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LAND USE/LANDCOVER CHANGE DETECTION MAPPING OF APA LOCAL GOVERNMENT AREA, BENUE STATE, NIGERIA

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ABSTRACT

The study was carried out to detect the changes in land use/landcover of Apa Local Government Area of Benue State. Many researches have been carried out on land use/land cover mapping in urban areas in Nigeria, however only few have been carried out in rural areas. This study therefore, was geared towards identifying the land use/land cover changes over the years in Apa Local Government Area of Benue State, Nigeria using satellite remotely sensed data, and determining the magnitude and rate of change over the years. For the study, Landsat satellite images were acquired for 1986 and 2001 while Nigeriasat-x was used for 2012. Images were subjected to various image processing techniques and a supervised classification was carried out on the various images using ILWIS (Integrated land and water information system) software. The classification resulted in six classes which include bare surfaces, cultivated area, urban area, forest, grassland and Water body. The result showed that during the 26 years period, the magnitude of change of forest area was -144.985km², ***percentage of change was -70.75% and annual frequency of change was -5.58km²; cultivated area had a magnitude of 208.041km², percentage of change was 97.04% and annual frequency of change was 8.00km²; the magnitude of change of urban area was 14.177km², percentage of change was 15.43% and annual frequency of change was 0.55km²; grassland in the study area also has a magnitude of change 54.63km², percentage of change was 18.61% and annual frequency of change was 2.10km². The study further revealed that loss of naturally vegetated area was mainly as a result of urban growth and expansion, farming activities and commercial activities. Land cover of the study area during the period between 1986 and 2012 changed from a forested area to other land uses as a result of increase in population, demand for land for agricultural purposes and increase in the demand for firewood. In order to curb the increasing rate of deforestation in the study areas, the study therefore recommends that, government at all levels should enforce existing laws/sanctions policies against activities that lead to deforestation like indiscriminate felling of tress, bush burning and illegal logging of trees.***

Keywords: Land use/land cover changes, remotely sensed data, Nigeriasat-X, ILWIS, image processing, supervised classification and deforestation.

INTRODUCTION

Land is definitely one of the most important natural resources, since life and developmental activities are based on it. Land use refers to the type of utilization to which man has put the land. It also refers to evaluation of the land with respect to various natural characteristics, but land cover describes the vegetal attributes of land. Land use and land cover data are essential for planners, decision makers and those concerned with land resources management (Ndukwe, 1997). Monitoring and analysis of the urban environment make use of up-to-date Land use and Land cover (LULC) information, for proficient and sustainable management of urban areas. Unfortunately, Ezeomedo (2006) noted that there is a general lack of accurate and current LULC maps in Nigeria.

However, the advent of air-and space-borne remote sensing has made it possible to acquire pre-and post-project land use and land cover data in consistent manner. In addition, the advent of geographic information system (GIS) has made it possible to integrate multisource and multi-date data for the generation of land use and land cover changes involving such information as the trend, rate, nature, location and magnitude of the changes (Adeniyi and Omojola, 1999).

Macleod and Congalton (1998) listed four aspects of change detection, which are important when monitoring natural resources: Detecting that changes have occurred, identifying the nature of the change, measuring the areal extent of the change and assessing the spatial pattern of the change. An image differencing technique has been implemented in this study, because according to recent research by Coppin and Bauer, (1996), image differencing appears to perform generally better than other methods of change detection; and such monitoring techniques based on multispectral satellite data have demonstrated potential as a means to detect, identify, and map changes in land use/land cover. Image differencing is probably the most widely applied change detection algorithm for a variety of geographical environments (Singh, 1989). It involves subtracting one date of imagery from a second date that has been precisely registered to the first.

Studying land use dynamics is essential in order to examine various ecological and developmental consequences of land use change over a space of time. This makes land use mapping and change detection relevant inputs into decision-making for implementing appropriate policy responses (Fasona and Omojola,2005).

The demand for land use/land cover data has grown in multiple folds over the years as an indispensable means of planning and implementation of developmental projects. Without considering the implications for planning of major developmental projects, there has been unprofessional use of agricultural lands and open spaces in an unplanned situation. The data derived for land use/land cover give insight to better understand land utilization aspects as well as play a vital role in the formulation of policies and programme implementation for development (Ejemeyovwi, 2015).

