

Original Research Article

LAND USE AND LAND COVER CHANGE AND FLOOD INCIDENCE IN DONGA LGA, NIGERIA

Abstract:

The study assessed land use and land cover changes and its effect on the communities in southern Taraba specifically in Donga. The paper identify and delineate different LULC categories, evaluates the rate of change that occurred and examine the implication on incessant flooding using multi-temporal satellite imageries of three different time periods, i.e Landsat Thematic Mapper (TM) of 2000, 2012 and 2016 acquired from USGS sites. Area calculations of the arc GIS 10.1 software were used to derive the trends, rates, and magnitude of changes while map overlay was employed for assessing the nature and location change. The images of the study area were categorized into five different classes namely water body, built up, vegetation, bare land and rock outcrop. The implication of LULC change on flooding incidence in the study area was analyzed by an interaction with local communities through personal interaction with focus group and usage of questionnaire. The results reveal that barely two decades, built- up and bare land have been increased by 4% (137.7021 km²), and 12% (409.8324 km²) while vegetation, water body and rock outcrop have decreased by 16% (541.1142 km²), 0.08% (2.5924 km²) and 0.1% (3.8279 km²) respectively. Based on the interview conducted, 93% of the respondents are attestants to the fact that flooding is on the increase and 47% affirmed that increase in rainfall intensity is the major cause. Even though only 8% of the respondents adduced flooding to change in land use and land cover, the analyzed imageries show that between the spaces of 16 years, the present built up area is fifth times of the capture in the year 2000 and that 16% of the vegetation cover has disappeared for other use. The understanding of the intricacy of nature and the influence of land use and land cover change on the farming community is of necessity, more especially as the climate change and the government look inward to divert from mono economy. The dependency on land and land cover could increase in order to get out of this present recession as agricultural sector top the recovering agenda in the Nation.

Keywords: Land Use/Land Cover, Deforestation, Encroachment, Flooding, Recession, Nigeria

1. Introduction

Human beings have been modifying land for her succor to obtain food, fuel and shelter and other essentials of life for thousands of years. Current rates, extents and intensities of such modification are far greater than ever in history and continue unabated (Efiong, 2011) as the population grows. The modification manifest in indiscriminate clearing of forest areas; shifting agriculture; forest and bush burning; cultivation of hill slopes without any anti-soil erosion measures; reckless housing site development; faulty road construction methods and indiscriminate quarrying which have been associated to flooding (Fernando, 2007). Naibbi et al., (2014) posited that, the vegetation of North-eastern Nigeria has been drastically reduced since the 1970s through the exploitation of natural forests for timber production or firewood and conversion to agricultural land. The observed pattern of change in land resource exploitation has multifarious implications in this area itself and the global environmental sustainability at large. Understanding the complexity of Land Use and Land Cover (LULC) changes and their drivers at local level is essential to better understand the relationship between human and the environment, and to support local planning process for the sustainable management of ecosystem goods and services (Bhawana, 2015).

The land covers are natural resources, natural biofilters, and erosion stabilizers protecting the land from direct punch of rainfall there by reducing the sedimentation load that would have find their course unto the river resulting to ache to aquatic animals consequently leading to flooding. There is need to understand the biophysical and human causes of land use and land cover change, because land use and land cover pattern and dynamics affect the structure and function of the earth ecosystem (Hersperger et.al., 2010). It could lead to a decreased availability of different products and services for human, livestock, agricultural production and damage to the environment. Such changes also determine, in part, the vulnerability of places and people to climatic, economic or socio-political perturbations (Lambin and Geist, 2006). For instance on research work on the socio-economic effect of 2012 flood in Ibi, adjacent to Donga LGA, Emmanuel (2013) observed that 16% of the respondents have their building destroyed and properties washed away. He added that 34% have their farmland washed away and the produce destroyed. Other effect includes road submergence preventing easy transportation of goods and

59 services. Still in this axis it was submitted that flooding could have link with Skirmish (Adelalu,
60 2012; Jack 2012).

61 Deforestation in the forestry sectors is generating much interest as a key source of flooding.
62 Relationship between this type of LULC change and flooding has become increasingly global
63 concern more so as population soars in the Nation. Large percentages of the populations of
64 developing countries like ours depend on agriculture for their livelihood. This is associated to the
65 fact that as the population increases, more people are added to the existing 70% of the nation that
66 are agrarian in a fixed land area. Malthus, (1798) propounded the first theory of population-land
67 use relationship. He declared that as a population grows and the area used for agriculture
68 expands, the average quality of new agricultural land brought into production declines. Also
69 where land area for cultivation is fixed and the populations grow geometrically food production
70 tends to increase only arithmetically (Soini, 2006). One of the reasons is that less time is given
71 for land fallowing. Consequently, this continual cultivation sets the strength of material loose,
72 changing the water retention capacity, absorbability of the soil and making it ready for erosion.
73 The impact of raindrops breaks the bonds holding soil aggregates together and catapults the
74 particles into the flowing water. Erosivity increases where land surface is unimpeded by forest
75 vegetation. When climate and topography are fixed and soil cover is varied, the rate of soil loss
76 by water erosion has a predictable and dramatic dependence on vegetation. Irrespective of
77 location, erosion losses are usually very small from forestland or permanent pastureland and
78 reverse is the case when it is denuded.

79 The relationship of the poor and the growing unemployed youths with the environment as
80 recession intensifies need be investigated. A number of researchers have supported this
81 contention of the basic correlation between environment and poverty: drop in purchasing power
82 due to recession. International Monetary Fund article, (1993) asserted that poverty and the
83 environment are linked in that the poor in the community are more likely to resort to activities
84 that can degrade the environment. More lands could be denuded and resultant runoff could lead
85 to flooding.

