LAND USE LAND COVER CHANGES: ITS EFFECT ON FORESTRY AND WOODLOTS IN THREE SELECTED LOCAL GOVERNMENT AREAS OF ADAMAWA STATE, NIGERIA

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Abstract
Forest reserves lands in most Nigerian cities have disturbed, encroached and converted to a different land uses Land cover is changing rapidly over time. This study focused on Maiha, Mubi North and Mubi South local government area of Northern Adamawa state, Nigeria. The Landsat's data from Nov.28,1985 to Nov.30,2015 was obtained. This paper aim at reviewing the effects on forestry and woodlots policy and practice in northern Adamawa state, Nigeria, with a view of making planning recommendations. The objective of this study is to investigate the nature of the forestry, woodlots and plantation for the period of thirty (30) years (1985-2015). A remote sensing images of multi spectral bands of 1985, 2000 and 2015 landsat images were used to identify the forest / sparse trees or vegetation loss and forest land encroachment, The result revealed notable increase and change pattern was observed. The built-up area has change from 101.50km^2 -694.10km^2 that is an increase of 592.6 km^2 or 25.43 percent. At the rate given an impression of increase over the year from 1985-2015. The built-up expansion resulted to loss in natural forest/sparse trees on average rate of 896km^2 – 424.20 km^2 as vegetation represent the most significant change. The losses of natural vegetation also result to increase in bare-surface and farmlands whereas increased in built-up leads to increase in their sizes. On average changes in bare- surface was from 182.10km^2 – 313.30km^2 while that of farmlands occurred by 1.42 km^2 – 518.70 km^2 it's also represented the most significant change in land use and land cover of Maiha, Mubi North and Mubi South local government area from 1985 to 2015. Hence the population to a continual demand for fuel wood, lumbering, construction and farming as the study's area landscape was observed to be changing rapidly in Maiha, Mubi North and Mubi South local government areas of Adamawa state particularly the North-Eastern part of Nigeria. It's recommended that State Ministries of Agriculture and Natural Resources, Forestry Departments, Local Government Councils chairmen and Ministry of Urban Planning to strongly promotes ecological breeding models in the study areas.

Keywords: Land use, land cover, Effect, Forestry, GIS, Remote Sensing, Changes, Detection.

Introduction

The increase in population density, land use dynamics exhibited exponential growth, and the relative changes in land use of woodland, grassland, construction land, and wetlands were directly proportional to the changes in population density (Liu et al, 2022). However, past research generally considered short-term LULC changes, future development planning, and policy formulation (Ciu et al, 2022). LULC changes result from the combined effects of various driving factors, and different factors can lead to changes in LULC (Niu et al, 2022). Urbanization and urban expansion can cause considerable changes in land use/land cover (LULC) patterns, which can impose negative impacts on urban areas, especially on green spaces, farmlands, vegetation cover, and natural environment (Adebayo,2004, and Adekunle, et al, 2009). Man in the bid to meet his basic needs of food, clothing and shelter, exploits the resources of the physical environment which are usually not deliberately replaced (Ba. et al,2014, and Nasiru et al, 2009). Forests and vegetal cover are prominent among such resources. Bin et al, (2023) affirmed that intensely revealing the changes in LULC and their driving mechanisms is fundamental to clarifying the relationship between regional socioeconomic development and ecological environment utilization and protection, which is crucial for exploring the pathways of regional green upgrading development. Growing interest towards achieving a greener environment through tree planting campaign efforts globally, as trees are purported to provide many benefits such as temperature modification, energy conservation, abatement of air, water pollution and as well as a wind breaker (Alberti, 2010 & REDDCELL, 2012). Environmental concern about global warming, urban heat islands, and air pollution has brought attention to the potential of trees to ameliorate climate conserve energy enhanced environmental conduciveness in terms of aesthetics and property value mostly in urban areas or cities (Bellefontaine, et al, 2002). and CPRE, 2015).

Trees and woods are vital to health and well-being. Also, there is a strong relationship between the quality of urban green space and people's health and wellbeing Simula, (2009), In the traditional African setting; trees are part of the visible features of villages and settlements (Herrmanran, et al, 2000). Past and even present deforestation activities in such countries has led to the removal of a large proportion of vegetal cover so much that deliberate steps need now to be taken to forestall further damage to the physical environment (Simula, 2009). At the same time, there is an increase in urbanization in developing countries. Urban centers in such countries are vast area of tar and concrete without the green component of vegetal cover. This loss of green areas can aggravate the urban heat island effect (Souza et al, 2000).

