ASSESSING THE IMPACT OF URBANIZATION ON VEGETATION IN MINNA PERI-URBAN AREA, NIGERIA

BY

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DECLARATION

I declare that this thesis "Assessing The Impact of Urbanization on Vegetation in Minna Peri- Urban Area" is my research work and has not been submitted at any institution before for whatever reason. All information derived from published and unpublished works have been duly acknowledged.

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CERTIFICATION

This thesis titled: Assessing The Impact of Urbanization on Vegetation in Minna in Pre-Urban Area by: Musa Cletus (M.Tech/SSSE/2007/1632) meet the regulations governing the award of the degree of M.Tech of the Federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

I dedicate this work to almighty God for infinite mercy upon my life and for giving me the wisdom and knowledge to conduct this research.

My beloved wife Mrs Kachollom C. Musa, you are my dream

To my dear family, you are my world

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ABSTRACT

In the world today there is hardly any vegetation that has not been affected by human activities. Activities of man such as farming, logging, grazing, hunting, urbanization and other development activities induced by the rapidly increasing population have together reduced natural vegetation cover to patches on the surface of the earth. The loss of natural vegetation has great implications such as destruction of wildlife habitat, depreciation or outright wiping off of genetic pool, loss of food and medicinal herbs and promotion of desertification and drought among others, building up of green house gasses. The aim of the study is to examine the impact of urbanization process of Minna on vegetation. For this study two moderate resolution Landsat imageries were acquired from Global Land Cover Facility (GLCF) website, this includes. Landsat Thematic Mapper (TM) Imagery of 1990, Landsat Enhance Thematic Mapper (ETM) Imagery 2006. To interpret and verify the accuracy of the satellite imagery, ground truth observations were conducted on the land use/land cover of the study area. Using IDRISI Andes soft ware, various image processing techniques and analyses were undertaken to produce land use/land cover maps of the study area. The aerial extent of coverage of each land use/land cover class was calculated in square kilometre and expressed in percentage. Results obtained from the use of satellite imagery showed that in the period (between 1990 and 2006) the impact of urbanization resulted in substantial changes in the landuse/ land cover, with losses in vegetation and water bodies by 48.47% and 1.53%, respectively. Gain occurred in bare land by 28.36, built-up by 21.64%. It is therefore, recommended that Construction or development should be done taking into account the preservation and conservation of vegetation in the study area. It is also recommended that professionals such as land use planners, geographers and other environmental scientists should be involved in decision making process, so that coherent and sound decision could be made to help reduce/mitigate environmental problems on land use/ land cover.

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CHAPTER ONE

1.0 INTRODUCTION

1.1: Background of Study

Rapid urbanization exerts strong impact on the vegetation. Urban water problems are similar to the rural poor that lack access to clean water, sanitation and adequate housing. Urban situation is compounded by overcrowding, exposure to domestic waste and pollution.

The need to meet the increasing demand and aspiration of a rapidly growing population in terms of food production, improved human settlement and associated element to enhance living conditions, led to some notable negative impacts on the vegetation in particular and the environment in general, such as lost of natural grasses, trees, forest which consequence resulted into flooding, increased runoff, degradation and loss of wildlife habitat.

For instance, World Report of 1990 noted that the current devegetation trend due to urbanization put the lives of 50 million Nigerian's into jeopardy and this trend must be checked so as to ensure sustainable development. The rapid urbanization in developing countries in general and Nigeria in particular has been of immense interest in the past. This is however now being replaced by a concept, which sees it as a process of social change and development. One of the purely natural phenomena that actually reduces the amount of green house gases in the atmosphere is vegetation. Through the process of photosynthesis, plants draw down more carbon dioxide than anything else.

Over the next century, urbanization is predicted to rise at a very high rate. The rate of urbanization in Nigeria is 5.5% while the annual population growth is 3.0%. Current estimates of urbanization rate for the world are 2.5%. For the developed nations, the rate of urbanization is 0.8% while that of the developing nations is 3.4%. The figure for Africa is a whopping 4.4%. As the most populous nation in Africa, the situation of Nigeria is more critical. The expectation is that by year 2010 more than half of the nation's population would be living in urban centers. In fact, it is estimated that worldwide the migration towards the cities has been moving at three times the rate of population growth. Only a third of the planet's population lived in urban areas 10 years ago. Now it is up to 50 percent and researchers believe that in 10 more years, it will be up to two third. When you consider that the human population will grow from six billion to 10 billion over the next 50years, an enormous amount of land is likely to be urbanized in a relatively short time.

Urbanization has significant impact on vegetation and the ecosystem in general, this is because as people develop cities, forests are cut, shrubs are removed and much of the ground is paved. The only vegetation left standing afterward is typically the standard urban fare of grass, loosely scattered trees, and hedgerows. Consequently, once an area has been urbanized, it is very difficult to bring the land back to its natural state, the soil which tends to be some of the one productive in a given urban area, is often severely degraded by urbanization.

Fazal, (2000) asserted that human's interaction with their environment has been seen as a major force shaping the biosphere, mostly its landscape. Human activities are the source of most contemporary changes in the vegetation cover and flow of the biosphere. In the same vain Nicolson, (1987) observed that the rapid land use changes by the growing population reduce natural vegetation cover in most countries of the world and the process of urbanization expresses itself through a distinct set of land use and human behaviors, It brings about phenomenal socio-economic transformation in the surrounding areas. Nanda, (2005) also identified that the propagation of urban influence has marked differential radial tendency measurable in terms of demographic component and land use assemblages and has also led to serious environmental and ecological problems. Kalnay, *et al* (2003) asserted that urban expansion can alter the local climate both in urban and surroundings areas.

In Nigeria the growth and complexity of human settlements and in particular the process of urbanization have been phenomenal. In 1950, the percentage of the total Nigerian population living in urban centers was less than 15 per cent; by 1975, this proportion had risen to some 23.4 per cent. By year 2000, the proportion had gone up to more than 43.5 per cent and it has been projected to be more than 50 per cent by the year 2010 (thematic committee, 2001). While the urban centers are growing in population and extent, the peri-urban areas are undergoing a two-fold transformation: with arable land coming under increasingly intense cultivation and both arable and non arable land being increasingly built over to provide space for commercial, industrial and residential establishments (Heimlich, *et al* (2001).

There is hardly any vegetation that has not been affected by human activities in the world. Farming, logging, grazing, hunting, urbanization and other development activities by the rapidly expanding population have together reduced natural vegetation cover to patches on the surface of the earth. Adesina, *et al,* (1999) revealed that in Nigeria, 400,000 hectares of vegetation cover is lost annually and most of these hectares of vegetation are deliberately removed to make way for development of infrastructure such as roads, railway, industries, commercial centers and expansion of settlements. Adesina, (2005) also asserted that the lost of natural vegetation from urbanization result in flooding, destruction of wildlife habitat, depreciation or outright wiping off of genetic pool, loss of food and medicinal herbs, promotion of desertification and drought among others, and building of green house gasses.

Urban areas are dynamic and complex in nature making conventional methods of data collection very tedious and tasking. Remote sensing and Geographic Information System (GIS) has been an effective and efficient tools for urban studies

1.2: **Statement of Research Problem**

The uncontrolled growth of Minna metropolis in the last twenty years culminated into massive removal of vegetation for developmental purposes. This has led to widespread environmental problems, such as increase in urban heat, pollution, soil erosion, flooding among others. Urbanized area also tend to have increased frequencies and intensity of flooding due to increase in impermeable surfaces, decrease in vegetative cover, and more sewers and storm drain accelerating runoff. Most of the unique vegetation cover in the (study) area has vanished and high quality agricultural lands are acquired for development which leads to.

- Destruction of wildlife habitat
- Depreciation or outright wiping off of genetic pool.
- Loss of food and medicine herbs.

- Building up of green house gases.
- Promotion of desertification and drought among others.
- Fertile agricultural land areas are displaced as a result of urbanization.

Such affected areas are the suburb of Minna like Sauka Kahuta, Barkin Sale, Kpakungu, Bida Road, Bosso, Eastern bypass, Kampani village, western bye-pass, Maitumbi, Shango, Chanchaga, and Tudun Fulani.

1.3: Aim and Objectives

The aim of the study was to assess the impact of urbanization process of Minna peri-urban area on vegetation. This aim would be achieved through the following objectives.

i. Determine the extent of land use / land cover of Minna peri- urban area between 1990 and 2006 using two different satellite imagery

ii. Assess the magnitude and percentage change of land use land cover in Minna peri urban area between 1990 and 2006

iii. Examine the rate of urban expansion within the study period.

iv. Determine the magnitude of change in vegetation loss in Minna peri-urban area between 1990 and 2006.

v. Establish the relationship between urban expansion and vegetation change within study period: and

vi. Examine the rate of vegetation loss within the period study:

vii. Examine factors responsible for the observed changes in land use land cover.

1.4: **Justification**

Urban vegetation is one of the important infrastructural components of any urban ecosystem. The existence of well-distributed and abundant vegetation cover in cities can provide many benefits for city dwellers. The most obvious benefit to the public is aesthetic. Trees, shrubs, and lawns add natural colour, shape, and texture to the rectilinear concrete and asphalt surfaces in cities and conceal unpleasant spots from view (Miller, 1997). Urban vegetation can also generate direct economic benefits by producing timber, fruits, fuel wood, cut flowers, and many other goods (Kuchelmeister and Braatz 1993).

However, urban vegetation also supplies other more indirect benefits by providing environmental services that enhance quality of life in cities. Urban vegetation can also filter air pollutants, sequester CO_2, shade and shelter homes from sun and wind, intercept urban runoff, and provide habitat for wildlife. Despite all this benefit, it is imperative to ascertain that urbanization has a significant impact on vegetation. Urbanization bring about cutting down of trees, forest, grasses leading to run-off, flooding, degradation, increase in urban heat which also has adverse effect on human and development. This calls for the study of a specified area to provide checks and balances in order to strike sustainability between man's environment and other components of the earth.

1.5: Scope and Limitation of the Study

The study covers the degree at which urbanization process alter the natural vegetation of Minna peri-urban area using landSat TM Imagery 1990 and landSat ETM 2006 imagery to ascertain the extent of damage done on vegetation within the study period. This allows for different classes of land use\land cover to be included in the analysis. The scope will also be limited in assessing the trend of vegetation damage from urbanization and the link between the urban expansion and vegetation change.

A major constraint in this study was the utilization of low resolution satellite imageries due to non-availability of higher (finer) resolution imageries which provide for more qualitative analysis, the moderate resolution landSat imageries still provide qualitative interpretation and analysis of data for the research work within the period of study.

1.6: **The Study Area**

Minna lies on latitude $9^0 36'22''$ N and longitude $6^0 33'15''$ east on a geographical base of undifferentiated basement complex of many gneiss and magnetic. The town enjoys a climate typical of the Middle Belt zone. The mean annual rainfall is 1334mm (52inches) with September recording the highest rain of 300mm (11.1 inches) the mean monthly temperature is highest in march at 30.5C(85F) and lowest in august at 22.30C (72F). Source :Minna master plan 1979.

