Impact of Urban Growth on Green Space in Maiduguri Metropolis, Borno State (1975 – 2015)

***Iyawa, A; **Waziri, M; **Jimme M. A. **Sambo, G.H.**

*Centre for Disaster Risk Management & Development Studies (CDRM&DS), University of Maiduguri, Borno State, Northeast, Nigeria.
** Department of Geography, University of Maiduguri, Borno State, Northeast, Nigeria.

Abstract

A green area in a city is an open space that is deliberately left untouched permanently. The trees, grasses and shrubs in a green area have special attributes associated with a planned city that nurture healthy living condition for the inhabitants of the city on a sustainable basis. The paper assessed the impact of urban growth on the green areas of Maiduguri city. Data was generated from the city plan and satellite images of 1975, 1986, 1999 and 2015 to determine the changing pattern of land use in the green areas. The study was conducted within an area of a 10 km radius that effectively housed the green areas of Maiduguri in 1975. The total area under study was 31,428 hectares comprising 3245 ha of green areas and 28,183 of other land use. In 1986 the green areas have reduced to 1889 hectares with a corresponding increase in other land use to 29,539 ha. The green area in 1999 has further reduced to 1114 ha with an increase of other land uses to 30,314 ha. The result indicated that the green area of 3,245 hectares in 1975 has virtually disappeared by 2015. At the same time, satellite images of the city suggest a progressive increase in other land uses (residential, institutional, commercial/industrial and transportation). The results indicated a tremendous decline in the green areas of the city. This can be attributed to a lack of adherence to planning rules and regulation and the growing need for housing and other infrastructural facilities in the city. The paper recommends the need for land-use land cover monitoring to restore the green areas in the city, pragmatic physical planning intervention by the government, an all-inclusive approach to green area management involving NGOs, individuals, traditional rulers and advocacy to regain the cities green areas among others.

Keywords: *Green Space, land use, Urban Growth*

Introduction

Urban green space is a component of "green infrastructure". It is an important part of public open spaces and common services provided by a city and can serve as a health-promoting setting for all members of the urban community. Urbanization results in an increasing proportion of the population living in cities. Although cities occupy only 2 per cent of the planet's surface, their inhabitants use 75 per cent of their natural resources; by 2050, 70 per cent of the global population will live in cities and towns (FAO,2016). Urban living limits access to nature and can increase exposure to certain environmental hazards, such as air and noise pollution.

Many urban areas face increasing pressure from expanding populations, limited resources and growing impacts of climate change (WHO Regional Office for Europe, 2017). Green spaces and other nature-based solutions offer innovative approaches to increase the quality of urban settings, enhance local resilience and promote sustainable lifestyles, improving both the health and the well-being of urban residents.

Parks, playgrounds or vegetation in public and private places are a central component of these approaches and can help to ensure that urban residents have adequate opportunities for exposure to nature, urban biodiversity is maintained and protected, environmental hazards such as air pollution or noise are reduced, the impacts of extreme weather events (heatwaves, extreme rainfall or flooding) are mitigated, the quality of urban living is enhanced, and the health and well-being of residents are improved.

The links between green space and health have been summarized in many publications (Hartig et al., 2014; WHO Regional Office for Europe, 2016). Through improved air and water quality, buffering of noise pollution and mitigation of impacts from extreme events, urban green spaces can reduce environmental health risks associated with urban living. Besides, they support and facilitate health and well-being by enabling stress alleviation and relaxation, physical activity, improved social interaction and community cohesiveness. Health benefits include improved levels of mental health, physical fitness and cognitive and immune function, as well as lower mortality rates in general.

A study by (Dami, *et al.,* 2014), shows that between 1962 and 2002, close to 1000km^2 of rural land was converted to urban land. Similarly, Ikusemoran & Jimme,(2014)

found that the city grew from 87.52km^2 in 2002 to 102.62km^2 in 2012.

