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Abstract

For almost a decade now, Maiduguri urban has been faced with security challenges which were believed to have negatively affected the growth and expansion of the city, hence the need for proper assessment of the rate and pattern of the urban expansion within the last one decade. Google images of 2002 and 2012 of Maiduguri urban were downloaded from the Google Earth Pro, the images were then referenced, classified and reclass into four main classes of undeveloped areas, developed areas, water body and bare surfaces. The area module of the Idrisi Andes was then used to calculate the area of the classes of the re-classed images. The calculated areas were then used to derive the trends, magnitudes and the annual changes of the urban during the study period, while the image calculator module of the Idrisi Andes was used to delineate the actual places where built-up existed between 2002 and 2012. The study revealed that a total land area of 15.1km² was occupied with built-up within the decade. It was also revealed that most of the expansion in the urban took place at the periphery of the urban notably, the University and its environs, Baga road, Bulumkutu/ Ngomari area, the land area between Biu and Damboa road as well as some areas in old Maiduguri. It was recommended that constant urban monitoring should be undertaken by the government so as to have an in-depth idea of the rate and pattern of urban growth for proper planning and sustainable development.

Index terms—

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1 A) STATEMENT OF THE PROBLEM

areas, water body and bare surfaces. The area module of the Idrisi Andes was then used to calculate the area of the classes of the re-classed images. The calculated areas were then used to derive the trends, magnitudes and the annual changes of the urban during the study period, while the image calculator module of the Idrisi Andes was used to delineate the actual places where built-up existed between 2002 and 2012. The study revealed that a total land area of 15.1km² was occupied with built-up within the decade. It was also revealed that most of the expansion in the urban took place at the periphery of the urban notably, the University and its environs, Baga road, Bulumkutu/ Ngomari area, the land area between Biu and Damboa road as well as some areas in old Maiduguri. It was recommended that constant urban monitoring should be undertaken by the government so as to have an in-depth idea of the rate and pattern of urban growth for proper planning and sustainable development.

aiduguri was made the capital of the defunct North Eastern state in 1967 and since then, the city has been state capital till date. In 1976 when Nigeria was divided into nineteen states and which Borno state was one of the newly created states, Maiduguri became the capital of Borno state. In 1991 Yobe state was carved out of Borno state and Maiduguri still maintains the capital of the state -the position the city holds till date.

According to Walad (1969) in Kawka (2002), the area of the town which is nowadays called Maiduguri was covered with *dusu* trees (*Dichrostachys* sp) and inhabited by large numbers of wild animals. Therefore, hunters came (here) to chase near the shores of the river, they latter set up their settlements and stayed for short periods. During this period, the people of Birni Gazargumo came southwards to the Mandara and Kasar mountains for warfare in order to capture slaves. It was during this period that the people of the Maidugu (title of a descendant of a ruler) arrived during their raids and settled around the areas. The hunters who had earlier settled near the river invited the people of the Maidugu to settle with them. The Maidugu took his people and settled with the hunters near the river. They called that place Maiduguri: meaning the town of the Maidugu. Maiduguri latter became an important town because in the words of Walad (1969) in Kawka (2002) that "whatever major road one takes, when you come to that place from the east, you will stay, from the south, you will stay there and from the north, it will be that place where you will stop. It became a busy trading center". Hence is likened to the present day nodal town. Maiduguri was founded in 1672 with Yerwa as the traditional name.

Maiduguri urban is the capital of Maiduguri metropolitan Council (MMC) and Jere Local Government Areas. Despite the fact that the city is located in semi arid region; the city is protected from intense rays of the sun with trees starting from the colonial authority when tree planting was a priority. Today, all major roads in the city are lined with trees; mostly neem tree which has adaptability capability with dry lands, coupled with its fast growth rate as noted by Ayuba (2009) that on the major streets of towns in Borno state there are exotic species of *Azadirachta indica*, *Gmelina arborea* and *Eucalyptus* spp which are to protect the environment from drought and desertification, and to supply fuelwood and other minor forest products

Since urban expansion cannot be discussed in isolation without demographic development, the rapid expansion of Maiduguri was said to have began in 1960s when the city rapidly expanded in landmass and population. The population of Maiduguri was 10,000 in 1910 This figure according to the National Population Census rose to 139,965 in the 1963 and 654,400 in Surroundings comprised Alau, Bale (Galtimari), Bolori, dala (Lawanti), Dusman, Gongulong, Liberty (Village), Maiduguri, Mai Musari (Mairi) and Ngudda (Addamari).

