# Population Growth and Urban Land Use Change along River Kaduna Floodplain

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**Keywords**: Population Growth, Urban Land Use Change, Remote Sensing, Geographic Information System.

**SUMMARY**

Population explosion experienced by metropolitan areas has resulted to transformation of many of the farmlands, river floodplains and forests into human settlements thereby causing urban land use changes. The ability to map and examine population growth on urban land use changes on river floodplain and assess the associated effects on the floodplain has important environmental and economic relevance. This paper therefore focused on the population growth in relation to urban land use changes along River Kaduna floodplain in Kaduna North Western Nigeria. The paper employed projected population data, Remote Sensing Technology and Geographic Information System to determine the trend of population growth and urban land use changes with reference to urban land use types along the river floodplain in Kaduna for the period of 1976 to 2010. The results revealed amongst others that population growth is not the only factor that can effect changes on urban land use along River Kaduna floodplain in Kaduna metropolis. In line with this finding, it is recommended that other dimensions of population should be considered to actually find out whether population growth is a major factor of urban land use change along River Kaduna floodplain.

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## 1. INTRODUCTION

Metropolitan areas in Nigeria are experiencing unprecedented growth rates and creating extensive urban landscapes in which many of the farmlands, river floodplains and forests have been transformed into human settlements. Urban growth rates show no signs of slowing, especially when viewed at the global scale. Cities have changed from small isolated population centers to large, interconnected economic, physical and environmental features. . One hundred years ago, approximately 15percent of the world's population lived in urban areas. Today, the percentage is nearly 50 percent (USGS, 1999).

Urban growth and the concentration of people in urban areas are creating societal problems world-wide. Major problems faced by these metropolitan areas are sprawl, loss of natural vegetation and open space and a general decline in the extent and connectivity of wetlands and wildlife habitat which are generally attributed to increasing population (USGS, 1999). This makes policy makers and the public to continue to raise concerns about the effects that unchecked population growth will have on the landscape. Uncontrolled population growth would quickly exceed carrying capacity, leading to overpopulation and social problems as hypothesized by Malthus (1798). In support of this statement, Oyekanmi (2008) stated that, unchecked population growth will exacerbates and accentuates social and economic problems and that it will be extremely difficult, if not impossible, to solve any of the social, economic, political and cultural problems if population growth is not stabilized. .

In developing countries, the problems of population explosions and the inherent characteristic effect of the population growth has been a source of concern. This problem was first noted by Thomas Malthus in 1798 when he first theorized that, at the population growing rate, a point would be reached when population will out-strip production and supply of food, education, housing, industry, technology and other facilities to be provided for the people (Chudi – Oji, 2013). This awareness of the socio-economic consequences of rapid population growth has led some of the African countries to formulate and implement several programmes and policies designed to influence undesirable population trends.

The determination of Nigeria's population has been a very contentious issue since 1866 when population census started in Nigeria. The establishment of the total population in the country, in each state and local government area has also been mere speculations. In like manner, the resultant effects of Nigeria's population on land use changes have received little attention. This paper therefore seeks to find out the effect of population growth on urban land use changes along River Kaduna floodplain.

## 2. LITERATURE REVIEW

### 2.1 Nigeria's Population Policy

The evolution of Nigeria's population policy started in the Second National Development Plan, 1970-1974, where the government clearly indicated that the population was growing at an estimated rate of 2.5% annually owing to the combined effects of declining death rates and continuing high birth rates (Federal Republic of Nigeria, 1970). From 1991 annual population growth rate was estimated 2.75% (NPC) and from 2006, the annual population growth rate estimation increased to 3.18% (Federal Republic of Nigeria, 1970: 77; Federal Republic of Nigeria, 1975: 293).

The official population measure used in Nigeria by the National Population Commission (NPC) since 1990 was the Nigeria Demographic and Health Survey (NDHS). The NDHS has the responsibilities of collecting, collating, analyzing and disseminating population census and survey data at all levels that contribute to policy formulation and population activity coordination in the country (NDHS, 2013).

### 2.2 Population Change and Urban Land Use

Every city has a unique experience and history and thus it is difficult to confine the changed process and pattern of any urban area into a unified theory or concept. However, theorizing and modeling urban land use greatly helps in simplifying complex urban systems for easy understanding, interpretation, comprehension and therefore management (Oluseyi, 2006).

