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2 Environmental Disaster

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6 **Abstract**

7 For almost a decade now, Maiduguri urban has been faced with security challenges which were  
8 believed to have negatively affected the growth and expansion of the city, hence the need for  
9 proper assessment of the rate and pattern of the urban expansion within the last one decade.  
10 Google images of 2002 and 2012 of Maiduguri urban were downloaded from the Google Earth  
11 Pro, the images were then referenced, classified and reclass into four main classes of  
12 undeveloped areas, developed areas, water body and bare surfaces. The area module of the  
13 Idrisi Andes was then used to calculate the area of the classes of the re-classed images. The  
14 calculated areas were then used to derive the trends, magnitudes and the annual changes of  
15 the urban during the study period, while the image calculator module of the Idrisi Andes was  
16 used to delineate the actual places where built-up existed between 2002 and 2012. The study  
17 revealed that a total land area of 15.1km<sup>2</sup> was occupied with built-up within the decade. It  
18 was also revealed that most of the expansion in the urban took place at the periphery of the  
19 urban notably, the University and its environs, Baga road, Bulumkutu/ Ngomari area, the  
20 land area between Biu and Damboa road as well as some areas in old Maiduguri. It was  
21 recommended that constant urban monitoring should be undertaken by the government so as  
22 to have an in-depth idea of the rate and pattern of urban growth for proper planning and  
23 sustainable development.

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25 **Index terms—**

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28 of the urban expansion within the last one decade. Google images of 2002 and 2012 of Maiduguri urban were  
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## 1 A) STATEMENT OF THE PROBLEM

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51 old Maiduguri. It was recommended that constant urban monitoring should be undertaken by the government  
52 so as to have an in-depth idea of the rate and pattern of urban growth for proper planning and sustainable  
53 development.

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

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

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

77 Since urban expansion cannot be discussed in isolation without demographic development, the rapid expansion  
78 of Maiduguri was said to have began in 1960s when the city rapidly expanded in landmass and population. The  
79 population of Maiduguri was 10,000 in 1910 This figure according to the National Population Census rose to 139,  
80 965 in the 1963 and 654, 400 in Surroundings comprised Alau, Bale (Galtimari), Bolori, dala (Lawanti), Dusman,  
81 Gongulong, Liberty (Village), Maiduguri, Mai Musari (Mairi) and Ngudda (Addamari).

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

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

### 102 1 a) Statement of the Problem

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

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

## 113 **2 b) Aim and Objectives**

114 The aim of this paper is to assess the level of urban expansion of Maiduguri urban between 2002 and 2012, so as  
115 to ascertain the level of expansion of the city within the period of the crisis. The specific objectives include:  
116 ? to assess, the built up areas in Maiduguri urban between the last one decade that is, 2002 and 2012 using  
117 GIS techniques based on Google maps of Maiduguri urban. ? to calculate the trends, magnitudes, percentages  
118 and annual rate of changes of the actual built up areas within the period (2002 to 2012).

## 119 **3 II.**

## 120 **4 The Study Area**

121 Maiduguri is located between latitudes 11 42N and 12 00 N and longitudes 12.54 and 13 14 E (Haruna 2010). She  
122 further claimed that Maiduguri covered an area of 543km<sup>2</sup>. The city is bounded in the north by Jere LGA, in  
123 the west, south and south-west by Konduga LGA, in the north-west by Mafa LGA. Maiduguri has mean annual  
124 maximum temperature of 34.8 with mean temperature ranging between 30 and 40 C. The months of March and  
125 April are usually the hottest months, while November and January are the cold and dry periods of harmattan.  
126 The city receives rainfall from June to September. However in rainy years, the city records rainfall earlier than  
127 June and latter than September. Being a nodal city, trading is the major occupation of the inhabitants with few  
128 agrarian practices. The city is situated in a plain area.

129 One of the problems confronting the geography of Maiduguri urban is the non-availability of a standard  
130 boundary of the urban. Therefore, in this study, the urban is defined to be the areas between latitudes 11° 27'  
131 30' N and 11° 33' 30' N and longitudes 13° 2' 30' E and 13° 9' 10' E (Fig. 1)

## 132 **5 Materials and Methods**

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

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## 144 **6 Global Journal of Human Social Science**