Studying the relationship between LULC changes and influencing factors is crucial for addressing issues related to the land system (Liu et al, 2022). Research indicates that natural elements and economic factors are the primary drivers of LULC changes (Niu et al, 2022). The combination of mathematical and statistical analysis methods these two has become a current research method (Liu et al,2022 & Niu et al 2022), these models can quantify the driving effects of LULC change drivers and have thus been widely applied.

Aim and Objectives of the study

The aim of this study is to review the forestry and woodlots policy and practice in three Local Government Areas of Adamawa state Nigeria with a view of making Planning recommendations.
The following objectives were set for the study:
To examine the policy, strategy and framework of forestry and woodlots practice.
To investigate the changes in forestry, woodlots and plantations areas between the period of 1985-2015 using remote sensing techniques.
To produce and assess the land Use/Land Cover changes map of the Study from (1985-2015).

The Framework of Analysis on Forest Land Disturbance in the Context of Nigerian Cities.

Forest disturbance is a serious environmental, social and economic problem. Quantifying the scale of the problem is difficult, however, because forest disturbance has many causes, occurs in different

forms and with varying intensity, and is perceived differently by different stakeholders (REDDCELL, 2012). The indiscriminate felling of trees has continued in virtually every part of the country. For instance, the Federal Department of Forestry FAO, (2000). estimated that Nigerian forests are being depleted at an annual rate of 3.5%. Nigeria used to have about 20% of its area covered with natural forests but, this has been reduced to about 10%. It lost about 60% of its natural forests to agricultural encroachment, excessive logging and urbanization between the 1960s and the year 2000 (FAO, 2000).

Another major factor contributing to environmental degradation in the country is the uncoordinated land use policy. Natural forests are being destroyed by other forms of land use, like agriculture, grazing and construction activities as a result of rapid urbanization leading to desertification and degradation of the environment (FAO, 2000).

There is evidence of land conversion to agriculture in some forest reserves without any serious effort by the authorities to stop the trend (USAID,2008). Forest disturbance, therefore, has the potential to adversely affect millions of people who depend, wholly or in part, on forest goods and services at a local scale, and billions of people who benefit from forest services at regional or global scale (Dahlin, 2010).

Sound forest management practices have been phased as an interesting strategy to ally forest conservation and rural economic development in the tropics (Patenaude et al,2005). Forest revenue systems were outdated, which tended to treat forest resources as free commodities, and state forestry departments had not been managing forest reserves systematically (Akosim. et al,2009). The increase in human population in Nigeria over the last four Akosim. et al, (2001). decades has resulted in an increase in demand for farmland and livestock grazing and forest resources such as wood for timber, building and energy. This resulted in an enormous pressure on land and wood resources in both protected and unprotected areas with the attendant Consequences of depletion, fragmentation and degradation of forest estate in the region (Akosim. et al,2001).

Over dependence on natural vegetations and improvement in technology of tree felling and transportation have eased access to, excessive cutting down of trees, nonetheless, is a primary source of livelihood as well as driven of changes with far reaching multiplier impact in the region and beyond (Ba. et al,2014). Tukur and Adebayo (1998). affirmed that modern means of transportation has made it possible for Yola to get 60% of its fuel-wood supplies from outside its immediate hinter land and it's also applicable to Maiha, Mubi North and Mubi South. The biodiversity of Nigeria contains a number of native species, like bush mangos and oil palms, as well as a number of plants with medicinal uses and many more useful plants that are yet to be scientifically discovered and utilized. Likewise, the chemical compounds produced by amphibians, insects, and a myriad of other species in Nigeria may one day be found to have important uses in agriculture, medicine, and other applications (Sabogel,2006).Modern notions of heritage conservation recognize the need for the integration of three interrelated objectives for urban conservation: physical, spatial and social (Ilesanmi,1999).

The strategy of incorporating tree-planting, habitat enhancement, and climate mitigation programs all within the context of supporting ecological services. Its improve community access to food, promote involvement and the Green print suggests food growing techniques, guidelines (Ilesanmi,1999).