86 International scholars have made extensive deposit in the field of remote sensing and GIS
87 application for land use/land cover change detection. Yuan et al. (2005) formulate a technique to
88 map and monitor land cover change using multi-temporal Landsat Thematic data in Twin Cities

Metropolitan Area of Minnesota for 1986, 1991, 1998 and 2002. They found out that barely two decades, between 1986 and 2002, the amount of urban land increased from 23.7% to 32.8% of the total area while the forest and the wetland have decreased from 69.6% to 60.5%. Using over 43 years of LISS III satellite data and Indian topographic sheet of the year 1965, Pooja et al. (2012) quantified land use/land cover of Gagas watershed in Almora. With ERDAS and Arc GIS, El Gammal et al. (2010) have used several Landsat images of different time periods (1972, 1982, 1987, 2000, 2003 and 2008) to analyze the changes in the shores of the lake and changes in the water volume.

Away from international studies, in Nigeria, Adepoju et al.(2006) have assessed the land use/land cover change in Lagos for the period of 20 years due to rapid urbanization. Zemba, (2016) analyzed the land use and land cover dynamics in Jalingo with a view to highlight the implications on the existing arable lands and food security. Only few researches have been done on the effect of the surrounding LULC change has on local and regional precipitation and flood pattern.

Changes in land use and land cover conditions and agricultural water management practices in irrigation was responsible for the problems associated with hydrological resources of the Lake Tana Basin (Yitaferu, 2007). Zemba, (2009), in his research work on Assessment of changes in Land use and development of Urban heat Island in Jimeta- Yola found out that, there exist positive correlation between land surface temperature and impervious surface fraction. He concluded that the resultant impervious urban surface alters the natural energy balance and runoff (flooding).

In Donga, flooding is now an annual occurring event especially after heavy rainstorm which is further worsened by the nature of the topography of the area (Oyatayo et. al, 2015). According to Bradshaw, (2007), factors contributing to the frequency and severity of flooding in an area include: Rainfall intensity and duration; antecedent moisture condition; changes in landscape resulting from wild fires, the existence of attenuating features, like levees and flood control channel; velocity of flow; availability of sediment for transport, and the erodibility of the bed and banks of the water course; watershed conditions, such as steepness of terrain, soil types, amount of vegetation, and density of development.

The advent of remote sensing data and GIS application has ushered in increase in research documentation worldwide on land use and land cover change. Consequently, evaluation of land use and land cover change has taking new dimension. A great deal of research has been conducted throughout the world in an attempt to understand major shifts in land use and land cover and to relate them to changing environmental conditions (Hussien, 2009). To achieve this, it is crucially important to consider multiple sources of information and to acquire temporal, spatial and other non-spatial forms of data (Hussien, 2009).

Donga town has witness great expansion, growth and developmental activities and many other anthropogenic activities since the construction of Donga Bridge and opening of rural roads. This has resulted in increased land consumption; modification and alteration without corresponding detailed and comprehensive attempt to assess this status as it change over time Oyatayo, et al (2015). There is still need for a detailed and methodology- proven regional assessment of many areas especially the North –East and specifically Donga. This will exhibits the region’s status to vulnerability to climate change (flooding) as this seems to have alliance with the Land use. The focus of this paper is to consider the configuration (shape and spatial arrangement) of land uses/land cover types, causes of the land use changes and its contribution to incessant flooding in Donga using geospatial technique and questionnaire.