145 The area module of the Idrisi Andes was then used to calculate the area cover of each of the landuse type. The  
146 maps of Maiduguri urban was finally overlain on the final output of the reclassified images so as to enable the  
147 readers to use the wards, roads or important features as reference in describing the areas where development has  
148 taken place or not as presented in 1, Built up areas and undeveloped areas constitute the major parts of the  
149 landuse of the urban. Built-up areas are the areas that are delineated by the image as places where buildings of  
150 houses have taken place. It must be noted that houses that are even yet to be roofed are classified as built-up  
151 areas. The term undeveloped areas denote areas that are suitable for development but are yet to be developed.  
152 That is, such areas are currently occupied by other landuse and landcover types such as agriculture, shrubs  
153 and open spaces. There was an increase in the built up areas from 87.52km<sup>2</sup> in 2002 to 102.62km<sup>2</sup> in 2012.  
154 This means that a total land area of 15.1km<sup>2</sup> was occupied by built up areas between 2002 and 2012, with,  
155 a percentage change of 2.62%. The study also revealed that built up areas is increasing at the rate of 0.26%  
156 annually, though if compared with the other landuse types, the annual rate of change of the built up areas may be  
157 considered low as bare surfaces for instance, is changing annually at the rates of 9.41%. Undeveloped areas that  
158 occupied a land area of 97.99km<sup>2</sup> in 2002 have decreased to 78.19km<sup>2</sup> in 2012. The reason for the decrease may  
159 be attributed to the fact that most of the developed areas took place from the hitherto undeveloped areas. For  
160 instance, part of the land area that have changed from undeveloped area to other landuse types which is 19.8km<sup>2</sup>  
161 (97.99 in 2002-78.19 in 2012) between 2002 and 2012 (Table.1) might have been taken over by built up areas  
162 which has 15.1km<sup>2</sup> increase in landmass in 2012. The remaining 4.7km<sup>2</sup> (19.8-15.1km<sup>2</sup>) of the undeveloped

## 8 V. CONCLUSION AND RECOMMENDATIONS

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163 areas might have been consumed by bare surface which increased from 0.87km<sup>2</sup> in 2002 to 5.87km<sup>2</sup> in 2012.  
164 Waterbody in the urban was also found to have reduced slightly from 0.75 to 0.40km<sup>2</sup> within the ten years period  
165 of study. Development was observed to have taken place along river courses such as River Nggada that runs  
166 through the city as Daura et al (1997) had reported that in Maiduguri, the flood plain at sides of the banks of  
167 river Ngadda have been converted to residential, public and commercial sites for block industry, markets, motor  
168 parks and shopping malls. It is these activities that is still in place and which is reducing the water body in the  
169 urban. Therefore, because of this developmental activities coupled with the pressure on land as a result of high  
170 population have made some of the areas that were formally waterbody areas to have changed to other landuse  
171 types. In summary, the increase in built up areas and the decrease in the yet-to-be developed areas as revealed  
172 from the image signifies urban expansion.

### 173 7 b) The Location and Pattern of Maiduguri Urban Expansion

174 Fig 5 shows the actual locations or areas where development had taken place within the decade which was derived  
175 through the use of the image calculator menu of Idrisi Andes. This ??ig 5, revealed that much of the expansion in  
176 Maiduguri urban were recorded especially at the hitherto periphery areas which include University of Maiduguri  
177 (UNIMAID) and the surroundings, Bulumkutu/Ngomari area, areas along Gamboru Ngala and Baga roads, Giwa  
178 barrack areas, some patches of land area between Biu and Damboa road and other suburbs. The development  
179 within the University of Maiduguri is attributed to so many completed and on-going Education Trust Fund  
180 (ETF) projects such as lecture theaters, laboratories, faculty buildings and some other notable buildings. The  
181 noticeable developments around the university up north to Ngomari costain were mainly to cater for the ever  
182 increasing demand of accommodation mostly for the university students. The Ngomari/Bulumkutu area has  
183 much government impact especially at Ngomari where 777 and 1000 housing units were constructed around the  
184 Ngomari Old Airport axis within the period of study. Equally along Gamboru-Dikwa Road, 505 housing units  
185 were constructed, in addition to new primary and secondary schools as well as new residential buildings that  
186 emerge in the areas. ??1967) ??1968) ??1969) ??1970) ??1971) ??1972) ??1973) ??1974) ??1975) ??1976) and  
187 that it has during these years been the focus of government, employment and trade as well as the gate way to  
188 Chad Republic, the northern province of Cameroon and the Diffa province of Niger Republic. They concluded  
189 that the agglomeration economies developed over the years have enabled Maiduguri to draw more people from  
190 far and near at the expense of other urban towns in the state. The most important structure of expansion that  
191 was noticed in the map (Fig. 5) is that Maiduguri urban is rapidly expanding towards the periphery areas of the  
192 city. This had earlier been noticed by Kawka (2002) that the growth of Maiduguri and the encroachment into its  
193 hinterland is a two process, the town expands into the periphery because new quarters are added at its boundary,  
194 and also the creation of new villages near the city and the growth of the peripheral settlements promote the  
195 expansion of the city. However, the current pattern of the urban expansion could be attributed to two major  
196 factors: the first is that the nucleus of the city (Yerwa, Gwange etc) have already been chocked up with buildings  
197 and hardly is any open space within these areas, as Lock (1976) in Jimme and Bashir (2009) had reported that  
198 some areas (in Maiduguri urban) that are marked green zones and are either unsuitable for farming have all been  
199 occupied by people and it is associated with a lot of environmental degradations, hence, people are forced to  
200 look towards the periphery for the construction of their houses. Secondly, the security challenges in the city for  
201 almost one decade has also make many inhabitants to build their houses in the suburbs of the city where the  
202 "heat" of the crisis is considered to be minimal. The high standard of living especially the civil servants between  
203 1999 and 2003 when the salary of the civil servants were increased also contributed a lot to the urban expansion  
204 as many people could then afford enough capital to erect their houses.