Researchers have worked on land use/land cover mapping of many cities of NigeriaEjemeyovwi,(2015) but only a few have been done in rural areas Nigeria. However, emphasis was laid on aerial photographs, landsat and spot satellite in land use/land cover mapping in cities, towns and rural areas of Nigeria for comparative analysis of sequential photographs, but none, perhaps, has been carried out with NARSDA image for land use/land cover of Apa Local government Area, Benue State, Nigeria. The detection in landscape on time series analysis is based on land absorption and consumption coefficients of new urban land carried out at a point in time with the image or area was same time in the pass and to correspond with the present. The review of literature on the related application on land use/land cover mapping shows that, there are few remarkable works on land use/land cover mapping and classification in north-central region of Nigeria and Benue state in particular, and this research tends to fill this gap.

The objectives of the study were to identify the past and present land use/land cover characteristics of Apa Local Government Area, Benue State, Nigeria using satellite remotely sensed image, identify the land use/land cover changes that has taken place over the years and determine the magnitude and rate of change over the years.

MATERIALS AND METHODS

Study Area

Apa Local Government Area (the study area) is located in North-Western part of Benue State. Apa Local Government Area (the study area) is located on latitude 7^0 20'north to 7^o 50'north and longitude 7^o 40'east to 8^o 10'. It is bounded in the North by Agatu Local Government Area, in the South by Otukpo Local Government Area, in the East by Gwer-West Local Government Area and in the West by Olamaboro Local Government Area of Kogi State. The local government Area has its headquarters at Ugbokpo and it consists of 11 council wards. The council wards include; Ugbokpo, Edikwu I, Edikwu II, Ojope, Ojantelle/Akpete, Ikobi, Oiji, Auke, Igoro, IgaOkpaya, and Oba wards. The Local government Area has a population of about 96,780 people and a land area of about 995km^2 (National population commission of Nigeria, 2006).

Apa Local Government Area is called “the green land” of Benue State because of its huge agricultural potential. The area is endowed with rich fertile lands, which encourage variety of arable crops such as yam, rice, cassava guinea corn, maize, groundnuts, beniseed, pepper, cowpea, e.t.c. Crops such as vegetables are produced on smaller scale during the dry season.

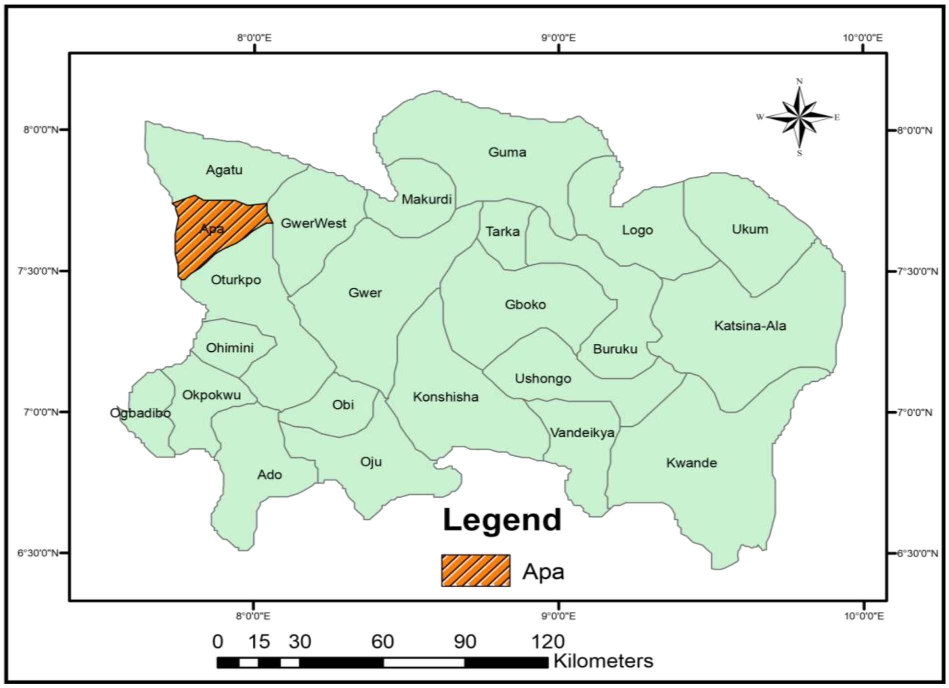


Figure 1: Map of Benue State showing the Study Area
Source: Author, From Nigeria shape file

Data Sources and Collection

This study will involve primary data collection and secondary data collection. The Landsat TM was for 1986, Landsat ETM+ for 2001 and NigeriasatX for 2012 images of the study area were obtained from the Archives of the National Centre for Remote Sensing, Jos, Nigeria. The census data will be collected from the National Population Commission office, Makurdi branch. Field visits to the study area will be carried out to obtain ground control points for geo-reference and ground truth sampling.