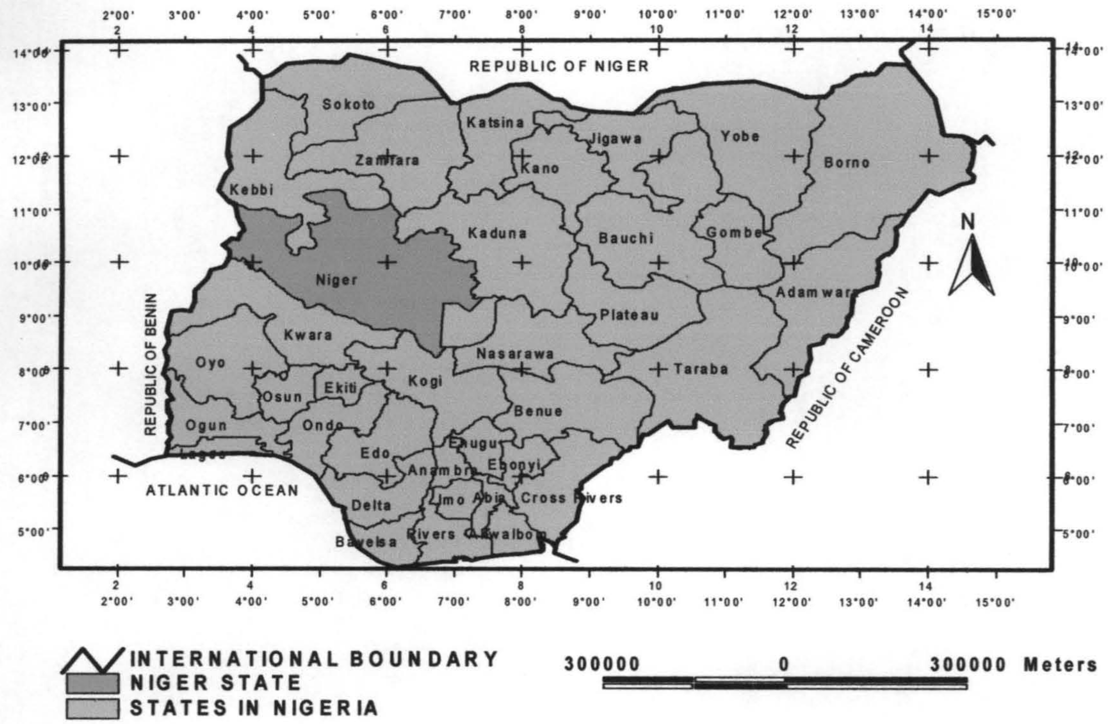

Fig 1.1: Location of Niger State, Nigeria

Source: Niger State ministry of land survey and town planning

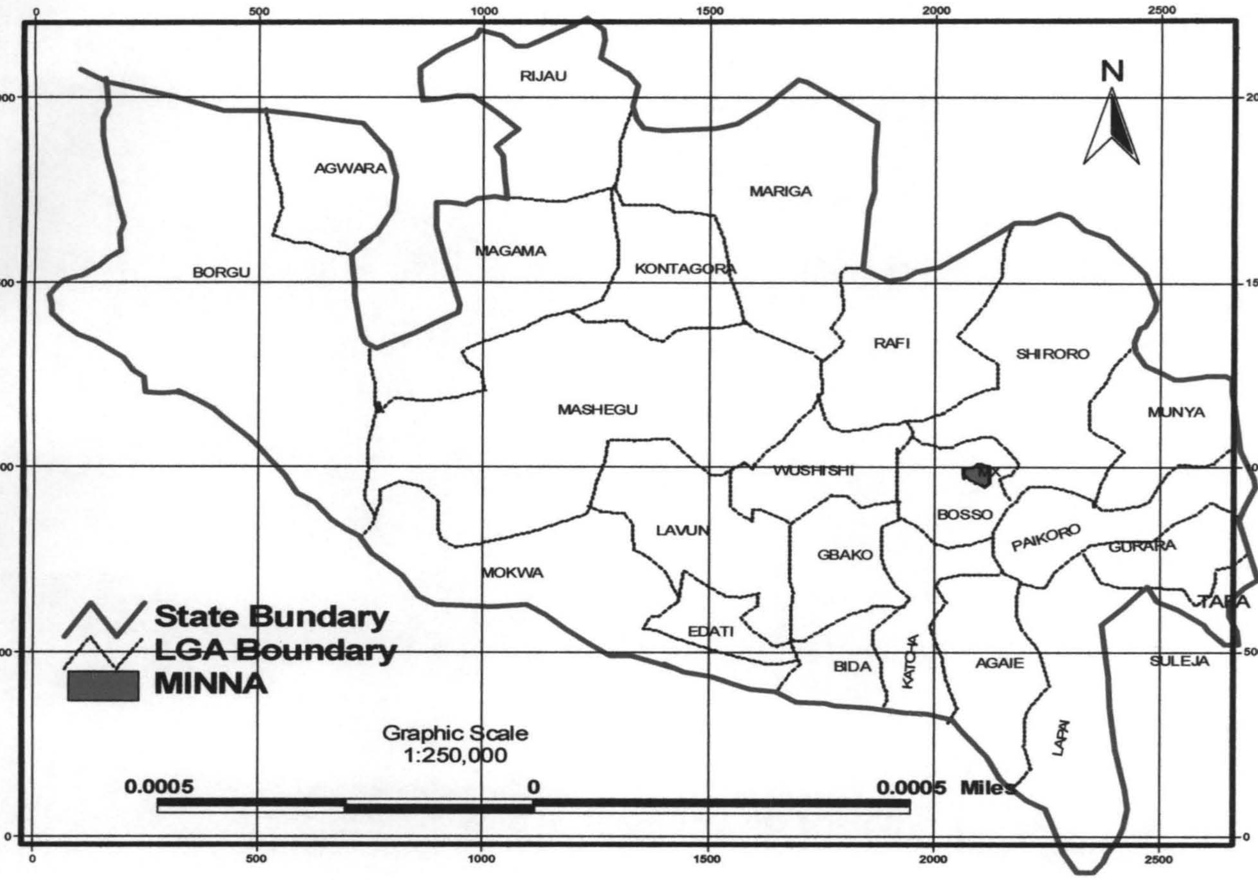

Fig 1.2: Location of Study Area in Red. Niger State

Source: Niger State ministry of land survey and town planning

1.7: **Climate**

Like the rest of West African region, the climate of Minna is influenced largely by two dominant air masses affecting the sub-region. They are the dry and dusty tropical continental air masses and the warm moist tropical air masses. There is dynamism in the climatic condition, which determines the nature of rainfall regimes, the temperature and the wind.

1.8: **Rainfall**

The rainy season is usually from the month of April to October. In some years however, the first two weeks of the month of November also witness some rainfall. Although the beginning of rainfall is recorded in the month of April, the rain becomes steady between the month of June and July and the highest rainfall is recorded between the month of August and September. Excess rainfall could cause lot of damage like flooding if devegetation is not properly checked.

1.9: **Temperature**

In Minna the highest temperature is between the month of March, April and May before the onset of the rainy season. During this period the atmospheric temperature rises to $38^{o}C$. The lowest temperature is recorded from the end of December to the period of February. The rise in atmospheric temperature during the period can be linked to highest amounts of sunshine experienced. Temperature will be at the increase and also the amount of carbon dioxide in the atmosphere.

1.10: **Wind**

There is the occurrence of heavy destructive wind that accompanies the early rainstorm, usually in the month of April and May. Similar winds come again towards the end of October signaling the end of the rainy season.

During the month of January and February, strong harmattan winds are also experienced which terminate with beginning of high temperature. The wind could cause a lot of damage like destruction of properties, loss of lives due to absence of vegetation cover to reduce the wind speed. Also during the harmattan period due to absence of vegetation to keep the soil moisture this will lead to hazy dust that may cause health hazard to the people.

1.11: **Drainage and Topography**

Before the devastating floods of September 1986 in Minna there was poor drainage system. Most of the existing drainage networks prior to the floods of 1986 were either inadequate or nonfunctional. The construction of large multimillion naira modern drainage systems across Minna has reduced flooding to the barest minimum. Minna is on a geological base of undifferentiated basement complex of mainly gneiss and magnetic. To the north-east of the town a more or less continuous steep outcrop of granite occurs. This outcrop formed the principal physical development constraint on the east side of the town. A major drainage valley flow the center of the south-west wards with many minor drainage channels feeding into it with storm water run-off from the hills to the east. To the south, the land offers reasonable development possibilities, but is curtailed by the Chanchaga River. On the eastside, there is a series of hills, one of the which was build on as the old GRA making use of the excellent breeze that wall over the escarpment, and also has the town water storage built on it.

1.12: **Vegetation**

The natural vegetation of Minna belongs to the Guinea savanna vegetation.

Tall grasses with scattered trees characterize this. The vegetation is transition between forest in the south and grassland in the north. Several years of repeated cultivation and the impact of urbanization have rendered the land almost bare. Instead of tall fresh grasses we now have short grasses with almost all the trees cut down as a result of urbanization and fuel wood demand. Vegetation in the study area has been greatly affected.

1.13: **Soil**

The surface soil in Minna is generally loamy sand. The soil is well drained and has high water infiltration rate. Soils in Minna are derived from basement complex rocks. They range from shallow to very deep soil overlaying weathered gneisses and magnetite. Some are underlain by iron pan at varying depths. They are strong brown to red sandy clay or clay with often loamy sand surface layers.

1.14: **Land Use**

The land in Minna is essentially used for developmental and agricultural purpose. Within Minna township crops like maize, melon, groundnuts are produced. Vegetable gardens are also maintained near some households. The largest percentage of the land is used to build residential houses to accommodate the rising population. A reasonable percentage of land area is also used to build township roads for ease of movement, commercial land use, public and semi public, institutions and light industries. These are processes of urbanization, which are on the increase due to population pressure, and are exerting more pressure on the natural vegetation due to expansion in the study area.

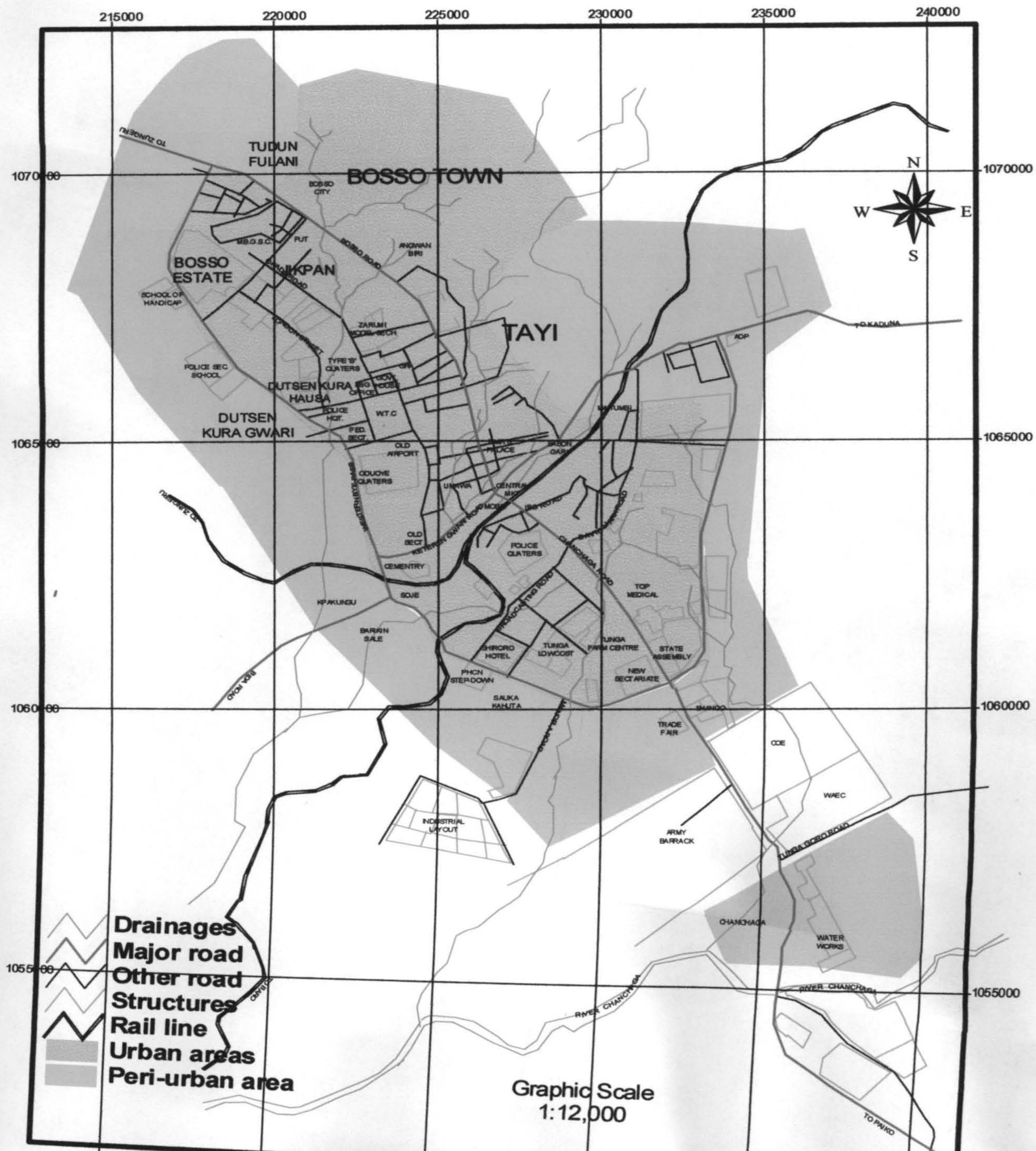

Fig. 1.3: Digitize Landuse Map of Minna.

