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ASSESSING THE LAND USE/LAND COVER DYNAMICS IN TORO LOCAL GOVERNMENT AREA, BAUCHI STATE, NIGERIA

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Abstract:
This study used both Remote Sensing and Geographic Information System (RS/GIS) for the analysis of land use land cover (LULC) dynamics of Toro for the period of 1985 to 2015. The purpose was to detect the nature and magnitude of these changes in order to determine its direction for future planning. The study was achieved using landsat 7 images of 1985, 2000 and 2015 by means of classifying the images into settlements, vegetation, farmlands, stones and water bodies.Erdas Imagine 9.2 and ArcGIS 10.1 through supervised image classification techniquewas used in the classification. The results show that significant changes occurred in settlements and least in water bodies. The study revealed that there is also a significant expansion in some towns of Toro LGA in terms of size and the expansion is more concentrated around the settlements situated along Bauchi-Jos road. Settlement like Gumau town also witnessed a remarkable expansion.

Keywords: Land use, land cover, Remote Sensing & GIS, classification, change detection

Introduction

Land use land cover design of a place is an outcome of natural and socio-economic factors and their utilization by man in time and space (Parvaiz et al 2017). Changes in land use land cover can be attributed to several factors depending on the socio-economic, political and climatic condition of a given area. However, one fundamental factor behind spatial change both in terms of size and pattern remains the same. Other factors attributing to land use land coverchanges are directly or indirectly dependent on population growth. As the population of a given area increases, the demand for land use land coversuch as built up area or settlement also increase, while other land classes such as farmland, vegetation, decreases as a result of the increased demand for built up area. Consequently, these changes in most cases if not continuously checked comes with certain negativities which may affect not only the environment but also its inhabitants. Therefore, accurate and up-to-date land use land coverchange information is necessary in understanding and assessing the environmental consequences of such changes (Giri*et al.*, 2005). Due to anthropogenic activities, the earth's surface is being significantly altered and man's presence on the earth and his use of land has had a profound effect upon the natural environment, thus resulting into an observable pattern in the land use land cover over time (Lambin and Lepers, 2003; Asthana and Asthana, 2005; Zubair, 2006).

Accurate and timely information about land use land cover changes in urban areas is crucial for urban land management, decision making, ecosystem monitoring and urban planning.Remote Sensing has the capability of capturing such changes, extracting the change information from satellite data requires effective and automated change detection techniques (Roy *et al*, 2002). The importance of remote sensing was emphasized as a 'unique view' of the spatial and temporal dynamics of the processes in urban growth and land use change (Batty and Howes, 2001). Satellite remote sensing techniques have therefore, been widely used in detecting and monitoring land use land cover change at various scales with useful results (Martha *et al*, 2008). As land becomes increasingly important and competition, shift in land use may be affected by further institutional and environmental constraint (Mahmud and Achide, 2012). Thus, it is imperative to consistently monitor the changes that are taking place so that planners can evaluate the impacts of change and plan or suggest alternative land use for development purposes which will help in policy making and implementation process. This research seeks to utilize remotely sensed data and GIS tool to analyze the land use land cove dynamics of Toro L.G.A for the purpose of detecting change by utilizing three dates images.

Statement of the Problem

Land use and land cover are very dynamic in nature and have to be monitored at regular intervals for sustainable environmental development (Zubair, 2006). Population is a very important factor or agent of change in land use of an area. For instance, as population increases, construction of houses increases, thus causing conversion of cropland and forest land to settlements. These urban land uses are of various types which could be for industrial, commercial, government, as well as transportation purposes.

Toro witnessed a remarkable expansion as a result of the population increase and rapid economic transformation in the period under review. Little or no effort has been made to document the land use land cover change in Toro and environs. This has therefore resulted in increased modification and alterations of land use land cover over time without any detailed and comprehensive attempt to evaluate land statusas it changes over time with a view to detect therate of land consumption and the possible changes that may occur in this status so that planners can have a basic information for planning. It is therefore necessary for a study to be conducted in the area using Remote Sensing and GIS to show the magnitude of change that had occurred.