Methodology

Data sources

Secondary data was the main source of data used for the research. For the study, Landsat satellite images of Apa Local Government Area were acquired for three Epochs; 1986, 2001 and 2012 respectively. Landsat TM and ETM+ with NigeriasatX satellite images were used for the three epochs. The Landsat TM was for 1986, Landsat ETM+ for 2001 and NigeriasatX for 2012. Both 1986 and 2001 were obtained from Global Land Cover Facility (GLCF) and Earth Science Data Interface, while that of 2012 was obtained from National Space Research and Development Agency in Abuja (NASRDA) through the National Centre for Remote Sensing, Jos.

Table 1: Specifications of Satellite Imageries Used

Satellite	Sensor	Number of Bands	Bands Used	Date of Acquisition	Spatial Resolution
Landsat	TM	7	NIR, R, G (4,3,2)	17/11/1986	30m
Landsat	ETM+	8	NIR, R, G (4,3,2)	02/11/2001	30m
NigeriasatX	SSDRs	4	NIR, R, G (3,2,1)	06/11/2012	22m

TM= Thematic Mapper, ETM+= Enhanced Thematic Mapper Plus, SSDRs= Solid State Data Recorders

Data preparation

ERDAS Imagine 9.2, ArcGis 10.1 and ILWIS 3.8.5 were used in data preparation and analysis. The Landsat images were downloaded using the path and row (p188r54, p188r55, p187r55 and p187r56) interface covering Benue State. The downloaded images were unzipped to show the multiband. ERDAS Imagine was used to generate the false colour composite in a process known as layer stacking, by combining near infrared, red and green which are bands 4, 3, 2 together for both images. This is a very common band combination and is useful for vegetation studies, monitoring drainage and soil patterns and various stages of crop growth. Generally, deep red hues indicate broad leaf and healthier vegetation while lighter reds signify grasslands or sparsely vegetated areas. Urban areas are shown in light blue. This was done for vegetation recognition, because chlorophyll in plants reflects very well to near infrared than the visible. The four scenes were mosaicked into a single image using the Mosaic tool under data preparation in ERDAS. The study area (Apa L.G.A) was then subsetted from the larger image using shape-file of Apa local government area. The images were re-projected from Geographic Coordinate System (GCS) to Universal Traverse Mercator (UTM) WGS 84 North zone 32 to enable easy determination of areas of identified classes. The Landsat images were re-sampled from 30m to 22m to conform to the resolution of NigeriasatX which is 22m. Ground control points obtained using a Global positioning System from locations in relation to the classes of the study area was plotted on Landsat ETM+ image, which was used to verify the training sites (defined classes) as regards the spectral signature. The images were then imported into ILWIS environment via geo-gateway for classification.

Data Analysis

Image Processing

Radiometric and geometric corrections were performed for satellite images of the study area using ILWIS software. For the radiometric correction, the Darkest Pixel (DP) atmospheric correction method, also known as the histogram minimum method was used. As haze has an additional effect on digital numbers, this correction value was subtracted from the digital numbers in the image. This method was applied to each individual band. The geometric correction was done for systematic and non-systematic geometric distortions of satellite image data. The correction process employs geographic features on the image called Ground Control Points (GCPs), whose position are known.

Image Classification

Radiometric and geometric corrections were performed for satellite images of the study area using ILWIS 3.8.5 software.A series of image classification operations was performed to produce land cover map from Landsat TM, ETM+ and NigeriasatX images. The Study area consists of several features having different reflectance. Therefore six classes including forest, grassland, cultivated area, urban area, bare surfaces and water were considered by carrying out fieldwork and using topographical maps. As a result, False Color Composite (FCC) image using bands 4, 3, 2 was used for classification. Sufficient number of training samples of each class by carrying out field work and using GPS were selected. At first using field survey data, training sets (known as sample sets in ILWIS) for classification were prepared on ILWIS software and used as reference data to generate ground truth map. Then the image was classified using maximum likelihood method and land cover map was produced. Maximum likelihood classification is a statistical decision criterion to assist in the classification of overlapping signatures; pixels are assigned to the class of highest probability. At the last stage of image processing, calculation of accuracy assessment of classification was performed. Accuracy assessment is an important feature of land-cover and land-use mapping, not only as a guide to map quality and reliability, but also in understanding thematic uncertainty and its likely implications to the end user. The classification accuracy in remote sensing shows the correspondence between a class label allocated to pixel and true class. The true class can be observed in the field, either directly or indirectly from a reference map (Janssen and Vander, 1994). To determine the accuracy of classification produced, land cover map and ground truth map were compared. The pixels of agreement and disagreement are generally compiled in the form of a confusion matrix. It is a c x c matrix (c is the number of classes), the elements of which indicate the number of pixels in the testing data. The columns of the matrix depict the number of pixels per class for the classified image, and the rows show the number of pixels per class for the reference data. From this confusion matrix, a number of accuracy measures such as overall accuracy, average accuracy and average reliability may be determined. The overall accuracy is used to indicate the accuracy of whole classification (that is, number of correctly classified pixels divided by the total number of pixels in the error matrix). Average accuracy is the sum of class's accuracy divided by the number of classes. Average reliability represents the number of pixels on reference data that have been correctly classified divided by whole pixels that is classified as those classes.