Source; Author (2010)

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter reviews available literature on the rationale of assessing the impa urbanization on vegetation, and also attempted reviews on remote sei applications in land use/land cover studies. The chapter also reviews studies th necessitated by the fact that vegetation is an essential natural resource v changes in quality.

2.2: Review of Studies on the Impact of Urbanization on Vegetation

Urbanization has been a major factor which has altered natural vegetation c due to anthropogenic activities; the result for these has left significant effe local climate and weather. The use of remote sensing data in recent time has be immense help in monitoring the changing pattern of vegetation. Urban vegetati one of the important infrastructural components of any urban ecosystem and existence of well-distributed and abundant vegetation cover in cities can provide many benefits for city dwellers. The most obvious benefit to the public is aesthetic. Trees, shrubs, and lawns add natural colour, shape, and texture to the rectilinear concrete and asphalt surfaces in cities and conceal unpleasant spots from view (Miller, 1997).

Urbanization is also one of the most common characteristics of land cover change found in many towns and cities around the world. Although it is seen as one of the measures of economic development, urbanization comes at a cost. Growth of many urban environments consumes much of the vegetation land lying in the peri-urban localities (Lambin *et al.* 2003). An assessment of initial vegetation/forest types that existed before the major towns and cities around the world are not easily discernible mainly due to lack of appropriate archival data.

The process of urbanization expresses itself through a distinct set of land use and human behaviors which brings about phenomenal socio-economic transformation in the surrounding areas. Urban growth both in population and in aerial extent, transforms the landscape from natural cover type to increasingly impervious urban land. The result of this change can have significant effort on local climate (Landsberg, 1981).

Kombe *et al.* (2000) reveals that urban centers over a half century ago have continued to witness unprecedented growth; this growth is premised on the perceived improvement in living conditions and the environment. Triggering the high level migration usually one way from the rural areas to the urban areas, this phenomenon comes with high level population increase in the urban areas as well as consistent decline in economic opportunities in rural areas (Gardner, 2001; UN-Habitat, 2004).

Heilig, (1997) noted that migration has two potential contrasting impacts on vegetation, on the one hand, the enormous exodus of people from rural areas allows re-growth of vegetation and reduces deforestation; on the other hand, huge rural-to-urban migration provided an almost unlimited labour force for construction and the expansion of manufacturing industry, causing rapid urban sprawl and loss of vegetation

Urbanization i s now considered a major driving force of biodiversity loss and biological homogenization not only in developed countries, but increasingly in less developed countries. Furthermore, urbanization appears to be having different effects on the biota of developed and developing countries (Lambin *et al*, 2001). In developed countries, urbanization is primarily fragmenting large areas, extending its influence over the entire landscape. In contrast, in developing countries, growth is still concentrated around urban cores, replacing adjacent land uses such as agricultural and more natural vegetation but at a slower rate than developed countries (McGranahan *et al*, 2003).

South America has not escaped the urbanization trend and is following current models of urban development where urban areas are expanding and replacing rural and natural vegetation (Primentel *et al*, 1998). Whilst the level of development in South America is far less pronounced than in the United States or Europe, urban sprawl is still a major cause of impacts in peri-urban ecosystems. This process has major implications due to the high population densities of the cities of South America.). Studies of land cover changes from 1972 to 2000 in the southeastern United States show a significant increase in the amount of urban land and a corresponding reduction in the amount of vegetation cover (Griffith *et al*, 2003).

Azocar *et al*, (2 003) observed that the economic development boom of some countries is bringing new pressure for cities to expand and for the development of suburban neighborhoods there by exerting pressure on vegetation cover and increased the use of the native vegetation for fuel wood and constructions, reducing the vegetation cover around the city. Koomen *et al*, (2007) sees changes in land use are amongst the most controversial consequences of human actions, as is clear from the heated debate on urban sprawl. The conversion of land may impact soil, water and atmosphere (Meyer *et al*, 2007) and is therefore directly related to environmental issues of global relevance. The large-scale deforestation and subsequent transformation of agricultural land in tropical areas are examples of land-use changes with strong impacts on biodiversity, soil degradation and the material resources to support human needs (Lambin *et al*, 2003). Land-use change is also one of the relevant factors among the determinants of climate change and the relationship between the two is interdependent; changes in land use may impact on the climate whilst climatic change will also influence opportunities for future land-use (Watson *et al*, 2000).

According to Bartone *et al*. (1994) human habitat is rapidly urbanizing and by 2030, the urban population globally will be twice as large as the rural population (World Bank n.d.). Especially in developing countries, this rapid urbanization is exacerbating serious problems such as availability of food, fuel, water, employment, and shelter. The enormous toll in terms of losses to human health and quality of life, natural resources, and economic productivity, makes a compelling case for action.

Too many cities are still designed strictly from an engineering perspective. Urban vegetation is often considered less important than the built structures, roads, and utility layers; yet, vegetation must be included in the planning process if healthy urban ecosystems are to be achieved (Kuchelmeiter 1997).

Urban vegetation improves the quality of urban life in many ways. Tangible benefits include fuel wood, food, fodder, and building materials. Environmental and social benefits relate to public health, recreation, and well-being of the urban population. These benefits include reduction of air and noise pollution, climate improvement, and landscape enhancement. Green areas can also provide habitats for wildlife, erosion control, and protection of watersheds for urban water supply and productive uses or safe disposal of urban wastes (Anderson *et al*, 1984).

2.3 **Remote Sensing Application in Land Use / Land Cover Change**

Lintz and Simonett (1976) defined remote sensing as "the acquisition of physical data of an object without touch or contact". Howard (1982) defines remote sensing as "the acquisition of data and derivative information about objects or materials (targets) located on the earth's surface or in its atmosphere by using sensors mounted on platforms located at a distance from the targets and electromagnetic radiation." Whichever definition one chooses to apply for understanding remote sensing, the essential point to note for the purpose of this study is that remote sensing is considered an investigative tool for earth resources impact assessment. It is a technology that has afforded making much diverse application. Its usage has gone through a number of phases, which include invention and utility of aerial photography.

Ojaleye (1996) while commenting on the importance for using visual interpretation of remote sensing data observed that there has been a tendency for "overselling" the use of computer technology in the third world countries like Nigeria. She recommended a gradual progressive approach from the traditional method of visual data interpretation techniques to advanced sophisticated systems involving the use of computers. In her opinion, visual interpretation of satellite imagery technique is a realistic alternative to numerical analysis of data especially when it comes to the question of assessing natural resources for development and when costs are the deciding factors

Ishaya *et al* (2008) used remotely sensed satellites imageries (data) supported with serious ground truth exercise was done for checking land use land cover changes. Apart from the fact the remote sensing is an effective and efficient tool for urban studies; it is consider being highly, economical easy to acquired and flexible to use in rapid updating of maps than aerial photographs. LandSat imagery were acquired and used for the study. The analysis reveals that Kaduna town has been transforming due to population increase thereby causing vegetation land cover changes, including the expansion of it's built up area. The study concluded that, of the 3272.3 ha of vegetation land cover lost between the study periods, 864.95 ha area recoverable (Land where no permanent construction has taken place in the transformation to bare land) and 2407.35 ha are not recoverable. It is evident that about 297.5 ha of vegetation cover is lost annually to various processes of urban transformation and Kaduna town is expanding at the rate of 167.8 ha annually since 1990. This implies that within the study area, the vegetation covers will be completely lost in few years from now. The implication of this rapid loss in vegetation covers and expansion of built-up area is the thermal properties of built-up land surfaces result in more solar energy being stored and converted to sensible heat and the removal of vegetation covers reduces those natural cooling effects of shading and evapotranspiration.

2.4: **Case Study: Impact of Urbanization on Vegetation in Shanghai, China.**

China is the world's third largest country by land area, the largest in population, and by some accounts, the third largest economy. In the past two decades, China's economy has experienced radical change, with double-digit growth rates in some years. As a result, the land use/cover change is also extensive, Rapid urbanization is leading to the loss of vegetation land cover. According to China's land resources management agency, the cultivatable acreage decreased by approximately 0.9% per during the 1980s and early 1990s (Chen *et al*, 1994). Moreover, desertification results in the gradual encroachment of originally vegetated areas. Meanwhile, some large catastrophic events, such as great floods and droughts, as well as increasing environmental pollution, may well have devastated vulnerable ecosystems, bringing about irreversible alteration of the vegetative cover. On the other hand, reforestation is to some extent potentially beginning to offset the negative impact of deforestation. It is apparent that the dynamic of land-cover change in China is quite complicated, because it is driven by biophysical, political, economic, and even cultural factors. China is, and will be, responsible for significant environmental changes at local to global scales (He, 1991; and Wang, *et al* 2000). Therefore, it is necessary to study China's land-cover change dynamic and to find appropriate strategies to reduce the negative impacts of environmental changes. Urban area in China increased by 25 percent from 1990 to 2000 based on satellite observations (Liu et al., 2005). In the southern coastal regions, the expansion of urban areas can be as much as 30 percent per year (Ji, *et al.*, 2001). In the same vein China lost approximately 500,000 ha/year of vegetation land to urbanization in the 1990s, (Smil, 1999).

In shanghai vegetation have been greatly altered over the past three decade as a result of urbanization. The vegetation lost increased from 159.1km in 1975 to 1179.3km in 2005. There were distinct phases in urbanization process. Shanghai's green areas have continued to increase in size from 8.7 km2 in 1975 to 252.9 km2 in 2005. In contrast, agricultural land area has fallen rapidly, from 6030.7 km2 in

1975 to 4743.1 km2 in 2005 as a result of urbanization. Attwell (2000) supported that urbanization is generally associated with an increase in managed green areas, such as street trees, lawns, and parks for urban recreation; these improve both the visual appeal of a city and environmental quality. The slowest rate of urbanization was 17.7 km2 yr–1, occurred between1975 and 1981, increasing to 52.4 km2 yr–1 between 1990 and 1995, and 54.9 km2 yr–1 between 2000 and 2005. This is consistent with China's economic policies, since the country began its economic reform in 1978, and accelerated the process in 1992 (Lin 1999).

Fang *et al.* (2004) explained that urbanization has also led to serious environmental and ecological problems, both in urban and surrounding areas, including increased air and water pollution local climate alteration and a major reduction in natural vegetation cover and production

2.5: **Case Study: Impact of Urbanization on Vegetation in Tweed Catchment New South Wale, Australia.**

Lu, T. *et al* (2004) measured land use land cover data analysis obtained from LandSat time series imagery, which offer one of the most extensive and continuous terrestrial imagery archives. The results of satellite imagery interpretation were used to document the spatio-temporal changes in land cover and land use that have occurred in the Tweed catchment since 1982.The expansion of built-up areas in the eastern part of the catchment. The urbanized vector layers for 1982, 1990 and 2002 periods are plotted over a 1-metre resolution digital aerial photography as a background to illustrate the landscape in the catchment. It is clearly visible that the foreshores of the catchment and the fringe of the lake were the major targets for development. The results indicate that over the last 20 years natural and semi-natural land uses have been gradually decreasing giving way to highly modified land uses such as urban residential and urban centers commercial/industrial, and transport (marked as urban high density.

However, the study also noted that in 1982, less than 1200 hectares (0.9%) of the Tweed catchment was classified as urban while in 1999 and 2002 the urbanization reached 1900 hectares (1.4%) and 2500 hectares (2%), respectively. The total urban change affected approximately 1400 hectares. Although the proportion of urban land use is relatively small, the rate of increase in urbanized land is significant and concentrated in specific areas. The coastal fringes and the area in close proximity to Cudgen Lake experienced quite staggering development growth exceeding 13%. To assess the trend in land use change in the area, land use classes were aggregated into just 3 major groups, that is: natural, rural and urban. The analysis shows that between 1982 and 2002 the urban area experienced a strong growth resulting in an increase in built-up areas at an average rate reaching 0.7% per year. In total, over the study period, more than 850 hectares of bushland and rural land became urban. The observations of land use change for 1982, 1990 and 2002 were then projected into the future to show the development trends. The results indicated that if the current trends persist, 31 to 36% of the area might be under development by the year 2010. The projected increase in built-up areas may have a profound impact on rainfall-runoff relationships in the catchment primarily because of the likely change in the level of imperviousness and the amount of runoff generated, which in turn would have a direct impact on pollutant loads.

