growth

n=number of years being projected

Thereafter, the land consumption rate and absorption coefficient of the built-up area was derived from the above given formulae.

Population figures of the study were projected. The population of the area is shown in table 3.2 below:

Table 3.2: Ashaka Area Population Figures

Year	Ashaka area	Source
1963	14,054	1963 Census Data
1972	18,658	Projected Population
1986	29002	Projected Population
1991	35569	1991 Census Data
1994	40823	Projected Population
2005	52756	Projected Population

Source: National Population Commission 1963 and 1991 Census

3.2.6 Limitation(s) to the Study

The limitations of the study are summarized as follows: (i) Spatial resolution difference where multispectral Scanner of 1970(s) 80m resolution was acquired and thematic Mapper of 1987 30m resolution was used. Others include Spot Xs

of 1994 20m resolution and ETM of 2005 with 15m resolution. These differences make comparisons of change detection difficult. Second limitation was the availability and affordability of recent remotely sensed data of the present period(2009). This is because the imageries readily available are expensive such as Quick bird and Ikonos 0.6 and 1.5m respectively. That was why the researcher made used of Landsat ETM of 2005 for the recent period. Thirdly, Poor processing of Satellite imageries also made Landuse/Landcover interpretation difficult more especially linear(roads) and points (built-ups) features.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This Chapter presents the results and discussion of the study on Landuse/Landcover changes over the decadian periods based on the objectives of the study.

KASUJIA IBRAHIM LIBRARY

4.2 Landuse/Landcover Classes

Ten landuse/landcover categories were identified and presented in table 4.1.The Landuse/Landcover categories are summarized on table 4.1.

Table 4.1 THE EXTENT OF LANDUSE/LANDCOVER CLASSES

Landuse/Landcover Type category	1970		1987		1994		2005	
	Km^2	%	Km^2	%	Km^2	%	Km^2	%
Agri land	193.41	65.18	202.59	68.36	207.20	67.81	206.06	71.16
Forest land	46.06	15.52	30.89	10.42	37.08	12.13	26.18	9.08
Grassland	37.71	12.17	16.83	5.68	8.89	2.91	9.59	3.33
Plantation	0.44	0.15	0.005	0.00	0.74	0.24	0.39	0.14
Riparian forest/flood plain	12.39	4.17	15.66	5.28	21.86	7.15	12.37	4.29
Water body	5.60	1.89	2.31	0.78	2.60	0.85	3.43	1.19
Mine land	00.00	0.00	1.12	0.38	1.52	0.50	1.84	0.64
Bare surface/gully	0.00	0.00	23.83	8.04	21.26	6.96	23.80	8.26
Airstrip	0.00	0.00	0.17	0.06	0.24	0.09	0.24	0.08
Built-up land	1.14	0.38	2.94	0.99	4.19	1.37	5.27	1.83

Source: Author's Field Survey, 2009

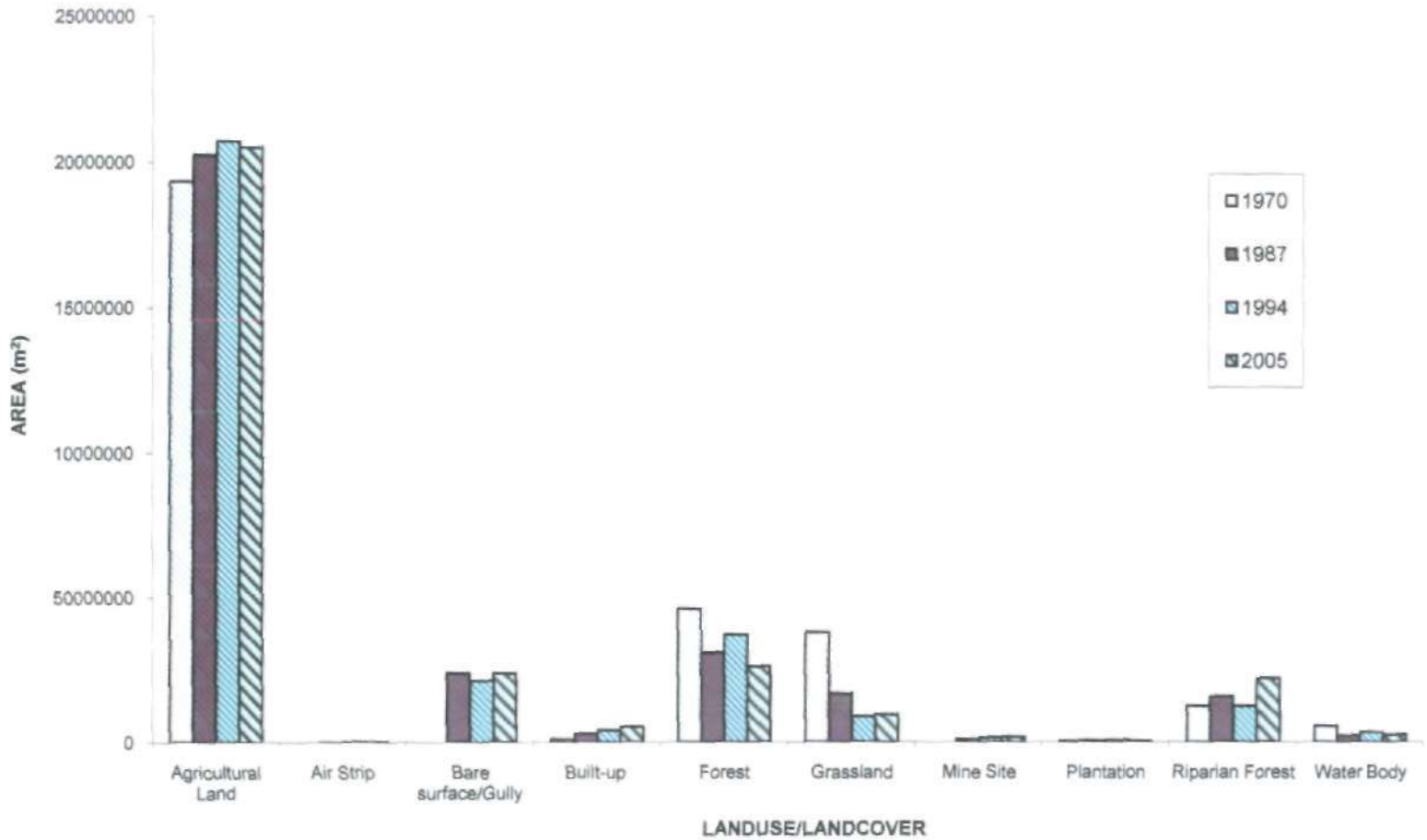


Figure 4.1: LANDUSE/LANDCOVER CHANGES OF ASHAKA AREA: (1970 - 2005)

Table 4.1 summarizes the landuse/landcover classes of the Ashaka area. Table 4.1shows the most extensive landuse was agriculture, contributing 65.18% in 1970, 68.36% in 1987 and 71.16% in 2005.This indicates a continuous clearing of land for cultivation due to population growth, settlement growth and the progressive expansion of the mining lands. The conversions were mainly from agricultural land to mining land and likewise forestland to agricultural land.

As shown in Table 4.1, the order of magnitude of the spatial extent of the landuse/landcover categories in 1987 is different from that of 1970(Fig 4.3 and 4.4).1987 shows an accelerated reduction in forestland which covered 30.89Km^2 and constituting 10.42% which was reduced about two third the size of the forestland in 1970 which covered 46.06 Km^2 indicating 15.52%.Grassland covered16.83Km^2 which was 5.68% in 1987 compared with the 12.71% in 1970.Grassland kept reducing from 1987 to 2005 which was 3.33% as of 2005.Rapid reduction in grassland could be attributed to overgrazing, excavation of land due to mining and the continuous clearing of land for cultivation.

Plantations which are mainly found along the main road and in association with settlements in the study area are scanty, decreasing from 1970 to 1987 .They however, increased slightly from 1994 to 2005.The intervention of the Savanna conservation programme where some trees were planted in some places was part of the strategy adopted to ameliorate the ecological problems. Plantation was observed to cover 0.44km^2 which is 0.15% in 1970 and decreased to 0.005km^2 in 1987. However, this increases slightly in the periods 1987/1994 and

1994/2005. The continuous human activities were observed to have interfered with plantation of the area.

Riparian forest/flood plain indicated decrease and increase. It covered 12.39 Km^2 in 1970 which was 4.17%, 15.66 Km^2 (5.28%) and then increased to 21.86 Km^2 in 1994.This could be attributed to the human-induced erosion due to the irrigation activities close to the river bank.

Mine land which was the focus of this study occupies the second least class with just 1.12 Km^2 in 1987, which constituted 0.38% of the ten classes. 1.52 Km^2 in 1994 which contributed only 0.5% and 1.84 Km^2 in 2005.This slight change could partly be attributed to the effects of rainfall in some parts of the year namely, July, August and September where the excavation has to be suspended because of the difficult nature of the muddy terrain. However, the area covered by mining activity was observed to change the natural landcover of the area as shown in plates 4.2 and 4.3. The overburden (top soil) record for a decade is presented in table 4.2 in tonnes to show the trend of the excavation process.

