IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 12, Issue 7 Ver. I (July. 2018), PP 55-65
www.iosrjournals.org

Land Use Patterns and Vegetation Cover Changes in Coastal Precinct of the Mount Cameroon Landscape

Longonje .N. Simon[1] Ndrozem .N. Ernesta[1.2]

1. *Department Of Environmental Science, University Of Buea, P.O. Box 63 Buea, Cameroon Tel +237(0)*
1.2 *Department Of Environmental Science, University Of Buea, P.O. Box 63 Buea,*
Corresponding Author: Longonje .N. Simon[1]

Abstract: *Mapping land use/land cover changes at regional scales has wide range of applications, including land planning, global warming mitigation, biodiversity conservation etc. The Mt Cameroon landscape is a coastal area with it natural resources and topography undergoing tremendous change due to residential growth and associated development. Land use and vegetation change information is necessary for sustainable management of the natural resources at regional level.*

This study applied remote sensing and GIS-based methodologies for analysis and modeling of land use pattern and vegetation change over the past 28 years. Firstly supervised classification technique was used for Landsat images acquired in 1986, 2000 and 2014. Three Landsat images were classified by 5 reflective bands, using maximum likelihood method with the aid of ground truth data. Land use and vegetation cover changes were analyzed using statistical change detection matrix.

The result revealed that significant land use and vegetation cover transformation occurred during these years. Built-ups increased by 3265 ha, dense forest decreased by 41539 ha, secondary forest increased by 8175 ha, plantation increased by 895ha and farmland increased by 1086ha.

It was observed that, there have been significant changes in land use pattern and vegetation cover in the mount Cameroon landscape. The land use/land cover changes mostly occurred in coastal areas of the mountain region. Therefore, better regulation for sustainable development is necessary.

Key words*: Land use, vegetation, cover change, Mount Cameroon*

Date of Submission: 30-06-2018 Date of acceptance: 17-07-2018

I. Introduction

The world's tropical forests are degrading at an alarming rate due to increasing human population, settlement, agricultural intensification and non timber forest-product trade (Sayer *et al*., 1992).

Forests are a valuable resource providing food, shelter, wildlife habitat, fuel, and daily supplies such as medicinal ingredients and paper that human beings and other animals depend on (Boltz, 2003). Information on vegetation changes is the basis on which the past and present human interactions with the natural resources and the environment can be understood (Maitima *et al*., 2004). Vegetation change is a major cause for habitat modification and has strongly influence the distribution of wildlife species and ecological systems (Hansen *et al.*, 2001).

As a response to worldwide concerns about environmental issues, especially on vegetation change, new technologies such as aircraft and satellite borne multispectral scanners, Global Positioning Systems (GPS), and Geographic Information Systems (GIS) are revolutionizing vegetation mapping and its dynamics (Walsh and Townsend, 1995). These technologies have contributed regionally and globally to a recovery of interest in vegetation pattern and processes and have made scientist work much easier (Walsh and Townsend, 1995), which were lacking in earlier times. Assessing change detection analyses via Geographic Information System (GIS) coverage and satellite data obtained prior to and following a disturbance, have been used to assess vegetation responses to drought (Peters *et al.*, 1993; Jacob berger-Jellison, 1994), insect outbreaks (Muchoney and Haack, 1994), deforestation (Foody and Curran, 1994), and other disturbances.

Various data sources and analytical approaches differing in mathematical complexity, processing and analysis intensity, and classification technique have been used to detect vegetation change. Recently, principal components analysis (PCA), various vegetation indices, and logic rules have been implemented utilizing multitemporal satellite data and the analysis reveals valuable information about both current and historical environmental characteristics on vegetation covers dynamics (Bauer *et al.,* 1994, Muchoney and Haack 1994; Jensen *et al.*, 1995; Walsh and Townsend, 1995).

The total forest area of Cameroon is estimated at about 212, 450 km2 with a deforestation rate of about 2,200 km^2 annually (FAO, 2005). Forest has decreased from 245 450 km^2 (1990) to 223, 450 km^2 (2000) and it was at 212, 450 km^2 in 2005(FAO, 2005). Maintaining ecosystem functioning/services is a prerequisite for sustainable land management (SLM). Sustainable land management helps to mitigate soil degradation and enhance soil development. It also helps to preserve biodiversity and its habitat. In Cameroon, SLM development priorities are defined in the Poverty Reduction Strategy Paper which is further defined by the National Action Plan for Environmental Management (PNGE) and the Forest and Environment Sector Programme (PSFE). Understanding land use patterns and vegetation cover changes especially within coastal precinct in Cameroon and

Capacity building is an essential element in the support programme in order to strengthen the stakeholders' capacities to identify existing and new resources for SLM and United Nations Conference on Environment and Development (UNCED) implementation.

Though Cameroon still has extensive forest cover, the country may become the next to fall in the chain of West African countries that have seen their formerly abundant forests lost or degraded (Killeen *et al*., 2008). This situation is crucial around the MCL where the local community depend on forest resources for income and livelihood. Furthermore, Kah *et al*. (2008) reported that, the Mount Cameroon Landscape (MCL) is undergoing radical changes in forest cover due to creation of vast plantations by Cameroon Development Corporation (CDC). The opening of new crop farms and other cash crops such as cocoa, tea, unsustainable exploitation of fuel wood, extension of settlements and to a lesser extent fire damage, all these put pressure on this forest ecosystems.