## 205 8 V. Conclusion and Recommendations

206 The paper demonstrated the applicability of Google images for urban monitoring and assessment, that is, Google  
207 images can as well be used like satellite images for urban monitoring and assessment. It was revealed in this  
208 study that the crisis and the security challenges has little or no effects on the urban growth of Maiduguri urban  
209 as a total land area of 15.1km<sup>2</sup> has been discovered to be built-up within the last one decade with annual growth  
210 rate of 0.26%. The location and patterns of the urban expansion was also discovered to be shifting towards the  
211 periphery of the urban, a development that is environmentally acceptable because it reduces the pressure on the  
212 land in the core areas and brings development to the periphery. Waterbody in the urban was also found to be  
213 reducing probably because of the ever increasing population and climate change, no wonder, the landuse type  
214 that had the highest annual rate of change is bare surfaces. The government and other stake holders should put  
215 up programs that will stabilize our environment nowprograms that will conserve our water bodies and reduce the  
216 encroachment of bare surfaces. The government through the federal and state ministries of urban planning, land  
217 surveys, environment and other relevant ones should undertake constant urban monitoring for proper planning  
218 so as to avert future calamities that may arise from improper urban planning. <sup>1 2 3</sup>

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

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Figure 1: Version 1 . 0

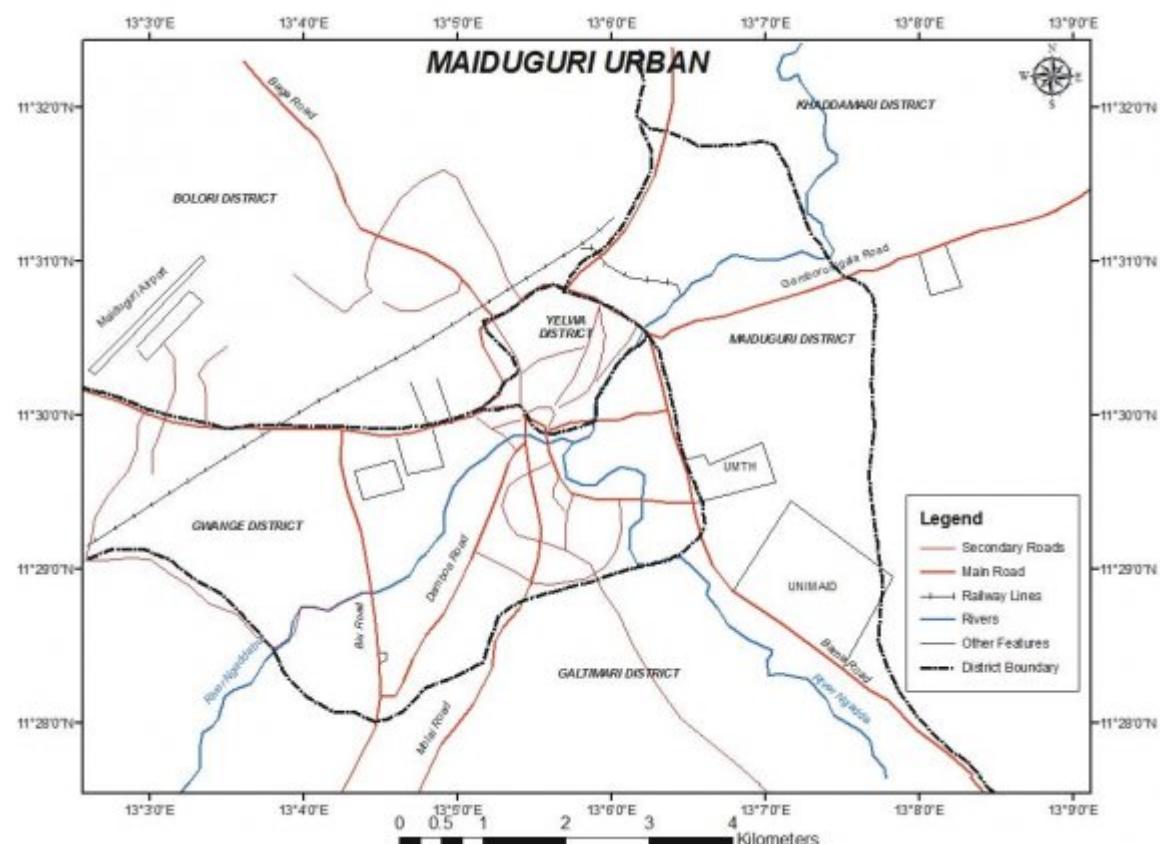
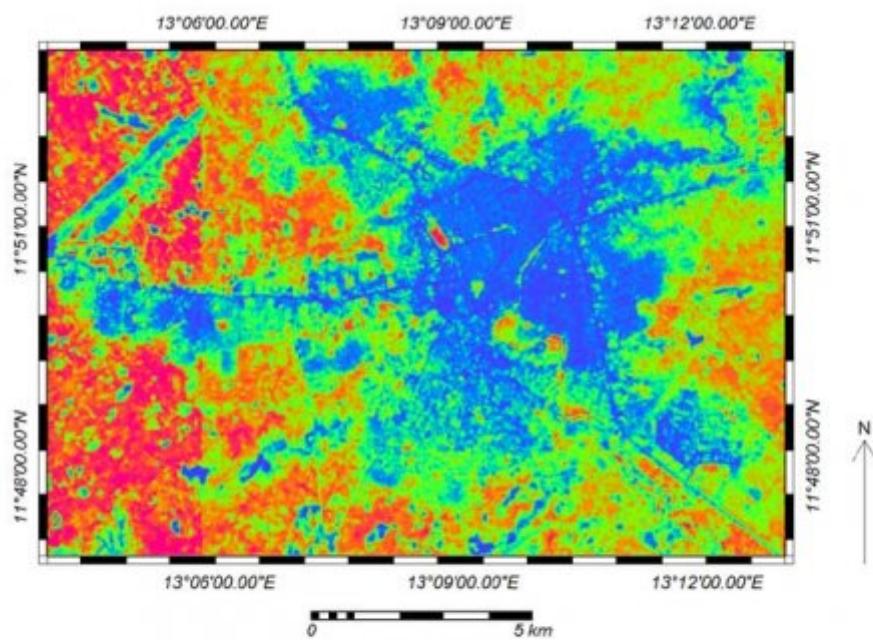
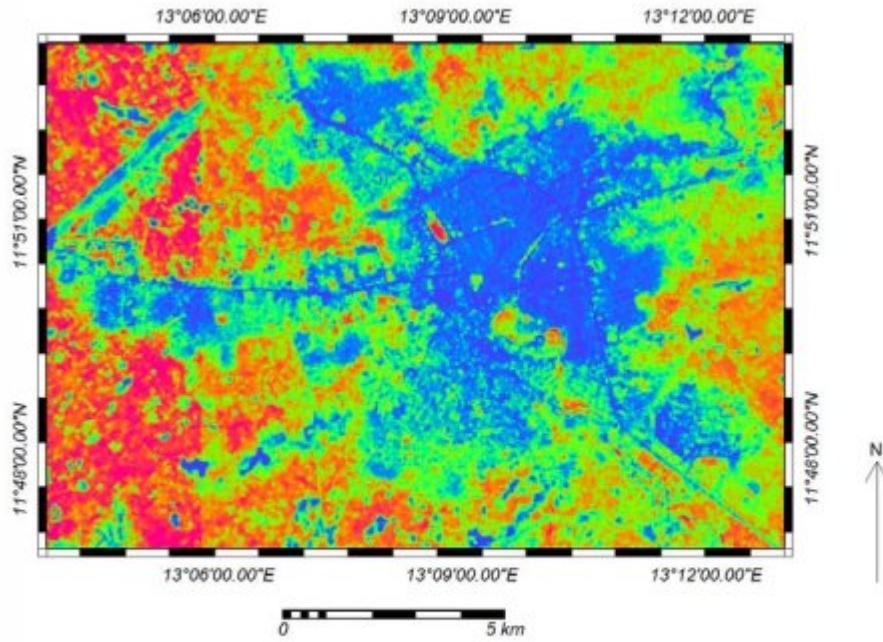