From the analysis of urban land uses structure theories such as the concentric zone theory (Burgess, 1925), the sector theory (Hoyt, 1933) and the multi nuclei theory Harris and Ullman (1945), population growth is one of the key factors for urban land use changes. This is because, as the rate of the city's economy grows, it gives room for employment which attracts rural – urban migration. Most theoretical perspectives on environmental change also argued that at any given level of affluence and technology, population is the key determinant of natural resource consumption (Hunter, 2001). Therefore, it can be said that Population density is related to land uses since more people in a given area will require homes, roads and business facilities, which all compete with other land uses.

Different dimensions of population change such as numbers of people, numbers of households, age structure and birth rates may influence land uses in general and changes over time in a fraction of land. Most studies on population changes stated that population density in any one fixed area, reduces the fraction of land devoted to agricultural uses in that area by hastening the transition toward a built environment. Moreover, within a fixed local area, the total effect of increasing trend in population change will result to less land devoted to agricultural uses and vegetation as a result of increase in construction of buildings and infrastructure (Heilig, 1997). Therefore, it can be seen that, marriages, childbearing, migration and changes in living arrangements all stimulate consumption of land in any environment.

### 2.3 Urban Land use Changes in River Floodplains.

Urban land use changes in river floodplains over time are inevitable in our contemporary societies all over the world. These are unavoidable phenomenon due to both temporary and permanent interest of the inhabitants in any given geographical area on the land resources. Thus, urban land use changes occur essentially for socio-economic and ecological reasons at local and national levels especially for a country to improve her Gross Domestic Product (GDP), Inclusive Wealth Index (IWI) and raising the Human Development Index (HDI) (Oyinloye and Oloukoi, 2013).

Most urban areas in developing countries are located by the coast or by major rivers and are experiencing uncontrolled growth of urban development's and thus adversely, affect their river basin ecosystems (Jahi and Hassan, 1996). Examples of such urban areas include Dhaka in Bangladesh and Kaduna in Nigeria. Therefore, there is need to examine the trend of these urban developments on urban land use changes, most especially, in urban areas located along major rivers.

### 2.4 Main Trends in Kaduna Population Growth

Kaduna town has experienced rapid growth in recent decades resulting to rapid urbanization. This has led to the transformation of River Kaduna floodplain into developed areas and most of the agricultural land has been converted to built-up areas. Several factors can be responsible for these changes in land use. These include population explosion, urbanization, security, employment opportunity, closeness to working environment, government acquisition for public interest, private acquisition for building houses and commercial centres to mention few but population explosion has been one of the key factors.

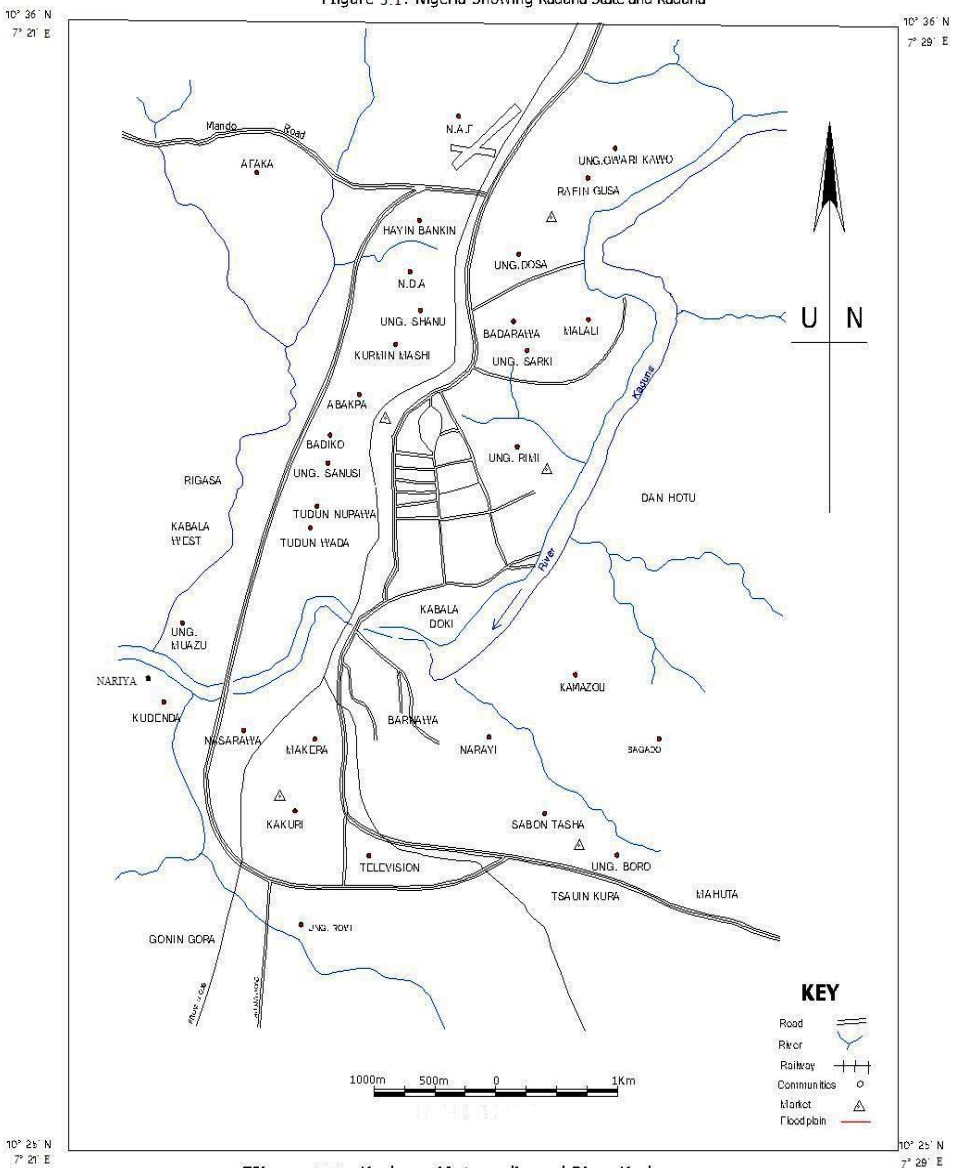
The trend of population growth within Kaduna metropolis most especially along River Kaduna floodplain has become a flow data type which shows the rate of population growth and its components over a certain period of time. However, in some cases, population growth can be as a result of stock data which may be more useful than flow data most especially during the period of insecurity and insurgencies