The Mount Cameroon landscape (MCL) is a biodiversity hotspot harbouring the most diverse ecosystem in Cameroon.(Killeen *et al*., 2008). The area harbours the last near isolated and threatened population of the forest elephants in the region. The forest resources in and around the MCL constitute an important asset supporting rural livelihoods. These tropical forests are of significance to the well-being of the increasing population on the landscape. However, the forest resources and high biodiversity are also under threat from unplanned land uses. Land clearance, agro-business expansion, and uncontrolled exploitation of forest resources are major threats to biodiversity in the region, hence a need for sustainable management of these forests (Killeen *et al*., 2008) .

Since MCL has witnessed remarkable forest fragmentation and degradation due to anthropogenic activities and natural pressure during the past few decades. This pressure is ongoing and presents a potential threat to wildlife, other natural resources and sustainable development. An assessment of vegetation changes and land use patterns will help explain the dynamics involved and also equip various stakeholders including policy makers, sustainable urban development experts and biodiversity conservation with information. However, no quantifications have been done to establish the magnitude and pattern of land use and vegetation cover changes in the coastal precinct of the mount Cameroon landscape. This study, therefore, assessed the extent of land use and vegetation cover changes in the study area. Specifically, the study investigated long-term changes that have occurred as a result of human activities in the area from 1986-2014.

II. Methods

Study area description

The Mount Cameroon landscape (MCL) is located in the South West Region of Cameroon, it is situated in Fako and Meme Division between latitude 3^0 90´ and 4^0 05´N and longitude 9^0 29´and 9^0 06´E (fig. 1). The major villages in this area include; Bomboko clusters; Bokwango, Bwassa, Likumbe, Bonakanda, Bova, Boteva, Ekonjo, Bandu, Mapanja, Bomana, Toko and Ekona Lelu,

The Mount Cameroon landscape is within the equatorial rainforest zone which is characterized by two main seasons: the raining season from June to October and the dry season from November to May. The annual precipitation ranges from 3000mm to 4000mm and temperature varies between 27 ^{0} C and 32 ^{0} C (Buh, 2009).The study area is known for its exceptional rich flora and fauna, it has a wide range of coastal vegetation including lowland evergreen rainforest, mangrove, swamp forest, submontane forest, montane forest and grassland (Thomas and Cheek, 1992). It has about 2,300 species of plants in more than 800 genera and 210 families, 49 strictly endemic (only occurring on Mount Cameroon) and 50 near endemic plant species (Thomas and Cheek, 1992). Almost all of the plant families endemic to Tropical Africa: Huaceae, Medusandraceae, Lepidobotryaceae, Octocknemataceae and Hoplestigmataceae are found on Mount Cameroon and the surrounding foothills (Thomas and Cheek, 1992). The study area is a hotspot of wildlife, it have about 176 Forest Elephant (Laxodonta africana), 70 species of butterfly (including 3 endemic species), drills and chimpanzees are also found in the area (MCNP, 2006).

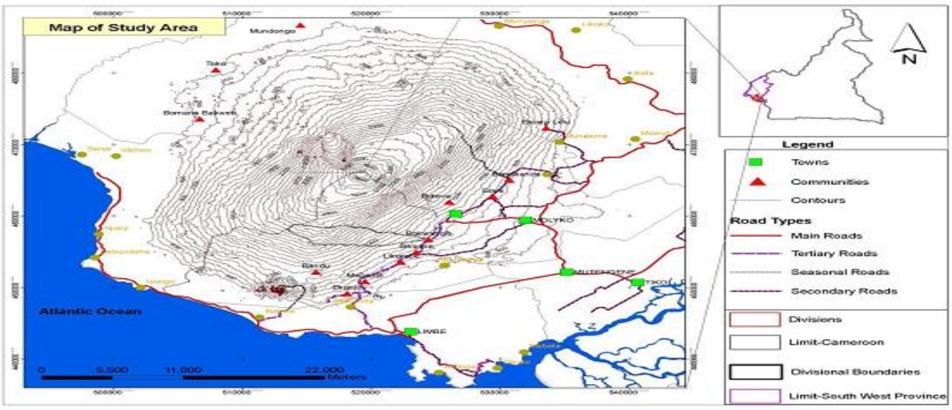

Figure 1: The study area in the South West Region of Cameroon, latitude (3^0 90′ and 4^0 05′N) and longitude (9^0 29′and 9^0 06′E).

Image acquisition and classification

This study made use of multispectral satellite remote sensing Land Sat Satellite data of Landsat Thematic Mapper (TM) and Landsat Enhanced Thematic Mapper (ETM+) scenes of the SEF of Mt. Cameroon for the periods 1986, 2000 and 2014 obtain from the University of Maryland Global Land Cover Facility website (http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp)/.The characteristics of these data sets are summarized in Table 1. The methodology adopted for this study is summarized in Figure 2, and involved radiometric normalization, geo-referencing, land cover classification, accuracy estimation and post classification analysis with GIS. The months for image acquisition were selected to increase the accuracy of the images from the study area. The images were co-registered (spatial resolution;30 m) using the 1986 image as the base image unto which the other images were warped using the image to image registration method , and the first order polynomial warping function in ENVI 4.4. ArcGis 9.3 was the GIS software used for the production/assessment of topographic and elevation data, surface area estimations, image displays and final map productions. A GPS for taking ground control points, digital camera for taking photographs, writing materials were used during fieldwork. The selection of the satellite images was based on the following criteria:

1) Availability of images within the geographic coordinates defined,
2) Reduced cloud cover (which is a common phenomenon observed for images obtained in the tropics) which is tied to the seasonality of the imageries and
3) Spatial resolution (which is determined by the satellite sensor used).