Table: 4.2 Overburden (tons) 2000-2008

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
2000	127760	121260	179860	147300	127590	152068	37994	11446	43362	107900	131152	117391	1305083
2001	112399	122820	116440	144972	82752	56490	17472	0	0	124937	164722	142432	1085438
2002	150248	137952	173830	158195	118236	197376	49016	41505	5599	75997	106799	77847	1292600
2003	70865	141154	103731	209123	76830	55434	50240	65808	44184	108136	199954	101530	1226989
2004	43152	55230	73400	81510	74578	43300	18060	23510	50750	287262	138249	203197	1092298
2005	20030	126530	175633	173870	109296	72850	79959	24308	64624	117732	326416	110441	1401689
2006	110443	76144	86425	127580	104869	106027	129934	136806	139392	108387	188984	162254	1477245
2007	112569	147063	93415	109178	168090	75271	207617	129040	166320	141484	88361	86780	1525188
2008	112385	135710	140328	159581	131262	137875	64378	0	0	36100	188255	189556	1295430

Source: Ashaka Cement Statistics Office, 2008Fig.4.1:

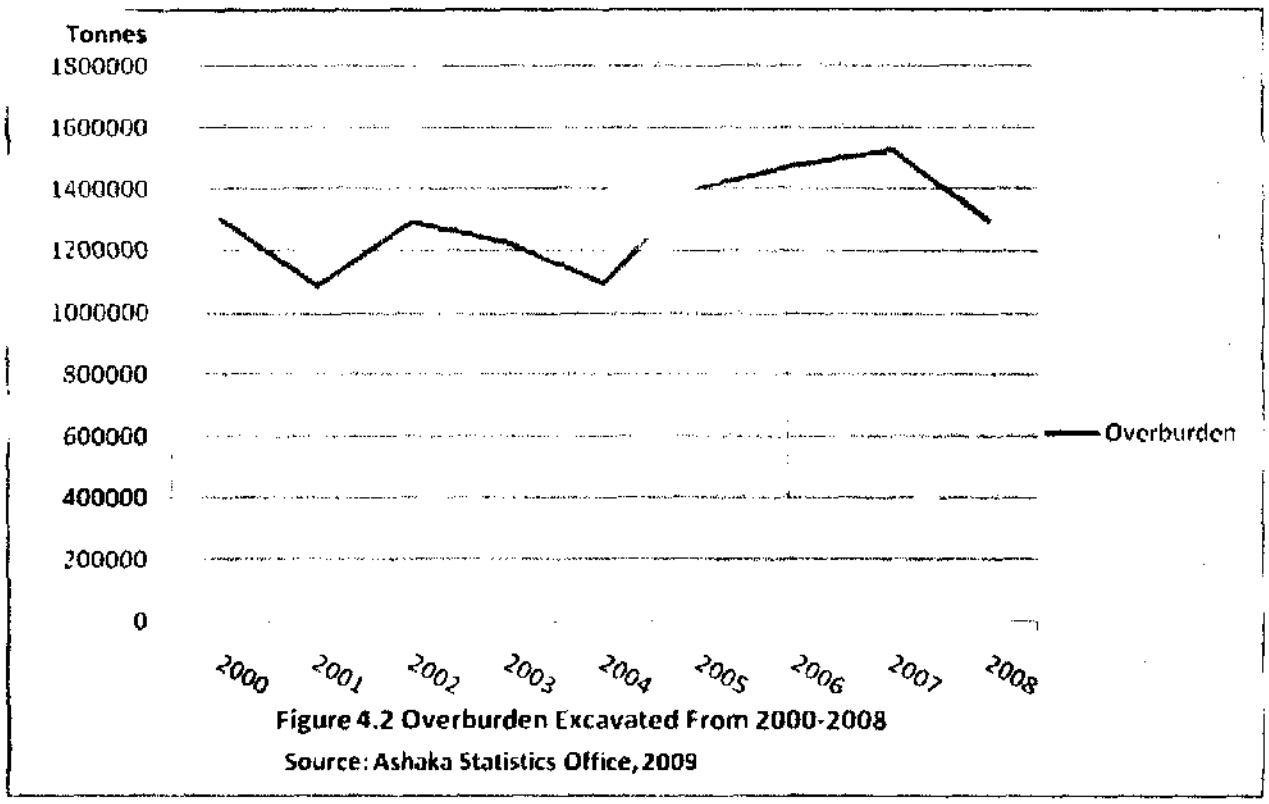
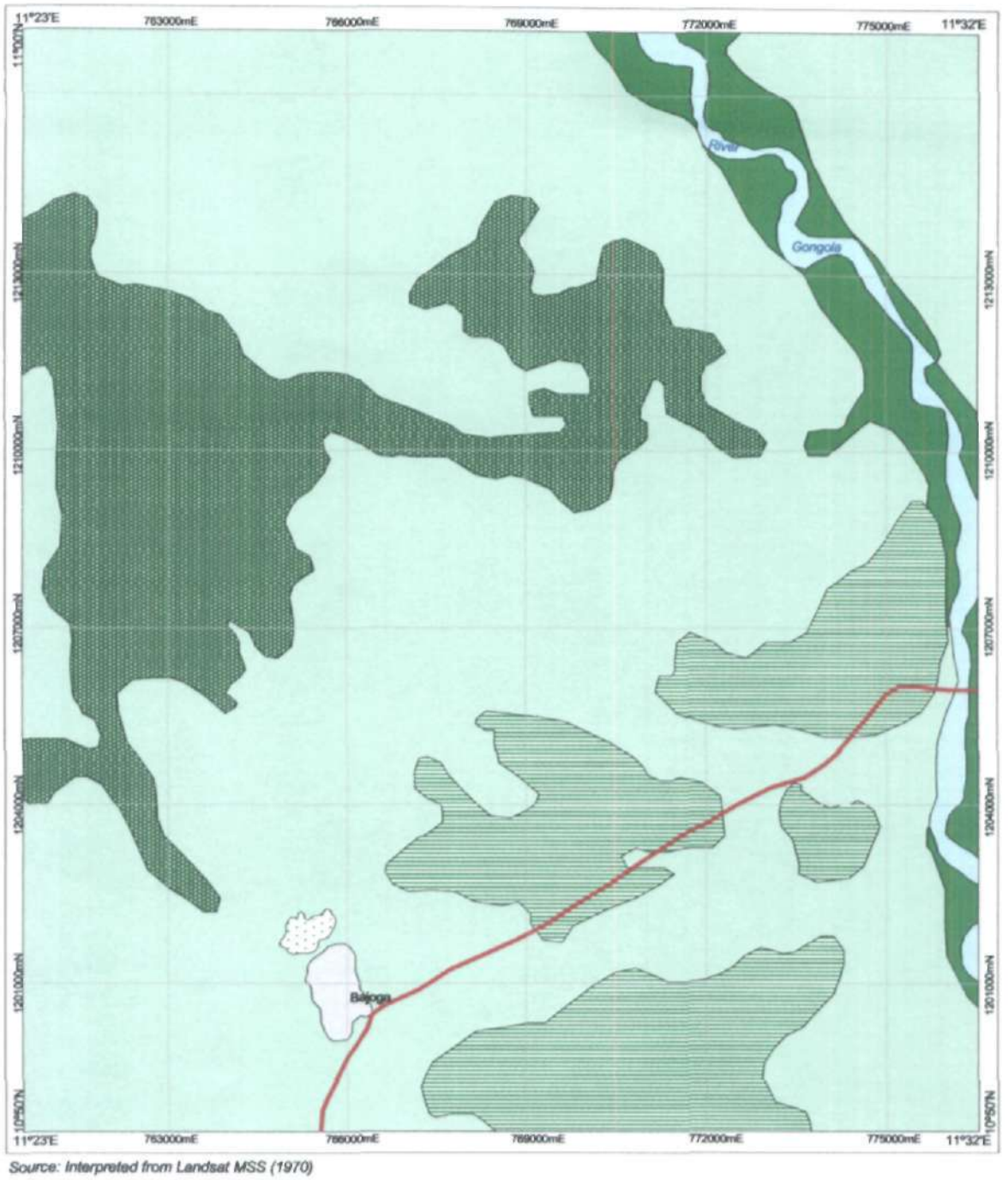


