Analysis of Landuse/Landcover Change in Damaturu Town of Yobe State, Nigeria

ABSTRACT

Landuse/landcover change detection is an essential process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial pattern, distribution, and variation of the physical and cultural landscape features. Damaturu town became the capital of Yobe State when it was created in 1991. Since then, Damaturu has been experiencing rapid changes in the landuse/landcover types due to urban expansion, economic development, and social transformation in the town. Therefore, there is a need to examine the trend and pattern of these changes for proper planning and development of the town. This study examined the dynamics of landuse/landcover change of Damaturu town from 1986 to 2009 using Remote Sensing and Geographic Information System techniques. The following satellite imageries of Damaturu Township were obtained and processed for the analysis: LandSat Multispectral Scanner (MSS) – 1985, 1991, Landsat Enhanced Thematic Mapper (ETM) – 1999, and Nig-sat1 Enhanced Thematic Mapper (ETM) of 2009. The images were resampled, rectified and georeferenced to the UTM map projection (zone 32), Minna Nigeria horizontal datum, and Clark 1880 ellipsoid. A supervised classification approach and maximum likelihood algorithm with a threshold of 50 and mahaloni respectively was used for landuse evaluation and mapping from Landsat data with spatial resolution of 30m. In order to detect landuse/landcover change of Damaturu town from 1986 to 2009, a modified version of supervised scheme was adopted to classify the images into five classes: the built-up, bare surface, cultivated land, wetland and shrubland. Then the image statistics was used to differentiate changes in landuse/landcover within the period of study. The change detection also used visual analysis which was combined with the information collected through field survey to complement the results of GIS analysis. Findings revealed that between 1986 and 1991, there were no significant landuse/landcover changes that have taken place in Damaturu town. After the creation of Yobe State in 1991, the policies of planning authorities played vital role in determining the urban landuse pattern which is described as bottleneck along the main roads and consequently the stratification of the lands within the town into high density, medium density, and low density areas within this period (1991-1999). During this period, Damaturu built-up area increased about four times. This significant increase led to corresponding increase in urban area which was responsible for significant decrease of bare surface and shrub land. From 1999 to 2005, the built-up area of Damaturu increased by 7 Km^2 while the urban area expanded by about 11 Km^2. In addition the large increase of cultivation during that period cannot be unconnected with increased agriculture to meet the demand of the growing population. However, the reduction of bare surface by more than half is the most remarkable of all the landcover changes that have taken place within this period. The growth pattern within this period could be described as radial. Moreover, it was observed that the high density built-up spread out from core-traditional city centre to medium density areas. Within the period of 4 years (2005-2009), the expansion of built-up area of Damaturu was not as significant as the reduction of more than two-third of the wetland, and there was also significant reduction of shrub land. However, the reduction of bare surface during this period is insignificant as development of the town has been steady for quite sometimes. Damaturu areal extent increases geometrically while built-up areas and population increase

arithmetically. In addition, findings from field survey revealed serious abuse of the masterplan and development plan of Damaturu town leading to many environmental problems in the town. There is urgent need to review and implement the present Damaturu masterplan to accommodate the present and future changes in the town.

Keywords: [Landuse, landcover, change detection, Remote Sensing, GIS]

1. INTRODUCTION

The terms landuse and landcover are often used concurrently and sometimes interchangeably to describe landscape features of the Earth's surface. However, landcover denotes the physical features such on the Earth's surface, while landuse refers to the human activities associated with the landcover. The landuse/landcover (LULC) pattern of a region is determined by the natural and socioeconomic factors as well as their interactions in space over time (Rimal, 2011).

Human activities have considerably changed the natural physical landscape of the Earth's surface resulting into characteristic pattern in the landuse and landcover over time (Abiodun et al., 2012). These changes continue as a result of continuous interaction between man and his environment for socioeconomic development. However, the magnitude of landuse and landcover change varies with time and space. Landuse and landcover change has become a central part in current strategies in natural resource management and environmental change monitoring. This is because urbanisation has brought about changes in landuse and landcover patterns (Rimal, 2011) especially in developing countries of the world. These changes have both positive and negative impacts on the environment. Change detection analysis is required to ascertain the magnitude and pattern of the change for proper landuse development, planning and management.

Landuse/landcover change detection is the process of discovering differences in the pattern of landuse/landcover observed over time. Change detection is an essential process in monitoring and managing natural resources and urban development (Zhou et al., 2008) because it provides quantitative analysis of the spatial distribution of the features of interest. Landuse/landcover change detection involves not only detecting the changes but also the nature, extent and the spatial pattern of the change. There are several techniques of Remote Sensing (RS) and Geographic Information Systems (GIS) used for landuse change detection. These include Composite Image; Image Comparison; Comparison of the Classified Images; Combination of the Classified Images; Radar Classification (Belaid, 2003).

Zhou et al. (2008) employed an object-based classification and post-classification change detection on multi-temporal high-spatial resolution aerial imagery to detect changes in the Gwynns Falls watershed from 1999 to 2004. The Gwynns Falls watershed includes portions of Baltimore City and Baltimore County in Maryland, USA. An object-based approach was first applied to implement the land cover classification separately for each of the two years. Following the classification, they conducted a comparison of two different landcover change detection methods: traditional (i.e., pixel-based) post-classification comparison and object-based post-classification comparison. The results of their analyses indicated that an object based approach provides a better means for change detection than a pixel based method. Sreenivasulu and Bhaskar (2010) produced landuse/landcover maps of Devak catchment in Jammu District of India for the years 1958, 1979, 1990 and 1998 by image processing and visual interpretation technique from the analysis of Geocoded standard False Colour Composite (FCC) paper print data for the year 1990, digital data for the year 1998 and SOI topographic maps for the year 1958 and 1979. They discovered significant changes in the

landuse/landcover of the area over the period of study. In addition, Balogun et al. (2011) used multi-temporal remote sensing data and GIS techniques with field survey to detect the landuse and landcover change between 1986 and 2007 in Akure, a city in south-western Nigeria. Their findings revealed that arable land and built-up/settlement have increased; while bare-surface land and dense forest have decreased between 1986 and 2007. Furthermore, Isma'il et al. (2013) integrated LandSat TM of 1988, LandSat ETM imageries of 1999 and 2007 of Kazaure Local Government Area of Jigawa State in northwestern Nigeria into a GIS environment to analyse urban growth pattern of the area using post-classification change detection approach. The results of the change detection analysis were combined with information obtained on landuse change from field survey in the area. Findings revealed that population growth and expansion of economic activities have resulted into the expansion of the built-up area from about 12% in 1988 to close to 30% in 2007. In addition, the bare surface was found to have decreased tremendously over the years from 34% in the year 1988 to 4% in the year 2007.

