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Tracking changes in land cover and adaptation strategies for food security in momo division, northwest Cameroon

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Abstract

Momo Division, one of the seven Divisions that make up the Northwest Region in the western highlands of Cameroon has experienced profound mutations in the land cover which has affected agricultural production and the food security situation of its population. It is in furtherance to this that this study was carried out with the main objective of examining the changes in the land cover situation and adaptation strategies of the local farming population to enhanced food production. Vital primary data were gotten through field survey, interviews and focus group discussions while information on the land cover situation was obtained using satellite images for the different observed periods and further complimented by ground truthing and expert judgement of the study area. Secondary data were obtained from both published and unpublished works. The results indicate that the various land parcels under investigation have experienced profound mutations from 1976-2016. However, the rates of change in the land parcels have been observed to be in fluxes. Findings further show that the landscape is largely hilly with lowlands occupying just 21.22%, while highlands 32.89% and the extremely highlands 45.89%. The population of the area has equally been increasing rapidlyand therefore necessitating adaptive measures to improve on farm outputs as agriculture and settlement have been observed to be in conflicts due to the limited land space. The adaptation strategies carried out by the local farming population to enhanced production are said to be unsustainable with spill-over effects that have impacted enormously on the climatic cycles and water regimes of the area. This paper therefore calls for urgent stakeholder intervention in the exploitation of the different land cover types to build the capacities of the rural farming population as resource managers. It concludes by drawing the attention of the State and most especially the local farmers to foster land resources conservation and invest in poverty alleviation initiatives which must be off-farm so as to reduce the huge pressure on the various land parcels under investigation and ensure environmental equity and justice.

Keywords: Evolution, land cover change, adaptation strategies, food security, Momo Division, Cameroon.

Introduction

Attempts in understanding the state of land cover change and agricultural production is a necessity as food production is becoming a major challenge in a world currently witnessing astronomical population growth and dwindling natural resources. This calls to mine the need for effective policy regulations and a legal framework that will ensure the efficient management of land resources and an increased in food productivity. Many scholars have noted that land-use land-cover changes (LULCC) are central issues in the global debates on food security challenge[1-3]. However, these challenges have emerged from anthropogenic impacts on the environment with enormous implications on climatic cycles and food security. According to Bruijnzeel[4], Chomitz and Kamari[5], global land cover change has been observed as a trigger to soil degradation and erosion in the tropics. This has affected the spatial extent and scale of agricultural productivity in many parts of the world with resultant effects on local livelihoods and food self-sufficiency.

According to the United Nations Food and Agriculture Organization, some 15 to 20 million hectares of forestland disappear annually in developing countries while West Africa alone loses more than two third of its wooded surface[6]. Equally, the Glowa-Impetus programme further predicted a 30 percent loss of vegetation in Tropical Africa and the Sahel zone by 2025[7]. This may affect the climate and extend to agricultural production of West Africa. Studies by Roy Chowdhury[8], Geist and Lambin[9], identify deforestation as the main cause of land cover changes in the tropics regions and Africa in particular[3]. They further observed that drivers such as infrastructural development, expansion of agricultural land, fuel wood extraction, rapid demographic increase, economic, technological, land policies, institutional, cultural, environmental, and biophysical factors have impacted enormously on the current changes in land cover. It is however noted that land cover change and soil degradation may seem difficult to bring under control as the increasing human numbers continue to exacerbate the demand for food, shelter and other goods and services in Cameroon and Momo Division in particular. This trend has enhanced the degradation of vital earth's resources with enormous implications on agricultural production. Amidst these emerging challenges to food production, adaptation strategies are needed if sustainable food production is to be achieved for generations.

The Problem: Momo Division, one of the seven Divisions that make up the Northwest Region in the western highlands of Cameroon has experienced profound changes in the land cover which has affected agricultural production and rural livelihoods of its population. This has therefore posed enormous challenges for the rural farmers as arable and rangelands are on a decrease. These challenges focused on ensuring proper land use/cover change, increasing and sustained food production, generating income to improve on livelihoods while maintaining the ecological integrity of the system.

In Momo Division, proper land use has remained a challenge as a significant proportion of the population depends absolutely on nature for survival. Coincidentally within a few decades, the demographic increase in the area coupled with the use of unsustainable methods in land resource exploitation, nature has been forced to bear the heavy brunt[10]. This is evident in the rapid disappearance in forest cover, retreating arable and range lands and the increasing savannization of the landscape. At present, more than three quarter of the landscape has been stripped off its natural vegetation while there has been a drastic decrease in arable and rangelands. Areas such as Mbengwi, Njikwa, Batibo, Ngie and parts of the upper Menka highlands have completely lost their natural vegetation while savannization has been on the rise. However, as agriculture remains the main source for generating income to meet up with livelihoods challenges, the involvement of many farmers in the sector in the mist of retreating arable and rangelands implies more land will be cleared, burnt and expose while settlements will continue to impact enormously on the forest and rangeland vegetation. Currently, the only measure to improve on soil fertility by the local population is allowing the farming plots to fallow. Unfortunately, increasing and uncontrolled population pressure is decreasing the fallow duration. The results have been the loss of soil fertility, decreased in crop yields and the increasing fluctuations in the climatic cycles. More still, the fact that land as a resource belongs either to a family or the community in the area, there exist the tendency where individuals in the quest to make maximum profit exploit unsustainably and degrade the resource base with impunity. With these growing challenges, the agricultural productive capacity and other issues on the food security nexus have become a challenge. It is on this premise that this paper the paper was aimed at tracking changes in land cover for Momo Division from 1976-2016 with the view of identifying adaptation strategies to enhanced food production.

Methodology

Research site: Momo Division is one of the seven divisions that make up the Northwest Region in the Western Highlands of Cameroon. It is located between longitudes $9^0$58" and $28^0$02" East of the Greenwich meridian and latitudes $5^0$54" and $1^0$91" North of the equator. Relatively, the division shares its borders with Menchum Division in the North and Mezam in the East. It equally shares an extensive border with the Southwest Region covering the Northwest, West and the Southwest of the study area. It has a total land surface of 1792km^2. According to the Cameroon National population Census (2005), it has a total population of 138693 inhabitants with approximately 95% of the population depending on the natural resource base for sustenance[11].

Methods: This study is based on a field survey carried out in the montane highlands of Momo Division in the months of November and December 2017. It adopts both the descriptive and analytical methods of investigation and further complimented by reviews from published and unpublished sources, interviews and focused group discussions. With regards to field observation, vital primary data were generated by the researcher intuition based on longevity in the area. Under this, the researcher embarked on observing the following; the various human activities and their intensities in the area. Evaluating the potentials of the different ecological niches as well as assessing the environmental peculiarities. Investigating evidence of land cover change and taking note of their spatial intensities.

In an attempt to justify changes in land cover, the researcher monitored the phenomenon for forty years (1976-2016) using remotely sensed satellite imageries. This long period was to show an appreciable evaluation in the changes that have taken place in the land cover. Four land parcels were placed under investigation. These are: forestland, savannah and bare land surfaces, built-up land, hydrology and montane forest land. To give meaning to the assembled remotely sensed data and relevance to the study, a set of techniques and tools were applied. Data processing was done by way of computer based image treatment procedures and techniques using specialized software. The principal software used in processing this data were ERDAS IMAGINE 9.1, and ARCGIS 10.5. Lands at images were obtained as isolated bands with each having different reflectance corresponding to surface features peculiar to each of the image bands. It was combined into composite multi-band images treatable in a remote sensing platform for analysis. The combined data was assembled using a function in ERDAS known as layer stacking and this resulted in different 185 x 185 km of multi-band images, for each of the reference years under investigation. This was followed by the combination of these different images into one whole image through a mosaic operation. The shape file of Momo division was extracted from an existing geodatabase using ArcGIS, and overlaid on the mosaic of the multi-spectral image bands and a subset of the image covering Momo division (the area of interest) was created for each of the five reference periods. Image to image geometric correction was carried out to match the 1976, 1986, 1996 and 2006 images to the characteristics of the 2016 image that had a higher resolution of less than 30m.