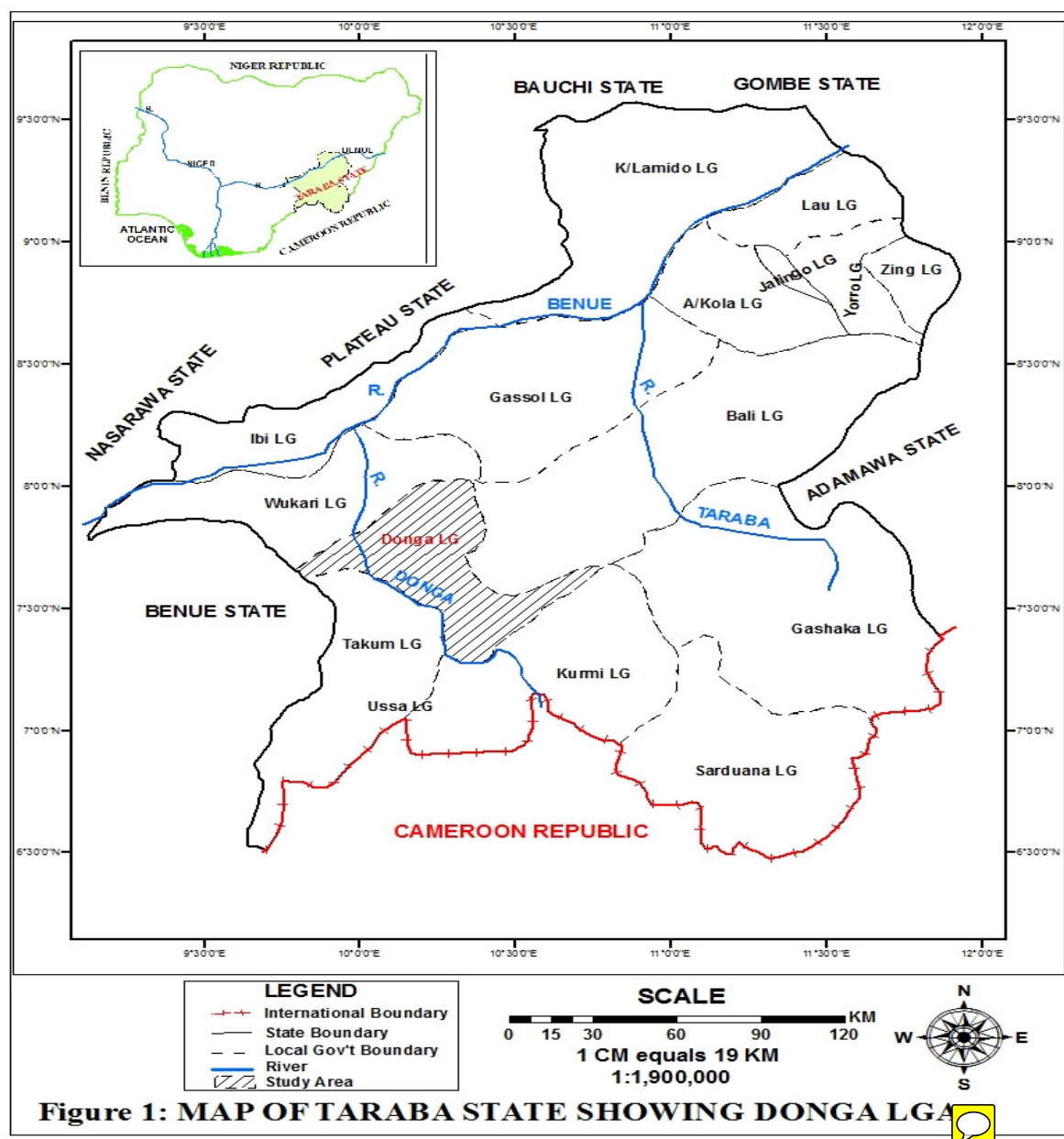
2. Study Area

Donga is a local Government Area in Taraba State, Nigeria. Its’ headquarter is in the town of Donga on the Donga River at $7^{\circ} 43' 00'' \text{ N } 10^{\circ} 03' 00'' \text{ E}$ and $7.71667^{\circ} 10.05000^{\circ} \text{ E}$ (Figure 1). It has an area of about 3,420 km². It is a commercial centre which attracts people from many parts of neighboring local government of the state like Takum, Wukari, Bali, Gassol. Not only that, it is also centre for administrative activities. Donga is well connected to the other part of the state with good transportation networks. These networks also give room for interstate trading in hide and skin especially fish business from River Donga.

The Donga River arises from the Mambilla Plateau in Eastern Nigeria, form part of the international border between Nigeria and Cameroon, and flows northwest to eventually merge with the River Benue. The Donga watershed is about 20000 square kilometers in area. At its peak, near the Benue the river delivers 1800 cubic meters of water per second (Inger, et. al,

147 2005). The watershed fall within the Guinea Savanna Zone with thick vegetation cover with tall
 148 grass and tree. The vegetation pattern shows faithful reproduction of rainfall pattern. Like the
 149 rainfall, which is higher in the south and reduces as one progress toward the north, the vegetation
 150 is also so pattern (Iloeje, 1981) with annual rainfall of between 1000mm and 1200mm.
 151 According to Iloeje, heavy rainfall promotes leaching and corrosion in the area. These two
 152 processes, he added that during the dry and wet season gives rise to lateritic soil. However, soil
 153 and hydrology of the place allow the cultivation of most staple foods and grazing lands for
 154 animals.

155 From 1999 to 2006, population of this area rose from 84,626 and the total population on board
 156 were 134,111 at the 2006 census, with overall density of over 43 persons per square kilometers.
 157 (Iloeje, 1981) submitted that soil fertility which is obtained through fallow period has been
 158 continuously shortened through increase in population and continuous cropping of the land.
 159 Increased population could generate increased pressure on the sustainability of land resources
 160 and environmental condition.



161

162 3. Data Sources and methodology

163 3.1 Data Sources and Type

164 The main images that were acquired for the assessment of the land use and land cover change are
 165 that of 2008, 2012 and 2016 (Table 1). These were obtained from earth explorer site
 166 (<http://earthexplorer.usgs.gov/>). The three images were acquired between June and September,

167 which is on-season and also fall within the period of wet season, hence the vegetation cover and
 168 land-use types appear the same on the images regardless of the year they were obtained (Olorokor,
 169 1995 cited in Jijingi et al, 2016). In addition 131 questionnaires of 17 items were also meted out
 170 to derive information on the socioeconomic and environmental changes and its connecting
 171 implications on flooding.

172 **Table 1:** Date Type and Sources

Type	Acquisition date	Dimension (in pixel)	Actual spatial resolution	Acquisition source
Landsat 7ETM+ (Thematic Mapper)	July 2000	379 × 279	30 × 30	USGS
Landsat 8 (Thematic Mapper)	Jun  2012	379 × 279	30 × 30	USGS
Landsat 8 (Thematic Mapper)	July 2016	379 × 279	30 × 30	USGS

173 **Source:** Compiled by the Authors

174 3.2 Image Classification and change detection Analysis

175 To Classify the images into the respective themes, the supervised approached to classification
 176 was adopted using Arc GIS 10.1 software. The images were classified into five major classes:
 177 water body, built up, vegetation, bare land and rock outcrop. Maximum likelihood classification
 178 algorithm technique was adopted. Area calculations of the arc GIS 10.1 software was used to
 179 derive the rates and magnitude of change. The extent and nature of change for the period of 2000
 180 to 2016 years was ascertained by map overlay. Following Ikusemoran and Olorokor (2014), the
 181 following steps were carried out for the derivation of the changes in the study area:

- 182 i) Calculation of the magnitude of change. This was derived by subtraction of observed change
 183 of post from the previous period of years.
- 184 ii) Calculation of the trends: The percentage change of each of the land-use. This was done by
 185 subtracting the percentage of the previous land-use, from the present land use. Then the
 186 difference divide by the total land area multiplied by hundred.

187 iii) Finally, calculation of the annual rate of change was by dividing magnitude change by
188 number of study years.

189 4. Results and Discussion

190 This section presents and analyses the data that were collected through the administration of
191 questionnaire in the study area.

192 4.1 Socio- Demographical Characteristics of Respondents

193 **Table 2: Sampled wards and gender of respondents**

Wards	Sex		Frequency	Percentage
	Male	Female		
Fada	63	8	71	54
GyataAure	56	4	60	46
Total	119	12	131	100

194 **Source:** Field survey, 2017

195 The demographic status depicts that 91% of the sampled respondents are male. Of this were 53%
196 and 47% from Fada and GyataAure respectively while 9% are female. Table 3 shows the age
197 group of the respondents. The demographic data reveals 5% of the respondents below age 20.
198 31% were between age 21 and 30. Between ages 31 to 40, we have 29% of the respondents in
199 this category while 35% of the respondents are above age 40.

200 **Table 3: Age group of the respondents**

Age Group	Frequency	Percentage (%)
Below 20	6	5
21-30	40	31
31-40	38	29
Above 40	47	35
Total	131	100

201 **Source:** Field survey, 2017

Table 4 shows the occupational status of the respondents. It is obvious that majority in the chosen wards are into farming business 61.8%. About 20% are engaged in Trading or Business. About 7 and 10% earn their livelihood through Artisan and white collar job respectively. It was also observed that there are ample numbers of respondents that engaged in two or more occupations.