Table 1: Key characteristics of satellite data used for land use/cover change analysis

Sensor	**Acquisition date (yy/mm/dd)**	**Resolution**	**Accuracy assessment**
Landsat TM	1986/12/12	30 m	95%
Landsat ETM+	2000/12/10	30 m	95%
Landsat ETM+	2014/12/07	30 m	95%

From the dates of acquisition of the images (Table 1), they were all taken during the dry season which accounts for the reduced cloud cover on their surfaces as opposed to rainy season images. These images were used as base maps during land use and vegetation cover analysis. The TM 1986 image has a ground resolution of 30m/pxl, while ETM+ 2000 and 2014 images had a resolution of 28.5m/pxl. But then, all the three images were co-registered under the same pixel resolution which was that of the base map (1986 image) in order to increase accuracy assessment. These images were acquired already geo-referenced (WGS 84, UTM Zone 32N), thus no geo-referencing was required for the images. The main procession carried out on these images was stacking/superimposing them together using the ENVI 4.4 software so that they had the same spatial (size) and spectral (resolution) extents needed to carryout accurate land use assessment.

Field Ground truthing

Vegetation types identified from the 1986-2014 images were counterchecked by carrying out fieldwork for primary and secondary data in the study area in order to update data interpreted from the image. A geographic positioning System (GPS) was used to record ground coordinates for different vegetation types on the map in order to increase the accuracy reference points. A GPS-guided field investigation was conducted in March and April 2014. The fieldwork supported interpretation of TM and ETM+ images and delineation of the general land cover types. The field observations provided independent reference data for the accuracy assessment. The obtained coordinates were later used to validate the observed landuse and vegetation cover types on the satellite images before classifying the land use and vegetation cover changes over time.

Satellite image pre-processing

Normalized Differential Vegetation Index (NDVI) 4.4 tool was the remote sensing software used for geo-referencing, classification, NDVI analysis, change detection, visual interpretation and the production of vegetation change maps. ArcGis 9.3 was the GIS software used for the production/assessment of topographic and elevation data, surface area estimations, image displays and final map productions. This present study made use of multi-temporal satellite data on a large scale possesses a number of challenges including geometric correction error, noise erasing from atmospheric effect, error arising from changing radiance geometer and instrument errors. The Landsat images were obtained as geometrically incorrect thus needed to be geometrically corrected through image enhancement. For this reason the GPS points gotten from “ground truthing” was used as reference points to rectify the Landsat images. The polynomial second order geometric registration method was used. The geometric registration accuracy (root mean square) was within one pixel. All the images had cloud cover, hence was used as part of the classification

Descriptions of land cover classes

Since there are some differences between the land cover classes in the historical land cover maps of 1986, 2000, 2014, and land cover classes which can be discriminated from the satellite image, recoding was needed to create a common classification for change detection purposes. Therefore, this section describes the land classes used for land cover mapping from satellite images. Change detection of the various land cover categories was done by comparing land cover statistics according to the method of Boakye *et al.,* (2008). The main aim was to automatically categorize all pixels in an image into land cover classes.

Image Classification and Accuracy Assessment

The image classification was carried out in ENVI 4.4. software, a supervised classification technique with maximum likelihood algorithm was applied. After classification in ENVI 4.4, the classification were polygonised and exported to ArcGIS for further processing with on screen digitising of some land cover classes areas. This was due to overlap in spectral reflectance among some land cover classes. Considering that all these images were taken in different years with different sun angle and sun elevation, individual pixels on each of these images could not be superimposed on each other. To make them align, they were co-registered using the 1986 image as the base image unto which the other images were warped using the image to image registration method and first order polynomial warping function in ENVI 4.3.

Supervised classification using maximum likelihood parametric classifier and nearest neighbour algorithm was performed to identify various features on these images and manually digitized to assess the different land cover categories.

Change detection of the various land cover categories was done by comparing land cover statistics according to the method of Boakye *et al.,* (2008). The main aim was to automatically categorize all pixels in an image into land cover classes (The classification for land use/land cover mapping was level 1, showing general land cover, and land use systems.

Finally, recoding of land cover types to the common classification was carried out since there are different in land cover maps of 1986, 2000, 2014 and the classes which be discriminated from satellite images.

For the qualitative accuracy assessment of the image classification, Kappa Statistics was applied. Kappa statistics is a measure of agreement between image data and the reference data (Jesen, 1996).

Change detection analysis entails finding the type, amount and location of land use changes that are taking place (Yeh *et al*., 1996). Change detection often involves comparing satellite imageries of an area taken at different times. Thus, change detection can only be assessed from more than one image and it is mostly visible over a period of 10 years. This process is mostly frequently associated with environmental monitoring and natural resource management.

The method applied for change detection in this study is the post classification method. This method was based on post classification comparison of independently classified land cover maps of 1986, 2000, and 2014. The technique used for change detection was GIS overlay in ArcGIS (intersect operation). This result in the output table forms the overlay of maps of the different dates. This output table was then exported as DBF table and further process in EXCEL (with pivot table function) to qualify and quantify the land cover changes. Land cover changes were investigated for the sub periods 1986-2000, and 2000-2014.