Figure 2: FOR



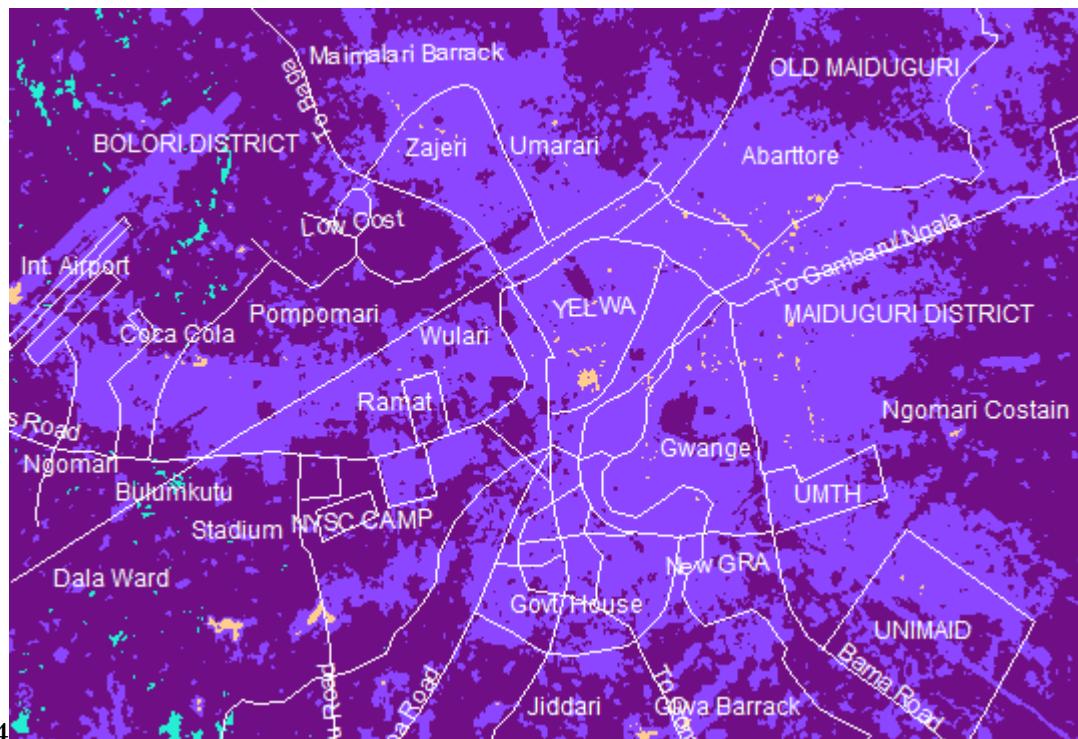
1

Figure 3: Figure 1 :



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Figure 4: Figure 2 a 2 Volume