Figure 4.2 Overburden Excavated From 2000-2008

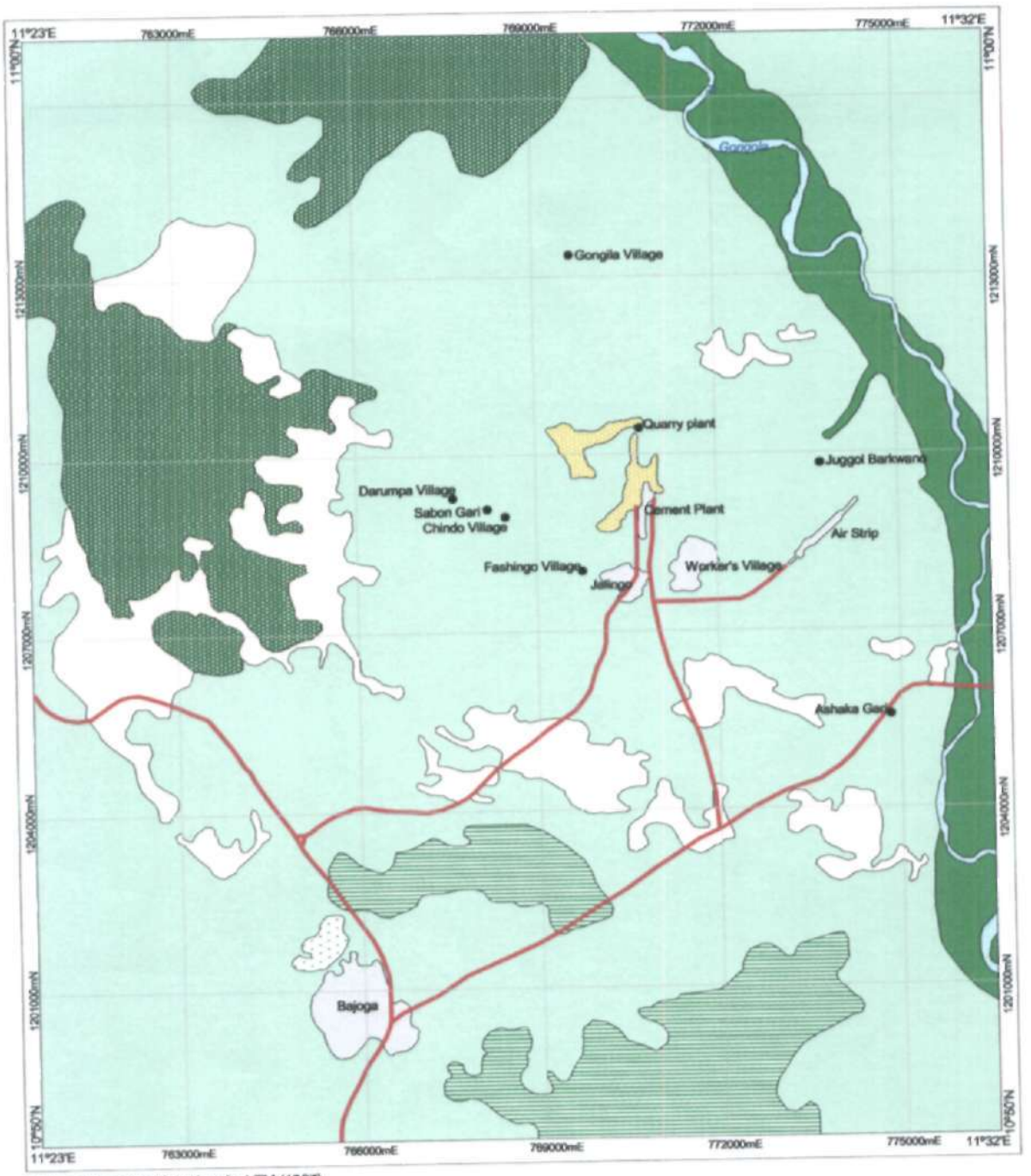
Source: Ashaka Statistics Office, 2009

Bare surface means land having potential for development of vegetative cover but not being used due to constraints including the impoverished nature of the soil, eroded land. The result of the analyses revealed an absence of bare



Source: Interpreted from Landsat MSS (1970)

Figure 4.3: LANDUSE\LANDCOVER OF ASHAKA AREA; 1970



Source: Interpreted from Landsat TM (1987)

Scale: 1 : 100000

Kilometers 2 0 2 4 Kilometers

LEGEND

- Settlement
- Road
- Agricultural land
- Bare surface/gully
- Built-up area
- Forest
- Grassland
- Mine site
- Plantation
- Riparian forest/floodplain
- Water body

Figure 4.4: LANDUSE\LANDCOVER OF ASHAKA AREA; 1987

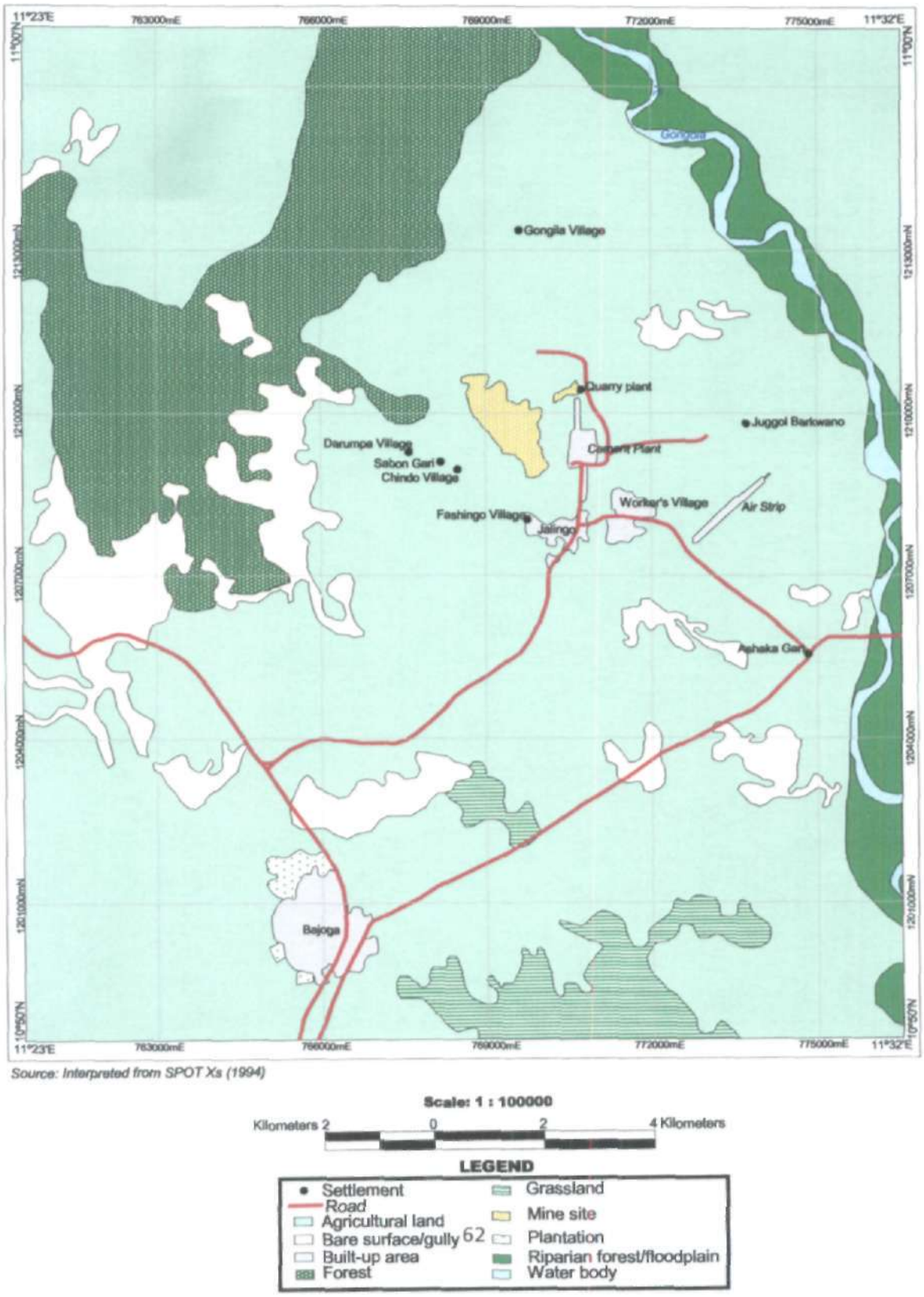


Figure 4.5: LANDUSE\LANDCOVER OF ASHAKA AREA; 1994



Source: Interpreted from Landsat ETM (2005)

Scale: 1 : 100000

Kilometers 2 0 2 4 Kilometers

LEGEND

Verify Point	Grassland
Road	Mine site
Agricultural land	Plantation
Bare surface/gully	Riparian forest/floodplain
Built-up area	Water body
Forest	

Figure 4.6: LANDUSE\LANDCOVER OF ASHAKA AREA; 2005

period have indicated a slight increased of 4.6km^2 in the period 1987/1994. In 2005 a decreased of -2.86km^2. Forestland has indicated a decreased of -15.17km^2 in 1987 compared to its total area of 46.06km^2 in 1970 represented in table 4.1.This decreased in forest land continuous in the subsequent periods, 1994 and 2005 as indicated in table 4.3. Grassland has decreased and changed indicating -20.88km^2 in 1987 compared to its size in 1970. This is kept decreasing in the subsequent periods indicating -7.94km^2 in 1994 and -0.70km^2 in 2005. Bare surface/Gully indicates 23.83km^2 increased in 1987. Conversely, reduced slightly to 0.4km^2 in1994 and -2.54km^2 in 2005. This has indicated that decreased in forestland and grassland have caused an increased in bare surface/gully. Mine land indicated 1.12km^2 in 1987 and continues steadily in the subsequent periods. These changes could be largely attributed to combined anthropogenic influence of human activities within the vicinity of Ashaka area. These human activities include Limestone mining, grazing, settlement growth and fuelwood harvesting.

4.4 Landuse/Landcover Conversions

Figure 4.7 of Landuse/Landcover composite map has shown a general conversion of agricultural land to other landuses as well as landcover. Agricultural land is being converted to mineland. The mining activity is slowly and steadily converting agricultural land to mine at a slower rate. Agricultural land is being converted likewise to built-up as indicated in figure 4.8. This conversion caused further conversion of forestland to agricultural land as

indicated in the composite map of 1987/1994 and 1994/2005 as represented in figure 4.8 and 4.9 respectively. Grassland is being converted partly to agricultural land and as well as baresurfaces/gully. These conversions of forestland to agricultural land and also grassland to agricultural land explained the reason for the increased in agricultural land from 1970-2005 as presented in table 4.1 and 4.3. Agriculture could be described to be extensive and intensive. The former causes destruction of forest resources and grassland depletion while the latter causes soil impoverishment and soil erosion(found along the riparian forest and floodplain of Gongola river).