## 3. STUDY AREA

The study area falls strategically inside four Local Government Areas of Kaduna State. These are parts of Chikun, Igabi, Kaduna South and Kaduna North. The localities and communities that make up the study area are as shown in Figure 3.1 and Figure 3.2. These include Ungwan Gwari kawo, Rafin Gusa, Malali, Ungwan Rimi, Kamanzo, Kabala Doki, Narayi, Ungwan Mejeiro, Barnawa, Doka, Makera (Down Quarters), Tudun-wada, Nassarawa, Kudende, Ungwan Mu'azu and Nariya wards. Spatially, Kaduna metropolis as shown in Figure 3.2 covers an area of about 25km long and 8-10km wide from Katabu in the north to the Nigeria National Petroleum Company (NNPC) oil refinery in the south, located between Latitudes$10^{o}$ 28' 00" – $10^{o}$ 36' 00"North and longitude $07^{o}$ 21' 00" – $07^{o}$ 29' 00" East at an

elevation of 612m above Mean Sea Level (Fallingrain,2009).


FIigure 3.1: Nigeria Showing Kaduna State and Kaduna




FIigure 3.2 : Kaduna Metropolis and River Kaduna

Source: Kaduna State Ministry of Lands, Survey and Planning, 2010

Kaduna had been an administrative capital of the old Northern Protectorate in 1931in Nigeria since the pre-independent colonial era and later the Northern Region even after Nigeria independence. Kaduna is also an important trade area and a major transportation hub for the surrounding agricultural areas with its rail and road junctions, air to all parts of Nigeria and attracts industry, commerce and government investments.

The population of Kaduna metropolis has shown a steady and rapid increase as follows: 10,653 in 1931; 44,540 in 1952; 149, 910 in 1963; 173,000 (estimated) in 1965; 853,000 (estimated) in 1985; 1,111,282 in 1991 and 1,570,331 in 2006 (Nigeria National Census 1951 and 1961 and Nigeria Population Commission -Vol. 03, 2010). The total populations of the localities within the study area were 331036 in 1976; 477012 in 1987; 587,917 in 1995 and 845,898 in 2010. Total populations of Kaduna were 694,551 in 1976; 1,000,154 in 1987; 1,117,528 in 1995 and 1,770,077 in 2010.

## 4. MATERIALS AND METHODS.

The spatial data acquisition techniques employed in this study were remote sensing and Global Positioning System (GPS). The reference data were mainly from 1973 Topographical map of Kaduna S. E. sheet 123 and Kakuri N. E. sheet 124 (1:50000); Satellite Imageries such as Landsat imageries MSS 1976 (50m resolution), Thematic Mapper 1987 (30m resolution) and Enhanced Thematic Mapper 2010 (15m resolution); Spots imagery Xs 1995 (20m resolution) and projected population census of Kaduna for 1976, 1987, 1995 and 2010.