With the five data sets harmonized, an unsupervised classification of each of the images was carried out for spectral discrimination into six classes. Geographical coordinates for the different classes were introduced into the Global Positioning System (GPS). The GPS device was used to identify these points on the field and the characteristics of this feature corresponding to each spectral signature were identified during down truthing. Digital Globe Images were equally used to verify ground truthing. Based on the characteristics of these features, a supervised classification was carried out using the false colour composite of the images into five classes of interest in terms of land cover and land use variability and evolution. This classification permitted an appreciation of dynamics in land cover and land use in Momo division. After classification, the resulting images were exported to ArcGIS 10.5 platform for layout as it is better done in this platform than in ERDAS. This was followed by a classification of the different classes obtained and their surface area calculated in hectares.

Research Results

Land cover changes (1976-2016): In Momo Division, agro-pastoralism, cropping and livestock grazing have been identified as the main livelihoods activities of the local people. The population makes use of the land to ensure the availability of these livelihoods assets. According to Batcha, these activities do not occupy the same space though they co-exist[12]. The spatial delimitation of these activities including the built-up areas takes into account the relief factor, water and vegetation attributes of the physical environment. For a visual appreciation of trend analysis in land cover change, it is important to look at the historical evolution of activities such as agriculture and settlement in this area dating back from the era of the colonial masters. Before the 1960s, the colonial masters brought agricultural reforms with the introduction of coffee in the Northwest Region in general and Momo Division in particular as a major source of income generating activity. They equally established cooperatives that were concern with the production of coffee. This was a way of improving on trade through the export of these cash crops for their home base industries in Europe. The creation of cooperatives and veterinary services from the 1950s to take care of livestock and cattle production began to bring the region into the mainstream of a money economy. However, traditional agriculture was practiced with food crops such as cocoyam, yams, potatoes, maize, beans, vegetable, cassava amongst others were cultivated for domestic consumption. Palm planting for the production of palm oil was another cash crop introduced by the Germans before the coming of the British in this area after the Second World War. Palm plantations were established mostly in the Widikum basin which habour the luxuriant evergreen vegetation of Momo Division and the establishment of an oil mill in Teze, Ngie for the processing of palm oil. Despite these agricultural establishments, extensive fallow lands still existed in this area. Away from agricultural land for cash and food crops, pastoral activities were highly encouraged through the settling in of the Fulani cattle graziers from the North of Cameroon. According to Batcha, local indigenes were asked to provide land to the cattle graziers who were practicing free grazing and transhumance[12]. Settlement use of land during this period consisted mainly of rural dwellings with dispersed settlements that were difficult to access. Thus land use/cover situation before 1961 help to illustrate the historical perspective on the way and how the changes on the use of land occurred in Momo Division.

Land Use/Cover Trends 1976-2016: Examining the land cover change maps 1, 2, 3, 4 and 5, it is clearly shown that the land parcels have been changing from 1976-2016. Various land uses were grouped into categories for easy examination. An examination of the land use portrays combination of cover types like;

Built-up areas: Settlements including communication where we have rural groupings, urban groupings, dispersed groupings and roads infrastructures.

Forestland: woodland, raffia, cultural covers, and montane forest.

Water surfaces: ponds, potholes, waterfalls, springs, streams, rivers and lakes.

Savannah/Bare lands: Barelands and open rangelands.

The land use/cover time series maps show land occupation of the various land use/cover types and the spatial representation of their surface areas. The percentage of the total surface areas was calculated for each land use/cover type Table-1.

Table-1: Areas occupied by the various land use/cover in hectares (ha) and their percentages from 1976-2016 in Momo Division.

Land use/cover type	1976 (ha)	%	1986 (ha)	%	1996 (ha)	%	2006 (ha)	%	2016 (ha)	%
Forestland	102054	56.93	100670	56.16	100193	55.9	99765	55.65	93394	52.1
Savannah	65878	36.75	66539	37.12	66783	37.25	66948	37.35	70856	39.53
Built-up	4717	2.63	5550	3.1	6408	3.57	6709	3.74	10033	5.597
Hydrology	219	0.12	214	0.12	112	0.12	210	0.12	206	0.11
Montane Forest	6395	3.57	6290	3.5	5667	3.16	5631	3.14	4773	2.66

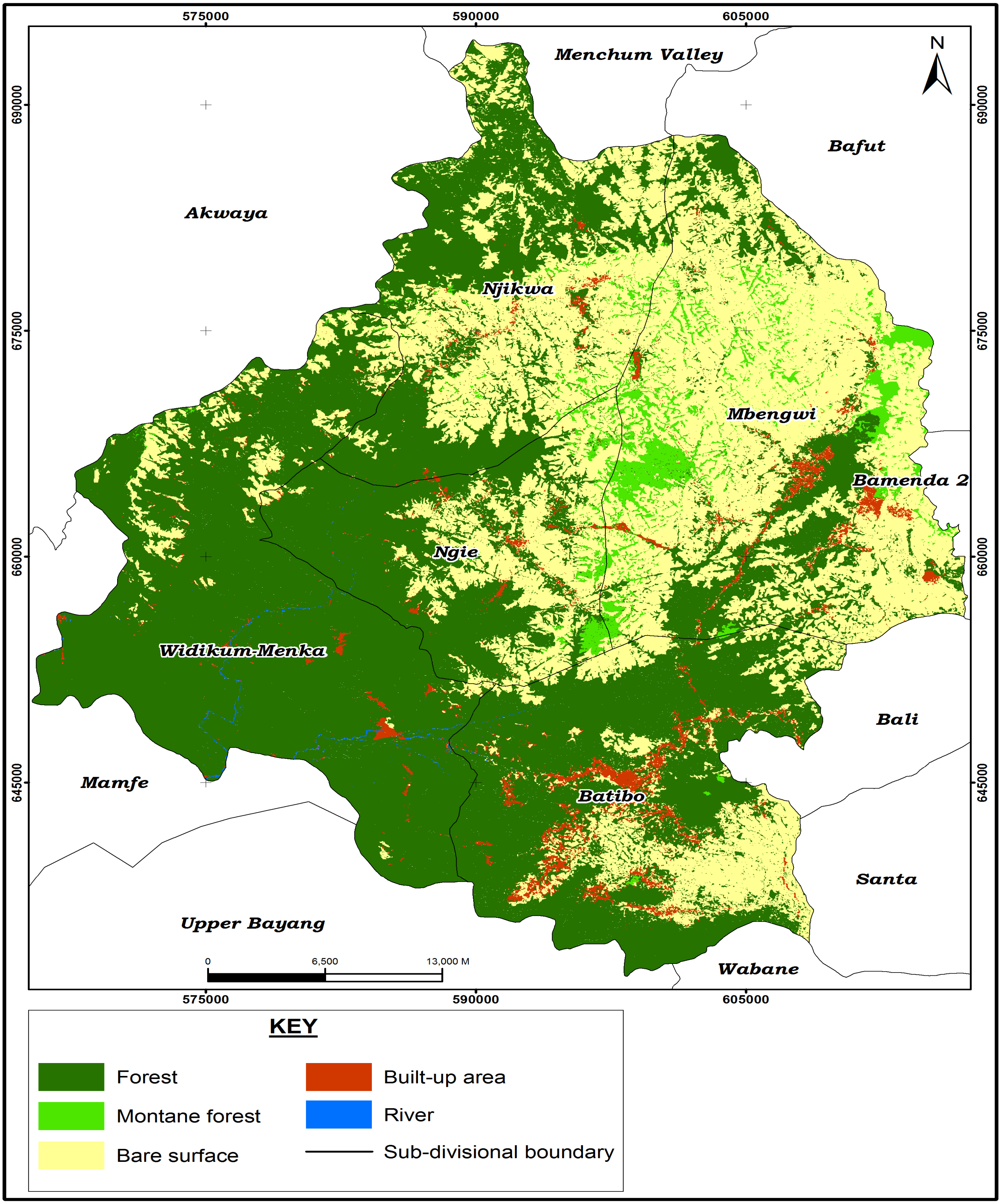

Figure-1: Land Cover and Settlement Map of Momo Division 1976[13].