Yobe is one of the states created in northeastern Nigeria in 1991, with the state capital located in Damaturu town. Since then, Damaturu has been experiencing rapid changes in the landuse/landcover types due to urban expansion and economic transformation in the town. These in addition to other factors influence the landuse/landcover change in the city. Therefore, there is the need to examine the trend and pattern of these changes for proper planning and development of the city. Daura et al. (2006) studied the problems of Damaturu urban development focusing on the expansion of residential neighbourhoods. Besides, Mamudo (2009) appraised Damaturu development plan of 1992 with a focus on conformity analysis. His findings revealed specific problems of the development plan implementation, some of which are social, political, and economic. However, their studies did not examine the trend and pattern of landuse/landcover change in Damaturu since it was made the capital of Yobe State in1991. Hence, the focus of this study is to examine the dynamics of landuse/landcover change of Damaturu town from 1986 to 2009 using Remote Sensing and Geographic Information System techniques.

1.1 The Study Area

Damaturu is located between latitude 11^0 39' 30'' – 11^0 47' 00'' N and longitude 11^0 54' 00'' – 12^0 02' 00''E as shown in Figure 1. The town has been the district headquarters of the then Borno province. It was later made the headquarters of Damaturu Local Government in 1976, and in 1991 it became the capital of Yobe State and headquarters of Damaturu Emirate in northeastern Nigeria. The town is on A3 highway and covers a land area of 206,241 Km^2. Damaturu was founded in 1813 and it is multi-ethnic with the Fulani and Kanuri as the dominant ethnic groups. Others are the Hausas, Karai-Karai, Bade and other minority tribes of the state. With the creation of Yobe state in 1991, a growing number of Igbo and Yoruba from southern Nigeria migrated there. Tivs and other southern tribes are also found as traders and public servants in Damaturu town.

According to the 1991 census of the National Population Commission, the population of Damaturu was 30,970. The population increased to 39,233 in the year 2000. It was estimated at 48,014persons according to 2006 census, and the population of Damaturu increased to 69,952 in 2010. The landuse and landcover of Damaturu consist of settlements, agricultural activities such as farming and animal rearing, and public structures such as schools, offices, road and markets etc. Being the administrative centre of the state, it is inhabited majorly by civil servants and traders.