After classification, a histogram of the classified images was generated from which areas of the different classes were shown for easy comparison and inferences.

RESULT

Analysis of Land use/Landcover of Study Area in 1986

From table 2, it can be seen that for 1986, largest part of the study area was Grassland (29.61%) 295.229km^2 while water surface was lowest (1.26%) 12.548km^2. Fig.2 and Fig 3 presents the image and classified map for 1986.

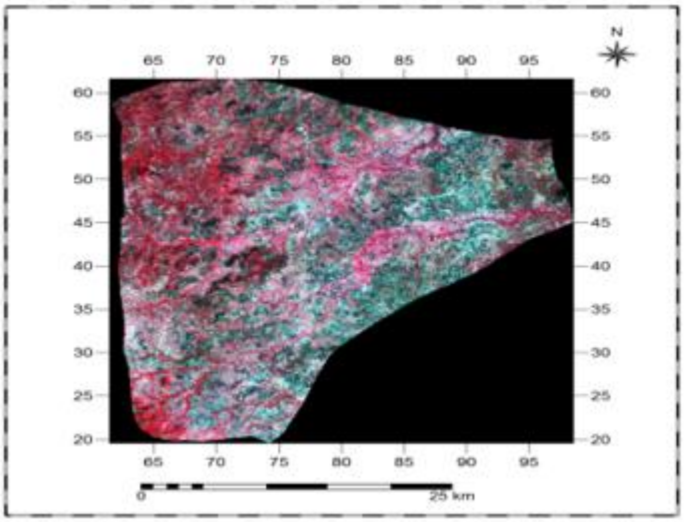


Figure 2: .Landsat TM Imagery of Apa for 1986

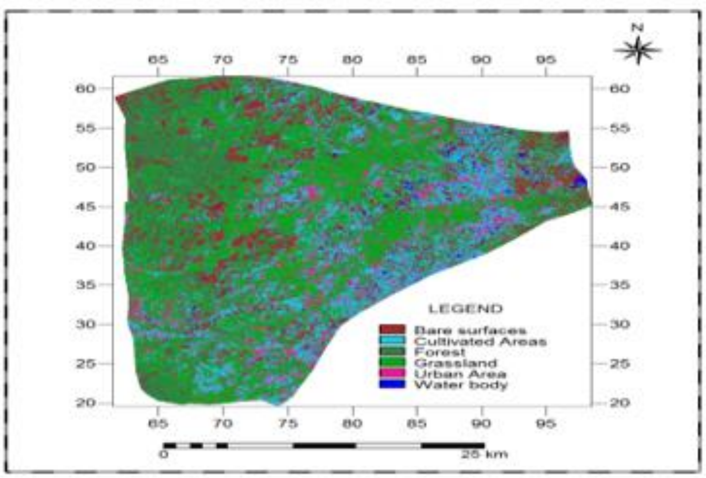
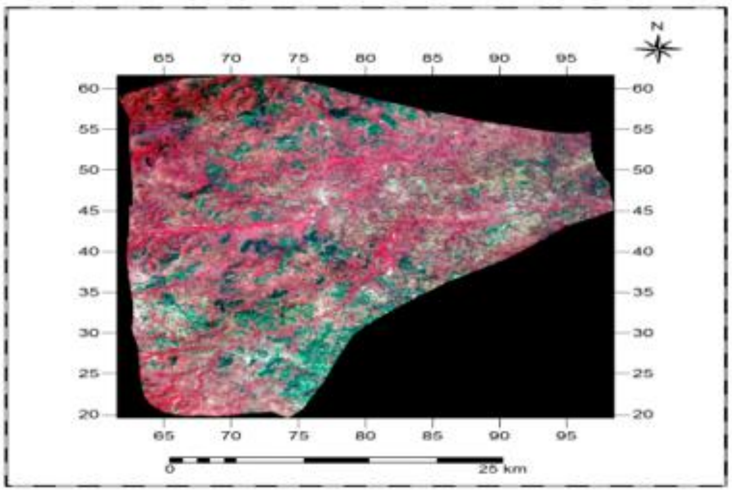