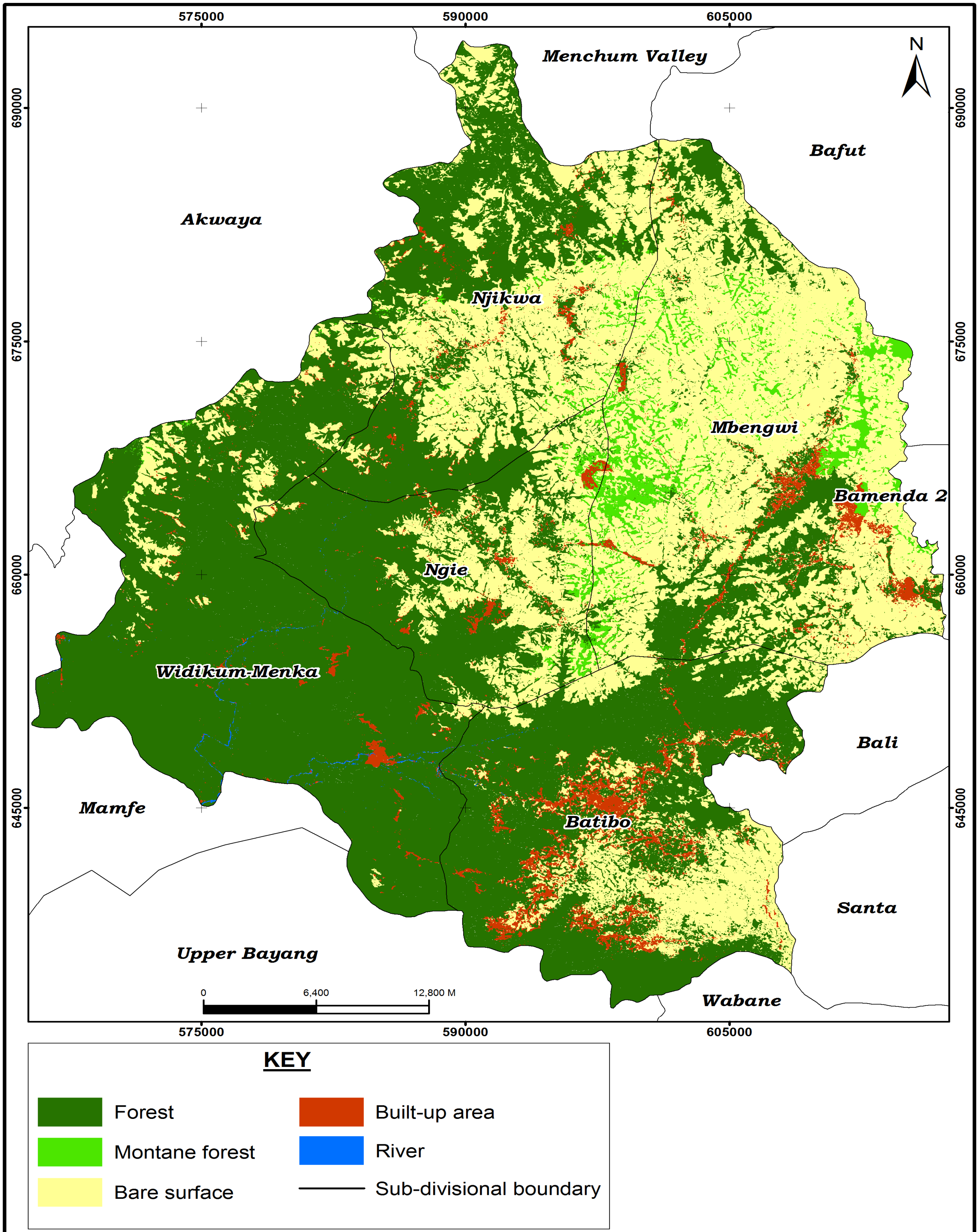

Figure-2: Land Cover and Settlement Map of Momo Division 1986[13].

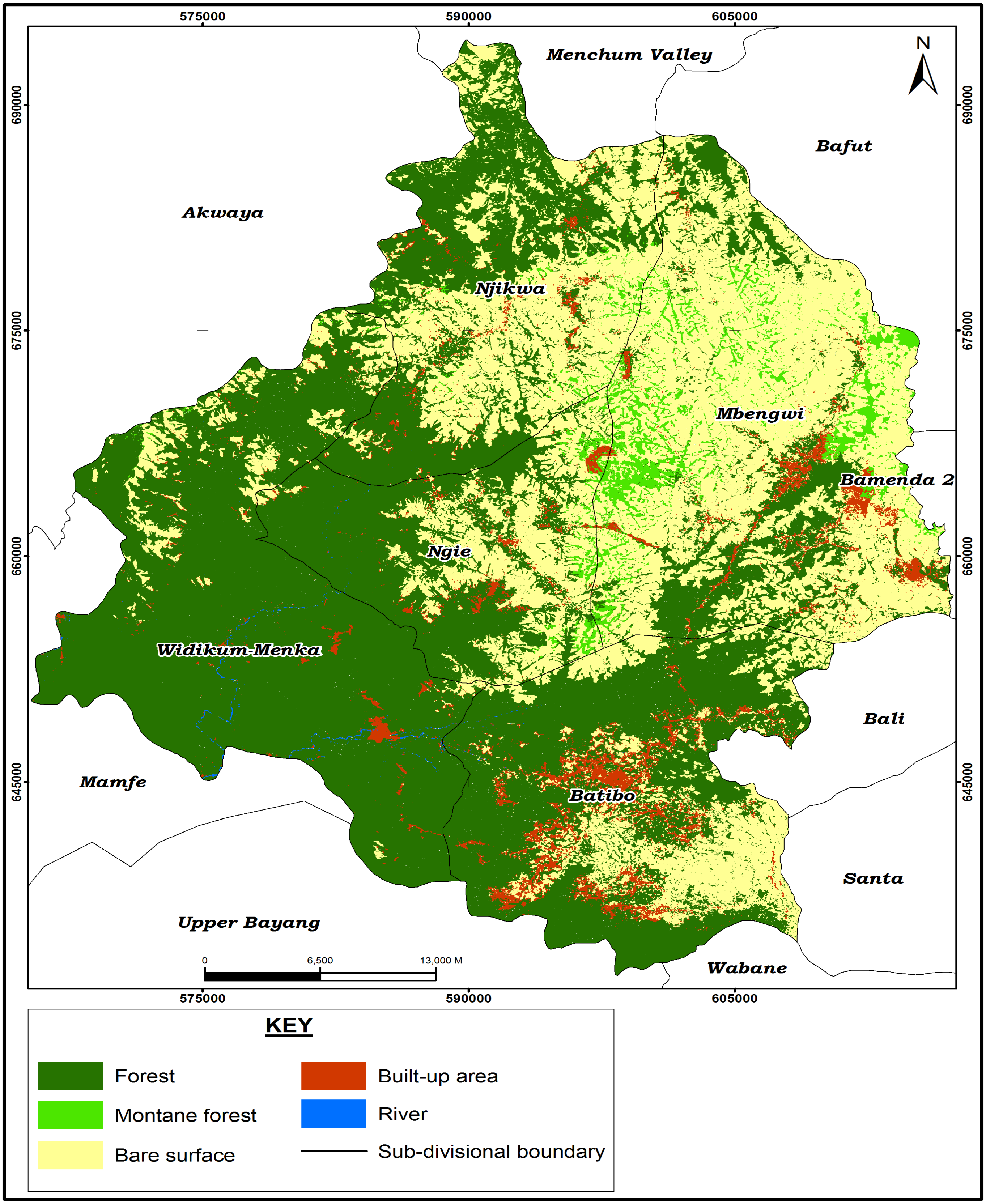

Figure-3: Land Cover and Settlement Map of Momo Division 1996[13].