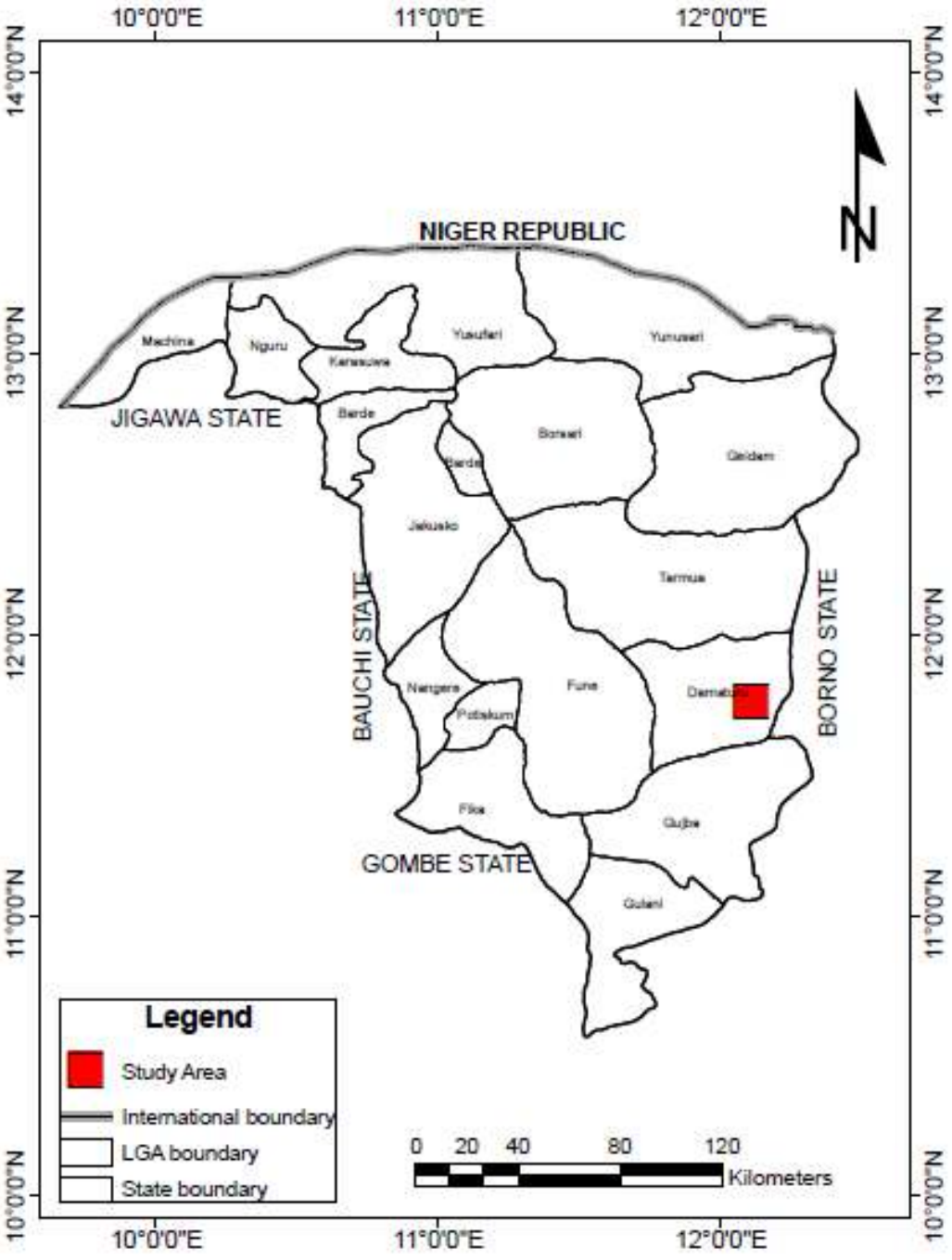


Figure 1: Yobe State Showing Damaturu
Source: Yobe State Ministry of Lands and Survey

2. METHODOLOGY

2.1 Types and sources of data

The primary data used for this study include four sets of satellite imageries, field survey, and information obtained from residents and key informants in the town. The satellite imageries

of Damaturu Township used are: LandSat Multispectral Scanner (MSS) – 1985, 1991, Landsat Enhanced Thematic Mapper (ETM) – 1999, and Nig-sat1 Enhanced Thematic Mapper (ETM) of 2009. All these imageries were obtained from National Centre for Remote Sensing in Jos, Nigeria. The images were resampled to 28.5m resolution and have band combinations in false colour of green, red and near infrared.

The response of the residents and key informants which included officials and traditional rulers was obtained through interviews. In selection of residential sampling units, the entire study area was divided in to three zones upon which 3 wards/layouts were selected from each zone based on simple random sampling method. Since the National Population Commission did not provide data at the level of wards/layouts, the house numbering by National Water Rehabilitation Project was used. Stratified sampling was employed by selecting housing estates, new private and traditional layouts. Then in selecting respondents from these sampling units, systematic sampling was employed, and the number of respondents selected from each sampled layouts was proportional to its size. The key informants included a total of 20 respondents from Ministry of Land and Survey. The selection of these respondents was through purposive sampling technique. The information obtained from these respondents includes evolution of settlements in the town, urban planning policies, the factors responsible for the spatial pattern of Damaturu urban growth and problems associated with the growth. The use of purposive, stratified and random sampling technique was employed because of the large size in the population of some of the wards and improper setting of houses especially in the inner city.

In addition, secondary data used for this study include Damaturu base map before the creation of Yobe State in 1991, Damaturu development plan of 1992, Damaturu SE topo-sheet, layout plans with a scale of 1:5000 and a reference ellipsoid of Clark 1880 and Universal Transverse Mercator (UTM) projection. These were obtained from Yobe State Ministry of Land and Survey. The population data of 1991, 1999, 2006, and 2011was obtained from National Population Commission, Yobe State Office, Damaturu. Other secondary data were sourced from journals and reports of Yobe State Ministries of Land and Survey, Works, and Housing Development.

2.2 Digital image processing

Sub-set: Satellite imageries covering Damaturu township were extracted from the full scene of the images of 1986, 1999, 2005 and 2009.

Geometric rectifications: Geometric rectification is critical for producing spatially corrected maps of land use and assessment, through time. The 1986, 1999, 2005 Landsat images, and the 2009 Nig sat-1 were rectified and georeferenced to the UTM map projection (zone 32), Minna Nigeria horizontal datum, and Clark 1880 ellipsoid. As only some small part of Damaturu around Maisandari falls into zone 33, with only 2' a degree.

2.3 Change detection

Image Classification scheme design: A supervised classification approach and maximum likelihood algorithm with a threshold of 50 and mahaloni respectively was used for landuse evaluation and mapping from Landsat data with spatial resolution of 30m. In order to detect landuse/landcover change of Damaturu town from 1986 to 2009, a modified version of supervised scheme was adopted to classify the images into five classes: the built-up, bare surface, cultivated land, wetland and shrubland. Then the image statistics was used to differentiate changes in landuse/landcover within the period of study. The change detection also used visual analysis which was combined with the information collected through field survey.

2.4 Field survey

Interviews were conducted to obtain relevant information from the residents of the town and key informants which included government officials and traditional rulers. In selection of

residential sampling units, the entire study area was divided based on the three zones (traditional areas, new layouts, and housing estate) in the town, upon which 3 wards were selected from each zone based on simple random sampling method. Since the National Population Commission did not provide data at the level of wards/layouts, the house numbering by National Water Rehabilitation Project was used. Stratified sampling was employed by selecting housing estates, new private and traditional layouts. Then in selecting respondents from these sampling units, systematic sampling was employed, and the number of respondents selected from each sampled layouts was proportional to its size as shown in Table 1. The residents were asked about their duration of stay in Damaturu town, their type of accommodation, the socioeconomic problems in the town, the common environmental problems within the town, the problems of urban planning policies of Damaturu town, as well the solutions to the problems.

Table 1 Sampling frame for Damaturu residents

S/No	Strata	Sampled wards	No of Houses	Sample Size	Total Sample Size Per Zone
1	Traditional Areas	Ajiyari Ward	305	29	89
		Abasha Ward	209	24	
		Nayi-nawa Ward	409	36	
2	New Layouts	Sabon Pegi Ward	361	32	96
		Kiri-Kasama Ward	Nil	32	
		Nasarawa Ward	Nil	32	
3	Housing Estates	Nyanya	440	44	84
		Waziri Ibrahim	250	27	
		Ben-kalio	130	13	

The key informants included a total of 20 respondents from various departments of Ministry of Land and Survey as shown in Table 2. In addition to this, traditional rulers in the area were also interviewed. The selection of these respondents was through purposive sampling technique. The key informants were asked about the evolution of Damaturu town, the nature of Damaturu urban growth before and after 1991, the factors responsible for the growth of Damaturu, and the urban development problems in Damaturu town. They were also asked to proffer solutions to these problems.