Table 4: Occupational Structure of the Respondents

Variables	Frequency	Percentage (%)
Farming	62	47.3
Fishing	19	14.5
Trading/Business	26	19.8
Artisan	9	6.9
Civil Servant	13	9.9
Others	2	1.5
Total	131	100

Source: Field survey, 2017

Table 5: Respondents years in Cultivation

Years in Farming	Frequency	Percentage (%)
Below 10	2	3.2
11-20	11	17.7
21-30	21	33.9
31-40	19	30.6
Above 40	9	14.5
Total	62	100

Source: Field survey, 2017

The researchers believed that those inhabitants especially long term residents could have a reasonable idea of the extent of flooding in the locality. The questions in Table 6 sought to ascertain how long the respondents have lived in the area. Close to 90% of the respondents had

214 been in the study area for more than 20 years. It is assumed that they have a better chance of
215 relating the story better.

216 **Table 6: Duration of Respondents stay in the study area**

Variables (Years)	Frequency	Percentage (%)
Below 10	11	8.4
11-20	62	47.3
21-30	38	29
31-40	11	8.4
Above 40	9	6.9
Total	131	100

217 **Source:** Field survey, 2017

218 Regarding the incessant flooding in the study area, number one on the list on the general
219 perception of the respondents who have lived more than 20 years and above in the study area
220 locality affirmed that there has been increase in the rainfall intensity. About 47% of the
221 respondents are attestants to this (Table 7). This corroborates the findings of Oyatayo et al, 2015.
222 Floodplain encroachment accounts for 37% while about 8% of the respondents support the fact
223 that the low land terrain is the cause of the flooding. Even though only 8% of the respondents
224 adduced flooding to change in land use and land cover, the analyzed imageries show that
225 between the spaces of 16 years, (2000-1016) the present built up area is fifth times of the capture
226 in the year 2000 and that 16% of the vegetation cover has disappeared for other use (Figure 3).

227 **Table 7: Perceived Causes of Incessant flooding in the study area**

Variables (causes)	Frequency	Percentage (%)
Floodplain Encroachment	49	37.4
Increase Rainfall intensity	61	46.6
Land use change(Deforestation, Constructions etc)	11	8.4
Low land area	10	7.6

Total	131	100
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Source: Field survey, 2017

As regard whether the respondents are aware of the flood on decrease or increase, 93% (122) indicate that the flood is on increase every year (Table 8).

Table 8: Respondents Response on flood Incidence in Donga

Wards	Sex		Frequency	Reduction in flooding	Increase in flooding	Indifferent
	Male	Female				
Fada	63	8	71	03	68	-
GyataAure	56	4	60	01	54	05
Total	119	12	131	04(3%)	122(93%)	05(4%)

Source: Field survey, 2017

This section presents and analyses the data that were collected through the imageries in the study area.

4.2 Changes in Land Use/ Land Cover (2000-2016)

Table 9: Land Use/Land Cover (LULC) classification and Area Extent change between 2000 and 2016 in Donga

LULC classes	2000	%	2012	%	2016	%
	Area (Km ²)		Area (Km ²)		Area (Km ²)	
WATER BODY	20.7368	0.6	20.6352	0.6	18.1443	0.5
BUILTUP AREA	34.3099	1	83.8213	2.4	172.0121	5.1
VEGETATION	1770.9421	51.7	1496.7472	43.7	1229.8279	35.9
BARELAND	1380.2624	40.3	1605.2726	46.9	1790.0948	52.3
ROCK	213.8568	6.4	213.6316	6.2	210.0288	6.2