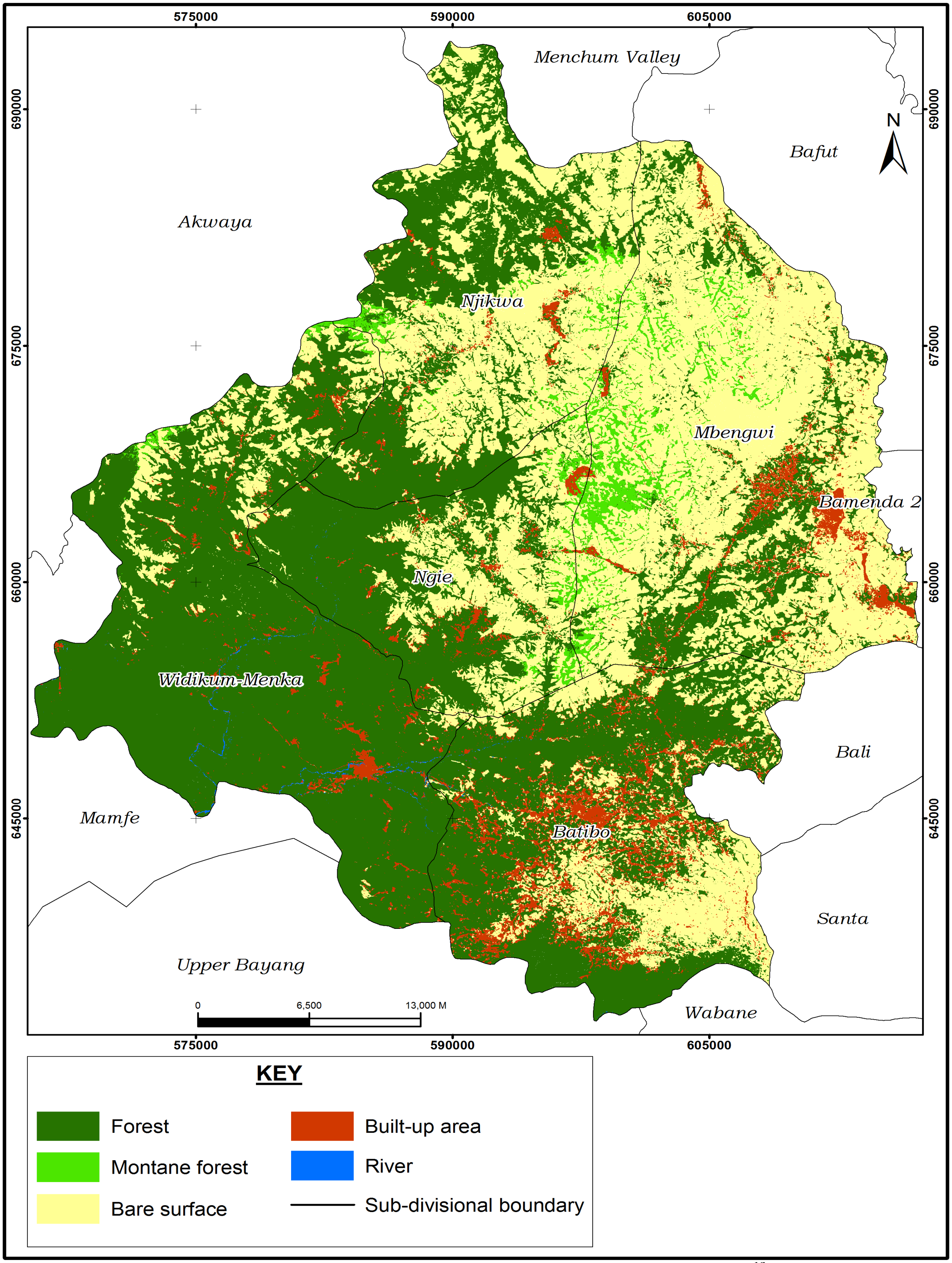

Figure-4: Land Cover and Settlement Map of Momo Division 2006[13].

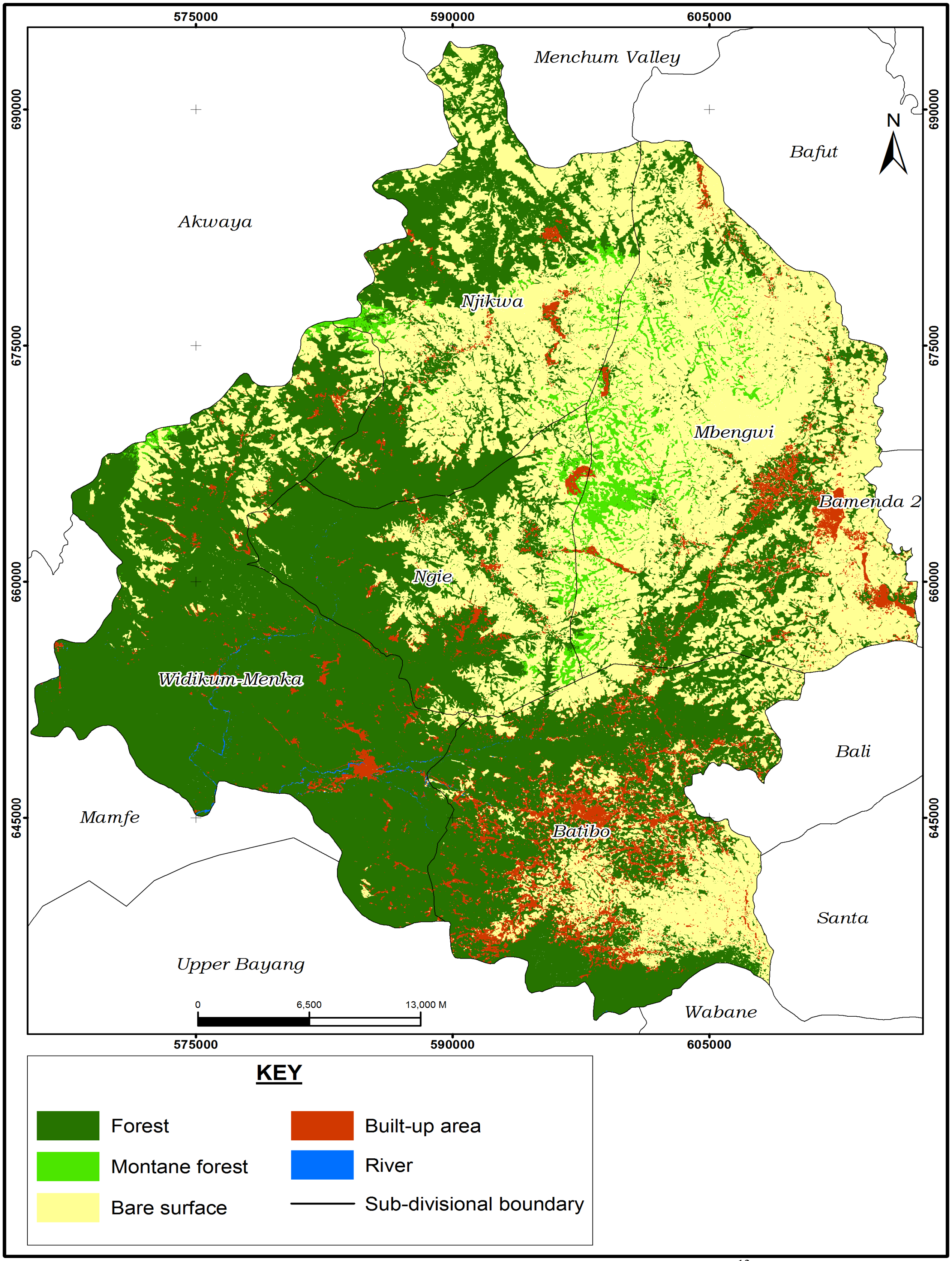

Figure-5: Land Cover and Settlement Map of Momo Division 2016[13].