Figure 3: Land use/landcover map of Apa for 1986

Table 2: Area covered by the various Land use/Landcover classes for 1986

Land use/Landcover Classes	Area Sq Km
Bare surfaces	178.233
Cultivated Area	214.388
Forest	204.933
Grassland	295.229
Urban Area	91.864
Water body	12.548
Total	**996.959**

From table 3, it can also be seen that most part of the study area was cultivated area (45.03%) 448.953km^2 followed by grassland (21.25%) 211.815km^2, forest (11.18%)111.51km^2 and urban area (10.25%) 102.201km^2. Fig.4 and Fig.5 presents image and classified map for 2001.



Analysis of Land use/Landcover of Study Area in 2001
Figure 4: Landsat ETM+ of Apa for 2001

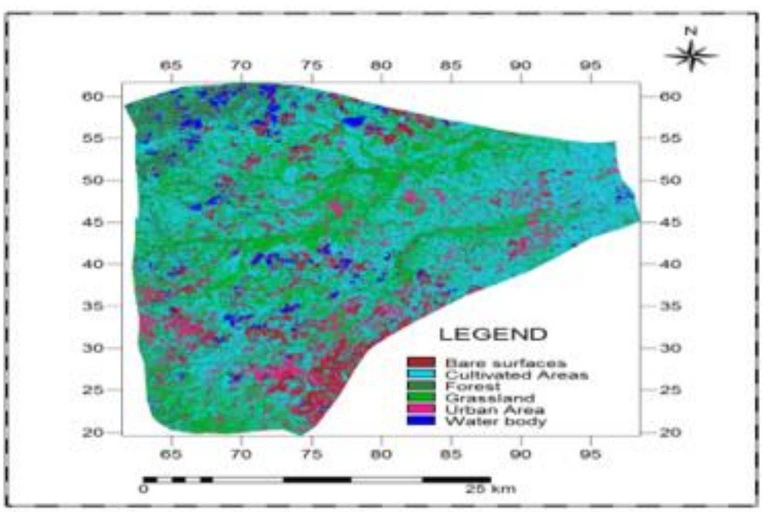


Figure 5: Land use/landcover map of Apa for 2001

Table 3: Area covered by the various Land use/Landcover classes for 2001

Land use/Landcover Classes	Area Sq Km
Bare surfaces	95.425
Cultivated Area	448.953
Forest	111.510
Grassland	211.815
Urban Area	102.201
Water body	27.056
Total	**996.959**

Analysis of Land use/Landcover of Study Area in 2012

From table 4, it can also be seen that most part of the study area was cultivated area 422.429km^2 (42.37%) followed by grassland 349.468km^2 (35.10%), forest 59.948km^2(6.01%) and urban area 106.041km^2(10.64%). Fig.6 and Fig.7 presents image and classified map for 2012.