Application of Remote Sensing and GIS on Forest Land Disturbance

Detection and mapping of forest disturbance with optical remotely sensed data is more challenging than mapping forest conversion due to deforestation because disturbed forest 'pixels 'are complex environments with mixtures of different land cover materials (i.e., vegetation, dead trees, bark, tree branches, soil, shade) (Souza and Robert, 2005). A detailed review of the available methods to detect and map forest disturbance is provided elsewhere. Several remote sensing techniques have been

used to characterize forest disturbance in the Brazilian Amazon. High spatial resolution sensors, such as Landsat (30m) and SPOT (20m) are the ones most used (Patenaude et al, 2005). The studies in the Brazilian Amazon have shown that Landsat reflectance data have limited capacity for detecting logged forests, with bands 3 and 5 providing the best spectral contrast between logged and intact forests (Souza and Robert, 2005). Vegetation indices and texture filters also showed some potential for detection of logging impacts (Asner,2001). A recent study demonstrated that textural filters applied to Landsat band 5 can enhance detection of logging infrastructure (i.e., roads and Log landings) (Manandhar, 2009).

Materials and Methods

Study Area

The study area covers Maiha, Mubi North and Mubi South Local Government Areas of Mubi Region. All the Local Government Areas are located adjacent to each other. They are located approximately between latitudes 09^{0}48'29"N and 11^{0}21'47"N of the equator and longitudes 12^{0}43'18"E and 13^{0}32'33"E of Greenwich meridian which it lies on the altitude 731 meter above sea level. The study area comprises three (3) local govt. areas, eleven (12) administrative Districts and their Headquarters and a total number of two hundred and seventy (270) rural settlements with 391,224 habitants over an area of 5,965.77 (2,329.80) km^2 (Adebayo,2004, and Adekunle, et al, 2009).

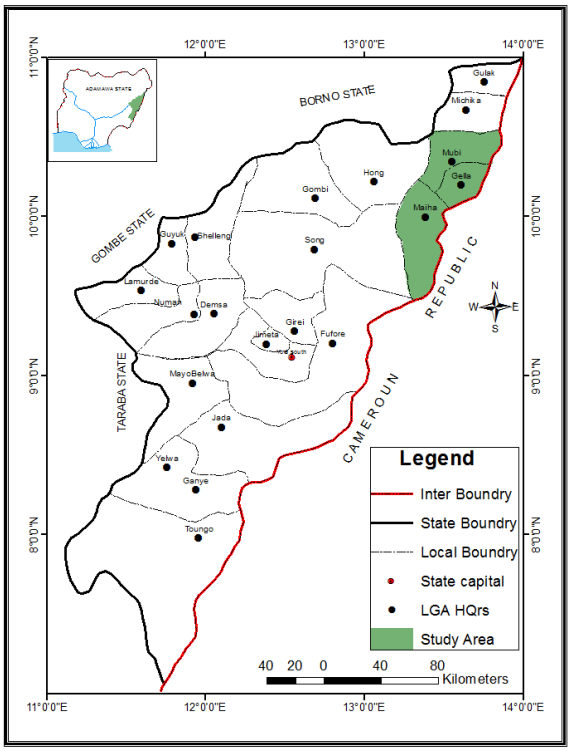


Figure 1:Map of Adamawa State Showing Study Areas

Source: GIS Laboratory, Geography Department MAUTECH Yola 2017

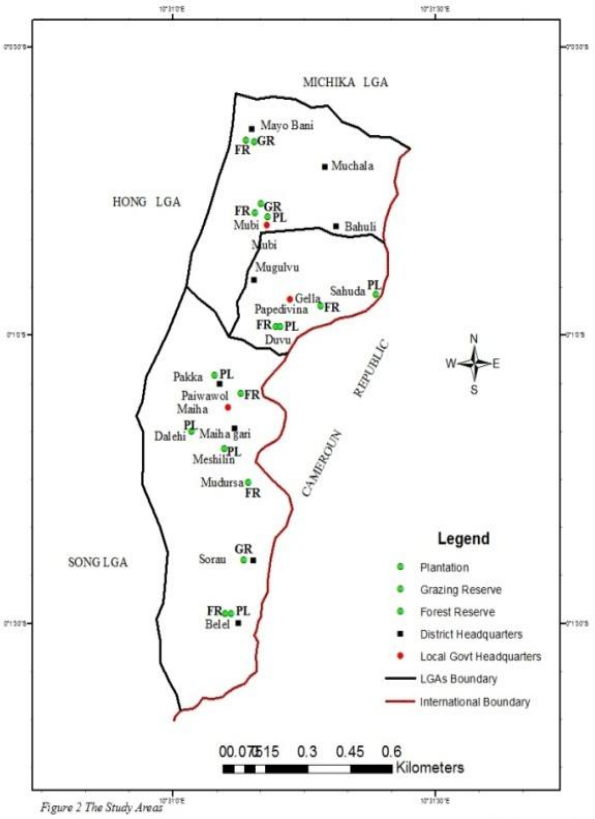


Figure 2 The Study Areas

Source: Adamawa in map, Geographical Synthesis, GIS Laboratory, Geography Department MAUTECH Yola 2017