OUTCROP						
TOTAL	3420.1080	100	3420.1080	100	3420.1080	100

Source: Authors, 2017 classified satellite imageries

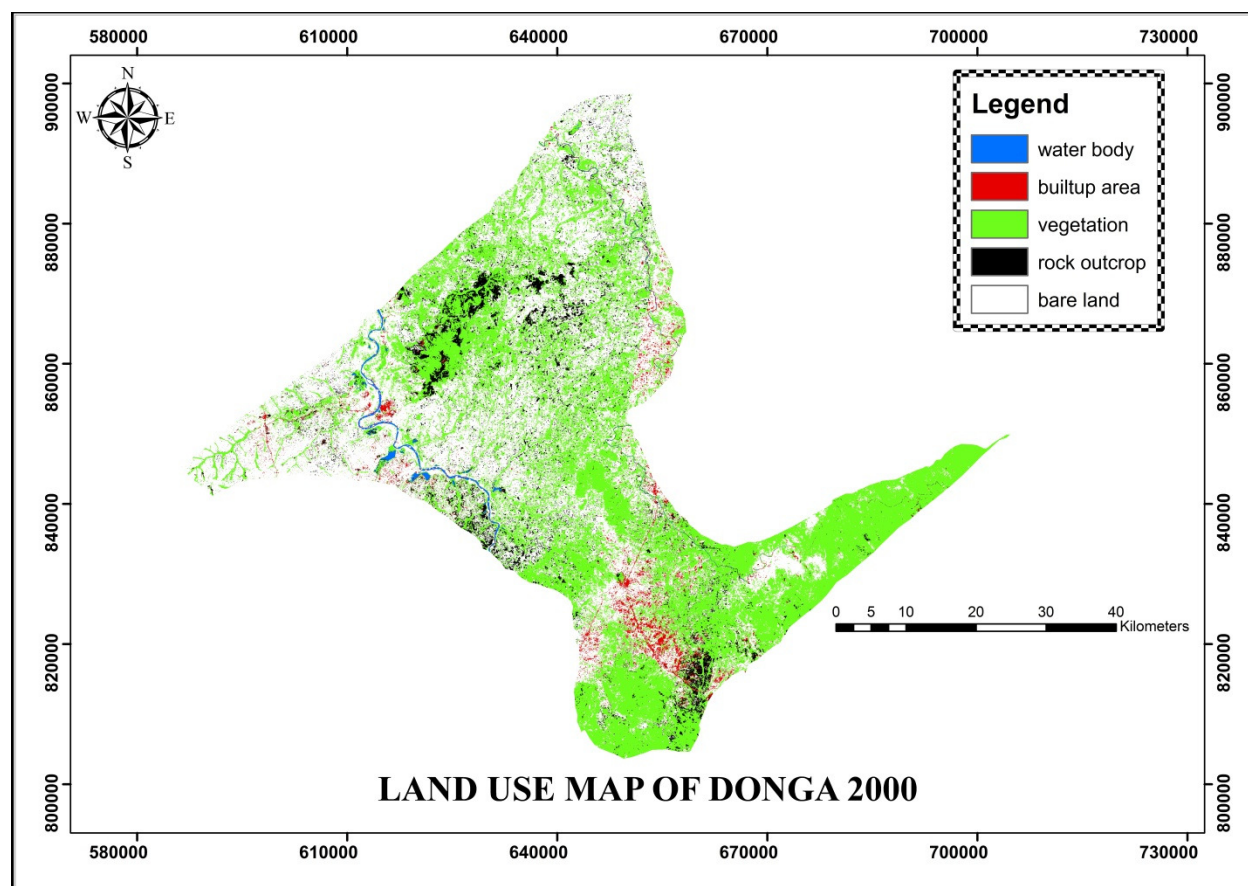


Figure 2a: Land use/cover status of Donga in 2000 (Based on Landsat Thematic Mapper Satellite Imagery).

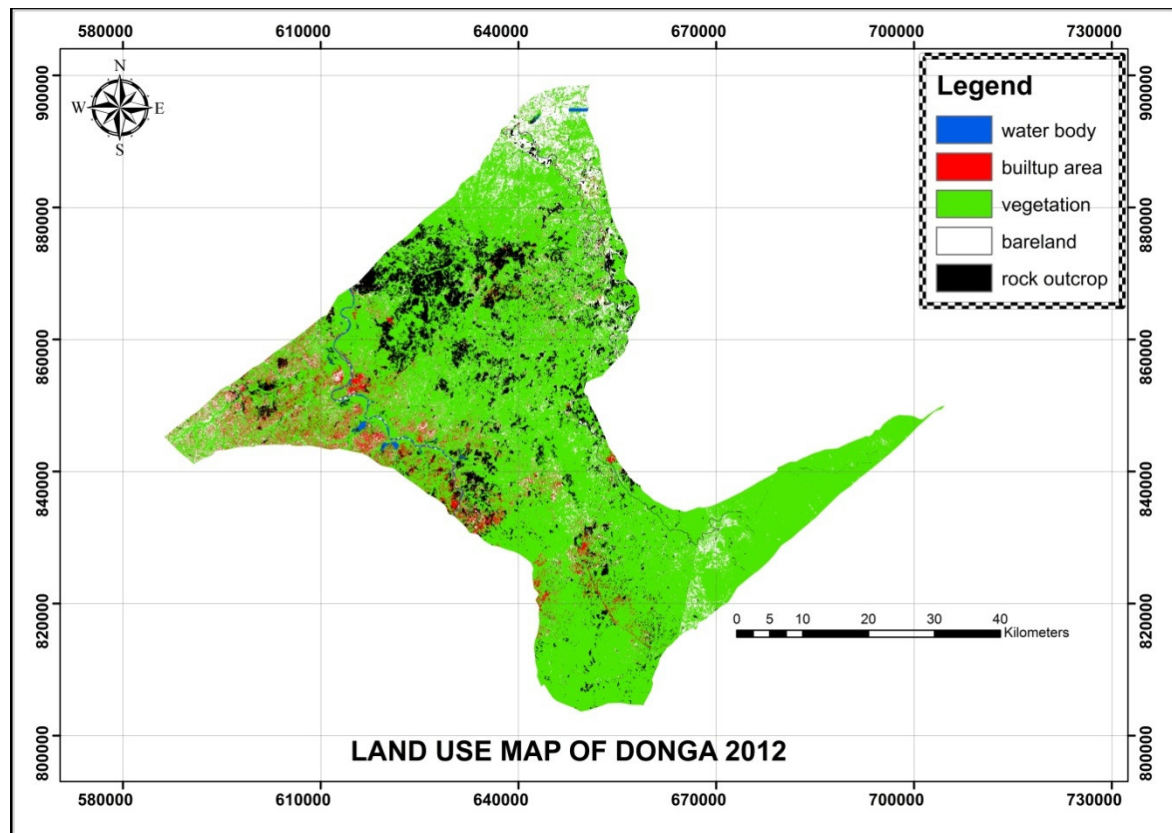


Figure2b: Land use/cover status of Donga in 2012 (Based on Landsat Thematic Mapper Satellite Imagery).