2.6: Case Study: Impact of Urbanization on Vegetation in Saharapur City Indian

Fazal (2000) enumerated that the loss of vegetation land to human settlement is far more serious in India, about 1.5 million hectares of vegetated land (mostly agricultural) went to urban growth between 1955 to 1985 and a further 800,000 hectares were transformed between 1985 and 2000, with rapid urbanization and the extension of urban areas, consumed with continuing population growth both agricultural and socio scientist have expressed a concern as to whether India will be able to feed its population. Notwithstanding, but in last five years, this has not been smooth because increases in yield have peaked. Over all, the situation is worrying given the great population pressure on vegetation land co ver, with an average agricultural land holding of only 1.7 hectares (and reducing rapidly), most which is still rain fed.

2.7: **Case Study: Impact of Urbanization on Vegetation in Florida**

Kautz *et al,* (2003) identified that Florida occupies about 9.86 million ha of natural and semi-natural land cover types between 1985 and 1989. 1.32 million ha (13.3%) were converted to urban, developed, or agricultural land uses between 1985–89 and 2003. Conversions of natural and semi-natural cover types to urban and developed lands accounted for 0.61 million ha (6.2% of natural cover types presenting 1985–89), and conversions to agricultural uses accounted for 0.70 million ha (7.1% of natural cover types between 1985and 1989). Shrub and brush was them lost heavily impacted semi-natural type, having lost around 0.60 million ha (36.3% of that between1985 and 1989) to intensive human uses. However, Pinelands, a land cover type that includes large tracts in silvicultural use, experienced the greatest impact in terms of total area of conversion with 0.24 Million ha (9.2% of the area between 1985 and 1989) having been lost, most (64%) of which was to urban and developed uses. Dry prairie experienced the greatest degree of loss with respect to percent of conversion, with 0.14 million ha (25.4% of the area between 198 and 1989) having been converted, 73% of which was lost to agriculture. Kautz,(1998) asserted that Sand hill, a formerly abundant but rapidly diminishing Natural xeric community also experienced a relatively high degree of loss with 53,356 ha (15.5% of that between1985 and 1989) converted to other uses between 1985 and 1989 and 2003, and 72% of the conversion was to urban or other developed uses. Scrub, a natural community type often associated with a high degree of endemism and rare species (Myers,1990) likewise experienced a relatively high degree of loss, with 21,208 ha (12.4% of the area presenting 1985–89) having been converted,79% of which was lost to urban or other enveloped uses.

Agricultural and pasture lands also experienced conversions to urban or other developed uses over the study period. There were 2.54 million ha of agricultural and pasture lands in Florida during the 1985–1989 period. By 2003, 0.36 million ha (14% of that presenting 1985–1989) of agricultural and pasture Lands had been converted to urban and developed uses.

However, Kautz *et al,* (2003) explained that a review of land use change maps produced during this project yields the following impressions of the geographic locations of the vari ous types of land u se conversions between1985–1989 and 2003.Conversions of natural and semi- natural lands to urban and developed uses most often occurred proximal to lands that were in urban or other developed uses in 1985–1989. Areas of Particular note include the Florida west coast from Citrus County south through Collier County; the Florida east coast from Duval County south through Brevard County; the vicinity of Orlando in Orange, Seminole, and Southwest Volusia counties; the vicinity of Jackson villain northeast Florida; the corridor from Tallahassee to the Gulf coast in the Big Bend region; and the vicinity of Panama City in the panhandle.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1: Introduction

This chapter is committed to research methodology, and is also devoted to explaining the techniques used in processing and analysing satellite image data and the procedures adopted.

3.2: Methods of Data Collection and source.

One basic research method used to carry out this study: qualitative.

Qualitative method: this involves processing of landSat imagery of the study area (Minna), two moderate resolution Landsat imageries were acquired for the study from Global Land Cover Facility (GLCF) website, this includes.

a) Landsat Thematic Mapper (TM) Imagery acquired in 1990 and

b) LandSat Enhance Thematic Mapper (ETM+) Imagery acquired in 2006.

c) Minna Street Guide Map 1996 was acquired from the Ministry of Land Survey and Town Planning Minna.

The time span of this study covers 16 years (1990-2006).

3.3: METHODS OF DATA ANALYSIS.

In assessing the extent to which the urbanization has effect on vegetation in the study area, multi-temporal data of the study area obtained were used for analysis. The data include landSat TM acquired in 27/11/1990 while landSat ETM+ acquired in 07/11/2006. The reason for the multi-temporal images is to enable change detection in the study area over the given periods.

Achieving the objectives of the study the following methods were used.

i. To determine the extent of land use / land cover in Minna peri- urban, classified land use / land cover in hectare, kilometre square and percentage coverage for landSat TM 1990 and landSat 2006 were produce to determine the extent of land use land cover. See Fig. 4.1 and 4.2, Table 4.2 and 4.3

ii. To assess the magnitude and percentage change of land use land cover in the study area between 1990 and 2006, the magnitude and percentage coverage were calculated from classified land use / land cover to determine the changes. See Table 4.4

iii. To examine the rate of urban expansion, the arithmetic mean per year for rate of urban expansion was derived from the calculated rate of urban expansion between the extent of built-up area 1990 and 2006. See Table 4.5

iv. To determine the magnitude in vegetation loss, magnitude and percentage coverage were calculated and determined in terms of loss and gain. See Table 4.6

v. To establish the links between urban expansion and vegetation change, the arithmetic means by percentage 6.25 derived in Table 4.5 and Table 4.7, rate of urban expansion and rate of vegetation loss respectively was used to determine the links. The percentage link 6.25 was derived by calculating the

Arithmetic mean per year (ha.) x 100
....
Total vegetation loss (1990-2006)

and the

Arithmetic mean per year (ha.) x 100
....
Total built-up area (1990-2006)

See Table 4.5 and 4.7

vi. To examine the rate of vegetation loss between the study period, the arithmetic mean per year was derived from the calculated rate of urban expansion between the extent of built-up area 1990 and 2006 to determine rate of vegetation loss, see Table 4.7

3.4: **Geo-Reference**

The precise coverage of the study area; Minna is not known, this was however based on the adopted coverage area within Minna street guide map referenced. The map(fig3.2 below) was however scanned and geo-referenced using five (5) ground control points(GCP) obtained from GPS reading of notable points in town(see table3. 1below).The boundary Coordinates(see Fig. 3.3 below) were then picked from the geo-referenced map and used to window the satellite imageries for this analysis.

s/n	**Location**	**Scanned Map**		**GPS Readings**	
		Default x	**Default y**	**New x**	**New y**
1	Tunga city gate Roundabout	902.210	478.029	232974.811	1060232.124
2	Maitumbi	1038.880	950.329	234346.089	1066206.284
3	Kpakungu	602.525	684.412	229178.538	106268.550
4	Tudun Fulani	475.362	1351.188	227099.970	1069908.012
5	Chanchaga	1275.252	225.234	234302.787	1054933.629

Table 3.1 showing Old and New GPS Reading

3.5: **Image Enhancement**

Regardless of the extent of digital intervention, analysis invariably plays a very strong role in all aspects of remote sensing. The time series images of the study area were enhanced using linear stretch with saturation so as to improve on the visual quality of the image features for good interpretation of different features. A number of methods can be applied to perform image enhancement. The most suitable methods must be selected to achieve the best colour of images for visual interpretation. In this study, the following spatial enhancements have been applied: False colour compositing (FCC), Principle component analysis (PCA) and normalize difference vegetation index (NDVI)

3.6: **Area Calculation of the Land use/Land cover**

Using the raster database generated, the area coverage of each land use/land cover class for the periods (1990 and 2006) was computed and expressed in square kilometers. From the raster maps of each year, the attribute table showing the number of pixels for each Land use/land cover class and the area for each class in square metre was produced. Using the column operation function, the area coverage in the respective Land use/land cover classes was calculated.

3.7: **Assessment of False Colour Compositing (FCC)**

A colour composite that is usually composed of three bands is assigned to one of the basic colures: Red, Green, and Blue. A False Colour Composite (FCC) is used here in order to create a clear feature on the Landsat TM 1990 and Landsat ETM

2006 images, it is necessary to know the reflection characteristics of the basic cover types of the earth surface.

The best FCC depends on the purpose of the study. From several FCC produced for visual interpretation the best combination was 3, 4 and 5 see S (Fig.4.1 and Fig 4.2). In this band combination, four (4) different types of features are distinguished as shown in Table 3.2 below.

3.8: **Multi-temporal Principal component analysis (PCA) for derivation of change in Urbanization and Vegetation**

Principal component analysis is a statistical method used for compressing the original data set without losing too much information. PCA is collecting the information of the spectral bands used in a cloud of points in a multidimensional space and calculates a new optimum set of axis through this cloud of data points. The number of principal components is equal to the number of bands. The first PC is defined by maximum variance of the original data set; the last PC defines the leftover variance (Meijerink *et.al,* 1994). In this research several PCA are produced for visual interpretation, the best combination was 5.4.3 that showed clearly the difference between urbanization, ba re land a nd vegetated areas (Fig.3.1a, 3.1b, 3.1c)

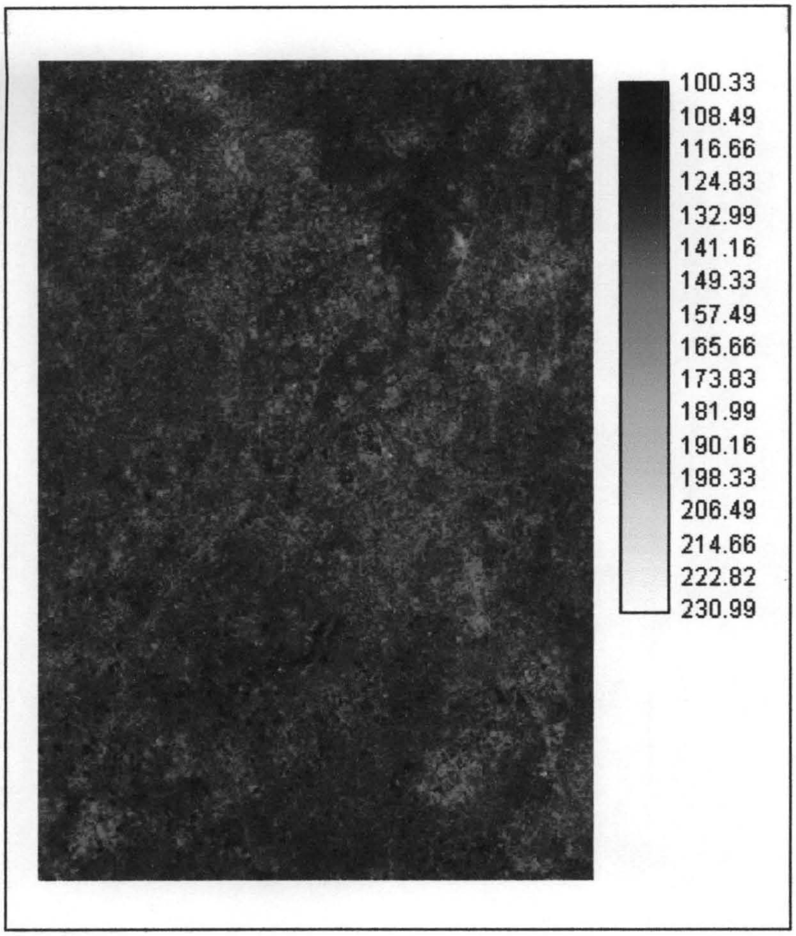

Fig. 3.1a: Principal component (5) shows clearly the reflectance of vegetation in darker tones.