Methods

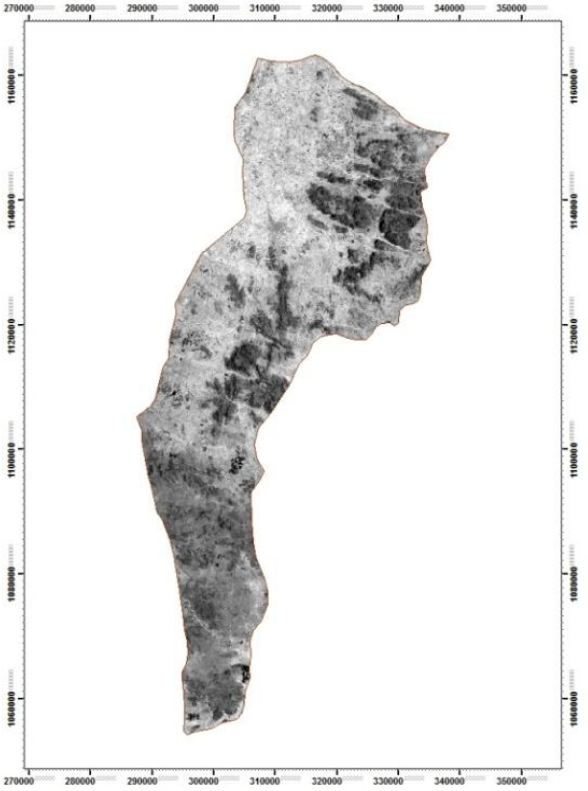
The Secondary Satellite data are collected from United States Geological Surveys (USGS).

Table 1. Data Acquisition and Sources

Data	Source	Date of Acquisition	Characteristics
Landsat-TM.	USGS.	28November, 1985.	Spatial
Landsat-ETM+.	USGS.	29November, 2000.	Spatial

Landsat-OLI.	USGS.	30November, 2015	Spatial
Ancillary data: Field data &Maps.	Maiha, Mubi North & Mubi South forest and woodlots, ADSMLS, Adamawa in map		Spatial /Non-Spatial
Software.	ArcGIS-9.0, ArcGIS-10.0 /10.1 and Google Earth.		

A: Landsat TM Nov 28, 1985,



B: Landsat ETM+ Nov 29, 2000

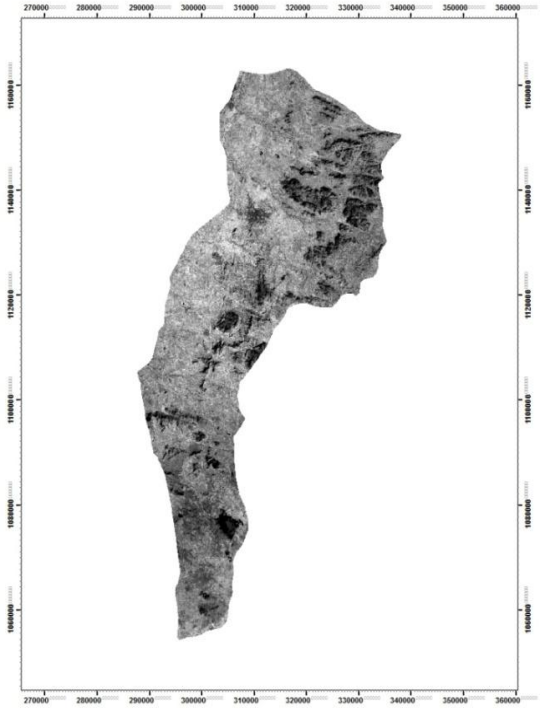


Plate A, B and C: Landsat Images of the Study Area Used in the Research.