Justification of the Study

Data on land use land cover change is of great importance to planners,decision and policy makers in monitoring the consequences of land use change in an area. Such data are valuable for the management of resources, land use patterns and in modeling and predicting future changes. Information on land use serves as a major input for any program on energy conservation, for monitoring environmental hazards and for the enhancement of equitable distribution of resources. Information on land use change has also been found to be of great importance in the political administration ofmany countries (Zubair, 2006).

Study Area

Toro is located at the southern part of Bauchi and is covered by Sudan savannah type of vegetation. The town is geographically located and bounded by latitudes10° 19′ 55″ and 10° 20′ 58″ north of the equator and longitudes 9° 50′ 50″ and 9° 51′ 29″ east of Greenwich (Prime) meridian, which covers an area of 6,932 square km. It is connected through good roads and has intra boundaries

with Ningi, Ganjuwa, Bauchi, Dass and TafawaBalewa and some part of Kaduna state and Plateau state. The population of the study area, according to the 2006 national population census, is three hundred and fifty thousand, four hundred and four (350,404) persons. Agricultural practices for production of both food and cash crops have captured the life of the inhabitants of the area.
The climatic of the area is hot in the months of April and May while December and January are the coldest months. Mean daily temperature ranges from 28.2°C in August to 36.6°C in April maximum while from about 13.3°C in December to about 22.1°C in April and May minimum and the rainfall ranges around 1300 mm per annum(Climate-data.org, 2013).

