



**Assessment of Landuse/Landcover Change in Kwali Area Council Using Geo-
Informatic Techniques**

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Abstract

This study examined the land use land cover changes in Kwali Area Council of the Federal Capital Territory, Abuja Nigeria. The study applied Geospatial techniques by using satellite images of 1990 and 2014 to assess the land use land cover changes in the study area (Kwali Area council) by Classifying the satellite imageries using supervised classification scheme, to determine the percentage change in land use/ land cover of the study area and the implication of land use/ land cover scenarios from 1990 to 2014. Result of the findings from 1990 include bare surface 1.7%, built up area 4.21%, farmland 56%, grass/shrublands 5.3%, riparian vegetation 3.3%, rock outcrops 25.27%, wetland/water bodies 4.47% while result for 2014 include bare surface 2%, built up area 3.3%, farmland 56.6%, grass/shrublands 25.45%, riparian vegetation 1.07%, rock outcrops 21.67%, wetland/water bodies 0.13%. The resulting Map analysis shows that, there is considerable increase in the rate of farm activities in the area with little or no loss in vegetal cover to urbanization as is being experience in other area councils and Urbanization in Kwali area council is not as rapid in Kwali as other area council. The study suggested that, further study should be conducted to assess farming activities in the area by extending the study to 2015 and 2016 when the nation went in to recession that lead many Nigerians to go into farming to ascertain the current status of land use land cover change.

Keywords: *Landuse/landcover changes, built up area, rock outcrop, Geo-informatics techniques, Landsat Imagery, ETM.*

Introduction

Several studies have shown that there remain only few landscapes on the Earth that is still in their natural state. Due to anthropogenic activities, the Earth surface is being significantly altered in some ways and man's presence on the Earth and his use of land and its cover has had a profound effect upon the natural environment thus resulting into an observable pattern in the land cover over time (Opeyemi, 2006). Changes in land cover and in the way people use the land have become recognized over the last 15 years as important global environmental challenge (Turner, 2002, Ishaya *et. al.*, 2008; Ishaya and Abaje, 2009). There has been a consistent rapid expression in the availability of data and information. However, there has not yet been a systematic examination, using global and regional observations, of the status and trends in regional observations, of the status and trends in terrestrial and coastal land cover or related important needs for such ecosystem processes (Turner, 2002; Ishaya *et. al.*, 2009). There is need to determine the interrelationship of remotely sensed and statistical inventory data, to integrate heterogamous data source (Lambin *et. al.*, 2003).

Since Nigerian independence in 1960 till date, the landcover/landuse has experienced significant changes. Climate change is acknowledge as a contributing factor to land use and land cover changes in the sub-sahara Africa as the gross vegetal loss is highly due to climate venturous over the years as well as anthropogenic activities linked to urbanization and modernization of infrastructures within the region (Lamgin *et. al.*, 2003; Alagbe, *et. al.*, 2013). Many urban areas in Nigeria have expanded mostly on agricultural land in recent decades, increase in population and introduction of various forms of land uses are the various issue threatening the environment today (Alagbe, *et. al.*, 2013). These land uses exert pressure on a seemingly finite land cover resources. Alagbe (2013) observed that in Nigeria, land cover change annually. Most of this land cover changes are deliberate to make way for mineral exploration, development of infrastructure such as roads and railway and expansion of settlements as well as high level of household dependent on fuel woods for the supply of domestic

energy most especially among the low income earners. Land cover changes have impacts on a wide range of environmental and landscape attributes including the quality of water, land and air resources, ecosystem processes and functioning, and the climate system itself through greenhouse gas fluxes and surface albedo effects (Turner, 2002).

Kwali Area Council is one of the Area Council in FCT which has been witnessing physical growth and infrastructural development as the city centre witness more pressure of rural-urban migration bringing about alterations on the land cover over the years just like other area councils in the FCT. According to Ejaro (2013), population explosion alongside urbanization seems to be the main factor responsible for the land cover changes within the FCT. The tremendous investment in scientific analysis of remote sensing over the last decade and the profusion of studies based on other data sources, provides a basis for a synthesis, although information is not complete globally, several products are now available that depict the land cover of the earth globally in the 1990s and in 2000s (Defries *et. al.*, 2002). The same is true for snapshots of many important regions with substantial land cover change. It is against this backdrop that, the research intends to specifically assess the landuse/landcover change in Kwali Area Council using geo-informatics techniques.