Table 2 Sampling frame for key informants

S/N	Department	No of Sampled Officials	Positions/Schedule of Duty
1	Town Planning	10	Director, O/C Design, Heads and Deputy Heads of four Development Zones.
2	Survey	6	Surveyor General, O/C Field, and four Surveyors
3	Land Administration	4	Director Land, Deed Registrar, Head of Land Allocation and Head of Quantity Survey.
4	Administration	Nil	Nil

The use of purposive, stratified and random sampling technique was employed because of the large size in the population of some of the wards and improper setting of houses especially in the inner city.

3. RESULTS AND DISCUSSION

The change detection analysis was divided into 3 periods based on available data and change scenarios. The first period took place 9 years after state creation which covered the period between 1986 and 1999; the second period examined the changes during 6 years of civilian administration which covered 1999 to 2005, while the third period covered the period between 2005 and 2009.

3.1 1st Period: Characteristics of Damaturu landuse/landcover during the military regime (1986-1999)

The first period took place before and after the creation of Yobe State which covered the period between 1986 and 1999. The landscape of Damaturu remained the same between 1986 and 1991 as there were no significant landuse/landcover changes that have taken place before the creation of Yobe State in 1991. This can be seen on the 1991 base map of Damaturu town in Figure 2, and confirmed by responses from key informants and focus group discussions.

After the creation of Yobe State in 1991, the policies of planning authorities such as locating the government offices and housing estates at the outskirt of the town away from the city centre played vital role in determining the urban landuse pattern within this period (1991-1999). Another policy implication was variation in land values within Damaturu, and stratification of the lands within the town into high density area as in the core traditional settlement, medium density as in Sabon-Pagi and housing estates, and low density around the Government Reserve Area behind the government house. This can be seen in Figure 4. Meanwhile, the spatial growth pattern formed a bottleneck along the main roads within this period. Therefore, after 8 years of becoming a capital city, Damaturu built-up area increased about four times, from 3.06 Km^2 in 1991 to 12.12 Km^2 in 1999 as shown in Table 3 and displayed in Figures 3.1 and 3.2. This significant increase led to corresponding increase in urban area which was responsible for significant decrease of bare surface from about 81

Km^2 to 62 Km^2 and shrub land from about 42 Km^2 to 21 Km^2 as shown in Table 3. During this time, the landuse/landcover changed significantly, the significant increase in build-up density is attributed to massive construction of housing estate, development of empty lands, demographic change, as well as increased economic activities and other socio-cultural activities introduced into the town by immigrants as can be observed in Figure 5.

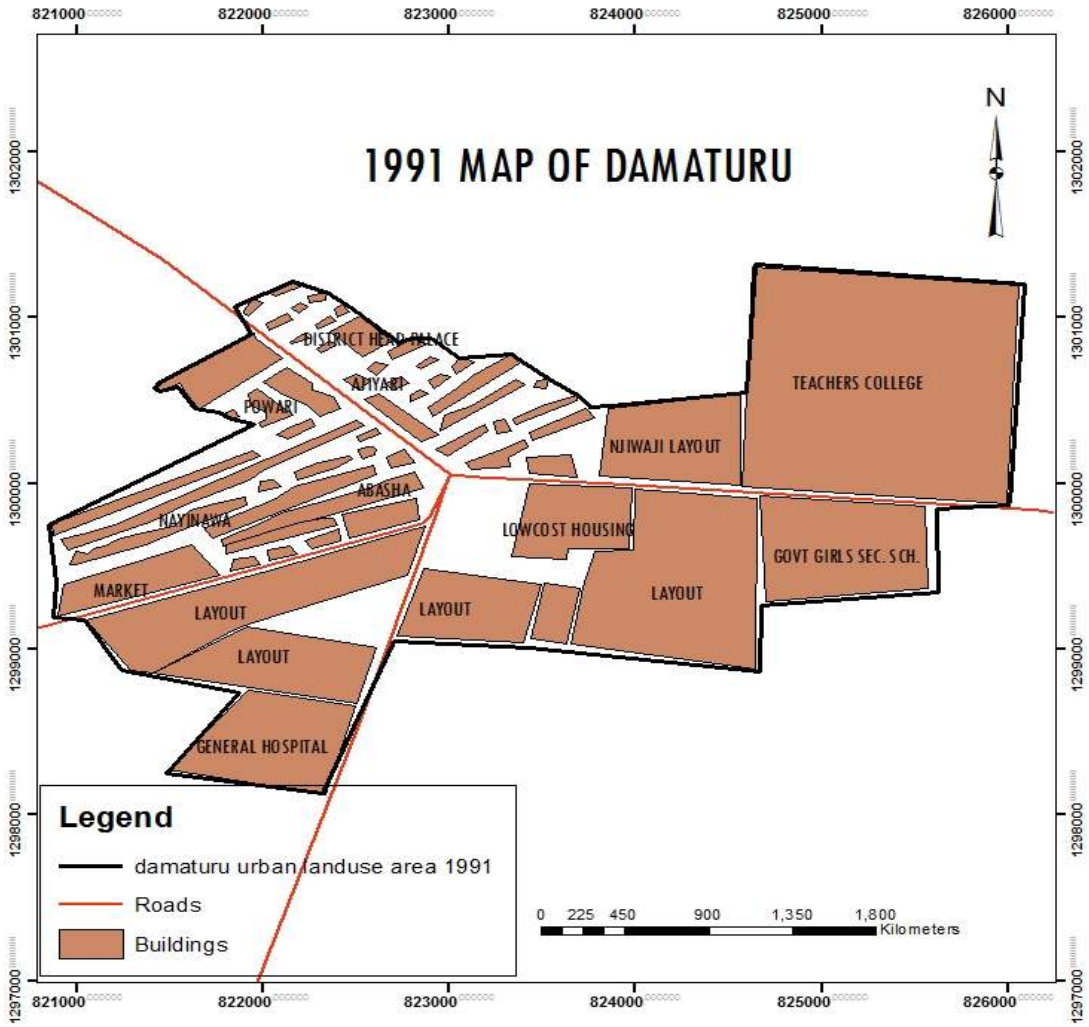


Figure 2: Damaturu before State Creation
Source: Yobe State Ministry of Land and Survey.