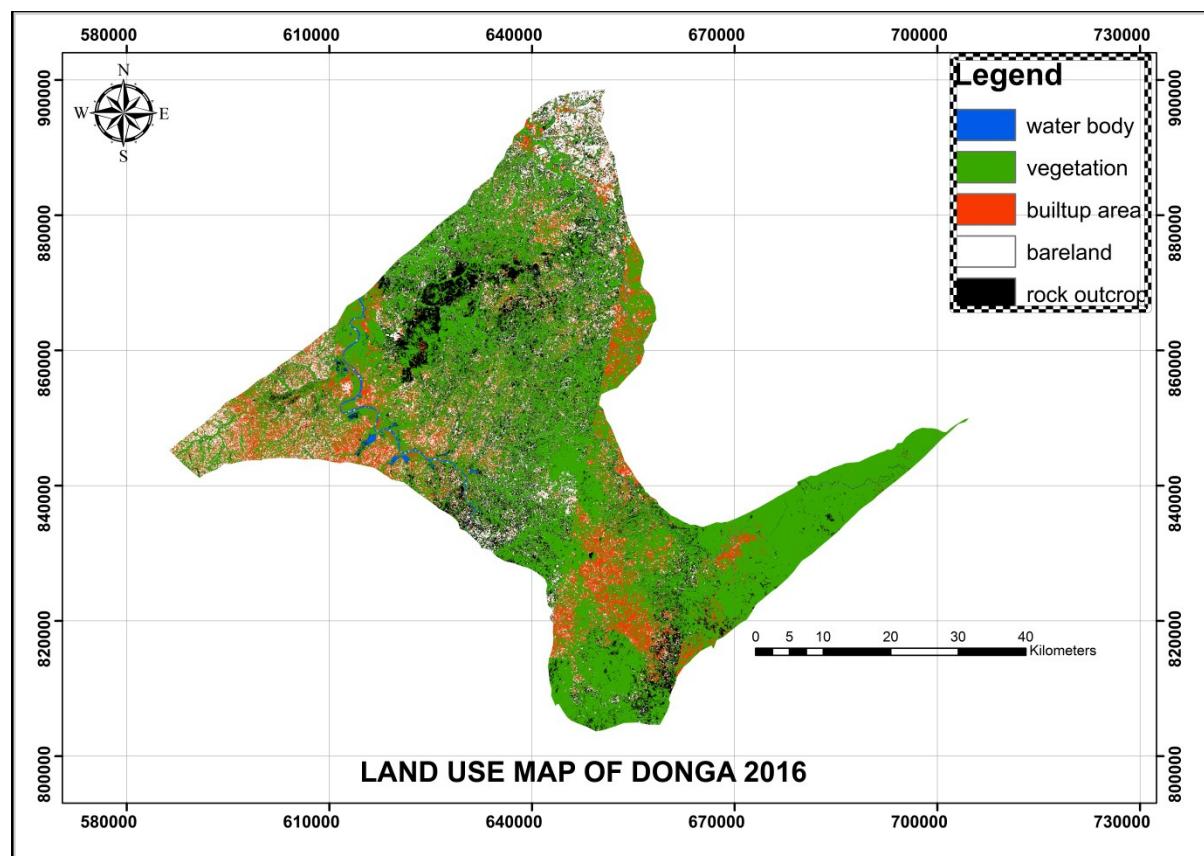


Figure 2c: Land use/cover status of Donga in 2016 (Based on Landsat Thematic Mapper Satellite Imagery).

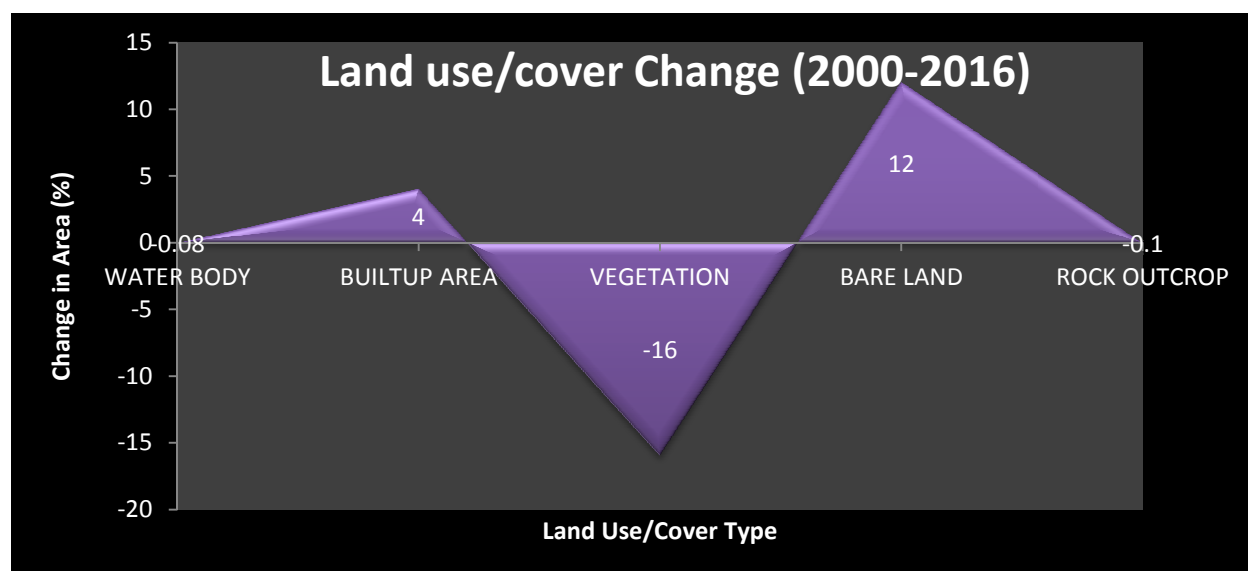


Figure 3: Diagrammatic illustration of land use/land cover change in percent between (2000 and 2016) in Donga

Table 10: Area and total change in land use/land cover categories in Donga during the year 2000-2016.

LANDUSE	2000(Km ²)	2016 (Km ²)	CHANGE(Km ²)	%
WATER BODY	20.7368	18.1443	-2.5924	-0.0800
BUILTUP AREA	34.3099	172.0121	+137.7021	4.0000
VEGETATION	1770.9421	1229.8279	-541.1142	-16.000
BARE LAND	1380.2624	1790.0948	+409.8324	12.000
ROCK OUTCROP	213.8568	210.0288	-3.8279	-0.1000
TOTAL	3420.1080	3420.1080	0.0000	0.0000

Source: Authors' Data Analysis

273 Table 11: The magnitude, percentage and annual rate of change in Donga (2000-2016)

LANDUSE	2000(Km ²)	2016 (Km ²)	CHANGE(Km ²)	%	Annual rate of change	Remark
WATER BODY	20.7368	18.1443	-2.5924	-0.0800	0.1620	Negative
BUILTUP AREA	34.3099	172.0121	+137.7021	4.0000	8.6064	Positive
VEGETATION	1770.9421	1229.8279	-541.1142	-16.000	33.8196	Negative
BARE LAND	1380.2624	1790.0948	+409.8324	12.000	25.6145	Positive
ROCK OUTCROP	213.8568	210.0288	-3.8279	-0.1000	0.2392	Negative
TOTAL	3420.1080	3420.1080	0.0000	0.0000	0.0000	

274

275 **Source:** Authors' Data Analysis

276 In this research, the imageries of 2000, 2012, and 2016 were evaluated and the obtained data

277 depicting the changes involved are summarized as follow:

278 4.3 Changes in Land Use/ Land Cover, 2000-2016

279 During this period, the built-up area increased by 137.7021 Km² (4%) with an annual rate of

280 change of 8.6064 Km². The bare land also increased by 409.8324 Km² (12%) This increased

281 were lost from the vegetal cover. Vegetal cover thus, lost as much as 541.1142 Km² (16%) with

282 annual rate at 33.8196 Km². There is also change in the rock outcrop of about 3.8279 Km²

283 (0.1%) with an annual rate of 0.2392 Km². The least change was in water body with decrease of

284 about 2.5924 Km² (0.08%) having annual rate of change of about 0.1620 Km² (Table 11). The

285 change trends are also graphically presented in figure 3.