Assessment of the Rate of Cover Change

The estimation for the rate of change for the different covers was computed based on the following formulae (Kashaigili, 2006):

$$\% \text{ cover change} = \frac{Areas_{\,i year\, x} - Area_{iyear+1}}{\sum_{i=1}^{n} Area_{iyearx}} \text{x}100 \qquad (1)$$

$$\text{Annual rate of Change} = \frac{Areas_{\,iyear\, x} - Area_{iyear+1}}{t_{years}} \qquad (2)$$

$$\% \text{ Annual rate of Change} = \frac{Areas_{\,iyear\, x} - Area_{iyear+1}}{Area_{iyearx} \;\text{x}\; t_{years}} \text{ x } 100 \qquad (3)$$

Where: $Area_{\,i\,year\,x}$ = area of cover i at the first date,
$Area_{\,i\,year\,x+1}$ = area of cover i at the second date,

$\sum_{i=1}^{n} Area_{iyearx}$= total cover area at the first date and

$t_{\,years}$ = period in years between the first and second scene acquisition data

GIS analysis

The classified and enhanced images processed in the ENVI 4.4 software were saved in geotiff format and exported to ArcGIS 9.3 and 10.2 (GIS software) for further analyses 15 and the production of the maps presented in the preceding chapters. The image analysis extension in ArcGIS helped to sharpen more features for better visualisation for the features of interest in the study area such as marshes and mangroves. The flow chart below (Figure 1) summarizes the procedure applied in this study to carryout change detection of the identified classes over the years.

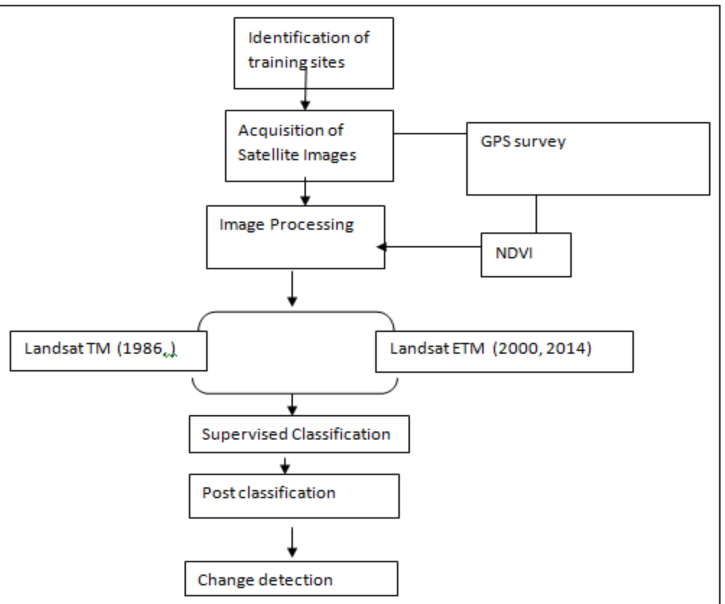

Figure 2: Flow chart of the Analysis

III. Results And Discussion

Land use and land cover class distribution 1986-2014

The land cover maps for 1986, 2000 and 2014 are presented in Figures 3, 4 and 5, respectively. Generally, the maps show the variation in cover between the three time periods under consideration. It can be observed that there have been significant changes in land use pattern and forest cover in the coastal precinct of the mount Cameroon landscape.

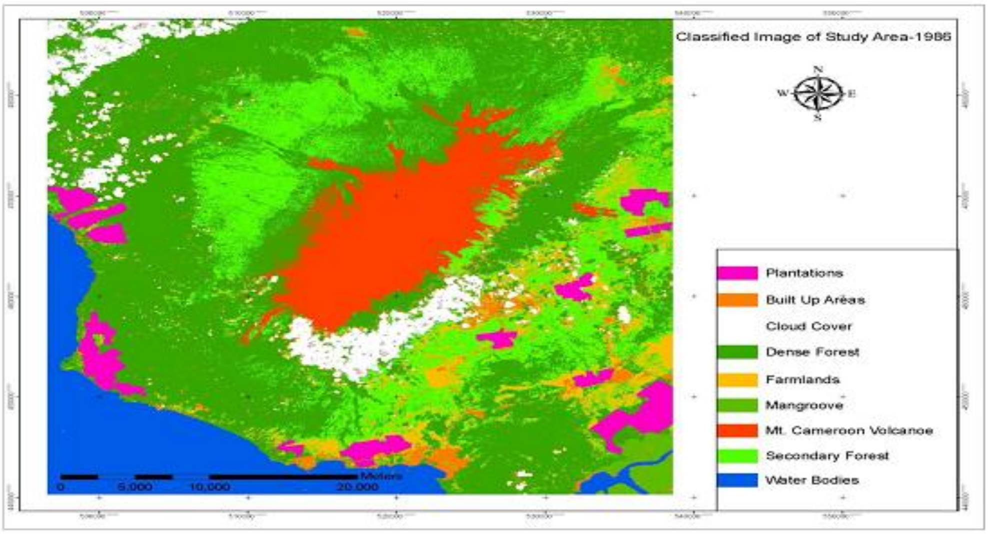

Figure 3. Land use and land cover map of image scene, 1986

Figure 3 shows that in 1986, dense forest dominated the area by covering 50% (98900 ha) followed by secondary forest 19% (37561ha), then water bodies 10% (20236 ha), plantations 4% (7128 ha), farmlands 1% (2625 ha), mangroves 1% (1788 ha), and lastly, settlements, 1025 ha.

Figure 4 shows that in 2000, dense forest is the dominated class which occupied an area of 64662 ha (30%), followed by water bodies' class 60261 ha (28%), then secondary forest 5784 ha (3%).

During this period, dense forest reduced by 20%, water bodies reduced by 28%, and secondary forest by 3%. The results clearly revealed the occurrence of significant land use and vegetation cover trans-formation from one land use class to another.

Figure 5 shows that in 2014, Settlements, farmland and water bodies increased and dense forest reduced significantly (Table 2).