Source: Author (2010)

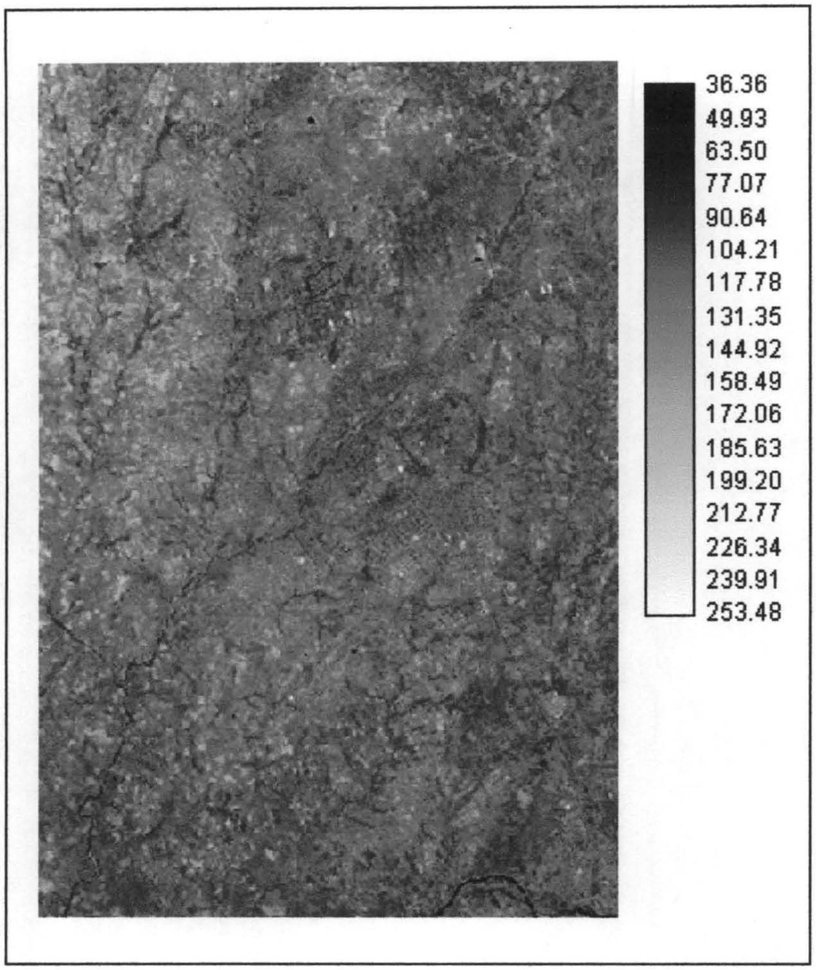

Fig. 3.1b: Principal component (4) shows clearly the reflectance of bare land in Lighter tones.

Source: Author (2010)

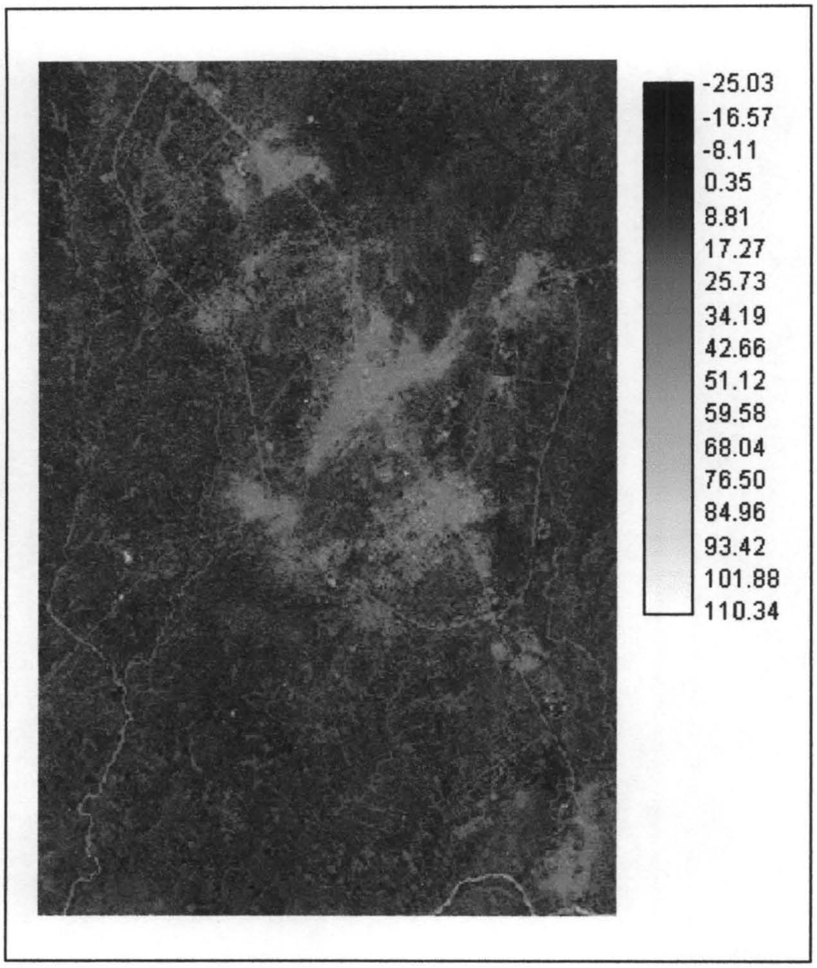

Fig. 3.1c: Principal component (3) shows clearly reflectance of Built-up Area in brighter tones.

Source: Author (2010)

Multi-temporal Principal Component Analysis (PCA) several PC are produced for the Visual interpretation, the best combination obtained are band 5, 4 and 3 (Fig. 3.1a, 3.1b and 3.1c). The figures show clearly the reflection of vegetation, bare land and built –up area.

3.9: **Method of land use Classification**

3.9.1 **Supervised Classification**

After extraction of the study area, stratified approach was applied to generate changes in vegetation from digital classification of landSat ETM data acquired in 2006, and landSat TM data acquired in 1990. The first step performed was linear contrast stretch for all the bands, and then the ETM bands with 30m pixel size were combined in order to select the most suitable band combination. The enhanced false colour composite of bands depicting the vegetation was chosen and classified by supervised mode with maximum likelihood (MXL) algorithm, using ground truth information. Data obtained during the site visits pertaining to vegetation loss substantiated the training sites during image classification by MXL classifier. This analysis offers the changing trends in vegetation patterns of the study area. The procedures adopted for supervised classification are as follows:

(a) **Training Site Selection**

This involves the creation of a vector file and the display of the image in question. The false colour image composite was displayed using the DISPLAY Module (the fourth icon) in composite palette and the DIGITIZ button activated. This Module was used to create a vector file and the file name was entered, including polygon option and identifier number for the first object. The selected features were digitized using the same number following IDRISI rule of ten for each training site except where the feature to be digitized is very small. The next feature was chosen with different identifier up to the last feature. The same features were given the same "ID" number while different features were given different "ID" number. SAVE DIGITZED data button (icon 16) was used to enter and save the polygons created as a vector map.

(b) **Signature File Development (MAKESIG)**

Training site signature was created for the classification. MAKESIG creates signatures from information contained in remotely-sensed images using training site polygons. MAKESIG first requires that the file containing the training sites be indicated as a vector or an image file. Then the name of the file entered. When vector file is chosen the module "rasterizes" the training sites to match image dimensions and stores the resulting image using the same name as the vector file. Next, the signature file names created for each of the training sites as defined in the input file was entered. Each signature name made to correspond with the IDs in the input file defining the training sites. From the dialog, the default setting was used to create a group file with the same name as the training site file. Then the group file was later edited with the Collection Editor, under the File menu.

3.9.2: **Maximum Likelihood Classification**

In this procedure, training site sets were developed. The sets are polygons which correspond with each of the finally defined urbanization/vegetation classes. A ground truthing was conducted to identify the existing land use/land cover of the study area. The training sets developed were radio metrically examined, i.e. observation of the differences in reflectance between each defined set of land use/land cover for the channels of the LANDSAT images and then transformed into final groups containing land use/land cover types.

3.9.3: **Classification Scheme**

The classification scheme is a simple scheme that shows the major land uses with so much consideration to avoidance of some ambiguities. It considered urbanization and vegetation because of the mix in the spectral response of the two in the season the image was acquired. Built-up Area, Bare land and water body are apparent in the classification, vegetation is considered to be areas with the mixture of shrubs and trees, water body.

Table 3.2: **classification scheme:**

Class	Definition
Vegetation	Extensive farmland, Intensive farmland, forest land, crop land and orchard, grass land etc
Built-up Area	Residential, commercial and services, industrial, transport, communication and utilities.
Water body	Streams and canals, lakes, reservoirs,
Bare land	Sand, sod, artificial turf, gravel, chip

3.10: **Normalized Differential Vegetation Index (NDVI)**

The Normalized Differential Vegetation Index (NDVI) is calculated from a TM-scene by taking the ratio of the difference of the near infrared and red reflection and the sum between these two bands using the following formula (Dejoing, 1994):

$$NDVI = (TM4 - TM3) / (TM4 + TM3)$$

Where:

NDVI: Normalized Differential Vegetation Index

TM4: TM spectral band 4

TM3: TM spectral band 3

On a NDVI image, vegetated areas will generally yield high values because of their relatively high near –infrared reflectance and low visible reflectance. In contrast, water, have larger visible reflectance than near-infrared reflectance.

In this study, the NDVI map has been produced see (Fig.3.2a, 3.2b) and then classified in a map with three-land use/land cover classes, i.e. vegetation land in green, Bare land in cream and built-up area in red. The NDVI band may also be combined with other bands of the multispectral image to form a colour composite image which help to discriminate different types of vegetation.

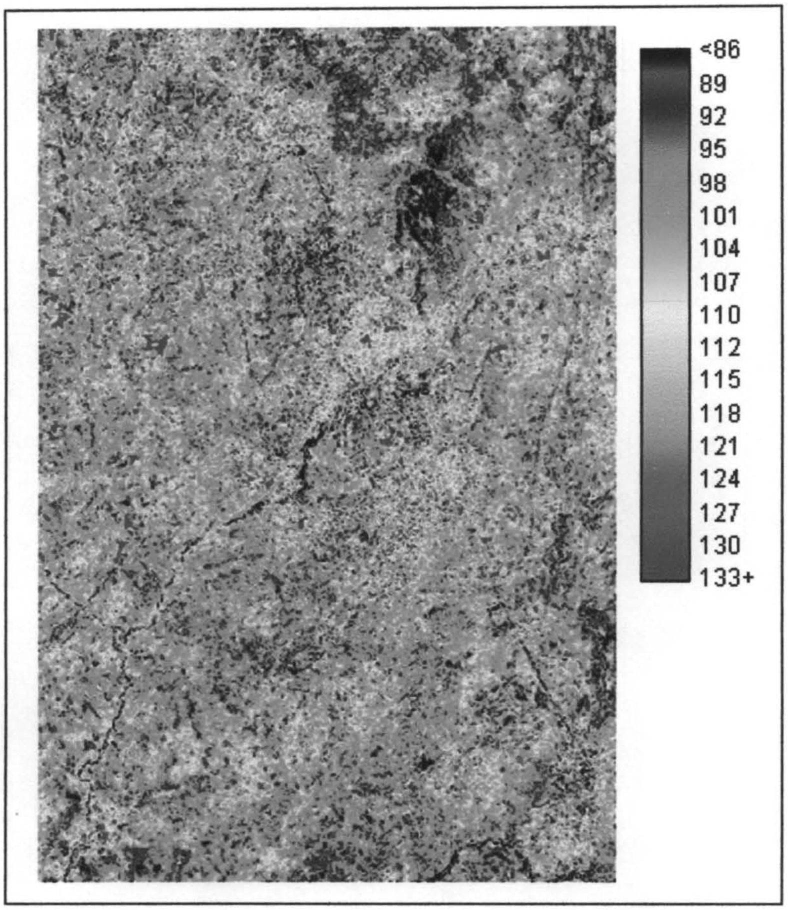

Fig. 3.2a: NDVI Map of Greenness Condition November, 1990

Source: Author (2010)