286

287

5. Conclusion and Recommendation

major observation in this research shows that there has been a continuous increase in flooding. The study reveals that the major land use in the study area is vegetation. The area under vegetation has decreased by 16% (541.1142 Km²) due to logging and construction purposes.

Construction of Donga bridge and rural roads by the Danbaba Danfulani Suntai administration with accumulation of income opportunities, and facilities along the road head were found as pull factors leading to increase in built up area. Closely follow to this is the bare land. Bare land area account for about 12% (409.8324 Km²). This has increased due to expansion of Donga town area, conversion in vegetation to agriculture and some serious mining of granite for road construction. During the study period i.e (2000-2016), built up area has increased by 4% (137.7021 Km²) due to mainly the expansion of the Donga town area. As the amount of vegetation decreases and density of development increases, especially as the nation diversifies now, there is likelihood of increased erosion and flooding. The land covers are natural resources, natural biofilters, and erosion stabilizers protecting the land from direct punch of rainfall, reducing the sedimentation load and runoff that would have find their course unto the river consequently leading to flooding.

Land use affects land cover and changes in land cover affect land use so change from the inception of oil mania to realization of agricultural prospect has implication. Based on the interview conducted, 93% of the respondents are attestants to the fact that flooding is on the increase and 47% affirmed that increase in rainfall intensity is the major cause. Even though only 8% of the respondents adduced flooding to change in land use and land cover, the analyzed imageries show that between the spaces of 16 years, the present built up area is fifth times of the capture in the year 2000 and that 16% of the vegetation cover has disappeared for other use. The understanding of the intricacy of nature and the influence of land use and land cover change on the farming community is of necessity, more especially as the climate change and the government look inward to divert from mono economy. The dependency on land and land cover could increase in order to get out of this present recession as agricultural sector top the recovering agenda in the Nation.

Chief message from this paper is that land use is fast changing and will increasingly affect the landscape and consequently increase vulnerability of the downstream users of the state. The more devastation the landscape is, the higher the likelihood of irreversible and grave damage to human and ecological system downstream. A replay of incidence after independence in 1960 is inevitable: the case where the country aggressively pursued economic growth by promoting agriculture in all the geopolitical regions in the Nation. Regional agriculture was then the pivot of economic growth as each of the then four regions exploited its comparative advantage: the south west in cocoa, the south east in palm produce and the North in groundnut. Before the oil boom of the 1970s agriculture played a major role in GDP in both aggregate and per capita terms throughout the decades (Hyacinth, et al.2012) but then, there were no if at all incidence of flooding. This of course, can be attributed to limited impact on the environment by the few populaces. LULC change could have important role in climate change leading to flooding. The unplanned logging (deforestation) and development (encroachment) along the river bank will impacts on the catchments and may further aggravate environmental degradation in a long run. The saying that Agricultural sector will be the panacea to getting us out of the present economic recession and even create a more stable and sustainable economic development is a welcome idea, but there should be check and balances. The poor community farmers in Philippines have deconstructed the oppositional thinking inherent in the conventional literature: if one is poor, then one degrades. The poor, unemployed and the rural farmers can be positive agents of environmental sustainability. Robin, (1994), gave scenarios and conditions where wise use of land can be put in place despites innumerable socio-economy lag, depression or hardship.

References

- Adelalu, T.G., Benjamin, E.B., Garba, A. H. and Wuyep, S. Z.(2012). Climate Induced Crisis: A Case Study of Ibi Skirmish Aftermath of 2012 Flooding. Doi: 10.5539/jgg.v7n2p97.
- Ademiluyi, I.A., Okude, A.S and Akanni, C.O (2008). An appraisal of land use and Land cover mapping in Nigeria. Africa Journal of Agriculture Research Vol. 3 (9) .pp581-586. Available online at <http://www.academicjournals.org/AJAP>
- Adeniyi, P.O (1984). Land use and Land cover Inventory in Nigeria, Nigeria Geography Journal 27 (1 &): 113-130.

- 345 Adepoju, M.O., Millington, A.C., Tansey, K.T.(2006). Land Use/ Land Cover Change Detection
346 in Metropolitan Lagos (Nigeria): 1984-2002, American Society for Photogrametry and
347 Remote Sensing, Annual Conference, Reno, Nevada, May 1-5.
- 348 Areola, O. (1977). Aerial Photo-Interpretation of Land types and Terrain conditions in Lagos
349 Coastal Region, Nigeria Geography Journal. 20 (1): 70-84.
- 350 Bhawana, K. C (2015). Land Use and Land cover change in relation to internal migration and
351 human settlement in the middle Mountain of Nepal. Thesis submitted to the Faculty of
352 Geo-Information Science and Earth Observation of the University of Twente. Pp 66.
- 353 Bradshaw, C. J., Sodhi, N.S., Peh, S.H and Brook, B.W. (2007). “Global evidence that
354 deforestation amplifies flood risk and severity in the developing world” Global Change
355 Biology, Vol.13, Pp2379-2395.
- 356 iong, J. (2011). Changing Pattern of Land Use in the Calabar River Catchment, Southeastern
357 Nigeria, Journal of Sustainable Development. Retrieved from www.ecsenet.org/jsd
358 [April 16 2017](#).
- 359 Emmanuel, A. Y.(2014). The Socio-Economic Effect of 2012 flood in Ibi Local Government
360 Area, Taraba State. An unpublished Bsc. Project submitted to the Department of
361 geography, Taraba State University, Jalingo, Nigeria.
- 362 Fasona, M.J, Omojola, A.S (2005). Climate Change, Human Security and Communal Clashes in
363 Nigeria. Paper Presented at an International Workshop on Human Security and Climate
364 Change, Asker, Norway, 21-23 June 2007
- 365 Fernando, J. (2007). Estimating and Modeling Soil Loss and Sediment Yield in the Maracas. St
366 Joseph River Catchment with Emperical Models (RUSLE & MUSLE) and a Physical
367 Based Model. An M. Sc thesis submitted to Civil and Environmental Engineering
368 Department, McGill University, Montreal.
- 369 EL Gammal, E.A., Salem, S.M., EL Gammal, A. E.A.(2010). Change detection studies on the
370 world’s biggest artificial lake (Lake Nasser, Egypt). Egypt. Journal Remote Sensing
371 Space Science. 13, 89-99.