According to (Bello, 2018), from 2000 to 2018 built-up areas dominated the land of Maiduguri urban with about 51.81% in 2000 to 64.57% in 2018. This was mainly due to the increased demand for housing associated with population growth in the city. These studies have essentially shown that the growth trend of the city is quite phenomenal; and hence the effect of the growth on green areas of the city. Several studies (Waziri, 2012, Bwala, *et al;* 2015, Akeh *et al,* 2018, Jimme *et al*; 2020), were carried within the city but the majority focused on urban expansion and environmental problems, hence the need to undertake this study. Maiduguri as a city was re-planned in 1975 with areas marked as green areas (Max Lock, 1976). This paper, therefore, assesses the impact of changes relating to the area, pattern and trend observed on green areas of Maiduguri city from 1975 to 2015.

Study Area

Maiduguri is located between latitude 11° 40′N and 11° 44′N and longitude 13°05′E to 13°14′ E (Fig.1). It covers a total area of 543km^2, which makes it the largest urban centre in the Northeastern region of Nigeria (Daura, 2002). Administratively, it is the capital of Borno State and covers Maiduguri Metropolitan Council, (MMC), Jere, Konduga and parts of Mafa Local Government Areas (Kawka, 2002). The vegetation within the metropolis is mainly Neem and economic trees such as Mango, black Currant trees and Cashew nuts. The 2015 projected population was estimated to be over 1,112,449 as a result of the influx of Internally Displaced Persons (IDPs) (World Atlas, 2016).

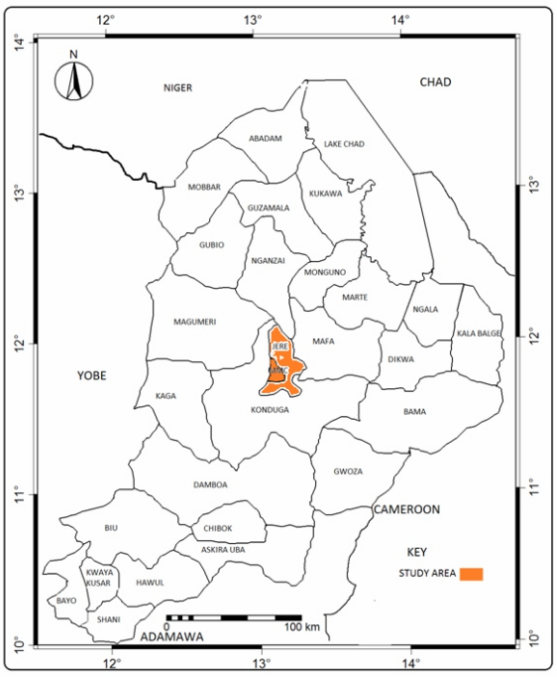

Fig.1: Map of Borno State showing the study area

Source: Digitized from base map obtained from Borno State Ministry of Land and Survey, Maiduguri