Uneven growth of the population in the different wards, administrative convenience and easy tax collection and control were the three reasons given for the creation and restructuring of the existing wards (Kwaka 2002). Prior to 1920, the present Maiduguri comprised of only one ward -the Udje District with Udje Maiduguri and Udje Mabani as the two big settlements. In 1957, the Yerwa town and Yerwa town surroundings were split into the urban Yerwa District and the periurban and the rural known as Maiduguri Districts. In 1991 Bolori District was created while the Gwange District was carved out from Yerwa District in 1994. Jere Local Government Area (LGA) was created from Maiduguri urban with Old Maiduguri, Mashamari, Ngomari Gana, Mairi, and Bale Galtimari belonging to the Jere LG. Today, Maiduguri urban comprised four

LGAs: Maiduguri metropolitan Council (MMC), Jere LGA, Konduga LGA and a smaller part of Mafa LGA.

The present day Maiduguri is blessed with infrastructural, developmental, commercial, health and industrial activities. Road network, international air port, and rail are some of the means of transportation. There are pipe borne water, boreholes and wells as sources of water. Many public and private primary and secondary schools, College of Education, State Polytechnic College of Agriculture, College of Legal Studies, School of Nursing and the University of Maiduguri are some of the tertiary institutions in the urban. Nigeria Television Authority (NTA), and Borno Radio Television (BRTV) are also available for information dissemination and entertainments. There are chains of hotels among the important ones are Chad Hotel, International Hotel, Dujima, Chezcon, Mairi Place and Lake View Hotels. Major industries include; Neital shoe Factory, Haske Sweet and confectionaries, Borno Aluminium and Co. Maiduguri Flour Mills, Borno Polythene and Plastic Industry, Nail and Office Pins factories etc. Modern banks such as GTB, Diamond, First Bank, Union Bank, UBA, Mainstream Bank, Keystone Access, Fidelity and other banks are also available in the urban.

1 a) Statement of the Problem

Borno State in general and Maiduguri in particular were known in history as a very peaceful state and city respectively, hence, the state slogan as "the home of peace". However, the recent crisis in the urban which started in almost a decade ago and which has gradually cropped into the other parts of the state and now extended

to other parts of Nigeria has served as threats to the peace of the urban in particular. We read, see and hear in newspapers; television and radio that the crisis has made many people especially the nonindigenes to flee to other parts of the country. This of course is believed to have major impacts on the growth and expansion of the urban especially in residential development sector. This paper therefore sought to assess the status of the urban expansion of Maiduguri so as to ascertain whether the city is expanding, static or contracting during the last one decade when the city has been under serious security challenges and also to measure the trends, magnitude and the annual rate of the expansion, or otherwise of the urban.

2 b) Aim and Objectives

The aim of this paper is to assess the level of urban expansion of Maiduguri urban between 2002 and 2012, so as to ascertain the level of expansion of the city within the period of the crisis. The specific objectives include:

? to assess, the built up areas in Maiduguri urban between the last one decade that is, 2002 and 2012 using GIS techniques based on Google maps of Maiduguri urban. ? to calculate the trends, magnitudes, percentages and annual rate of changes of the actual built up areas within the period (2002 to 2012).

3 II.

4 The Study Area

Maiduguri is located between latitudes 11 42N and 12 00 N and longitudes 12.54 and 13 14 E (Haruna 2010). She further claimed that Maiduguri covered an area of 543km². The city is bounded in the north by Jere LGA, in the west, south and south-west by Konduga LGA, in the north-west by Mafa LGA. Maiduguri has mean annual maximum temperature of 34.8 with mean temperature ranging between 30 and 40 C. The months of March and April are usually the hottest months, while November and January are the cold and dry periods of harmattan. The city receives rainfall from June to September. However in rainy years, the city records rainfall earlier than June and latter than September. Being a nodal city, trading is the major occupation of the inhabitants with few agrarian practices. The city is situated in a plain area.