The mapping of River Kaduna floodplain from satellite imageries were represented in floodplain maps and produced from 1973 Topographical maps of Kaduna S. E. sheet 123 and Kakuri N. E. sheet 124 (1:50000), Lansat MSS 1976, Lansat TM 1987, SPOT XS 1995 and Lansat ETM 2010 epoch respectively as shown in Figure 4.1. These depicted the land use and land cover classifications of the study area.

The classifications were divided into five and it includes built-up area, dry season farm, rain-fed farm, rock outcrop and water body though there were other urban land uses along the River Kaduna floodplain merged, such as bare surface/sand bar, gallery vegetative cover.

The river floodplain boundary map, produced from topographic maps, was overlaid on the satellite imageries of Lansat MSS 1976, Lansat TM 1987, SPOT XS 1995 and Lansat ETM 2010 in the Arc GIS 9.3 environment. Imaging ERDAS 9.1 was used to extract information from the satellite images. The combination of these processes resulted to composite map of land use and Land cover as shown in Figure 4.2

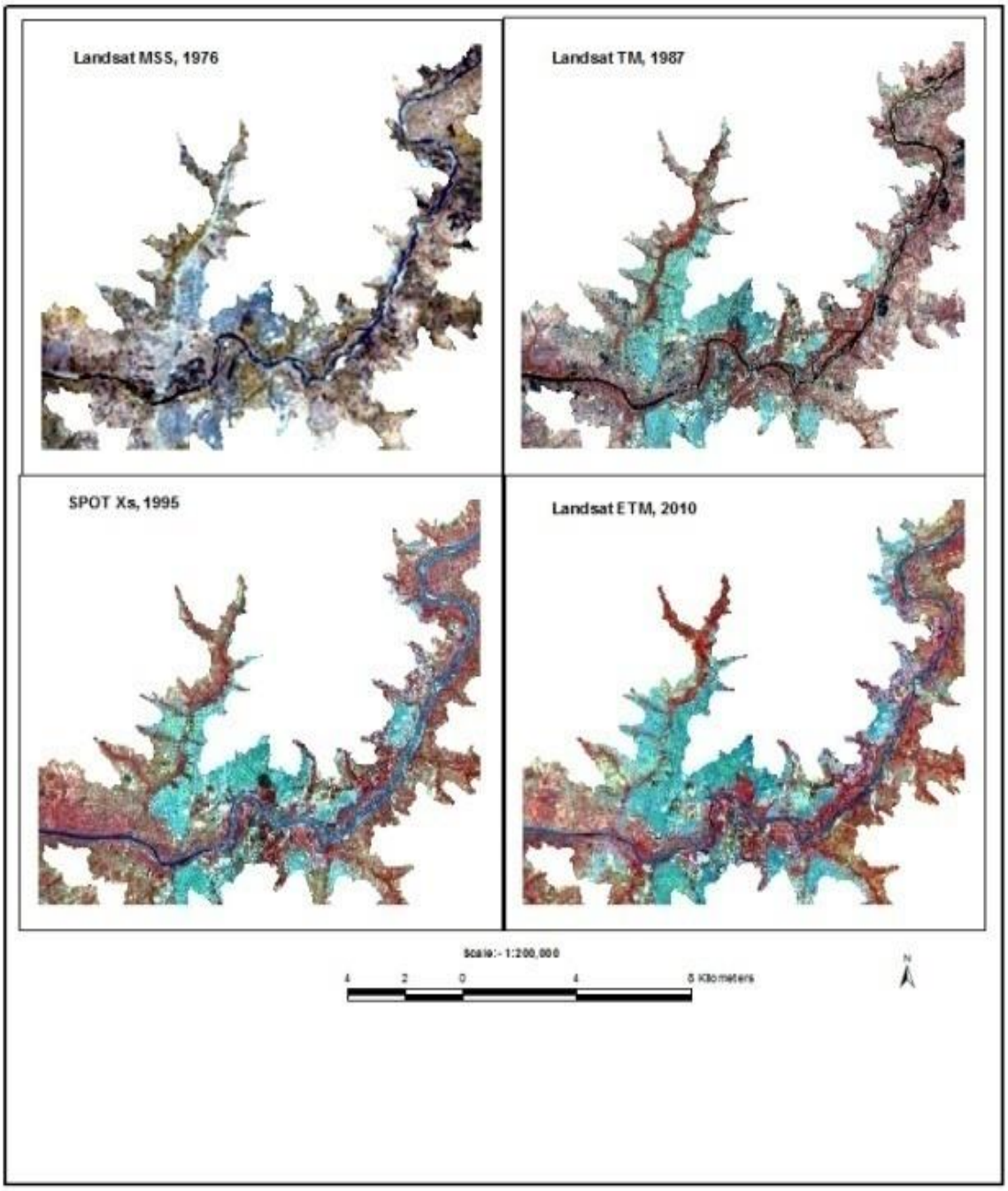



Figure 4.1: Composite Satellite Imageries of the Study Area for 1976, 1987, 1995 and 2010.