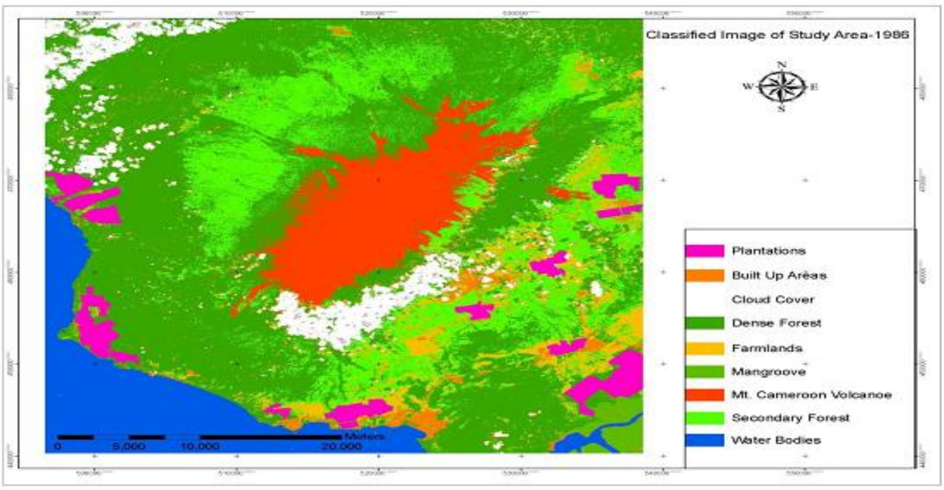

Figure 3. Land use and land cover map of image scene, 1986

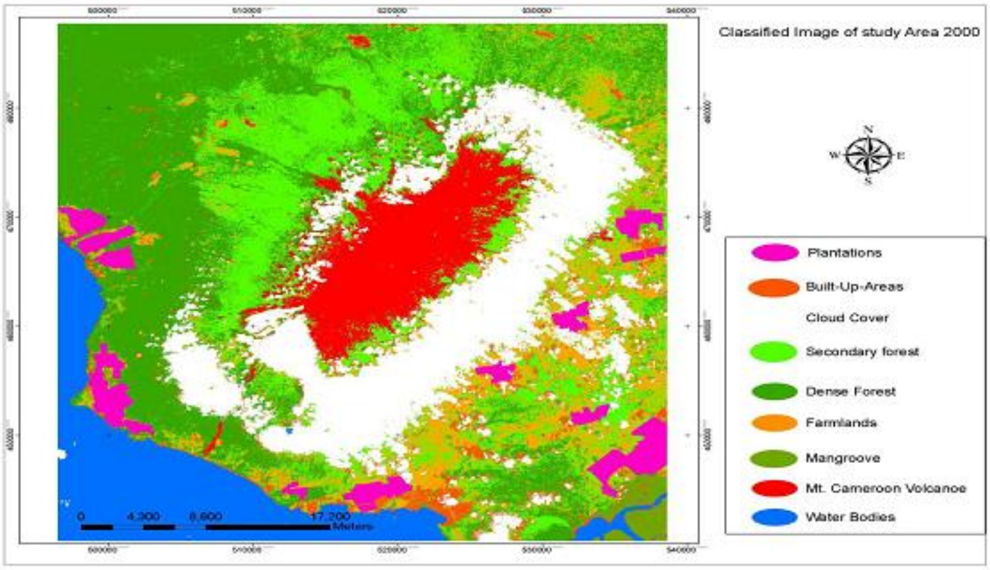

Figure 4. Land use and land cover map of image scene, 2000.

Table 2: Land cover change from 1986 – 2014

Class cover type	Area covered in 1986 (ha)	Area covered in 2014 (ha)	Change over 28 years*	Annual change (ha)**	Percentage change (%) ***	Projected change by 2020 (ha)****
Settlements	1025	4289	3264	116.57	11.37	5826.88
Dense forest	98900	57361	-41539	1483.53	1.50	-74178.32
Plantations	7128	8024	896	32	0.45	1600
Water bodies	20236	64558	44322	1582.92	7.82	81403.54
Mangroves	1788	7996	6208	221.71	12.39	8930.42
Secondary forest	37561	45734	8173	291.89	0.78	48998.12
Farmlands	2625	3712	1087	38.82	1.48	3391.04

*Change over 28 years = area covered in 2014 – area covered in 1986
**Annual change (ha) = change over 28 years/28
***Percentage change (%) = change over 28 years/Area covered in 1986 * 100
****Projected change by 2020 = (annual change × 22) + change over 28 years

Change distribution between 1986 and 2000

Table 3 shows that, built-up areas, plantations, water bodies, mangroves, and secondary forest increased between 1986 and 2000. built-up areas increased at a rate of 161.64 ha/year (0.08%/year), , plantations slightly increased at a rate of 85.57 ha/year (0.04%/year), water bodies increased at a rate of 2858.93 ha/year (1.44%/year), mangroves also had a slight increased at a rate of 333.07 ha/year (0.17%/year), and secondary forest increased at a rate of 2269.79 ha/year (1.14%/year). The dense forest and farmlands decreased at a rate of 2445.57 ha/year (1.23%/year) and 44.71 ha/year (0.02%/year) respectively. Figure 6 shows major areas of changes between 1986 and 2000.