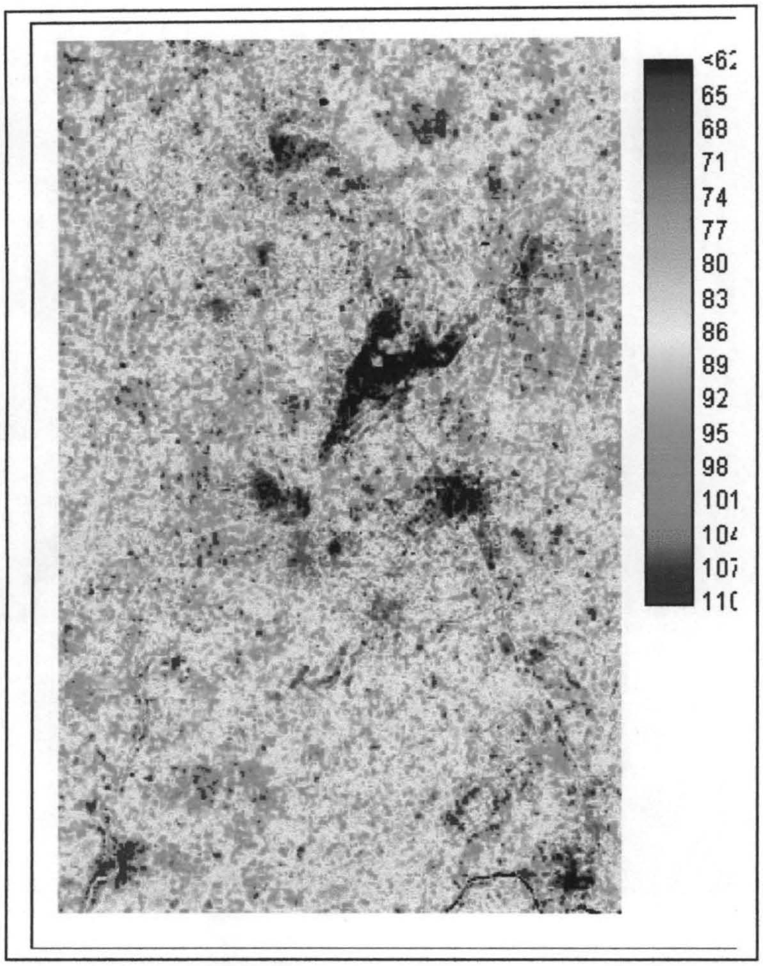

Fig. 3.2b: NDVI Map of Greenness Condition November, 2006

Source: Author (2010)

NDVI Maps of the study area for vegetation/urbanization (1990 to 2006) are produced as shown in Fig. 3.2, 3.2b. The maps show the condition of the vegetation for the period. The portions in brown show the built up areas, the yellow portions are bare lands, while the green portions show vegetation. Comparison of the NDVI maps of 1990 and 2006 reveals a drastic depletion in the vegetation in just 16 year period.

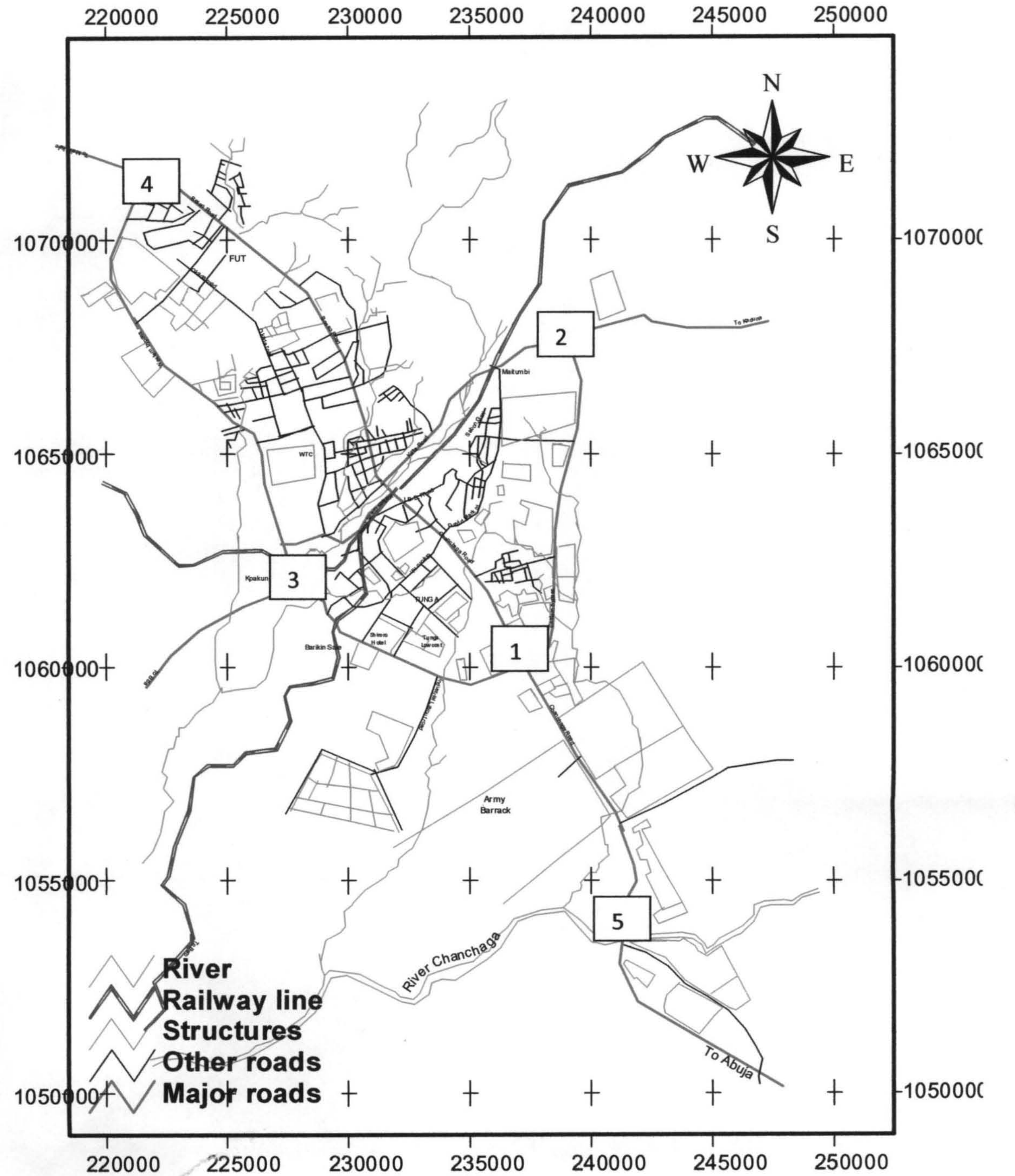

Plate 1: Street guide map of Minna

Source: Ministry of Land and Survey Minna

3.11: **Software Used**

Basically, one software is used for this project viz;

(b) Idrisi32 – This was used for the development of land use land cover classes and subsequently for change detection analysis of the study area.

(c) Microsoft word – was used basically for the presentation of the research.

3.12: **Approaches to Data Analysis**

Different approach and techniques have been used in the process of image, enhancement, classification and data analysis in this study. The approach followed is described below.

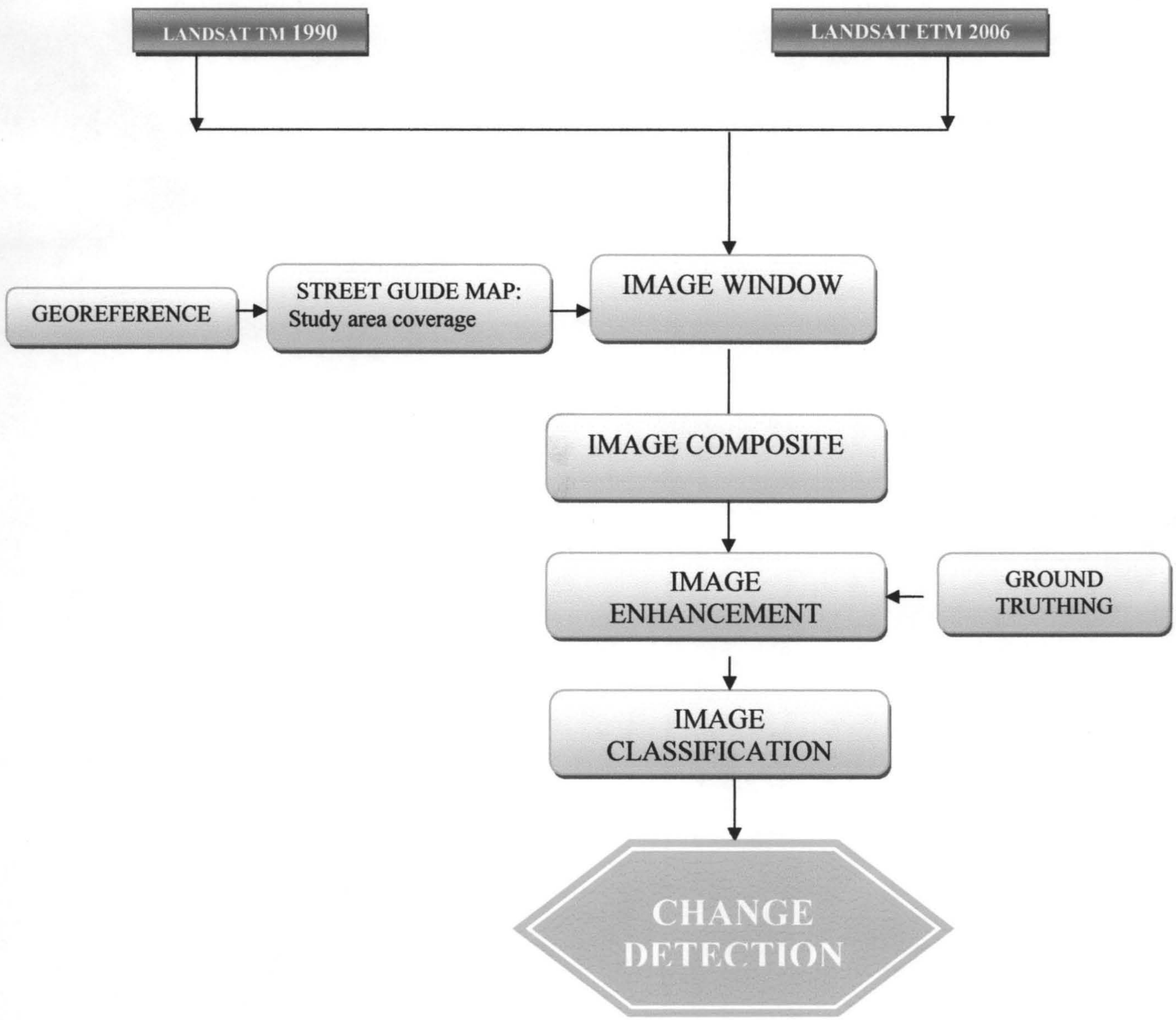

Fig. 3.4 Flow chart of Analysis

Source: Author (2010)

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

This chapter presents result arising from the procedures followed in processing and analysing the data obtained multi-temporal images, which include ETM Landsat Imagery of 2006 and TM Landsat Imagery of 1990.The results obtained are presented in tables and figures

4.1.1: Assessment of False Colour Composite (FCC)

False Colour Composite (FCC) within bands combination of 3, 4 and 5 produced the best FCC (Fig. 4.1and Fig. 4.2). The presentation shows that four different types of surface features shown in (Fig. 4.1 and 4.2) can be clearly seen and identified

Table 4.1: Colours of surface features in FCC 345

Surface feature	Colour
Vegetation	Light green
Water body	Blue
Bare land	Yellow
Built-up area	Red

4.1.2: **Classified land use / land cover Map for 1990.**

Classified land use/ land cover maps of the study area for 1990 is produced as shown in Fig. 4.1. The classified map shows the land use/land cover conditions for the period.