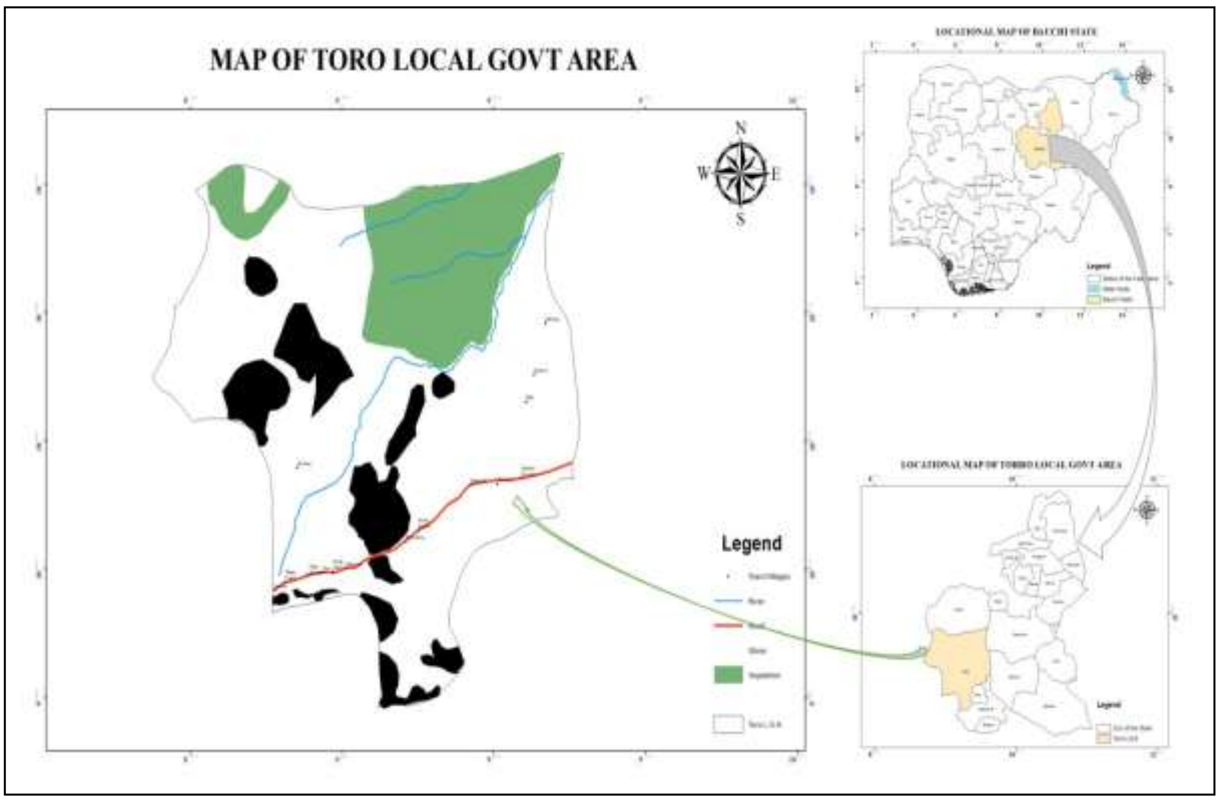

Figure 1: Location Map of Toro L.G.A.

Data Set and Methods

Varied data sets were employed in this study, these include: the satellite imageries for the year 1985, 2000 and 2015, coordinates of ground points and the based map of Toro Local Government AreaArcGIS 10.1and ERDAS

IMAGINE 9.2 Software were used to generate various thematic layers. Details is shown below

Image Classification

The objective of image classification in this research is to create cluster classes from multispectral images. Maximum Likelihood Classifier, as a per-pixel classifier, was used to show the spatial distribution of land use and land cover types in Toro. The landscape structure and land cover dynamics of Toro makes Maximum Likelihood Classifier an appropriate classification method. This is a sophisticated classifier and considered the most appropriate for the study area, the resulted is what (Lu *et al*., 2004) called "salt and pepper" pattern classification. The ground-truth data agreed with this outcome after the classified image was smoothened.

Land cover and land use classification scheme

Supervised classification was used in the classification scheme. The satellite images were classified into five major land cover types; Settlements, vegetation, stones, rivers and farmlands. The five classes in the classification scheme considered the land cover materials of the study area.

Selection of training data

Training data was based on the field data, and a cluster of pixels representing various land-use and land-cover categories was selected as a training set. The training sites (pixels) were selected and spread throughout the study area and analyzed. The tradeoff usually faced in the development of training data sets is that of having sufficient sample size to ensure the accurate determination of the statistical parameters used by the classifier and to represent the total spectral variability in a scene, without going past a point of diminishing returns (Lillesand*et al*., 2004). During the refining of the training set redundancy and gaps were identified in the data, so that important spectral classes were not omitted as well as inclusion of redundant spectral classes.

Change Detection

This research is focused on the changes between-class (conversion between land cover types) and within-class (changes within a land cover type).Post-classification change detection approach was employed due to its ability to bypass the problems and difficulties associated with analysis of images acquired at different times of the year and sensors (Yuan *et al.*, 1998). In this research, land cover change is detected as a change in land cover label between two image dates. It is based on two independent true land cover class classifications, and was achieved by supervised classification.

Results and Discussion

Figures 1, 2 and 3 are the classified images that show the land cover types of the study area together with the land cover change detection, achieved by the comparison of land area (kilometer square) in each class at different dates (1985 - 2000 and 2000 - 2015). There are five classes of land cover in all the images.The 1985, 2000 and 2015 images were classified independently. Tables 1 to 3 are the accuracy assessment of the various years while tables 4 and 5 are the changes that took place between 1985 and 2000 and 2000 and 2015.