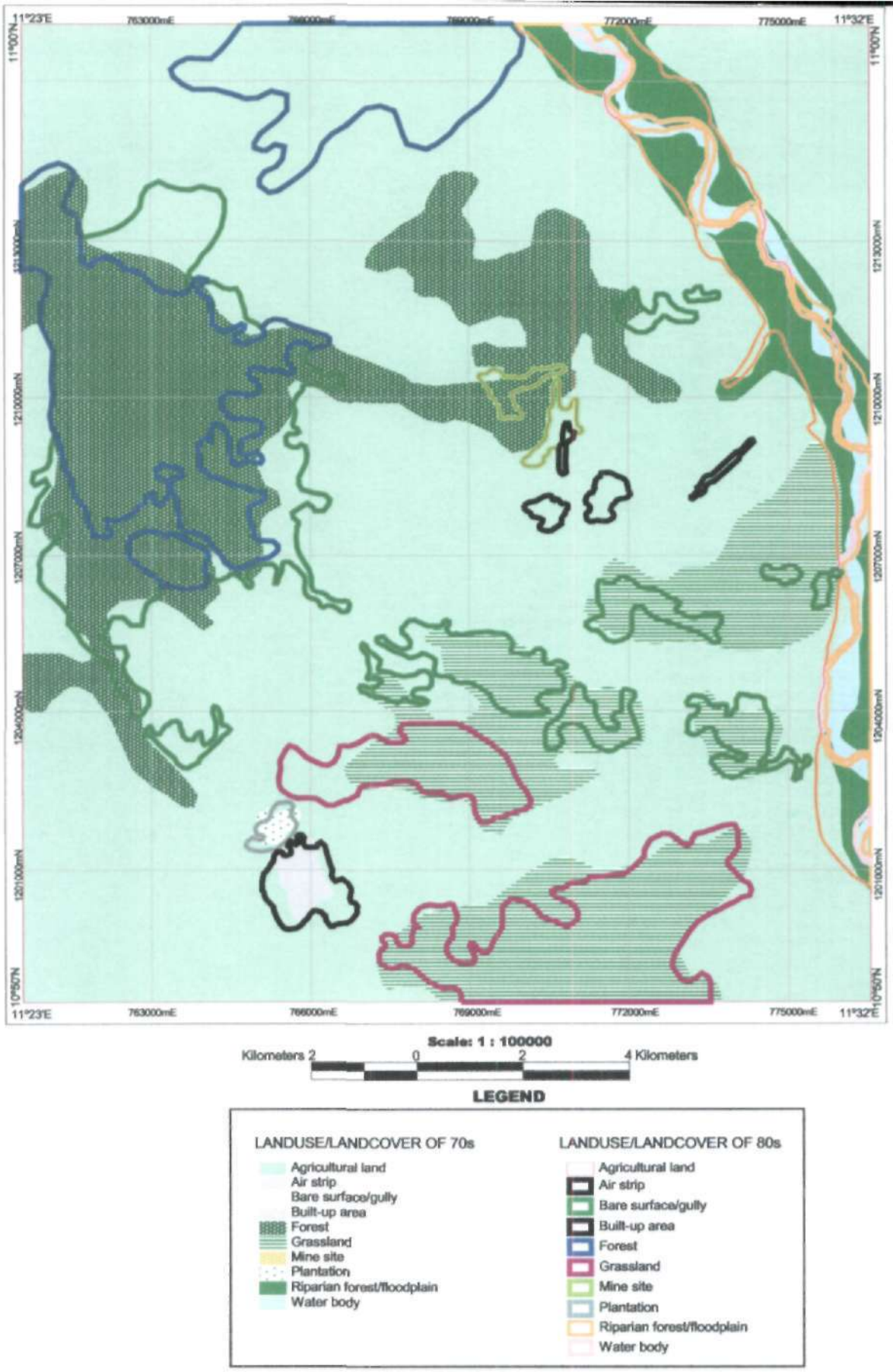


Figure 4.7: LANDUSE/LANDCOVER COMPOSITE MAP; 1970/1987

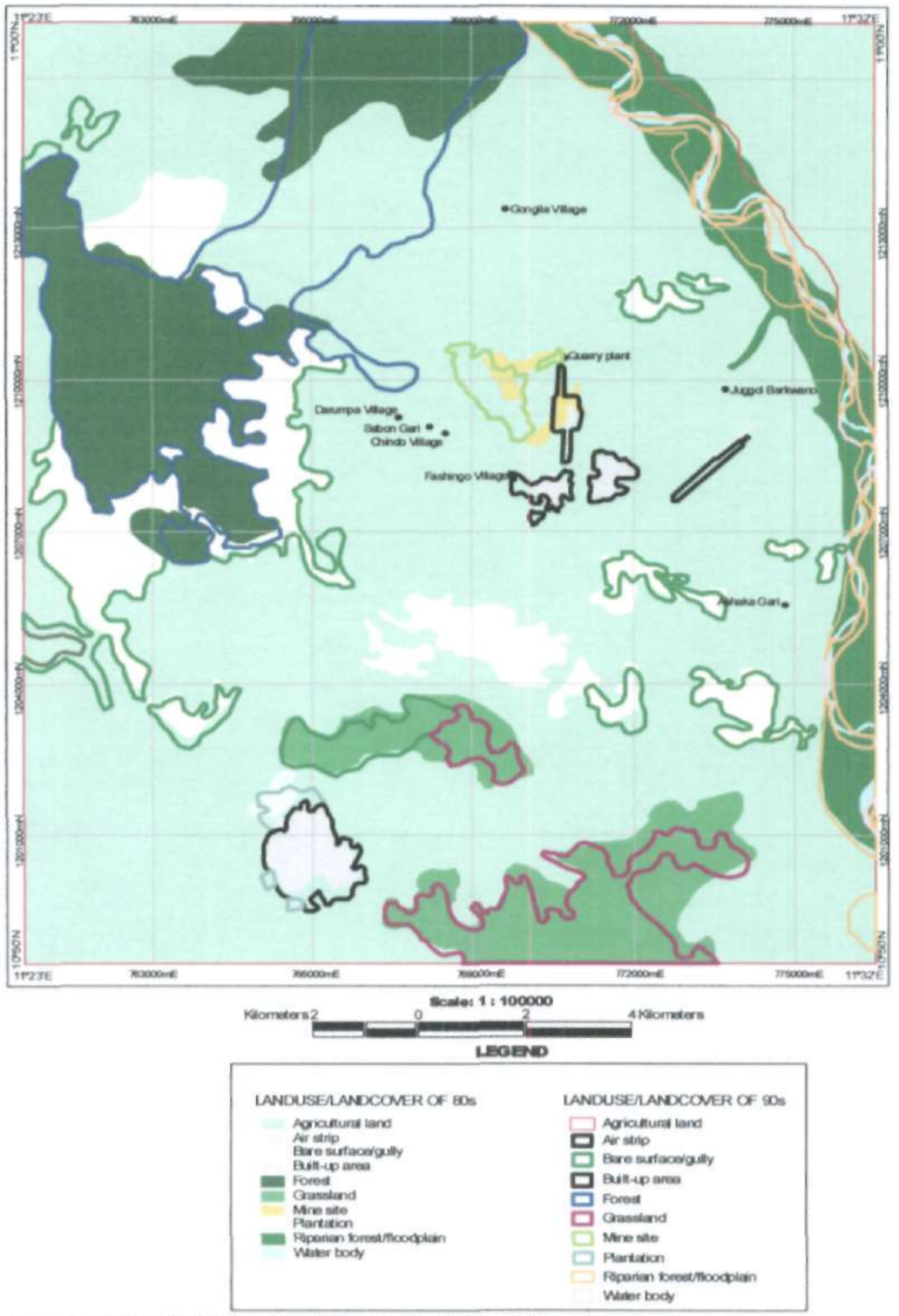


Figure 4.8: LANDUSE/LANDCOVER COMPOSITE MAP; 1987/1994

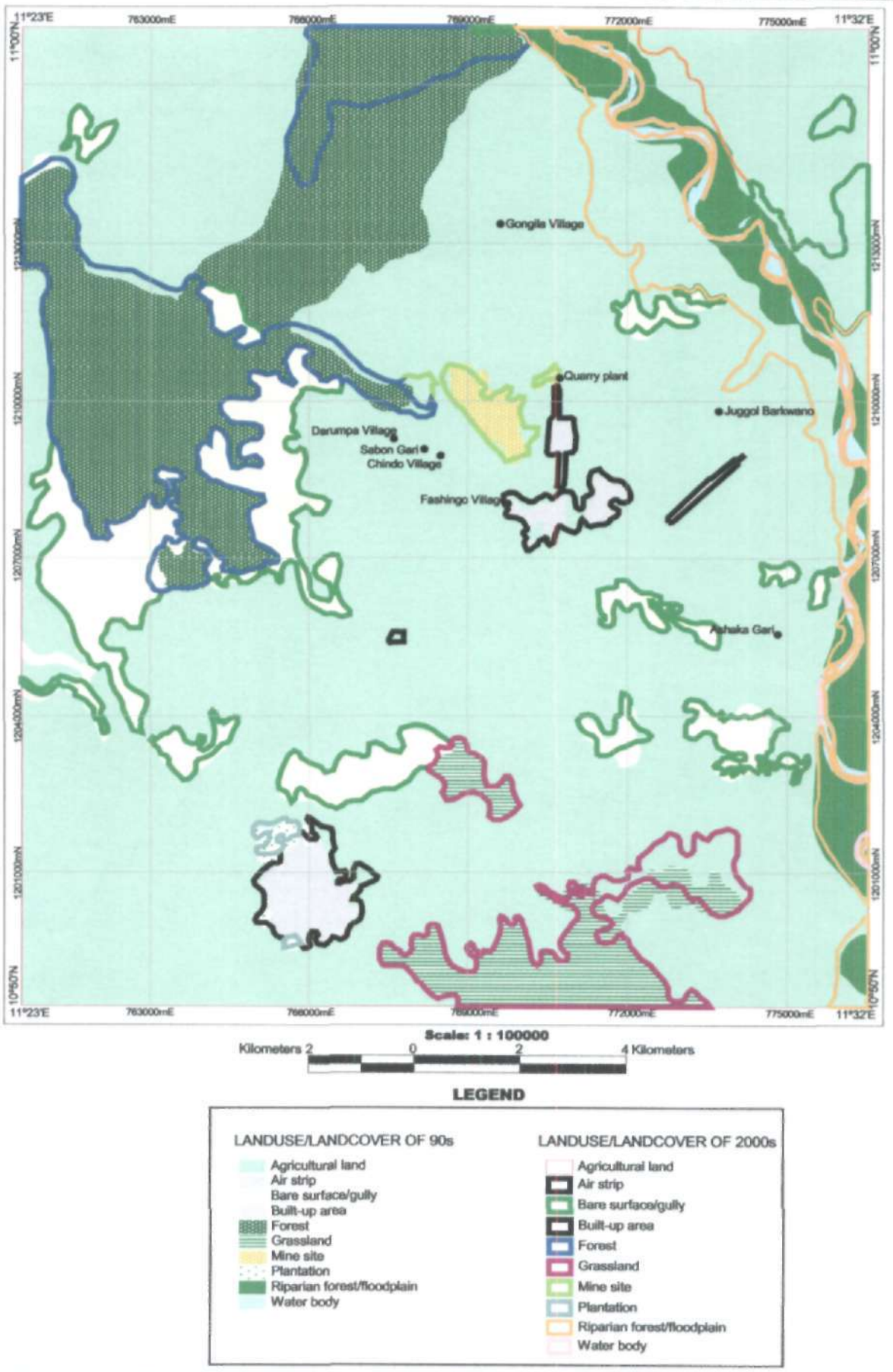


Figure 4.9: LANDUSE/LANDCOVER COMPOSITE MAP; 1994/2005

4.5 Environmental Problems

The four major environmental problems identified from the analysis and interpretations of the results include: (a) Increasing bare surfaces/gullies as shown in tables 4.1 and 4.3 above which in turn encourages soil erosion thereby resulting to soil impoverishment in most of the areas as indicated in figures 4.4, 4.5 and 4.6 of Landuse/Landcover maps.

(b) Over cultivation: This may be accounted for by the of increased population and continuous land clearing and excavation which in turn have caused depletion of biological resources through increasing conversion of forestlands to agricultural land as shown on table 4.3.

(c) Overgrazing perhaps is the major cause of grassland depletion. The conversion is mostly of grazing land to both bare surfaces/gully and also to agricultural land. This could be because the inhabitants are engaged in both domestication of animals and settling of the nomadic Fulani whose livelihood is depended on the livestock production. Almost seven out of ten every households identified were engaged in this occupation. In addition, farmsteads are seen to be scattered within the study area at approximately regular intervals.

(d) Deforestation: land conversion from agriculture to mining has resulted to loss of agricultural land to mining. This causes further conversion of forestland to agricultural land in order to cater for the growing population in the study area. Cutting down of trees for fuel woods as a major source of energy is the second cause of deforestation. The Industrial processes beginning from the quarry to the

end point (packing plant) have discharge considerable amount of dust into the environment and eventually the particulate matter gets deposited on the plants leave and flowers as well as the soil supporting the plants. The overall effects of this are that, the photosynthetic and fruiting ability of the trees are impaired with a consequent decrease in productivity.

4.6 Causes of the Landuse/Landcover Changes

Environmental changes as an outcome of the dynamic interplay of socio-economic, institutional and technological activities will be said to be the causes of Landuse/Landcover changes as in the study area as observed by previous in studies in India. Landuse/Landcover as a subset of environmental changes may be driven by factors including population growth, urbanisation, intensification of agriculture, rising energy use and industrial activities. Poverty still remains a problem at the root of several environmental problems.

4.6.1 Population

This is an important source of development, yet it is a major source of environmental degradation when it exceeds the threshold limits of the support systems(Cheng,1999).In addition, unless the relationship between the multiplying population and the life support system can be stabilized, development programmes, howsoever, innovative are not likely to yield desired results. The increase in population of the Ashaka communities from 1963 to 2005 is shown in figure 4.10.

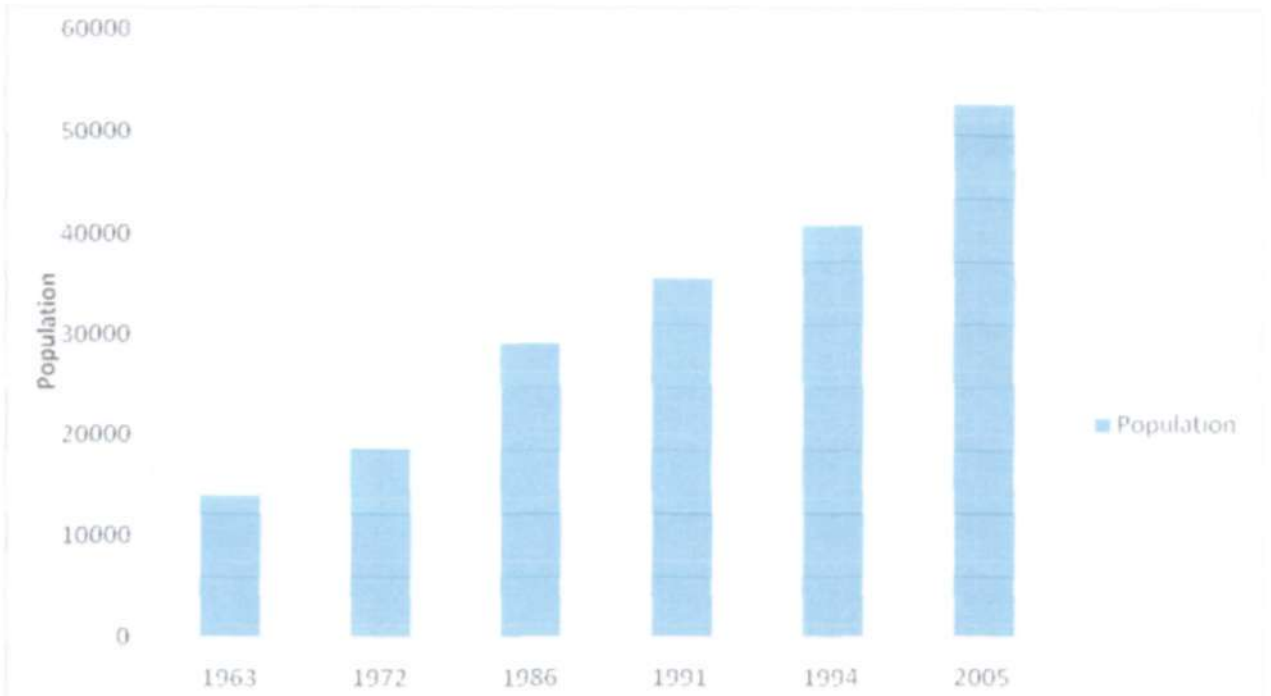


Figure4.10 Population of the communities around the factory site over the Years

Souce: National Population Commission office, Gombe

Population impacts on the environment primarily through the use of natural resources(Limestone, gypsum and shale) and biological resources and production of wastes is associated with environmental stresses like loss of biodiversity, air and water pollution and increased pressure on arable land.