One of the problems confronting the geography of Maiduguri urban is the non-availability of a standard boundary of the urban. Therefore, in this study, the urban is defined to be the areas between latitudes 11? 27? 30? N and 11? 33? 30? N and longitudes 13? 2? 30? E and 13? 9? 10? E (Fig. 1)

5 Materials and Methods

The 2002 and 2012 Google maps, both of which were captured in January, were acquired from Google Earth Pro. The map of Maiduguri urban which comprises the roads, wards, rivers, and important features and places in the urban was also acquired from Ministry of Land and Survey, Maiduguri. Ilwis 3.3 Academic and Idrisi Andes were the two main GIS software that were used in this study. While all the images and maps were referenced and resampled in Ilwis, map overlay, area calculations and analysis were done through the respective modules of the Idrisi Andes. It was the figures that were derived from the area calculations that were used to develop the items in table 1. The two Google images which were referenced in Ilwis were exported to Idrisi Andes where the images were reclassified into four main landuse and landcover types, that is, waterbody, built up areas, undeveloped areas and bare surfaces (Figs. ??a and 2b). Each of these classes was assigned a specific value to differentiate them from the other landuse types.

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The area module of the Idrisi Andes was then used to calculate the area cover of each of the landuse type. The maps of Maiduguri urban was finally overlain on the final output of the reclassified images so as to enable the readers to use the wards, roads or important features as reference in describing the areas where development has taken place or not as presented in 1, Built up areas and undeveloped areas constitute the major parts of the landuse of the urban. Built-up areas are the areas that are delineated by the image as places where buildings of houses have taken place. It must be noted that houses that are even yet to be roofed are classified as built-up areas. The term undeveloped areas denote areas that are suitable for development but are yet to be developed. That is, such areas are currently occupied by other landuse and landcover types such as agriculture, shrubs and open spaces. There was an increase in the built up areas from 87.52km² in 2002 to 102.62km² in 2012. This means that a total land area of 15.1km² was occupied by built up areas between 2002 and 2012, with, a percentage change of 2.62%. The study also revealed that built up areas is increasing at the rate of 0.26% annually, though if compared with the other landuse types, the annual rate of change of the built up areas may be considered low as bare surfaces for instance, is changing annually at the rates of 9.41%. Undeveloped areas that occupied a land area of 97.99km² in 2002 have decreased to 78.19km² in 2012. The reason for the decrease may be attributed to the fact that most of the developed areas took place from the hitherto undeveloped areas. For instance, part of the land area that have changed from undeveloped area to other landuse types which is 19.8km² (97.99 in 2002-78.19 in 2012) between 2002 and 2012 (Table.1) might have been taken over by built up areas which has 15.1km² increase in landmass in 2012. The remaining 4.7km² (19.8-15.1km²) of the undeveloped

areas might have been consumed by bare surface which increased from 0.87km² in 2002 to 5.87km² in 2012. Waterbody in the urban was also found to have reduced slightly from 0.75 to 0.40km² within the ten years period of study. Development was observed to have taken place along river courses such as River Ngadda that runs through the city as Daura et al (1997) had reported that in Maiduguri, the flood plain at sides of the banks of river Ngadda have been converted to residential, public and commercial sites for block industry, markets, motor parks and shopping malls. It is these activities that is still in place and which is reducing the water body in the urban. Therefore, because of this developmental activities coupled with the pressure on land as a result of high population have made some of the areas that were formally waterbody areas to have changed to other landuse types. In summary, the increase in built up areas and the decrease in the yet-to-be developed areas as revealed from the image signifies urban expansion.