Land cover trend analysis in Momo Division (1976-2016): Forestland: Table-1 and Figure-6 indicate that there has been a general decrease in forest vegetation from 1976-2016. The gradient of the linear regression equation line shows a negative deviation of (-1.010). However, the rate of decrease in forest vegetation has been rapid as indicated by the co-efficient of determination $R^2 = 0.7331$.

Savannah/ Bareland: The situation with savannah/bare land has rather been on an increase from 1976-2016 in Momo Division, Figure-7. The linear regression equation line shows a gradient with a positive deviation of (0.579) and a co-efficient of determination $R^2 = 0.6894$. This shows the advancement of savannah and bare land as the forest vegetation is retreating.

Built-up land: Built up areas from 1976-2016 have equally been increasing Figure-8. The rate of increase in built-up areas has been very fast as compared to the decrease in forest vegetation and the increase experienced in savannah/ bare land for the period under investigation. The gradient of the linear regression equation line shows a positive deviation of (0.6574) and a co-efficient of determination $R^2 = 0.8444$. This however, shows a strong positive trend in the horizontal expansion of built-up areas.

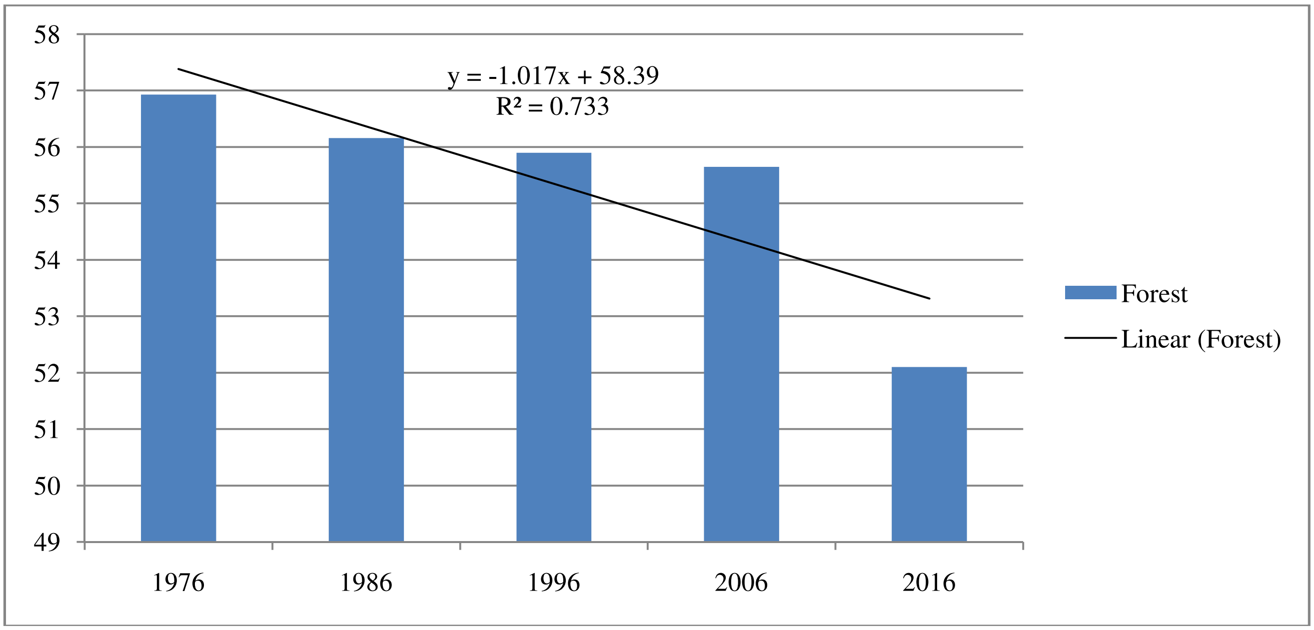

Figure-6: Trend of forest retreat 1976-2016 in Momo Division.

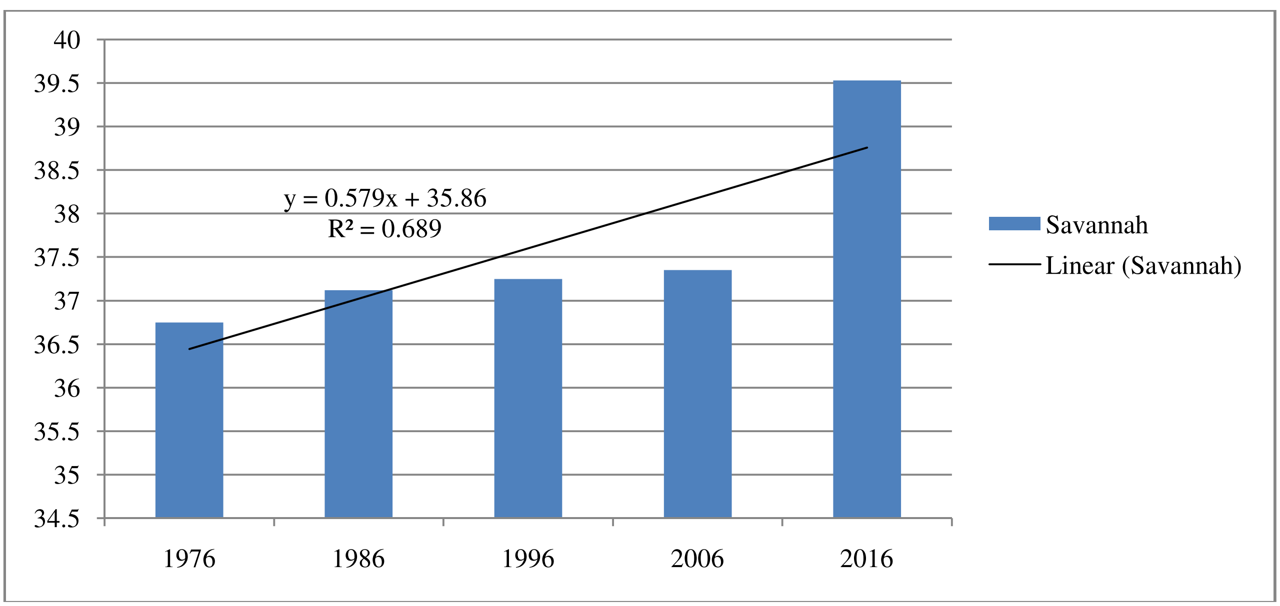

Figure-7: Trend of Savannization 1976-2016 in Momo Division.

Hydrology: The water regimes of the area have generally been experiencing a fairly decreasing trend from 1976-2016 (Figure-9). A negligible negative gradient of (-0.002) as indicated on the equation of the linear regression line. This is also indicated by the value of the co-efficient of determination $R^2 = 0.5$ which shows a neither weak nor strong relationship in the rate of decrease.

Montane Forestland: It is generally observed that the land parcel with the fastest rate of change from all the various land parcels under investigation occurred in the montane forest from 1976-2016, Figure-10. The gradient of the linear regression equation line shows a strong negative deviation (-0.218) and a co-efficient of determination $R^2 = 0.9078$. This shows that the rate of decrease in the montane forest vegetation is the fastest in the whole of Momo Division for the period under investigation.

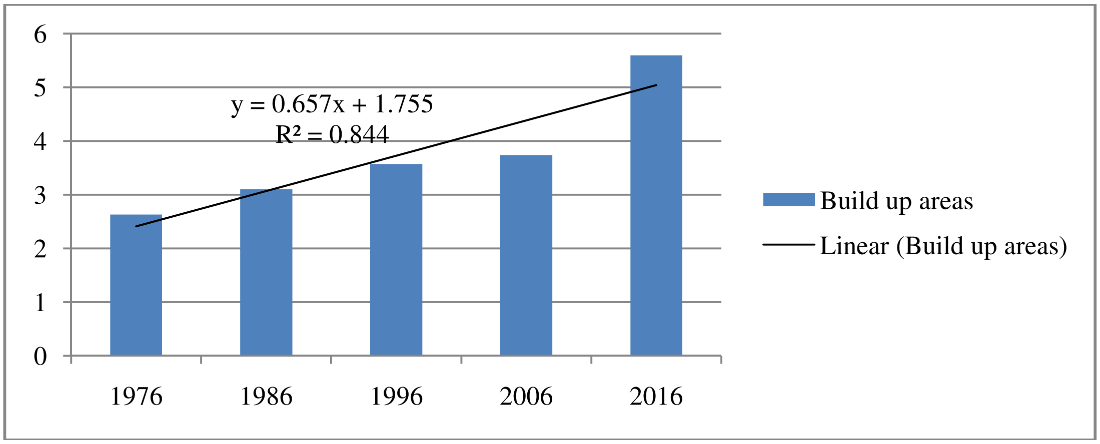

Figure-8: Trend of built-up areas 1976-2016 in Momo Division.