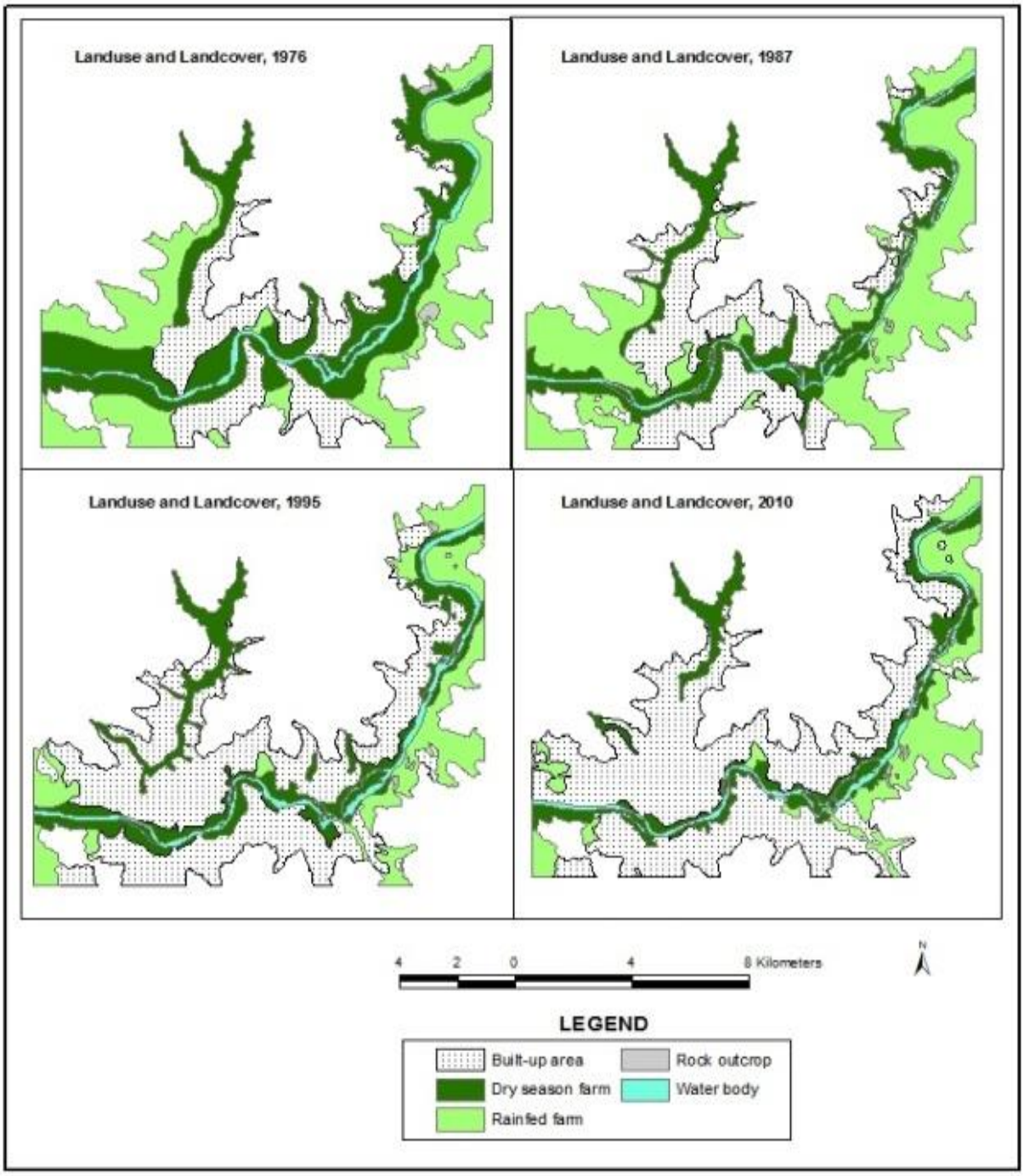



Figure 4.2: Composite Map of Land use and Land cover 1976, 1987, 1995 and 2010.