There has being settlement growth and development since the establishment of the factory in 1979. Prior to the establishment were only few settlements with Bajoga as the main settlement as shown in Landuse/Landcover map in Fig 4.3. However, the subsequent periods experienced an increase of human settlements that settled around the plant. This is presented in figures 4.4, 4.5 and 4.6.

4.6.2 Poverty

This is said to be both cause and effect of environmental degradation. Inequalities may foster unsustainability because the poor, who rely on natural

resources more than the rich, deplete natural resources faster as they have no real prospects of gaining access to other types of resources. Moreover, degraded environment can accelerate the process of impoverishment again because the poor depend directly on natural assets. The affected communities around the plant could be said to be engaged in over exploitation and utilization of biological resources as reflected from the rapid decline in forest land and grassland and increased in cultivated agricultural land as shown in table 4.1 above.

The reasons for their unemployment may be attributed to their low literacy level and lack of technical know-how. The few that were employed are unskilled workers who are engaged in menial unskilled labour in the factory.

4.6.3 Settlement Growth

Lack of opportunities for gainful employment in villages and the ecological stresses is leading to an ever increasing movement of poor families to towns. This has widened the gab between demand and supply of infrastructural services such as energy, housing, transport, communication, education, water supply and sewerage and recreational amenities, thus depleting the precious environmental resource base of the area. The result is the growing trend in deterioration of air and water quality, generation of wastes, the proliferations of slums and undesirable landuse changes.

The progressive expansion of settlement has been indicated by land consumption rate and absorption coefficient in table 4.4 below which indicated a

slight progression with high population density per unit area especially in Bajoga and Jalingo.

Table 4.4: Built-up Land Consumption Rate and Absorption Coefficient

Year	Land consumption Rate	Land Absorption Coefficient	Periods
1970	0.00006	0.0002	1987/1970
1987	0.0001	0.0002	1987/1994
1994	0.00010	0.00009	1994/2005
2005	0.000010		

Land consumption rate which is the progressive expansion of built-up areas have indicated a slight increase between the periods 1970 to 1987 which indicated 0.61%. This expansion has remained steady in the subsequent periods with a constant increase rate of 0.0001.The land absorption coefficient which is a measure of change in consumption of new land by each unit increase in the area population has shown a steady rate of 0.0002 except the periods 1994/2005 which shown a decline of 0.00009. Factors that might be responsible for these rates include among others cultural and social behaviour of the study population which in turn influence their pattern of settlements growth and development with high population density. Others include location of settlement near to the factory for easy accessibility thereby creating areas around the plant to be densely populated especially Jalingo where the low income earners live. Bajoga which housed the Cement factory could be said to have witnessed tremendous growth and development due to the establishment of the cement factory with an

increasing population growth. Growth in terms of physical infrastructures and economic development.