Table 2. Main Characteristics of the Imageries used in the Study

Instruments	**TM**	**ETM+**	**OIL TIR**
Landsat	Landsat5	Landsat7	Landsat8
Acquisition Date	November 28, 1985	November29, 2000	November 30, 2015
Path/Row No.	185/53	185/53	185/53
Spectral band(m)	Bands7 1 0.45-0.52 Blue 2 0.52-0.60 Green 3 0.63-0.69 Red 4 0.76-0.90 NIR 5 1.55-1.75 NIR 6 10.4-12.5 Thermal 7 2.08-2.35 MIR	Bands 8 1 0.45-0.52 Blue 2 0.52-0.60 Green 3 0.63-0.69 Red 4 0.76-0.90 NIR 5 1.55-1.75 NIR 6 10.4-12.5 Thermal 7 2.08-2.35 MIR 8 panchromatic -Optical bands -Thermal band -Panchromatic	Bands 11 1 0.45-0.52 Blue 2 0.52-0.60 Green 3 0.63-0.69 Red 4 0.76-0.90 NIR 5 1.55-1.75 NIR 6 10.4-12.5 Thermal 7 2.08-2.35 MIR 8 panchromatic 9 $SWIRI_1$ 10 $SWIRI_2$ 11 Optical bands -Thermal band -Panchromatic
Ground Resolution	30m*30m	30m*30m	30m*30m

Source: Compiled from the header files of various Landsat Images and United States Geological Surveys Data Archive (earthexplorer.usgs.gov)

Global Positioning System, Field Observation and Ground Truthing.

An intensive field survey was performed throughout Maiha, Mubi North and Mubi South local government areas using both Google image and Global Positioning System (GPS) equipment. A Garmin 60XS hand-held GPS is an efficient GIS data collection tools which allows for users to compile their own datasets directly from the field as part of 'ground truthing 'to determine the components of the classified satellite imageries. The field survey was conducted in order to obtain accurate

location for land use and land cover class, same method was applied for all other land use and land cover types.

The data were analyzed using the following steps, including identification of the study area, data collection, image pre-processing, supervised classification, data analysis, and change detection. The procedure of changing detection of Land Use Land Cover analysis in Maiha, Mubi North and Mubi South Local Government Areas for the period of 30 years from (1985 to 2015)

Table 3; Location and Coordinates of Training Samples used

Locations	**Northern**	**Eastern**
Duvu Bridge/ Mountain forest	3^0 15' 95"	12^0 09' 40"
Fishery Dept. ADSU	3^0 11' 78"	13^0 76' 06"
Gella, Kwaja Junction	3^0 14' 17"	12^0 16' 02"
Mudursa forest Reserve	2^0 99' 12"	11^0 60' 89"
Paiwawol forest Reserve	2^0 95' 33"	11^0 60' 76"
Shuware GDSS Playground	3^0 10' 97"	13^0 65' 69"