## 5. RESULTS AND DISCUSSION

### 5.1 Analysis of Land Use/Land Cover Changes in the Study Area

Table 5.1: Analysis of Land Use/Land Cover Changes in the Study Area (Hectares)

| S/N | LAND USE/ LAND COVER TYPE | LANSAT MSS 1976 Area (Ha) | DIFF B/W '76 & '87 (Ha) | LANSAT TM 1987 Area (Ha) | DIFF B/W '87 & '95 (Ha) | SPOT XS 1995 Area (Ha) | DIFF B/W '95 & '10 (Ha) | LANSAT ETM 2010 Area (Ha) | CHANGE IN AREA(Ha) 1976-2010 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | BUILT-UP AREA | 2155.883 | + 659.680 | 2815.563 | +2044.097 | 4859.660 | + 645.951 | 5505.611 | + 3349.728 |
| 2 | DRY SEASON FARM | 3160.972 | -1187.437 | 1973.535 | - 85.257 | 1888.278 | - 482.022 | 1406.256 | -1754.716 |
| 3 | RAIN-FED FARM | 3251.092 | + 640.357 | 3891.449 | -2089.739 | 1801.710 | -95.682 | 1706.028 | -1545.064 |
| 4 | ROCK OUTCROP | 52.606 | - 28.749 | 23.857 | -1.676 | 22.181 | -0.790 | 21.391 | -31.215 |
| 5 | WATER BODY | 461.774 | - 83.850 | 377.924 | +132.574 | 510.498 | -67.458 | 443.040 | -18.734 |
| | SUM | 9082.327 | 0.001 | 9082.328 | -0.001 | 9082.327 | -0.001 | 9082.327 | -0.001 |

Source: Author's Analysis of Lansat MSS, 1976; Lansat TM, 1987; Spot Xs 1995 and Lansat ETM, 2010

The computation of changes experienced within the land use and land cover of various classifications in the study area along River Kaduna floodplain between 1976 and 2010 are shown in Table 5.1. In addition, Table 5.2 shows the differences in hectares of land between two satellite imageries epochs and their percentages with respect to the sum of these differences for each class of land use and land cover. Moreover, the annual encroachment rates of each class of land use and land cover in hectares were computed from Table 4.2.

### 5.2 Changes Experienced on Land Use/Land Cover within Classifications in the Study Area

Table 5.2: Changes Experienced on Land Use/Land Cover within Classifications in the Study Area (Hectares).

| S/N | LAND USE/ LAND COVER TYPE | LANSAT MSS 1976 Area (Ha) | DIFF (Ha) | % DIFF | LANSAT TM 1987 Area (Ha) | DIFF (Ha) | % DIFF | SPOT XS 1995 Area (Ha) | DIFF (Ha) | % DIFF | LANSAT ETM 2010 Area (Ha) | CHANGE IN AREA(Ha) 1976-2010 | % DIFF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BUILT-UP AREA | 2155.883 | 659.680 | 25.372 | 2815.563 | 2044.097 | 46.955 | 4859.660 | 645.951 | 50.000 | 5505.611 | 3349.728 | 50.000 |
| 2 | DRY SEASON FARM | 3160.972 | 1187.437 | 45. 669 | 1973.535 | 85.257 | 1.958 | 1888.278 | 482.022 | 37.311 | 1406.256 | 1754.716 | 26.192 |
| 3 | RAIN-FED FARM | 3251.092 | 640.357 | 24.628 | 3891.449 | 2089.739 | 48.003 | 1801.710 | 95.682 | 7.406 | 1706.028 | 1545.064 | 23.062 |
| 4 | ROCK OUTCROP | 52.606 | 28.749 | 1.106 | 23.857 | 1.676 | 0.038 | 22.181 | 0.790 | 0.061 | 21.391 | 31.215 | 0.466 |
| 5 | WATER BODY | 461.774 | 83.850 | 3.225 | 377.924 | 132.574 | 3.045 | 510.498 | 67.458 | 5.222 | 443.040 | 18.734 | 0.288 |
| | SUM | 9082.327 | 2600.073 | 100% | 9082.328 | 4353.343 | 99.999 | 9082.327 | 1291.903 | 100% | 9082.327 | 6699.457 | 100.008 |

Source: Author's Analysis of Lansat MSS, 1976; Lansat TM, 1987; Spot Xs 1995 and Lansat ETM, 2010.

#### 5.2 .1 Built-up Area

Table 5.2 shows that the built-up area occupied 2156Ha in 1976; 2816Ha in 1987; 4860Ha in 1995 and 5506Ha in 2010. Thus between 1976 and 2010, the built-up area increased by almost 3,350 Ha, or nearly 155%. This represents a mean annual increase of 99Ha or nearly 5%. A careful examination of the data on land use changes covered by the study reveals that the rates of encroachment on urban land uses have assumed a growing trend since the second period. Thus, the area under the land use land cover on the river floodplain has declined progressively.