3.2 2nd Period: Damaturu landuse/landcover change during the civilian administration (1999-2005)

The second period which covered 1999 to 2005 analysed the changes that took place during the civilian administration. The large increase of cultivation during that period as seen in Table 3 cannot be unconnected with increased agriculture to meet the demand of the growing population. In addition, it can also be seen in Table 3 and Figure 5, the built-up area of Damaturu increased from 12.12 Km^2 – 19. 02 Km^2, depicting an increase of about 7 Km^2

of the built-up density; while the urban area expanded from 21.95 Km^2 – 33.32 Km^2 depicting an expansion of about 11 Km^2 within this period. The expansion can be seen in Figures 3.2, 3.3 and 5. The wide variation between the urban area extent and built-up density within this period is attributed to increase in urban sprawl. The growth pattern within this period could be regarded as radial around the 1999 urban growth, and the growth was attracted by the only housing estate (Sani Daura) which also represents high density area in the town. Other high density areas that developed later include Waziri Ibrahim and Ali Marami Housing Estates as shown in Figure 4. Furthermore, it can be observed from Figure 3.3 of the 2005 Damaturu map that the high density built-up spread out from core-traditional city centre to medium density areas shown in 1999 map around Gwonge, Injiwaji layout and around Nayi-Nawa and Damaturu Sunday Market. Besides, it can be seen from Table 3 that the reduction of bare surface by more than half is the most remarkable of all the landcover changes that have taken place within this period, while the increase in shrub land is also remarkable.

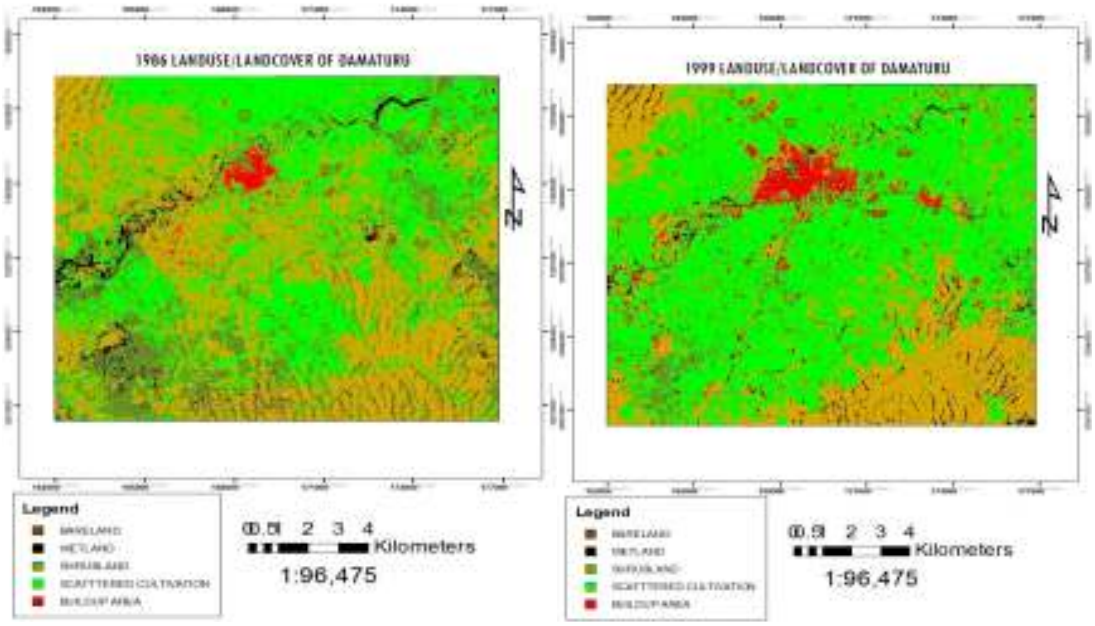
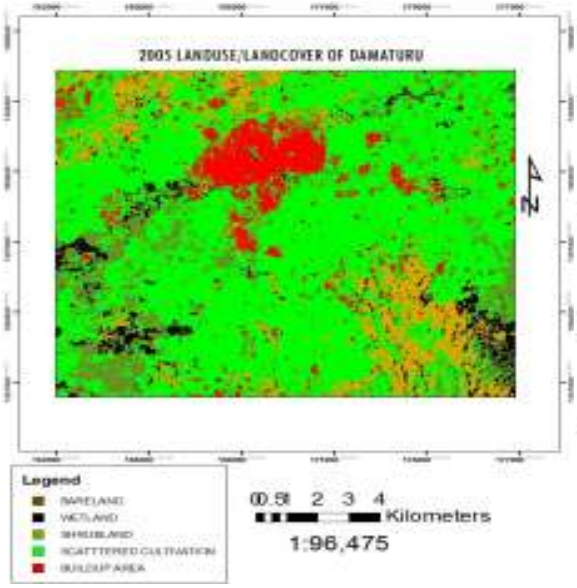