Source: Field Survey 2016

Plate A: Duvu – Gella Bridge /Mountain Forest

Plate B: Fishery Department in ADSU Mubi

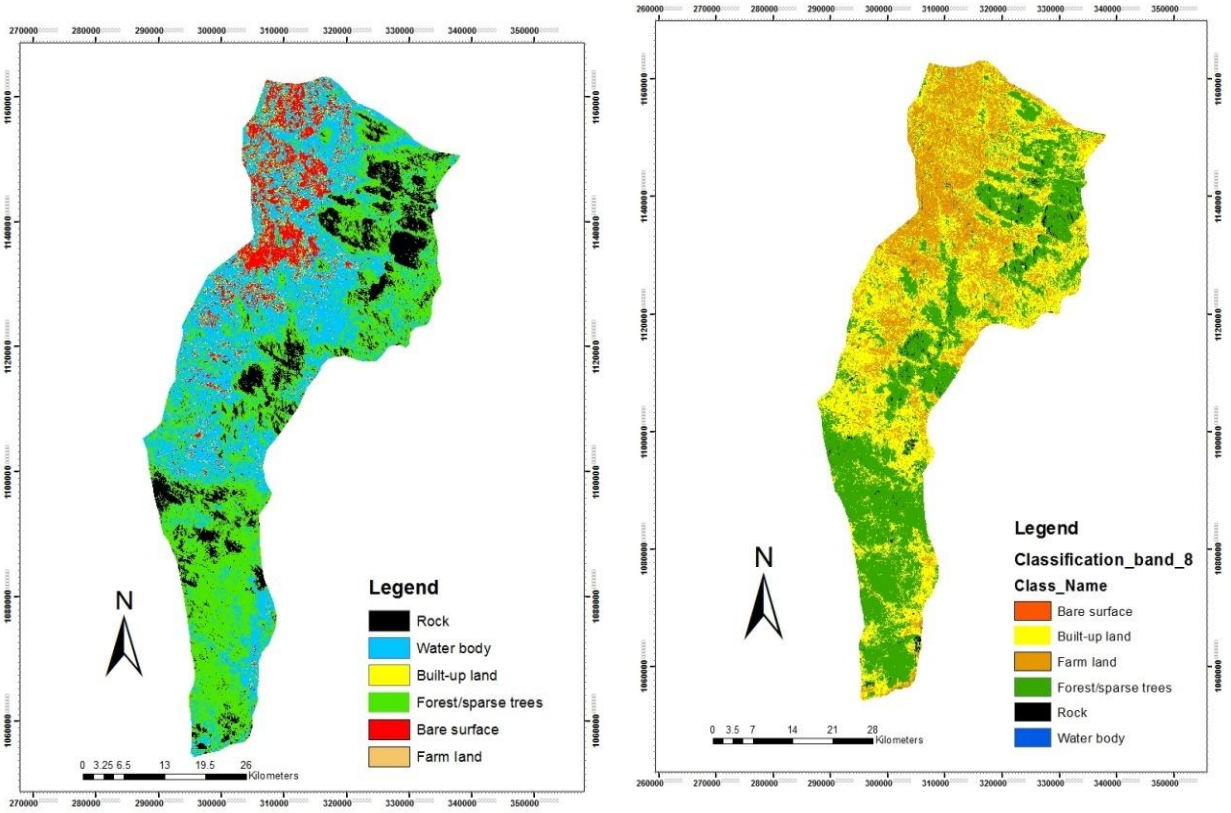
Plate C: Gella – Kwaja Evidence Deforestation in Mudursa Forest Reserve

Plate D: Evidence of Deforestation in Mudursa Forest Reserve

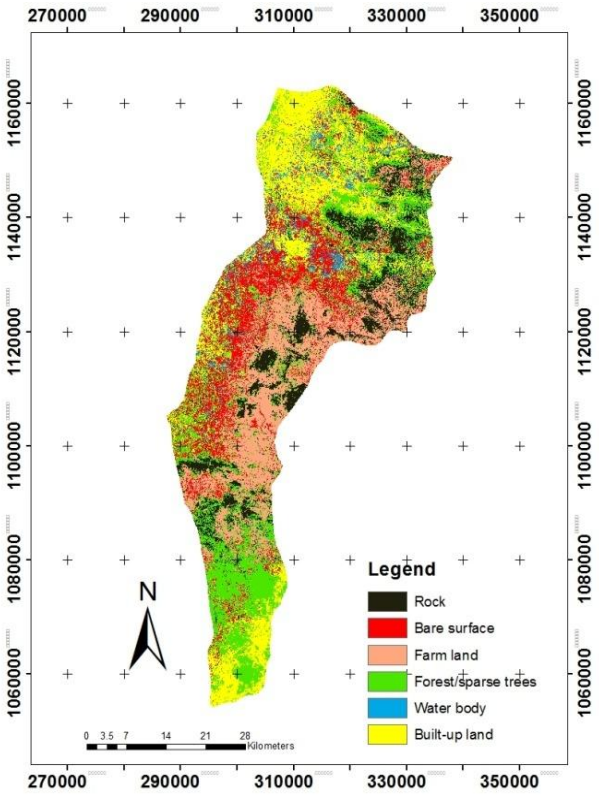
Plate E: Shuware Garden City GDSS Playground

Plate F: Pawawol Forest Reserve

Image Analysis



A: Classified Landsat Image TM 1985 **B: Classified Landsat Image ETM 2000**



C: Classified Landsat Image OLI, 2015
Plates A, B and C: Classified Landsat Images of the Study Area Used

Results and Discussions

Change Detection of 1985 to 2015

After classifying the three maps for each year it was then analyzed to quantify the changes over the period of fifteen (15) years each from (1985-2000-2015) and that of thirty (30) years (1985 -2015). The changes in the land use/land cover classification of Maiha, Mubi North and Mubi South LGAs revealed that in 1985-2015 forest /sparse trees accounted for about 38.46% drastically decreased to 18.22% of the total land area. Built-up area in 1985-2015 there was a significant increased from 4.36% to about 29.79% of the total land area. Water body was accounted about 36.19% decrease to 7.59% in 1985-2015, Rocks from the analysis carried out revealed a decrease from 12.57% in 1985 to 8.70% in 2015, and this would have been probably as a result of climatic conditions and weathering, while Bare surface from the classification in 1985 also witness increase from 7.82% to 13.44% in 2015. Lastly, Farmland in 1985-2015 was undergone increase as a result of anthropogenic from 0.60% to 22.26% of the total land area. (See table 2 below).