Table 3: Change distribution between 1986 and 2000

Landuse/Cover	Landuse Type in 1986 Area (ha)	Landuse Type in 2000 Area (ha)	Area Change (ha)	Cover Change (%)	Annual rate of Change (ha/year)	Annual rate of Change (%/year)
Built-up areas	1025	3289	2263	1.14	161.64	0.08
Dense forest	98900	64662	-34238	-17.23	-2445.57	1.23
Plantations	7129	8327	1198	0.60	85.57	0.04
Water bodies	20236	60261	40025	20.14	2858.93	1.44
Mangroves	1788	6451	4663	2.35	333.07	0.17
Secondary forest	37561	5784	-31777	-15.99	2269.79	1.14
Farmlands	2626	2000	-626	-0.31	-44.71	0.02

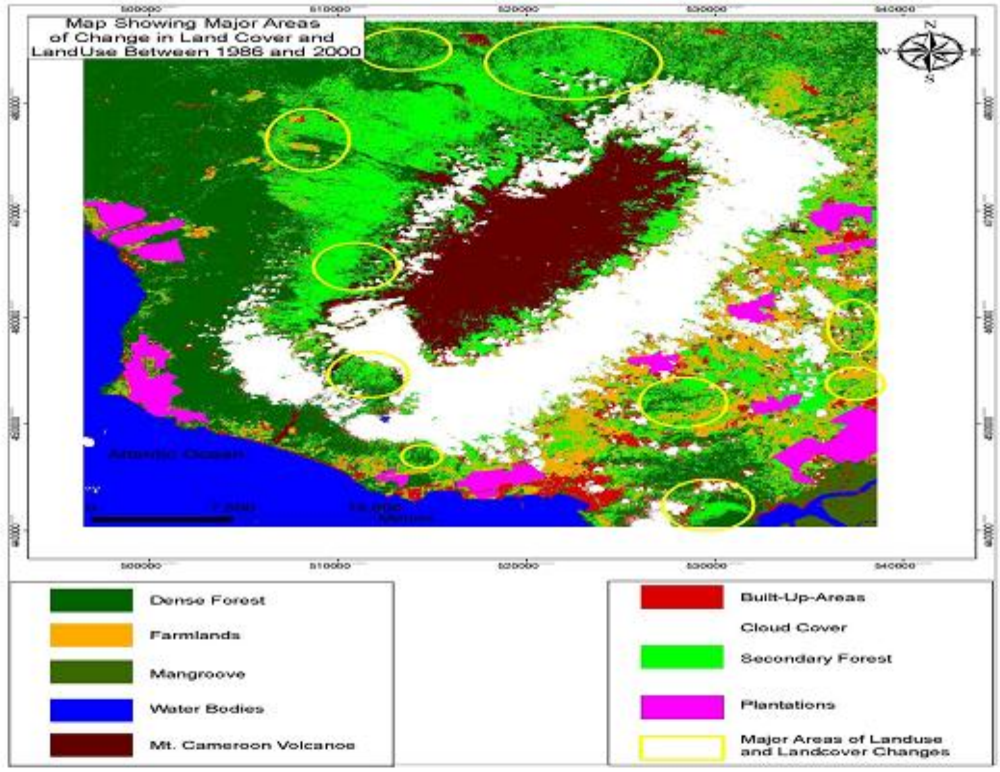

Figure 6: Major area of change in vegetation cover and land use between 1986 and 2000.

Land use change between 2000 and 2014

During this period, built up area increased by 71.43 ha/year (0.03%/year), water bodies increased by 306.93 ha/year (0.14%/year) and secondary forest increased by 2853.57 ha/year (1.31%/year).

Dense forest and plantations decreased by 521.50 ha/year (0.24%/year) and 21.64 ha/year (0.01%/year) respectively (Table 4). Figure 7 shows major areas of changes between 2000 and 2014.

Table 4: Change distribution between 2000 and 2014

Landuse/Cover	Landuse Type in 2000Area (ha)	Landuse Type in 2014 Area (ha)	Area Change (ha)	Cover Change (%)	Annual rate of Change (ha/year)	Annual rate of Change (%/year)
Built-up areas	3289	4289	1000	0.46	71.43	0.03
Dense forest	64662	57361	-7301	-3.35	-521.50	0.24
Plantations	8327	8024	-303	-0.14	-21.64	0.01
Water bodies	60261	64558	4297	1.97	306.93	0.14
Mangroves	6451	7996	1545	0.71	110.36	0.05
Secondary forest	5784	45734	39950	18.33	2853.57	1.31