To achieve the aim of this study, the following objectives were pursued; acquire satellite imagery of the study of Kwali Area Council between 1990 and 2014, Classify the satellite imageries using supervised classification scheme, determine the percentage change in land use/ land cover of the study area and, identify the implication of land use/ land cover scenarios from 1990 to 2014.

Materials and Methods

Kwali Area Council lies between Longitude $6^{\circ} 43' 30''$ and $7^{\circ} 43' 00''$ East of the Greenwich Meridian, and Latitude $9^{\circ} 00' 00''$ and $8^{\circ} 30' 00''$ North of the Equator. Kwali is bordered to the north by Gwagwalada Area Council, to the East by Kuje Area Council, to the South by Kuje Area Council and to the West by Abaji Area Council. Kwali Area Council has an area of 1,206 km² and a projected population of 218,400 at as at 2016. The settlement pattern is disperse with the indigenous cluster type of settlement mainly in Kwali town, Yebu, Leda, Dangna, Ashara, Sheda, Dabi, Pai, etc. The main ethnic grouping include the Gbagis, Ganagana, Basa, Hausa, Fulani and a handful of other ethnic groups.

The relative humidity in Kwali Area Council has a monthly value of over 50% and 75% during the raining season from April-October and decreases to 52% at the onset of the dry season (Leonard, 2003). The wind speed of Kwali ranges from a mean monthly total of 7.1m which increases from 7.8m in August and decreases to about 5.8m in December (Ebele *et.al*, 2014). The mean annual rainfall for Kwali Area Council ranges from 1,500mm-2,000mm. The mean annual rainfall duration is seven months, from April-October, the rain starts in April increase gradually to September with the mean annual volume of about 286mm and decrease to 6mm in December (Akiode and Adejoke, 2014).

The predominant vegetation within Kwali Area Council is of the Guinea savanna type, which is characterized by tall elephant grasses and scattered trees that have adapted themselves to the seasonal changes and man-made disasters such as fire and bush clearing. The trees have tap roots which anchor deeply into the sub-soil, while the predominant grass type grows to a height of about two meters during the raining seasons. The foliage of the trees is thin and the branches are canopy-shaped. The shea-butter trees, locust bean and oil

bean trees are the commonest. Riperian forest types also occur along the river banks accompanied with thick undergrowth which are almost impenetrable (Ishaya, 2013).

The topography of the site varies from the strips of flat plateau area to wide gently rolling terrain towards rivers and streams. The sub-region exhibits vestiges of heavy dissection by the tributaries of River Usuma and Gurara. River Epyal meanders through the site thus enhancing the visual quality of the site. Towards the eastern part of (Sheda village) Kwali are a range of hills (Akiode and Adejoke, 2014).

Medium resolution satellite imageries were obtained from United State geological Survey and Global land cover facility (GLCF). Imagery of Kwali was acquired for two different years; 1990 and 2014 (two epochs). These imageries enable the study of changes that has taken place in Kwali area council from 1990.

Table 1: Type of Satellite Imagery, Scale and Source

S/N	Satellite Type	Dates	Resolution	Source
1.	Land Sat Image ETM	1990	30M ^{ETM+}	USGS
2.	Land Sat Image TM	2014	32M TM	GLCF

The Landsat imageries were downloaded from the official website of Global Land Cover Data Facility (GLCF). The GLCF is hosted by the University of Maryland, USA. Software and hardware utilized includes; ArcGIS 10.1 Software which was used to perform the various digital image processing operations and spatial analyses, Integrated Land and Water Information System (ILWIS) Software 3.3, HP personal computer was used for the digital processing associated with this research, Garmin 97 hand held GPS was used in this research for field data verification collection and ground truthing.

Field survey was carried out using GPS to generate training data for digital image classification. This was done by identifying and obtaining the geographical coordinates of the various land use features such as the residential areas, water bodies, the bare surface, the urban agriculture areas and vegetation. The training data generated was used for image classification of the various sets of images.