Table 4: Statistics of changes in land use / cover between 1985 to 2015

	1985		**2015**		**Changes between 1985-2015**		
LAND COVER CLASS	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (Km^2)	Area (%)	OBSERVATION
Rock	292.70	12.57	202.70	8.70	90.00	3.87	DECREASE
Water body	843.30	36.19	176.80	7.59	666.50	28.60	DECREASE
Built-Up Area	101.50	4.36	694.10	29.79	-592.90	-25.43	INCREASE
Forest/Sparse Trees	896.00	38.46	424.20	18.22	471.80	20.24	DECREASE
Bare-Surface	182.10	7.82	313.30	13.44	-131.20	-5.62	INCREASE
Farmland	1.42	0.60	518.70	22.26	-517.28	-21.66	INCREASE
Total Area (km2)	**2329.80**	**100**	**2329.80**	**100**			

Source: Computed from the images using 'field calculator' algorithm in ArcMap

The Chosen Date (1985 to 2015)

The reason for chosen the topographic map and Landsat remote sensing images taken from (1985 to 2015), is to explore the pathways for green upgrading development in ecologically fragile areas and evaluated the landscape features of the Northern desert, the changes in the area of protective forests and grazing reserves in Mubi-North, Mubi-South and Maiha Local Government Areas located in the northern part of Adamawa an agropastoral transition zone. Based on the driving factors is direct reflections of regional natural and anthropogenic impacts.