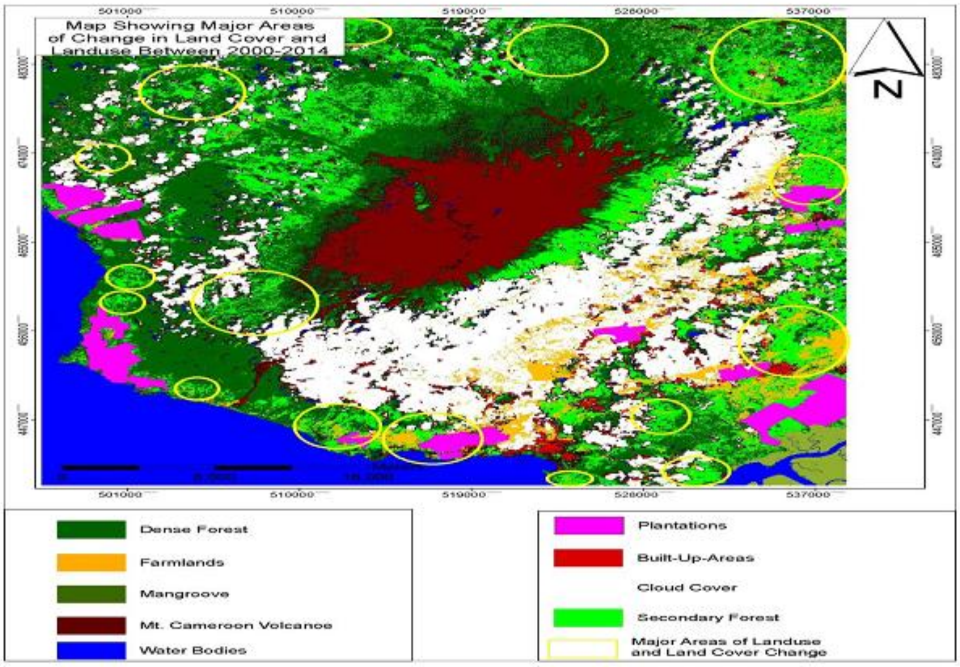

Figure 7: Major area of change in vegetation cover and land use between 2000 and 2014.

IV. Discussion

Land use trend between 1986 and 2014

Vegetation cover and land use pattern of a region is as a result of natural and socioeconomic factors and the manner in which they are being used by human with time. During the last three decades, from 1986 to 2014 anthropogenic activities have enormously changed vegetation cover in the study area. Vegetation cover is important natural resources since agricultural, forestry and wildlife productions solely depend on the productivity of the land which comprises of water, plants and soil.

Observing the earth surface by viewing the land satellite images we get a crucial understanding that anthropogenic activities have a great influence on natural resources over a period of time. Land use statistics is vital information used to access and analyze the changes of vegetation cover and landuse pattern. The change analysis presented in this research is based on the statistics extracted from the three vegetation cover/land use maps of the Mt. Cameroon landscape using remote sensing and GIS applications. The Land cover maps for 1986, 2000 and 2014 are presented in figure 3, 4, and 5 respectively. Generally the maps show the variation in cover between the three time periods under consideration. Nine classes were identified and classify as the land use/cover for all the three images, the major classes were; settlements, dense forest, plantations, water bodies, mangroves, secondary forest, and farmlands

However, amongst these major classes, four were identified as land use practices that are heavily depleting the vegetation cover in the area. They are; the settlements, farmland, plantations and water bodies. Settlements accounts for 3289 ha of deforestation in 2000, and 4289 ha of deforestation in 2014 while farmlands accounted for 2000 ha in 2000 and 3712 ha in 2014 and water bodies accounted for more than 64558 ha in the study area.

The population of people in the 1980's mostly comprised of immigrants from other parts of the nation, particularly in the North West Region, came to work in the plantations and made little impact on the vegetation (Balgah, 2011). This is in line with (Selcuk, 2008) who analyzed landuse and land cover changes in Rize, North-east Turkey from 1976 to 2000. He noted that deciduous forest, coniferous forest and pasture covered the largest areas in 1976 and later on started decreasing from the end of the twentieth century and the beginning of the 21st century. Dense forest (64662 ha) dominated the vegetation cover during 2000. Based on the classification analysis, there was a significant increase in water bodies from 1986 (20236 ha) to (60261 ha) in 2000. Settlements increased from 1025 ha to 3289 ha in 2000, this could be the reason for decrease in vegetation cover (dense forest from 98900 ha to 64662 ha). Thus, this gives a linear relationship over a period of fourteen years as woods would be logged for construction (Nzundu *et al*., 2013).

The increased in plantations may be tied to a corresponding increase in built-up areas. The creation of plantations by Cameroon development cooperation and Del monte banana plantation introduced in the 1980s, took up large expands of land and created path way for immigrants from different parts of the nation to seek jobs. As the plantations increase, the cooperation increase settlements by building camp houses for its workers to live in. The creations of new plantations and the construction process can be attributed to the increase in degraded vegetation as a result of anthropogenic activities within the forest. It has been argued that population rise is a key trigger of forest area loss in Cameroon a (Broklesby *et al*., 1997)

Between 2000 and 2014, plantation decreased 21.64 ha/year (0.01%)/year this is due to urban migration that has led to the conversion of portions that were formally plantations into settlement and agricultural land.

Dense forest decreased from 64662 ha to 57361 ha in 2000 and 2014, respectively. Forest degradation makes the soil susceptible to erosion that causes soil degradation and crop failure (Wily, 1995). Forest degradation also contributes to loss of wildlife habitat. Moreover, anthropogenic activities affect other forms of life in different ways. Some activities such as cultivated lands that have direct effect include indiscriminate exploitation of forest for construction purposes (Balgah, 2011).

Acknowledgement

We wish to thank the Government of the Republic of Cameroon for 'The Higher Education Research Modernisation Grant to the Academic Staff. (PSMR) through which some of the equipment used in this work was acquired. Also Cameroon Wildlife Conservation Society (CWCS) for their assistance during the field work.