False-Colour Composite Generation of Kwali Area Council

In carrying out this study, bands 4, 3, 2 and 5, 4, 3 were used to produce the false colour composite image covering the entire FCT in 1990 and 2014 respectively. The administrative boundary map of Kwali Area Council was used to subset the image of Kwali Area Council using ArcGIS 10.1. The Kwali Area Council image was imported into ILWIS Academic 3.3 environment for classification. Linear stretch was carried out on the image to enhance the radiometric resolutions and visual interpretation of the satellite image. Map list and sample set were created for each of the images in ILWIS working environment. The same domain items were used for all the images to ensure uniform representation of the classification characteristics. The seven (7) classification characteristics adopted and their descriptions are listed below:

Table 2: Land use land cover classification scheme

Code	Land use/land cover categories
1	Vegetation
2	Built-up land
3	Bare Surfaces
4	Water bodies
5	Riparian vegetation
6	Wetlands/water body
7	Grass/Shrubland

Source: Researcher Categorization, 2017

Digital Image Classification of Kwali Area Council

The supervised classification was performed using the training sites selected from the images based on the observation (land use/land cover) of features shown on the image. This is often called object oriented classification. This is done by selecting objects or features of same or near same reflectance values (spectral signatures) into groups or classes. After selecting the training sites for each of the classification characteristics, the classification algorithm is then applied using the maximum likelihood classifier of the ILWIS software. The Maximum Likelihood classification assumes that spectral values of training pixels are statistically distributed according to a 'multi-variate normal (Gaussian) probability density function'.

Change Detection for Kwali Area Council

After the classification, change detection analysis was performed on the classified datasets. In this case the area coverage of each of the classification characteristics for the two epochs was compared with each other in square metres (m²) and in percentage (%). The analysis of the result was carried out in Microsoft office excels and the result presented in Microsoft office word. The result gave information on the increment or reduction in the area coverage of the land use/land cover features of the study area.

Results and Discussion

Results on Land use/land cover Characteristic in 1990

The statistical estimates were derived and their spatial extents (Table 3) indicates that built up area covers 343854m² (4.21%), Rock outcrops 2064357m² (25.27%), Wetlands/water body 365103m² (4.47%), the vegetation cover are classified as Grass/Shrub land 432765m² (5.3%), Riparian vegetation 265878m² (3.3%) and Farmland 4600845m² (56%), which is mainly dominant land use around the northern part of Kwali Area Council like Adabu, Sheda, Daka, Ijadabutu and Yangoji towards the north-eastern part (fig.2), farming activities covers large areas down to the middle and towards the eastern part in areas like Tampe Shikuku, Lukoda, Gumbo, Nitse and Eghor, with few ponds and streams, few farming activities are carried out in the southern part of the area council, farming occupies largest part of land use in Kwali Area Council in the year 1990.

Table 3: Spatial Extent of Land Use/Land Cover of Kwali Area Council 1990

Land Use of Kwali 1990	m ²	(%)
Bare Surface	95526	1.7
Built-Up-Area	343854	4.21
Farmland	4600845	56
Grass/Shrubland	432765	5.3
Riparian vegetation	265878	3.3
Rock Outcrops	2064357	25.27
Wetlands/water body	365103	4.47
Total	8168328	100