7 b) The Location and Pattern of Maiduguri Urban Expansion

Fig 5 shows the actual locations or areas where development had taken place within the decade which was derived through the use of the image calculator menu of Idrisi Andes. This Fig 5, revealed that much of the expansion in Maiduguri urban were recorded especially at the hitherto periphery areas which include University of Maiduguri (UNIMAID) and the surroundings, Bulumkutu/Ngomari area, areas along Gamboru Ngala and Baga roads, Giwa barrack areas, some patches of land area between Biu and Damboa road and other suburbs. The development within the University of Maiduguri is attributed to so many completed and on-going Education Trust Fund (ETF) projects such as lecture theaters, laboratories, faculty buildings and some other notable buildings. The noticeable developments around the university up north to Ngomari costain were mainly to cater for the ever increasing demand of accommodation mostly for the university students. The Ngomari/Bulumkutu area has much government impact especially at Ngomari where 777 and 1000 housing units were constructed around the Ngomari Old Airport axis within the period of study. Equally along Gamboru-Dikwa Road, 505 housing units were constructed, in addition to new primary and secondary schools as well as new residential buildings that emerge in the areas. (1967) (1968) (1969) (1970) (1971) (1972) (1973) (1974) (1975) (1976) and that it has during these years been the focus of government, employment and trade as well as the gate way to Chad Republic, the northern province of Cameroon and the Diffa province of Niger Republic. They concluded that the agglomeration economies developed over the years have enabled Maiduguri to draw more people from far and near at the expense of other urban towns in the state. The most important structure of expansion that was noticed in the map (Fig. 5) is that Maiduguri urban is rapidly expanding towards the periphery areas of the city. This had earlier been noticed by Kawka (2002) that the growth of Maiduguri and the encroachment into its hinterland is a two process, the town expands into the periphery because new quarters are added at its boundary, and also the creation of new villages near the city and the growth of the peripheral settlements promote the expansion of the city. However, the current pattern of the urban expansion could be attributed to two major factors: the first is that the nucleus of the city (Yerwa, Gwange etc) have already been chocked up with buildings and hardly is any open space within these areas, as Lock (1976) in Jimme and Bashir (2009) had reported that some areas (in Maiduguri urban) that are marked green zones and are either unsuitable for farming have all been occupied by people and it is associated with a lot of environmental degradations, hence, people are forced to look towards the periphery for the construction of their houses. Secondly, the security challenges in the city for almost one decade has also make many inhabitants to build their houses in the suburbs of the city where the "heat" of the crisis is considered to be minimal. The high standard of living especially the civil servants between 1999 and 2003 when the salary of the civil servants were increased also contributed a lot to the urban expansion as many people could then afford enough capital to erect their houses.

8 V. Conclusion and Recommendations

The paper demonstrated the applicability of Google images for urban monitoring and assessment, that is, Google images can as well be used like satellite images for urban monitoring and assessment. It was revealed in this study that the crisis and the security challenges has little or no effects on the urban growth of Maiduguri urban as a total land area of 15.1km² has been discovered to be built-up within the last one decade with annual growth rate of 0.26%. The location and patterns of the urban expansion was also discovered to be shifting towards the periphery of the urban, a development that is environmentally acceptable because it reduces the pressure on the land in the core areas and brings development to the periphery. Waterbody in the urban was also found to be reducing probably because of the ever increasing population and climate change, no wonder, the landuse type that had the highest annual rate of change is bare surfaces. The government and other stake holders should put up programs that will stabilize our environment nowprograms that will conserve our water bodies and reduce the encroachment of bare surfaces. The government through the federal and state ministries of urban planning, land surveys, environment and other relevant ones should undertake constant urban monitoring for proper planning so as to avert future calamities that may arise from improper urban planning.

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²A Decade Assessments of Maiduguri Urban Expansion (2002 -2012): Geospatial Approach