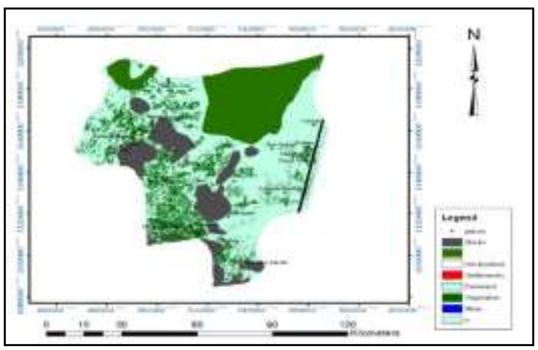

Figure1 Classified image of Toro at 1985

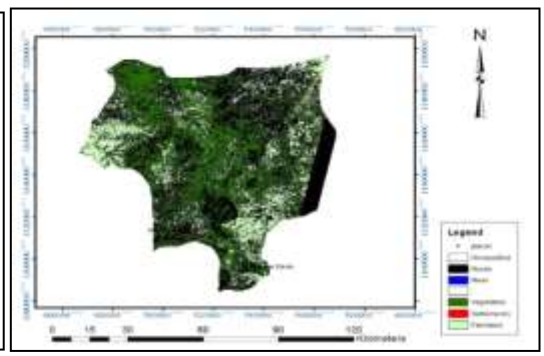

Figure 2 Classified image Toro at 2000

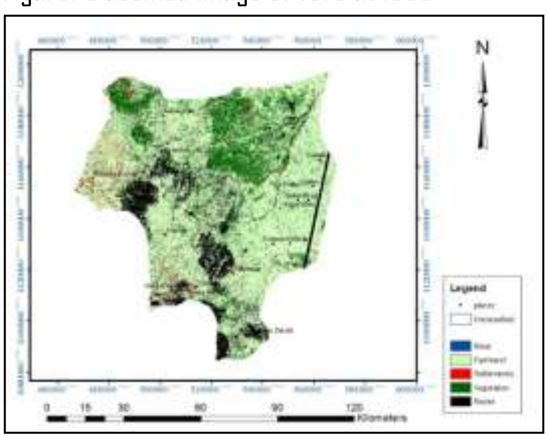

Figure 3: Classified image Toro at 2015

Table 1: Accuracy assessment of land cover map of Toro at 1985

Land Cover Type	River	Rocks	Vegetation	Settlements	Farmlands	Row Total	Producers Accuracy	Users Accuracy	Kappa Value
River	86	0	0	0	0	86	100.00%	100.00%	100%
Rocks	0	29	1	0	2	32	70.27%	89.66%	89%
Vegetation	0	0	80	2	18	100	77.98%	85.00%	80%
Settlements	0	0	9	97	0	106	81.82%	93.40%	91%
Farmlands	0	11	16	9	92	128	95.83%	71.88%	64%
Column Total	86	40	106	108	112	452			

Overall classification accuracy = 86.23% Overall kappa statistics = 0.8231

Table 2: Accuracy assessment of land use/cover map of Toro at 2000

Land Cover Type	River	Rocks	Vegetation	Settlements	Farmlands	Row Total	Producers Accuracy	Users Accuracy	Kappa Value
River	80	0	0	0	0	80	100.00%	100.00%	100%
Rocks	0	26	1	0	2	29	70.27%	89.66%	89%
Vegetation	0	0	85	3	13	101	77.98%	85.00%	80%
Settlements	0	0	7	99	0	106	81.82%	93.40%	91%
Farmlands	0	11	16	9	92	128	95.83%	71.88%	64%
Column Total	80	37	109	111	107	444			

Overall classification accuracy = 86.01% Overall kappa statistics = 0.8231

Table 3: Accuracy assessment of land use/cover map of Toro at 2015

Land Cover Type	River	Rocks	Vegetation	Settlement	Farmland	Row Total	Producers Accuracy	Users Accuracy	Kappa Value
River	72	2	0	0	0	74	90%	97%	97%
Rocks	0	22	7	4	4	37	59%	59%	56%
Vegetation	6	0	63	5	4	78	58%	81%	75%
Settlement /	0	0	17	104	1	122	86%	85%	80%
Farmland	2	13	22	3	89	129	91%	66%	57%
Column Total	80	37	109	116	98	440			

Overall classification accuracy = 78.65% Overall kappa statistics = 0.7261

Table 4: 1985 and 2000 Land cover change derived from post-classification comparison.