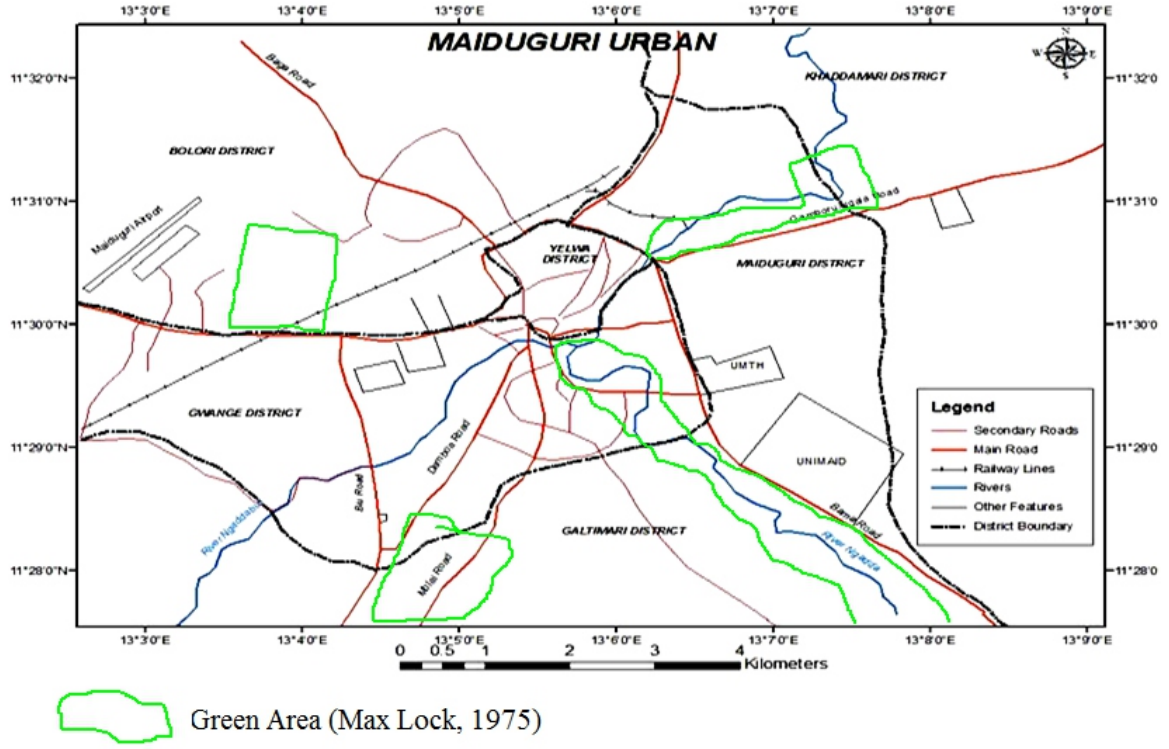

Figure 2: Maiduguri Township (Study Area)
Source; Digitized from base map obtained from Ministry of Land and Survey Maiduguri

Materials and Methods

This study used satellite imageries and a base map of Maiduguri city. The satellite images were obtained from Landsat MSS (Multispectral Scanner) – 1972, Landsat TM (Thematic Mapper) – 1986 and Landsat ETM+ (Enhanced Thematic Mapper – 2000 and 2010). The images were used to assess the trend, pattern and magnitude of the effect of changes on green areas in Maiduguri and Environs, nature and extent of the changes in the areas. Since the ETM+ developed mechanical failure in May 2003, the 2010 data had noise because its sensor's scan line corrector (SLC) instrument failed to compensate for the forward motion along-track. However, the Landsat Anomaly Response Team confirmed that the SLC noise was mechanical and permanent in nature and that Landsat 7 TM continues to acquire data, which are available with the missing data (from SLC). Hence, the use of Landsat 7 to fill the strip lines on the image.

The process largely involved overlays to determine periodic area changes of green areas (Figure 2). The base map is a Max Lock plan of Maiduguri of 1975. The plan was scanned into bitmap format. BMP

picture) after which it was imported into ILWIS. It was then geo-referenced using Grid Universal Transverse Mercator (UTM) Coordinate system before screen digitization process to determine the size of the green areas. The geo-referencing was achieved using GPS (set in UTM, Zone 33) field data from five control landmarks identified on the Max Lock Plan and the ground.

The 1975 Maxlock plan of Maiduguri was segmented using the Line Vector Map module of ILWIS. The images used were Landsat MSS 1986, ETM+ 1999 and Landsat ETM+ 2015, with a spatial resolution of 30m, 28.5m and 30m respectively (Figures 3,4, and 5).

The satellite images were overlaid on the Max Lock plan as a baseline map, to determine where exactly the green areas of 1975 were obtained. The knowledge of the physical area by the authors simplified the understanding of where the green areas were in the base year 1975. Re-screen digitizing of green areas of 1986, 1999, and 2015 using the ILWIS Line Vector Map was then achieved.

The redundant nodes of Line Vector Maps of green areas of different years were removed before the authors checked for correction of self overlap, dead ends, intersection and code consistency. Finally, the Line Vector Maps were polygonized and a topology was built before computing the respective areas that determined the extent of each green area. An overlay of all the green areas on one map was made to see the extent of encroachment. Using this process, the area for each green area in the considered years of 1975, 1986, 1999 and 2015 was achieved.

The areas were converted into square kilometre (sq km) and hectares (Ha) using the appropriate conversion table (or divide the area in m^2 by 1000,000 to obtain an area in Km^2 and/or divide the area in m^2 by 10,000 to obtain an area in Km^2). With the information obtained, a line graph was plotted to show the trend of changes in the green areas with periodic Figures.