#### 5.2.2 Dry Season Farmland

Table 5.2 presents the areas occupied by dry season farming. The data on area under dry season farming reveal a declining trend, falling from approximately 3161Ha in 1976 to

1974Ha in 1987, 1888Ha in 1995 and 1406Ha in 2010. Thus, between 1976 and 2010, the area under dry season declined by 1755Ha, or nearly 225%. This represents mean annual decline of 52Ha or 7%.

### 5.2.3 Rain-Fed Farmland

Table 5.2, shows that rain-Fed farmland occupied 3251Ha in 1976; 3892Ha in 1987; 1802Ha in 1995 and 1706Ha in 2010. The area under rain-Fed farmland witnessed an overall declining trend in the period under study. The only exemption being the period between 1976 and 1987. Thus, between 1976 and 2010, the area under rain-Fed farmland declined by 1545Ha, or nearly 210%. This represents a mean annual decline of 45Ha or 6%.

### 5.2.4 Rock Outcrop

Table 5.2, shows that rock outcrop occupied 53Ha in 1976; 24Ha in 1987; 22Ha in 1995 and 21Ha in 2010. The area under rock outcrop witnessed an overall declining trend in the period under study. Thus, between 1976 and 2010, the area under rain-Fed farmland declined by 1545Ha, or nearly 210%. This represents a mean annual decline of 45Ha or 6%.

### 5.2.5 The Water Body

Table 5.2, shows that water body occupied 462Ha in 1976; 378Ha in 1987; 511Ha in 1995 and 443Ha in 2010. The area under water body witnessed a declining trend in the period under study. The only exemption being the period 1976 and 1995where the water body witnessed increase.

### 5.3Relationship Between Population Growth and Land Use Change

The population data of the study area for 1991, as supplied by Nigeria Population Commission (NPC) Kaduna office was presented in Table 5.3. Annual population growth rate of 2.75% was applied to 1991 population figure to project 1995 population data. To project the population data for 2010, the annual population growth rate of 2.75% was applied from 1991 to 2005. From 2006, the annual population growth rate increased to 3.18%. From 1976 to 1991 population figure, 2.5% annual population growth rate was applied to derive the 1976 and 1987 population figure. Results from these projection rates were also presented in Table 5.3.

Table 5.1 shows the total land use within the study area to be 9082Ha 1976. Table 5.3 shows the projected population of the localities in the study area to be 331,036 in 1976; 477,012 in 1987; 587,917 in 1995 and 845,898 in 2010. Table 5.3 also shows the population growth of localities and land use changes within the study area to be 145976 within 1976 and 1987 with a corresponding land use change 2600 Ha; 110905 within 1987 and 1995 with a corresponding land use change 4353 Ha and 25798 within 1995 and 2010 with a corresponding land use change 1291 Ha.

Table 5.3: Projected Population Figures of Localities along River Kaduna Floodplain.

| Localities | 1991 | 1976 | 1987 | 1995 | 2010 |
|---|---|---|---|---|---|
| Rafin Gusa | 19,658 | 12,286 | 17,692 | 21,820 | 31,395 |
| Ungwan Gwari kawo | 10,781 | 6,738 | 9,703 | 11,967 | 17,218 |
| Malali | 22,677 | 14,173 | 20,409 | 25,171 | 36,217 |
| Ungwan Rimi | 52,717 | 32,948 | 47,445 | 58,516 | 84,193 |
| Kamanzo | 447 | 279 | 402 | 496 | 714 |

| | | | | | |
|---|---|---|---|---|---|
| Kabala Doki | 22,694 | 14,184 | 20,425 | 25,190 | 36,244 |
| Narayi | 23,674 | 14,796 | 21,307 | 26,278 | 37,808 |
| Ungwan Mejeiro | 302 | 189 | 272 | 335 | 482 |
| Barnawa | 32,684 | 20,428 | 29,416 | 36,279 | 52,198 |
| Doka | 13,566 | 8,479 | 12,209 | 15,058 | 21,666 |
| Makera | 77,374 | 48,359 | 69,637 | 85,885 | 123,572 |
| Tudun-wada | 60,299 | 37,687 | 54,269 | 66,932 | 96,302 |
| Nassarawa | 61,501 | 38,438 | 55,351 | 68,266 | 98,222 |
| Kudende | 754 | 471 | 679 | 837 | 1,203 |
| Ungwan Mu'azu/Kabala West | 37,713 | 23,571 | 33,942 | 41,861 | 60,230 |
| Nariya | 92,816 | 58,010 | 83,854 | 103,026 | 148,234 |
| TOTAL | 529,657 | 331,036 | 477,012 | 587,917 | 845,898 |

Source: Analysis of Population Data from Nigeria Population Commission (NPC), Kaduna.