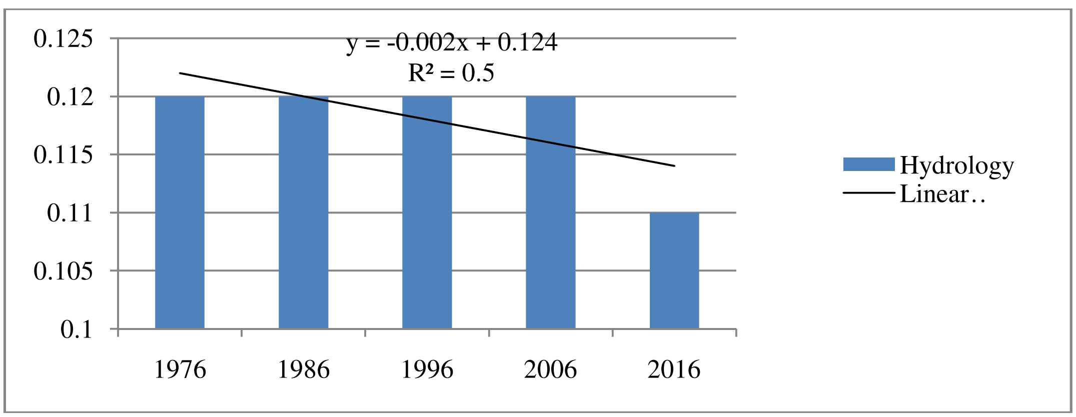

Figure-9: Changing trend of hydrology 1976-2016 in Momo Division.

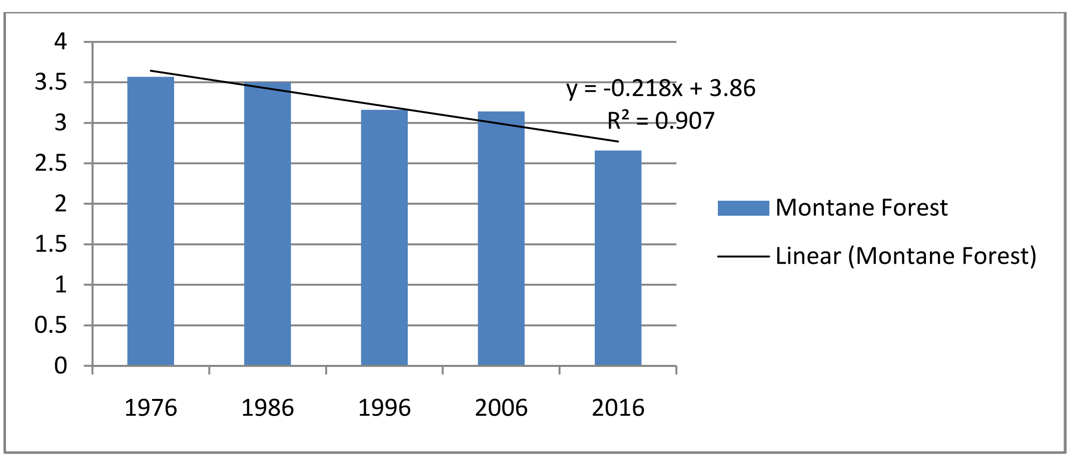

Figure-10: Changing trend of Montane forest 1976-2016 in Momo Division.

Analysis of Change Detection in the various land parcels under investigation 1976-2016: The change detection analysis of the various land parcels from 1976-2016 have been grouped into four decades for an appreciable evaluation of the changes experienced from one decade to another in all the land parcels. The changes in the land parcels were converted from hectares to percentages for easy interpretation as presented on Table-2. The various land parcels under investigation indicate trends that show a general increase and decrease in the land parcels from one decade to another. These variations however, show that the human-environmental nexus is dynamic and subject to changes over time. A critical examination of the land parcels in question shows that these changes are not the same in the various land parcels under investigation. The change detection trends indicate some loses and gains in the spatial representation of the land parcels.

Table-2: Percentages of Land Cover change for a period of Four Decades 1976-2016.

Land use/ Cover type	1976-86 %	1986-96 %	1996-06 %	2006-16 %
Forest land	15.9	5.38	5.18	73.5
Savannah/ bare land	13.31	2.68	3.59	78.45
Built-up Areas	15.82	15.82	5.72	62.53
Hydrology	32.43	32.43	32.43	2.70
Montane Forest	7.7	37.4	2.19	52.75

Change Detection in Forestland 1976-2016: From the thematic change analysis and image differencing, it is observed that forest vegetation decreased tremendously during the four decades under investigation (40- years). Forest cover between 1976 and 1986 recorded a percentage change of 15.9%. Secondary data analysis and the interpretation of lands at images reveals that this was the period of the green revolution policies in Cameroon where farmers were encouraged and subsidies granted to boast up the agricultural sector in the entire national territory. The agricultural landscape of Momo Division during this period was dominated by the coffee economy. The involvement of many in the coffee sector meant that more land had to be brought under cultivation. Equally, the demographic increase during this period in Momo Division and the demand for timber for the construction of settlements and fuel wood further aggravated the retreat in the forest vegetation during this period.

The decades 1986-1996 and 1996-2006 portrays some fascinating revelations in the retreat of forestland with just a slight decrease of 5.38% and 5.18% respectively, (Table-2). The slow pace in the decrease of forestland during these two decades is attributed to the economic recession experienced in Cameroon during the late 80s and the early 90s. During this period, the government resorted to structural adjustment programmes and liberalization policies which were seen as austerity short term measures for economic recovery. In this case therefore, farmers were left without assistant and all subsidies that were granted to farmers withdrawn by the state. Equally, the fall in coffee prices further worsen the situation. Since the agricultural land scape during this period in Momo Division was dominated by the coffee economy, many farmers had to abandon their coffee farms in the forest and therefore the rate at which the forestland during this period was changing became very slow.

The decade 2006-2016 recorded drastic retreat in the forest land with 73.5% decrease in the forest cover. These changes indicate the efforts made by the government to revitalize the agricultural economy and the recovery of the coffee sector. Population increase and the high demand for food, fuel wood, settlement expansion and equally the high demand for timber due to the growth of the local craft industry and rural development in Momo Division.

Change Detection in Savannah/bare land 1976-2016: The changes recorded in the savannah vegetation equally show a similar trend with that of the forestland. The only difference is that while the forest has been on a decrease, the savannah/bare land on the other hand has been on an increase. Therefore, an inverse relationship exists between these two land parcels under investigation. From 1976-1986, the savannah/bare land recorded a percentage increase of 13.31. The encroachment of human activities into the forestland which include the demand for food and the expansion of coffee farms, the gradual increase in the population and settlement infrastructures such as timber led to the increasing savannization during this period at the detriment of the forestland. The decades 1986-1996 and 1996-2006 recorded a percentage increase in the savannah vegetation of 2.68 and 3.59 respectively. The slow pace recorded during these two decades relates to political instability during the early 1990s where many people had to leave the area to seek refuge in other foreign countries and therefore, economic activities in this area were very slow while in some areas, these economic activities were halted. In this situation therefore, the changes experience in the land cover became slow as compared to the other decades.