Source: Researcher analysis, 2017

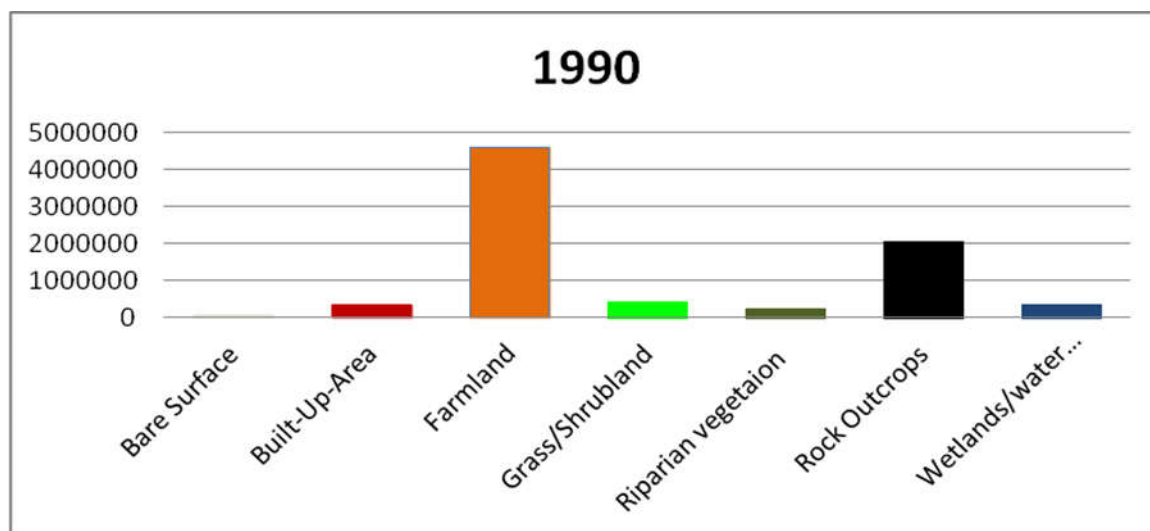


Figure 1: Statistics of Land Use/ Land Cover in 1990

Source: Researcher analysis, 2017

Rocky outcrops which occupies 25.27% was found separating the north-east from the north-west with few vegetation cover, the rocks out crops can be seen scattered at every part of the area. Vegetation is more pronounce in the south-western part of the area council and few farming activities in the area, the vegetation type most dominant in this area is Grass/Shrub land which occupies 432765m² (5.3%) of the land use, with few Riparian vegetation scattered in the north-eastern part, the south-western part which has grass/shrub land is also the area with more water bodies, the features are associated with settlements like Katgo, Daduma, Tutu, A ke, Ndeshi and Giridi (see figure 1).

The settlements are mainly nucleated kind of settlement, with gradual expansion from Kwali town at north-eastern part of the classified image (figure 2), Bare Surface which cover about 95526m² (1.7%) that can be seen in the town of Kwali which shows that development is concentrated in the town, the development were taking place in area like Gboro, Ijadabutu and Yangoji.

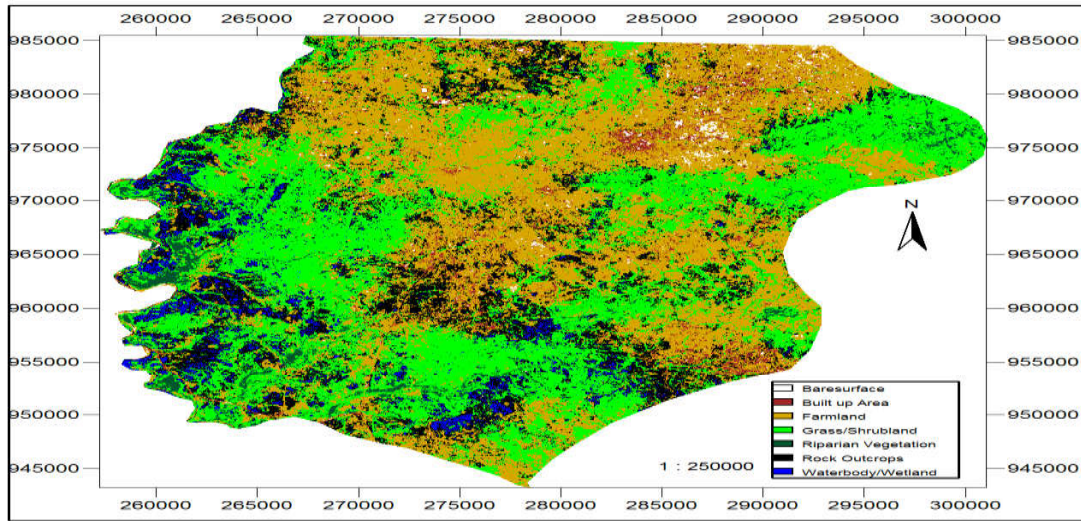


Figure 2: Derived Land use Land cover characteristics of Kwali Area council in 1990 (Source: Researcher analysis, 2017)

Results on Land Use/Land Cover Characteristic in 2014

The statistical estimates were derived and their spatial extents (see Table 4) indicates that built up area covers 405351m² (4.23%) from the derived satellite image of 2014, the settlement has increase some places giving way for bare surfaces, the settlement tends to be dispersed in Kwali town and later extended down south in 2014 in areas that were previously occupied by vegetation and farm lands in1990, this development could be attributed to change in political administration policies toward urbanization which lead to bare surface which occupied 248742 m² (2%) which was 1.7% in 1990, built up areas could be seen in areas like Tutu, Fukuta and Ake which were occupied by Grassland/shrub land in 1990.