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

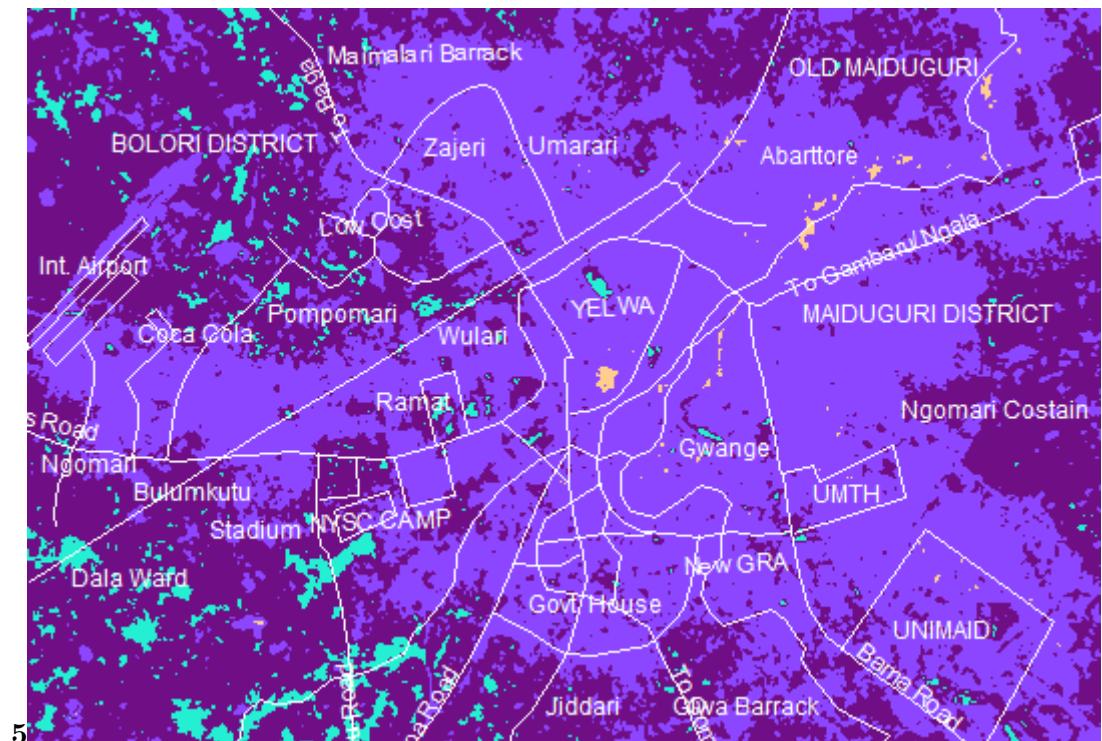


Figure 6: Figure 5 :

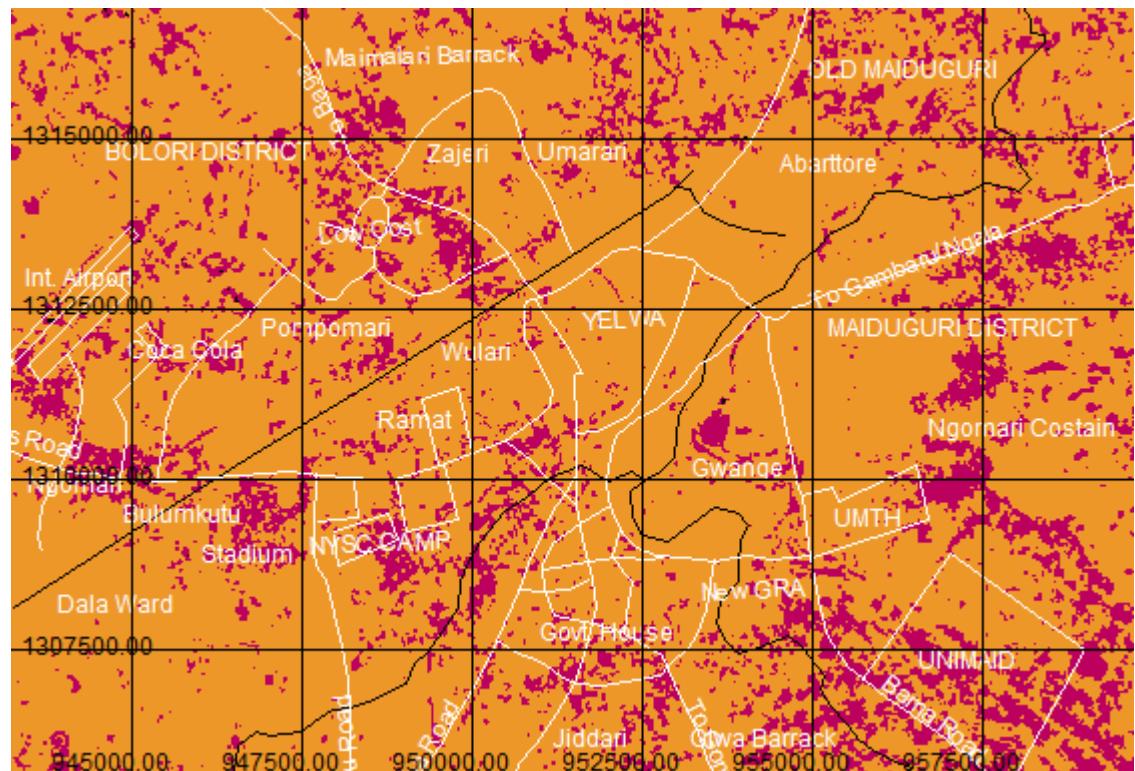


Figure 7:

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

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.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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