- 372 Hersperger, A.M., Gennaio, M., Verburg, P.H. (2010). Linking Land Change with Driving
373 Forces and Actors: Four Conceptual Models, Ecology and Society, 15 (4) .
- 374 Hussien, A. O (2009). Land Use and Land Cover Change, Drivers and its impact: A Comparative
375 study from Kuhar Michael and Lenche Dima of Blue Nile and Awash Basins of
376 Ethiopia. Msc. Thesis, Graduate School of Cornell University, Ethiopia.
- 377 Hyacinth, E.I., Chukwuma, A., John, E.O.A. (2012). What do we know about pro-poor growth
378 and regional poverty in Nigeria? International Journal of Economic Sciences and Applied
379 Research 5 (3): 147-172
- 380 Ikusemoran, M, and Olokor J.O(2014) Monitoring the Land-Use and Vegetation Cover Changes
381 in the Kainji Lake Basin, Nigeria. Africa Journal of Environmental Science and
382 Technology. Vol. 8(2), pp129-142.
- 383 Ileoje, N. (1981). A New Geography of Nigeria, Ibadan, Longman, Nigeria Ltd.
- 384 IMF, (1993). International Monetary Fund Survey, June, 1993, P187.
- 385 Inger, A., Qusmane, D., Martha, J., Holder, J.C (2005). “The Niger River Basin” Retrieved from
386 [www.revolvy.com/topic/Donga River May 18 2017](http://www.revolvy.com/topic/Donga+River)
- 387 Jack, H. (2013). How Nigeria’s vortex of violence is being driven by climate change and
388 desertification . RTCC- Response to climate Change Magazine.
389 <http://www.rtcc.org/magazine/rtcc2013.pdf>
- 390 Jijingi, H.E, Yuguda, T.K, Dauda, P.A. (2016). An Assessment of Changes in Land-Use and
391 Land-Cover within the Kiri Lake, Nigria (1976-2014). International Journal of
392 Engineering Research, Vol.No.5, Issue No.7, pp 606-609. Doi: 10.17950/ijer/v5s7/713
- 393 Lambin, E. F and Geist, H.J (Eds). (2006). The IGBP Springer-Verlag, Berlin, 222pp. (A
394 Synthesis of LUCC science).
- 395 Malthus, T. R. (1798).On Population (First essay on population). Reprint, Modern Library for
396 Random House, NewYork.

- 397 Muttitanon, W. and Tripathi, N.K. (2005). “ Land use/land Cover Changes in the Coastal Zone
398 of Ban Don Bay, Thailand using Landsat 5 TM data. “ International Journal of Remote
399 Sensing 26 (11): 2311-2323.
- 400 Naibbi, A.I., Baily, B., Healey, R.G. and Collier, P. (2014). Changing Vegetation Patterns in
401 Yobe State, Nigeria: an Analysis of the Rates of Change, Potential Causes and the
402 implications for Sustainable Resources Management, International Journal of 826, 754
403 Geoscience. Retrieved from <http://www.script.org/journal/ijg>
- 404 Oladipo, E. (2010). Towards Enhancing the Adaptation Capacity of Nigeria: A review of the
405 Country’s state of preparedness for Climate Change Adaptation.
- 406 Olokor, J.O (1995). The Climate of Gongola Lake Area. Annual Report of the Federal Ministry
407 of Agriculture, Water Resources and Rural Development. National Institute for
408 Freshwater Fisheries Research.
- 409 Oyatayo, K.T., Songu, G.A., Adi, T.A., Abuh, P.O., and Ndabula, C. (2015). Assessment of
410 people’s awareness and perception of flooding in Donga Town, Taraba state, Nigeria.
411 International Conference & Annual General Meeting of the Nigerian Meteorological
412 Society held on 23rd – 26th Sokoto, Nigeria.
- 413 Pooja, K., Kumar, M., Rawar, J.S. (2012). Application of remote sensing and GIS in Land use
414 and land cover change detection: a case study of Gagas Watershed, Kumaun Lesser
415 Himalaya. India. Quest. 6 (2), 342-345.
- 416 Robin, B. (1994) The Poor and the Environment: Friends or Foes? Elsevier Science Ltd. World
417 Development, Vol.22, No. 6, pp.811-822.
- 418 Soini, E (2006). Livelihood, Land Use and Environment Interactions in the highlands of East
419 Africa. Academic Dissertation submitted to Department of Geography Faculty of Science
420 University of Helsinki.
- 421 Yitaferu, B. (2007). Land Degradation and Options for Sustainable Land Management in the
422 Lake Tana Basin (LTB), Amhara Region, Ethiopia. PhD. thesis, Centre for
423 Development and Environment, University of Bern, Switzerland.

- 424 Yuan, F., Sawaya, K.E., Loeffelholz, B., Bauer, M.E., (2005). Land cover classification and
 425 change analysis of the Twin Cities (Minnoesota) Metropolitan Area by multitemporal
 426 Landsat remote sensing. Remote sensing Envi.98, 317-328.
- 427 Zemba, A. A (2009) Assessment of Changes in Land use and Development of Urban Heat Island
 428 in Jimeta- Yola. An Unpublished PhD. thesis submitted to Department of Geography,
 429 School of Environmental Sciences, Federal University of Technology, Yola.