From 2006-2016, a marked increase in the savannah/bare land recorded a percentage increase of 78.45.This marked increase in savannah and bare land relate to rapid population growth, expansion in settlements construction due to remittances from those who flee the country during the 90s due to political instability, increase pressure for fuel wood, food demand and agricultural expansion into the forestland.

Change Detection in Settlements and built-up land 1976-2016: Settlements and built-up land from 1976-1996 recorded a constant change of 15.82%. This probably was due to the enclave nature of the area during this period. Accessibility was a major constraint and therefore the transportation of building materials into most of the rural areas was a major challenge.

From lands at maps and image differencing, it shows that most of the roads into this area were mostly footpaths which made life quite unbearable for the local population. Equally, rural-urban migration into the city of Bamenda was the order of the day as a significant proportion of the population had to migrate to Bamenda which had promising opportunities at that time to the rural population. Equally from the satellite imageries and image differencing, it is observed that settlements consisted mostly of rural dwellings with a dispersed nature.

From 1996-2006, only a slight increase of 5.72% was recorded in settlement and built-up expansion. From field investigations, this period coincided with the political instability that rocked the entire national territory in the 1990s which equally affected the Northwest Region of Cameroon and Momo Division in particular. Many persons were forced to flee the country and seek refuge elsewhere and therefore, the slow pace recorded in settlements and built-up land.

The decade 2006-2016 witnessed astronomical changes in settlements and built-up land. This period recorded a percentage increase of 62.53 in settlements and built-up. Current field realities show that there has been tremendous improvement in accessibility with the construction of the Bali-Batibo highway, the passing of the Trans-African highway from Batibo to Widikum, the construction of the Bamenda-Mbengwi road and other rural roads like the Widikum-Menka axis, the Mbengwi-Njikwa axis amongst others. The constructions of these roads couple with rapid population growth have actually contributed to rural development in Momo Division. These field findings corroborate with the common axiom that where a road passes, development follows.

Change Detection in Hydrology 1976-2016: The hydrology of the area from 1976-2006 has been fairly constant with a percentage of 32.4. It is only the decade 2006-2016 where a remarkable decreased is observed in the water regimes of the area with a percentage decrease from 32.4 to 2.7. The drastic drop in the water bodies are mostly linked to anthropogenic activities such as settlement expansion, unsustainable agricultural practices such as bush burning and the “ankara” farming system which is a common practice in Momo Division, the retreat in forestland for agriculture and built up areas amongst others.

Change Detection in Montane Forestland 1976-2016: The montane forestland has been witnessing fluctuating trends from one decade to another from 1976-2016. Remotely sensed landsat imageries and image differencing shows that the decade 1976-1986, the montane forest recorded a percentage decrease of 7.7%. A drastic decrease of 37.4% is recorded in the decade 1986-1996. This decrease has been influenced by the settlement of the Fulani cattle graziers in this area from the North of Cameroon and over grazing on the highlands. Equally, since the entire landscape constitutes approximately 85% highlands; settlements too have equally been encroaching into the montane forest land leading to a decrease as observed on the landsat images.

The decade 1996-2006 recorded just a fairly decrease of 2.19% which correspond to the period of political instability and many people had to flee to neighbouring countries. The period 2006-2016 recorded the highest decrease in the montane forestland with a percentage decrease of 52.75. This is due to increase in the cattle numbers on the highlands and over grazing, population growth, expansion of settlements and the extraction of fuel wood for household consumption in the highlands areas.

Local strategies to enhanced food production: Marked variations have been observed in land cover changes for Momo Division over the years as the population keeps on increasing. The desire to increased food production as the population is growing within the limited landscape has necessitated local adaptations to sustain production at some acceptable levels. The strategies observed ranged from farm preparation through soil fertility enrichment, irrigation, crop harvesting and processing techniques. According to Bambouye, the manner in which farming plots are prepared significantly determines the farm performance[14].

However, the increasing pressure on land for farming in Momo Division due to land scarcity has compelled the farmers to effect changes in their farming operations in order to render productivity sustained at acceptable levels to satisfy the growing need of the population for food.

Farm clearing techniques: The various farm clearing techniques identified in the field range from the old primitive methods of using fire as a means of clearing to the use of cutlasses and chemicals to kill grass. Though fire as a means of clearing the farms as reported during field interviews has long been losing its importance, it was noted that it has not been totally eliminated. However, the percentage of those using fire is significantly reducing in favour of the cutlass and chemicals. It was noticed that the use of fire in farm preparation varies across the study area based on the peculiarities observed in the different ecological zones.

Recent trends in the demand for more yields and the inability of the cutlass to ensure large scale clearing has resulted in farmers adjusting to new strategies where by herbicides are used in the clearing of farming plots and in the process of removing weds from the farms. Despite the above techniques, it was observed that fire is still being used in the area such as Widikum, Menka, Ngie and other areas especially in newly open farming plots and in thick forest areas to ease access. This however as observed in the field does not discard the use of the cutlass in farm preparation as itstill remain the principal farm clearing tool. These techniques according to Bambouye are used in association with each other by the same farmers or by different farmers in the same or different parts or localities based on the need for more farm yield[14].

Table-3: Summary of Ground Truth characteristics of the various land parcels under investigation from 1976-2016.

Land use/Cover type	Observed Ground Truth Characteristics			
	Land cover type	Physical Environment	Characteristics	Location
Forestland	Very moist evergreen forest	Altitude of <500m above sea level, rainfall >2000mm, high soil depth and undulating relief.	Very tall trees, stratified in layers with climbers. Dense canopy and evergreen.	Predominantly in Ambelle. It existed in Widikum but has been degraded by agriculture.
	Moist evergreen forest	Altitude of <1000m, rainfall of 2000mm, fairly hilly relief	Tall trees, strata not well distinct, open canopy with climbers.	Exist in Bussam, lower Menka, parts of Ngieand Njikwa
	Moist semi deciduous forest	Altitude of 1000m-1500m, steep slopes, low soils depths.	Medium height, trees and shrubs, thick undergrowth and evergreen	Lower Menka, Ambelle, Emua and Ekaw, Teze, Ekweri, Batibo.
Savanah/Bare land	Observed characteristics			
	The area has numerous rocky outcrops, delicate steep sided gorges and cascading waterfalls, and incised valley system which has restricted cattle movement and rangeland expansion. Most of the pasture along the concave foot slopes is not good for cattle and the proliferation of the bracken fern which is unpalatable for cattle. The long dry season causes the pasture to be scourged. Veterinary officials are not regular to treat the animals from diseases. Agricultural expansion, bush burning, settlement development are a threat to the grazing activity. The grazers are deficient in capital resource to invest in ranching, pasture regeneration, research, to get the high yielding and resistant species as well as to adequately treat their cattle against animal diseases.			
Built-up land	Tarred roads such as the Bali-Batibo Highway, the Trans-African highway, the Bamenda-Mbengwi roads are the only tarred roads in the whole of the Division. Nucleated Settlements mostly at the Sub-Divisional head quaters of Mbengwi, Batibo, Widikum, Ngie and Jikwa. Although some villages appear to be nucleated and mostly found around water points, a majority of the villages are dispersed in nature and accessibility to these villages is mostly by footpaths and earth roads in some cases.			
Hydrology	The dominance of streams and springs, cascading waterfalls which runs from the highlands to the valley bottom and rivers such as River Momo, Tanjoh, Abi, Emom amongst others characterize the landscape. Most streams and springs in the Menka Highlands, Ngie, Njikwa and Mbengwi have disappeared living behind dry valleys which are void of water. Thus, the effect of climate variability is increasingly felt on these water bodies. Most of the rivers are not viable in their hydraulic potentials due to the effect of seasonality and their single regimes.			
Montane Forest land	Tree savannah with altitude >1500m above sea level and rocky landscape, thin soils on the slopes, Short trees and shrubs growing within tall thick grasses. Trees grow along the high altitude valleys.			