Table 4: Spatial Extent of Land use land cover of Kwali Area council 2014

Land Use Of Kwali 2014	m ²	(%)
Bare Surface	248742	2
Built-Up-Area	405351	3.3
Farmland	5507325	56.6
Grass/Shrubland	3039318	25.45
Riparian vegetation	128034	1.07
Rock Outcrops	2584737	21.67
Wetlands/water body	15075	0.13
Total	11928582	100

Source: Researcher analysis, 2017

Kwali area council tend to show little difference in urbanization compared to other area councils as stated by Maisamari (2015) who reported a significant change in the city centre to other parts of the FCT. The pattern of development from federal city centre is more applicable to Abuja municipal area council (AMAC) (Efiong, 2015).

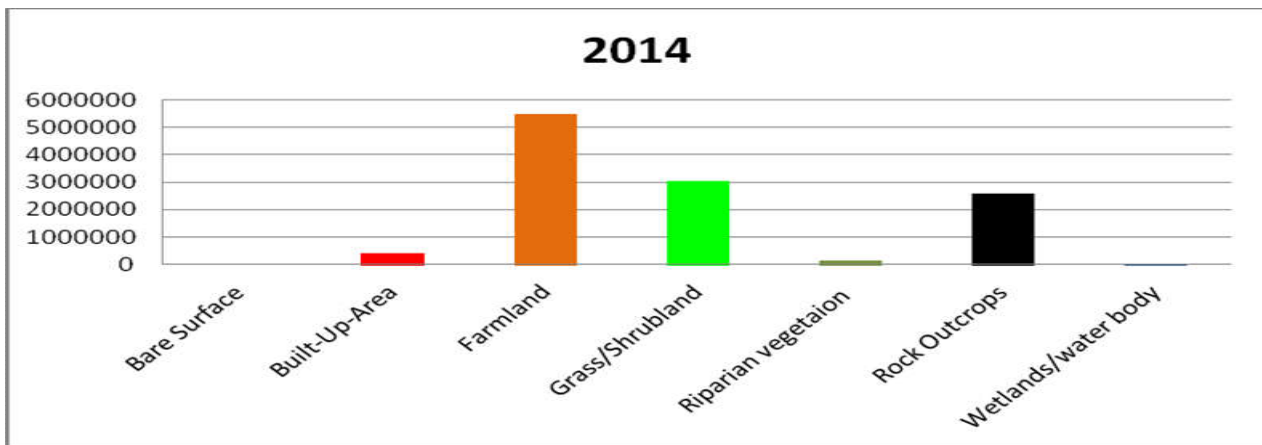


Figure 3: Graphical representation of Kwali Area council showing land use land covers 2014

Source: Researcher analysis, 2017

Farm land occupied 5507325 m² (56.6%), the people of Kwali area council are popularly known for yam farming as there major crop, farming activities over the years as intensify in the southern part of the area council around town like Wako, Ake, Giridi, Munu and Fukuta which were vegetated areas in 1990. Figure 4 depicts the increase of farming activities in Kwali Area Council in the year 2014.