The generated data were analyzed using a digitized quantification using the ILWIS 3.3a GIS software model to assess the city's green area as well as the shapefile technique to show periodic changes. Satellite data showing the trends and pattern of changes in the identified green areas is obtained.

Results and Discussion

Spatio-Temporal Changes to Landcover

The findings of this paper were based on the satellite images of Maiduguri of 1986, 1999 and 2015. These images show the visible green areas of the city, thus provided the areas in km^2 and hectares (Ha and Km^2) of each period. The total green area polygon for each period of the city images of 1986, 1999 and 2015 shows the trend and pattern of changes that took place in the green areas (Figures 4 and 6). These results are equally presented in table 1.

Table 1: Gazetted Green Areas of Maiduguri Metropolis (1975-2015).

S/N	Year	Hectare	Km^2	Percentage (%)
1.	1975	3,245	32.45	10.32
2.	1986	1889	18.89	6.01
3.	1999	1114	11.14	3.54
4.	2015	0.0	0.0	0.0
	Total	**6,248**	**62.48**	**19.87**

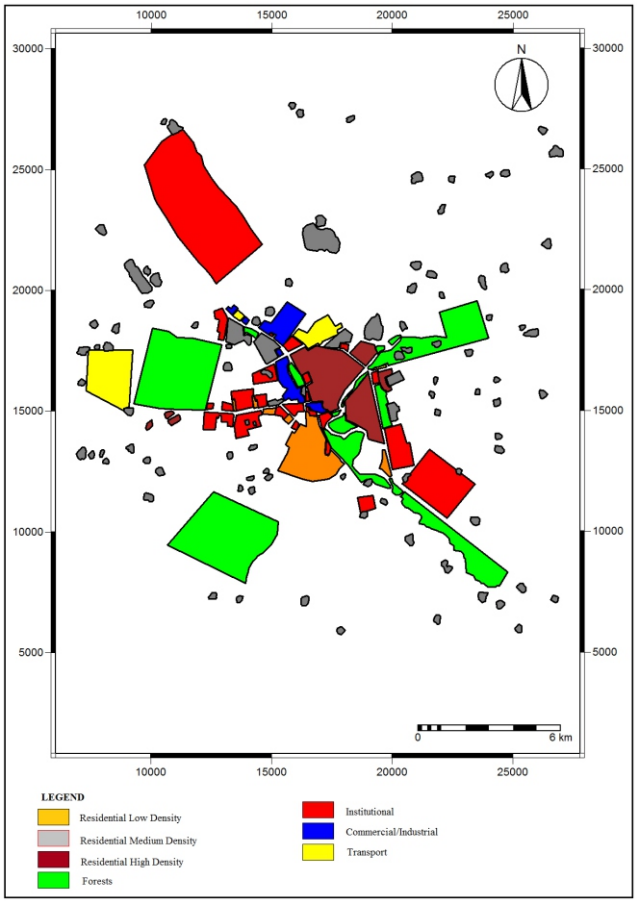

Figure 3: Land use Pattern in Maiduguri City (1975)
(Source: Max lock Group Maiduguri plan 1975)