Figure: 3.1 1986 LULC of Damaturu

Figure: 3.2 1999 LULC of Damaturu



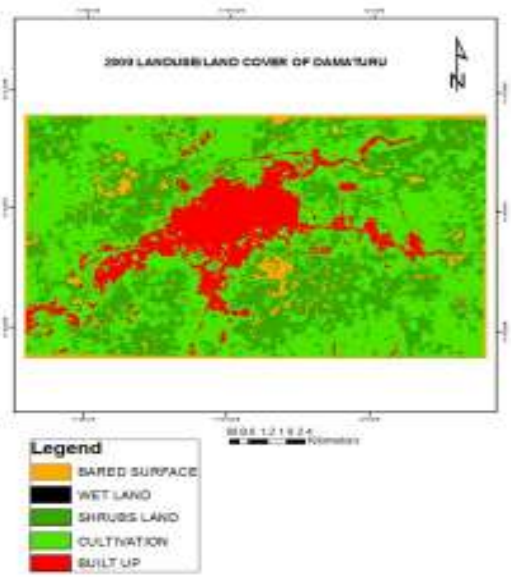


Figure: 3.3 2005 LULC of Damaturu **Figure: 3.4 2009 LULC of Damaturu**

Table 3 Damaturu Landuse/Landcover change from 1991-2009

Years / Classes (Km^2)	1991	1999	2005	2009
Built-up	3.06	12.12	19.02	23.42
Bare surface	81.47	62.11	25.35	23.13
Urban area	4.99	21.95	33.32	54.37
Wetland	4.56	6.65	11.02	4.05
Cultivation	95.99	107.92	124.43	117.63
Shrub land	41.63	20.95	18.56	9.10

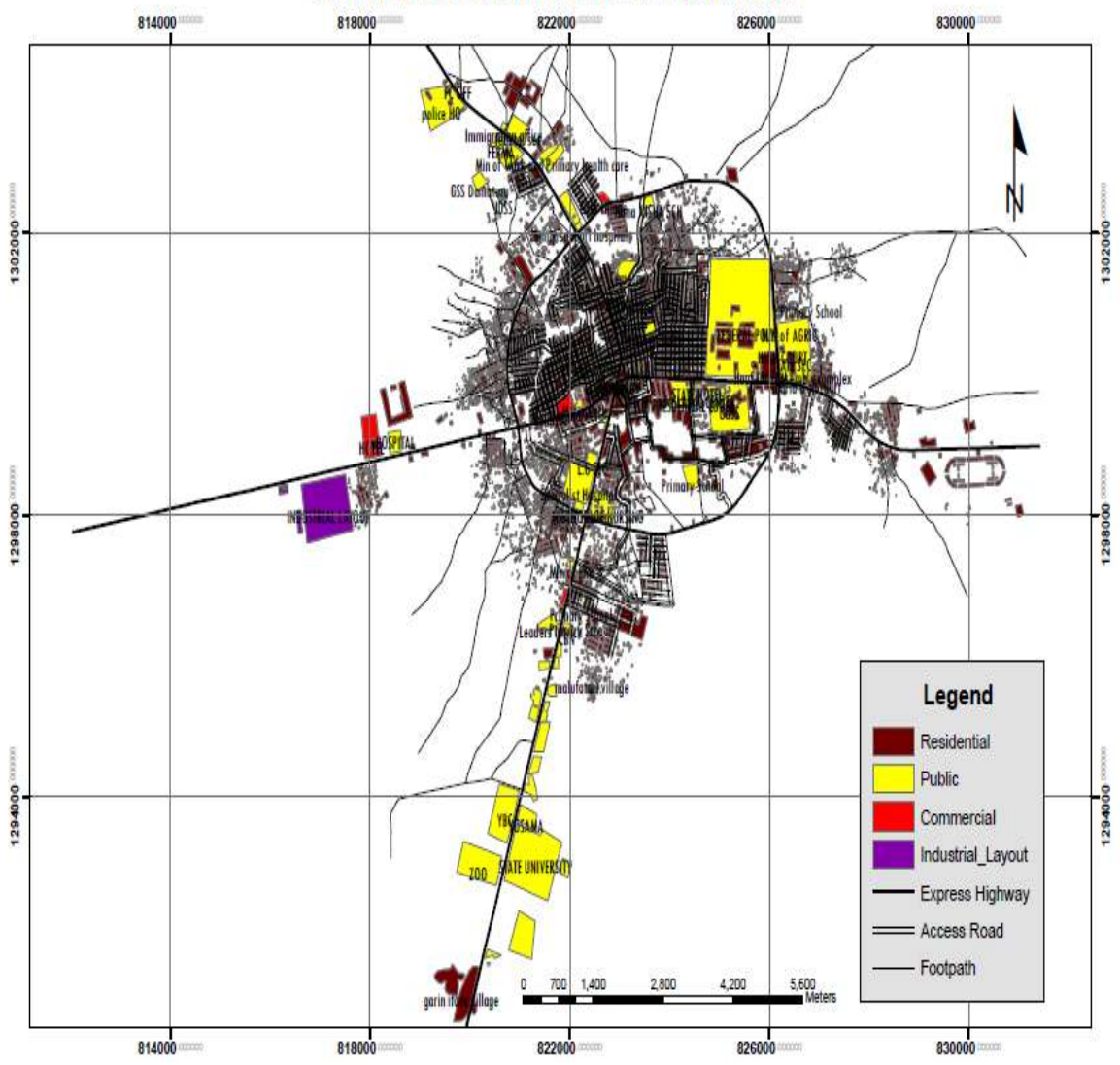


Figure 4 Damaturu urban landuse
Source: Google Earth Image

3.3 3rd Period: Current trend in Damaturu landuse/landcover change (2005-2009)

Within the period of 4 years (2005-2009), the built-up area of Damaturu expanded from 19.02 Km^2 – 23.42 Km^2, and the urban area expanded from 33.32 Km^2 – 54.37 Km^2 as shown in Table 3 and visualised in Figures 3.3, 3.4 and 5. This indicates a great variation between the rates of increase in urban area and built-up density, as the urban area extent was expanding at 4.8 times more than the built-up area as shown in Figure 5. This tremendous expansion of built-p is responsible for the significant reduction of more than two-third of Damaturu wetland and significant reduction of shrub land. However, the reduction of bare surface during this period is insignificant as development of the town has been steady for quite sometimes.