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Figure 1: Version 1 . 0

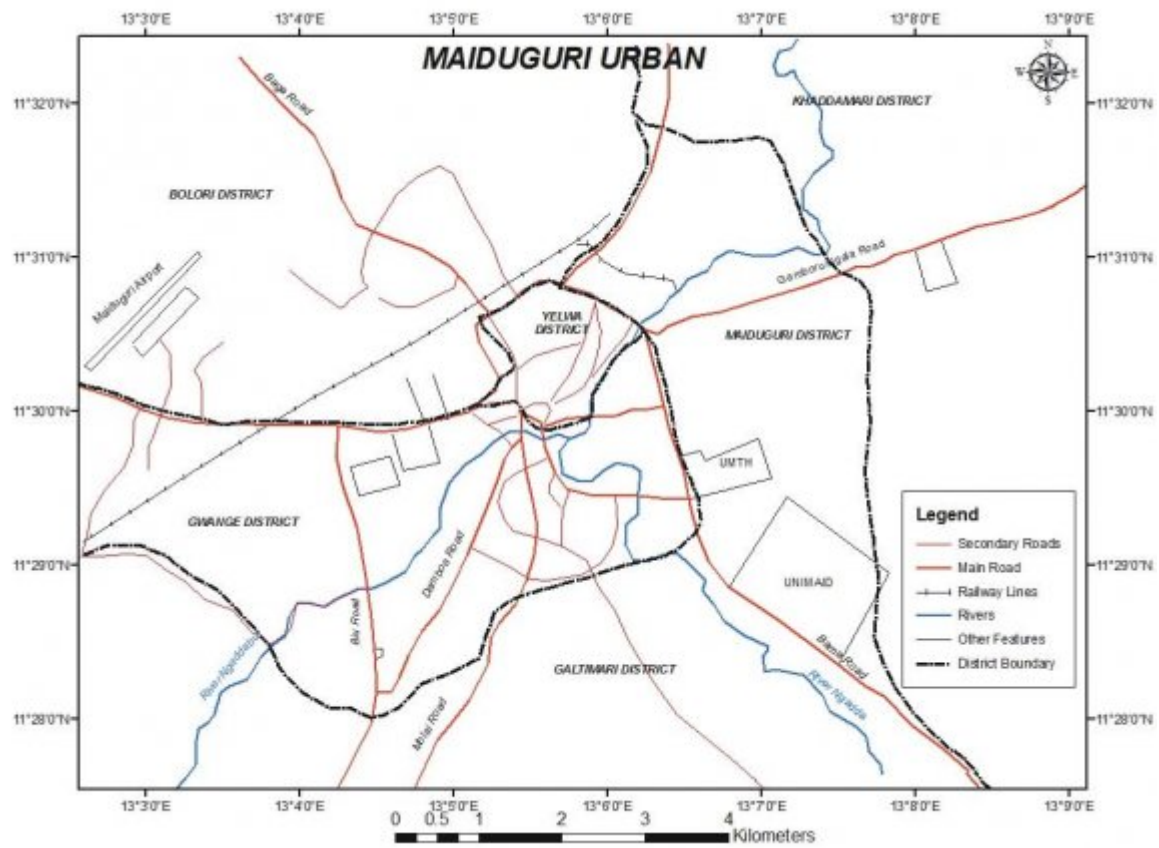
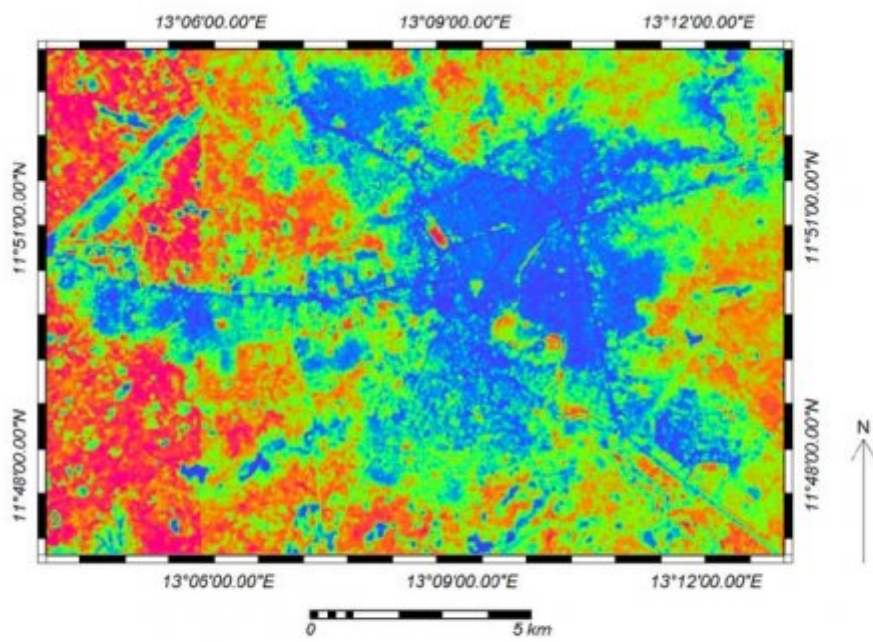
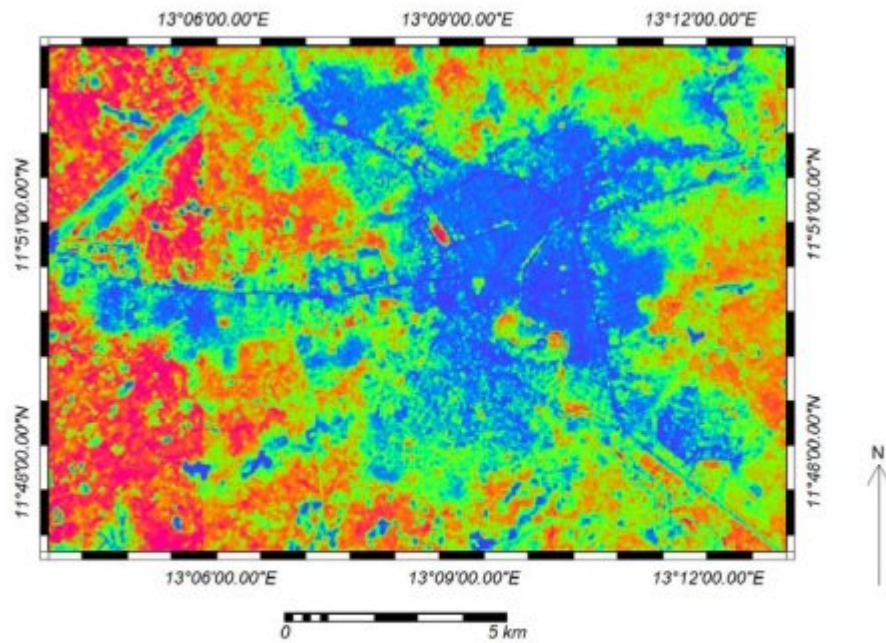