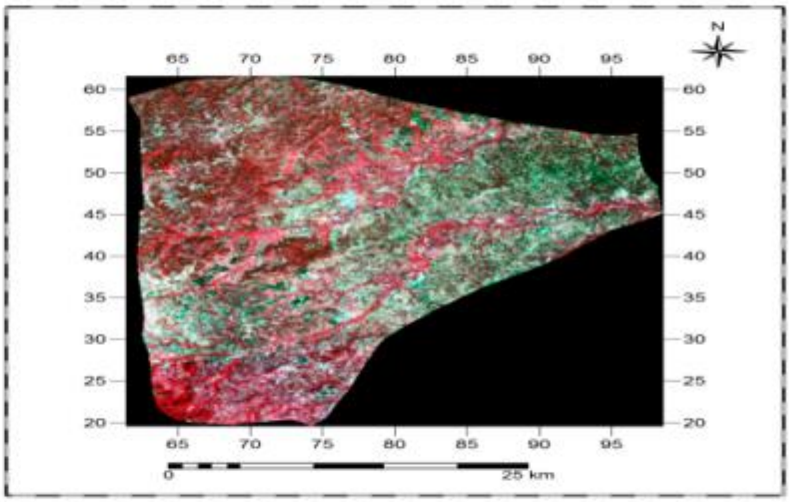


Figure 6: Nigeria sat-X imagery of Apa for 2012

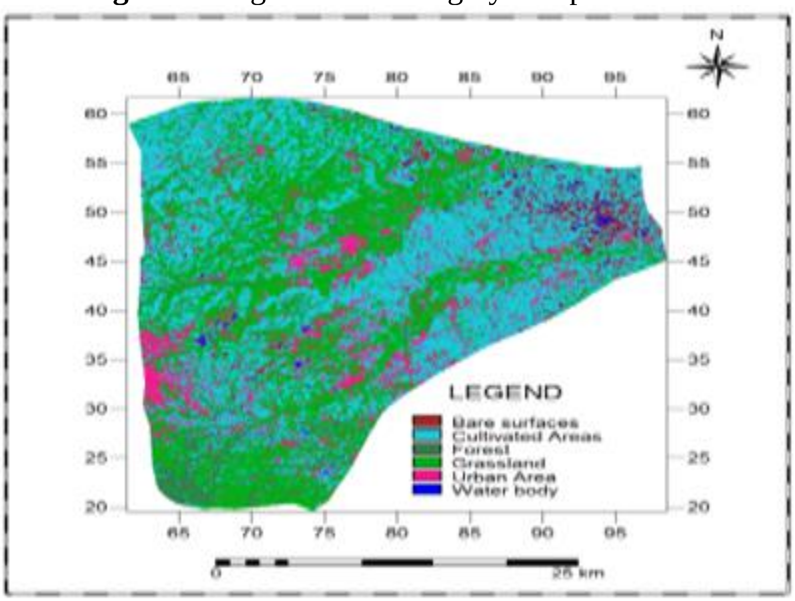


Figure 7: Land use/landcover map of Apa for 2012

Table 4: Area covered by the various Land use/Landcover classes 2012

Land use/Landcover Classes	Area Sq Km
Bare surfaces	50.313
Cultivated Area	422.429
Forest	59.948
Grassland	349.868
Urban Area	106.041
Water body	7.861
Total	**996.959**

Table 5 shows that while the naturally vegetated areas (Forest and Grassland) accounted for 50.16%, the non-vegetated areas [Bare surfaces (17.88%), cultivated area (21.50%), Water body (1.26%) and urban area (9.21%)] accounted for 49.84%. The 15 years period between 1986 and 2001 witnessed considerable increase in anthropogenic activities in the study area. The urban area increased from 9.2% in 1986 to 10.25% in 2001. The forest areas conversely decreased as a result of the increase in anthropogenic activities from 20.55% in 1986 to 11.10% in 2001. The bare surfaces also decreased from 17.88% in 1986 to 9.57% in 2001. The cultivated area however increased from 21.50% in1986 to 45.03% in 2001. The Grassland decreased from 29.61% in 1986 to 21.25% in 2001. The water body also increased from 1.26% in 1986 to 2.71% in 2001.

Table 5 shows that, naturally vegetated area [Grassland (21.25%) and Forest (11.10%)] accounted for 32.35% while the non-vegetated area [Bare Surfaces (9.57%), Cultivated area (45.03%), water body (2.71%) and Urban area (10.25%)] accounted for 67.65%.

Table 5: Percentage of Land use/Landcover in Apa Local Government (1986, 2001 and 2012)

Land use/Landcover Classes	1986		2001		2012	
	Area (sqkm)	%	Area (sqkm)	%	Area (sqkm)	%
Bare Surfaces	178.233	17.88	95.425	9.57	50.313	5.05
Cultivated Area	214.388	21.50	448.953	45.03	422.429	42.37
Forest	204.933	20.55	111.510	11.10	59.948	6.01
Urban Area	91.864	9.21	102.201	10.25	106.041	10.64
Grassland	295.229	29.61	211.815	21.25	349.868	35.10
Water Body	12.548	1.26	27.056	2.71	7.861	0.81
Total	**996.959**	**100**	**996.959**	**100**	**996.959**	**100**

Table 6 shows that the forest covers 204.933km^2 (20.55%) of the total land area under study which is 996.959km^2 in 1986. In 2001 it decreases to 111.510km^2(11.19%). It decreases further to 59.948km^2 (6.01%) in 2012. This decrease in forest land is due to deforestation in the study area. The deforestation in the area can be attributed to urbanization, increase in commercial activities, and increase in population, agricultural activities, and infrastructural development amongst others.