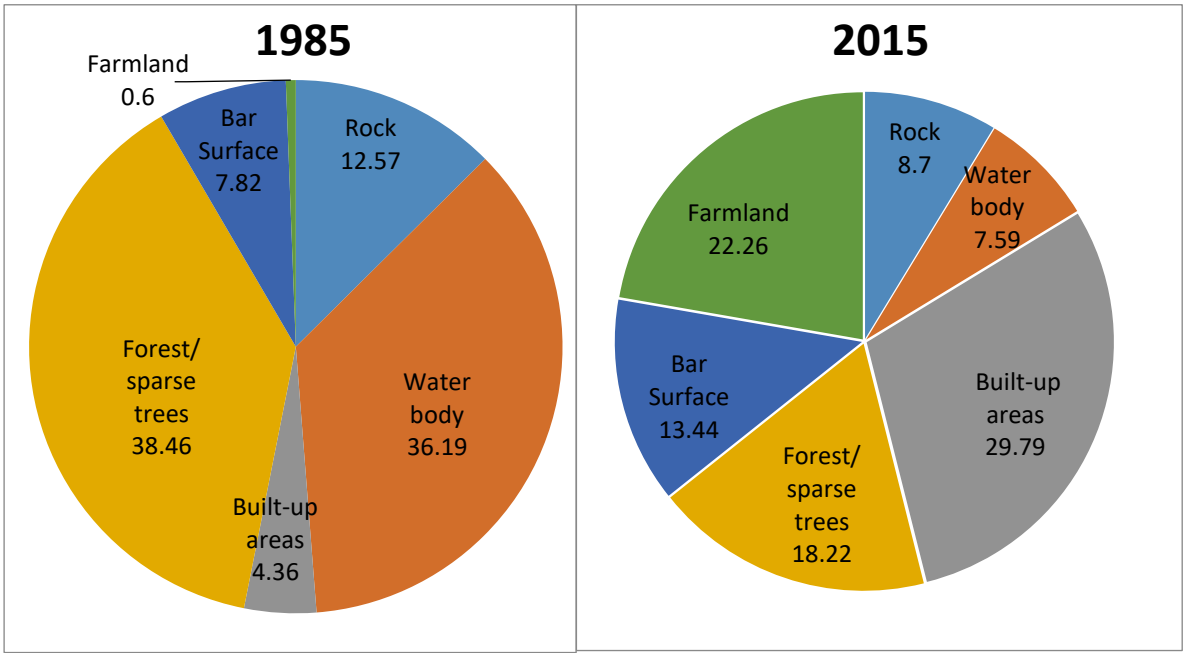


Figure 2: Pie-chart of Changes in Land Use / Cover Between 1985 - 2015

Conclusion

The study concludes that, integrated approach of Remote Sensing (RS) and Geographic Information System (GIS) was adopted in evaluating the anthropogenic activities of human as forest disturbance, forest land encroachment and felling of trees and it impact on the environment of Maiha, Mubi North and Mubi South Local Government Areas. Result revealed a notable increase in farmland and built up land in land use and land cover between1985-2015. The built-up area has change from the rate given an impression of increase over the years. The built-up expansion result to loss in natural forest/sparse trees the losses of natural vegetation also result to increase in bare- surface and farmlands whereas increased in built-up leads to increase in their sizes. Hence the study's area landscape was observed to be changing rapidly.

Recommendations and Further Study

Based on the findings of this research the following recommendations are hereby presented:

1. The State Ministry of Agriculture and Natural Resources, Forestry Department, Local Government Councils Chairmen and Ministry of Urban Planning strongly promotes ecological breeding models in the future, advocates diverse agricultural planting systems, and integrates agriculture, animal husbandry, and aquaculture.
2. To strengthens the development of green agriculture and other low-carbon environmental industries; intensively develops clean energy; reduces the impact of agricultural activities on other ecosystems.
3. Recommendations were made for forestry and woodlots long term development plan should be taken to maintain and reestablish the natural balance between vegetation and urban landscape.
4. To continues afforestation efforts constructs the ecological barrier in northern region.
5. To combats land desertification; optimizes land use structure; scientifically resolves the conflict between construction land and cropland.
6. Formulation of an integrated policy including effective and harmonized legislative framework for conservation, sustainable use and equitable sharing benefits of biodiversity and forestry.
7. Establishes an urban ecological network system to ensure the connectivity and integrity of the ecosystem is protected; enhancing information, education and communication system for forest conservation.
8. Improving information on the taxation, values and local conservation and management strategies for forest through research work.

9. Established more forest plants, woodlots, plantations and shelter belt; encourage the management practice of grazing on the range land. adaptation of ecologically friendly farming practice.
10. To Introduce effective legislation against indiscriminate tree felling and bush burning that must be enforced gradually implements ecological restoration projects and comprehensive land reclamation projects to restore soil fertility.
11. To achieve sustainable agricultural production, which is also an effective way to reduce the conflict between agriculture and ecological functions; promotes local farming; and develops characteristic animal husbandry, fruit and forestry products.
12. To encourage forest regeneration on a special legislation on both state and local government level that will guarantee the protection of forest resources fosters ecotourism and agricultural tourism through green approaches, enhancing the region's sustainable economic development.

Action Require by Individual/community/stakeholders level

i. Individuals, interest group and local government should plan and manage trees in farms in such a way as to promote forest resources by planting trees, perennial flowers and shrubs in our environment, this will prevent erosion and act as carbon storage.
ii. Support a nature- protection association by becoming a member, by making a donation, by bringing them publication and product and by participating as a volunteer in conservation and protection projects.
iii. Discuss the idea of "payment for environmental services "with friends and neighbor using the roles of trees in our environment for example they absorb run-off water, capture and convert Co_2 into O_2 shelter and food for numerous flora and fauna species.
iv. Participate in tree planting campaign and replace every tree you cut down.
v. Individuals and organizations should reduce their consumption of papers and cardboard in order to save our forest, this can be done through recycling and storing of information in hand and software of the computers.
vi. Encourage your organization to take action for forest by supporting nature-protection associations to compensate for its impact in Co_2 emissions and habitat loss.
vii. Individuals and civil societies should rise up and hold government accountable to their commitment on environmental protection
viii. Individual should make themselves available for community groups, civil organizations, to produce greater effects on forestry conservation and protection in their village and community
ix. Communities should revive their traditional knowledge, local innovations and practices for protection of forest resources.

Further Study

Future research work should address the question on how social conditions together with land uses will apply and analyze the current state of the environment as from (2015 -2025).This will require more advanced Geographical Information System (GIS) tools and geostatistical integration of Cellular Automaton (CA) and Markov Chain (MC) Models with current Sintenil-2 images for environmental modelling methods and its application in the built environment.

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