Figure 2: FOR



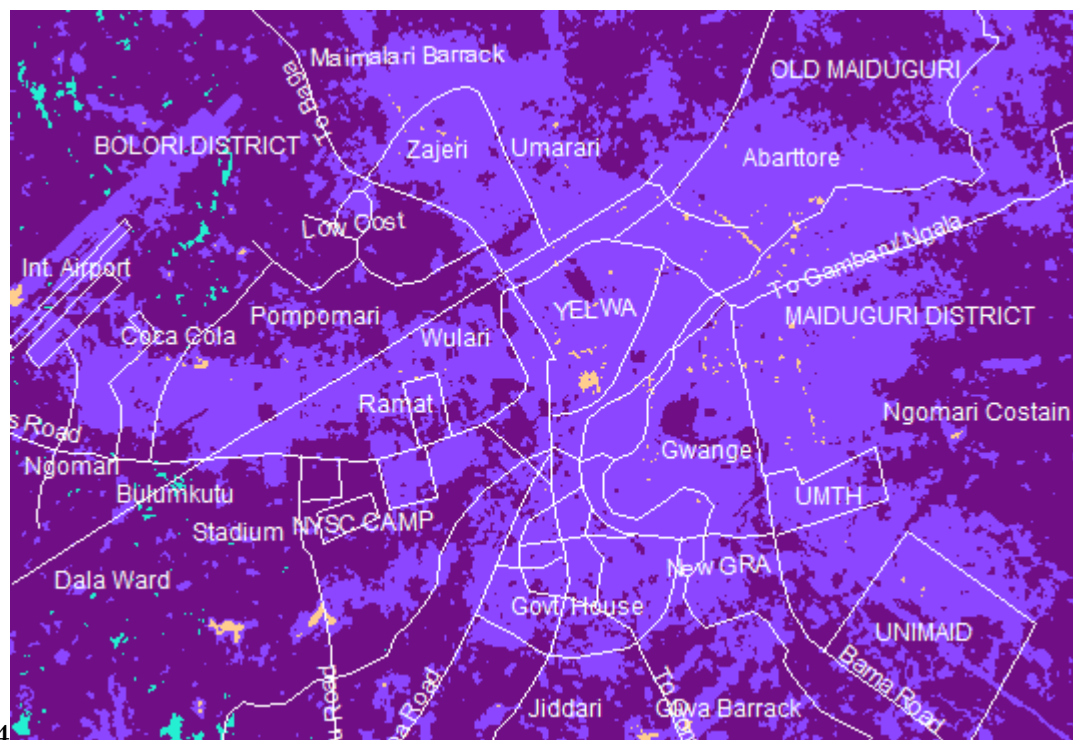
1

Figure 3: Figure 1 :