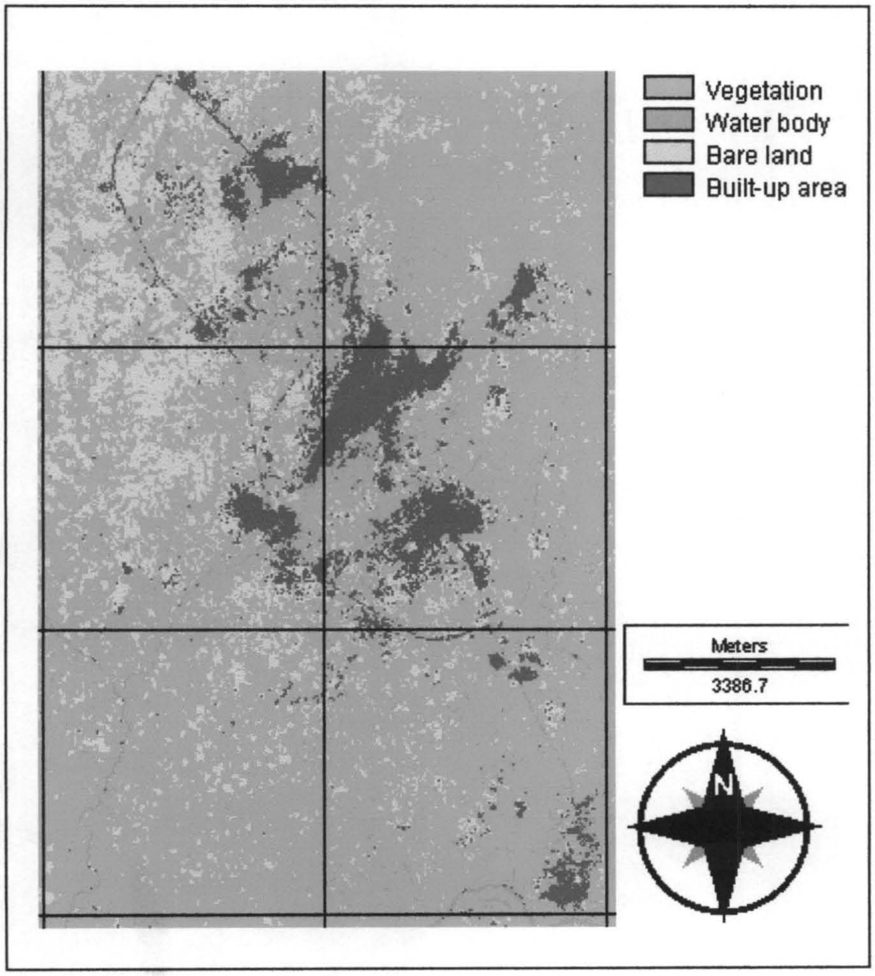

Fig 4.1: **False color composite classification of LandSat TM 1990 imagery**

Source: Author (2010)

4.1.3: **Aerial Extent and percentage coverage of each classified landuse/land cover 1990**

The aerial extent of each class of land use / land cover are expressed in hectares, kilometre square and percentage coverage for landSat TM 1990,

Table 4.2: **Aerial Extent and percentage coverage of classified landuse/land cover 1990**

Landuse Type	**Hectares (Ha)**	**Kilometer square (Km^2)**	**Percentage (%)**
Vegetation	11,061	110.61	71.51
Water body	526	5.26	3.40
Bare land	2,723	27.23	17.60
Build-up area	1,158	11.58	7.49
Total	15,468	154.68	100

Source: Author (2010)

4.1.4: **Classified land use / land cover Map for 2006.**

Classified land use/ land cover maps of the study area for 2006 is produced as shown in Fig. 4.2 below. The classified map shows the land use/land cover conditions for the period.

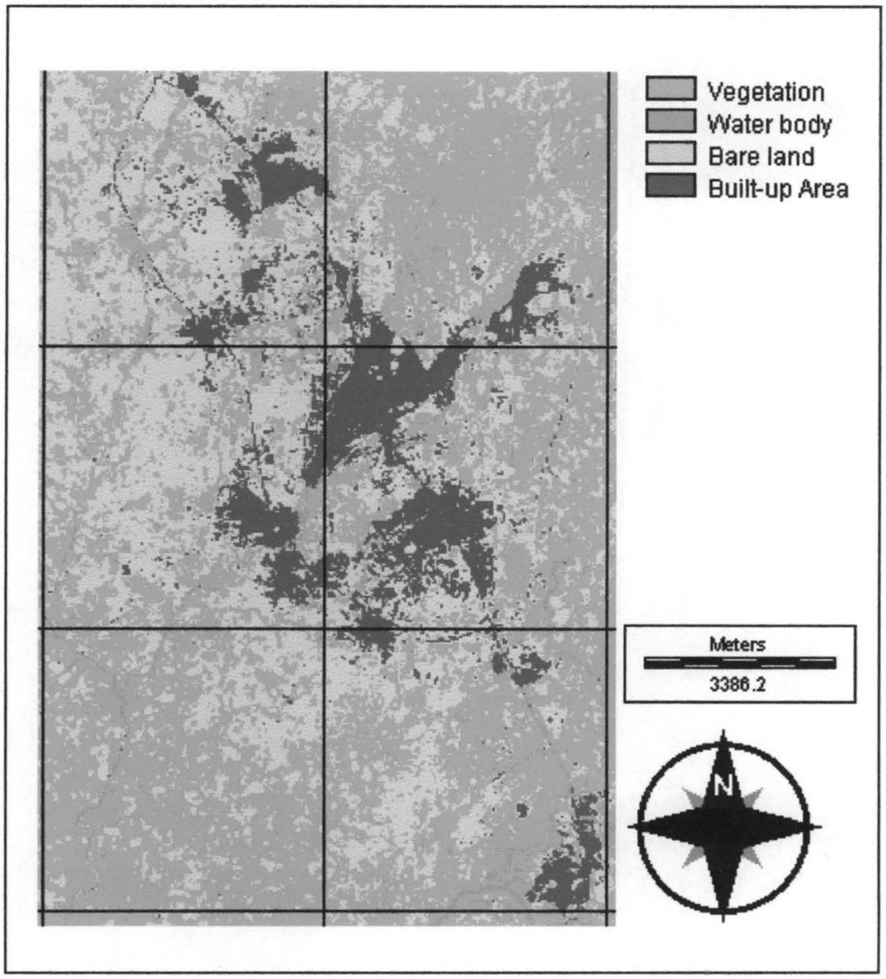

Fig 4.2: False color classification of LandSat TM 2006 Imagery

Source: Author (2010)

4.1.5: **Aerial Extent and percentage coverage of each classified landuse/land cover 2006**

The aerial extent of each class of land use / land cover expressed in hectares, kilometre square and percentage coverage for landSat ETM 2006.

Table 4.3: **Aerial Extent and percentage coverage of classified landuse/land cover 2006**

Landuse Type	Hectares (Ha)	Kilometer square (Km^2)	Percentage (%)
Vegetation	7,708	77.08	49.83
Water body	420	4.20	2.72
Bare land	4,685	46.85	30.29
Build-up area	2,655	26.55	17.17
Total	15,468	154.68	100

Source: Author (2010)

4.1.6: **Magnitude and percentage change of landuse/land cover between 1990 and 2006.**

The magnitude and percentage of changes of land use / land cover condition for the period was identified in terms of its magnitude and percentage of changes..

Table 4.4: **Magnitude and percentage change of landuse/land cover between 1990 and 2006**

Landuse Type	Kilometer Squre 1990	Percentage	Kilometer Squre 2006	Percentage	Magnitude of Change	percentage Change
Vegetation	110.61	71.51	77.08	49.83	3353	48.47
Water body	5.26	3.40	4.20	2.72	106	1.53
Bare land	27.23	17.60	46.85	30.29	1962	28.36
Built-up area	11.58	7.49	26.55	17.17	1497	21.64
Total	154.68	100	154.68	100	6918	100

Source: Author (2010)

4.1.7: **Rate of urban expansion of Minna between 1990 and 2006**

Looking at the extent of urban expansion of Minna between 1990 and 2006, Table 4.5 shows the rate of urban expansion between the period of study and the annual rate of expansion in both hectare and percentage.

Table 4.5: **Rate of urban expansion of Minna between 1990 and 2006**

Year	Built-up area (Ha)	Expansion rate (Ha)	Time of year	Arithmetic mean loss per (Ha)	%
1990	1,158				
		1,497	16	93.58	6.25
2006	2,655				

Source: Author (2010)

4.1.8: **Magnitude of change in vegetation loss between 1990 and 2006**

Changes in vegetation condition are identified between 1990 and 2006. Table 4.6 shows the magnitude of change in vegetation loss in times of gains and losses in aerial extent and percentage coverage for each class.

Table 4.6: **Magnitude of change in vegetation loss between 1990 and 2006**

Landuse Type	**Kilometer Square 1990**	**Kilometer Square 2006**	**Magnitude of Change**	**Percentage**	**Remark**
Vegetation	110.61	77.08	3353	48.47	Loss
Water body	5.26	4.20	106	1.53	Loss
Bare land	27.23	46.85	1962	28.36	Gain
Built-up area	11.58	26.55	1497	21.64	Gain
Total	154.68	154.68	6918	100	

Source: Author (2010)

4.1.9: **Rate of vegetation losses in Minna between 1990 and 2006**

Rate of vegetation cover loss in Minna between 1990 and 2006, Table 4.6 shows the extent of vegetation cover loss between the period study and the annual loss of vegetation in both hectare and percentage.

Table 4.7: **Rate of vegetation loss in Minna between 1990 and 2006**

Year	Vegetation (ha)	Total loss of veg. Cover (ha.)	Time of year	Arithmetic mean loss per (Ha)	%
1990	11,061				
		3353	16	209.56	6.25
2006	7,708				

Source: Author (2010)

4.1.10: **Overlay of landuse land cover imagery 1990/2006 showing the location change.** Overlay land use/ land cover maps of the study area for 1990 and 2006 is produced as shown in Fig. 4.3. The overlay map shows the land use/land cover conditions of change in built-up and vegetation for the periods.

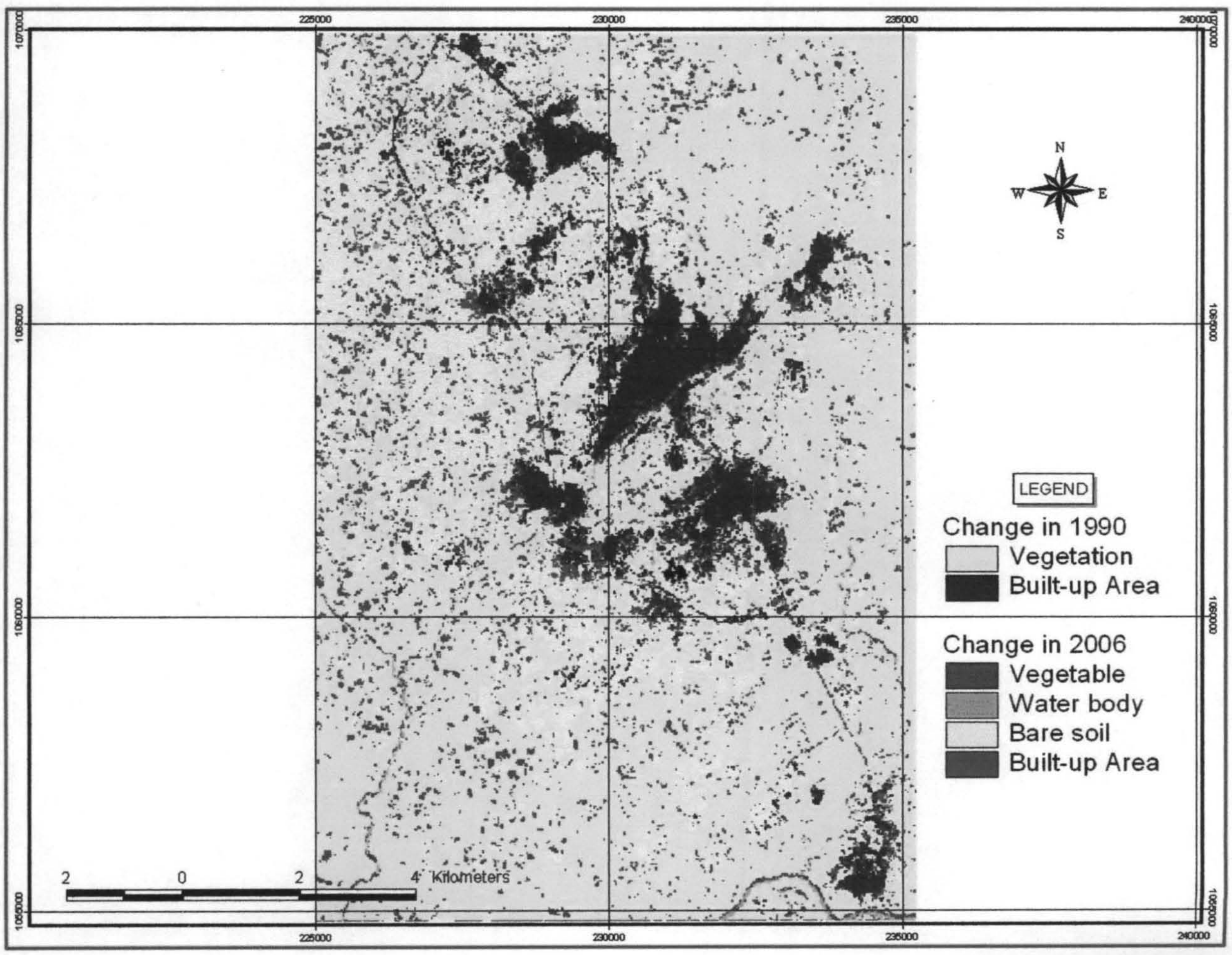

Fig 4.3: **Overlay of 1990 and 2006 landuse land cover Imagery**

Source: Author (2010)

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1.: Discussion of Result

5.1.1: Estimate of Past and Present Population of Minna

The main base data for estimating population in Minna is the 1991 and 2006 population census that should be reasonably comparable because Minna town is a fairly defined area with no nearly outlaying settlement that might or might not have been included in the town figure. The 1991 population census figures was 155,343 and that of 2006 census figure for Minna is 201,429 . One would discover that the population of Minna has grown steadily since 1991, between 1991 and 2006 the population growth of Minna was estimated at 46,086.