Table 6: Magnitude and Percentage of Change in Land use/Landcover between 1986 and 2001

Land use/Landcover Classes	A 1986	B 2001	C Magnitude of changes (B-A) ABS	D Annual Frequency of change C/15	E Percentage of change C/A x 100
Bare Surfaces	178.233	95.425	-82.808	-5.520	-46.46
Cultivated Area	214.388	448.953	234.565	15.64	109.41
Forest	204.933	111.510	-93.423	-6.228	-3.04
Grassland	295.229	211.815	-83.414	-5.560	-1.88
Urban Area	91.864	102.201	10.337	0.69	0.75
Water Body	12.548	27.056	14.508	0.967	7.71
Total	**996.959**	**996.959**	**-0.235**	**-0.011**	**66.49**

The 11 years period between 2001 and 2012 witnessed a decrease in forest area from 11.10% in 2001 to 6.01% in 2012 as shown in Table 7. This is due to deforestation in the study area. This decrease in forest area is due to increase in population, demand of land for farming, fuelwood demand and commercial purposes. Many houses were built and the process of road construction also led to the clearing of forest area. The demand for food to feed the teeming population also necessitated the clearing of forest area being converted to agricultural lands the purpose of food production. Conversely, the urban area increased from 10.25% in 2001 to 10.64% in 2012. Also, Bare surfaces decreases from 9.57% in 2001 to 5.05% in 2012. The cultivated area also decreased from 45.03% in 2001 to 42.37% in 2012. Grassland however increases from 21.25% in 2001 to 35.10% in 2012 while Water body decreases from 2.71% in 2001 to 0.81 in 2012.

Furthermore, the period between 2001-2012 showed also a decrease further in the forest area from 111.510km^2 in 2001 to 59.94km^2 in 2012, a 51.562km^2 as shown in table 3.6. Percentage of change during the period was -46.23% and annual frequency of change during the period was -4.69km^2. This means that 4.69km^2 of forest land was cleared annually for 11 years. Urban expansion into the area resulted in a 51.562km^2 loss of forest area during the period from 2001-2012

Table 7: Magnitude and Percentage of Change in Land use/Landcover between 2001 and 2012

Land use/Landcover Classes	A 2001	B 2012	C Magnitude of changes (B-A) ABS	D Annual Frequency of change C/11	E Percentage of change C/A x 100
Bare Surfaces	95.425	50.313	-45.112	-4.10	-47.27
Cultivated Area	448.953	422.429	-26.524	-2.41	-54.18
Forest	111.510	59.948	-51.562	-4.69	-46.23
Grassland	211.815	349.868	138.053	12.55	65.17
Urban Area	102.201	106.041	3.84	0.35	3.75
Water Body	27.056	7.861	-19.195	-1.75	-70.95
Total	**996.959**	**996.959**	**-0.5**	**-0.05**	**-149.71**

Table 8 further shows that, during the 26 years period from 1986 to 2012, the magnitude of change of forest area was -144.985km^2, percentage of change was -70.75 and annual frequency of change was -5.58km^2.

This signifies that 5.58km^{2}of forest area was lost annually in the study area for 26 years. Also, cultivated area had a magnitude of 208.041km^2, percentage of change was 97.04% and annual frequency of change was 8.00km^2. This signifies that cultivated area increased by 8.00km^{2}annually in the study area for 26 years. More so, the magnitude of change of urban area was 14.177km^2, percentage of change was 15.43% and annual frequency of change was 0.55km^2. This implies that urban area increased by 0.55km^2 annually in the study area for 26 years. Grassland in the study area also has a magnitude of change 54.63km^2, percentage of change was 18.61% and annual frequency of change was 2.10km^2

Table 8: Magnitude and percentage of change in landcover between 1986 and 2012

Land use/Landcover classes	A 1986	B 2012	C Magnitude of Change (B-A) ABS.	D Annual frequency of Change C/26	E Percentage of Change C/Ax100
Bare Surfaces	178.233	50.313	-127.92	-4.92	-71.77
Cultivated Area	214.388	422.429	208.041	8.00	97.04
Forest	204.933	59.948	-144.985	-5.58	-70.75
Grassland	295.229	349.868	54.639	2.10	18.61
Urban Area	91.864	106.041	14.177	0.55	15.43
Water Body	12.548	7.861	-4.687	-0.18	37.35
Total	**996.959**	**996.959**	**0.735**	**-0.03**	**25.91**

DISCUSSION

The results of the analysis unveil a tremendous change in the Land cover of the study area during the 26 years period from 1986- 2012. It can be noticed that the percentage change in the proportions of some Land cover classes increased while others decreased. For the convenience of interpretation, the total Land cover classes are divided into forest areas, cultivated areas, grassland, urban areas, water body and bare surfaces. The magnitude of change of forest area between 1986 and 2001 was 93.423km^2 representing a Change (3.04%) as shown in Table 6, hence annual frequency of change, stood at 6.228km^2 per year. This annual frequency of change implies that 6.228km^2 of the land was deforested annually for 15 years (1986-2001). Therefore, this period showed a total decrease in forest area of 93.423km^2 for the period. This agrees with the findings of Ogunmula *et al*. (2014) who that observed natural vegetated area in most Nigeria communities have been decreasing in recent years.