4.6.4 Technological Factor

The manufacturing technology adopted by most of the industries has placed a heavy load on environment especially through intensive resource and energy use, as is evident in natural resource depletion (fossil fuel, minerals), water, air and land contamination, health hazards and degradation of natural eco-systems. With high proportion fossil fuel as the main source of industrial energy and major air polluting industries such as cement industries have contributed to a relatively high share in air pollution. Large quantities of industrial and hazardous wastes poised a management problem with serious environmental health implications. Transport activities have a wide variety of effects on the environment such as air pollution, noise from road traffic e.t.c. The gaseous emission from the cement manufacturing process could be summarized below:

Gaseous emissions from all sources into air can be categorized into two groups; these are direct and indirect emissions. Direct emissions are emissions from sources that are within the direct control of the management of AshakaCem, e.g. captive generators, the kiln, company vehicles, etc. While the indirect emission are from sources outside the control of the management but the company consumes services provided by such sources, e.g. power generated by NEPA from gas plants, contractor's supply vehicles, etc. Gaseous emissions generated

by Ashaka Cem include NO_x, SO_2, CO_2, CO, H_2S and VOCs (Ashaka Environmental Audit, 2004).

4.6.4.1 Quantification of Impacts

Environmental Audit reported that the quantities of gaseous pollutants from AshakaCem operations can be estimated from material balance. However, it is important to note that the quantities of H_2S, NO_X and SO_2 generated are more dependent on the quality of fuel used in generating energy, whereas CO and CO_2 are more dependent plant operating variables, which is under the direct control of AshakaCem. Furthermore, since CO_2 is of utmost concern in the cement industry was used as the basis for these quantitative analyses. The total direct CO_2 emitted from all sources in 2003 is 596,822 tons. This is equivalent to 845kg CO_2/ton cement.

TABLE 4.5: ***QUANTIFICATION OF GASEOUS EMISSIONS***

EMISSION SOURCE	**CO_2 EMITTED** (tons)	**REMARK**
Kiln oil	230,184	Both LRS and LPFO
Raw meal	350,998	As a by-product of calcinations of $CaCO_3$
Generators	12,871	Based on MWh of electricity generated
Boiler	1,545	Based on diesel used
Vehicles	1,224	Based on gasoline consumed
TOTAL	**596,822**	

Source: Ashaka cement Statistics Office, 2008

4.6.4.2 Ambient Air Qualities

Air quality was measured within and outside the Works premises, at five different locations, namely: -. Generator House, Laboratory, Dispatch Gate, Boiler Room and Welding Workshop.

Average values of the air quality parameters for the above-mentioned locations are given in Table Comparisons with previous measurements are also made on the same Table.

Concentration of pollution gases in ambient air is a function of the quantities deposited in the atmosphere, dispersion rate and height of emission stacks.

Table 4.6: Ambient air Qualities

Sampling point	NO_x				SO_2				CO_2				CO				H_2S	VOCs
	Dec'02	Jul '03	Dec'03	PRESENT Jul'04	Dec'02	Jul '03	Dec'03	PRESENT Jul'04	Dec'02	Jul '03	Dec'03	PRESENT Jul'04	Dec'02	Jul '03	Dec'03	PRESENT Jul'04	SAME VALUE	SAME VALUE
CAB	<0.001	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	2350	2420	2360	2450	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Laboratory	<0.001	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	2256	2360	2250	2256	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Clinic	0.021	0.018	0.018	0.018	0.011	0.018	0.015	0.018	1974	2450	2440	2433	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Welding W/Shop	<0.001	<0.001	0.021	0.018	0.018	0.009	0.018	0.021	1825	2580	2560	2734	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Paper Sack	<0.001	<0.001	<0.001	<0.001	<0.001	0.021	<0.001	<0.001	2154	1985	1970	2734	<0.001	<0.001	0.001	NM	<0.001	<0.001
Dispatch Gate	0.026	0.021	0.026	0.026	0.120	0.021	0.027	0.021	2467	2250	2340	2467	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Jalingo	0.026	0.018	0.018	0.021	0.026	0.021	0.021	0.026	2734	2433	2480	2154	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boiler House	0.018	0.009	0.018	0.026	0.018	0.018	0.018	0.015	2433	2125	2498	2433	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Generator House	0.021	0.015	0.021	0.018	0.018	0.021	0.018	0.021	2570	2455	2155	2480	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
FEPA REGULATORY LIMITS	0.0062 – 0.093				0.026				-			11.43						
FEPA TOXITY LEVELS	7.75				26.12				8980			114.3						

Concentrations are in mg/m^3 N.M= Not Measured

Source: sAshaka Environmental Audit,2004

4.6 Observed Effects of Mining Activities on the Environment

4.6.1Resettlement

The ongoing mining activities in Ashaka area apart from the impact it is having on biophysical and social environments, it has also led to the relocation or displacement of some communities around the factory site in the North-western block viz: Sabon Gari and Chindo villages to an entirely new sites about 7km from the mining sites. Darumpa and Lariski settlements also located in the North western block are under threats of being affected by blasting operations which causes vibration and emission of particulate matters among other factors. Even though the new site where the communities are relocated is made up of concrete building materials compared to their former mud thatch houses were not devoid of some environmental and social problems. Figure 3 and 4 of Landuse/Landcover maps have shown the locations of these settlements. This has led to the continuous conversion of a natural landscape into a cultural landscape and the conversion of agricultural land into urban settlement. As observed by Chambers 1969, Schudder 1981, Hansen and Oliver-smith, 1982) resettlement schemes have not succeeded in improving the basic necessities of life, rather, they had led to increased human suffering and environmental degradation. This could be seen in the resettled area where physical and social distance are some of the problems encountered by the resettled communities. Plate 4.1show the resettlement site.



Plate 4.1: Resettlement Site

4.6.2 Damage of Vegetation

Vegetation in form of natural forest or crop plantation is usually the first casualty to suffer total or partial destruction or degradation during the exploration and exploitation of minerals in the locality as observed by Aigbedion et al., 2007. The vegetation damage is more extensive at the time of mine development and mining operations and is more expensive when crop plantation is affected. This is reflected in forestland reduction of the period 1987/1970 and increased bare surfaces of the same period. Forestland is observed to have reduced significantly from a total area of 46.06Km^2 in 1970 to 30.89% indicating a decrease of -15.17Km^2 representing -5.1% of the total Landuse/Landcover classes. This reduction continuous in the subsequent periods. The environmental audit(2004) has supported this assessment where

was reported that there is significant deterioration of natural vegetation of the area. Also, that the grasses are short and overgrazed with large exposed patches of bare soil susceptible to erosion. Fuel wood collection is particularly intense within the area.

4.6.3 Ecological Disturbances

Another adverse effect of mineral extraction and processing activities, which may not be immediately felt, is the disturbance of the ecosystem with possible adverse consequences on the flora and fauna communities in general. The deforestation by some areas during the mine development in the study area have led to the elimination of some plants and the exodus of some animals that feed on such plants or depend on them for cover, from the affected area. Similarly, the noise generated in the course of blasting, quarrying and crushing have also frighten away part of the fauna in a mining locality. Generally speaking, the plants, animals, soils and water are affected. As mentioned earlier, the vegetation suffers degradation and eventually death. The noise generated during

the cement making process in 2004 is illustrated by a bar graph below:

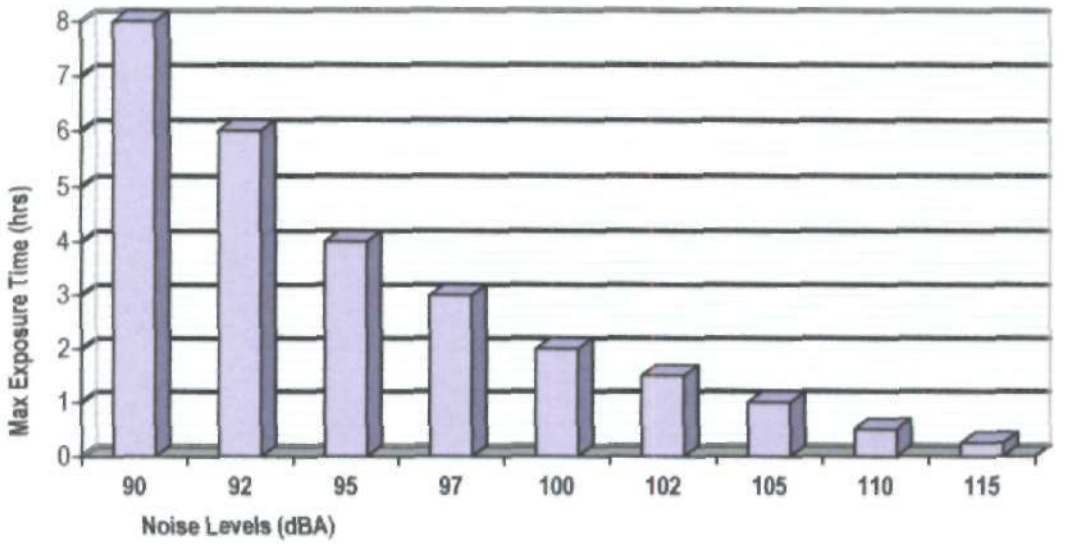


Figure 4.11: Noise Exposure Limits

4.6.4 Geological Hazards

Mining operations normally upset the equilibrium in the geological environment, which may trigger off certain hazards such as landslides, subsidence, flooding, erosion and tremors together with their secondary effects (Aigbedion, 2007). Similarly, minor earth tremors are generated due to blasting of rocks in the quarries as observed by the neighbourhood of Darumpa, Feshingo, and Lariski communities. As further observed, villages and settlements in the neighbourhood of the quarries have experienced unpleasant earth movements when the rocks are blasted. Some buildings are damaged by developing cracks due to minor tremors occasioned by the incessant blasting of the rocks.