Land cover Type	1985 Area (kmsq)	1985 %	2000 Area (kmsq)	2000 %	Change Area	% Change
Rocks	1368.25	19.74	1341.32	19.35	-26.93	-1.97
Settlement	2.136	0.03	20.19	0.29	18.05	845.22
Vegetation	1538.86	22.20	1531.97	22.10	-6.89	-0.45
Farmlands	3870.31	55.83	3883.53	56.02	13.22	0.34
River	152.44	2.20	154.99	2.24	2.55	1.67
Total	6932.85	100.00	6932.00	100.00		

Table 5: 2000 and 2015 Land cover change derived from post-classification comparison.

Land cover Type	2000 Area (kmsq)	2000 %	2015 Area (kmsq)	2015 %	Change Area	% Change
Rocks	1341.32	19.35	1335.13	19.26	-6.19	-0.46
Settlement	20.19	0.29	30.13	0.43	9.94	49.23
Vegetation	1531.97	22.10	1528.26	22.05	-3.71	-0.24
Farmlands	3883.53	56.02	3909.46	55.99	25.93	0.67
River	154.99	2.24	157.02	2.27	2.03	1.31

Total	6932.00	100.00	6932.00	100.0 0		

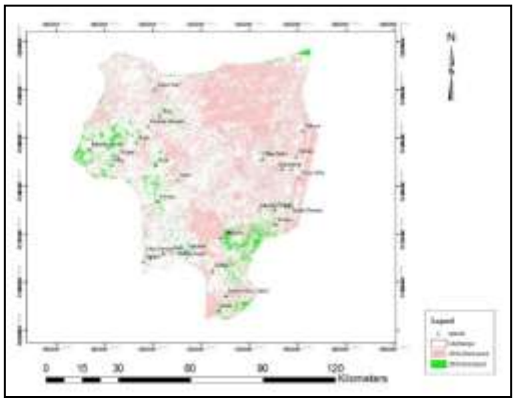

Figure 4: The change detection map of 1985 to 2000

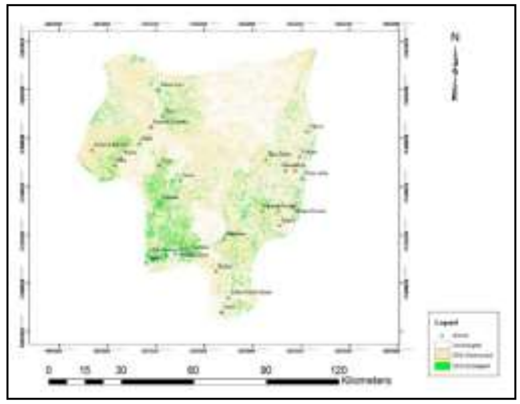

Figure 5: The change detection map of 2000 to 2015

Discussion of Results

Classified images were used to map and detect the land cover classes that have changed over time. Land cover class at significant risk of total elimination is revealed based on Remote Sensing and GIS spatial analytical methods. The post-classification comparison of land cover classes gives the change that took place between 1985 and 2000 then 2000 and 2015 in kilometers as shown in Tables 1 and 2. The land cover classes show detail of spatio-temporal changes between land cover types classification, as theclassification scheme is based on the land cover change.

The rocks accounted for 19.74% of land cover in the study area in 1985.This land cover type occupied 19.35% in 2000 which is-1.97% decrease for the period under study. The decreaseoccurredat the surface of the rocks where the rocks disintegrate gradually as a result of weathering after which trees and grasses grow upon it. The places where the trees and grasses grown will then be depicted on the imageries as vegetation. The places where there are no grasses or trees are usually depicted on the imageries as farmland and so on.