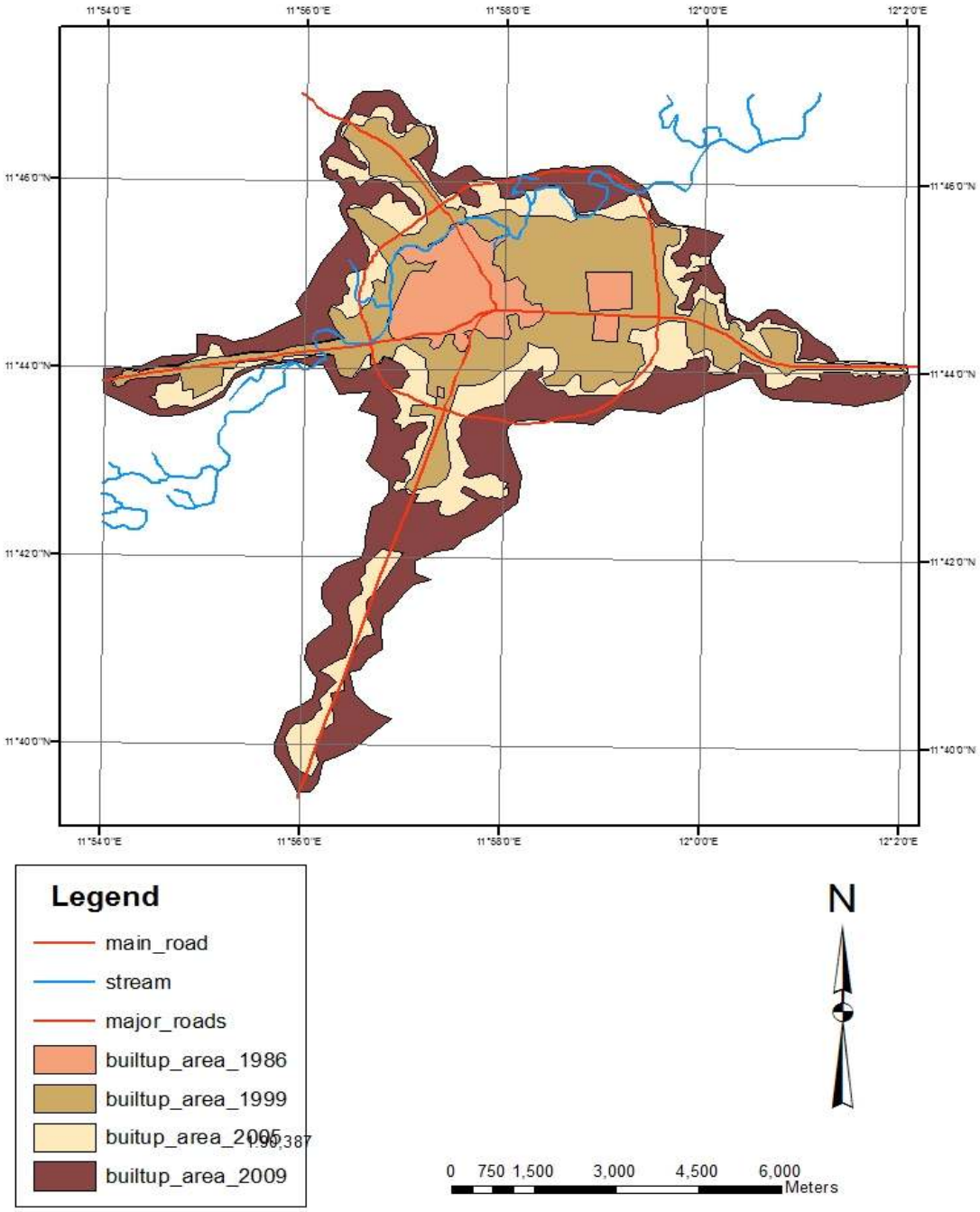


Figure 5 Damaturu Landuse/Landcover Changes

3.4 Results from field survey

The key informants revealed that Damaturu town was formed in 1813 during the Jihad of Usman Danfodio. According to them, Damaturu was a typical rural-urban settlement before 1991 and that the creation of Yobe State in 1991 and the advent of democracy in 1999 have

had profound effect on the development of the city. However, majority of them believed that the pinnacle of development of the town was reached in 2005. Besides, the key informants described the growth pattern as linear along the main roads (4 cardinal roads) of the town. Moreover, based on the majority view of the key informants, gully erosion and flooding are the major ecological problems; while illegal construction of business and commercial activities along the main roads are the major socioeconomic challenges of development of the town. They therefore suggested stringent penalty for abusing the masterplan and strict adherence to the development plan especially by the government.

Majority of the respondents from among Damaturu residents are heads of household, males of between 30 – 55 years of age, comprising of mostly civil servants, some business men and farmers. They observed that the town is fast becoming heterogeneous, and about 82% of respondents from traditional settlement observed diffusion of social cultures as one of the social factors transforming the town. The respondents from the traditional settlement mentioned air pollution especially in the evening, flooding, and mosquitoes breeding as the major environmental problems of the town. Besides, the attitude of the residents of disposing refuse in the drainage channels and water logs in the core traditional settlement have resulted into water pollution, breeding mosquitoes, and unpleasant odour around the settlements . About 52% of the respondents did not appreciate the planning policies and efforts of planning authorities in the development of the town. Furthermore, observations from the field survey revealed that, residential areas at Pawari, Nayinawa, Tsamiyar-Lilo have encroached the water logs, while the central drainage channel is not draining the water, consequently, these water logs have blocked the road side drainage channels thereby providing a conducive atmosphere for mosquito breeding. Field survey revealed that the roads reserves are converted to commercial layouts contrary to provision of developmental plan and layout plan. The access roads in most of residential areas are not up to standard as observation has shown that the size of access roads in traditional wards are even more standard and larger than those of some new layouts in some parts of Sabon Pegi, Pompomari, Nasarawa, Kiri-Kasamma, etc. In addition, 88% of the respondents reported that Damaturu urban growth is lacking some infrastructural facilities and services, especially manufacturing industries, modern market, airport and recreational services. These have seriously affected the growth and development of Damaturu town. Other responses of the residents are presented in Tables 4 and 5 below:

Table 4 Urban environmental problems

URBAN ENVIRONMENTAL PROBLEMS	**TRADITIONAL AREAS**		**NEW LAYOUTS**		**HOUSING ESTATE**		**TOTAL FRQ**
	FREQUENCY (FRQ)	%	FRQ	%	FRQ	%	
AIR POLLUTION	66	80.5	32	38	1	1.2	99
FLOODING	67	82	21	25	11	14	99
WASTE DISPOSAL	56	6.1	50	58.06	81	100	136
MOSQUITOES	66	80.5	45	53.0	35	43.2	146

Table 5 Socioeconomic problems

SOCIOECONOMIC PROBLEMS	TRADITIONAL AREAS		NEW LAYOUTS		HOUSING ESTATE		TOTAL FRQ
	FREQUENCY (FRQ)	%	FRQ	%	FRQ	%	
PRESSURE ON FACILITIES	69	84.1	43	50.6	29	35.8	141
DIFUSSION OF SOCIAL CULTURE	71	86.6	81	95.3	78	96.3	230
POVERTY	72	87.8	31	36.5	46	57	149
CRIME AND SOCIAL VICES	62	75.6	45	53.0	31	38.3	138

4. CONCLUSION

This study analysed landuse/landcover change of Damaturu town using remote sensing and GIS techniques. Information from field survey was used to complement the results of GIS analysis. Findings of this study revealed that Damaturu town remained almost the same between 1986 and 1991 as there were no significant landuse/landcover changes that have taken place. After the creation of Yobe State in 1991, the policies of planning authorities such as locating the government offices and housing estates at the outskirt of the town away from the city centre played vital role in determining the urban landuse pattern which was described as bottleneck along the main roads within this period (1991-1999). Another policy implication was variation in land values within Damaturu, and stratification of the lands within the town into high density, medium density, and low density areas. Therefore, after 8 years of becoming a capital city, Damaturu built-up area increased about four times, from 3.06 Km^2 in 1991 to 12.12 Km^2 in 1999. This significant increase led to corresponding increase in urban area which was responsible for significant decrease of bare surface from about 81Km^2 to 62 Km^2 and shrub land from about 41 Km^2 to 8 Km^2. In addition the large increase of cultivation by about 45 Km^2 during that period cannot be unconnected with increased agriculture to meet the demand of the growing population.

Moreover, after the creation of Yobe State in 1991and during the military regime, before the development of the town fully started, the population density of Damaturu town was 6,206.41 persons per Km^2. In 1999 when government offices, residential areas and recreation parks were fully developed and provided for the population, the population density decreased to 1,733.895 persons per Km^2.

In addition, it was found that from 1999 to 2005, the built-up area of Damaturu increased from 12.12 Km^2 – 19. 02 Km^2, depicting an increase of about 7 Km^2 of the built-up density; while the urban area expanded from 21.95 Km^2 – 33.32 Km^2 depicting an expansion of about 11 Km^2 within this period. The wide variation between the urban area extent and built-up density within this period is attributed to increase in urban sprawl. The growth pattern within this period could be regarded as radial, and the growth was attracted by the only housing estate (Sani Daura) which also represents high density area in the town. Furthermore, it can be observed that the high density built-up spread out from core-traditional city centre to medium density areas. Besides, the reduction of bare surface by more than half is the most remarkable of all the landcover changes that have taken place within this period, while the increase in shrub land is also remarkable.

Within the period of 4 years (2005-2009), the built-up area of Damaturu expanded from 19.02 Km^2 – 23.42 Km^2, and the urban area expanded from 33.32 Km^2 – 54.37 Km^2. This indicates a great variation between the rates of increase in urban area and built-up density. This tremendous expansion of built-p is responsible for the significant reduction of more than two-third of Damaturu wetland and significant reduction of shrub land. However, the reduction of bare surface during this period is insignificant as development of the town has been steady for quite sometimes.

Damaturu areal extent increases geometrically while built-up areas and population increase arithmetically; also the rate of built-up expansion is far greater than the rate of population growth. This is as a result of improved living standard, as most of migrant to Damaturu residents after becoming the state capital are high and medium income civil servants. The spatial dimension of Damaturu town increases the travelling distance, as proximity to place of work is determining the people choice of place of residence, as some residents travelled over 13km to their various place of work.

The key informants from the Ministry of Land and Survey revealed that Damaturu town Damaturu was a typical rural-urban settlement before 1991 and that the creation of Yobe State in 1991 and the advent of democracy in 1999 have had profound effect on the development of the city. However, majority of them believed that the pinnacle of development of the town was reached in 2005. Besides, the key informants described the growth pattern as linear along the main roads (4 cardinal roads) of the town. Moreover, based on the majority view of the key informants, gully erosion and flooding are the major ecological problems; while illegal construction of business and commercial activities along the main roads are the major socioeconomic challenges of development of the town. They therefore suggested stringent penalty for abusing the masterplan and strict adherence to the development plan especially by the government.

Majority of Damaturu residents observed that the town is fast becoming heterogeneous. The respondents from the traditional settlement mentioned air pollution especially in the evening, flooding, and mosquitoes breeding as the major environmental problems of the town. Observations during field survey revealed water pollution and unpleasant odour around the settlements. In addition, more than half of Damaturu residents did not appreciate the planning policies and efforts of planning authorities in the development of the town. Furthermore, observations from the field survey revealed that, residential areas at Pawari, Nayinawa, Tsamiyar-Lilo have encroached the water logs, while the central drainage channel is not draining the water, consequently, these water logs have blocked the road side drainage channels thereby providing a conducive atmosphere for mosquito breeding. Field survey revealed that the roads reserves are converted to commercial layouts contrary to provision of developmental plan and layout plan. There is urgent need to review the present Damaturu masterplan to accommodate the present and future changes in the town.

COMPETING INTERESTS

: “Authors have declared that no competing interests exist.”.

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