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Figure 4: Figure 2 a 2 Volume



434

Figure 5: Figs 3 and 4 Figure 3 Figure 4 :

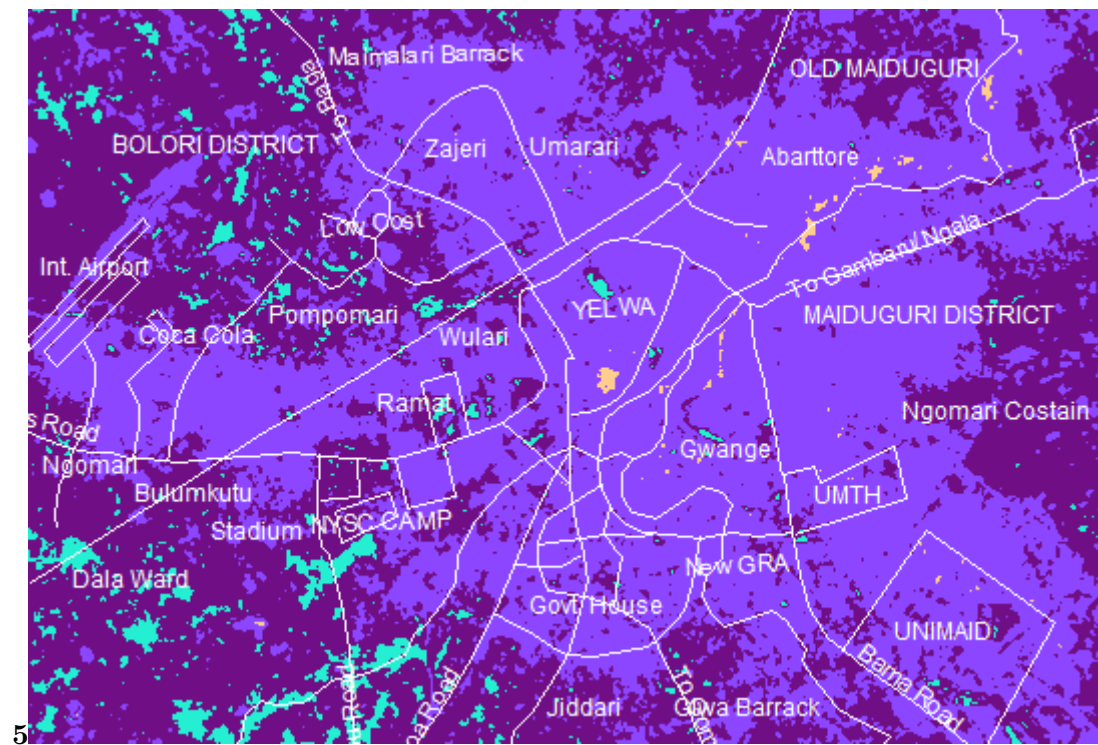


Figure 6: Figure 5 :



Figure 7:

1

Landuse & Landcover	2002 Area (Km2)	%	2012 Area (Km2)	%	Magnitude of Change (km 2)	Percentage Change	Annual Rate of Change
Waterbody	0.75	0.40	0.40	0.21	-0.35	-99.25	-9.93
Built-up Areas	87.52	46.77	102.62	54.84	15.1	2.62	0.26
Undeveloped Areas	97.99	52.36	78.19	47.78	-19.8	-21.81	-2.18
Bare Surface	0.87	0.46	5.87	3.14	5	-94.13	9.41
Total In Table	187.13	100	187.13	100			

Figure 8: Table 1 :

.1 (Kwaka 2002). The 2006 Population Census put the total population of the Maiduguri urban (MMC and

Jere LGA) at 749,123. The increase in population and expansion of urban land mass, also lead to the creation and restructure of the wards. The 1952 census in Kwaka (2002), distinguished between the administrative units of Yerwa town and Yerwa town surroundings. Yerwa town comprised the following wards: Bulabuni, Fezzan, Gamboru, Hausari, Lamisula, Limanti, Mafoni, Shehuri North, Shehuri South and Zongo. Yerwa Town M

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