4.6.5 Degradation of natural Landscape

A common negative effect of Limestone mining in the study area, similar to Aigbedion(2005) reports in other limestone regions in Nigeria is the earth's surface destruction of its natural landscape, creating open space in the ground(plate 4.2) and generating heaps of rock wastes that cannot be easily disposed off. The mining sites are characterized by heaps of mining mounds which invariably result in eyesore (plate 4.3). The alteration of the landscape almost invariably creates a problem of erosion in the mining sites.



Plate 4.2: Mining pit

4.7 Implications of Environmental and Landuse/Landcover Changes for Sustainable Development

The trend of landuse and landcover changes detected in this study has shown conversion of agricultural land to mining land .Also, conversion of forestland into agricultural land. There is also an increasing conversion of grassland to bare

surfaces/gully. Given these trend therefore, the following implications can be deduced:

1. The ongoing conversion of agricultural land largely and forestland to mining land have led to temporal and sometimes permanent loss of farmlands which triggers off continuous clearing of forestland for cultivation. The quarried land where mining activities occurred was observed to be declining in fertility and the reclaimed areas are slow to re-establish in the natural regeneration or secondary succession pattern. If this phenomenon continuous unchecked it will have serious implication on the food security of the study area.

Grasses which are useful for soil stabilisation are increasingly diminishing from the area due to overgrazing by domestic animals as depicted from its conversion to bare surfaces/gully. The decline of the grasses is followed by increased abundance of less palatable annual grasses and herbs. As overgrazing and trampling continue, plant cover of all types decrease further. The soils get more and more compacted by trampling and wind and water, and increasingly eroded, making it increasingly difficult for plant to establish at all. Eventually grazing decreases vegetation cover, soil loss and compaction increases, water infiltration decreases and runoff increases. Low productivity grasses, like natural grass, and farm lands, have low leaf area and produce less litter than the original vegetation. With a lower leaf area, the grass does not intercept as much rainfall as the forest does, and a higher fraction reaches the ground. With less litter, the capacity of surface detention is decreased, and a greater proportion of the

rainfall runs off as overland flow. Therefore, the shift from sub-surface flow to overland storm flows accompanying deforestation may produce accelerated erosion problems in the area.

Cutting down of trees for fuel wood is the second cause of deforestation in the study area. This has contributed to biological resource depletion and the attendant emergence of bare surfaces/gully erosion creating an opening for desert encroachment to emerge.

Studies carried out to assess the impact of the cement dust falling on the soils around the Ashaka area has revealed that the impact has affected the physical and chemical properties of the soils. Among the physical properties is the surface soils structural deterioration leading to surface crust. The surface crust leads to increased bulk density which limit seedling emergence and early root development. The chemical impacts on the soils are evidenced in increased soil pH, and exchangeable cations especially Ca and Mg. The high pH has not reached the critical level. However, it is approaching that zone.

Ecological studies have revealed that the vegetation of the area is predominantly wooded scrubland. There is significant deterioration of natural vegetation due to mining and deforestation activities in the area. The grasses are short and overgrazed with large exposed patches of bare soil susceptible to erosion. Fuelwood collection is particularly intense within the area.

Gaseous and particulate emissions have changed the biogeophysical and biogeochemical properties of the study area. Impacts can be categorised into natural and man-made. Existing impacts of high temperature aridity, severe stress could lead to alteration or diversion of energy required for growth and reproduction to maintenance of survival strategies. This will also lead to stunted growth due to decrease in biomass accumulation and alteration of species composition and diversity. Stack emissions, concentration of particulate dust, wind direction, topography and distance from the emission points determine the level of exposure.

Studies have shown that in most impacted areas severe physiological processes linked to blockage of carbon metabolism in the plants were observed. Visible symptoms are selective injury and defoliation of leaf areas among the different plant species.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

This study focuses on the analysis of land use/ land cover changes of Ashaka area and the effects and implications of such changes for sustainable Landuse development .

For change detection, satellite imageries of 1970 (LANDSAT MSS), 1987 (LANDSAT TM), 1994 (SPOT XS) and 2005 (LANDSAT ETM) were used for the analysis. The satellite imageries were rectified or geometrically corrected using Ground Control Points (GCPs) obtained from the Global Positioning System (GPS), points collected from the field. Using GCPs, training sets were generated for different landuse and landcover types and the image classified based on a combination of visual and digital classification scheme. The satellite data were analyzed using specialized GIS software.

The results of the analysis show that agricultural land has increased from 65.18% (193.41km^2) in 1970 to 71.16% (206.06km^2) in 2005, a percentage increase of 5.98%. The gradual increase in agricultural land is attributed to accelerated conversion of forestland to agricultural land and likewise conversion of grassland to partly agricultural land .The conversion is being identified to be due to continuous clearing of land for cultivation, cutting down of trees for fuel wood and ongoing mining activities in the area. Also, there is a substantial

decreased in forest from 15.52% (46.06km^2) in area in 1970 to 9.08% (26.18km^2) in 2005 which indicated a percentage decreased of 6.44%. The decreased in forestland is largely observed to occur between the period 1970/1987. This may be because of the combined effects of exploration and exploitation of the natural resource (limestone mining) in the area. However, this has reduced significantly in subsequent periods as presented in table 4.1.

Similarly, grassland was observed to also decline significantly from -7.03% (-20.88km^2) in 1970/1987 to -0.42% (-0.70) in 1994/2005. This conversion was observed to change from grassland to bare surfaced/gully.

Therefore, giving the above landuse/landcover pattern and changes, causes and effects were deduce in order to suggest practices that will help reduced or minimized the undesirable landuse/landcover conversions. The causes of landuse/landcover changes observed ranges from social, such as: population pressure due to growth, urbanization (settlements growth), economic, technological and institutional factors. The environmental problems identifies are: overgrazing, over-cultivation and deforestation.

The trend of landuse/landcover changes detected in this study has shown general conversion of agricultural land to mine land which causes partly the conversion of forestland to agricultural land. These conversions have potential consequence on the ecosystem of the area. Mining affects the soil and hydrology while conversion of forestland for agricultural purposes has lead to changes in the soil conditions and the geomorphology of the factory area. Low productivity grasses,

like natural grass and farmlands, have lower leaf area and produce less litter than the original vegetation. With a lower leaf area, the grass does not intercept as much rainfall as the forest does, and a higher fraction reaches the ground. With less litter the capacity of surface detention is decreased, and a greater proportion of the rainfall runs off as overland flow (Boakye et al. 2008).

Landuse/Landcover changes of the Ashaka area were found to be associated to ongoing mining activities, demographic pressure due to population growth, social factor such as poverty which is resulting to over-dependence on primary resources, settlement growth, and both extensification and intensification cultivation of agricultural land. Identified effects of such changes are among others include; displacement of two communities(Figure 4.4), forest depletion, accelerated soil erosion and general decreased in soil fertility as supported by the soil environmental audit of the Ashaka area.

5.2 CONCLUSION

The monitoring of mining activity to ascertain undesirable changes, overexploitation of primary resources, increase bare surfaces/gullies and depletion of grassland resources as evidenced by changes in land use/landcover in this study are the major concerned of these findings. Therefore, up to date data on land use/landcover is necessary for sustained and healthy biophysical environment. Such information is necessary to provide a basis for more effective understanding and management of the mining environment. The

approach adopted in this study clearly demonstrated the potential of Remote sensing and GIS techniques in quantifying land use/landcover changes.

5.3 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

(i) Quarry rehabilitation should take advantage of the agro forestry which intentionally combines agriculture and forestry to create integrated and sustainable landuse systems should be adopted in an attempt to restore back the fertility of the soil. Agro forestry takes advantage of the interactive benefits from combining trees and shrubs with crops and/or livestocks. Agroforestry practices that should be adopted include:(i)Alley cropping(ii) forest farming (iii) Riparian forest buffers and windbreaks.

(ii) Trees such as *Guiera Senegalensis, Adonsonia digitata, Acacia Seyal* and *Piliostigma retuculatum are* observed to strive well in the area due to their conserve water retentions and adaptations. These should be planted along side with economic trees such as water resistance species of Umbrella tree, Mango and Guava. This will help to reduce the bare surfaces/gullies and check the problem of soil erosion identified from the study.

(iii) Quarry recommended international standards rehabilitation procedures should be pursuit for reclamation and mitigation measures towards environmental and amelioration due to industrial activities. Such industrial

development process should be monitored and its negative externalities and environmental impact assessed to avoid wrong attitude to industrial growth no matter the environmental cost.

(iv) The company should embark on massive forestation in partnership with the savanna conservation with the active participation of the communities. This will assist to enlightened and educate the communities toward the importance of the tree planting.

(V) There is a need to embark on soil conservation measures, by building proper channels for storm water. This becomes imperative due to observed gradual and massive soil erosion around the plant. Particularly, the area between the crusher, junior staff club and Juggol village as observed in the studies.

(vi) Government policies should be enforced to ensure protection of forest and grassland reserves to in order to safeguard forest and forest resources and reduce the increasing forest and grassland depletion in the study area. Also to minimize the rate of extinction of biodiversity.

5.4 SUGGESTION(S) FOR FURTHER STUDY

Research should be carried out on determining the future landuse/landcover pattern of limestone mining to predict the future environmental sustainability of the mining process and other land use activities such as grazing and agriculture. Attempt should be made to separate the human

induced factors responsible for landuse/landcover change from climatologically induced change in the study area. Methodology in the form of descriptive and predictive models, which will facilitate the determination of factors driving landuse/landcover change should be adopted.