Settlements accounted for 0.03% in the study area in 1985. Settlement occupied 0.29% in 2000 which increases for the period under study. Most of the growth took place at the towns periphery where forest and agricultural land cover is the major target for town growth such as residential, commercial and industrial. In 1985 vegetation covered about 22.20% of the total land in the study area. The area covered later decreased to 22.10% in 2000 which is equivalent to -0.45% for the period under study. The decrease occurred as a result of continues demand of settlement and farmland due to influx of people into various settlements.There was an increase in farmlands of 56.02% in 2000 compared to 55.83% in 1985. The increase occurred as a result of the conversion of most of the shrub areas of the vegetation to farmlands. The increase also occurred as a result of continuous weathering of the rocks which makes it disintegrate and turned to look like farmlands. Furthermore, people plant on those parts of the rocks which contributed in reducing the size of the rocks and increasing the size of the farmlands. There was a 2.24% increase recorded in this land cover class in 2000 compared to 2.20% in 1985. This can be attributed either to the differing ability of sensors in detecting water, or human activities.

Considering the changes between 2000 and 2015, the rocks accounted for 19.35% of land cover in the study area in 2000.This land cover type occupied 19.26% in 2015 which is -0.46% decrease for the period under study. The decrease occurred at the surface of the rocks where the rocks disintegrate gradually as a result of weathering after which trees and grasses grow upon it. The places where the trees and grasses grow will be depicted on the imageries as vegetation. The places where there are no grasses or trees are usually depicted on the imageries as farmland and so on. Settlementsaccounted for 0.29% in the study area in 2000. Settlement occupied 0.43% in 2015 which increases for the period under study. Most of the growth took place at the town periphery where forest and agricultural land cover is the major target for town growth such as residential, commercial and industrial. In 2000 vegetation covered about 22.10% of the total land in the study area. The area covered later decreased to 22.05% in 2015 which is equivalent to -0.24% for the period under study. The decrease occurred as a result of continues demand of settlement and farmland due to influx of people into various settlements.

Farmlands increase by 56.40% in 2015 compared to 56.02% in 2000. The increase occurred as a result of the conversion of most of the shrub areas of the vegetation to farmlands. The increase also occurred as a result of continuous weathering of the rocks which makes it disintegrate and turned to look like farmlands. Furthermore, people plant on those parts of the rocks which contributed in reducing the size of the rocks and increasing the size of the farmlands. There was a 2.27% increase recorded ofrivers in 2015 compared to 2.24% in 2000. This can be attributed either to the differing ability of sensors in detecting water, or human activities.

The change between 1985 and 2000, 2000 and 2015 then 1985 and 2015 detected from classification comparison of satellite images helped understanding of the relationships, interaction and influence of human activities on the land cover as it affects the land use of the study area.Post-classification comparison and change detection was analysed after the rectified images were separately classified from three periods of time (1985, 2000 and 2015). The land cover was labeled according to the classification scheme.Land cover type or patterns and temporal change over time in the study area were mapped with post-classification change detection methods. The 1985, 2000 and 2015 images were classified at three levels independently. The classified images were used to calculate areas occupied by individual classes which were analysed for changes within and between classes. Three images (1985, 2000 and 2015 images) were separately classified and a post-classification change detection method was used for land cover change detection. Land cover class at significant risk of total elimination is revealed based on Remote Sensing and GIS spatial analytical methods.

Conclusion and Recommendations

Conclusion

The use of GISandRemote Sensing tools were helpful in finding the amount of land cover change that has taken place in Toro over the span of 30 years. The study concludes that there is a significant increase in some towns of Toro LGA in terms of size. All land cover classeshave increased except rocks and vegetation over the years. Rocks have witnessed a decrease of up to -1.97% from 1985 to 2000 and -0.462% from 2000 to 2015. Settlement increased by 845.22% from 1985 to 2000, 49.23% from 2000 to 2015. Vegetation has decreased to about -0.45% from 1985 to 2000 and -0.242% from 2000 to 2015. Farmland also increased up to 0.34% from 1985 to 2000 and 0.668% from 2000 to 2015. Water bodies increased with about 1.67% from 1985 to 2000 and 1.310% from 2000 to 2015. The study also revealed that the increase is more concentrated around the settlements situated along Bauchi-Jos road. Other settlements like Gumau and Lame towns witnessed a remarkable increase too.

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