Crops planting techniques: Crop density on farms significantly determines performance and output[12]. However, the higher the crop density on cultivated farms, the lower the quality of yield or output. This tendency has resulted in farmers adjusting to new and adaptable strategies to improve on farm output. In this case therefore, it is observed that the farmers have resorted to reducing crop density on farms through the principle of planting distances. As observed in the field, the farmers are gradually moving away from the undefined and massive sowing on ridges. Farmers equally reported during field interviews that they plant crops at some distances or intervals along and across ridges. This technique according to field investigations gives maximum spacing and therefore making it possible for the crops to obtain enough soil nutrients and sunlight and equally to grow with less competition from other surrounding crops. Bambouye further noted that this technique is organized to produce a plant mix in which on the same ridge, planting is done such that several crops are associated but with individual and specific crops occupying specific portions of the ridges without inter mingling with other crop types[14]. With this organization, it was observed that on certain farms, maize could occupy one edge of the ridge and beans the other edge while potatoes may occupy the middle portion. For several years, maize and beans have been observed to be planted in rotation from one year to another with maize occupying one edge of the ridge and in the following year, the other edge and vice versa. This technique as observed while having the advantage of providing enough air for the plants and the opportunity for the crops to absorb enough nutrients from the soil, it also contribute in enriching the soil fertility due to the nitrogen fixing role played by beans in rotation with maize on the same ridge. It was equally observed that groundnuts and maize are planted on the same ridge due to its nitrogen fixing ability through the root noodles. At the end of the growing season, it was reported that outputs are usually very high on the same piece of land which solves the problem of food shortages, limit the need for more arable land and equally guarantee the nutritional diversity of the population.

Other crop planting intensification techniques according to field respondents during interviews and focus group discussions, farmers reported that they are currently experiencing variations in the planting season of crops due to variations in the climatic cycles. They reported that crops such as maize, beans, groundnuts and even vegetables that formerly used to be planted in the month of March with the approach of the first rains do not follow the normal trends again. Farmers expressed worries that the planting of these crops in the month of March has led to great losses because the number of rainy days during this month are gradually reducing and unreliable. They noted that when the first rains approach in March, they usually rush for planting and sometimes the rains may ceased and the crops planted become scourged by the sun and even when the seeds managed to germinate, they are usually destroyed by some black pest. Also in other to overcome the adverse effects of the intense sunlight that usually destroy the seeds, some farmers reported that they usually soak the seeds before planting to ease germination and to prevent the intense heat from destroying the crops in the soil. In some other areas, farmers reported that because of intense heat and sunlight due to the decreasing number of rainy days, they plants some resistant species of maize and beans without soaking in a bid to withstand such harsh weather conditions whenever the rains cease.

Equally, farmers noted that in order to prevent the destruction of crops from prompt climatic uncertainties, they are adapting by varying the planting periods, using different weeks in the planting of the same crop in order to prevent these crops from being scourged by the sun due to the unreliability in the rainfall patterns. They noted that this strategy equally helps to fight against pest which often attack once and go. In order to prevent the damaging effects of pest on crops, farmers revealed that they have developed a strategy whereby they plant different species of the same crops in the farms. This is because they have found out that the insects have different taste to the leaves of the crops and whenever they attacked, those that might not be tasteful to them will cause them to probably leave and go without destroying all the crops. In the drier seasons, farmers revealed that in order to ensure the availability of vegetables, they cultivate the swamps and built sheds to prevent the vegetables from the harsh effects of sunlight during this period. From field survey and interviews, farmers revealed that another crop planting intensification technique they are currently using is the rotatory planting of maize and some improved species of cassava which have a dense canopy on the same farm. They reported that whenever they plant this improved specie of cassava and after harvesting, they immediately plant maize on the farm. The reason for this rotation of maize and cassava according to field respondents was that the canopy of the cassava usually improves on the biomass content of the soil which serves as manure for maize planting. In this case therefore, the planting of maize is enhanced.

Farm tilling intensification techniques: Tilling with hoes has so far remained with little changes and the way soil preparation in terms of ridges is done has witnessed significant transformations[14]. Generally, mass tilling that characterized farm preparation techniques in the 1960s consisted of burning all the cleared grass so as to soften the ground for seeds to be sowed. The main limitation with this system relate to the fact that burning of the grass eliminated all the soil nourishing organisms and the possibility for the enrichment of the organic matters of the soil that result from the decay and decomposition of this grass that was burnt. It is on this premise that tilling techniques capable of allowing grass to decay in the soil for soil nutrient enrichment were sought. This led to a paradigm shift from mass tilling of the soil to ridges.

The construction of ridges required more energy and time for a large parcel of land to be prepared for sowing of seeds and planting of crops. In order to limit the time spend in this process, Bambouye noted that farmers in Momo Division adopted tilling across the contours that proved easier[14]. With the issue of soil nutrient enrichment solved, the nature of ridges equally constituted another problem that farmers had to deal with in order to maintain output in an increased and sustained state to meet up with the food needs of the population.

From interviews, field survey and focus group discussions; it was revealed that the construction of large and long ridges across the slopes was an option adopted by the farmers that proved to be easier. However, this pattern of ridge gave room for runoff water to erode great quantity of essential soil nutrients thereby depriving the farms of their needed vitality. With increasing pressure from the growing population due to food shortages, the farmers according to focused group discussions revealed that with the guidance from agricultural field extension workers, they have evolved the contour ploughing system to limit the amount of soil and soil nutrients eroded by running water which contribute significantly to environmental dynamics and degradation. As this system of ridge is accepted and generally practiced in Mbengwi, Batibo, parts of Widikum and Njikwa, the cone-shaped ridge system seems to dominate the Menka, Ambelle and Ngie areas. In an attempt to investigate why the cone-shaped ridge system is very common in Menka and Ngie, it was revealed that; i. These areas aremade up of very rouged and difficult terrain with steep slopes and skeletal soils. In this case therefore, the cone-shaped ridge system is more adapted to this environment where the soil is piled and supported by sticks and stones to prevent the soils from sliding off slope. ii. Equally, the cone-shape ridge system does not give room for many crops to be planted. In this case, only one or two seeds are planted in a ridge. This gives maximum allowance and space for the crops to grow with increased productivity. This was observed in Menka, Ambelle and Ngie and mostly in cocoyam farms.

Bambouye noted that farmers in Momo Division are gradually moving away from large ridges of approximately 50cm wide to smaller ridges of less than 30cm wide[14]. This he noted is a way of economizing the available soil and increasing the number of ridges per farming plot. This is in order to reduce plants density per ridge and increase the plant density for the farm in general for higher yields. In some cases, others are currently moving from the short ridges of about two meters long to longer ridges of four to six meters. This measure is to check erosion by reducing the number of water conduits on the farming plot which has resulted in an increase in the total farm area under crops.

Despite these intensification practices in the farm tilling process, field observations showed that the traditional methods of land preparation have not been completely waved away as some of the terrain conditions especially on steep slopes compelled some farmers to stick to some of those traditional methods such as mass tilling while conservatism and illiteracy equally explains the continuous application of some old tilling practices and at the same time embracing and applying the some new techniques. The system of integrating new and old farm preparation techniques observed in Momo Division are demonstrative of the extent to which the agricultural system is being intensified to ensure improved farm output and guarantee increasing food demands and nutritional diversity.

Conclusion

This paper examined the land cover change situation for Momo Division from 1976-2016 and presented the land cover and settlement maps for the different periods under investigation. Despite the changes observed in the land cover situation, the eyes of the farmers are focused on using the available means at their disposal to improve on farm output by adoptinglocal intensification practices. This has resulted in an increase in the livelihood challenges of the population and environmental degradation. The paper however has noted that land cover changes and the degradation of natural resources is not an issue that is meant for Momo division alone but a global problem affecting mankind in the 21st Century. Despite regional, national and international efforts to reach a compromise, the phenomenon still persist, and further widening the scope of human challenges on the planet. This paper therefore recommends the putting in place of a legal framework at the local, regional and national levels to monitor guide changes in the land cover and implement and enforced effective policy options aimed at the conservation of natural resources and ensure environmental equity and justice.

Figure-11: Smaller ridge system of 30cm wide. A means of economizing the available soil and increasing the number of ridges per farming plot.

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