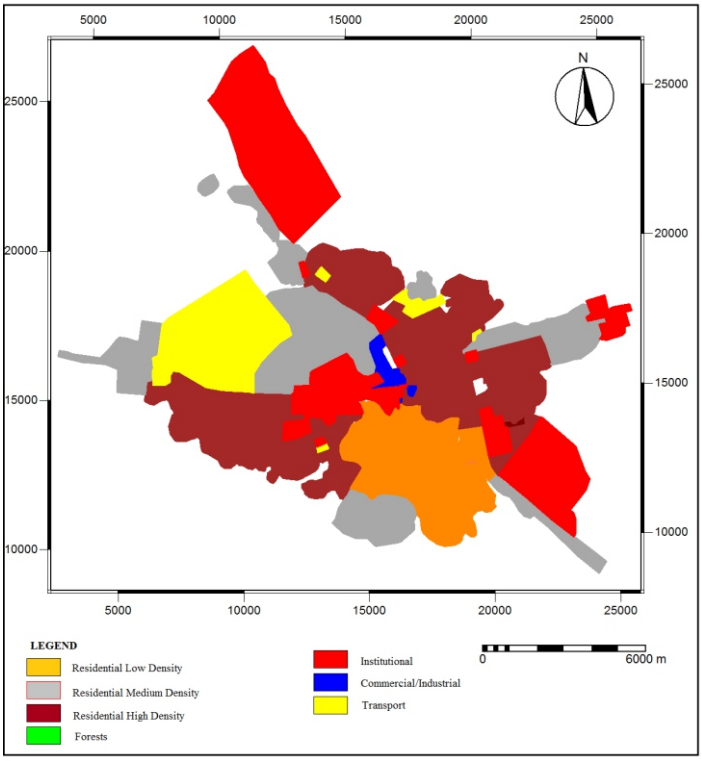

Figure 4: Land use Pattern in Maiduguri City (1999)
(Source: GEONET CAST, 2015)

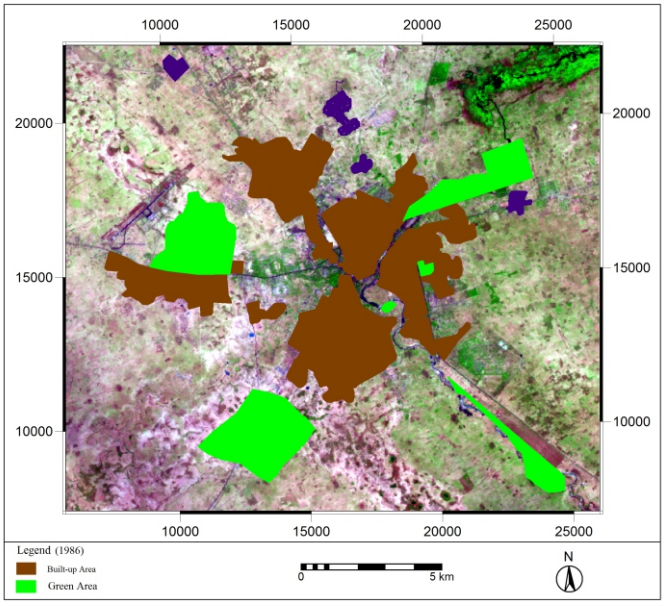

Figure 5: Land Cover Image of Maiduguri (1986)
(Source: GEONET CAST, 2015)

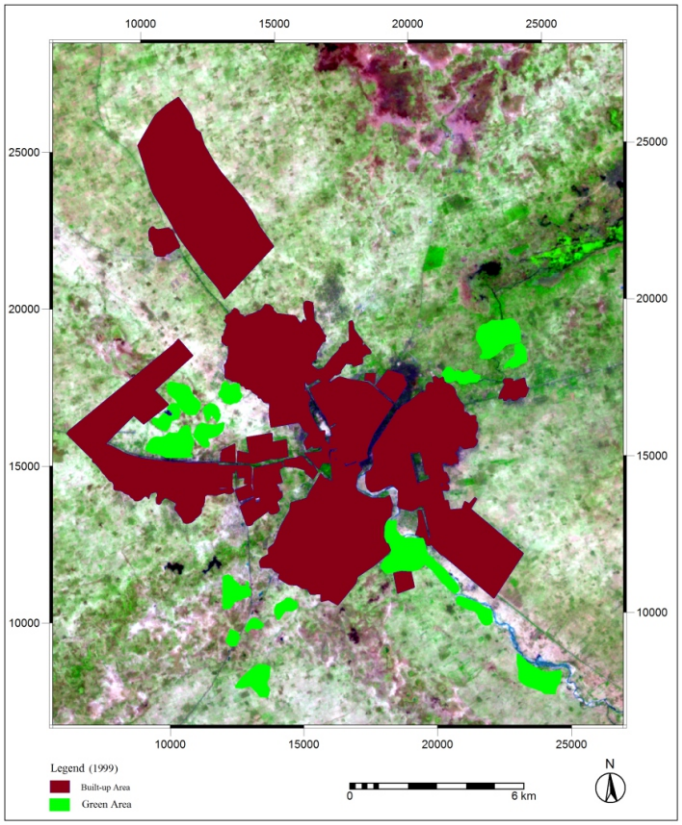

Figure 6: Land Cover Image of Maiduguri (1999)
(Source: GEONET CAST, 2015)