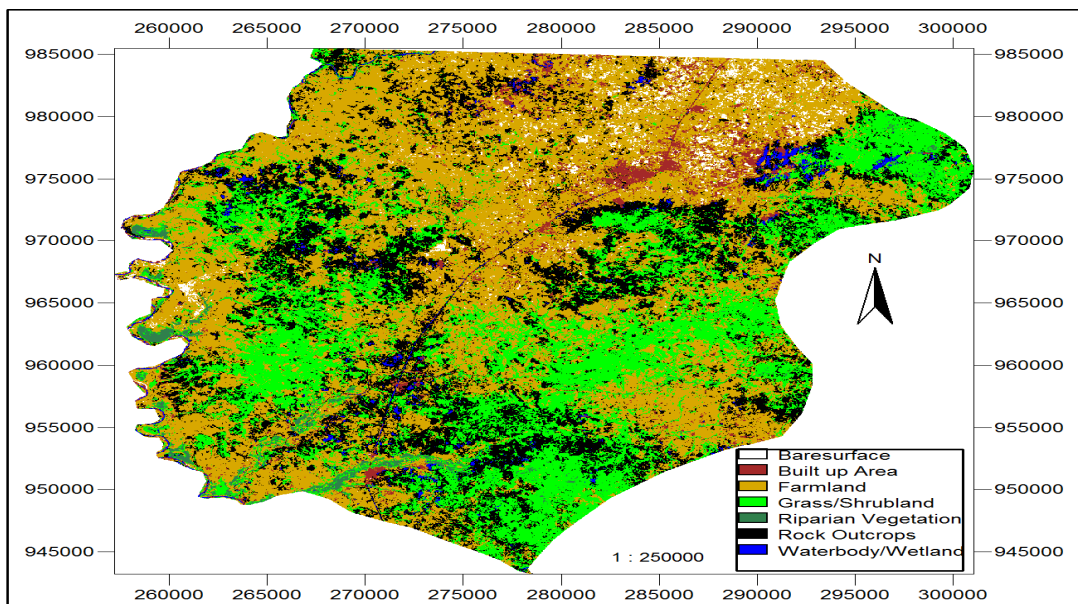


Figure 4: Derived Land use Land cover characteristics of Kwali Area Council in 2014

Source: Researcher analysis, 2017

Grass/Shrub land covers 3039318m² (25.45%), Riparian vegetation cover 128034m²(1.07%) which constituted vegetal cover of the area, the Grass/Shrubland which cover 5.3% of the area in 1990 gain significant increase in 2014, the increase in grass/shrubland in 2014 (see figure 4) tend to be dispersed compare to 1990 with 25.45% while the riparian vegetation reduce from 3.3% in 1990 to 1.07%, the riparian vegetal cover is not significantly appear in the area as much as the Grass and Shrub land. The rocky outcrop

cover which occupied 25.27% in 1990 was later (21.67%) and cover 2584737m² in 2014, this is believe to be exposure as a result of farming activities in the area, which shows that, quarry activities are not more in the area like other part of the FCT.

Spatial Extent of Land use/Land Cover Change 1990 to 2014

The landuse/landcover changes (table 5 and figure 5) shows that within the research period, positive changes were observed for bare surface positively increased with 153216m², built up area increased with 61497 m², farmland increased with 906408m², grass/shrubland increased with 2606553 m² and rock outcrop 520380m². Riparian vegetation and water bodies recorded negative changes. The findings of this study concur with that of Ujoh *et. al.*, (2010) and Effiong, (2015) study of urban sprawl in FCT from 1987 and 2006 which study revealed significant increase in urban sprawl over a period 19 years of study. The findings of this study is also line with that of Ishaya and Ifatimehin (2009), of their study in Kaduna town using GIS and Remote Sensing to assess urban expansion and loss of vegetation cover which revealed that built up areas were expanding at about 1678600m² annually while vegetation covers were declining at a faster rate annually. The findings of the study equally concur with that of Abbas and Arigbede (2011), whose study located in Zaria to determine the changes in land use/land cover between 1985 and 2005 with a view to providing database for future planning found that built-up areas increased from 2.3% in 1985 to 36.4% in 2005, water body decreased from 22.5% in 1985 to 6.5% in 2005. With reference to farmland, the findings of this study is in variance with that of Abbas and Arigbede (2011) that depicts decreased in farmland from 44% in 1995 to 40% sending a bad signal of imminent food crisis if not checked. In the vein, Ishaya (2015) analysis of Landuse and Landcover change in southern part of Kaduna Metropolis, Kaduna State, depicts that agricultural land use being the most dominant land use in 1990; witnessed a significant decrease of 54,810,000m² (25.64%) between 1990 and 2014.

Table 5: Spatial Extent of Land use/Land Cover Change 1990 to 2014

Landuse/Landcover	1990 m ²	2014 m ²	Area Change in m ²	%Change
Bare Surface	95526	248742	+153216	3.24
Built-Up-Area	343854	405351	+61497	1.1
Farmland	4600845	5507325	+906408	19.14
Grass/Shrubland	432765	3039318	+2606553	55
Riparian vegetation	265878	128034	-137844	2.91
Rock Outcrops	2064357	2584737	+520380	10.99
Wetlands/water body	365103	15075	-350028	7.39

Source: Researcher analysis, 2017

Note: The positive sign means gain and the negative sign indicates loss in a real extent.