5.1.2: Aerial Extent and percentage coverage of each classified landuse/land cover 1990

The classified map of the study area reveals that vegetation occupies 110.61sq.km, (Figure 4.1 and Table 4.2), which is predominant class of about 71.51% of the total study area, Bare land also existed with a significant aerial coverage of 27.23sq.km representing 17.60%. Built-up is seen to significantly occupied 11.58sq.km representing 7.49% while water body is observed to occupied 4.20 with a least class of about 3.40% these is because as built –up area increases water body tends to diminishes gradually. It is glaring that, there is tremendous expansion of built up area at the fringe of the town as well as significant dominant of built up area in the central part of the town

5.1.3: **Aerial Extent and percentage coverage of each classified landuse/land cover 2006**

The classified map of the study area reveals Minna urban expansion has taken place in different parts of the town within the study period, that vegetation occupies.77.08sq.km, (Figure 4.2 and Table 4.3), which is predominant class of the total area study 49.83%, the result also shows that the bare land occupied 46.85sq.km representing 30.29% and built-up area occupied 26.55sq.km representing 17.17%, this indicate that there is tremendous expansion of built-up area in Minna, most especially at the fringe of the town, while water body occupies 4.20sq.km representing 2.72%.

5.1.4 Table 4.4: **Magnitude and percentage change of landuse/land cover between 1990 and 2006**

The findings show that some of the various land use classes in the study area recorded significant increase during the study period with the exception of vegetation and water body which are declining. This phenomenon can be attributed to an intensive cultivation and over grazing activities of vegetated land, coupled with significant loss in water bodies. However, Table 4.3 shows that Bare Land experienced a noticed increase from 17.60% to 30.29 % representing 28.36%, it also shows that there is a significant increase of built-up area from 11.08% to 17.17% representing 21.64%. Other land uses decreased within the study period such as vegetation from 71.51% to 49.83% representing 48.47%, this decrease is as a result of urban expansion and other human induce activities. Similarly, a remarkable loss in water body is noticed for 3.40sq.km to 2.72sq.km representing 1.53%, this phenomenon therefore resulted to a drastic loss in the moisture content of the vegetation areas thereby causing them to dry up.

5.1.5: Rate of urban expansion of Minna between 1990 and 2006

Table 4.5 shows that 1,497 hectare of vegetation land cover is gain to urban expansion between periods of study. It is also observed that 93.58 representing (6.25%) hectare of vegetation cover is gain annually to various processes of urban transformation between 1990 and 2006 in Minna. The expansion is evidenced by the increasing number of built-up area looking at Figure 4.2 in every direction but with more concentration in the city center.

5.1.6: **Magnitude of vegetation losses in Minna between 1990 and 2006.**

The magnitude of vegetation losses distribution in the study area between 1990 and 2006 reveals substantial changes in form of decrease and increase in aerial extent and percentage coverage. The overall magnitude of changes (Table 4.6) shows that out of the total size of the study area (15,468 ha.), vegetation area decreased from 11,061 hectare in 1990 to 7,708hectare in 2006, losing land to the built-up area (3,353 hectare), and other land use except water body. Bare land increased from 2,723 hectares to 4,685 hectares representing 22.36% of the total study area, gaining a total (1,962 hectares) from other land uses, such a gain can be attributed to a possible occupational change especially farming and grazing practices. Area covers by built-up increase from 1,158 hectares to 2,655 hectares representing 21.64% gaining (1497 hectare). The changes between 1990 and 2006 as presented in (table 4.5) implies that within the study area, the removal of vegetation cover will lead to complete loss of vegetation, destruction of wildlife habitat, depreciation or outright wiping of genetic pool and loss of food and medicinal herbs as well as building-up of green house gases, Promotion of desertification and drought among others. Fertile agricultural land areas are displaced as a result of urbanization. Water body have also indicated a drastic loss from 526 hectare to 420 hectare representing 1.53% losing (106 hectare) to urbanization.

5.1.7: **Establishing the link between urban expansion and vegetation changes**

In establishing the link between built-up per annum to the vegetation loss per annum, the percentage derived at Table 4.4 and 4.6 was used. At Table 4.5 the final percentage derived was 6.25 of the total expansion of the built-up per annum, while at Table 4.7 the final percentage derived was 6.25 of the total vegetation loss to built-up per annum. Therefore the link is positive that is (6.25%) and a perfect link, which means the annual loss in vegetation (6.25%) of the period study is equal to the annual increase built-up (6.25%) of the period study.

5.1.8: **Rate of vegetation Loss in Minna between 1990 and 2006**

Assessing vegetation lost in Minna between the study periods, Table 4.7 show that of the 3,353 hectares of vegetation land cover was lost within the period study, it is evident that about 209.56 ha of vegetation cover was lost annually to various processes of urban transformation, and Minna town is expanding at the rate of 3.58 hectare annually since 1990. This implies that within the study area vegetation covers will be completely lost in few years from now. The implication of this rapid loss in vegetation covers and expansion of built-up area is the thermal properties of built-up land surfaces, and also result in environmental problems such as flood, urban heat island, pollution, soil erosion, drought, and desertification, which often lead to destruction of lives and properties.

5.1.9: **Overlay of built-up and vegetation land cover showing the location change in 1990/2006.**

An important aspect of change detection is to determine what is actually changing to what that is which land use class is changing to the other. This information reveals both the desirable and undesirable change and class that are "relatively" stable overtime. This information also serve a vital tool in management decision, this process involve a pixel comparison of the study years image through overlay.

In term of location of change, the emphasis is on built- up and vegetation table 4.4 shows this magnitude of change between 1990 and 2006. The observation is that there seem to exist a growth toward the eastern and western part of the Minna, there exists also a drastic reduction in vegetation at the per-urban area of the city.

On the other hand, looking at the magnitude of change in term of loss or gain by each class between 1990 and 2006 particularly the change in percentage as observable in table 4.6, changes seem to be relatively seen in all the class during this period as observed from the percentage change. Thus, between 1990 and 2006, vegetation land area has a loss of 48.47%. Water body on the other hand loss by 1.53% be tween 1990 and 2006; bare land increased that is gai ned by 28.36% between 1990 and 2006, while built-up area gained an increase of 21.64% between 1990 and 2006.

Factors Responsible For Landuse Land Cover Changes

Changes in land use and land cover date to prehistory and are the direct and indirect consequence of human actions to secure essential resources. This may first have occurred with the burning of areas to enhance the availability of wild game and accelerated dramatically with the birth of agriculture, resulting in the extensive clearing (deforestation) and management of Earth's terrestrial surface that continues today. More recently, industrialization has encouraged the concentration of human populations within urban areas (urbanization) and the depopulation of rural areas, accompanied by the intensification of agriculture in the most productive lands and the abandonment of marginal lands. All of these causes and their consequences are observable simultaneously around the world today. Some factors includes

i. **Natural Variability,** Natural environmental changes interact with the human decision making processes that cause land-use change. Highly variable ecosystem conditions driven by climatic variations amplify the pressures arising from high demands on land resources, especially under resource limiting conditions, such as dry to sub-humid climatic conditions. Land-use change, such as cropland expansion in dry lands, may also increase the vulnerability of human environment systems to climatic fluctuations and thereby trigger land degradation.

ii. **Economic and Technological Factors,** Economic changes are increasingly mediated by institutional factors, markets and policies, such as agricultural subsidies, that are influenced by global factors driving a trend toward intensive commercial agriculture and away from subsistence croplands. For example, giving farmers better access to credit and markets (by road building and other infrastructure changes), combined with improved agricultural technology and secure land tenure can encourage vegetation conversion to cropland, depending on how the new technologies affect labor markets and migration

iii. **Demographic Factors,** Both increases and decreases in local populations have large impacts on land use. Demographic changes include not only shifts in fertility and mortality (e.g. the demographic transition), but also changes in household structure and dynamics, including labor availability, migration, urbanization, and the breakdown of extended families into multiple nuclear families. Migration is the single most important demographic factor causing rapid land-use changes, and interacts with government policies, changes in consumption patterns, economic integration, and globalization. The growth of urban aspirations, urban-rural population distribution, and rapid urban expansion are increasingly important factors in regional land-use change, within major urban centers, in peri-urban areas

iv. **Institutional Factors,** Land-use changes are influenced directly by political, legal, economic, and traditional institutions and by their interactions with individual decision making. Access to land, labor, capital, technology, and information are structured by local and national policies and institutions, including: property rights; environmental policies; decision-making systems for resource management (for example decentralized, democratized, state-controlled, local communal, legal) and social networks concerning distribution and access to resources. Land managers differ in their ability to participate in and to define these institutions. Moreover, institutional controls on land use are increasingly shifting from local to regional and global levels as a result of the increasing interconnectedness of markets, the rise of international environmental conventions, the consolidation of small landholdings, and the shift from communal, traditional systems to formal, state-sanctioned land ownership.

v. **Cultural Factors.** The motivations, collective memories, personal histories, attitudes, values, beliefs, and individual perceptions of land managers influence land use decisions, sometimes profoundly. The intended and unintended ecological consequences of land-use decisions all depend on the knowledge, information, and management skills available to land managers, and these in turn are often linked to political and economic conditions, for instance, t he status of women or ethnic minorities.

5.2. Summary of Major Finding

From the study analysis, the following summaries of findings are deduced. There is rapid urban development due to increase urbanization that led to massive de vegetation in the study area. Between 1990 and 2006 the Built up area has increase from 11.58sq.km to 26.55sq.km representing 21.64%, while vegetation decreases from110.61 sq.km to 77.08sq.km representing 48.47%.

The total loss of vegetation cover between 1990 and 2006 was (3353ha) and the annual vegetation loss was 209.56ha.The increase in built-up expansion between 1990 and 2006 was (1497ha) and the annual rate of change was 93.56ha. Urban expansion is also responsible for vegetation depletion in the study area.

5.3. Conclusion

It is evidenced from this study that the negative impacts of urbanization on vegetation far outweigh the positive impacts. This study has revealed that there is a tremendous transformation in the various land use in Minna town. The built-up area has shown the highest rate of expansion while vegetation suffered the greatest loss. The water body has also reduced drastically as a result of increase in siltation. The increasing urbanization has also been discovered to have negative implications on the environment particularly the weather and water supply. Loss of vegetal cover to urban expansion cannot be totally halted, but sustainable planning and management will go a long way in ensuring reliable and sustainable vegetation cover, which serves as ecosystem service provider to the urban centres.

5.4. Recommendations

Based on findings of this work, the following recommendations are made in order to arrest the problems of peri-urban de-vegetation:

1. Adequate intervention measures should be put in place by both the community and the government in arresting the problems, through environmental education and awareness, enforcement of environmental legislation, replanting of trees, re-vegetating the destroyed vegetation and creation of green areas.
2. Construction or development should be done taking into account the preservation and conservation of vegetation in the study area.
3. It is also recommended that professional such as land use planners, meteorologists and other environmental scientists should be involved in decision making process, so that coherent and sound decision could be made to help reduce/mitigate environmental problems on land use/ land cover.

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