References

[1]. Balgah, S.N ., 2011. Land Tenure and Land Use Dynamics in Limbe City, South West Region of Cameroon. Journal of Agriculture Science Developments, Pp: 14-24, University of Buea.
[2]. Bauer, M.E., Burk, T.E., Ek, A.R., Coppin, P.R., Lime, S.D., Walsh, T.A., Walters, D.K., Befort, W., and Heinzen, D.F.,1994. Satellite inventory of Minnesota forest resources. Photogrammetric Engineering & Remote Sensing 60(3): 287-298.
[3]. Boakye, E.; Odai, S., Adjei, K. and Annor, F., 2008. Landsat Images for Assessment of the Impact of Land Use and Land Cover Changes on the Barekese Catchment in Ghana. European Journal of Scientific Research, **22** (2) 269-278.
[4]. Boltz, F.; Holmes, T. P.; and Cater, D.R.. 2003. Economic and environmental impacts of conventional and reduced-impact logging in Tropical South America: a comparative review. Forest Policy and Economics, **5**(1): 69-81.
[5]. Broklesby, M., Ambrose, O. and Tekwe, C., 1997. Developing Participatory Forest management. The user group analysis on Mount Cameroon .Paper presented on the Tropical Forest Forum Conference Limbe, Cameroon .
[6]. Buh, W.G., 2009. Geographic information systems based demarcation of risk zones: the case of the Limbe Sub-Division – Cameroon Journal of Disaster Risk Studies, Vol. 2, No.1.
[7]. FAO ., 2005. State of the World's forests 2005. Food and Agriculture Organization of the United Nations, Rome, Italy. 1-47.
[8]. FAO/FRA., 2005. Evaluation des Ressources Forestieres Mondiales. Cameroun. Rapport Nationale 122, Rome.
[9]. Foody, G.M., and Curran, P.J.,1994. Estimation of tropical forest extent and regenerative stage using remotely sensed data. Journal of Biogeography 21: 223-244.
[10]. Fresco, L.O.; Huizing, H.; Keulen, H.V.; Luning, H.A., Schipper, R.A.,1994. Land Evaluation and Farming Systems Analysis for Land Use Planning, FAO Working Document; FAO: Rome, Italy.
[11]. Hansen, A. J., Neilson, R. R., Dale, V. H., Flather, C. H., Iverson, L.R., Currie, D. J., Shafer, S.R., Cook, and Bartlein, P. J. , 2001. Global change in forests: Responses of species, communities, and biomes. BioScience 51:765-779.
[12]. Jacobberger-Jellison, P.A.,1994. Detection of post-drought environmental conditions in the Tombouctou region. International Journal of Remote Sensing 15(16): 3138-3197.
[13]. Jensen, J.R.,1996. Introductory Digital Image Processing: A Remote Sensing perspective. 2nd edition. Prentice-Hall, New Jersey.
[14]. Jensen, J.R., Rutchey, K, Koch, M.S., and Narumalani, S.,1995. Inland wetland change detection in the everglades water conservation area 2A using a time series of normalized remotely sensed data. Photogrammetric Engineering & Remote Sensing 61(2): 199-209.
[15]. Kah, E., Tchindjang, M., Tonye, E. and Talla, T., 2008. Combined supervised classification methods in remote sensing for the evaluation of forest dynamics along the slopes of Mount Cameroon. Pp 1– 6.
[16]. Kai, S., 2003. Rural Livelihood and Social Infrastructure around Mount Cameroon. GmbH Back ground information for the M.C-SE GIS
[17]. Killeen, J., Anna G., Miki C., Lisette C., Veronica C., Lillian S., Belem Q. and Marc K., 2008. Total Historical Land use change in Eastern Bolivia. Who, Where, When and How much? Ecology and Society,**13**(1): 36-49
[18]. MCNP .,2006. Mount Cameroon National Park, Annual report 2006
[19]. Maitima, J., Reid, R.S., Gachimbi, L.N., Majule, A., Lyaruu, H., Pomeroy, D., Mugatha, S., Mathai, S., Mugisha, S., 2004. The linkages between land-use change, land degradation and biodiversity across East Africa. Journal of Working Paper Series No. 42. p.63.
[20]. Muchoney, D.M., and Haack, B.N. ,1994. Change detection for monitoring forest defoliation. Photogrammetric Engineering & Remote Sensing 60(10): 1243-1251.
[21]. Nzunda, N.G.,Pantaleo K.T.M., Japhet, J. K., Geofrey, E.S and Joel, F. M.,2013. Land use and vegetation cover dynamics in and around Kagoma Forest reserve Tanzania. Journal of ecology and natural environment Vol.5 (8), pp. 206-216
[22]. Peters, A.J., Reed, B.C., Eve, M.D., and Havstad, K.M.,1993. Satellite assessment of drought impact on native plant communities of Southeastern New Mexico, U.S.A. Journal of Arid Environments 24: 305-319.
[23]. Sayer J.A., Harcourt C.S. and Collins N.M. (1992). The Conservation Atlas of Tropical Forests. Africa. WCMC-IUCN, NewYork.
[24]. Selçuk, R.,2008. Analyzing land use/land cover changes using remote sensing and gis in rize,
[25]. North-East Turkey. Journal of sensors 1424-8220.
[26]. Thomas, B. and Check, M., 1992. Vegetation and plant species on the south side of Mount Cameroon I the proposed Etinde Rainforest Reserve. Report to Cameroon Government/OD A/ RBG, Kew. 37pp tropical forests. Africa. New York. Simon & Schuster. Walsh, S.J., and Townsend, P.A.,1995. Comparison of change detection approaches for assessing a riverine flood hydroperiod. ACSM/ASPRS Proceedings, pp. 134-143.

[27]. Wily, L. ,1995. What future for community forestry in Nepal? Journal of Social Development Newsletter. Overseas Development Administration, London, vol. 3 (1) p. 8.
[28]. Yeh ,A., Gar. A., Xia. L., 1996. Urban Growth Management in Pearl River Delta: an Integrated Remote Sensing and GIS Approach. ITC J. 1:77–78.

Longonje .N. Simon "Land Use Patterns And Vegetation Cover Changes In Coastal Precinct Of The Mount Cameroon Landscape." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 12.4 (2018): 55-65.