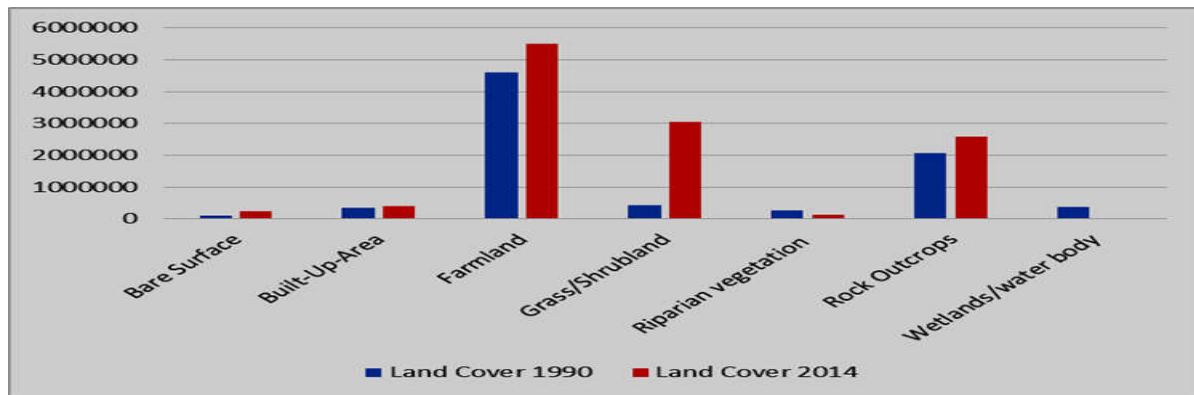


Figure 5: Spatial Extent of Land use/Land Cover Change 1990 to 2014

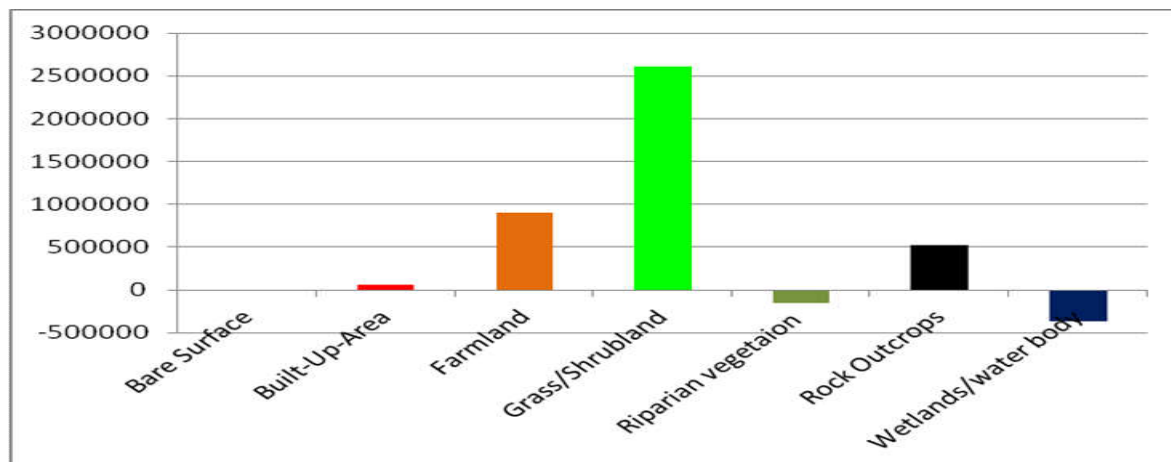


Figure 6: Trend in Land cover change 1990-2014

Source: Field Survey, 2017

Conclusion

This study has investigated the land use land cover change characteristics in Kwali Area Council of the FCT using Geospatial techniques. The resulting image analysis shows that, there is considerable intense increase in farming activities as well as urbanization taking over grass/shrubland, riparian vegetation and wetlands/water body in the area as is being experience in other area councils of the FCT.

Recommendations

As human activities and population increases thereby putting pressure and changes on the environmental landscape which alters the master plan by changing land use from areas originally allotted for farming and green areas, the following recommendations are made and for further research, which are as follows:

- i. Further study should be conducted to assess farming activities in the area by extending the study to 2015 and 2016 when the nation went in to recession that lead many Nigerians to go into farming.
- ii. There is need for further study to investigate nature of landuse/landcover changes from the date of creation of the FCT (1976) till date so as to unveil succinctly the situation of decadal landuse/landcover changes in Kwali Area Council of the FCT.

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