The Landsat image of 2015 has shown that there were no reserved green areas as earmarked in the Max Lock Plan on the image of 1975 (Figure 3). Therefore, by 2015 it was obvious that all the green areas have completely been lost due to human encroachment as the areas were allocated for use by the Ministry of Lands and Survey and now under the control of Borno State Urban Development Board. The total surface area of green areas of Maiduguri in 1975 was 32.45 Km^2 (Figure 3). Therefore, using the pie r^2 formula the total area within which form the basis of the study area is 314.28 Km thus is equal to 314.28 x 100 = 31,428 ha.

The green area in 1975 was 3,245 ha while other land uses constituted about 28,183 ha i.e., the percentage of the green area to the total land area under study was 10.32%. As of 1986, the green areas of the city have reduced to 1,889 ha with 52.2%, while the area covered by other land uses increased to 31,428 ha. The percentage of green area in 1986 is 6.01%. A reduction of the green

area between the period of 1975- 1986 in eleven years (11yrs) has increased by 1,356 ha. The green area in 1999, was 1,114 ha and 31,428 ha is built. The green area in 2015 is 0.00 ha and another land use is 31,428 ha. This shows that by 2015 the green areas have been lost to other land use as evidence in the satellite image of 2015 which is not visible. Therefore, it will be assumed that the green areas of Maiduguri have been completely lost to built area which includes other land use totalling 31,428 ha.

The green area in 1975 (Figure 3), was estimated as 3,245 ha and progressively in 1986, the areas have reduced to 1,889 ha (58.2%). In 1999, the green area has reduced to 1114 ha with a corresponding percentage of 34.3% (Figures 5 & 6). The green area based on the 2015 satellite image was totally lost, as a result of Urbanization and their conversion to a built-up area for residential, institutional and commercial purposes.

An attempt was made to show the different land-use type in 2015 to facilitate understanding of land use type that exists to serve for further research analysis in quantifying land type that dominates the Maiduguri land use over the years. Figures 7 and 8 show a graphical representation of the green area and other land use from 1975 to 2015 with a clear indication of the impact of the trend of changes and development pattern and of the city as it has affected the green areas.

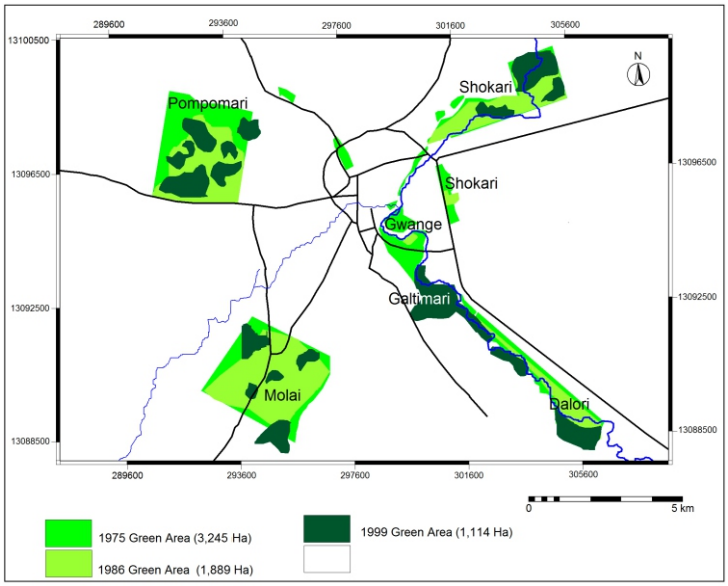

Figure 7: Life overlay of Green Area of different Dates (Source: GEONET CAST, 2015)