References

Ademiluyi, I. A., Okude, A. S. And Akanni, C. O.(2008). An appraisal of Landuse and Landcover mapping in Nigeria. African Journal of Agricultural Research Vol. 3(9), pp 581-586

Adeniyi P. O. (1984).Land use and Land cover Inventory in Nigeria, Niger. Geogr. J. 27(1&2): 113-130.

Aina, E. O. (1998). The state of the Nigerian Environment. Pp. 16-42,

In:*Poverty, Health and the Nigerian environment.* A. Osuntogun(Ed.). FEDEN, Lagos, Nigeria.

Akintola, F. O. (1998). *Mineral l and Energy Resources.* Oguntoyinbo J. S., Areola and Filani (Eds). A Geography of Nigerian Development. Ibadan: Heinemann Educational Books Ltd. Pp. 90-92

Amos, B. B.(2004). The Effects of Gypsum Mining in Funakaye L. G. A. Gombe State. An unpublished B.Sc thesis, Department of Geography, University of Jos, Nigeria.

Areola. O. (1997). Aerial Photo-interpretation of Land Types and Terrain Conditions in the Lagos Coastal Region, Nigeria *Geogr. J. 20(1)*:70-84

Adefila, S. S. (2004). *Ashaka Cement Environmental Audit* Report. Eds :EEMS

Boakye E., Odai S. N., Adjei K. A. and Annor F. O.(2008). Landsat Images for Assessment of the Impact of Landuse and Landcover changes on the Berekese Catchment in Ghana. *European Journal of Scientific Research Vol. 22* No.2 pp 269-278

Bonnie,B.S.(2005).*Geography matters*: GIS, Availablefrom: http://www.digitaldivide.net/view.php?ArticleID=493(Accessed 19 Nov 2005).

Burrough, P.(1986). *Principles of Geographical Information Systems for Land Resources Assessment*. Clarendon Press, Oxfort, p. 6

Cunnigham, A. B. (2001). *Applied Ethnolobotany.* People, wild plant use and Conservation. Earthscan publication Ltd; London. 300pp

Cunningam, W. P. and Saigo, B. W. (1999). *Envronmental Sciences*: A Global concern U. S. A.: The McGraw-Hill Companies, Inc.

Gonzales Inca, C. A.(2009). Assessing the Land cover and Land use change and its Impact on watershed services in a Tropical Andean watershed of Peru. Unpublished PhD dissertation, *department of Biological and Environmental Science, Jyvaskyla. Pp. 8-15.*

Haack and English(1996). Quoted from Lee et al.,(2002). *Land cover Classification and Interpretation of NASA/JPL AIRSAR data* based on Info@Gisdevelopment.Net.

Hwang C, Ku CY (2004). Exploring the Optimum Spatitial Resolution for Satellite Imagery: A Coastal Area Case Study, In Barlett, D and Smith, J(eds), GIS for Coastal Zone Management CRC Press LLC, USA, pp. 77-93. *IGBP Report 41*

Iqbl, M. Z. and Shafiz, M.(2001). Periodical Effect of cement dust pollution on the Growth of some species. *Turkish Journal of Botany, 25:19-24*

James A. H., Paul B. and John P.(1998). *Land Restoration and Reclamation,* London: Addison Wesley Longman Lmited pp. 3-4

Keith N. M. (2008). *Landuse Landcover Analysis of Maverick County Texas along the US Mexico Border.* Unpublished PhD dissertation, Department of Environmental Science and Engineering San Antonio, Texas.

Lameed G. A. and Ayodele A.E. (2008). Environmental Impact Assessment of Cement Factory production on Biodiversity: A case study of UNICEM, Calabar Nigeria. *World Journal of Biological Research 001:1*

Lambin E. F., Helmut J., Geist H. J., (2007). Causes of Land-use and Landcover Change.In: *Encyclopedia of Earth Eds. Cutler J. Cleveland* (Washington, D. C.: Environmental Information Coalition, National Council for Science and Environment. Last Retrieved August 8,2007; Retrieved October 19, 2009.

Mark, D. M. (1989). Cognitive Image-Schemata and Geographic Information: relation to the *user view and GIS interface proceedings,* GIS/LIS'89, Oriondo, p.1

Meyer, W. B. 1995. *Past and Present Land-use and Land cover in the U. S. A. consequences*. p. 24-33

Negendra, H., Munroe, D. K. and Southworth, J.(2004). From pattern to process: Landscape fragmentation and the analysis of Lasnduse/Landcover change. *Agric., Ecosyst. Environ,* 111-115

Negendra, H., Southworth, J. and Tucker, C.(2003).Accessibility as a determinant of Landscape transformation in Western Honduras:Linking pattern and process. *Lands. Ecol.*, 18, 141-158

NEST(1992). *The Nigerian Environmental Study/Action Team(NEST),* Edited by T. A. Aina, A. T. Salau. Pp. 167-168

Nwakor, J. C.(1981). *An Evaluation of Land conservation problems of Extractive and Manufacturing Industries in Nigeria.* A case study of Nkalagu Cement industry, U. M. Igbozurike (ed) Land use and Conservation in Nigeria. Nsukka: University of Nigeria press, pp. 128-136

Nyong, A. O. and Kanaroglou P. S. (1999). The influence of Water resources and their location on rural distribution in North Eastern Nigeria. *Journal of Environmental Sciences 3(1), pp. 46-54*

Okafor F. C.(1998). Rural Development and the Environment: Degradation verses Protection '*Journal of Environmental Issues and Management in Nigerian Development*: Ibadan: Evans Brothers(Nigerian publishers) limited. Pp. 154-156

Okoye, C. O. (1997). *Implementation Strategies of Policies on Industrial Waste Disposal and Environmental Education in Nigeria,* in S. U. Udoh, G. O. Akpa (Eds) pp. 265-271

Okude, A. S. (2006). *Landcover change along the Lagos Coastal area,* Unpublished PhD Dissertation, Department of Geography, university of Ibadan, Nigeria.

Omojala A. (1997). *Landuse and Landcover Inventory and change Assessment in a semi Arid Region of Nigeria using remote sensing and GIS techniques,* unpublished PhD Thesis, University of lagos.

Oyinloye R. O., Agbo B. F. and Aliyu Z. O. (2008). *Landuse/landcover Mapping in Osun State using Nigeria Sat-1 Data.* Paper presented by: Gueye A.L., Regional Centre for Training in Aerospace surveys (RECTAS)

Philip M. M. (2008). *The Mineral Industry of Nigeria.* U. S. Geological Survey Mineral Yearbook.

Prakas, A. and Gupta, R. P. (1998). Landuse mapping and change detection in a Coal mining area. A case study in the Jharia Coalfield, *India.int.j. remote sensing,* 1998, vol. 19, no.3 391-410

Pranjit, K., Bibhuti P., Sonali, G., Abhijit, R., Jyoti, P., Naba, K., Santanu, D., and Namita B.(2008). Landuse and Landcover change and future implication analysis in Manas National Park, India using multi-temporal Satellite data. *Journal of Communication Research,* Vol.95, No. 2, 223-227.

Pushpam K.(2008). Assessment of Economic drivers of Landuse change in Urban ecosystems of Delhi, India. *India:AMBIO, 38 9(1) pp. 35-39*

Raymond, A. B. and Dan, H, F.(1973). *What is a corpora social Audit.* Harvard Business Review(January-February) p.38.

Roberts, D. A., Bastita G. T., Pereria S. L. G, Waller E. K., and Nelson B. W. (1998). *Change Identification Using Multitemporal Spectral Mixture Analysis- Application in eastern Amazonia in Lunetta* RS. Elvidge CD (eds) Remote Sensing and 21 Change Detection Environmental monitoring methods and application s. Sleeping Bear Press Inc, Michigan.

Ronade P. (2006). Environmental Impact Assessment of Land use planning around the leased Limestone mine using Remote sensing Technique. *Iran Journal of Environmental Health vol. 4, No 1, pp. 61-65.*

Seto K.C., Woodcock C.E., Song C., Huang X., Lu J. & Kaufmann R.K. 2002. Monitoring land-use change in the Pearl river delta using Landsat TM. *International journal of remote sensing 23 (10).*

Trotter, C. M. (1998). Characterising the topographic effect at red wavelengths using juvenile conifer conifer canopies.*int. remote sensing, 1998, vol 19, no. 11, 2215-2221*

Turner, B. L. II, Skole, Sanderson, S Fischer, G., Fresco, L. and Leemans, R (1995). Land use and Land cover Change; Science; Science/ Research plan, *IGBP and HDP, Stockholm and Geneva.*

Vitonset, D. M. *et al.*,1997. *Human Domination of Health's Ecosystems.* Science 27:494-499

Welfort R. and Strachan, P. A. (2005). *Environmental Issues and Corporate environmental management* pp. 551-604.In:management: Concepts and practices. T. Hannagan(Eds.). Prentice Hall, London.

Wilkie, D.S.and Finn, J. T.(1996). *Remote Sensing Imagery for National Resources Monitoring*. Columbia University press, New York P. 295

Yeates, M and Garner, B.(1976). *The North American City,* Harper and Pub. New York.

Zubair, A. O. (2006). *Change detection in Land use Land cover using Remote Sensing Data and GIS*(A case study of Ilorin and its environs in Kwara State). Unpublished MSc thesis, University of Ibadan.

Appendix A



Plate 4.3 Ashaka Quarry Reclaimed Site: Mining mounds with treeless surface



Plate 4.4: Ashaka Quarry: Exposed limestone prior to blasting

Appendix B



4.5: Ashaka Quarry: Overburden, Exposed Limestone and Mining Pond