Table 5.4: Population Growth of Localities and Land use Change along River Kaduna Floodplain.

| Period | Population Growth | % | Rate/ Year | Land use Change | % | Rate/ Year |
|---|---|---|---|---|---|---|
| 1976 – 1987 | 145976 | 28.352 | 13270 | 2600.073 | 31.534 | 236.370 |
| 1987 – 1995 | 110905 | 21.541 | 13863 | 4353.343 | 52.798 | 544.168 |
| 1995 – 2010 | 257981 | 50.107 | 17199 | 1291.903 | 15.668 | 86.127 |
| Total | 514862 | 100% | | 8245.319 | 100% | |

Source: Analysis of Population Data from Nigeria Population Commission (NPC), Kaduna and Lansat MSS, 1976; Lansat TM, 1987; Spot Xs 1995 and Lansat ETM, 2010.

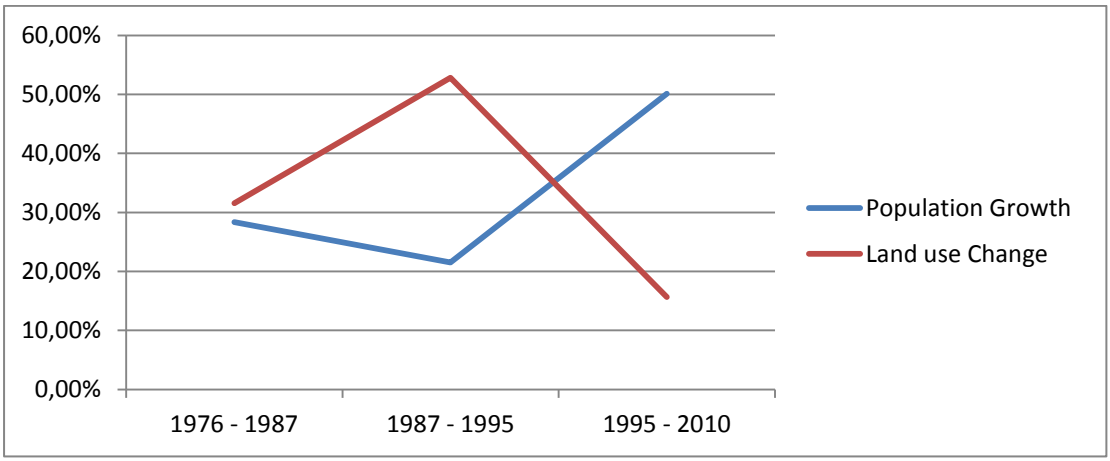



Figure 5.1: Relationship Between Population Growth and Land Use Change within the Study Area

Thus between 1976 and 2010, the population increased by almost 514862, or nearly 156%. This represents a mean annual increase of 15143 or nearly 5%. Within the same period of study, land use changes have an overall declining effect of 8245Ha or 110%. This represents a mean annual increase of 2425 or nearly 3%.

A careful examination of the population data on land use changes covered by the study reveals that, the population growth takes an increasing trend while land use change takes a declining trend. No correlation exist between population growth and urban land use changes along River Kaduna. These relationships were as shown in Figure 5.1.

## 6. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

### 6.1 Summary of Findings

This study focused on the impact of population growth in relation to urban land use change along River Kaduna floodplain in Kaduna, Nigeria. The study employed Remote Sensing Technology and Geographic Information System to determine the trend of population growth and urban land use changes with reference to urban land use types along the river floodplain in Kaduna for the period of 1976-2010.

The result of the study revealed amongst others that population growth is not the only factor that can effect change on urban land uses along River Kaduna floodplain within Kaduna metropolis. In line with this finding, it is recommended that other dimensions of population should be considered to actually find out whether population growth is a major factor of urban land use changes along River Kaduna floodplain.

### 6.2 Conclusion

This paper discovered that within the period 1976 to 1987, there was no appreciable effect of population growth on the urban land use change. The effect of population growth started having a decreasing trend on urban land use from the period 1987 to 1995 which has continued to 2010. This therefore means that the population growth of Kaduna along River Kaduna floodplain could be a function of the changes experienced on the urban land use in the study area.

### 6.3 Recommendation.

The paper suggests the following recommendations.

1. Effort should be made to mitigate the detrimental effects associated with population growth on urban land use change.
2. Updating of land use mapping of Kaduna town North-western Nigeria should be intensified.
3. Considerable effort should be made to control the effect of population on the changes in urban land use.

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