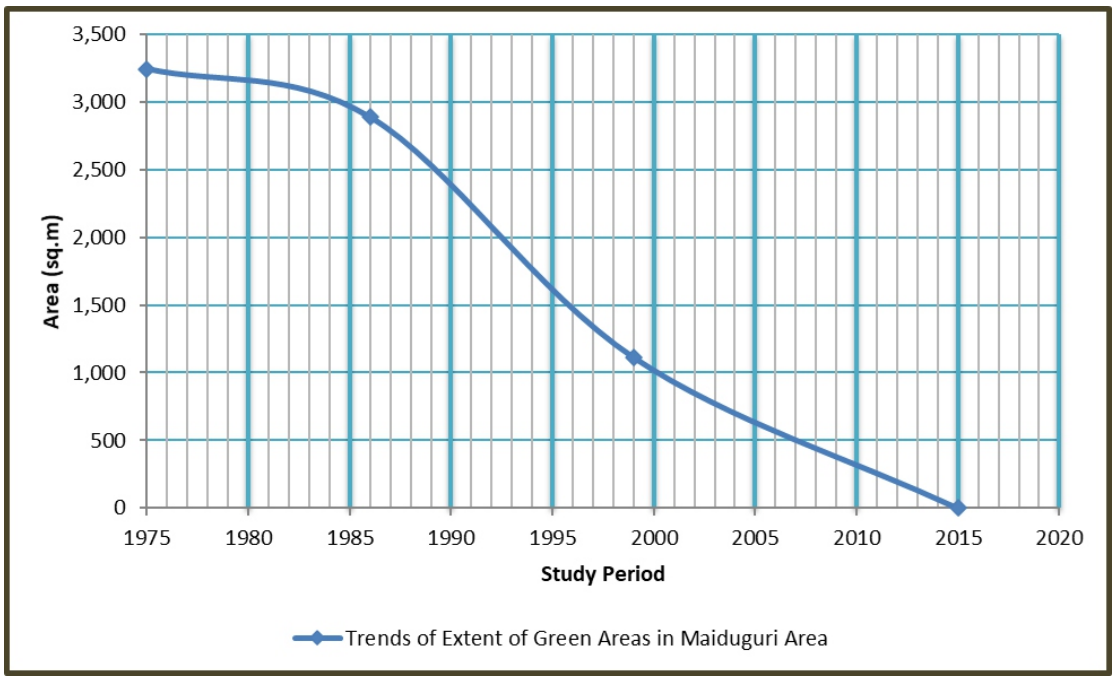

Figure:8: Trend of Green Areas (1975-2015)

Conclusion

The paper established that changes within the green areas of Maiduguri in the study period 1975 to 2015 was quite tremendous to the extent that by 2015 no green area is visible on the satellite image obtained. The trend shows that out of a total area of 3,245 hectares of green areas in 1975, a decrease to 1,889 ha was observed in 1986, and in 1999 seen on the satellite image, while in 1999 it has reduced to 1,114 ha and completely disappeared in 2015. The 2015 satellite image of Maiduguri shows that land use is predominated by residential developments, institutional, commercial and transportation land uses. Forests and trees in cities, if properly managed, can make important contributions to the planning, design and management of sustainable, resilient urban landscapes. They can help make cities more pleasant, attractive and healthy places in which to live, as well as safer, wealthier and more diverse. It is, therefore, necessary to ensure that public green spaces are easily accessible for all population groups and distributed equitably within the city.

Recommendations

Based on the findings, the paper, therefore, recommended that: -

- There is a strong need for the restoration of the city's green areas, adopting

effective strategies towards afforestation.

- There should be strong media participation through radio jingles, advertorials, in the print media, community awareness fora and NGOs, and conservation groups for residents of the city through the vigorous campaign for awareness of the importance of the city's green areas.
- Development plans should be revisited to implement realizable plans for the restoration of the cities green areas as we have seen recently in the cities of Lagos, Kano and Calabar.
- Governments and individual land speculators who have acquired most of the cities green areas over the years should actively be involved in the drive for the restoration and mitigation of the city's green areas.
- The idea of the importance of green areas should be inculcated in schools' program from the primary, secondary and tertiary institutions as well as the community.

Further research should be encouraged for sustainable approaches to city green areas, restoration, protection and conservation.

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