This implies that grassland increased by 2.10km^{2}annually in the study area for 26 years. This research is in line with Ogunmula *et al.* (2014) who asserted that rapid population growth, has remained the principal factor that has triggered and continued to stimulate downward spiral in environmental resources degradation.

Worthy of note in the study area also is the problem of soil erosion. In the past human activities including production and agricultural activities has led to accelerated gulling which has stripped substantial areas of lands of their vegetation and led to the formation of bare surfaces. As observed earlier, forest land decreased during the 26 years period. Similarly, Grassland area was 295.229km^2 in 1986. In 2001, it decreased further to 211.815km^2 and in 2012, the Grassland area again increased to 349.868km^2 (Table 3.5 and 3.6). This is agrees with the findings of Gutti*et al*. (2012) who observed that rapid population growth has forced people to build and farm on marginal lands which have increased erosion processes. This has also resulted in the loss of forestlands and land resources.

Bare surfaces in the study area however decreased also from 178.233km^2 (17.88%) in 1986 to 95.425km^2 (9.57%) in 2001. It decreased further to 50.313km^2 (5.05%) in 2012. The magnitude of change between 186 and 2001 was -82.808, percentage of change between was -46.46 and annual frequency of change was -5.520km^2. This shows that 5.520km^2 of bare surfaces was lost annually for 15 years (1986-2001) to other uses. From 2001 to 2012, the magnitude of change was -45.112, annual frequency was -4.10km^2 and percentage of change was -47.27%. This implies that, 4.10km^2 of bare surfaces was lost annually for 11 years (2001-2012). The loss in forest land (naturally vegetated areas) in Apa Local Government Area was attributed to the increase in urban area. As shown in Table 6 and 7, urban area increased from 91.864km^2 (9.21%) in 1986 to 102.01km^2 (10.25%) in 2001. The magnitude of change was 10.337km^2, percentage of change was 0.75 and annual frequency of change was 0.69km^2. This signifies that 0.69km^2 of natural vegetation was converted to urban area for 15 years. From 2001-2012, urban area further increased from 102.201km^2 910.25%) in 2001 to 106.041km^2 (10.64) in 2012. The magnitude of change was 3.84, percentage of change was 3.75 and annual frequency of change was 0.35km^2. This means that 0.35km^2 of land was lost to urban area for 11 years (2001-2012) in Apa Local Government Area. The result agrees with Harrison (1993) who observed that rapid environmental growth has resulted in many environmental problems which has escalated deforestation and loss of vegetation in urban fringes. As population increases, more land is cleared for farming, building of houses and road construction; less is left to forest or fallow.

CONCLUSION

The results of the analysis unveil a tremendous change in the Land cover and land use of the study area during the 26 years period from 1986- 2012. From the result of the study, the following conclusions were made:

I. There has been a steady decline in forest area coverage from 1986 to 2012. Similarly, grassland area coverage decreased from 1986 to 2012.
II. Urban area is continuously on the increase from 1986 to 2012. Similarly, cultivated area also increased from 1986 to 2012.
III. The rate of change of forest area between 1986 and 2001 was -6.228sqkm per annum, while that of 2001 and 2012 was -4.69sqkm per annum.

From the above observations, the following conclusions were arrived at:

I. Loss of naturally vegetated area in Apa Local Government Area is mainly as a result of urban growth and expansion, farming activities and commercial activities.
II. Land cover of the study area during the period between 1986 and 2012 changed from a forested area to other land uses as a result of increase in population, demand for land for agricultural purposes and increase in the demand for firewood.

RECOMMENDATIONS

From the findings of this study, the following are recommended:

i. Government should encourage its personnel through funding so that changes in land use and land cover at regular interval will be detected. If such funds are made available, more research should be focused towards the use of modern application; such as satellite imagery, GIS and digital equipment to obtain fast and accurate digital data or information. Since ground survey methods are not convenient and aerial or photographic maps production are very expensive and time consuming.
ii. In order to curb the increasing rate of deforestation, the government at all levels should enforce the existing laws/sanctions and policies against activities that lead to deforestation like indiscriminate felling of tress, bush burning and illegal logging of trees. More so, community and urban forestry should be encouraged by the Government and NGO'S. Furthermore, there should be regular awareness and campaigns on the need for individuals to prioritize conservation of our fragile environment, depleting ecosystem and global warming.

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